Site Characterization/ Remedial Investigation Work Plan
for
Former TRW Union Springs Facility – Off-site

March 2018

Site ID C706019A
Union Springs, NY 13160
Cayuga County, New York

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1.0 INTRODUCTION

1.1 Background

This document details the investigation that will be conducted for the Former TRW Union Springs Facility – Off-site, Site ID C706019A (the off-site areas). It pertains to the remedial program for areas surrounding the Former TRW Union Springs Facility which may be impacted by contamination from the facility.

The Former TRW Union Springs Facility, Site C706019 (the Site) is undergoing a remedial program which is being conducted by TRW Automotive U.S., LLC (TRW) (a past owner and operator of the facility) through the Brownfield Cleanup Program (BCP) with oversight by the New York State Department of Environmental Conservation (Department) and the New York State Department of Health (NYSDOH). The Site is located at 13 Salem Street in the Village of Union Springs, Town of Springport, Cayuga County, New York.

In 2015 TRW applied to the BCP as a Volunteer, and its application was approved by the NYSDEC on November 24, 2015. A Brownfield Cleanup Agreement (BCA) was executed between TRW and the Department on January 7, 2016. The NYSDEC determined the Former TRW Union Springs Facility, Site C706019, presented a significant threat to public health and the environment on December 30, 2016. The NYSDEC was unsuccessful in its attempts to compel potentially responsible parties to conduct the off-site remedial program. As such, the remedial program for the off-site areas is being conducted by the NYSDEC, through its consultant and contractors. If a potentially responsible party (PRP) is identified that is willing and able to conduct the remedial program for the off-site area, the PRP would complete the remedial program pursuant to a Consent Order.

1.2 Site Description

The area of concern subject to this work is considered off-site from BCP site C706019, Former TRW Union Springs Facility (the Site). The Site covers approximately 11.83 acres and is located at 13 Salem Street in the Village of Union Springs, Town of Springport, Cayuga County. Cayuga Lake is located approximately 500 feet west of the site. The site location is show on Figure 1 and the approximate bounds of the area currently included in the off-site area of potential interest is included as Figure 2.

On-Site Area

The Site is comprised of the entirety of two tax parcels and a portion of a third parcel. Lot 21 (Tax ID 141.09-1-21) is a 10.92-acre lot containing a 126,500-square foot building located in the central portion of the lot and the ruins of another building in the northwestern portion of the lot. Approximately one third of the parcel is covered in asphalt, including an employee parking lot to the south and east of the building; a shipping and receiving parking lot to the north of the building; an access road to the north of the building (which is connected to/an extension of Howland Street); and an access road to the west of the building (which is connected to/an extension of Creamery Road). The western edge of the site, to the west of Creamery Road, consists of a vegetated lawn area which is utilized as part of a public park. The northern portion of the site is covered by a vegetated lawn area, except for the northwest corner of the site, which is wooded. Lot 21 is owned by LPW Development, LLC.

Lot 22.1 (Tax ID 141.09-1-22.1) is a 0.19-acre parcel located at the end of Salem Street that contains an asphalt paved access road that runs north and south along the east end of the on-site building. It is also owned by LPW Development, LLC.

The Site also encompasses a 0.72-acre portion of Lot 22.2 (Tax ID 141.09-1-22.2). Lot 22.2 is an approximately 8.9-acre parcel located east of Lot 21. Lot 22.2 is owned by the Village of Union Springs and contains an approximately 5.8-acre spring-fed pond (referred to as the mill pond). The mill pond is formed by a manmade earthen embankment along the west end of the pond. The upland portion of the lot around the mill pond is covered by vegetation. The Site encompasses the western end of Lot 22.2, extending approximately 85 feet from the western boundary of Lot 22.2 to the crest of the earthen embankment along the western end of the mill pond.

A former canal is located in the northern portion of Lot 21. It runs east and west and discharges to Cayuga Lake approximately 500 feet west of the site boundary. The former canal is a Class C waterbody and the adjacent portion of Cayuga Lake is a Class A waterbody. The eastern end of the former canal was filled prior to 1954 and possibly by 1938.

Off-site Areas

To the west, the Site is bounded by the Village of Union Springs wastewater treatment plant (WWTP), a public park, and a portion of a surface waterbody referred to as the former canal, with Cayuga Lake beyond. The park, Frontenac Park, includes a large lawn area, playground, baseball/softball field, basketball court, picnic pavilion, a beach, and a swimming area. The former canal also extends onto the Site.

To the east, the Site is bounded by Salem Street, residential properties, an unnamed stream, which also crosses part of the on-site area, and the mill pond. The mill pond discharges to the unnamed stream via a culvert near the northwest corner of the pond. The unnamed stream discharges to the former canal, which in turn, is connected to Cayuga Lake, approximately 500 feet west of the Site. The unnamed stream and the former canal are Class C waterbodies and the adjacent portion of Cayuga Lake is a Class A waterbody.

To the north, the Site is bounded by several vacant parcels, which contain a wetland area, beaver pond, and portions of the unnamed stream.

To the south, the Site is bounded by residential properties and Chapel Street.

The off-site area has been divided into four operable units. An operable unit represents a portion of a remedial program that for technical or administrative reasons can be addressed separately to investigate, eliminate or mitigate a release, threat of release or exposure pathway resulting from the site contamination. Operable unit 1 (OU1) is the Mill Pond Parcel; OU 2 is the Southeastern Parcel (which is a parcel located on the southeast corner of Green Street and Salem Street); OU 3 is the WWTP Parcel; and OU 4 consists of all Other Off-site Areas. The areas of potential concern are identified on Figure 3.

1.3 Current Zoning and Land Use

On-site Area

Lot 21 is currently zoned for commercial use, and is currently leased by MacKenzie-Childs, LLC, and Jay Strongwater, LLC who use the facility for warehousing; shipping and receiving; assemblage and production of home goods, decor and accessories; and associated administrative offices. Lots 22.1 and 22.2 are currently vacant, and are zoned for residential use.

Off-site Areas

The WWTP parcel is zoned for Commercial use and the park parcel is zoned as a Park. Most of the residential parcels to the east, south and southeast of the Site are zoned Neighborhood Commercial. The mill pond parcel is zoned Residential, and the parcels to the north of the Site are zoned Agricultural/Residential.

1.4 Past Use of the Site

On-site Area

The on-site area has been used for industrial purposes since at least the 1830s, and possibly as early as 1789. Reportedly, the spring was dammed and the pond created in 1789, with a grist mill having been developed at the time, which was later abandoned. Another grist mill was developed in the 1830s. The mill was connected to Cayuga Lake by the former canal which extended across the northern portion of the site. Additional facilities were developed on-site through the years, including a saw mill, a plaster mill, a cooper shop, and a coal yard. The on-site facility was serviced by rail spurs from at least 1887 until at least 1911.

The facility was used for manufacturing electrical components for the automotive industry from 1932 until 1997. The following companies owned and operated the site during that time period: General Products Corporation and Guaranteed Parts Company 1932-1962; Gulf & Western, Inc. 1962-1985; Wickes Manufacturing Company 1985-1990 (Wickes); and TRW, Inc. 1990-1997. The on-site area and portions of the off-site area were sold to LPW Development, LLC (LPW) in 1997, which has leased the facility to various manufacturing and commercial tenants since. In 2012, LPW sold the mill pond parcel to the Village of Union Springs.

The southern end of the on-site area formerly contained a small woodworking shop, foundry and machine shop at various times from the late 1800s through at least 1938.

The on-site industrial usage has resulted in contamination of on-site areas. Prior investigations have identified disposal areas in the northern portion of the site and in the filled portion of the former canal. There was also formerly a drum storage area in the northeastern portion of the site. Known contaminants which are present at the site that are associated with past industrial operations and/or past disposal include trichloroethene (TCE) and its degradation products, polychlorinated naphthalenes (PCNs), pesticides, and petroleum.

Numerous investigations have been conducted on-site since 1992 and have resulted in certain remedial actions being conducted.

A spill of TCE was reported on-site in 1988 (spill 8801317). Impacted soil was excavated and removed, but contamination remained. In 1989 it was reported that TCE had been disposed on-site 20 years prior (spill 8808131).

In 1989 two underground fuel oil storage tanks, measuring 15,000 gallons and 20,000 gallons, were removed from the on-site area.

In 1992, an investigation was conducted which focused mainly on the northern portion of the on-site area. The investigation identified TCE and petroleum contamination. Based on that investigation, excavations were conducted in 1993. Certain areas of contaminated soil were excavated and disposed off-site, while other areas were excavated, mechanically processed to promote volatilization of contaminants, and then reused on-site.

Additional investigations were conducted between 1997 and 2015, which were focused largely on delineation of the TCE impacts in the northern portion of the site. An investigation in 2013 also identified contamination by PCNs.

From 1998 to 2003 a dual-phase extraction system was operated to remove contaminated groundwater and vapor. The system removed contaminated groundwater and vapor from the subsurface. It was decommissioned in 2003 or 2004. In 2004 a groundwater extraction and treatment system was installed and operated for a period of time, and then was replaced by a groundwater interceptor trench. The trench was installed in 2004 to prevent TCE-contaminated groundwater, which was periodically discharging to the ground surface, from entering the storm sewer and subsequently the former canal. In 2005 and 2007 injections of sodium permanganate were conducted to treat the contaminated groundwater in-situ through chemical oxidation. The interceptor trench, and the associated groundwater extraction and treatment system, is still in operation. Treated groundwater is discharged to the Village of Union Springs wastewater treatment plant.

TRW is conducting the remedial investigation for the Site. Field work for the on-site investigation began in January 2016 and the latest investigation field activities were conducted in September 2017.

Off-site Areas

The WWTP parcel was formerly owned by the owner/operator of the Site. One vacant residential parcel to the southeast of the Site, located on the southeast corner of the intersection of Green Street and Salem Street, is and was owned by the current and past owners/operators of the Site. This parcel will be referred to as the Southeastern Parcel. Portions of the park are believed to have been used for commercial/industrial purposes in the past, but not necessarily associated with operations at the Former TRW Union Springs Facility.

1.5 Geology and Hydrogeology

A summary of information obtained from past investigations is included here. For further information regarding the geology of the Site and surrounding area, refer to the Remedial Investigation Work Plan for the Site, dated December 2015, which was prepared by ERM Consulting and Engineering, Inc. (ERM) on behalf of TRW, and approved with modifications by the Department on February 25, 2016.

The geology of the area is characterized by glacial and lacustrine (lake) deposits underlain by bedrock, reported to be Coeymans and Manlius limestone of the Helderberg Group, which is reported to have interbedded layers of sandstone and shale.

The geology of the site was characterized by prior investigations, with four soil units identified. The top unit is fill. The fill is underlain by a silty sand layer ranging from three to 22 feet thick, which is underlain by a silt and clay layer which contains sand lenses.

The silt and clay layer ranges from seven to 23 feet thick. A discontinuous sand and gravel layer up to five feet thick was encountered across much of the site, and is underlain by a sandy glacial till.

Bedrock at the site is a grayish brown limestone which was present at depths ranging from 43 to 71 feet below the ground surface. In one of the three bedrock wells, a layer of black shale approximately 9.5 feet thick was encountered beneath approximately 23 feet of limestone. The shale was underlain by grayish brown limestone at least 20 feet thick.

Overburden groundwater flow across the site is generally from east to west, towards Cayuga Lake, and that is the anticipated generalized groundwater flow direction for the off-site areas. However, localized shallow overburden groundwater flow direction varies on-site. Groundwater flow across the northernmost end of the site appears to be to the north, towards the unnamed creek. In the vicinity of the former canal, groundwater flow is towards the canal. It is anticipated shallow groundwater flow in the off-site areas would be similarly divided. Groundwater flow in the off-site areas will be further refined as more data become available.

Groundwater in the deeper overburden on-site exhibits an upward flow tendency, which is consistent with conditions noted in bedrock. Bedrock groundwater was noted to be under artesian conditions.

Groundwater was encountered on-site at depths ranging from less than one foot below grade to approximately 11 feet below grade.

2.0 INVESTIGATION ACTIVITIES

Investigation activities will be conducted for the off-site areas based on consideration of the results of the on-site investigation and other historical information.

The planned sampling locations are summarized in the attached figures and tables. The protocol to be followed are included in the Field Activities Plan, Quality Assurance Project Plan and Health and Safety Plan, prepared by the Department's consultant, which are also attached. Modifications to the generic plans are included in the attached sampling protocol for perfluorinated compounds (PFCs) which will be followed for all samples that include PFC analysis and on all days that include sampling for PFCs.

2.1 Surface and Shallow Soil Sampling

Surface and shallow soil samples will be collected from areas adjacent to areas of the Site where surface or shallow soil contamination was identified, and from areas where other historical information indicates a need for data. Surface samples will be collected from 0-2 inches below the vegetative layer for all parameters except volatile organic compounds (VOCs), which will be collected from 0-6 inches. Shallow samples will be collected at depths up to 24 inches below grade. It is anticipated all surface and shallow soil samples will be collected manually (e.g., with trowels and/or hand augers). Figure 4 shows the location of the planned surface and shallow soil samples and Table 1 includes a summary of the analytical parameters for each sample. Sampling locations may be modified based on field conditions (e.g., location of drainage pathways, etc.).

2.2 Subsurface Soil Sampling

Subsurface soil samples will be collected from areas where off-site subsurface contamination is known or suspected based on the on-site investigation, and from areas where other historical information indicates a need for data. Subsurface soil samples will be collected from soil borings which will be installed by a direct push drill rig and/or a hollow-stem auger drill rig with two-foot split spoon sampler. Figure 5 shows the location of the planned off-site soil borings and Table 2 includes a summary of the soil analytical parameters for each boring. Boring locations may be modified based on field conditions (e.g., subsurface utilities, etc.). Actual sample depths will be determined during boring installation.

2.3 Monitoring Well Installation and Groundwater Samples

Groundwater monitoring wells will be installed in locations where off-site subsurface contamination is known or suspected based on the on-site investigation, and from areas where other historical information indicates a need for data. Monitoring wells will be constructed of 2-inch diameter schedule 40 PVC, with a 0.010-inch slot screen. Screen lengths will be based on conditions encountered and will range from 2-5 feet for non-groundwater table wells, and will be 10 feet long for groundwater table wells.

It is anticipated two rounds of sampling will be necessary for most wells and most parameters. The analytical parameters for the second round of sampling may be adjusted based on the results of the first round.

Monitoring wells will be installed at the locations shown on Figure 5, and Table 3 includes a summary of the planned groundwater samples.

2.4 Sediment and Surface Water Sampling

Sediment and surface water samples will be collected at locations where off-site subsurface contamination is known or suspected based on the on-site investigation, and from areas where other historical information indicates a need for data.

Sediment samples will be collected utilizing a hand-driven lexan core, or similar. Sediment samples will be collected from 0-6 inches, 6-12 inches and from each subsequent foot of recovered sediment. Surface water samples will be collected for the same parameters as its co-located sediment sample. Surface water samples will be collected prior to sediment sampling. Sediment samples will be collected from downstream locations prior to upstream locations.

Figure 6 shows the planned sediment and surface water sampling locations and Tables 4 and 5 includes a summary of the analytical parameters for each sediment and surface water location, respectively. Sampling locations may be modified based on field conditions.

2.5 Soil Vapor Intrusion Sampling

Sub-slab vapor, indoor air and outdoor air samples were collected by the Department in January 2018 at several nearby properties to evaluate the potential for soil vapor intrusion. The samples were collected prior to completion of this document in order to ensure the samples could be collected during the heating season.

2.6 Investigation-Derived Waste

All drill cuttings, sediment cores, and purged water will be containerized, characterized and disposed of properly.

2.7 Reporting

A report of the findings will be prepared by the Department's consultant and will include figures showing all sampling locations and other pertinent information, data tables, field sampling logs, laboratory deliverables (electronic only), data usability summary reports, a summary of the cost of the investigation, and proof of proper disposal of all investigation-derived waste.

For OU 1 – Mill Pond Parcel, OU 2 – Southeastern Parcel and OU 3 – Wastewater Treatment Plant, the report will be consistent with a Site Characterization Report and will identify if a full remedial investigation is needed; unless that determination is made during the course of the investigation activities, in which case the report will be a full remedial investigation report. For OU 4 – Other Off-site Areas, the report will be a remedial investigation report. A feasibility study/alternatives analysis will also be completed which will address each operable unit for which a remedial investigation is completed.

Table 1 - Surface and Shallow Soil Analytical Parameters

Area	OU	Sample Type	Sample ID	Analytical Parameters										Purpose
				VOCs	SVOCs	PCNs	Pests	PFCs	Metals	Cd	Cr	Cu	Mn	
East	01	Surf Soil	SS-01-0-0.2	0	0	1	1	0	0	1	0	1	1	Delineate Pests, PCNs, Some Metals
East	01	Shall Soil	SS-01-0.2-1	0	0	1	1	0	0	1	0	1	1	Delineate Pests, PCNs, Some Metals
East	01	Shall Soil	SS-01-1-2	0	0	1	1	0	0	1	0	1	1	Delineate Pests, PCNs, Some Metals
East	04	Surf Soil	SS-02-0-0.2	0	0	1	1	0	0	1	0	1	1	Delineate Pests, PCNs, Some Metals
East	04	Shall Soil	SS-02-0.2-1	0	0	1	1	0	0	1	0	1	1	Delineate Pests, PCNs, Some Metals
East	04	Shall Soil	SS-02-1-2	0	0	1	1	0	0	1	0	1	1	Delineate Pests, PCNs, Some Metals
SE Parcel	02	Surf Soil	SS-03-0-0.2	1	1	1	1	1	1	0	0	0	0	Assess for all COCs
SE Parcel	02	Shall Soil	SS-03-0.2-1	1	1	1	1	1	1	0	0	0	0	Assess for all COCs
SE Parcel	02	Shall Soil	SS-03-1-2	1	1	1	1	1	1	0	0	0	0	Assess for all COCs
SE Parcel	02	Surf Soil	SS-04-0-0.2	1	1	1	1	1	1	0	0	0	0	Assess for all COCs
SE Parcel	02	Shall Soil	SS-04-0.2-1	1	1	1	1	1	1	0	0	0	0	Assess for all COCs
SE Parcel	02	Shall Soil	SS-04-1-2	1	1	1	1	1	1	0	0	0	0	Assess for all COCs
Park	04	Surf Soil	SS-05-0-0.2	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Shall Soil	SS-05-0.2-1	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Shall Soil	SS-05-1-2	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Surf Soil	SS-06-0-0.2	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Shall Soil	SS-06-0.2-1	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Shall Soil	SS-06-1-2	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Surf Soil	SS-07-0-0.2	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Shall Soil	SS-07-0.2-1	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Shall Soil	SS-07-1-2	0	1	1	0	0	0	0	0	0	0	Delineate SVOCs, PCNs
Park	04	Surf Soil	SS-08-0-0.2	0	1	1	0	0	0	0	1	0	1	Delineate SVOCs, PCNs, Cr, Mn
Park	04	Shall Soil	SS-08-0.2-1	0	1	1	0	0	0	0	1	0	1	Delineate SVOCs, PCNs, Cr, Mn
Park	04	Shall Soil	SS-08-1-2	0	1	1	0	0	0	0	1	0	1	Delineate SVOCs, PCNs, Cr, Mn
North	04	Surf Soil	SS-09-0-0.2	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs
North	04	Shall Soil	SS-09-0.2-1	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs
North	04	Shall Soil	SS-09-1-2	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs
North	04	Surf Soil	SS-10-0-0.2	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs
North	04	Shall Soil	SS-10-0.2-1	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs
North	04	Shall Soil	SS-10-1-2	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs
North	04	Surf Soil	SS-11-0-0.2	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs
North	04	Shall Soil	SS-11-0.2-1	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs
North	04	Shall Soil	SS-11-1-2	1	1	1	1	1	1	0	0	0	0	Assess for all site COCs

VOCs - target compound list (TCL) volatile orgranic compounds via EPA Method 8260
SVOCs - TCL semivolatile orgranic compounds via EPA Method 8270
PCNs - polychlorinated naphthalenes via EPA Method 8270 SIM
Pests - TCL pesticides via EPA Method 8081
PFCs - polyfluorinated compounds via EPA Method Modified 537
Metals - target analyte list metals via EPA Methods 6010/7471
Cd - cadmium via EPA Method 6010
Cr - chromium via EPA Method 6010
Cu - copper via EPA Method 6010
Mn - manganese via EPA Method 6010

Table 2 - Suburface Soil Analytical Parameters

Area	OU	Sample Type	Sample ID	Analytical Parameters VOCs	SVOCs	PCNs	Pests	PFCs	Metals	Purpose
SE Parcel	02	Sub Soil	MW-01D-XX-XX	1	1	1	1	1	1	Assess for all COCs
SE Parcel	02	Sub Soil	MW-01D-YY-YY	1	1	1	1	1	1	Vertical delineation
SE Parcel	02	Sub Soil	MW-02D-XX-XX	1	1	1	1	1	1	Assess for all COCs
SE Parcel	02	Sub Soil	MW-02D-YY-YY	1	1	1	1	1	1	Vertical delineation
North	04	Sub Soil	MW-03D-XX-XX	0	0	0	1	1	0	Complete suite minus MW-302 data
North	04	Sub Soil	MW-03D-YY-YY	1	0	0	1	1	0	Deeper sample for potential deeper issues
North	04	Sub Soil	MW-04S-XX-XX	1	0	1	1	1	1	Assess for all COCs
North	04	Sub Soil	MW-04S-XX-XX	1	0	1	1	1	0	Vertical delineation
North	04	Sub Soil	MW-05D-XX-XX	1	0	1	1	1	1	Assess for all COCs
North	04	Sub Soil	MW-05D-YY-YY	1	0	1	1	1	1	Vertical delineation
WWTP	03	Sub Soil	MW-06D-XX-XX	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-06D-YY-YY	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-07D-XX-XX	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-07D-YY-YY	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-08D-XX-XX	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-08D-YY-YY	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-09D-XX-XX	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-09D-YY-YY	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-10D-XX-XX	1	1	1	1	1	1	Assess for all COCs
WWTP	03	Sub Soil	MW-10D-YY-YY	1	1	1	1	1	1	Assess for all COCs

VOCs - target compound list (TCL) volatile orgranic compounds via EPA Method 8260
SVOCs - TCL semivolatile orgranic compounds via EPA Method 8270
PCNs - polychlorinated naphthalenes via EPA Method 8270 SIM
Pests - TCL pesticides via EPA Method 8081
PFCs - polyfluorinated compounds via EPA Method Modified 537
Metals - target analyte list metals via EPA Methods 6010/7471

Table 3 - Groundwater Analytical Parameters

Area	OU	Sample Type	Sample ID	Analytical Parameters: VOCs	SVOCs	PCNs	Pests	PFCs	Metals	Purpose
SE Parcel	02	GW	MW-01S	2	2	2	2	2	2	Assess for all COCs - 2 rounds
SE Parcel	02	GW	MW-01D	2	2	2	2	2	2	Assess for all COCs - 2 rounds
SE Parcel	02	GW	MW-02S	2	2	2	2	2	2	Assess for all COCs - 2 rounds
SE Parcel	02	GW	MW-02D	2	2	2	2	2	2	Assess for all COCs - 2 rounds
North	04	GW	MW-300	0	0	1	2	2	0	Complete suite minus MW-300 data - 2 rounds
North	04	GW	MW-03D	2	0	2	2	2	0	Assess for all site COCs - 2 rounds
North	04	GW	MW-04S	2	0	2	2	2	0	Assess for all site COCs - 2 rounds
North	04	GW	MW-05S	2	0	2	2	2	0	Assess for all site COCs - 2 rounds
North	04	GW	MW-05D	2	0	2	2	2	0	Assess for all site COCs - 2 rounds
WWTP	03	GW	MW-06S	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-06D	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-07S	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-07D	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-08S	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-08D	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-09S	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-09D	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-10S	2	2	2	2	2	2	Assess for all COCs - 2 rounds
WWTP	03	GW	MW-10D	2	2	2	2	2	2	Assess for all COCs - 2 rounds

VOCs - target compound list (TCL) volatile orgranic compounds via EPA Method 8260
SVOCs - TCL semivolatile orgranic compounds via EPA Method 8270
PCNs - polychlorinated naphthalenes via EPA Method 8270 SIM
Pests - TCL pesticides via EPA Method 8081
PFCs - polyfluorinated compounds via EPA Method Modified 537
Metals - target analyte list metals via EPA Methods 6010/7470

Table 4 - Surface Water Analytical Parameters

Area	OU	Sample Type	Sample ID	Analytical Parameters VOCs	PCNs	Pests	Metals	PFCs	Purpose
Mill Pond	01	SW	MP-SW-14	2	2	2	1	2	Assess for all site COCs - 2 rounds
Mill Pond	01	SW	MP-SW-15	2	2	2	1	2	Assess for all site COCs - 2 rounds
Mill Pond	01	SW	MP-SW-16	2	2	2	1	2	Assess for all site COCs - 2 rounds
Mill Pond	01	SW	MP-SW-17	2	2	2	1	2	Assess for all site COCs - 2 rounds
North	04	SW	BP-SW-18	2	2	2	1	2	Assess for all site COCs - 2 rounds
North	04	SW	BP-SW-19	2	2	2	1	2	Assess for all site COCs - 2 rounds
North	04	SW	BP-SW-20	2	2	2	1	2	Assess for all site COCs - 2 rounds
WWTP	03	SW	FC-SW-10	1	1	1	1	1	Assess upstream Former Canal for all site COCs
WWTP	03	SW	FC-SW-08	1	1	1	1	1	Assess for all site COCs
WWTP	03	SW	FC-SW-07	1	1	1	1	1	Assess for all site COCs
WWTP	03	SW	FC-SW-05	1	1	1	1	1	Assess for all site COCs
WWTP	03	SW	UnSt-SW-06	1	1	1	1	1	Assess for all site COCs
WWTP	03	SW	CL-SW-21	2	2	2	2	2	Assess for all site COCs

VOCs - target compound list (TCL) volatile orgranic compounds via EPA Method 8260
SVOCs - TCL semivolatile orgranic compounds via EPA Method 8270
PCNs - polychlorinated naphthalenes via EPA Method 8270 SIM
Pests - TCL pesticides via EPA Method 8081
PFCs - polyfluorinated compounds via EPA Method Modified 537
Metals - target analyte list metals via EPA Methods 6010/7470

Table 5 - Sediment Analytical Parameters

Area	OU	Sample Type	Sample ID	Analytical Parameters: VOCs	PCNs	Pests	PFCs	Metals	Purpose
Mill Pond	01	SED	MP-SED-14	3	3	3	3	1	Assess for site COCs - surface and deeper
Mill Pond	01	SED	MP-SED-15	3	3	3	3	1	Assess for site COCs - surface and deeper
Mill Pond	01	SED	MP-SED-16	3	3	3	3	1	Assess for site COCs - surface and deeper
Mill Pond	01	SED	MP-SED-17	3	3	3	3	1	Assess for site COCs - surface and deeper
North	04	SED	BP-SED-18	3	3	3	3	1	Assess for site COCs - surface and deeper
North	04	SED	BP-SED-19	3	3	3	3	1	Assess for site COCs - surface and deeper
North	04	SED	BP-SED-20	3	3	3	3	1	Assess for site COCs - surface and deeper
WWTP	03	SED	FC-SED-08	3	3	3	3	2	Assess for site COCs - surface and deeper
WWTP	03	SED	FC-SED-07	3	3	3	3	2	Assess for site COCs - surface and deeper
WWTP	03	SED	FC-SED-05	3	3	3	3	2	Assess for site COCs - surface and deeper
WWTP	03	SED	UnSt-SED-06	3	3	3	3	2	Assess for site COCs - surface and deeper
WWTP	03	SED	CL-SED-21	3	3	3	3	2	Assess for site COCs - surface and deeper

VOCs - target compound list (TCL) volatile orgranic compounds via EPA Method 8260
SVOCs - TCL semivolatile orgranic compounds via EPA Method 8270
PCNs - polychlorinated naphthalenes via EPA Method 8270 SIM
Pests - TCL pesticides via EPA Method 8081
PFCs - polyfluorinated compounds via EPA Method Modified 537
Metals - target analyte list metals via EPA Methods 6010/7471

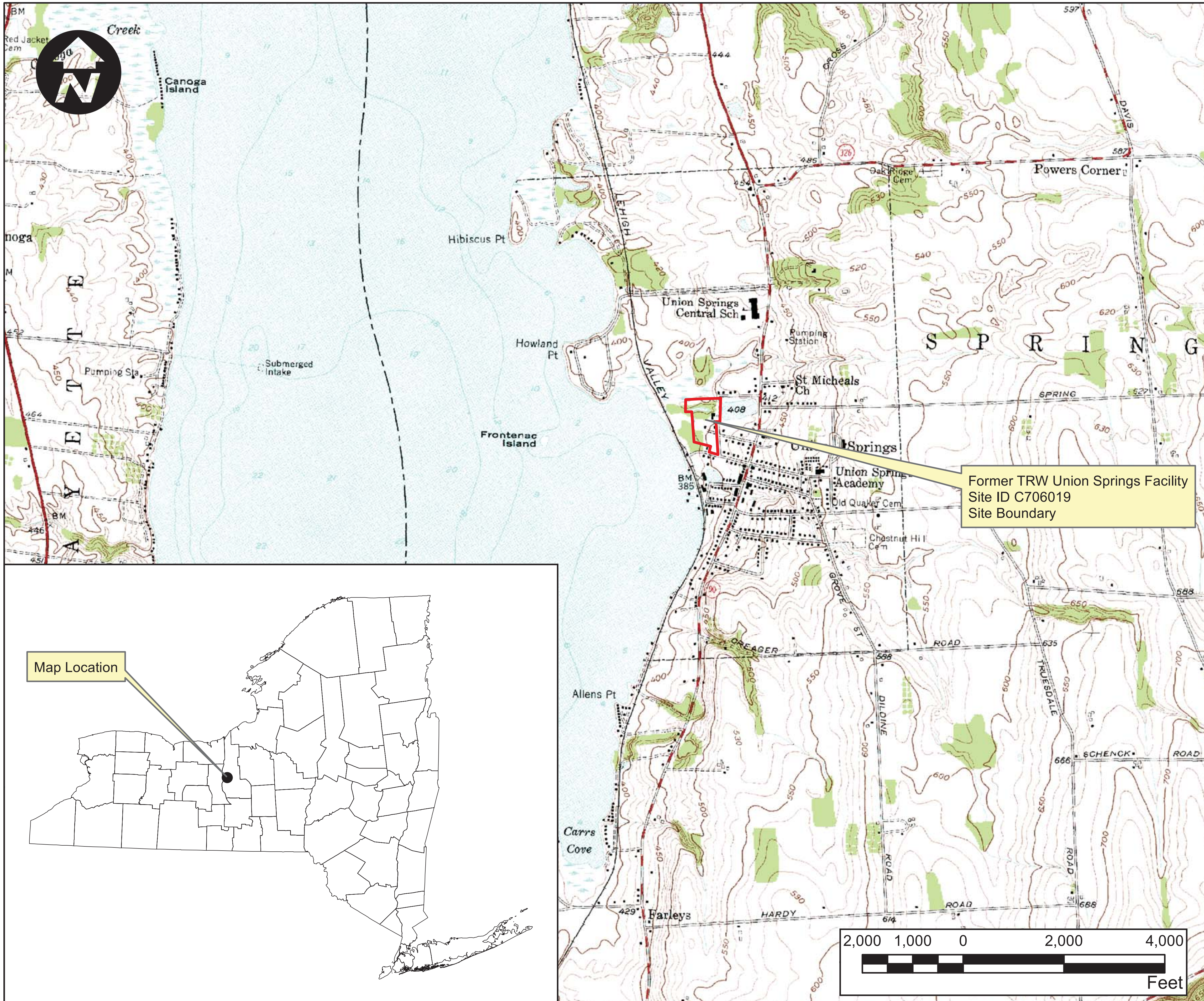

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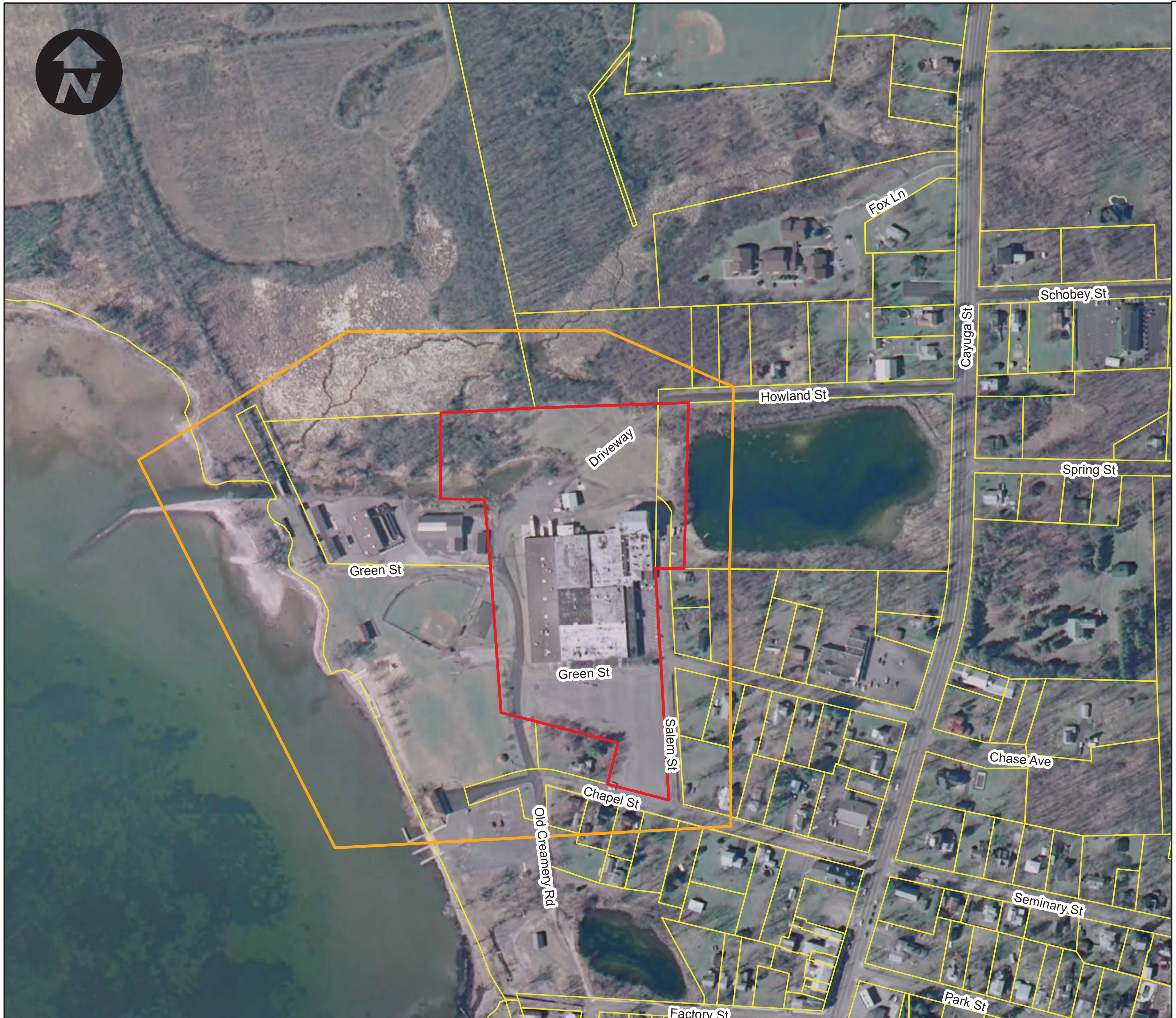
FIGURE 1
SITE LOCATION

Former TRW Union Springs
Facility Off-Site
Site ID# C706019A

Village of Union Springs
Town of Springport, Cayuga County



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APPROXIMATE AREA OF INTEREST

Former TRW Union Springs Facility OFF-SITE

Village of Union Springs
Town of Springport, Cayuga County

Legend

- Site_Boundary
- Tax Parcel - Cayuga County
- Approx_Off-site_Area of Interest

300 150 0 300 600
Feet

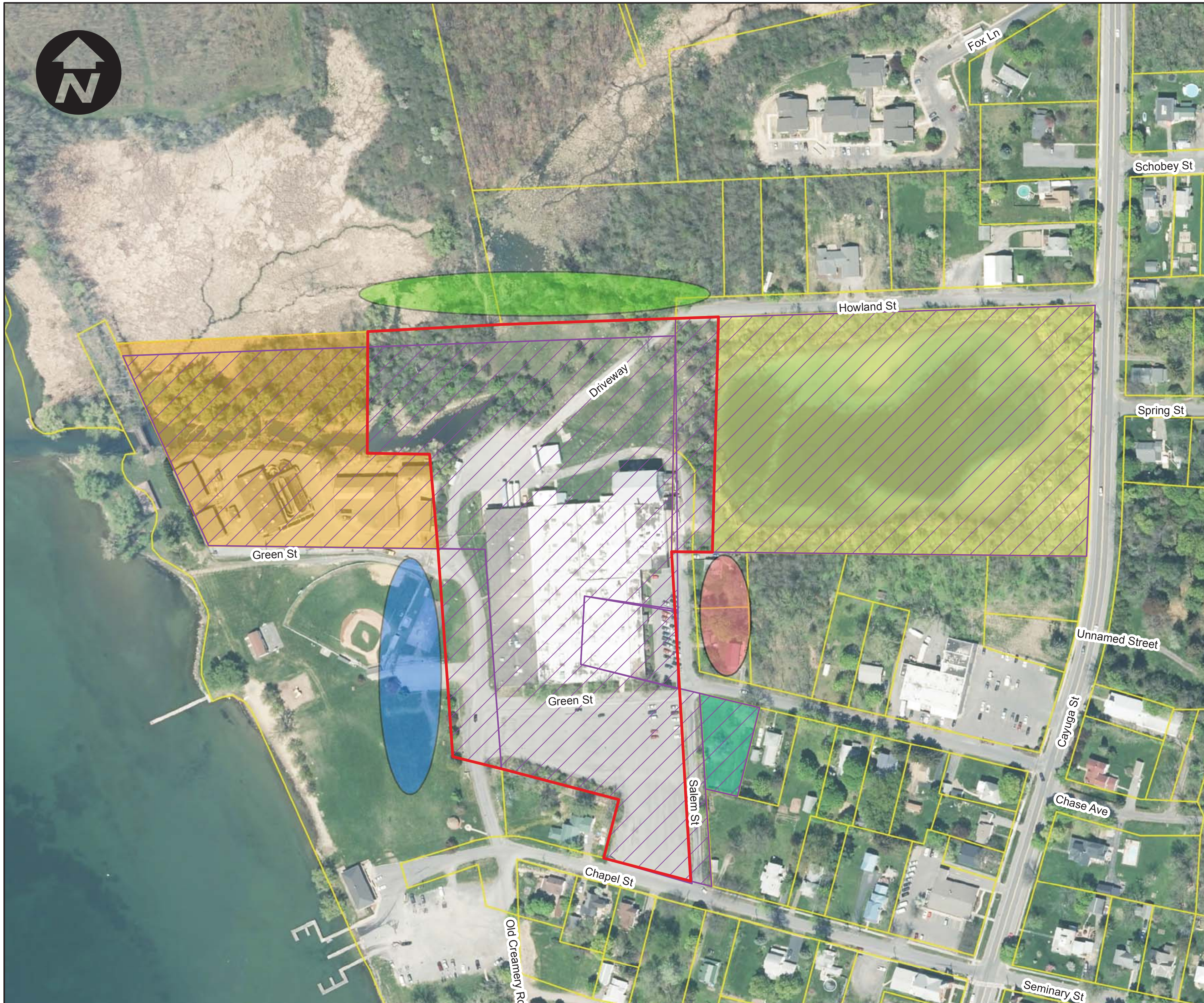

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FIGURE 3
AREAS OF POTENTIAL CONCERN

Former TRW Union Springs
Facility Off-Site
Site ID# C706019A

Village of Union Springs
Town of Springport, Cayuga County

Legend

- Approx BCP Site Boundary
- Approx Former Facilty Bounds
- Park Area
- Wastewater Treatment Plant
- Northern Area
- Mill Pond Area
- Eastern Area
- Southeast Parcel
- Tax Parcels - Cayuga County

200 100 0 200 400
Feet

FIGURE 4
PROPOSED SURFACE AND SHALLOW SOIL SAMPLING LOCATIONS

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Former TRW Union Springs
Facility Off-Site
Site ID# C706019A

Village of Union Springs
Town of Springport, Cayuga County

Legend

▲ Approx Location - On-site Investigation Surface and Shallow Soil Samples

▲ Proposed Location - Off-site Investigation Surface and Shallow Soil Samples

150 75 0 150 300
Feet

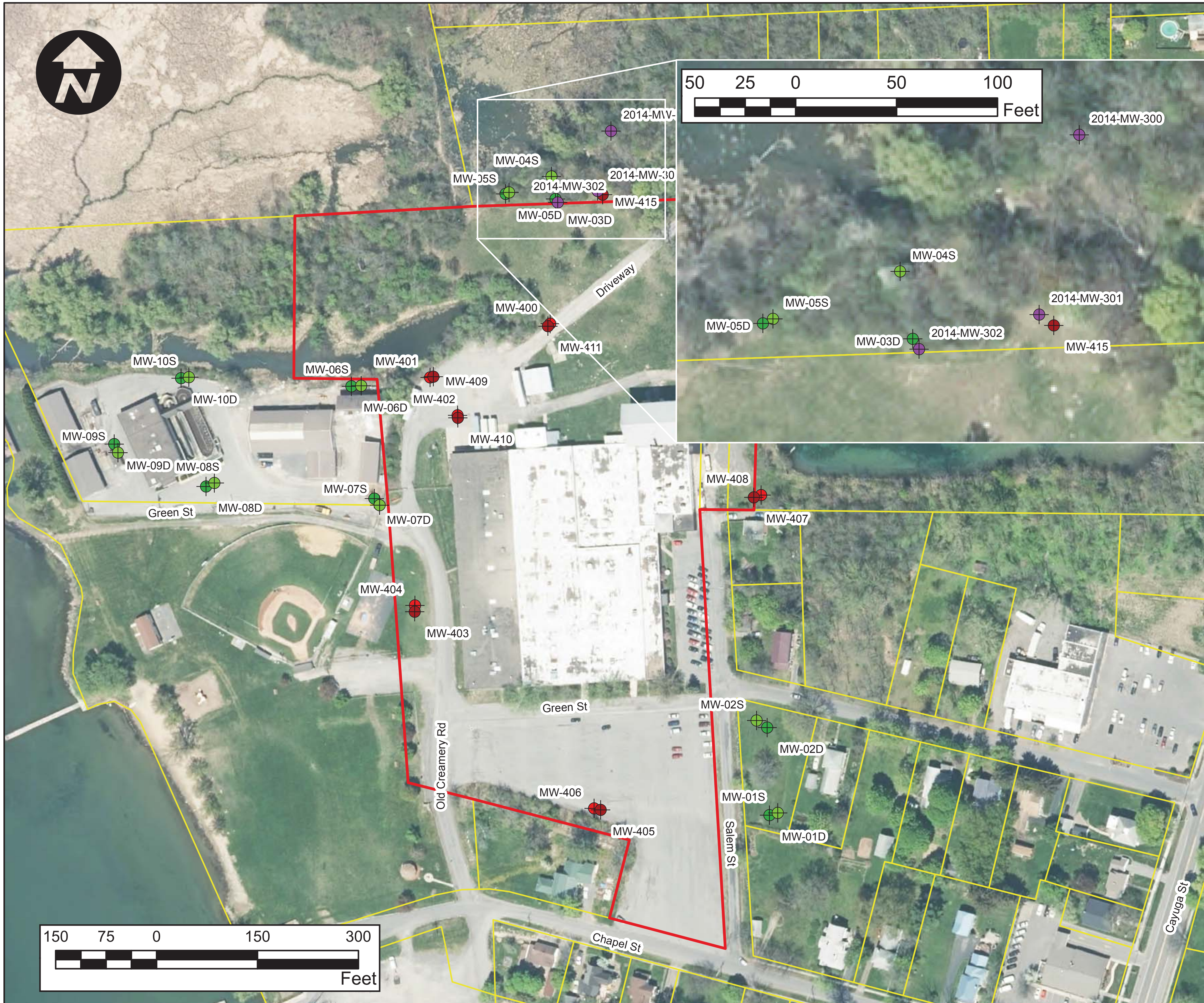

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FIGURE 5
SELECT EXISTING WELLS AND PROPOSED OFF-SITE MONITORING WELLS

Former TRW Union Springs
Facility Off-Site
Site ID# C706019A

Village of Union Springs
Town of Springport, Cayuga County

Legend

- Existing Shallow MW - 2014
- Existing Shallow MW - BCP RI
- Existing Deeper MW - BCP RI
- Proposed Shallow MW
- Proposed Deeper MW

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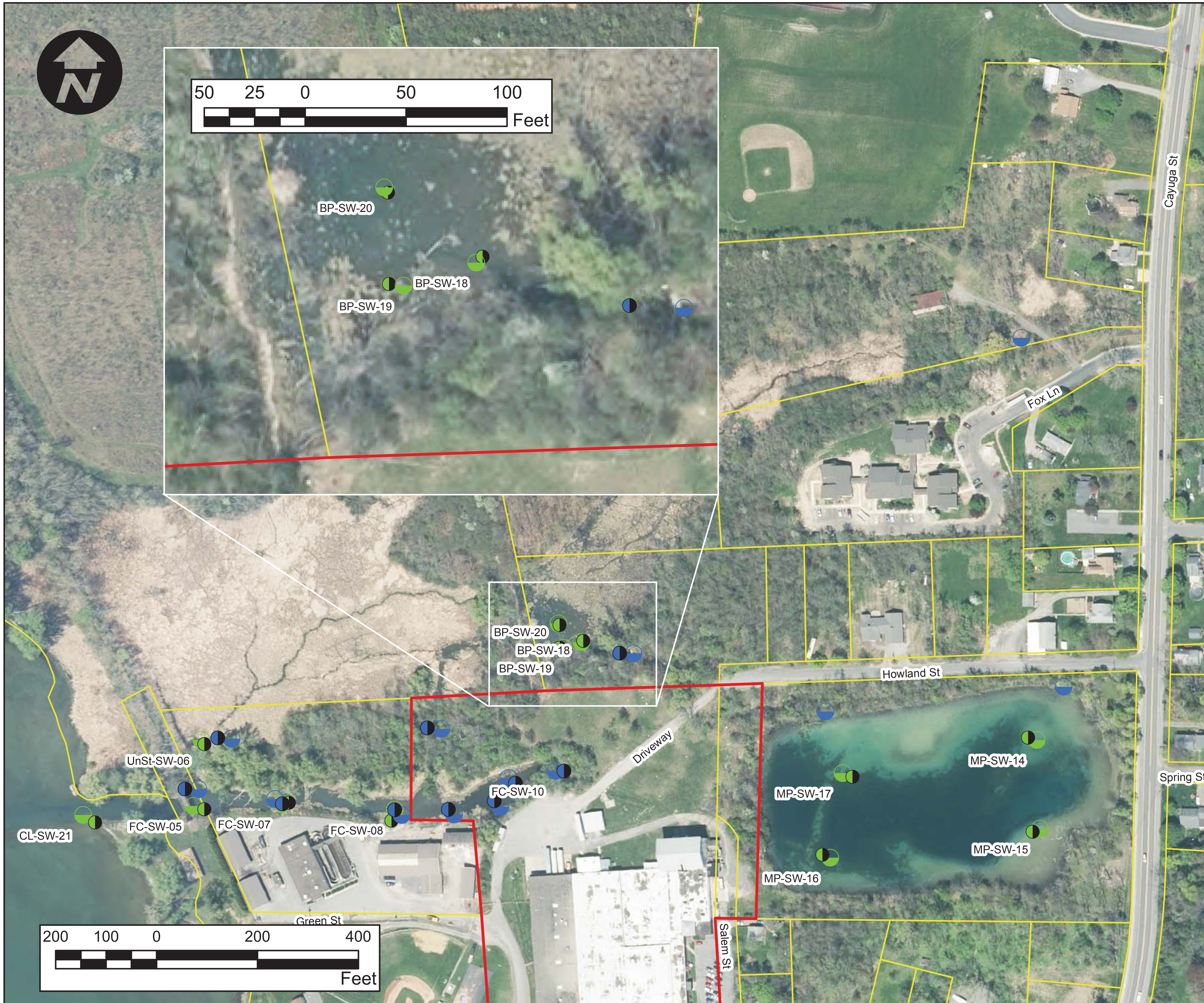
FIGURE 6 SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS

Former TRW Union Springs Facility Off-Site
Site ID# C706019A

Village of Union Springs
Town of Springport, Cayuga County



Legend

- Prior Sediment Sample
- Prior Surface Water Sample
- Proposed Sediment Sample
- Proposed Surface Water Sample

Collection of Shallow Soil Samples for Perfluorooctanoic Acid (PFOA) and Perfluorinated Compounds (PFCs) Protocol

General

The objective of this protocol is to give general guidance for the collection of soil samples for PFC analysis. The sampling procedure used must be consistent with the NYSDEC March 1991 SAMPLING GUIDELINES AND PROTOCOLS http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf with the following materials limitations.

Laboratory Analysis and Container

Samples collected using this protocol are intended to be analyzed for PFOA and other PFCs by Modified (Low Level) via the modified (low level) EPA Test Method **537**. Based on four laboratories, the PFC reporting limits range from 0.1 to 3 micrograms per kilogram. One 8 ounce high density polyethylene (HDPE) container is required for each sample. Pre-cleaned sample containers, coolers, sample labels and a chain of custody form will be provided by the laboratory.

Sampling Location and Survey

Shallow soil sampling will generally be confined to surface or near-surface soils and/or sediments with hand equipment. For screening purposes, sampling of this type should be conducted in potential depositional areas. Sample locations shall be located and recorded.

Equipment

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE), PVC, silicone, acetate and polypropylene. Additional materials may be acceptable if proven not to contain PFCs. <u>All sampling equipment components and sample containers should not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer</u>. A list of acceptable equipment is provided below, but other equipment may be considered appropriate at a later date.

- stainless steel spoon
- stainless steel bowl
- carbon steel hand auger without any coatings

Equipment Decontamination

Standard two step decontamination using detergent and clean water rinse will be performed for equipment that does come in contact with PFC materials.

Sampling Techniques

Sampling is often conducted in areas where a vegetative turf has been established. In these cases a clean stainless steel spoon should be used to carefully remove the turf so that it may be replaced at the conclusion of sampling. Surface soil samples (e.g. 0 to 6 inches below surface) shall then be collected using a pre-cleaned, stainless steel spoon. Shallow subsurface soil samples (e.g. 6 to ~36 inches below surface) may be collected by digging a hole using a hand auger. When the desired subsurface depth is reached, a pre-cleaned hand auger shall be used to obtain the sample.

When the soil sample is obtained, it should be deposited into a stainless steel bowl for mixing prior to filling the sample containers. The soil should be placed directly into the bowl and mixed thoroughly by rolling the material into the middle until the material is homogenized.

Sample Identification and Logging

A label shall be attached to each sample container with an identification consistent with the format indicated below. Each sample shall be included on the chain of custody (COC).

- Each sample shall be labelled as Street#, Street Name, date, Sample S#, Depth Interval (e.g. 2MainSt-3-30-16-S1-0-2).
- Each duplicate shall be labelled as a blind duplicate identified as “date, DUP, # (e.g. 3-30-16-DUP1).

Quality Assurance/Quality Control

- Immediately place samples in cooler maintained at 4 ± 2^{o} Celsius.
- Collect one field duplicate for every sample batch, not to exceed 20 samples. The duplicate shall consist of an additional sample at a given location.
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, not to exceed 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC.
- Request appropriate data deliverable (Category A or B) and an electronic data deliverable.

Documentation

A soil log or sample log shall document the location of the sample/borehole, depth of the sample, duplicate sample, visual description of the material and any other observations or notes determined to be appropriate.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler must wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFC materials must be avoided. All clothing worn by sampling personnel must have been laundered multiple times.

Collection of Surface Water Samples for Perfluorooctanoic Acid (PFOA) and Perfluorinated Compounds (PFCs) Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by Modified (Low Level) Test Method 537. Reporting limits of 2 nanograms per liter.

The sampling procedure used must be consistent with the NYSDEC March 1991 SAMPLING GUIDELINES AND PROTOCOLS
http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE), PVC, silicone, acetate and polypropylene. Equipment blanks should be generated at least daily. Additional materials may be acceptable if pre-approved by NYSDEC. Requests to use alternate equipment should include clean equipment blanks. All sampling equipment components and sample containers should not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer. Standard two step decontamination using detergent and clean water rinse will be performed for equipment that does come in contact with PFC materials. Where conditions permit, (e.g. creek or pond) sampling devices (e.g. stainless steel cup) should be rinsed with site medium to be sampled prior to collection of the sample. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFC materials must be avoided. Many food and drink packaging materials and "plumbers thread seal tape" contain PFCs.

All clothing worn by sampling personnel must have been laundered multiple times. The sampler must wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, sample labels and a chain of custody form will be provided by the laboratory.

1. Fill two pre-cleaned 500 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at 4 ± 2º Celsius.

Collect one equipment blank for every sample batch, not to exceed 20 samples.

Collect one field duplicate for every sample batch, not to exceed 20 samples.

Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, not to exceed 20 samples.

Request appropriate data deliverable (Category A or B) and an electronic data deliverable.

Collection of Groundwater Samples for Perfluorooctanoic Acid (PFOA) and Perfluorinated Compounds (PFCs) from Monitoring Wells Sample Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by Modified (Low Level) Test Method 537.

The procedure used must be consistent with the NYSDEC March 1991 Sampling Guidelines and Protocols http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE), PVC, silicone, acetate and polypropylene. Equipment blanks should be generated at least daily. Additional materials may be acceptable if pre-approved by NYSDEC. Requests to use alternate equipment should include clean equipment blanks. **NOTE: Grunfos pumps and bladder pumps are known to contain PFC materials (e.g. Teflon™ washers for Grunfos pumps and LDPE bladders for bladder pumps).** All sampling equipment components and sample containers should not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer. Standard two step decontamination using detergent and clean water rinse will be performed for equipment that does come in contact with PFC materials. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFC materials must be avoided. Many food and drink packaging materials and "plumbers thread seal tape" contain PFCs.

All clothing worn by sampling personnel must have been laundered multiple times. The sampler must wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form will be provided by the laboratory.

1. Fill two pre-cleaned 500 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at 4 ± 2º Celsius.

Collect one equipment blank for every sample batch, not to exceed 20 samples.

Collect one field duplicate for every sample batch, not to exceed 20 samples.

Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, not to exceed 20 samples.

Request appropriate data deliverable (Category A or B) and an electronic data deliverable.

PROGRAM
FIELD ACTIVITIES PLAN
NYSDEC STANDBY ENGINEERING CONTRACT
CONTRACT #D007625

PREPARED FOR
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 BROADWAY
ALBANY, NEW YORK 12233

Prepared by

HDR

One Blue Hill Plaza
Pearl River, NY 10965

April 2011

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Pearl River, NY 10965

Approved:

April 14, 2011

Michael Lehtinen — Date
HDR Program Manager

April 14, 2011

Peter McGroddy, P.E. — Date
HDR Contract Manager

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1.0 PURPOSE AND OBJECTIVES

1.1 Purpose

This Program Field Activities Plan (FAP) has been prepared as a generic document of potential field activities that Henningson, Durham & Richardson Architecture and Engineering, P.C. in association with HDR Engineering, Inc. (HDR) will perform or oversee for Standby Engineering work assignments issued by the New York State Department of Environmental Conservation (NYSDEC) under Superfund Standby Engineering Contract No. D007625. This document provides general provisions and task related details for field activities anticipated to be conducted according to various site-specific Work Plans.

1.2 Field Activity Plan Objectives

An initial step in every work assignment is the development of a site-specific Work Plan, which includes the specific details of the individual work assignment field activities. The Program FAP provides the specific detailed information about field activities that HDR, NYSDEC, and subcontractors will potentially perform at a given site. This information includes the definition, rationale, protocol, and any construction details or operation and maintenance of field activities. For those assignments where the activities are not fully described by the Program FAP a site specific addendum will be provided to describe those elements of the assignment.

The elements of the Program FAP have been prepared in accordance with the most recent and applicable guidelines and requirements of the NYSDEC and the New York State Department of Health (NYSDOH).

2.0 BRIEF DESCRIPTION AND RATIONALE OF FIELD ACTIVITIES

The primary focus of work assignments is to evaluate existing onsite conditions, groundwater flow direction, the nature and extent of the contamination, and possible human exposure to the contaminants through a systematic site investigation/characterization or a full scale remedial investigation.

The following list of tasks represent the various methods/activities HDR may employ as part of a site investigation/characterization or remedial investigation:

SECTION FIELD ACTIVITY

3. 0 ***Surface Soil Sampling*** – Collected to assess and delineate potential contamination within the shallowest subsurface soils at a work assignment site.

4.0 ***Wipe, Chip, and Sweep Sampling*** **–** Assess potential areas of contaminant release, typically within structures or from machinery/debris associated with activities conducted in a given structure.

5.0 ***Exploratory Test Pits/Trenches*** **–** Shallow to intermediate depth excavations to provide field identification/verification of potential contaminant source areas and subsurface impact areas.

6.0 ***Direct-Push/Probe Drilling*** **-** Identify possible source areas, characterize the overall volume and distribution of contaminants in the subsurface, delineate the limit and extent of contaminants of concern (COC), and determination of whether the site should remain or be added to the list of Inactive Hazardous Waste Sites..

7.0 ***Monitoring Well Installation and Construction*** **-** Identify hydrogeologic characteristics, groundwater constituents, contaminant plume transport, and the hydraulic relationship between the site and localized groundwater flow.

8.0 ***Monitoring Well Development*** **-** Develop wells at an appropriate time interval post-installation using airlift or surging and pumping techniques. Monitor appropriate field measured groundwater chemistries for stabilization and appropriate values.

9.0 ***Groundwater Monitoring and Sampling -*** Conduct periodic monitoring/sampling events to delineate the extent of contaminants of concern within a groundwater flow system. Monitor groundwater elevations to determine the local groundwater flow gradient and direction.

10.0 ***Surface Water Sampling –*** Collect surface water from surface water bodies (i.e. storm sewers, ditches, streams, etc.) on or adjacent to the site that may serve as a pathway or receptor for contaminants of concern.

11.0 ***Sediment Sampling -*** Collect sediment samples on or adjacent to the site, typically done in combination with surface water sampling.

12.0 ***Soil Vapor Point Installation and Sampling -*** Install soil vapor points using mechanized or manual methods for the purpose of collecting representative soil vapor or sub-slab vapor samples for laboratory analysis, at relevant locations as determined by the NYSDEC and in consultation with the NYSDOH.

13.0 ***Indoor Air Monitoring -*** Evaluate the migration of vapors into onsite and offsite residential and commercial structures through the collection of indoor air and outside ambient air samples.

14.0 ***Community Air Monitoring -*** Monitor volatile organic compounds (VOCs) and particulate levels at the perimeter of the work area in real-time. Monitoring will typically consist of a combination of continuous and periodic monitoring, contingent upon site-specific field and construction activities.

15.0 ***Waste Handling and Disposal -*** HDR will provide proper storage, handling, and disposal of investigative-derived waste.

16.0 ***Site Survey and Base Map Preparation –*** Complete survey of pertinent investigation/characterization locations, performing a topographic survey as required, and preparation of a site base map by a licensed professional land surveyor. Alternatively, HDR will locate all field sampling location using a high precision GPS unit as directed by the NYSDEC representative.

3.0 SURFACE SOIL SAMPLING

Surface soil samples will be obtained from the first 3 to 6 inches of soil depending on the nature of the surface material. In grassy or other vegetated areas with a significant root zone, up to 6 inches of soil may be required to obtain a sufficient sample volume. Sample locations will typically be selected based on the possibility for human exposure through dermal contact, ingestion, or inhalation of contaminated dust. Sample spacing will be set up in a grid layout, with specific spacing intervals determined by site conditions and dimensions of the area of concern. The sampling naming convention outlined in Attachment 1 will be used for all samples collected for testing at the analytical laboratory.

Leaves, grass, and surface debris will be removed from the sample location using a laboratory cleaned stainless steel spoon or shovel, if necessary. Sample material will then be collected with a dedicated, laboratory-cleaned stainless steel spoon and homogenized in a stainless steel bowl prior to being transferred into appropriate sample jars.

Once sample collection is completed, each sample point will be flagged or staked to mark the location for future reference, with each flag or stake labeled with the appropriate sample identification and the date of sampling.

4.0 WIPE, CHIP AND SWEEP SAMPLING

Wipe, chip and sweep samples are collected to assess potential contamination of structural components and associated equipment, typically within or near a building or structure at a work assignment site. Sample locations will be selected based on information gathered as part of a detailed site reconnaissance. If possible, certain process areas within the building(s) will be isolated such that representative samples are collected. Sample locations will be clearly marked and the surface area will be calculated for each location.

Equipment contamination samples, collected from existing equipment, scrap metal, and other debris, will typically consist of a combination of wipe and sweep samples, depending on the quantity of dust present in the area of concern.

Structural contamination samples will consist of wipe and chip samples, typically collected from the wall and floor of the structure. In some cases separate samples will be collected to isolate paint and wood samples, if either of these components is present in the area of concern.

Wipe samples will be collected using a sterile gauze pad soaked in distilled water. Any excess water will be allowed to run off the gauze pad before the sampling surface is wiped with the pad using firm strokes to obtain the sample. Once collected, the wipe sample will be placed in a laboratory-cleaned glass jar with a Teflon lid.

Sweep samples will be obtained using a dedicated, natural bristle brush to sweep the sampling surface, collecting any dust or dirt onto a dedicated dust pan. The samples will be transferred from the dust pan into a laboratory-cleaned glass jar with Teflon lid.

Chip samples will be collected using a hammer and chisel to chip fragments of the sampling surface onto Teflon sheets or aluminum foil that has been rinsed with distilled or deionized water and autoclaved. The chips will be obtained from a depth of 3 to 5 mm, with enough chips collected to ensure a total sample mass of at least 100 grams. Each sample will be transferred to a laboratory-cleaned glass jar with Teflon lid. Between each sample the hammer and chisel will be cleaned with a mix of potable water and Alconox/Liquinox, rinsed with distilled or deionized water, and allowed to air dry before use on a subsequent sample point.

The sampling naming convention outlined in Attachment 1 will be used for all samples collected for testing at the analytical laboratory. All samples collected will be labeled with the appropriate sample number, date, time, sampler, and required analyses before being submitted to the contracted analytical laboratory, following chain of custody protocols, via overnight courier.

5.0 EXPLORATORY TEST PITS/TRENCHES

Test pits or trenches may be excavated to evaluate the nature of shallow soils and to allow direct visual inspection of drain lines, dry wells, and other underground structures potentially related to site contamination. In some cases test pits may also be utilized to monitor groundwater depths and seepage to evaluate the presence of zones of perched water. The primary objective of excavating test pits is to investigate potential areas of contamination and pathways for contaminant migration. Test pits are not intended for waste removal or remediation purposes. Exposed contaminated soil or waste containers will be documented, marked and backfilled. At the direction of a NYSDEC representative, small quantities (i.e. single drums/other waste containers) of obvious hazardous waste can be removed, if requested.

The test pits will be excavated with a rubber-tire backhoe or track mounted excavator operated by OSHA 40-hr health and safety trained personnel. All excavations will be supervised and documented by an HDR geologist. To the extent possible, test pit excavation will be conducted to avoid removal of grossly contaminated materials and any material removed will be used to backfill the pit once inspection is completed.

As excavation progresses the characteristics of the test pit will be logged and photographed by the on-site HDR geologist. Features such as the depth of fill, any piping or other man-made structures, depth to groundwater, depth to bedrock, stratigraphic changes, and sensory or instrument (PID) indication of contamination will be logged. Soil samples from within the test pit may be collected from the side walls and/or floor of the pit. Soil samples will be collected with laboratory-cleaned dedicated stainless steel spoons and bowls, with sample material homogenized in the bowl prior to being transferred to laboratory-cleaned sample bottles. The sampling naming convention outlined in Attachment 1 will be used for all samples collected for testing at the analytical laboratory and all samples will be labeled with the site name, project number, sample identification, date, time, and parameters for analysis.

Upon completion of the test pit inspection, the excavation contractor will backfill the pit with soil removed during the excavation. The contractor will adequately compact the backfill material so as to minimize settling after backfilling is completed. Stakes or flagging will be placed at each corner point of the test pit footprint to delineate the area of excavation and will be labeled with the test pit identification number and date of excavation.

6.0 DIRECT – PUSH/PROBE DRILLING

The purpose of direct-push/probe drilling and sampling is to evaluate the shallow overburden at a site is to assess the nature and extent of contamination at a site and areas down gradient of the site.

6.1 Direct Push/Macro-Core Soil Borings

Direct push soil borings will be advanced using a truck mounted probe rig utilizing a direct push hydraulic hammer system. Soil borings will be drilled in 4-ft runs, using a 1.5-in inside diameter (ID) macro core soil sampler (**Figure 6-1**). This sampler is adequate for soil sampling to a depth of approximately 16 feet. The sampler is pushed or hammered to the desired sampling depth using the hydraulic system and soil cores (up to 4 ft in length) are recovered in a dedicated acetate liner contained inside the macro-core tube prior to advancement.

Upon removal of the liner from the sampler barrel, several sample parameters, including sample interval, soil description/stratigraphy, moisture content, color, and evidence of contamination (odor/sheen), will be noted on a soil probe log (**Figure 6-2**). The recovered material will also be field screened for organic vapors using a photoionization detector (PID).

Samples will be collected for volatile organic compounds (VOCs) from intervals exhibiting the highest PID response during field screening. If no response is noted or no visual/olfactory evidence of contamination is present, the VOC sample will be collected from sub-surface material collected from just above the water table. Soil for VOC samples will be transferred directly from the acetate liner used for obtaining the sample to an appropriate sample jar. If SVOC samples are required from the same interval, material may first be homogenized in a cleaned stainless steel bowl since a higher sample volume is typically required for SVOC samples.

Soil probe samples will be submitted to a certified contract laboratory, under chain of custody protocol, via overnight delivery for sample analysis. The sampling naming convention outlined in Attachment 1 will be used for all samples collected for testing at the analytical laboratory.

6.2 Probe Groundwater Sampling

Groundwater probe samples will be collected to allow analysis of groundwater quality from discrete intervals within the aquifer being characterized. Samples collected from groundwater probing are obtained as an alternative to installing a monitoring well in situations where drilling using a full size rig is inaccessible, where the permanent installation of a well is considered unnecessary, or where groundwater probing provides a more cost effective method of providing vertical and areal delineation due to the ability to collect data from a relatively large number of samples from different locations and at multiple depth intervals.

The groundwater probe samples will be collected using a screen point sampler which enables sampling from discrete intervals and allows for pumping of groundwater from the sampling point. The sampler is constructed of a stainless steel mesh enclosed in a stainless steel, threaded sheath. Attached to the inner steel mesh is a solid, stainless steel drive point that connects flush to the end of sheath as the sampler is driven to sampling depth. The sampler unit threads onto a direct push probe rod and the sampler is pushed or driven into the subsurface in the same manner as described for the soil sampler in Section 6.1 except that advancement is continuous since soil cores are not collected as the groundwater sampler is advanced. The sampler is driven to between one and two feet below the desired sample depth. The drill string is then raised approximately 2 feet which allows the drive point to separate from the sheath. As the drive point separates it also pulls the mesh screen out of the sheath, exposing the screen to the aquifer material and allows groundwater to enter the sampler sheath (**Figure 6-3**).

Once the screen is deployed there are two possible sampling methods for bringing groundwater to the surface where it can be collected and submitted for analysis. The first method involves running a length of dedicated polyethylene tubing with a check valve inserted in the bottom of the tubing. The tubing is then oscillated and water is forced into the tube as the ball in the check valve is repeatedly raised and lowered. An alternative method involves attaching the dedicated tubing directly to the sampler using a stainless steel adaptor. The outlet of the tubing at the surface is then attached to a peristaltic pump and groundwater is purged and sampled from the sample interval.

Groundwater samples will transferred from the tubing directly into laboratory-cleaned sample bottles and labeled with the appropriate sample identification information (see Attachment 1) prior to being transported under chain of custody protocol to a certified analytical laboratory for analysis.

6.3 Membrane Interface Profiling

Membrane Interface Profiling (MIP) provides real-time, qualitative soil and contaminant profiles via a suite of detectors embedded within specialized tooling that is used in conjunction with direct push probing systems. As the probe is advanced into the subsurface continuous data from instrumentation, including electrical conductivity (EC), photoionization potential (PID), and flame ionization potential (FID), as well as from an electron capture detector (ECD) are collected and compiled by the operator at the surface. Although the MIP results do not provide a quantitative response output, the subsequent response profiles provide relative information used to determine the depth at which potential contamination exists. The typical application for the MIP system entails advancing the MIP probe through subsurface stratigraphic units from the ground surface to the groundwater interface with the MIP relaying real-time information as the soils are screened for volatile organic compounds (VOCs). Volatile compounds located within the subsurface soils and encountered by the various sensors during probe advancement are diffused across a membrane at the bottom of the probe and carried from the probe to the gas phase detector at the ground surface, allowing determination of the depths of contamination in the subsurface. The MIP probe also collects electrical conductivity measurements from within the subsurface soils, which can be used to assign a probable stratigraphic unit (i.e. sand, silt or clay) for correlation with the qualitative VOC concentration detections.

7.0 MONITORING WELL INSTALLATION AND CONSTRUCTION

7.1 Types Of Monitoring Wells

For a given project site, a combination of permanent and temporary monitoring wells may be installed, depending on the anticipated number of samples required from a given point and the anticipated time period required for sampling (i.e. will sampling occur during several sampling events). Permanent wells may be installed as deep, intermediate, or shallow wells, with the depths generally defined as greater than 100 ft, 50 – 100 ft, and less than 50 ft, respectively.

The actual depth definitions of permanent wells will vary relative to groundwater monitoring objectives and site geology. Temporary monitoring wells are typically shallower than shallow permanent wells and are used primarily for short term monitoring or for collecting single samples from a location.

Upon installation, each monitoring well will be assigned an identification number which includes an 'MW' notation preceded by a two letter prefix to designate the name of the site; a number designation would be assigned according to the order in which the wells were installed. In addition, a designation for deep (D), intermediate (I), and shallow (S) wells would be included after the well number (i.e. for the first well (a deep well) installed at a site, the well identification label would be SNMW-1D for **S**ite **N**ame **M**onitoring **W**ell **– 1 D**eep).

Shallow monitoring wells will be used for monitoring water table elevations or collecting analytical data from an aquifer composed of surficial or overburden deposits. Intermediate depth wells can be used in determining the vertical hydraulic gradient and the vertical extent of contaminants. Intermediate depth wells also may also intersect groundwater representative of the interface zone between overburden and bedrock. Deep monitoring wells are often bedrock wells and are installed for long term and regional monitoring programs or where very deep migration of contaminants is suspected. The drilling and installation of monitoring wells will be supervised and documented by an HDR geologist according to the procedures described in Sections 7.2 and 7.3.

7.2 Temporary Monitoring Well Construction

Temporary groundwater sampling wells will be installed using direct-push techniques to the appropriate depth or, if drilling proves too difficult due to the nature of the subsurface materials, through the use of hollow stem auger drilling as described in Section 7.3. A temporary 1-in. diameter well will be installed into an open borehole. The temporary monitoring wells will be constructed with an appropriate length of 0.01-inch (10 slot) screen and an appropriate length of Schedule 40 PVC riser to the ground surface. The annulus space will be backfilled with sand to approximately 2 ft above the screen interval. A bentonite seal will be placed from the top of the sand to the ground surface to prevent hydraulic connection between the screened interval of the well and potential infiltration of surface water along the borehole.

7.3 Permanent Monitoring Well Construction

7.3.1 Overburden Wells, Hollow-Stem Augers, Mud Rotary

Overburden monitoring wells will typically be installed using the hollow-stem auger method. In general, 4.25 inch ID hollow-stem augers will be used to install 2 inch diameter wells, and 6.25 inch ID hollow-stem augers will be used to install 4 inch diameter wells. Split spoon samplers will be used to collect soil samples for classification and sampling, either on a continuous or five foot interval basis, depending on the nature of the site (**Figure 7-1**). Once groundwater is encountered, the borehole will be extended an additional 5 ft into the groundwater table, or to a depth as directed by the NYSDEC. Once the target drilling depth is reached, the inner bit within the augers will be removed, and the well material will be placed within the augers. Monitoring wells will typically be constructed with a ten foot section of 2 inch diameter, schedule 40, 0.01-inch (10 slot) PVC well screen, and the appropriate length of threaded, flush joint, 2 inch diameter, schedule 40 PVC well riser to the ground surface. Once the well screen and material have been installed to the target depth through the augers, the annulus space between the augers and the well screen will be backfilled with #0 Morie sand or equivalent (**Figure 7-2**).

As the sand is added to form the filter pack around the well screen, the augers will slowly be retracted until the sand reaches a level of at least 2 feet above the top of the screened interval. A two foot thick layer of bentonite chips will then be installed through the augers to form, once the bentonite is fully hydrated, an impermeable seal above the filter pack. The remaining annular space between the borehole and well riser will be backfilled with a cement/bentonite grout mixture. Upon complete removal of the augers, additional grout will be added to top off the remaining volume of the borehole.

When drilling of deeper overburden wells is required, typically located in a geologic formation where hollow-stem augers would not be effective, mud-rotary drilling will be utilized. Mud-rotary utilizes drilling fluid (mud) which is pumped through the drill stem, out the bit, and up the annulus between the drill stem and the borehole wall. The mud runs through a de-sander at the ground surface, and then re-circulates down through the drill stem. As in hollow stem auger drilling, soil samples can be collected at desired intervals using split spoons samplers. Once the well is drilled to depth, the well casing will be placed in the open borehole. A tremie pipe will be placed at the bottom of the borehole and clean potable water will be circulated to thin out the mud. Once it is determined that there is no longer a presence of mud in the borehole, the monitoring well will be constructed as described for the hollow stem auger method.

Monitoring wells will be completed in flush mount curb boxes with protective steel manholes or with a steel riser casing depending on well location and anticipated site usage. Each well will have a vented cap and a locking cover. A cement pad will be installed to channel surface water away from the well. A weep hole will be drilled in the protective casing to allow any water between the inner and outer casing to drain.

7.3.2 Bedrock Monitoring Wells

Bedrock monitoring wells will typically be installed using a combination of rotary drilling and rock coring methods. The preferred method involves hollow stem auger drilling through overburden to the top surface of the bedrock with 4.25 inch ID augers. Once bedrock is encountered the drilling method is switched to rock coring, with an initial core run of 5 feet drilled using an HX/HQ core barrel (3.8 inch OD) to form a rock socket into which a surface casing is grouted in place (**Figure 7-3**). A five foot run of coring allows the casing to be seated deep enough such that competent bedrock is penetrated rather than the weathered bedrock that is typically encountered at the top surface of rock. Grouting the surface casing into the rock socket forms an effective seal that prevents hydraulic connection via the borehole penetrating the overburden and bedrock.

Once grouted in place the surface casing is allowed to set a minimum of 24 hours to allow the grout to harden. Drilling will then resume using a smaller diameter (3 inch OD) core barrel (NX/NQ) to continue coring into the competent bedrock to the target depth of the well. If the bedrock being cored is found to be highly fractured or friable an inner 2 inch schedule 40 PVC well screen and riser may be installed into the open borehole to prevent collapse of the bedrock portion of the boring.

Split spoon samples may be collected during overburden drilling, with samples logged and collected as described in Section 7.3.1. Rock cores recovered during coring will be collected in core boxes for logging by an HDR geologist. Core logging will include descriptions of the core lithology, texture, structure, fracture density and characterization, core run length, depth, and core recovery.

Once completed, each well will be fitted with a stick-up lockable steel protective casing which will be cemented into the ground a minimum of three feet or will be completed at grade and housed in a flush mount protective manhole set in a cement curb box. Each well riser will be fitted with an inner vented PVC cap or lockable compression plug.

7.3.3 Multi-Level Well Installation

Monitoring wells set at different depth intervals may be utilized in situations where vertical delineation of contamination or characterization of multiple stratigraphic units is desired. In some instances where multiple stand-alone monitoring wells completed to different depths are not practical or are cost prohibitive, consolidated multi-level well installation may be employed.

Depending on the specifics of the required application, three strike systems will be considered for multi-level monitoring and sampling:

FLUTe® is a trademarked shortened name for Flexible Liner Underground Technologies, LLC system where a synthetic liner is advanced into an open borehole, sealing groundwater contributions from specified fractures zones while allowing for discrete sampling of groundwater originating from other intervals. The FLUTe system is particularly useful for deployment in fractured bedrock systems where the relative flow contributions from various fractured bedrock zones can be otherwise difficult to characterize.

The Westbay System is a trademark of Schlumberger Water Services which consists of a vertically separated series of packers, measurement ports, and pumping ports. The system allows for the vertical isolation of discrete water bearing zones in a continuous assembly that can be deployed in a single borehole.

CMT® (Continuous Multi-channel Tubing) by Solinst Canada, Ltd is a trademarked system of continuously extruded tubing with separately molded channels within the overall diameter of the tubing that can be opened prior to installation and wrapped in stainless steel to form a narrow screened interval at any combination of desired depths. This method allows for precise groundwater characterization at any depth along the total depth of the tubing and, with the use of adjacent channels, simultaneous water level monitoring to evaluate response to pumping during sampling.

8.0 MONITORING WELL DEVELOPMENT

Upon completion, newly installed monitoring wells will be allowed to stabilize for a minimum of 24 hours prior to being developed. Well development is conducted to allow for the collection of a low turbidity sample of groundwater by removing any fine-grained materials from the well bore. The monitoring wells will typically be developed using air lift or pump and surge techniques. In air lift development compressed air is injected into the well in the vicinity of the screened interval, causing rapid changes in pressure which serve to mobilize fine-grained particles. Continued air lifting brings these sediments upward through the water column where they rapidly discharge from the well head. An alternate method uses a submersible pump fitted with dedicated tubing to quickly pump high volumes of water from the water producing zone of the well. The rapid removal of the water causes water in the immediate vicinity of the well to rapidly recharge back into the well bore, flushing fine grained silty material into the well where it can be pumped to the surface. The pump and tubing can simultaneously be surged rapidly up and down in the well causing further mobilization of the fine-grained material. In some cases a surge block can be used to enhance the agitation and further suspend fine particles in the well water. As development progresses estimates of well yield and field measurements of temperature, pH, specific conductivity, and turbidity will be taken. The development of the wells will continue until groundwater from the wells reaches a turbidity of 50 nephelometric units (NTUs) or less, or until development has continued for two hours. Development parameters will be recorded on a field log as shown in **Figure 8-1**.

9.0 GROUNDWATER MONITORING AND SAMPLING

9.1 Groundwater Monitoring and Sampling Procedures

Components of groundwater monitoring and sampling include collection of pre- and post-sampling water level measurements, interface probe measurements (if applicable), well purging, field collected groundwater chemistry measurements, and sample collection. Groundwater sampling is conducted following protocols established to ensure the collection of groundwater representative of the local conditions for the aquifer being characterized. The sampling naming convention outlined in Attachment 1 will be used for all samples collected for testing at the analytical laboratory.

A copy of the well purge and groundwater sampling log used to record sampling information is attached as **Figure 9-1**. A discussion regarding the specifics of equipment and protocols used for groundwater sampling are contained in Sections 9.2 to 9.4 depending on the type of groundwater well that will be sampled.

9.2 Groundwater Sampling from Temporary Monitoring Wells

Groundwater samples will be collected from temporary monitoring wells using a peristaltic pump and a length of dedicated polyethylene tubing. Sampling will follow protocols outlined in Section 9.3, although well yields and purge volume requirements are typically much lower for 1-inch diameter temporary wells than in standard 2-inch diameter permanent monitoring wells.

Upon completion of sampling, shallow temporary well points will be removed, if possible, and the remaining borehole backfilled with bentonite to seal the boring. Borings that required penetration through pavement or concrete at the surface will be similarly backfilled and patched with either concrete patch or asphalt cold patch.

9.3 Groundwater Sampling from Permanent Monitoring Wells

9.3.1 Purging and Sampling Equipment

A list of equipment used for purging and sampling groundwater from permanent monitoring wells includes the following items:

- Peristaltic and submersible pumps, or dedicated polyethylene bailers for use in purging the well and collecting groundwater samples.
- Electronic water level meter with an audible indicator and an accuracy of 0.01 feet.
- A method for determining flow rates – either a graduated container or flow meter of appropriate capacity.
- A photoionization detector for vapor monitoring during purging and sampling activities (according to guidance outlined in the site specific HASP).

9.3.2 Field Analytical Equipment

Equipment which will be used for monitoring groundwater chemistry during purging and sampling includes:

- pH meter for determining acidity/alkalinity.
- Turbidity meter.
- Dissolved oxygen meter.
- Thermometer.
- Specific conductivity meter.
- Eh meter for quantifying oxidation-reduction potential.

If applicable, a multi-parameter meter such as the YSI 556 model may be substituted for individual meters, and the meter may be used in combination with a flow cell, whereby the sensors are continuously exposed to purge water pumped from the well, to provide continuous groundwater chemistry data.

In addition to the groundwater chemistry meters, a PID will be used to monitor well head vapor concentrations upon first removing the well cap or plug.

At the beginning of each day all meters required for anticipated site activities will be field calibrated using applicable calibration standards by the on-site HDR representative. Calibration results and any discrepancies between standard and calibrated values will be noted on either a calibration log or in a site specific field book.

9.3.3 Sampling Procedures

Prior to sampling newly installed wells, the wells will be allowed to stabilize for a minimum of 7 days after development is completed.

The general procedures for collecting samples from a typical monitoring well are as follows, with variations possible depending on site specific conditions and the particular objectives of the sampling program:

- Prior to opening the well to be sampled the sampling crew will don PPE as required by the site specific HASP Addendum. The PPE may include gloves, eye protection, and splash protection.
- Upon removal of the locking well cap/manhole cover and the inner compression plug the well head will be scanned using the PID and any responses noted on an appropriate sampling log or field book.
- The static water level in the well will be measured using an electronic water level meter. The probe and tape portion of the meter will be washed with Alconox and water, and then rinsed with distilled/deionized water between individual wells to prevent cross-contamination.
- Based on the measured water level, the well volume will be calculated based on the assumption that the well volume includes the water contained in the screen and riser plus that contained in the filter pack. For a 2 inch diameter overburden well with a water level below the top of the well screen, a well volume can be approximated by multiplying the water column height by 0.93 (a purge factor determined by the geometry of the well boring and screen, as well as the porosity of the filter pack sand). An open hole bedrock well would have a purge factor of 0.37, the volume of water per linear foot in a 3 inch diameter borehole.

- A polyethylene tarp will be placed around the well to prevent contamination of sampling equipment due to contact with the ground.

- Purging of the well will be initiated using either a dedicated polyethylene bailer or, for higher yielding wells/purge volume requirements, a submersible pump with dedicated polyethylene tubing.

- Prior to sampling, well purging will continue until field chemistries measured during the well purge stabilize. Stabilization criteria include $\pm$0.2 pH units, $\pm$0.5^{o}C temperature change, and $\pm$10% fluctuations in specific conductivity readings during consecutive measurements (typically based on a measurement interval of 0.5 well volumes).

- Once the purge stabilization criteria have been met the water level in the well will be measured again to assess the drawdown, if any, during purging. Prior to sampling the water level will be allowed to recover to within 90% of its static level or for 2 hours. If the well was purged dry and is a poor yielding well, the water level will be allowed to recover up to 24 hours to allow enough recovery to collect an adequate sample volume.

- The sample will be collected using a dedicated bailer lowered into the well with a new length of nylon bailer twine. If a VOC sample is required it will be collected from the first bailer volume retrieved from the well, to minimize the potential for volatilization during retrieval of subsequent bailers.

- Samples will be collected in laboratory cleaned bottles appropriate for the analyses required for the project. Samples will be placed in a cooler on ice and sent via overnight delivery, under chain of custody protocols, to the contract analytical laboratory.

- After the samples are collected a final set of field chemistries will be collected, as well as a final water level, before the well is securely closed and re-locked.

9.3.4 Low Flow Sampling

Low flow sampling protocols are increasingly used in situations where investigation derived waste management is a concern, particularly due to the volume of purge water generated during sampling of large diameter or deep wells. The low flow or low stress sampling method is employed to impart low pumping stresses on the well and aquifer and to insure zonal flow of groundwater across the screened interval of the well rather than resulting in mixing of water from various intervals within the aquifer. In addition, the typically low flow rates (< 0.5 mL / min) utilized during purging and sampling leads to less potential for volatilization of volatile compounds during the sampling process.

The procedures for low flow sampling generally follow those for conventional sampling as described above with the exception that flow rates are significantly lower and stabilization criteria for the field parameters, indicating that the well is ready to be sampled, are also somewhat different from those required during conventional purging and sampling. The specific protocol followed by HDR during low flow sampling is contained in USEPA's guidance document and protocol {USEPA Ground Water Issue – April 1996: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures} which is attached to this program field activities plan as Attachment 2.

9.4 Residential Well Sampling

Residential well samples will be collected directly from the well casing (typically 6 inch diameter steel casing for bedrock wells) using dedicated bailers or submersible pumps if possible. More typically the service pump and associated wiring and piping will prevent access to the water column or the wellhead itself will be inaccessible. In these cases samples will be collected from a service point as close to the wellhead as possible such as a hose bib or outside spigot or, if available, a pressure tank. Primary consideration is given to collecting a sample of raw groundwater prior to encountering any treatment systems, including water softeners or activated carbon canisters. For cases where samples from off-site private property must be collected to address the extent of impacted groundwater, the property owners will be contacted by NYSDEC to discuss and schedule the sampling program. Contact will be attempted both through telephone calls and through a written notice delivered a minimum of 10 days prior to the collection of the sample(s).

An attempt will be made to purge at least one well volume from the well prior to sample collection to insure that groundwater collected is representative of groundwater from the source aquifer for the well. This will typically be accomplished by opening the valve at the sampling point and allowing the water to run for 10 – 15 minutes prior to collection of samples. Groundwater chemistries (pH, specific conductivity, temperature, and turbidity) will be collected during purging as stable chemistry values are an additional indicator that aquifer derived water, rather than water contained in the well casing or borehole, is being sampled.

9.5 In-Situ Hydraulic Testing (Slug Testing)

In-situ hydraulic tests (slug tests) provide a method for estimating aquifer parameters such as hydraulic conductivity and storativity using techniques that are significantly simpler and more cost-effective than full scale aquifer (pumping) tests. In a typical slug test a pressure transducer will be installed at least 10 feet below the measured static water level in the well. A solid stainless steel slug attached to nylon rope will be lowered to just above the water table. The pressure transducer and data logger will be programmed to set the static level as a reference level and to collect water levels following a logarithmic schedule. Data collected according to a logarithmically increasing sample interval allows the maximum number of levels to be recorded during the earliest portion of the test, while the water level is changing most rapidly. Once the transducer is set up, data collection will be started and the slug will be advanced rapidly but smoothly into the water column until completely submerged to start the falling head portion of the test. Importantly, advancement of the slug will not occur simultaneously with the start of data logging but will be slightly delayed (1 – 2 seconds) to allow the collection of a reference, static water level in the well at the very start of the test. Collection of water level data will then continue until the displacement of the water level in the well due to slug installation recovers to near static levels. The data logger and transducer will then be re-programmed, with the slug still in the well, in preparation for the rising head portion of the test whereby the slug is removed from the water column and the subsequent drawdown recovers to static conditions. Typically three sets of both rising and falling head tests are run on each well to eliminate potentially anomalous results.

Using applicable methods and solutions for the tested aquifer system, type curve matching software (i.e. AQTESOLV) will be utilized to evaluate the resultant data and calculate values for pertinent aquifer characteristics such as hydraulic conductivity and storativity.

9.6 Water Level Measurements

Water level measurements will be collected using an electronic water level meter and will be measured to an accuracy of 0.01 feet. To facilitate the preparation of potentiometric surface maps displaying groundwater elevation contours each measurement will be referenced to a measurement point elevation surveyed to an accuracy of 0.01 feet. The measurement point will be the top of the inner PVC well riser whenever possible and will be clearly indicated by a notch cut into the top edge of the riser pipe. A designated point on the top surface of the outer rim of the protective casing will also be surveyed as an alternative reference point in the event that the inner casing is inaccessible for use as an accurate reference.

10.0 SURFACE WATER SAMPLING

Surface water samples may be collected at sites where impacts to surface water bodies are suspected, either directly through a release into the surface water or through hydraulic connection between impacted groundwater and a surface water body.

In some situations collection of surface water samples from off-site locations will be required. When these circumstances arise it may be necessary to collect samples from locations on private property. For cases where samples from private property must be collected to address the distribution of impacted waters, the property owners will be contacted by NYSDEC to discuss and schedule the sampling program. Contact will be attempted both through telephone calls and through a written notice delivered a minimum of 10 days prior to the collection of the sample(s).

Once surface water sampling points are selected the samples will be collected using a laboratory-cleaned, dedicated dip bucket or directly using the sample container. If possible the samples will be collected from points near shore to allow sample personnel to avoid entering the water during sampling. In the event that entry into the water is required to obtain the sample, entry will only be attempted if site conditions support sampling under non-hazardous conditions. Specific details relating to the health and safety considerations for this type of sampling will be covered in the site specific health and safety plan for the appropriate project.

During sampling the approximate location where each sample is collected will be indicated on a sketch map in the project field book. Field surface water chemistries, including pH, dissolved oxygen, temperature, and specific conductivity will be measured and noted in the field book as well. In addition, the field crew will note any other pertinent information, including flow rate, visual and olfactory observations of the water, and the presence of distressed vegetation or wildlife.

If field conditions and access to the satellite signals for the system are favorable, GPS surveying will be used to record the field sampling locations. GPS will be utilized since other methods commonly used to mark sampling locations, such as staking or flagging, are not well suited to an environment with changeable stream channels, shorelines, or water levels.

Surface water samples will be submitted in laboratory-cleaned bottles under chain of custody protocols via overnight delivery to a certified contract laboratory for analysis. The sampling naming convention outlined in Attachment 1 will be used for all samples collected for testing at the analytical laboratory.

11.0 SEDIMENT SAMPLING

Sediment sampling is often conducted along with surface water sampling, with a similar procedure as that outlined in Section 10. Shallow sediment samples will be collected using a laboratory cleaned, dedicated stainless steel sediment corer, hand auger, or stainless steel scoop as warranted by the consistency and accessibility of the sediment to be sampled. In some cases, where direct access is not possible, a dredge may be required to retrieve samples from more remote sample points.

As is the case for surface water samples, all sediment samples will be transferred to an appropriate sample jar and submitted, via overnight delivery, to the contract laboratory under chain of custody protocols. Sample locations may be temporarily marked in the field for reference using stakes or flagging, however, if possible, the points will be permanently located using GPS.

12.0 SOIL VAPOR POINT INSTALLATION AND SAMPLING

Soil vapor points may be installed using a direct push method similar to that described for temporary monitoring wells (but typically using a smaller diameter sample point installed somewhat shallower) or by manually driving a soil vapor sample point to a target depth (typically 2 – 3 feet below the surface).

In general, permanent or semi-permanent installations are preferred for enhanced data quality and consistency. Temporary points will only be used if an adequate surface seal can be maintained to prevent ambient air infiltration and if a tracer gas (e.g. helium) is used to verify the seal at each location. Whether, temporary or permanent systems are employed, the general methodology for soil vapor point installation and sampling is as follows:

- Sample points will be driven or pushed into place using an appropriate method based on site conditions.
- Porous, inert backfill material will be used to backfill a sampling zone approximately 1 – 2 feet in length.
- The vapor point will be fitted with inert polyethylene or PTFE tubing (laboratory grade) extending to the surface.
- The sampling zone will be sealed at the upper surface with a bentonite slurry for a minimum of 3 ft to prevent ambient air infiltration; the remainder of the borehole will be filled with clean material, if necessary.
- When multiple sample depths are required separate nested probes will be installed.
- A protective casing will be installed around the top of the tubing at the surface to prevent infiltration of water and ambient air and to reduce the chance for damage to the point.

Representative soil vapor samples will be collected using the following procedures:

- The vapor point will be allowed to set for at least 24 hours after initial installation for permanent points.
- After installation and the required delay prior to sampling for the permanent points, a total of 1 – 3 sample system volumes (i.e. volumes of the sample probe and tubing) will be purged prior to sample collection.

- The system purge and sample collection will be completed at flow rates not to exceed 0.2 liters per minute to minimize the potential for ambient air infiltration.

- Samples will be collected in an appropriate container – consistent with the sampling and analytical requirements for the project. Typically, samples will be collected in laboratory cleaned Summa canisters for EPA Method TO-15 analysis. Canister volume, regulator flow rate, and sample duration requirements will be reviewed with NYSDEC on a project specific basis since these requirements are typically dependent on the particular setting and the final desired use of the data collected.

- A log of vapor sampling, such as that shown in **Figure 12-1**, will be maintained to provide a record of sampling time, location, and vacuum pressures.

In some cases sub-slab vapor sampling may be conducted to address the presence of vapors beneath building floors as a potential source for migration of contaminants inside structure and occupied spaces above the floor grade. Procedures for collecting sub-slab vapor samples are similar to those outlined above, with sub-slab sample points typically penetrating shallower than soil vapor points. The detailed guidance that HDR will refer to for vapor sampling is contained in the Final NYSDOH BEEI Soil Vapor Intrusion Guidance document from October 2006.

13.0 INDOOR AIR MONITORING

Prior to collection of indoor air quality samples, a pre-sampling inspection will be conducted, consisting of an indoor air quality questionnaire and building inventory to assess the usage or storage of potential contaminants of concern in the building where sampling will occur. In addition, an assessment of the HVAC system and other activities/systems associated with the building will be performed to identify potential interference issues regarding laboratory analysis and data.

Indoor air samples will be collected using 6-liter capacity Summa canisters with 8-hour flow regulators provided by a certified analytical laboratory. Samples will be collected within the area(s) of concern and an additional air sample will be collected from a location considered to be outside of the area of concern, such as from an outside location, as an ambient air sample.

The intakes of the sampling canisters will be placed approximately three to four feet above ground level. Canister vacuum readings from the pressure regulators will be recorded before, during, and after sample collection. Once the vacuum pressure decreases to 5 psi as indicated by the pressure regulators the flow valve is closed to complete sample collection.

Each indoor air sample will then be submitted under chain of custody protocol to a certified contract laboratory via overnight delivery for analysis. Sample analysis will typically be conducted following EPA TO-15 methods.

14.0 COMMUNITY AIR MONITORING PROGRAMS

A Community Air Monitoring Plan (CAMP) requires real – time monitoring for volatile organic compounds (VOCs) and particulates (i.e. dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not implemented to establish action levels for worker respiratory protection but rather to provide a measure of protection for the downwind community (i.e. off-site receptors).

In some cases a site specific CAMP may be required to fully address NYSDOH requirements, however the methods outlined below provide the framework for monitoring community air quality during most site activities where this issue may be a concern.

Depending on the nature of the known or suspected contaminants at the site, real-time air monitoring for VOCs and/or particulates at the perimeter of work or exclusion zones will be necessary. Continuous monitoring will be required for certain ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. These activities include but are not limited to, soil/waste excavation and handling and test pit or trench excavation. In some cases monitoring may also be required during drilling of soil borings and monitoring wells. Periodic monitoring may also be conducted during drilling activities and during non-intrusive activities such as during soil and water sampling. Periodic monitoring typically entails field screening of a well head or scanning the vicinity of soil sampling locations for organic vapors.

VOCs must be monitored at the downwind perimeter of the immediate work area on a continuous basis or as otherwise specified. Upwind concentrations should also be measured at the start of the day and periodically thereafter to establish background conditions. Monitoring should be conducted using equipment appropriate for the suspected contaminants. The equipment should be calibrated at least daily for the contaminants of concern or an applicable surrogate. The equipment used for monitoring should be capable of recording 15 minute running average concentrations, which will be used for comparison to applicable standards/action levels.

Particulate monitoring will occur continuously at the upwind and downwind perimeters of the exclusion (work) zone. The monitoring will be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate concentrations exceeding the action level.

15.0 WASTE HANDLING AND DISPOSAL

HDR will be responsible for the proper storage, handling, and disposal of investigative-derived waste; including personal protective equipment, and solids and liquids generated during the well drilling, well development, and well sampling activities. All drummed materials will be clearly labeled as to their contents and origin and all investigation derived waste will be managed in accordance with NYSDEC-DER 10 Section 3.3(e):

- Liquids generated from equipment decontamination that exhibit visual staining, sheen, or discernable odors will be collected in drums or other containers at the point of generation and stored in a designated staging area. A waste subcontractor will then remove the drums for disposal at an offsite location.

- Liquid generated during well purging or a decontamination activity that does not exhibit visible staining, sheen, or discernable odors will be discharged to an unpaved area on the site, where it can percolate into the ground.

- Concrete dust will be collected in shop vacuums or by sweeping the work area and disposed of as non-regulated solid waste, unless photoionization detector readings or visual indications of contamination are noted during field operations.

- Soil and rock cuttings from drilling operations that do not exhibit visible staining, sheen, or discernable odors will be disposed of on-site by spreading the cuttings in the area of the well head.

- Soil and rock cuttings from drilling operations that exhibit visible staining, sheen or discernable odors will be staged onsite in clearly labeled drums until an appropriate disposal alternative have been determined.

- Excavated soils from test trenching or test pit excavation will be used to backfill the excavations after inspections of the soil have been completed.

- Used protective clothing and equipment that has been exposed to contaminants will be collected in plastic bags, packed in 55-gal ring-top drums, and transported to the designated drum staging area.

- Non-contaminated protective clothing, trash, and debris will be placed returned to the HDR- Nanuet warehouse and disposed of in a trash dumpster and disposed of by a local waste management hauler.

16.0 SITE SURVEY AND BASE MAP PREPARATION

A site survey will be conducted of all soil boring locations, monitoring well locations, test pit locations, soil vapor point locations, and surface water/sediment sampling locations. Additional tasks may include performing a topographic survey, and preparation of a site map (typically based upon a previous base map or site control markers). To ensure consistent elevation data, each of the existing monitoring wells or other pertinent locations will be included in the site survey as well.

A detailed topographic base map of the site and immediate vicinity will be developed. All relevant features of the site and adjacent areas will be plotted. As detailed in the various sampling sections, the HDR field representative will be responsible for either flagging or staking each of the pertinent sample locations. In some applications, a high-precision GPS survey will be completed rather than a standard level survey.

The site map will also include site-specific features associated with the characterization/ investigation (i.e., surface water drainage, above and underground storage tanks, buildings, drywells, cesspools). Additionally, engineering controls implemented at the site must be clearly labeled. Contours will be plotted at 1-ft intervals or as warranted by the overall topography of the site. The location and elevation of each survey point will be surveyed by a New York State licensed surveyor.

The elevations of all monitoring well casings will be established to within 0.01 ft based on the National Geodetic Vertical Datum. A permanent reference point will be placed in all interior polyvinyl chloride casings to provide a point to collect future groundwater elevation measurements.

The site tax map number will also be identified. The tax maps will be reviewed and the property lines of the parcels will be plotted on the base map.

With respect to the site survey and base map preparation, the following assumptions have been made:

- The estimated survey area should include the whole site boundary. All elevations will be referenced to the NAVD 88. All horizontal locations will be referenced to the NAD 83.

- Three blueline copies of the site base maps with topography (1 ft intervals), and three blueline copies of the site basemap, without topography, will be submitted to the NYSDEC.

- The site map must be provided in AutoCAD, version 12 or higher and ArcMap™ 9.1.

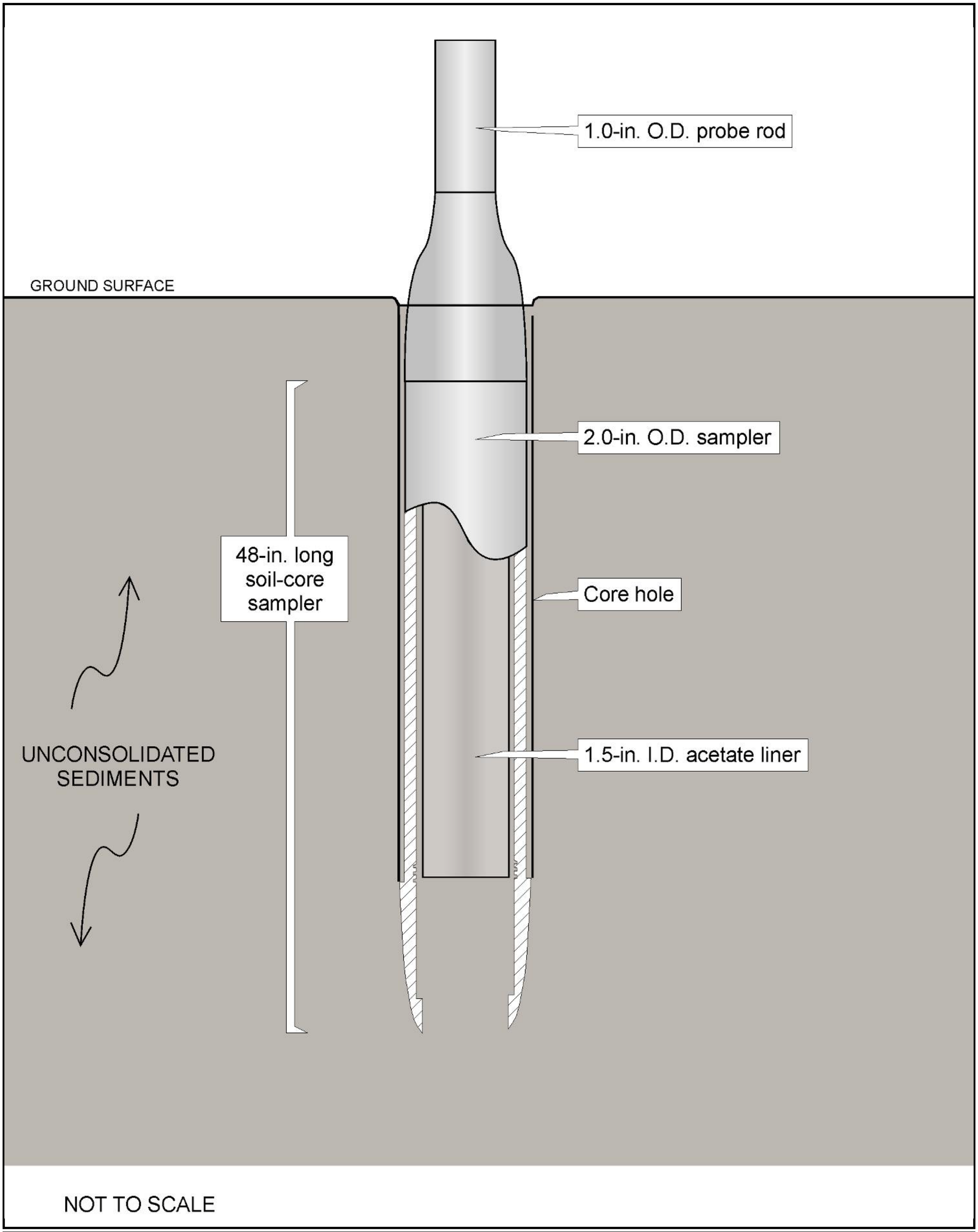
17.0 REFERENCES

New York State Department of Health. October 2006. *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*. New York State Department of Health, Division of Environmental Health Assessment, Center for Environmental Health.

New York State Department of Environmental Conservation – Division of Environmental Remediation. May 2010. *Draft DER-10 Technical Guidance for Site Investigation and Remediation.*

United States Environmental Protection Agency. Ground Water Issue - April 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.*

Figures



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Soil Core Sampler Cross Section

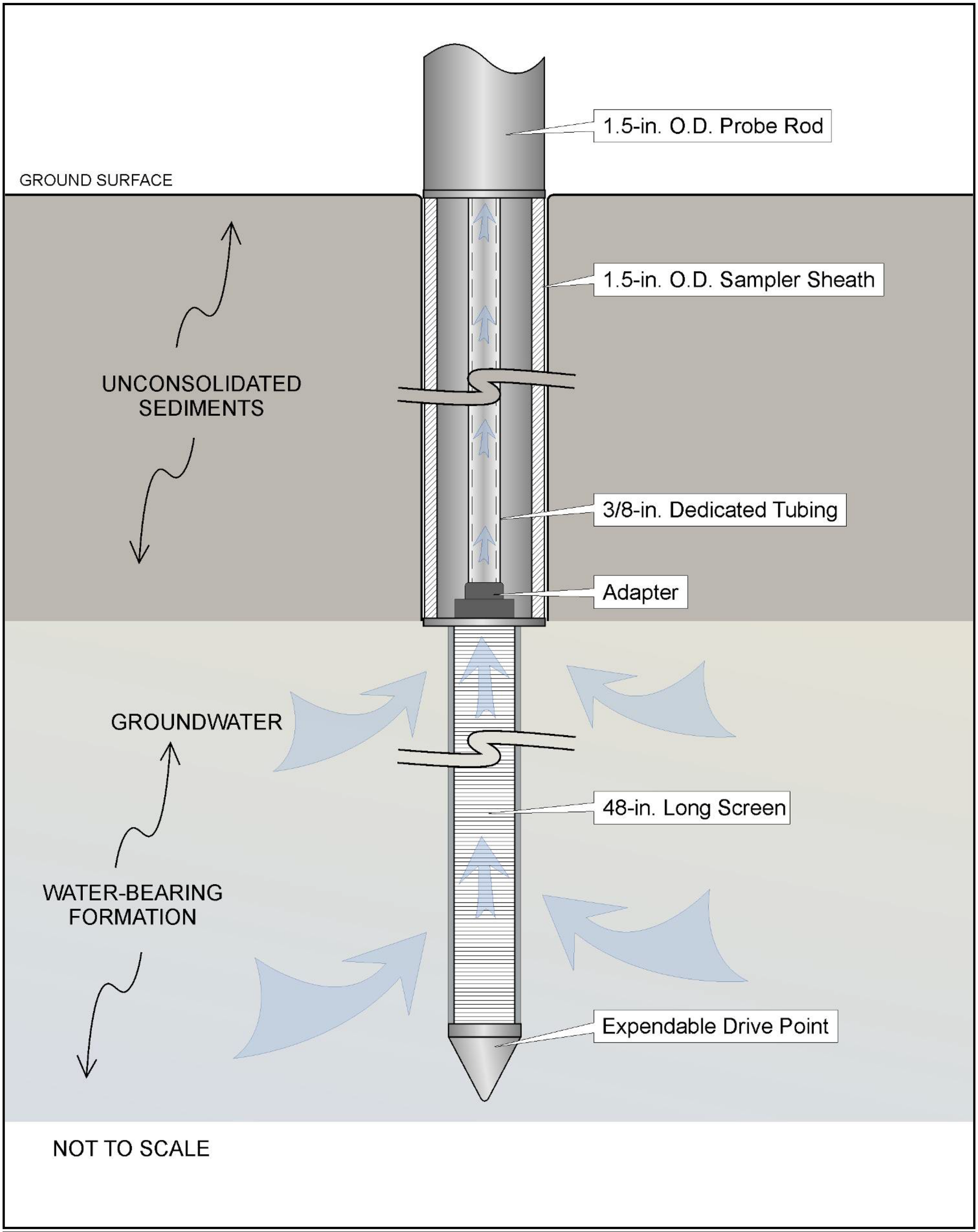
NYSDEC Standby Contract

Figure 6-1

Test Boring Log

Boring No.:	
Sheet of	
Project Name:	**Project No.:**
Client:	**Date:** Start
Driller:	Finish
Drilling Method:	**Total Depth:**
Boring Location:	**Depth To Water:**
Coordinates:	**Surf. Elevation:**
Logged By:	**Hole Diameter:**
Monitoring Instrument(s):	

Depth (ft)	Blows On Sampler				Recovery (ft)	Instrument Reading	Sample Retained		Classification Of Material	Remarks
	0"-6"	6"-12"	12"-18"	18"-24"					f - fine m - medium c - coarse and - 35-50% some - 20-35% little - 10-20% trace - 0-10%	



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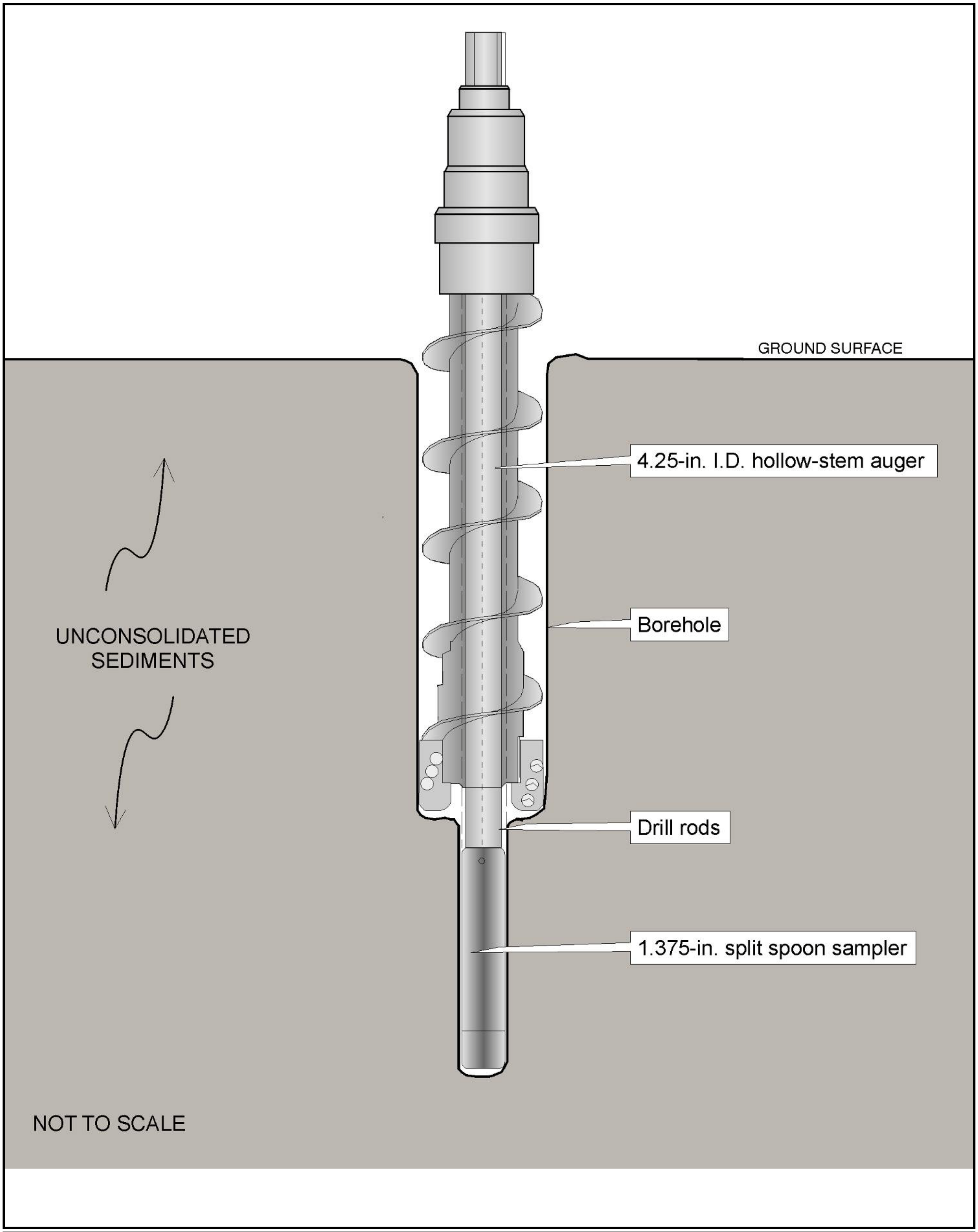
Probe Unit Groundwater Sampler Cross Section

NYSDEC Standby Contract

Figure 6-3



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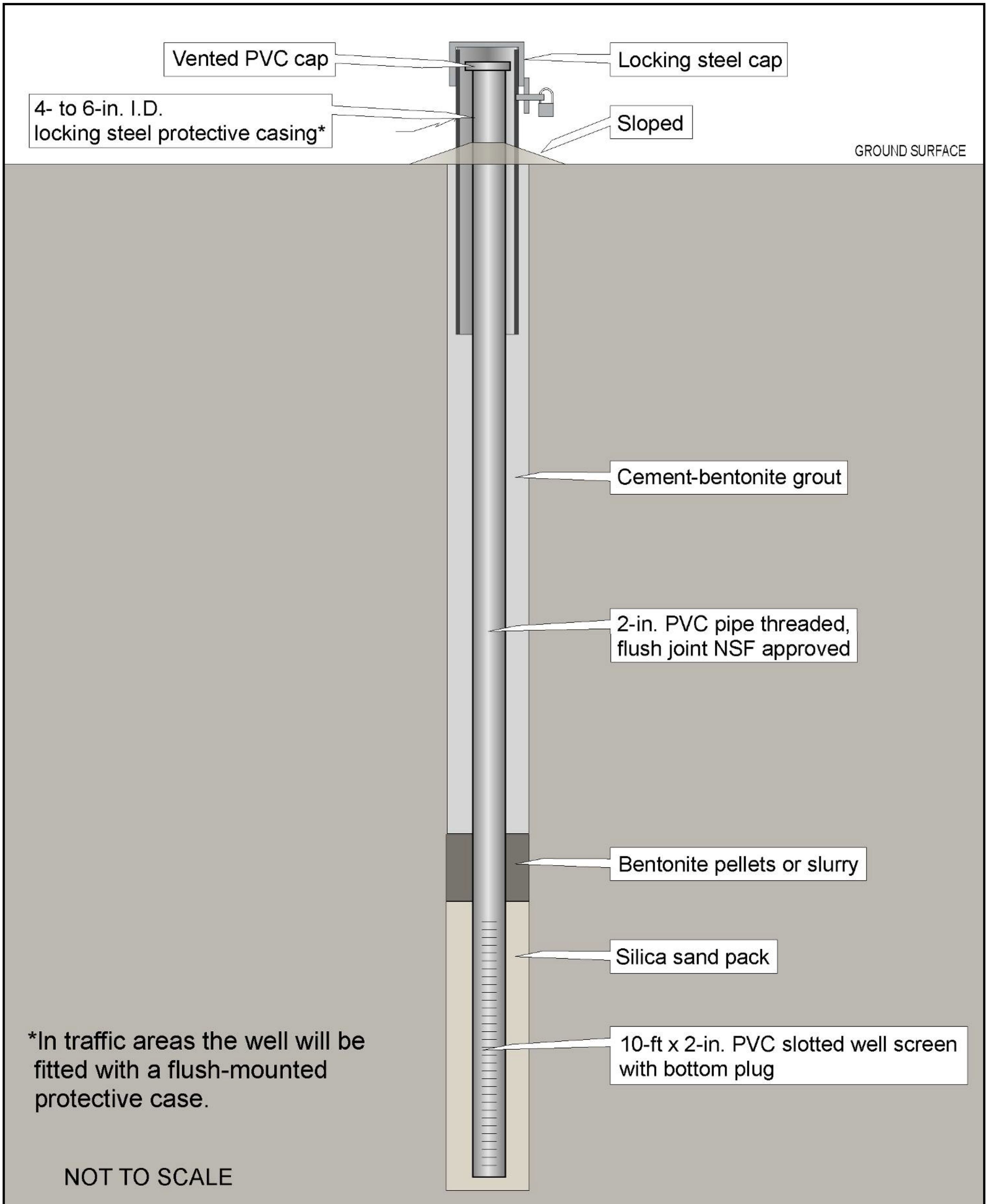
Test Boring/Sampling Cross Section

NYSDEC Standby Contract

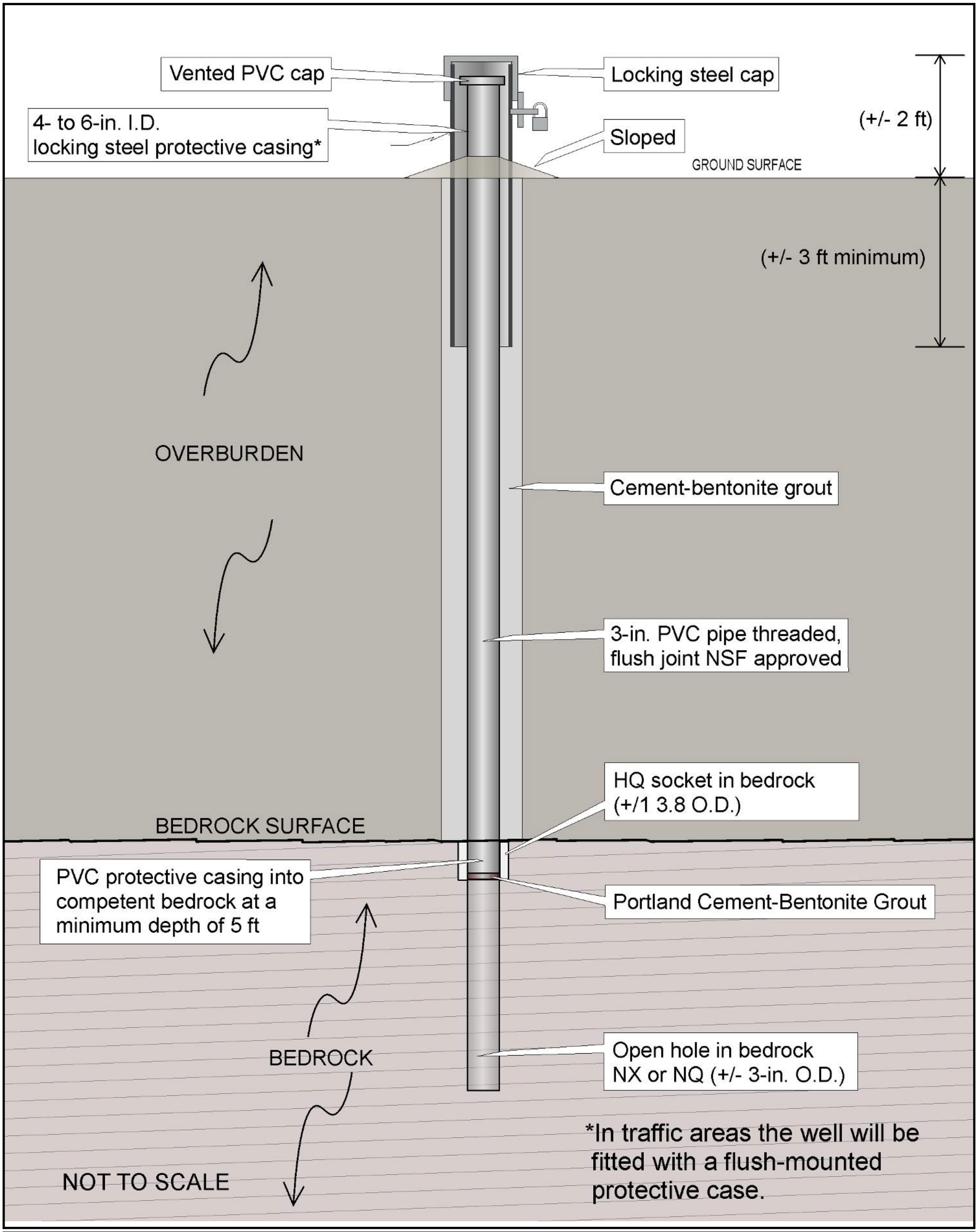
Figure 7-1



Typical Overburden Monitoring Well Cross Section

NYSDEC Standby Contract

Figure 7-2



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Bedrock Monitoring Well

NYSDEC Standby Contract

Figure 7-3

Well Development Log

Well ID No.:

Well Casing Type:
Well Depth*:
Screened Interval:
Well Elevation*:
Ground Elevation:
Well Condition:
Weather Conditions:

Start SWL:
Water Column Ht.:
Well Volume (gallons):

Project:
Date:
Crew:
Purge Method:
Meters Used:
PID Head Space (ppm):

Time	Est. Gal. Purged	Purge Rate (gpm)	pH	Cond. (S/m)	Turbidity (NTU)	D.O. (mg/L)	Temp. (C°)	Salinity (%)	TDS (g/L)	ORP (mV)	Depth to Water*	Comments

Comments:

Notes: Volume is measured in Gallons
* - Measurement taken from top of well casing

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Well Development Log

NYSDEC Standby Contract

Figure 8-1

Well Sampling Log

Well ID No.:

Well Casing Type:
Well Depth*:
Screened Interval:
Well Elevation*:
Ground Elevation:
Well Condition:
Weather Conditions:

Start SWL:
Water Column Ht.:
Well Volume (gallons):
SWL During Sampling:
Sample Time:
Sample Method:
Sample Analyses:

Project:
Date:
Crew:
Purge Method:
Meters Used:
PID Head Space (ppm):

Time	Est. Gal. Purged	Purge Rate (gpm)	pH	Cond. (S/m)	Turbidity (NTU)	D.O. (mg/L)	Temp. (C°)	Salinity (%)	TDS (g/L)	ORP (mV)	Depth to Water*	Comments

Comments:

Notes: Volume is measured in Gallons
* - Measurement taken from top of well casing

Soil - Gas Boring Log

	Crew:
	Sheet of
Project Name:	**Project No.:**
Client:	**Date:** Start
Drilling/Boring Method:	Finish
Pumping Method:	**Pump ID**
Boring Location:	**Depth to Water:**
Coordinates:	**Surf. Elevation**
Logged By:	**Hole Diameter:**
Monitoring Instrument:	

Sample ID	Start Time	End Time	Start Pressure	End Pressure	Purge Rate	Sample Depth	Cannister ID	Regulator ID	Remarks And Observations

Note: Start Time end Time refers to Start and end time for sample collection only.

Attachment 1

NYSDEC Standby Contract Environmental Sampling Naming Convention

In order to be consistent with the Electronic Data Deliverables (EDD) requirement outlined under the Standby Contract, a sample naming convention has been adopted for each of the work assignments under the contract as shown in table below. The specific requirements of the EDDs are discussed in more detail in the Program QAP.

Example Sample ID:	**SA-MW-1s-GW-50-0**
Abbreviation	Explanation
SA	Denotes the location (site or portion thereof) **-** in this example **S**ite **A**
MW	Denotes sample source for example: MW **- M**onitoring **W**ell SS **-** Soil Sample SP **-** Soil Probe GWP- Groundwater Probe
1s	Sample source unique identifier (e.g. well number)
GW	Denotes sample matrix
50	Denotes sample depth or other sample descriptor
0	Sample type code for example: 0 regular sample 1 duplicate sample 2 field blank sample 3 trip blank

Attachment 2

USEPA Ground Water Issue: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures

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

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.

For further information contact: Robert Puls, 405-436-8543, Subsurface Remediation and Protection Division, NRMRL, Ada, Oklahoma.

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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Director

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.

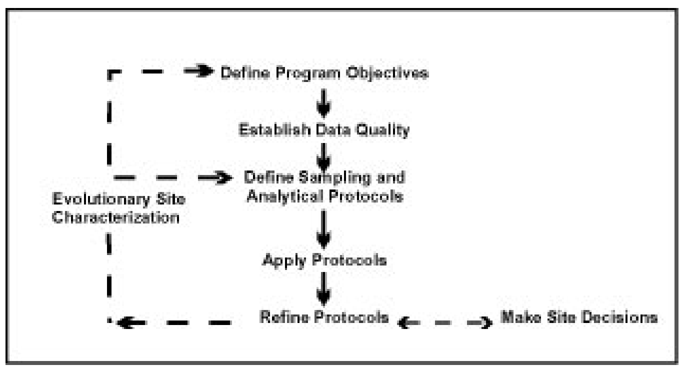

Figure 1. Evolutionary Site Characterization Model

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

The U.S. Environmental Protection Agency through its Office of Research and Development funded and managed the research described herein as part of its in-house research program and under Contract No. 68-C4-0031 to Dynamac Corporation. It has been subjected to the Agency's peer and administrative review and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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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: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi\ r^3$

PROGRAM
QUALITY ASSURANCE PROJECT PLAN
NYSDEC STANDBY ENGINEERING CONTRACT
CONTRACT #D007625

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Prepared by

HDR

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4/15/2011

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1.0 PURPOSE AND OBJECTIVES

1.1 Purpose

This Program Quality Assurance Project Plan (QAPP) has been prepared as a generic companion document to accompany the site-specific Work Plans for the individual work assignments issued to Henningson, Durham, & Richardson Architecture and Engineering, P.C. (HDR) by the New York State Department of Environmental Conservation (NYSDEC) under Engineering Standby Contract No. D007625. The principal purpose of this document is to specify quality assurance/quality control (QA/QC) procedures for the collection, analysis, and evaluation of data that will be legally and scientifically defensible. The site-specific QAPP Addendum provided as an appendix to each site-specific Work Plan specifically supplements this document.

1.2 Quality Assurance Project Plan Objectives

The QAPP provides general information and references standard operating procedures (SOPs) applicable to the analytical sampling program detailed in each site-specific Work Plan. This information includes definitions and generic goals for data quality and required types and quantities of QA/QC samples. The procedures address field documentation; sample handling, custody, and shipping; instrument calibration and maintenance; auditing; data reduction, validation, and reporting; corrective action requirements; and QA reporting specific to the analyses performed by the NYSDEC approved analytical laboratories under a subcontract agreement with HDR.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

HDR, as prime contractor will be responsible for overall technical direction and administration of each work assignment. Each work assignment will be managed through an organized effort directed by the Project Manager and the individual task managers. These efforts will employ pre-approved field procedures, sampling techniques, and analytical methods to accomplish the project objectives. Effective program organization will accommodate these requirements while maintaining a manageable degree of control over these activities.

2.1 Overall Project Organization

The project-specific organizational and management plan is detailed in each site-specific Work Plan. Each site-specific Work Plan will include an organizational chart that illustrates the project organization for the accomplishment of each task.

The key technical management of the work assignments will be accomplished by a designated Project Manager and an assigned project team. Additional individuals will be made available, if warranted. Each of the laboratories will have a designated Laboratory Project Manager who will serve as the liaison between the laboratory staff and the overall project manager.

For the purpose of QA/QC, the Program Quality Assurance Officer (QAO) will assess the effectiveness of the QA/QC program and recommend modifications when applicable. Additionally, the QA/QC Officer may delegate technical guidance to specially trained individuals under his direction. The QAO will assign a Project Quality Assurance Officer to all work assignments completed under this contract. The Project Quality Assurance Officer will provide guidance on technical matters and review technical documents relating to the work assignments.

The Program Health and Safety Officer (HSO) is also an integral part of the project implementation teams. The Program HSO is responsible for the development, final technical review, and approval of the Generic Health and Safety Plan and overall corporate Safety

Program. Our designated Office Safety Coordinator (OSC) will review the project-specific Health and Safety Plans. In addition, the OSC will provide authorization, if warranted, to modify personal protective equipment requirements based on field conditions. The OSC will also provide final review of all health and safety monitoring records and personal protective equipment changes to ensure compliance with the provisions of the Health and Safety Plans.

2.2 Analytical Laboratories

The analytical laboratories will perform chemical analyses of environmental samples collected for each work assignment, as necessary. The laboratories are capable of providing a complete range of analytical services consistent with NYSDEC ASP CLP. These laboratories will maintain their certification by the New York State Department of Health Environmental Laboratory Approval Program.

The laboratories will have their own provisions for conducting an internal QA/QC review of the data before they are released to HDR. The Laboratory Project Managers will contact HDR's Project Managers with any sample discrepancies or data concerns.

Hardcopy and electronic data deliverables formatted QA/QC reports will be filed by theanalytical laboratories when data are submitted to HDR. Corrective actions will be reported to the HDR Project Managers along with the QA/QC reports (Section 8). The laboratories may be contacted directly by HDR or NYSDEC personnel to discuss QA concerns.

3.0 QUALITY ASSURANCE/QUALITY CONTROL OBJECTIVES FOR DATA MEASUREMENT

3.1 Overview

This section discusses QA objectives for the activities conducted for the individual work assignments under the Standby Contract. QA objectives are met in part with the development of data quality objectives (DQOs). DQOs are qualitative and quantitative statements that specify the quality of data required to support decisions, and are therefore based on the end uses of the data. DQOs for the individual assignments will ensure that data will be extensive enough and of sufficient quality to allow the following project goals to be realized through data assessment:

- Determine the nature and extent of contaminated material present on-site.
- Define the nature and extent of off-site contamination (as required).
- Identify hot spots of environmental contamination.
- Complete the feasibility study.
- Complete risk assessment activities.
- Determine if the site poses a significant threat to human health or the environment.

DQOs are met with the development of QA/QC procedures which are designed to maintain data quality and adherence to established protocol.

Quality data can be assured if the QA objectives set forth in this QAPP are realized. Data quality is measured by how well the data meet the QA/QC goals of the project. In this plan, "Quality Assurance" and "Quality Control" are defined as follows:

- Quality assurance is the total integrated program for assuring reliability of monitoring and measurement data.
- Quality control is the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process.

QA elements to be evaluated include accuracy, precision, sensitivity, representativeness, and completeness. The database must be accurate enough to assess potential environmental impacts. Reporting of the data must be clear, concise, and comprehensive. QC elements that are important to this project are blank contamination, instrument calibration, completeness of data packages, sample holding times, and sample custody.

3.2 Laboratory Quality Assurance Objectives

The fundamental mechanisms that will be employed to achieve these quality goals in laboratory analyses can be categorized as prevention, assessment, and correction. These include:

- Prevention of defects in the quality through planning and design; documented instructions and procedures; and careful selection of skilled, qualified personnel.
- Quality assessment through a program of regular audits and inspections to supplement continual informal review.
- Permanent correction of conditions adverse to quality through a closed-loop corrective action system.

Overall compliance with laboratory QC procedures will be evaluated against the criteria specified for each method. Deviations will be reported in the narrative, which contains comments or problems encountered during fractional analyses of the samples. The narrative includes the laboratory's assessment of the impact on data usability and will address QC issues related to the following:

- ***Laboratory Method Performance*** - QC criteria for method performance must be met for target analytes for data to be reported. These criteria generally apply to instrument tune, calibration, method blanks, surrogates, and laboratory control samples.
- ***Sample Matrix Effects*** - QC samples are analyzed to determine measurement bias due to the sample, and may include surrogates, matrix spikes, matrix spike duplicates, and laboratory duplicates. If criteria are not met, matrix interferences are confirmed either by reanalysis or by inspection of the laboratory control sample results to verify that laboratory method performance is in control. Data are reported with appropriate qualifiers or discussion.

3.3 Field Parameters and Quality Assurance Objectives

Water quality parameters consisting of pH, conductivity, dissolved oxygen, temperature, oxygen reducing potential and turbidity will be measured to provide general surface water and groundwater quality information. These parameters will also be monitored for stability during purging of groundwater monitoring wells. Field test methods that will be utilized to measure these specific parameters are described in the Program Field Activities Plan and any deviation from these methods for the individual assignments will be described in the project-specific Field Activities Plan.

Field screening of soil samples using a photoionization detector will be performed to assess the presence and relative concentrations of volatile organic vapors. The method for quantification of soil volatile organic compounds (VOCs) using headspace measurement, as well as operational protocols of the photoionization detector, will be presented in the Program Field Activities Plan.

Soil vapor, indoor/outdoor air, and soil/sediment sampling locations and monitoring wells will be surveyed with the accuracy and precision requirements discussed in Program Field Activities Plan. Ground surface and top-of-casing elevations for each of the newly installed monitoring wells will be measured to the nearest 0.01 ft as referenced to the North American Vertical Datum of 1988.

For field QC data, no QA objectives have been determined by the NYSDEC. Field QC data will be maintained primarily for descriptive purposes and data variability. The task manager will be responsible for reviewing and evaluating the field QC data.

Similar samples will be collected using consistent sampling methods, analyzed using consistent analytical procedures, and reported in conventional units (e.g., μg/L, μg/kg, and $\mu g/m^3$ for analytical results). Therefore, the data will be comparable throughout the project.

3.4 Detection and Quantitation Levels

In addition, analytical sensitivity is an important component of data quality, and is evaluated using analyte detection and quantitation levels.

3.4.1 Detection Limits

A detection limit has been defined by the Committee on Environmental Improvement of the American Chemical Society (Anal. Chem. 55:2210-2218 [1983]) as "the lowest concentration that can be determined to be statistically different from a blank." Various methods are available for determining detection limits, most of which are based on the standard deviation of measurements in the region near the blank responses. The following detection limits are determined routinely in the laboratory.

Instrument Detection Limits (IDLs) are determined using the protocols given in the inorganic and organic statements of work for the EPA Contract Laboratory Program (CLP). A standard deviation is calculated from replicate measurements of a low level standard and multiplied by 3 to give the IDL. IDLs are used as an index of instrument performance that does not include sample effects and, therefore, represent the lowest detection limit achievable. IDLs can vary between instruments of the same type and can change when redetermined.

Method Detection Limits (MDLs) are determined using the EPA procedure published in 40 Code of Federal Regulations 136 Appendix B. The MDL is defined as "the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte." This procedure requires that "sample processing steps of the analytical method be included in the determination of the method detection limit." Therefore, the sample matrix and sample preparation process, as well as the analytical instrumentation influence MDLs. A minimum of 7 replicate spikes at 1-5 times the expected MDL are analyzed. The MDL is calculated by multiplying the standard deviation of the measurements by the Student *t*value for a 99 percent confidence level. Because of the wide variety of matrix types analyzed by the laboratory, MDLs are routinely determined in reagent water or standard solid matrix. These

MDLs represent, therefore, the optimum values, and the MDLs for actual sample matrices are likely to be higher. MDLs can be determined for specific matrices when requested by the client.

Unless superseded by other program, project, or client requirements, IDLs and MDLs are determined annually. In addition, IDLs and MDLs are redetermined after an instrument is moved or modified, and MDLs are redetermined after a method has been significantly changed. Where more than one instrument is used in sample analyses by a given technique (e.g., gas chromatograph/mass spectrometry, gas chromatograph, graphite furnace atomic absorption [GFAA], or inductively coupled plasma), detection limit studies are performed for each instrument. A standard laboratory reporting limit is determined for each analyte based on the highest detection limit determined. Data for instruments are maintained for use in reporting data when project-specific requirements dictate lower detection limits.

A detection limit measured at a given time is an estimate of the true detection limit because the measured standard deviation used to calculate the detection limit is subject to random error and is an estimate of the population standard deviation. The confidence limits on the standard deviation and, hence the detection limit, can be determined using the chi-square (X^2) distribution (40 Code of Federal Regulations 136 Appendix B). The 95 percent confidence limits for an MDL determined from 7 replicates are 0.64 MDL and 2.20 MDL. A re-determination of the detection limit could produce a value between the chi-square limits, even if the conditions remain the same. Day-to-day changes in instrument performance can further produce changes in the measured detection limit.

When interpreting data and detection limits, it is important to remember that, when a measured concentration is greater than the detection limit, the analyte has the specified probability of actually being present (i.e., of having a true concentration greater than zero); however, the detection limit cannot be used to say anything about the presence or absence of an analyte that has a measured concentration less than the detection limit. From the definition of the MDL, there is a 1 percent chance that a sample with no analyte will produce a concentration greater than or equal to the MDL (false-positive). The probability is 50 percent, however, that a sample with a concentration at the MDL will be measured at less than the MDL (false-negative).

3.4.2 Quantitation Levels

To ensure better precision in low level data and to reduce the false-negative error rate, quantitation limits have been proposed as the minimum concentration at which an analyte can be quantified with an acceptable degree of confidence. The American Chemical Society Committee on Environmental Improvement has recommended that quantitation limits be calculated by multiplying 10 times the standard deviation, giving a relative standard deviation of 10 percent. The Committee further advised that quantitative interpretation, decision making, and regulatory actions should be limited to data at or above the limit of quantitation. The laboratories will use the term "Reporting Limit" for the laboratory quantitation limit.

3.4.3 Project-Specific Quality Control and Reporting Limits

Reporting limits applicable to the work assignments are the most current contract required quantitation limits for both CLP and SW-846 found in the NYSDEC Analytical Services Protocol (ASP) July 2005. Any project-specific revisions will be addressed in the project-specific QAPP Addendums.

4.0 SAMPLING AND SAMPLE CUSTODY PROCEDURES

4.1 Field Sampling Operations

The collection and subsequent laboratory analyses of environmental samples will provide the majority of the data collected during the standby contract work assignments. The number and types of analyses to be performed and the matrix of each of the samples are detailed in each assignment-specific Work Plan. The handling of samples in the field and in the laboratory must conform with the sample custody procedures established in this QAPP. Field custody procedures will involve proper handling of the laboratory supplied sampling containers, sample identification, chain-of-custody forms, and packaging and shipping procedures. Laboratory custody will begin with the receipt of samples at the laboratory and continue through sample storage, analysis, data reporting, and data archiving. This section provides the procedures that will be followed during the course of this project to ensure proper sample custody.

4.1.1 Sample Bottle Preparation

Chain-of-custody procedures begin with preparation of sample containers and preservatives to be used in sample collection. The standby laboratories will provide cleaned sample containers. Batch-certified clean summa canisters will be provided by the standby laboratories. Sample kits (coolers containing chain-of-custody forms, custody seals, sample containers, preservatives, and packing materials) will be prepared by the standby laboratories in response to receipt of the analytical task order submitted by HDR.

Container, preservation, and holding time requirements for aqueous and soil samples will be summarized in the Program Field Activities Plan.

4.1.2 Sampling Procedures

Sampling protocols will be presented in the Program Field Activities Plan. The protocols include standard sampling procedures for sample collection, accurate sample identification, and packing of samples for shipment. During sample collection, a chain-of-custody form is initiated, which accompanies the samples during shipment to the analytical laboratory.

The following elements will be important for maintaining the field custody of samples:

- Sample identification
- Sample labels
- Custody records
- Shipping records
- Packaging procedures

Sample labels will be attached to all sampling bottles before field activities begin; each label will contain an identifying number that has a suffix identifying the site and where the sample was taken. Approximate sampling locations will be marked on a map with a description of the sample location. The number, type of sample, and sample identification will be entered into the field log book.

A chain-of-custody form will be initiated at the laboratory and accompany the sample bottles from the laboratory into the field. Upon receipt of the bottles and cooler, the sampler will sign and date the first "Received" blank space. After each sample is collected and appropriately identified, entries will be made on the chain-of-custody form which will include:

- Site name and address
- Samplers' names and signatures
- Names and signatures of persons involved in chain of possession
- Sample number
- Number of containers
- Sampling station identification
- Date and time of collection
- Type of sample and the analyses requested
- Preservative used
- Pertinent field data (pH, temperature, turbidity, etc.)
- Condition of samples upon arrival at laboratory

After sampling has been completed, the sampler will deliver the samples to the laboratory, overnight currier, or laboratory supplier currier. The sampler will sign and date the next "Relinquished" blank space. One copy of the custody form will remain in the field and the remaining copies will accompany the samples to the laboratory. All samples will be received by the laboratory within 48 hours of collection. Samples will be received by the laboratory personnel who will assume custody of the samples, and sign and date the next "Received" blank. An example of a typical laboratory's chain-of-custody form can be found in Attachment 1.

4.2 Laboratory Sample Receipt

Upon receipt at the laboratory, a laboratory representative inspects the samples for integrity, checks the shipment against the chain-of-custody/analytical task order form, and signs the chain-of-custody. Discrepancies are addressed at this point and documented on the chain-of-custody form. Discrepancies are reported to the Laboratory Project Manager who contacts the designated HDR project staff as shown on the chain-of-custody for resolution.

When the shipment and the chain-of-custody are in agreement, the custodian enters the samples into the Laboratory Information Management System (LIMS) and assigns each sample a unique laboratory number. This number is affixed to each sample bottle. The custodian then enters the sample and analysis information into the laboratory computer system.

During the time the sample is in the laboratory's custody the laboratory must satisfy the sample chain-of-custody requirements by implementing a number of specific measures and standard operating procedures (SOPs). The specific SOPs the laboratory will follow are described in the individual laboratories QAPP. Once the HDR standby laboratories are selected the specific QAPPs will be appended to this plan.

5.0 CALIBRATION PROCEDURES AND FREQUENCY

Instruments and equipment used during the data collection efforts associated with the individual work assignments are controlled by a formal calibration program, which verifies that equipment is of the proper type, range, accuracy, and precision to provide data compatible with specified requirements. Instruments and equipment that measure a quantity, or whose performance is expected at a stated level, are subject to calibration. Calibration is performed using reference standards or externally by calibration agencies or equipment manufacturers. In the case of any subcontracted analytical services the calibration procedures for the analytical equipment used by the analytical laboratory will follow the NYSDEC ASP guidelines.

5.1 Calibration System

The following sections contain a discussion of the elements comprising the calibration system.

5.1.1 Calibration Procedures

Written procedures are used for all instruments and equipment subject to calibration. Whenever possible, recognized procedures, such as those published by the American Society of Testing and Materials or EPA, or procedures provided by manufacturers, are adopted. If established procedures are not available, a procedure is developed considering the type of equipment, stability characteristics of the equipment, required accuracy, and the effect of operational error on the quantities measured.

5.1.2 Calibration Frequency

Calibration frequency is based on the type of equipment, inherent stability, manufacturer's recommendations, values provided in recognized standards, intended data use, specified analytical methods, effect of error upon the measurement process, and prior experience.

5.1.3 Calibration Reference Standards

Two types of reference standards will be used by the standby laboratories for calibration:

- ***Physical standards***, such as weights for calibrating balances and certified thermometers for calibrating working thermometers, refrigerators and ovens, are generally used for periodic calibration.
- ***Chemical standards***, such as Standard Reference Materials provided by the National Institute of Standards and Technology or EPA. These may include vendor-certified materials traceable to National Institute of Standards and Technology or EPA Standard Reference Materials. These are primarily used for operational calibration.

5.1.4 Calibration Failure

Equipment that cannot be calibrated or becomes inoperable is removed from service. Such equipment must be repaired and satisfactorily recalibrated before re-use. For laboratory equipment that fails calibration, analysis cannot proceed until appropriate corrective action is taken and the analyst achieves an acceptable calibration. This is documented in a Non-Conformance Record, which is discussed in Section 11.

Laboratory managers are responsible for development and implementation of a contingency plan for major equipment failure. The plan includes guidelines on waiting for repairs, use of other instrumentation, subcontracting analyses, and evaluating scheduled priorities.

5.1.5 Calibration Records

Records are prepared and maintained for each piece of equipment subject to calibration. Records demonstrating accuracy of preparation, stability, and proof of continuity of reference standards are also maintained. Copies of the raw calibration data are kept with the analytical sample data.

5.2 Operational Calibration

Operational calibration is generally performed as part of the analytical procedure and refers to those operations in which instrument response (in its broadest interpretation) is related to analyte concentration. Included is the preparation of a standard response (calibration) curve and often the analysis of blanks.

5.2.1 Preparation of Calibration Curve

Preparation of a standard calibration curve is accomplished by the analysis of calibration standards, which are prepared by adding the analyte(s) of interest to the solvent that is introduced into the instrument. The concentrations of the calibration standards are chosen to cover the working range of the instrument or method. Sample measurements are made within this working range. The calibration curve is prepared by plotting or regressing the instrument responses versus the analyte concentrations. Concentrations of the analyzed samples are back calculated from the calibration curve.

5.2.2 Blanks

Reagent and/or solvent blanks are analyzed to assess if the materials used to prepare the standards are free from interfering substances that could affect the analysis. A method blank is prepared whenever samples are processed through steps that are not applied to the calibration standards.

5.3 Periodic Calibration

Periodic calibrations are performed for equipment (e.g., balances, thermometers) that is required in the analytical method, but that is not routinely calibrated as part of the analytical procedure. The periodic calibration requirements used by the standby laboratories is found in their QAPP which will be appended to this document once the laboratories are procured and approved.

5.4 Field Equipment Calibration

The procedures and frequencies for the calibration of field equipment and their associated quality control objectives are found in Tables 1 and 2 respectively.

Table 1
Field Instrumentation Calibration Frequency

Instrument	Frequency of Calibration Check	Calibration Standard
pH Meter	Prior to use – daily	Commercially prepared pH buffer solutions (4.00, 7.00, 10.00)
Conductivity Meter	Prior to use – daily	Commercially prepared saline solution (12.9 mS/cm)
Water Level Meter	Prior to initiating field work	.1-ft graduated engineer's tape
Dissolved Oxygen Meter	Per sampling event	Saturation
Photoionization Detector	Prior to use – daily	100 ppm isobutylene
Turbidity	Prior to use – daily	10 NTU, 200 NTU

Note: NTU = Nephelometric turbidity units.

Table 2
Field Measurement Quality Control Objectives

Field Parameter	Precision[a]	Accuracy
Water Temperature	±1°C	±1°C (instrument capability)
pH	±1 pH Standard Unit	±1 pH Standard Unit (instrument capability)
Conductivity	±1 mS/cm	±5% standard
Dissolved Oxygen	±0.02 mg/L	±5%
Turbidity	±1.0 Nephelometric turbidity units	±2% standard
Water Level	±0.1 ft	±0.01 ft

Note: [a] Precision units presented in applicable significant figures.

6.0 ANALYTICAL PROCEDURES

6.1 Field Analytical Procedures

Field analytical procedures include the measurement of temperature, conductivity, dissolved oxygen, pH, turbidity, organic vapors, and groundwater levels. Specific field measurement protocols are presented in the Program Field Activities Plan. Field measurement QC limits in terms of precision and accuracy are presented in Table 2.

6.2 Laboratory Analytical Procedures

Laboratory analytical requirements presented in the subsections below include a general summary of project-specific requirements related to each sample matrix to be analyzed.

Concentrations of target compounds and analytes will be analyzed according to the laboratory specific method SOPs developed for the NYSDEC Analytical Services Protocol (ASP) (2005) and EPA SW-846 Methods listed in the table below. Additional information regarding the number and types of samples to be collected at each area of concern is presented in each work assignment specific Field Activities Plan.

Analyte List	Matrices	Method No.
EPA CLP Target Compound List organics (VOCs/semivolatile organic compounds [SVOCs])*	Groundwater, surface water, surface and subsurface soil, sediment, and debris	ASP 95-1 for VOCs ASP 95-2 for SVOCs Or EPA SW-846 Method 8260B for VOCs EPA SW-846 Method 8270C for SVOCs
EPA CLP Target Analyte List metals	Groundwater, surface water, surface and subsurface soil, sediment, and debris	ASP Method 200.7 Mercury by Method 245.1/245.5 CLP-M Cyanide by 335.2
Polychlorinated biphenyls	Groundwater, surface water, surface and subsurface soil, sediment, and debris	EPA SW-846 Method 8082
VOCs	Air and Soil Vapor	EPA TO-15

NOTE: * = Specific method to be used for VOC or SVOC analyses will be identified in each project-specific QAPP Addendum

Samples will be analyzed by the laboratory within the holding times presented in each project specific Field Activities Plan on a standard turnaround schedule.

6.3 Sample Matrices

6.3.1 Water

No filtering of groundwater samples will be performed. Analytical results for analyses will be reported in µg/L

6.3.2 Soil, Sediment, and Debris

Analytical results of soil, sediment, and debris samples will be reported in terms of dry weight in mg/Kg

6.3.3 Soil Vapor and Indoor/Outdoor Air

Analytical results for soil vapor and indoor/outdoor air samples will be reported as mcg/m^3.

6.4 Standard Operating Procedures

The standby laboratories will maintain a manual of procedures other than laboratory-specific analytical methods in a document controlled SOP Manual. Laboratory Method SOPs will be maintained as controlled documents in the laboratory's Methods Manuals.

6.5 Recordkeeping

The requirements for laboratory recordkeeping are given in the laboratory's SOP Manual. Data entries are made in indelible, water-resistant ink. The date of the entry and the observer are clear on each entry. The observer uses his/her full name or initials. An initial and signature log is maintained so that the recorder of every entry can be identified. Information is recorded in a notebook or on other records at the time the observations are made. Recording information on loose pieces of paper is not allowed.

When a mistake is made, the wrong entry is crossed out with a single line initialed and dated by the person making the entry, and the correct information recorded. Obliteration of an incorrect entry or writing over it is not allowed; neither is the use of correction tape or fluid on any laboratory records.

7.0 FIELD AND LABORATORY QUALITY CONTROL CHECKS AND FREQUENCY

Quality control checks will be performed to ensure the collection of representative and valid data. Internal quality control refers to all data compilation and contaminant measurements. QC checks will be used to monitor project activities to determine if quality assurance objectives are being met. QC measurements for analytical protocols are designed to evaluate laboratory performance and measurement biases resulting from the sample matrix and field collection/sample management procedures.

- ***Laboratory Method Performance*** - QC criteria for method performance must be met for all target analytes for data to be reported. These criteria generally apply to instrument tune, calibration, method blanks, laboratory control samples, and Standard Reference Materials.

- ***Sample Performance*** - The accuracy and precision of sample analyses are influenced by both internal and external factors. Internal factors are those associated with sample preparation and analysis. Internal factors are monitored by the use of laboratory QC samples. QC field samples are analyzed to determine any measurement bias due to the sample matrix based on evaluation of matrix spikes, matrix spike duplicates, and laboratory duplicates.

- ***Field Performance*** - QC samples are used to evaluate the effectiveness of the sampling program to obtain representative samples, eliminating any cross contamination.

7.1 Laboratory Quality Control Samples

Laboratory QC samples are included in each analysis to provide information on both method performance and sample measurement bias, and are included in each analytical batch. A batch is defined as a group of field samples of similar matrix, not to exceed 20, which are processed as a unit using the same method and the same lots of standards and reagents. The laboratory QC samples discussed in the following sections are not counted in the maximum batch size of 20.

7.1.1 Method Blank

The method blank is used to monitor laboratory contamination. This is usually a sample of laboratory reagent water, or a standard solid matrix, processed through the same analytical procedure as the sample (i.e., digested, extracted, distilled). One method blank is prepared and analyzed with each analytical batch.

7.1.2 Laboratory Control Sample

A fortified method blank is analyzed with each analysis. These samples generally consist of a standard solid matrix fortified with the analytes of interest for single-analyte methods and selected analytes for multi-analyte methods according to the appropriate analytical method. The analyte recovery from each is used to monitor analytical accuracy and precision.

7.1.3 Matrix Spike

A matrix spike is an aliquot of a field sample, which is fortified with the analyte(s) of interest and analyzed to monitor measurement bias associated with the sample matrix. A matrix spike duplicate and matrix spike blank will be performed for every analytical batch.

7.1.4 Surrogates Spike Analysis

Surrogates are organic compounds that are similar to analytes of interest in chemical composition, extraction, and chromatography, but are not normally found in environmental samples. Surrogates are added to field and QC samples in every batch. These compounds are used to monitor system performance as well as sample measurement bias. Percent recoveries are calculated for each surrogate, and evaluated against acceptance criteria.

7.2 Field Quality Control Samples

These samples are not included specifically as laboratory QC samples but are analyzed when submitted to provide quality control data relative to the field sampling and sample management procedures. Data for these QC samples are reported with associated samples.

7.2.1 Field Blanks

Field blanks will be collected to evaluate the cleanliness of aqueous sampling equipment and sampling bottles, and the potential for cross-contamination of samples due to equipment handling and/or contaminants in the air. Field blanks will be collected at a frequency of one per 20 decontamination event for each type of sampling equipment (e.g., a groundwater bailer for groundwater) and, at a minimum, one per equipment type and/or media per day. Field blanks will not be collected in conjunction with soil vapor or air sampling programs.

Field blanks will be collected prior to the occurrence of any analytical field sampling event by pouring laboratory supplied deionized water over a particular piece of sampling equipment and into a sample container in a similar setting as the actual sample collection. The analytical laboratory will provide field blank water and sample jars with preservatives for the collection of all field blanks. Glass jars will be used for organic blanks. The field blanks as well as the trip blanks will accompany field personnel to the sampling location. The field blanks will be analyzed for the same analytes as the environmental samples being collected that day and shipped with the samples taken.

Field blanks will be collected in accordance with the procedures described below:

- Decontaminate sampler using the procedures specified in this QAPP.
- Pour distilled/deionized water over the sampling equipment, and collect the rinsate water in the appropriate bottles.
- Immediately place sample in a cooler and maintain a temperature of 4ºC until receipt by the laboratory.
- Fill out sample log, labels, and constituents of concern forms, and record in field logbook.

7.2.2 Trip Blanks

The trip blank will be used to determine if any volatile organic cross-contamination occurs between aqueous samples during shipment. They are only appropriate for aqueous volatile organic samples. Trip blanks will be supplied by the analytical laboratory as aliquots of distilled, deionized water that will be sealed in a sample bottle that travels with the set of sample bottles during the field sampling effort and subsequent shipment to the analytical laboratory. Glass vials (40 ml) with Teflon®-lined lids will be used for trip blanks. The sealed trip blank bottles will be placed in a cooler with the empty sample bottles and shipped to the site by laboratory personnel. If multiple coolers are necessary to store and transport aqueous volatile organic compound samples, then each cooler must contain an individual trip blank. Trip blanks are typically not collected in conjunction with the soil vapor or air sampling programs.

7.2.3 Field Duplicates

Field duplicates are two samples of the same matrix, which are collected, to the extent possible, from the same location at the same time using the same techniques. Field duplicates provide information on the precision of the sampling and analysis process. Field duplicates will be collected at a frequency of 1 duplicate per 20 sample media. Separate duplicate samples will be collected for the following media: surface and subsurface soil, sediment, surface water, groundwater, air, and soil vapor samples.

7.2.4 Temperature Blanks

Laboratory will use either 1) an infrared instrument to measure the temperature of liquid samples or 2) a temperature blank will be used to measure the temperature of liquid samples. If used, temperature blanks will be supplied by the analytical laboratory. If multiple coolers are necessary to store and transport aqueous samples, then each cooler must contain an individual temperature blank (if used).

7.3 Office Quality Control

7.3.1 Technical Checks

A minimum of two qualified professionals will proof and check all final reports and workplans for technical errors and/or inconsistencies. Checks will be made of all references and protocol cited to ensure they will be correct. Procedural descriptions will be reviewed to ensure they are accurate with referenced protocol. After technical review is complete, each document will be reviewed by the editorial staff for grammar and punctuation.

7.3.2 Numerical Checks

A minimum of two qualified professionals will proof and check all final reports and workplans for transcription and/or calculation errors. All data tables will be checked to ensure no transcription errors have occurred. Data tables will also be checked to see that criteria cited for comparison purposes is appropriate and correctly referenced. All calculations will be checked to ensure that they will be properly presented and that resulting values are achievable. If any results can not be duplicated the calculations will be independently checked for accuracy.

8.0 PREVENTIVE MAINTENANCE

Periodic preventive maintenance is required for all sensitive equipment. Instrument manuals will be kept on file for reference if equipment needs repair. The troubleshooting chapter of factory manuals may be used in assisting personnel in performing maintenance tasks. The frequency of preventive maintenance for field equipment is indicated in each operating instruction manual. Manually operated sampling equipment will be routinely checked to ensure proper operation and that excessive wear has not occurred. If necessary, equipment will be taken out of service for repair or replacement.

Field equipment is checked by field personnel under the supervision of the task manager. It is the responsibility of HDR's Environmental Measurements Section to conduct preventive maintenance on HDR owned equipment that maybe used in sampling efforts associated with NYSDEC work assignments. A summary of general preventative maintenance schedule is provided in Table 3.

The maintenance procedures for the analytical equipment used by the standby subcontract analytical laboratories are found in their Quality Assurance Program Plan which will be amended to this Program QAPP once the laboratories are procured and approved.

Table 3
Preventive Maintenance Summary

Maintenance	Frequency
Conductivity, pH, Dissolved Oxygen Meters	
Store in protective casing	D
Inspect equipment after use	D
Clean probes	D
Keep logbook in instrument	D
Have replacement meter available	D
Replace probes	X
Return to manufacturer for service	X
Calibration	D

Table 3 (Continued)

Preventive Maintenance Summary

Maintenance	Frequency
Turbidity Meter	
Store in protective casing	D
Inspect equipment after use	D
Clean sample cells	D
Clean lens	M or X
Check and recharge batteries	D
Keep logbook in instrument	D
Have replacement meter available	D
Return to manufacturer for service	X
Calibration	D
Thermometer	
Store in protective casing	D
Inspect equipment after use	D
Have replacement thermometer available	D
Water Level Meter	
Store in protective covering	D
Inspect equipment after use	D
Check indicators/batteries	D
Keep logbook on instrument	D
Have replacement meter available	X

9.0 QUALITY ASSURANCE PERFORMANCE AND SYSTEM AUDITS

Audits are systematic checks to determine the quality of operation of some activity or function in the field or laboratory. One field audit will be conducted by the Project Quality Assurance Officer to assure adherence to proper field and sampling procedures. Audits are of two types:

Performance audits are independent safety and health, procedure, and/or sample checks made by a supervisor or auditor to arrive at a **quantitative** measure of the quality of the data produced by one section or the entire measurement process.

System audits are onsite **qualitative** inspections and reviews of the QA system used by some part of or the entire measurement system. The audits are performed against the QAPP. A checklist is typically generated from the requirements and becomes the basis for the audit. The results of any deficiencies noted during the audit are summarized in an
audit report.

Analytical laboratory performance and system audits are performed by the laboratory QA staff to assess the effectiveness of the quality system. These internal audits are performed on a routine basis. Audits are also performed by certifying agencies. Audit reports and corrective actions are available to NYSDEC for review.

9.1 Responsibility, Authority, And Timing

QA audits to be conducted for the project may include system, performance, and data audits. The Program QAO working with the Project Quality Assurance Officer will keep a tentative schedule on record that details the number and types of audits.

9.2 Field Audits

Field performance audits will be conducted on an ongoing basis during the project as field data are generated, reduced, and analyzed. All numerical manipulations, including manual calculations, will be documented. All records of numerical analyses will be legible, of reproduction quality, and sufficiently complete to permit logical reconstruction by a qualified individual other than the originator.

Indicators of the level of field performance include the analytical results of the blank and replicate samples. Each blank analysis will be considered an indirect audit of the effectiveness of measures taken in the field to ensure sample integrity (e.g., field decontamination procedures). The results of the field replicate analyses are an indirect audit of the ability of each field team to collect representative sample portions of each matrix type.

System audits of site activities will be accomplished by an inspection of all field site activities. During this audit, the auditor(s) will compare current field practices with standard procedures. The following elements will be evaluated during a field system audit:

- All activities conducted in accordance with the Work Plan All procedures and analyses conducted according to procedures outlined in the QAPP and Addendum
- Sample documentation
- Working order of instruments and equipment
- Level of QA conducted per each field team
- Contingency plans in case of equipment failure or other event preventing the planned activity from proceeding
- Decontamination procedures
- Level of efficiency with which each team conducts planned activities at one site and proceeds to the next
- Sample packaging and shipment.

After completion of the audit, any deficiencies will be discussed with the field staff and necessary corrections identified. If any of these deficiencies could affect the integrity of the samples being collected, the auditor(s) will inform the field staff and corrections will be implemented immediately. The audit will be performed by the Project Quality Assurance Officer or the assigned task manager.

9.3 Laboratory Performance And System Audits

The New York State Department of Health Environmental Laboratory Analytical Program Contract Laboratory Program certified laboratory that has satisfactorily completed performance audits and performance evaluation samples will be used for all sample analysis. The results of the most recent performance audits and performance evaluations will be made available upon request.

9.4 Audit Procedures

Prior to an audit, the designated lead auditor prepares an audit checklist. During an audit and upon its completion, the auditor(s) will discuss the findings with the individuals audited and discuss and agree on corrective actions to be initiated. The auditor will then prepare and submit an audit report to the manager of the audited group and the project manager.

The manager of the audited group will then prepare and submit, to the Program QAO, Project Quality Assurance Officer and the Project Manager, a plan for implementing the corrective action to be taken on non-conformances indicated in the audit report, the date by which such corrective action will be completed, and actions taken to prevent reoccurrence. If the corrective action has been completed, supporting documentation should be attached to the reply. The auditor will ascertain (by re-audit or other means) if appropriate and timely corrective action has been implemented.

Records of audits will be maintained in the work assignment project files.

9.5 Documentation

To ensure that the previously defined scope of the individual audits is accomplished and that the audits follow established procedures, a checklist will be completed during each audit. The checklist will detail the activities to be executed and ensure that the auditing plan is accurate. Audit checklists will be prepared in advance and will be available for review. Following each system, performance, and data audit, the Program QAO will prepare a report to document the findings of the specific audit.

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

10.1 Overview

The process of data reduction, validation, and reporting will ensure that assessments, designs, or conclusions based on the final data accurately reflect actual site conditions. This section of the QAPP presents the specific procedures, methods, and formats that will be employed for data reduction, validation and reporting of each measurement parameter determined in the laboratory and field. Also described in this section is the process by which all data, reports, and work plans will be proofed and check for technical and numerical errors prior to final submission.

10.1.1 Field and Technical Data Reduction

Field personnel will record all field data in bound field logbooks and on standard forms. After checking the validity of the data in the field notes, the task manager or his/her designee will reduce the data to tabular form, when possible, by entering the data into data files. Where appropriate, the data files will be set up for direct input into the project database. Subjective data will be filed as hard copies for later review by the Project Manager and incorporation into technical reports, as appropriate.

10.1.2 Laboratory Data Reduction

Data reduction is the process by which raw analytical data generated from laboratory instrument systems is converted into usable concentrations. The raw data, which may take the form of area counts, instrument responses, or observations, are processed by the laboratory and converted into concentrations expressed in the parts per million or parts per billion range. Raw data from these systems include compound identifications, concentrations, retention times, and data system print-outs. Raw data are usually reported in graphic form, bar graph form, or tabular form.

The laboratory will follow standard operating procedures consistent with the data handling requirements of the applicable methods. The laboratory reporting limits for each work assignment must be less than or equal to those stipulated by this QAPP as ammneded by any assignment specific changes to the reporting limits. Any noted assignment specific changes will be clearly presented in each site-specific Field Activities Plan.

All analytical data will be reported by the laboratory with NYSDEC ASP Category B deliverables. Electronic data deliverables (EDD) provided by the laboratory will also be consistent with the current ASP requirements and NYSDEC standards for electronic data delivery.

10.2 Validation

10.2.1 Field and Technical Data Validation

Validation of objective field and technical data will be performed at two different levels. The first level of data validation will be performed at the time of collection by following standard procedures and QC checks. The task manager, who will review the data to ensure that the correct codes and units have been included, will complete the second level of data validation. After data reduction into tables and arrays is complete, the task manager will review data sets for anomalous values. The Project Manager, who will review field reports for reasonableness and completeness, will validate subjective field and technical data. In addition, the Project Manager will conduct random checks of sampling and field conditions.

10.2.2 Analytical Data Validation

If a Work Assignment requires the validation of data; i.e., data validation is performed to establish the data quality for all data, which are to be considered when making project decisions. Laboratories will be submit results that are supported by sufficient back-up data and QA/QC results to enable the reviewer to conclusively determine the quality of the data. The laboratory will review data prior to its release from the laboratory. Objectives for review are in accordance with the QA/QC objectives stated in each site-specific Field Activities Plan. The laboratory is required to evaluate their ability to meet these objectives. Outlying data will be flagged in accordance with laboratory standard operating procedures, and corrective action will be taken to rectify the problem.

A NYSDEC-approved qualified independent third party data validator will review the data package to determine completeness and compliance in accordance with Schedule 1 (Scope of Engineering Services) of the Standby Contracts D007625.

A narrative describing how the data did or did not meet the validation criteria is part of the data validation procedure. The validation assessment will describe the overall quality of the data and the data validation report will provide a written statement upon completion of the validation indicating whether or not the data are valid and usable, and include a percent completeness value of usable data.

10.2.3 Data Usability Summary Report

A Data Usability Summary Report (DUSR) provides a thorough evaluation of analytical data without the third party data validation. The primary objective of a DUSR is to determine whether or not the data, as presented, meets the site/project specific criteria for data quality and data use. If a Work Assignment requires a DUSR, the DUSR will be developed by a NYSDEC-approved qualified environmental scientist in accordance with Schedule 1 of the Standby Contract D007625.

10.3 Reporting

10.3.1 Field Measurements

Any field analysis results will be recorded in a dedicated field logbook at the time the results are available. The results will be tabulated and plotted in the office as part of the reporting tasks. Reports also will consist of the field logbook, required standard forms, photographic documentation, and daily QC Reports.

10.3.2 Analytical Data

The content of analytical laboratory data packages designed for work conducted at the project site are work assignment specific and will include the following information:

- Pertinent physical data presented in concise, easy to follow formats (i.e., sample number, client, date of sample preparation, date analyzed, percent moisture, etc.)
- Reference for analytical methodology used
- General discussion including a description of sample types, tests performed, any problems encountered, and general comments
- Data from each discrete sample reported using cross-referencing between normal samples and QC samples and including all pertinent dates, information, and reporting limits
- Reported data to include associated QC samples such as blanks, spikes and spike duplicates, laboratory duplicates, field duplicates, and appropriate check standards
- Copies of chain-of-custody sheets
- Raw data.

10.3.3 EQuIS EDD's

All analytical data obtained for each work assignment will be submitted to the NYSDEC as a standardized electronic data deliverable (EDD) that is compatible with the NYSDEC Electronic Information Management System (EIM). The EIM uses the database software EQuIS and all EDDs will be compatible with the latest NYSDEC file format. The EDD will be data checked using the EQuIS Data Processor (EDP)™. If the EDP detects errors, the errors will be identified and most will be corrected within the EDP. The EDD will have a clean confirmation from the EDP and then will be sent to NYSDEC. In order to submit an EDD, the "sign and submit" feature in the EDP will be used.

11.0 CORRECTIVE ACTION PROCEDURE DESCRIPTION

11.1 Objectives

The objectives of the corrective action procedures presented below are to ensure that recognized errors in performance of sample and data acquisition lead to effective remedial measures and that those steps are documented to provide assurance that any data quality deficiencies are recognized in later interpretation and are not recurrent.

11.2 Rationale

Many times corrective measures are undertaken in a timely and effective fashion but go undocumented. In other cases, corrective actions are of a complex nature and may require scheduled interactions between departmental groups. In either case, documentation in a formal or informal sense can reinforce the effectiveness and duration of the corrective measures taken.

11.3 Corrective Action Methods

11.3.1 Immediate Corrective Actions

Immediate corrective actions are of a minor or routine nature such as correcting malfunctioning equipment, correction of data transcription errors, and other such activities routinely made in the field, laboratory, or office by technicians, analysts, and other project staff.

11.3.2 Long-Term Corrective Actions

Long-term corrective action will be used to identify and eliminate causes of non-conformances which are of a complex nature and that are formally reported between management groups.

11.3.3 Corrective Action Steps

For long-term corrective actions, steps comprising closed-loop corrective action system are as follows:

- Define the problem
- Assign responsibility for investigating the problem
- Investigate and determine the cause of the problem
- Determine a corrective action to eliminate the problem
- Assign and accept responsibility for implementing the corrective action
- Verify that the corrective action has eliminated the problem.

Non-conformance events associated with analytical work are documented by the laboratories' Non-Conformance Records, which are reviewed and approved by the QAOr.

11.3.4 Audit-Based Non-Conformances

Following audits, corrective action is initiated by documenting the audit finding and recommended corrective action on an Audit Finding Report.

11.4 Corrective Action Report Review and Filing

Immediate and long-term corrective actions require review to assure that, during the time of non-conformance, erroneous data were not generated or that, if possible, correct data were acquired instead. Such confirmation and review is the responsibility of the supervisor of the staff implementing the corrective action. Confirmation will be acknowledged by notation and dated signature on the affected data record or appropriate form or by memorandum to cognizant project management.

11.5 Corrective Action Reports To Management

The QAO will provide project management with corrective action reports.

The Project Manager is informed verbally of non-conformance events as soon as possible and decisions made after evaluation is documented in the Non-Conformance Records. A copy of each Non-Conformance Record is maintained in the report.

12.0 QUALITY ASSURANCE REPORTS

Fundamental to the success of this QA/QC is the active participation of the Project Manager and the Project Quality Assurance Office. The Program QAO will be advised of project activities and will participate in development, review, and operation of the project. Project management will be informed of QA activities through the receipt, review, and/or approval of:

- Project-specific QA project plans
- Corporate and project-specific QA/QC plans and procedures
- Corrective action notices
- Non-conformance records.

Periodic assessment of field and laboratory QA/QC activities and data accuracy, precision, and completeness will be conducted and reported by the laboratory. Items to be included in the QA reports are the summary of results for the performance or the system audit and, where applicable:

- Assessment of adherence to work scope and schedule for the audited task
- Assessment of the precision, accuracy, and completeness of sample batches and
- subsequent status of data processing and analyses
- Significant QC problems and the status of any ongoing corrective actions
- Changes to the site-specific Work Plan
- Status of implementation of the site-specific Work Plan.

Attachment 1

Typical Laboratory Chain-of-Custody Form

MITKEM LABORATORIES
A DIVISION OF SPECTRUM ANALYTICAL, INC. Featuring HANIBAL TECHNOLOGY

CHAIN OF CUSTODY RECORD

Page ______ of ______

Special Handling:
- ☐ Standard TAT - 7 to 10 business days
- ☐ Rush TAT - Date Needed: __________
- · All TATs subject to laboratory approval. Min. 24-hour notification needed for rushes.
- · Samples disposed of after 60 days unless otherwise instructed.

Report To: ______________________	Invoice To: ______________________	Project No.: ______________________
______________________	______________________	Site Name: ______________________
______________________	______________________	Location: ______________ State: ________
______________________	______________________	Sampler(s): ______________________
Project Mgr.: ______________________	P.O. No.: ____________ RQN: ____________	

1=Na_2S2O_3 2=HCl 3=H_2SO_4 4=HNO_3 5=NaOH 6=Ascorbic Acid
7=CH_3OH 8= $NaHSO_4$ 9=______________ 10=______________

DW=Drinking Water GW=Groundwater WW=Wastewater
O=Oil SW= Surface Water SO=Soil SL=Sludge A=Air
X1=__________ X2=__________ X3=__________

G=Grab C=Composite

Lab Id:	Sample Id:	Date:	Time:	Type	Matrix	Preservative	Containers: # of VOA Vials	# of Amber Glass	# of Clear Glass	# of Plastic		Analyses:								QA Reporting Notes: (check if needed)

QA Reporting Notes:
- ☐ Provide MA DEP MCP CAM Report
- ☐ Provide CT DEP RCP Report

QA/QC Reporting Level
☐ Standard ☐ No QC
☐ Other __________

State specific reporting standards: __________

☐ Fax results when available to (_____) __________
☐ E-mail to __________
EDD Format __________
Condition upon receipt: ☐ Iced ☐ Ambient ☐ °C ________

Relinquished by:	Received by:	Date:	Time:

PROGRAM
HEALTH AND SAFETY PLAN
NYSDEC STANDBY ENGINEERING CONTRACT
CONTRACT #D007625

PREPARED FOR
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 BROADWAY
ALBANY, NEW YORK 12233

Prepared by

HDR

One Blue Hill Plaza
Pearl River, NY 10965

April 2011

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Approved:

4/7/2011

Michael Lehtinen — Date
HDR Program Manager

April 7, 2011

James Woolcott, CIH — Date
HDR Health and Safety Officer

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1.0 INTRODUCTION

1.1 Objective

This Program Health and Safety Plan (HASP) has been prepared by Henningson, Durham, & Richardson, Architecture and Engineering, P.C. and the objective of this HASP is to provide personnel with protection standards and mandatory safety practices, procedures, and contingencies to be followed while performing field activities under the New York State Department of Environmental Conservation (NYSDEC) Standby Contract D007625. The typical work activities addressed within this Program HASP include the following onsite field investigations:

- Surface soil sampling
- Exploratory test pits with subsurface soil sampling
- Soil borings with subsurface soil sampling
- Monitoring well installation and development
- Short duration (slug) testing
- Groundwater gauging and sampling
- Surface water and sediment sampling
- Subsurface structure sediment/debris sampling
- Characterization of investigative-derived waste
- Soil vapor, sub-slab, indoor, and outdoor air sampling.

Depending on site conditions and/or potential issues which may be present, one or more of the above field investigations may not be applicable for a Standby Contract site. In addition, there may be specific field investigation procedures that are appropriated for a specific site; therefore, a site-specific HASP Addendum will be included with the Work Plan for each Standby Contract site.

The safety organization, procedures, and protective equipment for this HASP have been established based on an analysis of potential physical, chemical, and biological hazards. Specific hazard control methodologies have been evaluated and selected to minimize the potential for accident or injury. One copy of this Program HASP will be maintained for use during the scheduled field sampling effort. The copy will be made available for site use/employee review.

This Program HASP describes the procedures that must be followed during referenced site activities. Operational changes to this Program HASP that could affect the health and safety of personnel, the community, or the environment will not be made without the prior approval of the Contract Manager and the Program Health and Safety Officer (HSO). This document will be periodically reviewed to ensure that it is current and technically correct. Changes in site conditions and/or the scope of work will involve a review and modification to the Program HASP. Such changes will be completed in the form of a numbered revision.

The provisions of this Program HASP are mandatory for the personnel and subcontractors assigned to the project. Visitors to the work site must abide by the requirements of the Program HASP. It should be acknowledged that the employees of other consulting and/or contracted companies will work in accordance with their own independent HASP. Subcontractor’s HASPs must, at a minimum, meet the requirements of this Program HASP and applicable site-specific HASP Addendums.

1.2 Site and Facility Description

General site-specific information concerning the layout of the site, site features, and description of items or site features, which specifically may affect site safety will be provided in the site-specific HASP Addendum. A detailed site history and regulatory history for each site will be provided in the site-specific Work Plan.

1.3 Policy Statement

HDR will take every reasonable step to provide a safe and healthful work environment and to eliminate or control hazards in order to minimize the possibility of injury, illness, or accident to personnel working onsite. HDR and HDR subcontractor employees will be familiar with the HASP for the project activities that they are involved in. Prior to entering the site, this HASP and the site-specific HASP Addendum will be reviewed, and the agreement to comply with the requirements will be signed by HDR personnel, subcontractors, and visitors.

By signing a site-specific HASP Review Record, the subcontractors and visitors acknowledge their responsibility to comply with the occupational health and safety requirements defined in this HASP. HDR and HDR subcontractor personnel onsite will be informed of site emergency response procedures and potential safety or health hazards associated with the operations conducted in support of this project.

1.4 References

This HASP addresses the following regulations and guidance documents:

- Quick Selection Guide to Chemical Protective Clothing, K. Forsberg and S.Z. Mansdorf, 2nd Ed. (1993)
- Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, National Institute for Occupational Safety and Health, Occupational Safety and Health Administration (OSHA), U.S. Coast Guard, U.S. Environmental Protection Agency (EPA) (86-116, October 1985)
- Occupational Safety and Health Administration (OSHA) Standards for General Industry, 29 Code of Federal Regulations (CFR) 1910
- OSHA Standards for Hazard Waste Operations, 29 CFR 1910.120/1926.65
- OSHA Standards for Hazard Communication, 29 CFR 1910.1200/1926.59
- OSHA Standard for Respiratory Protection, 29 CFR 1910.134
- OSHA Standards for Construction Industry, 29 CFR 1926
- NIOSH Pocket Guide to Chemical Hazards, Department of Health and Human Services, PHS, Center for Disease Control, National Institute for Occupational Safety and Health (2005)
- Threshold Limit Values, American Conference of Governmental Industrial Hygienists (2008)

1.5 Definitions

The following definitions are applicable to this HASP:

Site	-	The area where the work is to be performed.
Project	-	Onsite work performed under the scope of work for each Standby Contract site.

Contract Manager - The HDR individual who is currently serving as the overall manager of the Standby Contract.

Program Manager - The HDR individual designated by the Contract Manager to coordinate and monitor HDR activities on a daily basis.

Project Manager - The HDR individual(s) who will have overall responsibility for a particular Standby Contract site. The Project Manager will provide services associated with the implementation of the site-specific Work Plan.

Task Manager - The HDR individual(s) who have responsibility for the various field tasks associated with a particular Standby Contract site.

Subcontractor - Includes third party personnel hired by HDR.

Onsite Personnel - HDR and subcontractor personnel involved with the project.

Visitor - Personnel, except the onsite personnel. Visitors must receive approval to enter the site.

Exclusion Zone - Portion of the site where hazardous substances are, or are reasonably suspected to be, present in the air, water, or soil.

Contamination Reduction Zone - Area between the Exclusion Zone and Clean Zone that provides a transition between contaminated and clean areas. Decontamination stations are located in this zone.

Clean/ Support Zone - The rest of the site. Support equipment is located in this zone.

2.0 ROLES AND RESPONSIBILITIES

2.1 Personnel

HDR and subcontractor employees are responsible for reading, understanding, and meeting the health and safety requirements contained in this HASP and additional site-specific plans and addenda. A HASP Review Record sign-off sheet for each site is provided in each site-specific HASP. Employees are required to implement these procedures when carrying out daily operations. This will include receiving appropriate training and medical monitoring and using appropriate health and safety equipment (to include personal protective equipment [PPE]) to safely conduct site operations. Employees will review each task prior to commencement to consider the potential health and safety hazards and the measures to be taken in the event of an emergency. Employees will know where material safety data sheets (MSDS), first aid supplies, and emergency equipment are maintained. The Project Manager and site-specific HSO will be notified of potential health and safety hazards, near-miss conditions, or incidents present on the job site or unusual effects believed to be related to hazardous chemical exposures. Failure to follow established health and safety procedures could result in immediate dismissal from the site and, if repeated, a potential loss of employment.

2.2 Responsibilities

Clear lines of authority will be established for enforcing compliance with the safety, health, and contingency procedures consistent with industry policies and procedures. Designated HDR personnel are responsible for implementation of the HASP during field activities. This includes field supervision; implementing and directing emergency operations; coordinating with onsite and offsite emergency responders; enforcing safe work practices and decontamination procedures (if needed); ensuring proper use of PPE; communicating site safety program modifications and requirements to site personnel; proper reporting of injuries, illnesses, and incidents to the appropriate internal and external organizations; and containing and controlling the loss of potentially hazardous materials to soil, air, and surface/groundwater during field operations.

In the event of an onsite injury, occupational illness, near-miss, or environmental contamination incident, the following organizations/individuals will be notified as appropriate (Section 11):

- Task Manager
- Site-Specific Health and Safety Officer
- Project Manager
- Program Health and Safety Officer
- New York Department Manager
- Corporate Health and Safety Officer
- New York State Department of Environmental Conservation representatives
- Other organizations or persons as appropriate.

2.2.1 Key Project Personnel

A table containing information on key project personnel for each of the Standby Contract sites will be included in each site-specific HASP Addendum. A description of each key project personnel position and their responsibilities follows.

2.2.1.1 Program Health & Safety Officer

The Program HSO has overall project responsibility for the development of this HASP. The Program HSO will also be consulted and approve changes to this HASP or significant modifications of health and safety procedures.

2.2.1.2 Site-Specific Health & Safety Officer

The Site-Specific HSO is responsible for coordination of onsite contingency operations and the Site Health and Safety Program. The Site-Specific HSO will be onsite at all times throughout the project and will be responsible for daily compliance with site health and safety requirements. The Site-Specific HSO's responsibilities include:

- Conducting visual inspections of the work site
- Stopping work when imminent safety or health risks exist or as outlined in the HASP
- Authorization for personnel to perform work onsite (i.e., relative to medical examinations and training)
- Implementing the use of forms in the site-specific HASP Addendum
- Implementing the guidance within this HASP
- Providing an initial health and safety briefing to site workers and visitors
- Evaluating reported hazardous conditions and recommending corrective actions
- Conducting necessary health and safety monitoring
- Identifying, investigating, and preparing incident reports as necessary
- Consulting with the Program HSO or Project Manager for guidance on occupational health and safety and contingency issues affecting this project
- Providing technical support and guidance in the modification of site-specific HASP requirements
- Evaluating onsite environmental monitoring results and providing reporting requirements to the Project Manager.

During an emergency, the Task Manager (or the Alternate in the absence of the Task Manager) will be responsible for initiating and coordinating emergency responses/contingency operations.

Both the Program HSO and the Site-Specific HSO will have the authority to make on-the-spot corrections dealing with safety, health, and environmental pollution infractions. If it is determined that the infraction cannot be remedied immediately and is of such a nature that continuance of the job could result in significant illness, injury, environmental contamination, and violations, the Program HSO and/or Site-Specific HSO will have the authority to order a cessation of the activity until such time as the problem can be remedied.

2.2.1.3 Project Manager

The Project Manager will have overall responsibility for site activities and will be the primary contact during the work activities. The primary responsibilities of the Project Manager include:

- Ensuring compliance with this HASP
- Coordinating with the Task Manager
- Approving the HASP Addendum and revisions
- Reviewing individual training and medical records prior to work start
- Providing overall supervisory control for health and safety protocols in effect for this project
- Assigning the Task Manager and Site-Specific HSO
- Ensuring adequate resources are available for carrying out this HASP
- Preparing and submitting project reports.

2.2.1.4 Task Manager

The Task Manager's responsibilities include but are not limited to:

- Providing technical support to the Site-Specific HSO
- Evaluating onsite environmental monitoring results and reporting to the Project Manager and Program HSO
- Being responsible for initiating the evacuation of the work site when needed, communicating with offsite emergency responders, and coordinating activities of onsite and offsite emergency responders
- Determining if the abatement of hazardous conditions is sufficient prior to allowing resumption of work operations after an emergency.

2.2.1.5 Subcontractors

Responsibilities of HDR subcontractor personnel include:

- Following their HASP and applicable health and safety rules, regulations, and procedures
- Understanding and complying with 29 CFR 1910 and 29 CFR 1926 rules and regulations applicable to the operations they are conducting to ensure the health and safety of their personnel
- Using required controls, procedures, and safety devices, including PPE as necessary

- Notifying his/her supervisor of identified or suspected emergencies and safety or health hazards
- Complying with training and medical requirements.

2.2.1.6 Visitors

Visitors entering the site area will be required to sign the Entry/Exit Log (found in each site-specific HASP) and to read and verify their understanding of potential and/or known site hazards as outlined in the Work Plan and site-specific HASP Addendum and willingness to comply with this Program HASP. Visitors will remain in an observation area or the Support Zone and will not be allowed in the Exclusion Zone or Contamination-Reduction Zone unless they have met the appropriate OSHA training and medical requirements, and have received clearance by the Project Manager and the Site-Specific HSO.

3.0 RISK ANALYSIS

3.1 Project Scope of Work

The scopes of work for the field investigations covered by this HASP will be presented in the site-specific Work Plan Template/ Work Assignment Letter for each Standby Contract site.

Specific field investigation activities may include the following:

- Surface soil sampling
- Exploratory test pits with subsurface soil sampling
- Soil borings with subsurface soil sampling
- Monitoring well installation and development
- Short duration (slug) testing
- Groundwater gauging and sampling
- Surface water and sediment sampling
- Subsurface structure sediment/debris sampling
- Characterization of investigative-derived waste
- Soil vapor, sub-slab, indoor, and outdoor air sampling

Based upon the above field activities, the following potential hazardous conditions may be anticipated:

- The use of mechanical equipment such as drill rigs, backhoes, and powered augers can create a potential for crushing and pinching hazards due to movement and positioning of the equipment; movement of lever arms and hydraulics; entanglement of clothing and appendages in exposed drives and augers; and impact of steel tools, masts, and cables should equipment rigging fail, or other structural failure occur during drilling mast extension and operation. Heavy equipment work must be conducted only by trained, experienced personnel. If possible, personnel must remain outside the turning radius of large, moving equipment. At a minimum, personnel must maintain visual contact with the equipment operator. When not operational, equipment must be set and locked so that it cannot be activated, released, dropped, etc.

- Equipment can be energized due to contact with overhead or underground electrical lines, utilities impaired by excavation of communication or potable/wastewater lines, or a potential for fire or explosion may occur due to excavation of below ground propane/natural gas lines. Prior to commencement of intrusive operations, a drilling/excavation permit will be obtained and the area will be inspected and flagged. A call will be made to the Underground Utility Locators within one week of the start of any subsurface digging to mark out all utilities. Personnel should be aware that although an area may be cleared, it does not mean that unanticipated hazards will not appear. Safe distances will be maintained from live electrical equipment as specified in HASP. Workers should always be alert for unanticipated events such as snapping cables, digging into unmarked underground utilities, etc. Such occurrences should prompt involved individuals to halt work immediately and take appropriate corrective measures to gain control of the situation.

- Work around large equipment often exposes personnel to excessive noise. Noise can cause workers to be startled, annoyed, or distracted; can cause physical damage to the ear, pain, and temporary and/or permanent hearing loss; and can interfere with communication. See Section 3.4.6 for more detailed information.

- Personnel may be injured during physical lifting and handling of heavy equipment, bags of grout, gravel, or other well construction materials, or waste containing drums or containers. Proper lifting techniques must be utilized, and the buddy system employed when lifting very heavy or large sized items. Additionally, personnel will be exposed to slip, trip, and fall hazards due to irregular terrain on the site(s), presence of excavations and/or test pits, or the presence of oil, grease, or other slurry materials. Avoidance consists of maintaining a clean uncluttered site, examining the ground for terrain irregularities, not crossing/jumping excavations/pits, and wearing over-the-ankle work boots with lug soles.

- Field operations conducted during the hot summer months can impose excessive heat loading on personnel conducting strenuous activities, especially when wearing PPE. Workers shall start off the day fully hydrated, and drink cool water or dilute sports drinks frequently thereafter. If necessary, heat strain monitoring shall be instituted, in accordance with HDR H&S Procedure # 28 – *Heat Stress*. See also Section 3.4.2.

- Field operations conducted during cold winter months can expose personnel to extreme low temperatures and wind chill, resulting in hypothermia. Workers shall prepare prior to site arrival by dressing in multiple light layers, with extremities fully protected (hands, ears), shall avoid getting wet/immersed, and shall make sure that they remain fully hydrated. Frequent breaks in exposure to the cold are necessary to prevent frostbite.

- Field investigation activities intended to define potential sources of environmental contamination often focus on employees to be in direct proximity or contact with hazardous substances. Employees may be exposed through the route of inhalation to toxic dusts, vapors, or gases. Normal dust particulates from surficial soils may have adsorbed or absorbed toxic solvents, petroleum compounds, polychlorinated biphenyl (PCBs), or toxic metal salts or metal particulates. Soils saturated with petroleum or waste solvents may give off vapors, and create high vapor concentrations in excavations, trenches, pits, and other confined spaces or enclosures. Water collected during well development and groundwater sampling activities may also contain toxic vapors, liquids, and gases and be inhaled during normal operations, or may be splashed onto the skin or in the eyes. Toxic materials contained in dusts/particulates can be ingested if eating, smoking, drinking, and gum chewing are permitted prior to personnel washing their hands and face or removing contaminated work clothing and PPE. Some chemicals may be absorbed directly through the skin (e.g., PCBs). PPE, properly selected for the chemicals of concern, will be provided and worn when a potential for skin contact is present.

- Field investigation activities may expose the worker to biological hazards including: poisonous plants (e.g., poison ivy), poisonous snakes, and/or venomous stinging insects. Biting flies can be a real problem in certain low lying areas. Deer ticks may transmit Lyme disease and mosquitoes are potential vectors for West Nile Virus. Avoidance to these biological hazards consists of field recognition, looking before you place your hands on natural strata, application of insect repellents (e.g., containing DEET) and wearing proper PPE. Workers sensitive or allergenic to stings from bees/wasps should always carry the necessary medical supplied as directed and supplied by their personal physician, and notify co-workers of their condition.

- Selected field activities may involve entry into a permit-required confined space, which will require all workers to comply with the OSHA standard, 29 CFR 1910.146 – Permit Required Confined Spaces.

3.2 Hazard Communication

A written OSHA Hazard Communication Program (required by 29 CFR 1910.1200/1926.59) will be maintained onsite during investigative activities. HDR employees will be informed of the Hazard Communication Program's existence, contents, and location. This Program will be kept with the MSDSs and contain a list of site-specific chemicals present. The list will be cross-referenced with the applicable MSDS for ease in MSDS accessibility.

An MSDS for each chemical brought onsite during field activities will be maintained onsite by the Site-Specific HSO. Subcontractors must inform the Task Manager and Site-Specific HSO of hazardous substances brought onsite, and provide appropriate MSDSs to the Site-Specific HSO. Chemicals brought onsite must be labeled in accordance with OSHA Hazard Communication Requirements (29 CFR 1910.1200) and the labels must not be defaced. HDR site workers and visitors will be informed of the Hazard Communication Program, their legal rights under the Program, the location of the chemical inventory, and the location of the MSDSs. Subcontractors will coordinate with HDR to provide a list of the hazardous materials that will be used onsite in support of their operations. This information will be shared jointly with site employees and visitors to the site.

Employee training, consisting at a minimum of awareness of chemical identities, the health and physical hazards associated with their use and symptoms from overexposure, fire potential and first aid response will be provided to site workers before first use. This training shall be documented.

3.2.1 Hazardous Substance List

HDR will maintain a dynamic list of "hazardous materials." Examples of hazardous materials which might be present at the site include solvents, adhesives, irritants, corrosives, flammables, combustibles, compressed gases, organic peroxides (curing agents), and oxidizers (sanitizing agents). This list will be used in the Hazard Communication Program. Additionally, other potential hazardous substances that could be present onsite may also be listed. Examples of other hazardous substances associated with site operations may include carbon monoxide generation from generators or internal combustion engines, contaminants which could be present on the site and encountered in the process of site assessment, and potential atmospheric contaminants present in confined spaces.

3.2.2 Hazard Communication Labeling

HDR will ensure that in-house containers are properly labeled and that workers understand the contents of containers. Container labels will contain at least information on the name of the product, identity of hazardous chemical(s) in the product, major body organ system(s) affected by overexposure or improper use, manufacturer's name and address, protective equipment required for the safe handling of the product, and first aid procedures in case of overexposure to product contents. Labels shall be in English, and if any non-English speaking workers are employed, shall be also translated into their language.

3.2.3 Hazard Communication Training

HDR site employees and visitors must be informed of HDR's Hazard Communication Program, their legal rights under the program, and location of chemical inventory and MSDS files. The employee's supervisor must describe hazardous substances used and provide information concerning:

- Nature of potential hazards
- Appropriate work practices
- Appropriate control programs
- Appropriate protective measures
- Methods to detect presence or release of hazardous substances
- Emergency procedures.

3.3 Site Chemical Hazards

Potential compounds of concern will vary, and be determined, on a site-by-site basis. Typical compounds of concern encountered at investigative sites and their relevant properties are shown in Table 1. Specific potential compounds of concern for each site will be identified in each site-specific HASP Addendum. Potential compounds of concern for a particular site may include, but are not limited to, the following:

- Volatile organic compounds (VOCs); semi-volatile organic compounds (SVOCs); total petroleum hydrocarbons; and metals in soil, sediment, and groundwater.
- VOCs in air.
- PCBs on concrete and in soil, sediment, and water.

Field operation precautions and preventive measures for Standby Contract sites are described in the following paragraphs:

- **Test Pit Excavation/Sampling** — VOCs, SVOCs, metals, and PCBs may be encountered. Continuous organic vapor monitoring, upwind worker positioning, and PPE are required (see Section 5 for specific PPE).

- **Surface Soil/Wipe Sampling** — VOCs, SVOCs, metals, and PCBs may be encountered. Potential routes of worker exposure are through dermal contact and inhalation and ingestion (see Section 5 for specific PPE).

- **Surface Water/Sediment Sampling** — VOCs, SVOCs, metals, and PCBs may be encountered. Potential routes of worker exposure are through dermal contact and inhalation and ingestion (see Section 5 for specific PPE).

- **Installation of Monitoring Wells/Subsurface Soil Sampling** — VOCs, SVOCs, metals, and PCBs may be encountered. Continuous organic vapor monitoring, upwind worker positioning, and PPE are required (see Section 5 for specific PPE).

- **Groundwater Sampling** — VOCs, SVOCs, metals, and PCBs may be encountered. Potential routes of worker exposure are through dermal contact, inhalation, and ingestion; wear PPE when in contact with groundwater (see Section 5 for specific PPE).

- **Soil Vapor Sampling** — VOCs, may be encountered. Potential routes of worker exposure are through dermal contact and inhalation and ingestion; continuous organic vapor monitoring, upwind worker positioning, and PPE are required (see Section 5 for specific PPE).

Dermal contact is a potential concern during the above tasks due to the possible presence of skin irritants such as petroleum products and other toxic substances (PCBs) that may be absorbed through the skin. This information is based upon a worst-case scenario. Dermal protection listed in Section 5 must be worn during work tasks involving contact with soil and groundwater.

A description of the requirements for the different levels of PPE, as well as upgrade/downgrade requirements, is provided in Section 5. Although ingestion of contaminants is also a primary source of exposure, vigilance by site health and safety personnel and site workers to ensure proper use of PPE and personal hygiene will effectively eliminate this route of exposure as a significant health concern.

3.3.1 Chemicals for Equipment Calibrations and Operations

In addition to the compounds detected on the site, the following chemicals are typically used during investigative activities:

- Methane calibration gas
- Isobutylene calibration gas
- Pentane calibration gas
- Hydrogen sulfide calibration gas
- Hydrogen gas (FID fuel)
- Isopropyl alcohol
- Methanol
- Alconox®
- Nitric acid
- Sample preservatives (e.g., hydrochloric acid).

These chemicals may be used for equipment calibration and operations of field instrumentation, the processing and/or preservation of samples, and the decontamination of equipment. Isopropyl alcohol, methanol, and Alconox are typically used for cleaning and decontamination. The quantities to be used will not exceed 1-oz quantities for sample preservatives in each bottle, and will be used within controlled conditions, primarily to support equipment calibration. The anticipated occupational exposures from these operations will be negligible. OSHA has clarified that the field use of these small amounts of chemicals for sample preservation does not fall under the scope and requirements of 29 CFR 1910.1450 – *Occupational Exposure to Hazardous Chemicals in Laboratories.*

3.4 Physical Hazards

Physical hazards can potentially be present during field activities. These physical hazards may include, but not be limited to:

- Fire/explosion hazards
- Heat stress
- Cold stress
- Equipment hazards
- Vehicle and pedestrian hazards
- Noise hazards
- Electrical hazards
- Utilities
- Biological hazards
- Weather hazards
- Confined space hazards
- Excavation hazards
- Slip/Trip hazards

Physical hazards are listed below for each work task. Physical and Biological Hazard Information Sheets provided in the site-specific HASP Addendum will list potential hazards and protective measures.

- **Test Pit Excavation/Sampling**—General safety hazards, heavy equipment hazards, general physical hazards, electric hazards, underground utilities, fire/explosion, noise hazards, cold/heat stress, and biological hazards.

- **Surface Soil/Wipe Sampling**—General safety hazards, cold/heat stress, and biological hazards.

- **Surface Water/Sediment Sampling**—General safety hazards, cold/heat stress, and biological hazards.

- **Drilling and Installation of Monitoring Wells**—General safety hazards, heavy equipment hazards, electrical hazards, underground utilities, fire/explosion, noise hazards, cold/heat stress, and biological hazards.

- **Groundwater Sampling**—General physical hazards, cold/heat stress, and noise hazards.

- **Soil Vapor Sampling**—General safety hazards, heavy equipment hazards, electrical hazards, underground utilities, fire/explosion, noise hazards, cold/heat stress, and biological hazards.

Each site will be visually inspected for the presence of general safety hazards (e.g., trip/slip hazards, unstable surfaces or steep grades, biological hazards – thorny plants, poison ivy, wasp nests, sharp objects) prior to beginning work. If hazards are present, these hazards will be recorded, workers informed and precautionary measures taken to prevent injury.

3.4.1 Fire/Explosion Hazards

The potential for fire and/or explosion emergencies is always present on a site. Substances capable of creating fire and explosion at a site include methane gas, petroleum-contaminated soils, and other flammable vapors. Workers must continuously monitor the work area for combustible or explosive gases when operations have the potential to generate sparks. Employees should always be alert for unexpected events, such as ignition of chemicals or sudden release of materials under pressure, and be prepared to act in these emergencies.

Field vehicles will be equipped with a dry powder A/B/C fire extinguisher. Employees must be trained in the proper use of portable fire extinguishers, and instructed to attempt to extinguish fires in their incipient stage only. Large fires that cannot be controlled with a portable fire extinguisher should be handled only by professional Fire Department personnel. The proper authorities should be notified in these instances.

3.4.2 Heat Stress, Heat Strain and Heat-Related Illness

The wearing of PPE may create heat strain to the wearer. All hot environments produce some **heat stress** on the living organisms exposed; most of the time we can effectively deal with it within the context of our normal physiological response range, and it does not harm. However, when an unhealthy response is elicited, we say it has caused **heat strain** on the worker – this is what we want to avoid when working in hot environments. Heat strain leads to heat-induced illness. There are six major categories of heat-related disorders:

1. Transient heat fatigue, a state of discomfort and psychological strain arising from prolonged heat exposure, is usually developed by workers that are not acclimated to heat. Task performance, concentration, alertness, and vigilance decline. Gradual acclimation to heat can lessen the stress.

2. Heat rash, also known as prickly heat, is caused by the body's inability to remove sweat by evaporation. The sweat ducts become plugged, sweat glands are inflamed, and a rash that can become infected develops. Resting in a cool place at regular intervals and showering after each work shift prevent the condition.

3. Fainting is usually caused by a worker's standing erect and immobile in the hot sun. Blood pools in the lower section of the body, thereby reducing the amount of blood pumped to the brain. Moving periodically prevents the blood from pooling.

4. Heat cramps are painful spasms of the working muscles of individuals who sweat profusely in heat, and who drink large quantities of water but fail to replace the body's salt loss. The lack of salt causes painful cramps that can be relieved by drinking half a glass (approx. 4 ounces) of water containing one-half teaspoon of salt every 15 min. Muscles should be massaged gently to relieve spasm. Cramps can also be prevented by drinking an electrolyte mixture (such as Gatorade') while working. Persons with heart problems or low-sodium diets must consult a physician for relief of heat cramps.

5. Heat exhaustion is caused by excessive sweating. The worker will continue to sweat but experience extreme weakness, fatigue, giddiness, nausea, or headache. The worker may vomit or faint in severe cases. The skin is clammy and moist, complexion is pale or flushed, and body temperature is normal or slightly higher. The victim should lie down in a cool place, with feet elevated 8-12 in. Lightly salted liquids, i.e., half a glass of water with half a teaspoon of salt, should be administered every 15-min. (See above caution on heart patients.) Cool, wet cloths can also be applied. If vomiting occurs, discontinue fluids and take victim to nearest hospital.

6. Heat stroke, the most dangerous form of heat-related injury, is life threatening. Help must be obtained immediately or the worker may die. Heat stroke is caused by the breakdown of the body's thermoregulation system under stress and results in disruption of the sweating mechanism. Body temperature will rise significantly and rapidly, i.e., >105°F; the skin will be hot, dry, and usually red in spots; pulse will be rapid and strong. An ambulance should be summoned, but the victim should be moved immediately to a cool place, his/her clothes soaked with water, and his/her body vigorously fanned to promote cooling and reducing body temperature. Alternatively, the victim can be undressed and placed in a tub of cold (not ice) water, sponged with cool water or rubbing alcohol, or given continuous applications of cold packs. Although high body temperature can cause permanent brain damage and/or death, the victim must not be overchilled.

When workers are <u>wearing impermeable personal protective clothing</u> (e.g., coated disposable coveralls), monitoring of personnel for the onset of heat-induced illness should commence when the ambient temperature exceeds 70°F. Monitoring frequency should increase as ambient temperature increases or as slow recovery rates are observed. Heat strain monitoring will be performed by a person with a current first-aid certification who is trained to recognize heat stress symptoms. For monitoring the body's physiological response to excess heat, one or more of the following techniques will be used. Physiological monitoring like that described here measures the body's response to the hot environment, and is the most accurate way of determining the ability of each worker to handle the heat/humidity. It is the best method to use when workers wear impermeable PPE in an outdoor setting. If workers wear standard permeable clothing, however, another method, called heat stress monitoring, can be employed. This method does not measure the individual workers ability to respond to the heat; rather, it measures the environmental heat "load" itself and assumes all workers will be affected the same. Heat stress monitoring employs using the wet bulb globe temperature index published by the American Conference of Governmental Industrial Hygienist (ACGIH) and found in their Threshold Limit Value (TLV) Booklet.

To monitor the worker heat strain (physiological monitoring):

- Measure heart rate by counting the radial pulse during a 30-second period as early as possible in the rest period.
- If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.
- If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third.
- Measure oral temperature using a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).
- If oral temperature exceeds 99.6° F (37.6° C), shorten the next work cycle by one-third without changing the rest period.
- If oral temperature still exceeds 99.6° F (37.6° C) at the beginning of the next rest period, shorten the following work cycle by one-third.
- Do not permit a worker to wear a semi-permeable or impermeable garment when oral temperature exceeds 100.6° F (38.1° C).

3.4.2.1 Prevention of Heat Strain

Proper training and preventive measures will aid in averting loss of worker productivity and serious illness. Heat strain prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat-related illness. To avoid heat strain, the following steps should be taken:

- Adjust work schedules to reduce exertion
- Modify work/rest schedules according to monitoring requirements
- Mandate work slow downs as needed
- Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods
- Maintain worker's body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e., 8 fluid oz (0.23 L) of water must be ingested for approximately every 8 oz (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that enough water will be consumed to replace lost sweat. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:
  - Maintain water temperature 50-60°
  - Provide small disposable cups that hold about 4 oz (0.1 L)
  - Have workers drink 16 oz (0.5 L) of fluid (preferably water or dilute drinks) before beginning work
  - Urge workers to drink a cup or two every 15-20 minutes, or at least each monitoring break. A total of 1-1.6 gals (4-6 L) of fluid per day are recommended, but more may be necessary to maintain body weight.
  - Train workers to recognize the symptoms of heat-related illness.

3.4.3 Cold-Related Illness

If work on a project begins in the winter months, deleterious health effects of cold exposure are possible during the performance of field activities. Tissue injury from cold exposure, termed frostbite, may occur in persons working outdoors during a period when temperatures average below freezing. The extremities, such as fingers, toes, and ears, are the most susceptible to frostbite. Hypothermia, or a lowering of the body's core temperature may also occur when prolonged exposure to cold is encountered; it does not have to be below freezing for hypothermia to occur.

3.4.3.1 Prevention of Cold-Related Illness.

To avoid cold-related illness, the following steps should be taken:

- Educate workers to recognize the symptoms of frostbite and hypothermia
- Identify and limit known risk factors
- Assure the availability of an enclosed, heated environment on or adjacent to the site
- Assure the availability of dry changes of clothing
- Develop the capability for temperature recording at the site
- Assure the availability of warm drinks.

3.4.4 Heavy Equipment Hazards

Working with large motor vehicles and heavy equipment could be a major hazard on these sites. Injuries can result from equipment hitting or running over personnel, impacts from flying objects, or overturning of vehicles. Vehicle and heavy equipment design and operation will be in accordance with 29 CFR, Subpart O, 1926.600 through 1926.602. In particular, the following precautions will be utilized to help prevent injuries/accidents:

- Brakes, hydraulic lines, light signals, fire extinguishers, fluid levels, steering, tires, horn, and other safety devices will be checked at the beginning of each shift by the equipment operator.

- Large construction motor vehicles will not be backed up unless the vehicle has a reverse signal alarm audible above the surrounding noise level, or the vehicle is backed up only when an observer signals that it is safe to do so.

- Heavy equipment or motor vehicle cabs will be kept free of all non-essential items, and loose items will be secured.

- Large construction motor vehicles and heavy equipment will be provided with necessary safety equipment (seat belts, rollover protection, emergency shut-off in case of rollover, backup warning lights, and audible alarms).

- Blades and buckets will be lowered to the ground and parking brakes will be set before shutting off heavy equipment or vehicles.

3.4.5 Vehicle and Pedestrian Hazards

Vehicle or pedestrian traffic, particularly in busy areas, may be susceptible to site hazards, or may present a hazard to site workers. Project equipment must be located in an area that does not present a hazard to vehicular traffic or the public. Barriers must be used to separate the work areas from both vehicular and pedestrian traffic areas and to prevent inadvertent entry into the work area. Whenever possible, work in high traffic areas will be performed during times when traffic is minimal. Safety cones will be placed around the work area to create a buffer zone. Workers must wear safety vests or equivalent reflective material to enhance their visibility in these areas. The buffer zone will be maintained even when work is not being performed in the area to prevent unauthorized access and to make the work site visible.

3.4.6 Drilling

Prior to drilling activity, efforts will be made to determine whether underground installations will be encountered and, if so, where these installations are located. Hard hats, safety glasses, and safety boots must be worn as a minimum, within 25 ft of the drill rig. The drill rig cannot be operated within 10 ft or 10 ft plus 4 inches for every 10 kV over 50 kV of overhead power lines. The Task Manager or Site-Specific HSO will provide onsite supervision of the drilling subcontractor to ensure that they are meeting the health and safety requirements of the site as outlined in their HASP. If deficiencies are noted, work will be stopped and corrective action will be taken (e.g., retrain, purchase additional safety equipment). Reports of health and safety deficiencies and the corrective action taken will be forwarded to the Project Manager.

3.4.7 Noise Hazards

Work around large equipment often creates excessive noise. Noise can cause workers to be startled, annoyed, or distracted; can cause physical damage to the ear, pain, and temporary and/or permanent hearing loss; and can interfere with communication. If possible, move away from the noise source. If workers are subjected to noise exceeding an 8-hour time-weighted average sound level of 85 dBA, hearing protection will be required. The selected hearing protection should provide a noise reduction rating (NRR) in compliance with 29 CFR 1910.95 to reduce noise pressure levels inside the PPE below 85 dBA. In the unlikely event that workers are exposed to sustained continuous noise levels exceeding 100 dBA, both ear plugs and ear muffs shall be worn simultaneously.

3.4.8 Electrical Hazards

Overhead power lines, electrical wiring, electrical equipment, and buried cables pose risks to workers of electric shock, burns, heart fibrillation, and other physical injuries, as well as fire and explosion hazards. Workers will take appropriate protective measures when working near live electrical parts, including inspection of work areas to identify potential spark/ignition sources, maintenance of a safe distance, proper illumination of work areas, provision of barriers to prevent inadvertent contact, and use of nonconductive equipment. If wiring or other electrical work is needed, it must be performed by a qualified electrician. General electrical safety requirements include:

- Electrical wiring and equipment must be a type listed by UL, Factory Mutual Engineering Corporation, or other recognized testing or listing agency.
- Installations must comply with the National Electrical Safety Code or the National Electrical Code regulations.
- Portable and semi-portable tools and equipment must be either grounded (three-prong) by a multi-conductor cord having an identified grounding conductor and a multi-contact polarized plug-in receptacle, <u>or</u> be double-insulated (generally, these are plastic case power tools, and will be marked as such by a box inside a box, or a “D” inside a “D”, stamped on the plastic housing.
- Live parts or wiring or equipment must be guarded to prevent persons or objects from touching them.

- Electric wire or flexible cord passing through work areas must be covered or elevated to protect it from damage by foot traffic, vehicles, sharp corners, projections, or pinching.

- Circuits must be protected from overload.

- Temporary power lines, switch boxes, receptacle boxes, metal cabinets, and enclosures around equipment must be marked to indicate the maximum operating voltage.

- Plugs and receptacles must be kept out of water unless equipped with approved submersible construction.

- Extension outlets must be equipped with ground fault circuit interrupters (GFCIs).

- Attachment plugs or other connectors must be equipped with a cord grip and be constructed to endure rough treatment.

- Extension cords or cables must be inspected prior to each use, and replaced if worn or damaged. Cords and cables must not be fastened with staples, hung from nails, or suspended by bare wire. Electrical tape cannot be used to repair damaged cords.

- Flexible cords must be used only in continuous lengths without splice, with the exception of molded or vulcanized splices made by a qualified electrician.

3.4.8.1 High Voltage Hazards.

Employees may be required to work around sources of high voltage at the site. Caution should be exercised to minimize contact with high voltage equipment, including contact between sampling equipment and potentially charged items. The minimum working distances from power transmission and distribution lines and equipment that will be allowed at the site are presented in the table below:

Nominal System Voltage	Minimum Required Clearance
0-50 kV	10 ft
51-100 kV	12 ft
101-200 kV	15 ft
201-300 kV	20 ft
301-500 kV	25 ft
501-750 kV	35 ft
751-1,000 kV	45 ft

To minimize the dangers presented by underground high voltage electric lines, the Project Manager will review existing underground utility maps to determine if underground utilities are present at the proposed test pit, soil boring, and monitoring well locations prior to intrusive activities. Subcontractor personnel performing ground intrusive activities will provide grounding cables that will be attached to equipment and a grounding source (i.e., ground grid cable) during subsurface excavation and drilling. Use of the grounding cables will reduce the potential for worker injury in the event that underground utilities are encountered during intrusive activities.

To minimize the dangers presented by backhoe or drill rig contact with aboveground high voltage electric lines, personnel will locate test pits and monitoring wells to maintain an adequate working distance from power transmission and distribution lines.

3.4.9 Utilities

Underground utilities pose hazards to workers involved in drilling and other intrusive operations. These hazards include electrical hazards, explosion, and asphyxiation, as well as costly and annoying hazards associated with damaging communication, sewer, and water lines. Prior to commencement of intrusive operations, Dig Safely NY which services all areas outside of New York City and Long Island, will be contacted (800-962-7962) to inspect and flag the area of investigation. Alternately, for investigations within New York City and Long Island, NY City One Call must be contacted (800-272-4480). Personnel should be aware that although an area may be cleared, it does not mean that unanticipated hazards will not appear. Workers should always be alert for unanticipated events such as snapping cables, drilling into unmarked underground utilities, drilling into a heavily contaminated zone, etc. Such occurrences should prompt workers to halt work immediately and take appropriate corrective measures to gain control of the situation.

3.4.10 Inclement Weather Hazards

Weather conditions should always be taken into consideration. Heavy rains, electrical storms, high winds, and extreme temperatures, for example, may create extremely dangerous situations for field employees. Equipment performance may also be impaired because of inclement weather. Whenever unfavorable conditions arise, the Task Manager and Site-Specific HSO will evaluate both the safety hazards and ability of the employees to effectively perform given tasks under such conditions. Site activities will be halted at their discretion.

Wind direction should be accounted for when positioning equipment at sampling locations. If exposure to organic vapors is anticipated, workers should locate upwind of the sampling point.

Wind direction often changes abruptly and without warning, so personnel should always be prepared to reposition, if necessary.

Wind is a real danger when performing services on aerial lifts or other elevated equipment, particularly those with extended booms. As a general rule, all aerial lift work should cease when wind gusts reach 30 mph, and/or lightning is approaching.

3.5 Biological Hazards

Potential hazards may be present at the site due to bites from stray domestic and wild animals (to include rodents), spiders, bees, and other venomous anthropods, ticks may be encountered during field operations potentially resulting in Lyme disease, or punctures from sharp objects presenting a possible hazard from Tetanus. In the case of an animal or insect bite that can be serious or fatal, workers must seek immediate medical attention and report the incident to the Site-Specific HSO prior to leaving the site. An employee known to be allergic or sensitive to poisonous insects should alert the Task Manager and Site-Specific HSO. Prompt medical attention procedures, as outlined in Section 11.2 of this HASP will be followed in the event of animal bites.

3.5.1 Bloodborne Pathogens

During the conduct of site operations, HDR employees may be exposed to blood and body secretions in support of emergency response operations where site personnel have been injured, and require first aid and/or CPR. Due to the potential that blood and body secretions may contain disease causing organisms such as Hepatitis B Virus and Human Immunodeficiency

Virus, employees electing to provide first aid and CPR support, until the arrival of a competent onsite medical responder, should take appropriate measures to reduce or eliminate their potential for contact and exposure. The concept of "Universal Precautions" will be followed, assuming a potential hazard is present. Employees providing first aid support should wear the appropriate PPE to prevent or reduce their potential for contact and exposure. This will typically be accomplished through the use of rubber gloves, splash-proof eye protection, and the use of mouth-to-mouth guards and proper cleanup (good sanitation and hygiene) following an incident. Hands and face should be thoroughly washed with water and an antiseptic soap or cleanser following an incident, or antiseptic containing disposable towelettes used in the absence of appropriate field washing facilities. The Program HSO should be notified of potential employee exposures to blood and body fluids while conducting work in support of this project.

3.5.2 West Nile Virus

West Nile virus is a member of the Japanese encephalitis complex of flaviviruses, transmissible by mosquitoes, and can cause febrile, sometimes fatal human illness. The New York State Department of Health (NYSDOH) has developed a set of complementary action plans to prevent West Nile virus infections.

According to NYSDOH, outdoor workers should take the following precautions to minimize potential exposure to the West Nile virus from adult mosquito bites:

- It is not necessary to change standard work health and safety practices outdoors, unless there is evidence of the mosquito-borne disease.
- If the West Nile virus is identified in an area, workers should be advised of the precautions to reduce the risk of mosquito bites:
  - Wear shoes, socks, long pants, and a long-sleeved shirt when outdoors for long periods of time or when mosquitoes are most active (between dusk and dawn). Maintain body fluids to avoid heat stress.
  - Consider the use of mosquito repellent, according to directions, when it is necessary to be outdoors for long periods or at times when mosquitoes are most active.

3.5.3 Lyme Disease

Lyme Disease commonly occurs in summer and is transmitted by the bite of infected ticks. "Hot spots" in the United States include New York, New Jersey, Pennsylvania, Massachusetts, Connecticut, Rhode Island, Minnesota and Wisconsin. Few cases have been identifies in other states. Symptoms of Lyme disease include a rash or a peculiar red spot, like a bull's eye, which expands outward in a circular manner. The victim may have a headache, weakness, fever, a stiff neck, swilling and pain in the joints, and eventually, arthritis.

Tick repellant containing diethyltoluamide (DEET) should be used when working in tick-infested areas, and pants legs should be tucked into socks. In addition, at the end of each day workers should inspect their entire body for attached or crawling ticks. Attached ticks should be removed promptly and carefully without crushing, since crushing can potentially squeeze the disease-causing fluid into the skin. A gentle and steady pulling action should be used to avoid leaving the head or mouth parts in the skin. Hands should be protected with surgical gloves when removing ticks.

3.6 Confined Space

A confined space is a space which is large enough and so configured that an employee can bodily enter and perform work, has limited or restricted means for entry or exit, is not designed for continuous employee occupancy, and requires a permit if it has one or more of the following characteristics:

- Contains a potentially hazardous atmosphere due to accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere
- Contains a material with the potential for suffocation of an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls, or a floor that slopes downward and tapers to a smaller cross-section
- Contains other recognized safety or health hazard.

Confined spaces include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than 4 ft in depth such as pits, tubs, vaults, and vessels.

Based on the definition of a confined space, it is not anticipated that confined space entry will be required during field investigations at Standby Contract sites. Although test pit excavations may be required at certain sites, no personnel will be allowed to enter a test pit where excavation exceeds 4 ft in depth unless the sides are shored or sloped in accordance with excavation regulations (29 CFR, Subpart P).

Entry into any confined space is prohibited until the potential confined space is thoroughly assessed by the Program HSO. Only those personnel properly trained and certified will be allowed to conduct permit-required confined space entries.

3.7 Excavation Hazards

On some sites, excavations and/or test pits may be required as part of the investigation tasks. An excavation is defined by OSHA as a man-made cut, cavity, trench or depression formed by earth removal. The excavation regulations require that all excavations be assessed for the potential to cave-in prior to entry, and that all excavations greater than five ft deep be sloped, shored, or otherwise prevented from caving-in prior to worker entry. All provisions contained in the applicable OSHA Excavation Standard, 29 CFR 1926, Subpart P, will be followed whenever an excavation must be entered during the execution of this contract.

3.8 Falls

Fall from heights above six feet may occur on site. If an employee must work at a height of more than six feet and there is a danger of falling, fall protection must be employed as described in the OSHA regulations, 29 CFR 1926, Subpart M.

4.0 GENERAL SAFETY PRACTICES

4.1 Safety Procedures

Safe work practices, which must be followed by site workers, include:

- At least one copy of this Program HASP must be maintained at the project site, in a location readily available to personnel, and reviewed by project personnel prior to starting work.
- Site personnel must use the buddy system.
- Potentially contaminated PPE must not be removed from the work area before being cleaned or properly packaged and labeled.
- Potentially contaminated waste, debris, and clothing must be properly contained, with legible and understandable precautionary labels affixed to each container to define its content.
- Removing potentially contaminated soil or debris from protective clothing or equipment with compressed air, shaking, or any other means that may re-suspend contaminants into the air is prohibited.
- Eat, drink, and smoke only in those areas designated by the Task Manager/Site-Specific HSO. These activities will not take place within any work zone.
- Large bulk containers, such as 55-gal drums, must only be moved with the proper equipment, and must be secured to prevent dropping or loss of control during transport.
- Emergency equipment such as eyewash, fire extinguishers, portable shower, etc. must be staged in readily-accessible locations.
- Employees must be aware, and inform their partners or fellow team members, of the potential non-visible effects of overexposure to toxic materials or other health threatening conditions/hazards. The symptoms of such overexposures may include:
  - Headaches
  - Dizziness
  - Nausea
  - Blurred vision
  - Cramps
  - Irritation of eyes, skin, or respiratory tract.

- Visitors to the site must adhere to the following:

  - Visitors must be instructed to stay outside the Exclusion Zone and Contaminant Reduction Zone, and remain within the Support Zone during the extent of their stay. Visitors must be cautioned to avoid skin contact with surfaces that are contaminated or suspected to be contaminated.

  - Visitors requesting to observe work in the Exclusion Zone must, in addition to complying with the requirements contained in this Program HASP, have their own site-specific HASP and must don appropriate PPE prior to entry into that zone. Additionally, they must have received proper training and appropriate medical clearances for hazardous site work, per 29 CFR 1910.120. If respiratory protective devices are necessary, visitors who wish to enter the Contaminant Reduction Zone must also demonstrate that they have completed proper respirator training and a fit test within the past 12 months.

  - Visitor inspection or access of the Exclusion Zone will be made at the discretion of the Task Manager. Only those personnel fully qualified may access the Exclusion Zone as defined in the site-specific HASP Addendum.

Each employee required to take prescription drugs will notify the Site-Specific HSO prior to the start of work, and upon approval, may take prescription drugs in the Support Zone only. Alcohol, controlled substances, or unauthorized drugs will **not** be permitted on site at any time.

4.2 Buddy System

Onsite personnel must use the buddy system. Visual contact must be maintained between crew members, and crew members must observe each other for signs of chemical exposure, health reactions and/or heat or cold stress. Indications of adverse health effects include, but are not limited to:

- Changes in complexion and skin coloration
- Changes in coordination
- Changes in demeanor
- Excessive salivation and pupillary response
- Changes in speech pattern.

Team members must also be aware of potential exposure to possible safety hazards, unsafe acts, or noncompliance with safety procedures.

If protective equipment or noise levels impair communications, pre-arranged hand signals must be used for communication. Personnel must stay within line of sight of another team member.

4.3 Emergency Equipment

Adequate emergency equipment for field activities and as required by applicable sections of 29 CFR 1910 and 29 CFR 1926 must be maintained onsite.

Personnel will be provided with access to emergency equipment including, but not limited to, the following:

- Emergency eyewash unit(s) and showers meeting ANSI Z358.1-2004 and 29 CFR 1910.151(c).
- Fire extinguishers of adequate size, class, number, and location (one in each HDR vehicle) as required by applicable sections of 29 CFR 1910 and 29 CFR 1926.
- First aid kit of adequate size for the number of personnel onsite.

4.4 Personal Hygiene and Sanitation

4.4.1 Break Area

Breaks will be taken in a designated Support Zone, away from the active work area. Prior to taking a break, site personnel must complete decontamination procedures. There will be no smoking, eating, drinking, or chewing gum or tobacco in the work area other than the Support Zone.

4.4.2 Potable Water

The following rules apply for project field operations:

- An adequate supply of potable water will be provided at the work site. Potable water must be kept away from hazardous materials, contaminated clothing, and contaminated equipment.
- Portable containers used to dispense drinking water must be labeled, capable of being tightly closed, and must be equipped with a tap dispenser. Water must not be consumed directly from the container, nor dipped from the container.

- Containers used for drinking water must be clearly marked and not used for any other purpose.
- Disposable cups will be supplied; both a sanitary container for unused cups and a receptacle for disposing of used cups must be provided.

4.4.3 Sanitary Facilities

Access to facilities for washing before eating, drinking, or smoking will be provided. Personnel are required to wash off exposed skin surfaces prior to eating, smoking, or drinking following site operations and work activities.

4.4.4 Lavatory

If permanent toilet facilities are not available within a short distance of the project site, an appropriate number of portable chemical toilets will be provided.

4.4.5 Trash Collection

Trash from the Contaminant Reduction Zone will be inspected and, if considered a hazardous waste, disposed of as a hazardous waste. Trash collected in the Support Zone and break areas will be disposed of as non-hazardous (solid) waste. Labeled trash receptacles will be set up in the Contaminant Reduction Zone and the Support Zone.

4.5 Spill Control Plan

Personnel must take every necessary precaution to minimize the potential for spills during site operations. Onsite personnel are obligated to report immediately any discharge, no matter how small, to the Project Manager.

Spill control apparatus will be located onsite at locations, where hazardous waste/chemicals are being used/collected, that the Task Manager anticipates a spill to ground may occur. Sorbent materials used in a cleanup effort will be containerized and labeled separately from other wastes. In the event of a spill, the Project Manager will follow the clean-up provisions outlined in the site-specific HASP Addendum, with the goal being to prevent environmental spread and contamination.

4.6 Lockout/Tagout Procedures

Maintenance procedures on equipment, requiring the isolation of energy to prevent worker injury may be necessary during the performance of this contract. Equipment maintenance will only be performed by fully qualified and trained individuals. Before maintenance begins, lockout/tagout procedures per OSHA 29 CFR 1910.147 will be followed.

Lockout is the placement of a device that uses a positive means such as a lock to hold an energy or material isolating device or system ensuring that the equipment cannot be operated until the lockout device is removed. If a device cannot be locked out, a tagout system will be used. Tagout is the placement of a warning tag on an energy or material isolating device indicating that the equipment controlled may not be operated until the tag is removed. Only personnel properly trained in lockout/tagout procedures, and having knowledge of the system requiring maintenance, will conduct these activities. Lockout/tagout procedures will be reviewed and assessed by the Site-Specific HSO prior to maintenance being conducted on the system.

5.0 PERSONAL PROTECTIVE EQUIPMENT

5.1 Respiratory Protection Program

Respiratory protection is an integral part of employee health and safety at sites with potential airborne contamination. The site respiratory protection program will consist of the following:

- Site personnel who use respiratory protection will have an assigned respirator.
- Site personnel who use respiratory protection will have been fit-tested and trained in the use of a full-face air-purifying respirator within the past 12 months.
- Site personnel who may use respiratory protection must have been medically certified as capable of wearing a respirator (initial exam, no annual repeat requirement). (Note: This may be included as part of the overall HazWoper medical exam). Documentation of the medical certification must be provided to the Site-Specific HSO prior to commencement of site work.
- Only cleaned, maintained, National Institute for Occupational Health and Safety (NIOSH)-approved respirators and cartridges are to be used on the site for Level C respiratory protection.
- If chemical cartridge respirators are used, a determination will be made that there is an appropriate cartridge available for the contaminant(s) of concern. When used the chemical cartridges will be properly disposed of at the end of each work shift, or when load-up or breakthrough occurs, or per change out schedule, whichever occurs first.
- Site personnel who use respiratory protection must be clean shaven - visible beards are prohibited. Mustaches and side burns are permitted, but they must not interfere with the sealing surface of the respirator.
- Respirators will be inspected, and a positive/negative pressure test performed prior to each use.
- After each use, the respirator will be cleaned and wiped with a disinfectant. When used, the respirator will be thoroughly cleaned at the end of the work shift. The respirator will be stored in a clean plastic bag, away from direct sunlight in a clean, dry location, in a manner that will not distort the face piece, and labeled with the user’s name.

5.2 Levels of Protection

Based upon currently available information, the sites are considered non-hazardous and will require Level D protection for currently anticipated conditions and activities. In the event that potential chemical hazards are identified, the level of protection may be upgraded appropriately to the potential hazard conditions. Only those personnel identified and qualified for hazardous waste work, as defined in 29 CFR 1910.120, will be allowed to upgrade beyond Level D or provide support of hazardous material/substance contingency operations. Only the Task Manager and Site-Specific HSO, in conjunction with the Program HSO, will be allowed to approve PPE upgrade beyond Level D and site re-entry for the purpose of hazardous conditions assessment. The following is a list of the PPE components for the maximum levels of protection authorized for use during this project.

5.2.1 Level D Personal Protective Equipment (May be considered Mod-D when polycoated coverall body protection is required)

Level D will be worn for initial entry onsite and initially for all activities and will consist of the following:

- Coveralls or appropriate work clothing
- Protective-toe, steel-shank safety boots
- Hard hats (when overhead hazards are present or as required by the Site-Specific HSO)
- Chemical resistant gloves (e.g. nitrile or neoprene) when contact with potentially contaminated soil or water is expected
- Safety glasses with side shields
- Hearing protection such as ear plugs or ear muffs (during drilling or other operations producing excessive noise)
- Boot covers/overboots (optional unless in contact with potentially contaminated soil or water)
- Polycoated coveralls (optional unless contact with heavily contaminated soil and water is anticipated, e.g., when surging/pumping contaminated wells and pressure-washing contamination soils from equipment).

Insulated clothing, hats, etc. should be worn when temperatures or wind chill fall below 40°F.

5.2.2 Level C Personal Protective Equipment

Based upon the preliminary information concerning potential investigative sites, contaminant concentrations are not expected to require the use of Level C PPE. However, should the following conditions be identified, the Site-Specific HSO is authorized to increase the level of PPE to be worn as long as an assessment has been made to determine the contaminant(s) of concern [COC(s)] and the proper level of skin/respiratory protection. Refer to Section 5.3 for PPE upgrade criteria.

If the action levels are exceeded as specified in Section 5.3, the level of personal protection will be upgraded to Level C. Level C protection consists of:

- Full-facepiece, air purifying respirator equipped with combination organic vapor and high efficiency particulate cartridges that are appropriate for the COC(s) and approved by the manufacturer for the concentrations present
- Polycoated or other water resistant coveralls if the COC(s) present a dermal hazard and contact with heavily contaminated soil and water is anticipated
- Protective-toe, steel-shank safety boots
- Chemical-resistant boot covers if the COC(s) present a dermal hazard
- Hard hats (when overhead hazards are present or as required by the Site-Specific HSO)
- Hearing protection such as ear plugs or ear muffs (during drilling or other operations producing excessive noise)
- Chemical resistant inner (latex/nitrile) and outer gloves (nitrile/neoprene) if the COC(s) present a dermal hazard.

5.3 Upgrade or Downgrade of Personal Protective Equipment Level

As the new or additional site-specific information surfaces an upgrade or downgrade in level of PPE may be appropriate. Only the Task Manager and Site-Specific HSO, in conjunction with the Program HSO, can authorize an upgrade or downgrade in the PPE level worn onsite, basing their decision on the criteria presented in this Program HASP. Changes in PPE levels must be documented on the PPE Activity Report provided in the site-specific HASP Addendum, along with the rationale for the PPE change. Upgrade is currently limited to Level C. Should an upgrade to Level A or Level B PPE be considered necessary, this Program HASP must be amended, and approved by a Certified Industrial Hygienist (CIH) experienced in HazWoper operations prior to upgrade.

The following general guidelines will be used to help define conditions requiring an upgrade to Level C:

- If the sustained level of total organic vapors in the worker breathing zone exceeds 5 ppm calibration units (PCU) above background for 2 minutes or more continuously with a photoionization (PID) or flame ionization detector (FID), site workers will evacuate the Exclusion Zone and the condition will be brought to the attention of the Site-Specific HSO. Appropriate air purifying respirators and Level C PPE will be donned. Efforts will then be undertaken to mitigate the source of organic vapors.

- A portable gas monitor (PGM) with a lower flammable limit (LEL) sensor will be used to monitor the breathing zone. If the PGM reads 10% LEL sustained over a 1 to 2-minute period, site workers will evacuate the Exclusion Zone and the condition will be brought to the attention of the Site-Specific HSO. The cause of the elevated LEL reading will be assessed based on available project site history and/or the collection of a sample for laboratory analysis. Once it has been determined Level C is the appropriate level of respiratory protection and there is a chemical cartridge available and appropriate for the COC(s), respirators will be donned. A reading of greater than 10 % of the LEL or less than 19.5 % oxygen will require immediate evacuation of the Exclusion Zone.

- A visible condition, odor, or employee perception that a chemical of concern may be released or be present may require an upgrade in respiratory protection or additional skin protection. This condition should always be brought to the attention of the Site-Specific HSO.

5.4 Hearing Protection

Hearing protection must be available and properly worn whenever sustained noise levels exceed 85 dBA (noise level at which a normal conversation cannot be carried on at a 3-ft distance). When the Site-Specific HSO determines that a potential excessive noise exposure exists, the use of hearing protection may become mandatory. Two types of hearing protection will be available onsite: foam earplugs and ear muffs. The hearing protectors will have a Noise Reduction Rating sufficient to reduce the sound level to below 85 dBA inside the ear.

5.5 Selection and Use of Personal Protective Equipment

Equipment for personal protection will be selected based on the potential for chemical contact, site conditions, ambient air quality, and the judgment of supervising site personnel and health and safety professionals. The PPE used will be chosen to provide effective protection against the compound(s) present at the site.

Depending upon the level of protection selected, specific donning and doffing procedures may be required. The procedures listed in this Section are mandatory when Level D or higher PPE is used.

Persons entering the Exclusion Zone must put on the required PPE in accordance with the requirements of this Program HASP. When leaving the Exclusion Zone, PPE will be doffed in accordance with the procedures presented in Section 5.5.2 to minimize the spread of contamination.

5.5.1 Donning Procedures

The following procedures are mandatory when Level D or higher PPE is required at the site and it has been determined there is a dermal hazard as well as a respiratory hazard:

- Remove bulky outerwear; remove street clothes and store in a clean location
- Put on work clothes or coveralls

- Put on chemical protective coveralls or rain gear (if required)
- Put on chemical protective boots or boot covers (if required)
- Tape the legs of the coveralls to the boots with duct tape
- Put on chemical protective gloves (if required)
- Tape the wrists of the protective coveralls to the gloves
- Don the required respirator (Level C only) and perform appropriate fit check
- Put hood or head covering over head and respirator straps (Level C only) and tape hood to facepiece
- Don remaining PPE, such as safety glasses or goggles and hard hat.

When Level C procedures are instituted, one person must remain outside the work area to ensure that each person entering has the proper protective equipment.

5.5.2 Doffing Procedures

These procedures are mandatory when Level Mod –D or higher PPE is used at the site. Whenever a person leaves a Level Mod-D or higher work area and the COC(s) present a dermal hazard that may be present on the PPE, the following decontamination sequence will be followed:

- Upon entering the Contaminant Reduction Zone, rinse contaminated materials from the boots or remove contaminated boot covers
- Clean reusable protective equipment
- Remove protective garments, equipment, and respirator (if necessary); disposable clothing should be placed in plastic bags, which are labeled with contaminated waste labels
- Wash hands, face, and neck or shower (if necessary)
- Proceed to clean area and dress in clean clothing
- Clean and disinfect respirator (if necessary) for next use.
- Disposable equipment, garments and PPE must be bagged in plastic bags and labeled for disposal.

6.0 SITE CONTROL

6.1 Authorization to Enter

Only personnel who have completed hazardous waste operations initial training, as defined under OSHA Regulation 29 CFR 1910.120/29 CFR 1926.65, or refresher training within the past 12 months will be allowed within a site area designated as an Exclusion Zone or Contaminant Reduction Zone. Personnel without such training may enter the designated Support Zone only. If Level C or higher respiratory protection is required, each person required to wear a respirator will have documented clearance to wear a respirator by a physician as part of the HDR medical monitoring program. The Site-Specific HSO will maintain a list of authorized persons, and only personnel on the list will be allowed within the Exclusion Zone or Contaminant Reduction Zone.

6.2 Site Orientation and Hazard Briefing

Prior to entering the site, HDR personnel will attend a pre-entry orientation session presented by the Site-Specific HSO. Personnel will verify attendance of this meeting by signing the HASP Review Record provided in the site-specific HASP Addendum.

Visitors entering designated work areas will be subject to applicable health and safety regulations during field operations at the site. The Site-Specific HSO is responsible for briefing the personnel onsite of potential hazards that may be encountered on the site, the presence and location of both the Program HASP and site-specific HASP Addendum, and emergency response procedures. Visitors will be under the direct supervision of the Site-Specific HSO or his/her representative.

At a minimum, the pre-entry orientation session will discuss the contents of this Program HASP, potential health effects of hazards associated with onsite activities, and potential hazards presented by unearthing unidentified hazardous materials. Personnel will be instructed in the emergency notification and evacuation procedures, including onsite communications, route to the nearest medical facility and implementation of the site-specific contingency plans. Additionally, personnel will be briefed on safe work practice, level of required PPE and the proper donning, doffing, and use of required PPE.

6.3 Certification Documents

A training and medical file will be established for the project and kept onsite during site operations. Proof of completed 24-Hour or 40-hour HAZWOPER or current 8-hour refresher training, updates, and required specialty training (i.e., CPR/first aid certificates, medical clearance to wear a respirator) will be maintained within the file. Site personnel and subcontractor personnel must provide their training and medical documentation to the Site-Specific HSO prior to the start of field work.

6.4 Entry Log

A log-in/log-out sheet must be maintained at the site by the Task Manager. Personnel may sign in and out on a log sheet provided in the site-specific HASP as they enter and leave the Contaminant Reduction Zone.

6.5 Entry Requirements

In addition to the authorization, hazard briefing, and certification requirements listed above, personnel will not be allowed on the field site unless the individual is wearing the minimum Support Zone PPE as described in Section 5. Personnel entering the Exclusion Zone or Contaminant Reduction Zone must wear the required PPE for those locations.

6.6 Emergency Entry and Exit

People who must enter the site on an emergency basis will be briefed of the hazards by the Task Manager. Exclusion Zone activities will cease in the event of an emergency and sources of emissions will be controlled, if possible.

In an emergency, personnel will gather in a pre-designated safe area for a head count. The Task Manager is responsible for ensuring that all personnel who entered the work area, exit the area safely and timely in the event of an emergency.

Emergency procedures are discussed in more detail in Section 11.

7.0 WORK ZONES AND DECONTAMINATION

7.1 Site Work Zones

In order to reduce the spread of hazardous materials by workers from the contaminated areas to the clean areas, separate work zones have been established at the site, including the Exclusion Zone, Contamination Reduction Zone, and Support Zone. The flow of personnel between the zones will be controlled. Establishment of these work zones will help ensure that personnel are properly protected against the hazards present where they are working, work activities and contamination are confined to the appropriate areas, and personnel can be located and evacuated in case of an emergency.

7.1.1 Exclusion Zone

A 25-ft radius Exclusion Zone will be established at drilling or sampling locations. This area has the highest potential for exposure to chemicals onsite.

7.1.2 Contaminant Reduction Zone

If appropriate, a Contaminant Reduction Zone will be established by the Site-Specific HSO between the Exclusion Zone and Support Zone. This zone will include personnel and equipment necessary for decontamination. There will be one access point between the Exclusion Zone and Contaminant Reduction Zone. Personnel and equipment in the Exclusion Zone must pass through this zone before entering the Support Zone.

7.1.3 Support Zone

The Support Zone will include the remaining areas of the job site, such as the HDR vehicle and equipment staging area. Break areas, operational direction, and support facilities will be located in this zone. No equipment or personnel will be permitted to enter the Support Zone from the Exclusion Zone without passing through the personnel or equipment decontamination station if decontamination is required. Eating, smoking, and drinking will be allowed only in this area.

7.2 Posting

The Exclusion Zone, Contaminant Reduction Zone, and Support Zone will be prominently marked and delineated using cones or caution tape.

7.3 Decontamination

7.3.1 Decontamination of Personnel

The following procedures will be used for the decontamination of personnel if the soils/sediments encountered during the investigation activities are contaminated:

- Remove and discard boot covers if worn.
- Wash boots with detergent and water and rinse if they have contaminated soils/sediments on them.
- If worn, wash outer gloves with detergent and water, rinse, and remove.
- Remove coveralls, then respirator if worn.
- Remove and discard inner gloves.
- Wash hands, face, and other exposed skin with soap and water.
- If non-disposable coveralls came in contact with contaminated soils, sediment, or groundwater, place them in plastic bags prior to leaving the site and prior to entering any HDR or personal vehicle.
- Launder non-disposable clothing worn in Exclusion Zone prior to reuse, separately from other laundry items.

7.3.2 Decontamination of Equipment

The following procedures will be used for the decontamination of equipment if it comes in contact with product, contaminated soils, sediment, or groundwater:

- Instruments used onsite must be wet-wiped with clean water prior to leaving the site; wet-wipe respirator exteriors whenever exiting work areas.

- Clean respirators with a manufacturer-recommended sanitizer, then hang to drip dry, and place in plastic bags for protection against dust.
- Change respirator chemical cartridges at least daily, when breakthrough occurs, when breathing resistance becomes uncomfortable or per change out schedule, whichever occurs first. Used cartridges will be damaged to prevent accidental reuse. Cartridges generally can be disposed of as solid waste.
- Drilling and sampling equipment must be decontaminated in accordance with federal and state requirements as specified in the site-specific Field Sampling and Analysis Plan.

7.3.3 Personal Protective Equipment Decontamination

Wherever and whenever possible, single use, external protective clothing (e.g., disposable coveralls) should be used for work within the Exclusion Zone or Contaminant Reduction Zone. If contaminated, this protective clothing must be disposed of in properly labeled containers.

Contaminated reusable protective clothing will be rinsed at the site with detergent and water. The rinse water will be collected for disposal.

When removed from the Contaminant Reduction Zone, respirators will be thoroughly cleaned with soap and water. The respirator face piece, straps, valves, and covers must be thoroughly cleaned at the end of each work shift, and made ready for use prior to the next shift. Respirator parts may be disinfected with a solution of bleach and water, or by using a spray disinfectant.

8.0 SITE MONITORING

8.1 Environmental Monitoring and Action Levels

For intrusive work (e.g., soil boring) conducted onsite, environmental monitoring for toxic, flammable/combustible gases, and oxygen will be performed as needed using a PGM and a PID or FID. Instruments will only be used by employees who have been trained in the proper operation, use limitations, and calibration of the monitoring equipment. Monitoring will be conducted at intervals not less than once every 30 minutes using either the PID/FID and/or the PGM. **Task-specific environmental monitoring requirements for the work scheduled at each site will be discussed in each site-specific HASP Addendum**, including the type of monitoring to be performed, the frequency and location of monitoring, action levels, and required responses if action levels are detected.

Environmental monitoring will include sufficient monitoring of air quality in work zones during intrusive field operations to assess levels of employee exposure and to verify that the level of PPE being worn by personnel is adequate. Monitoring will also be conducted to ensure that contaminants are not migrating offsite, to prevent/minimize the exposure to nearby populations and/or workers.

8.2 Calibration and Maintenance

Direct-reading instruments will be calibrated on a daily basis with a known concentration of calibration gas following the instrument manufacturer's guidance. Instructions in the manufacturer's operations manual regarding storage, cleaning, and maintenance of the instruments will be followed. Calibration will be properly recorded in the field logbook to show the date, calibration material type and concentration, and the actual reading obtained. Equipment failing to meet the manufacturer's standards for accuracy and repeatability will be considered suspect and replaced with an alternate, properly functioning piece of equipment.

8.3 Onsite Monitoring Plan and Response Activities

As described above, sufficient air monitoring will be performed in worker breathing zones and other onsite areas during intrusive field operations to assess levels of employee exposure, to determine that contaminant levels do not constitute a fire/explosion hazard, and to verify the level of PPE being worn by personnel is adequate. Air monitoring is also designed to ensure that contaminants are not migrating offsite to minimize exposure to nearby populations and/or workers.

Based on the known and anticipated types of field services and exposures, monitoring will be conducted:

- Upon commencement of each different phase of operation;
- During intrusive field procedures (at intervals not less than once every 30 minutes using either a PID or FID, and a PGM);
- Upon worker or local community complaints or concerns, and
- At sufficient intervals, if any action level is exceeded, in order to assess the adequacy or need for PPE upgrade and/or evacuation and HASP reassessment.

If action levels in the worker breathing zone are exceeded, additional air monitoring will be required at various onsite/perimeter locations to determine appropriate response activities that are protective of (a) personnel onsite not directly involved with the investigation, (b) public at adjacent commercial sites, and (c) residents in the surrounding community. This additional monitoring is discussed in Section 8.3.1, below.

8.3.1 Monitoring and Response Activities

The following activities will be implemented if contaminant action levels are exceeded during onsite investigation activities.

8.3.1.1 Total Organic Vapors

If the sustained level of total organic vapors in the worker breathing zone exceeds 5 PCUs above background on the PID or FID, then the level of total organic vapors will be manually recorded at the downwind perimeter of the work area (i.e., Exclusion Zone) at 15-minute intervals. If the level of total organic vapors at the downwind perimeter of the work area exceeds 5 PCUs above background, then work activities will be halted and additional downwind monitoring will be performed. Efforts will be undertaken to mitigate the source of organic vapors. The Exclusion Zone will be enlarged, if necessary, to keep personnel who are not involved with the investigation from being exposed to organic vapor levels exceeding 5 PCUs above background.

During the investigation, it is also possible that the downwind perimeter of the work area will coincide with the fenced site perimeter. If the level of total organic vapors adjacent to the downwind site perimeter reaches 5 PCUs above background, then the level of total organic vapors adjacent to the nearest downwind residential or commercial property from the work zone will be monitored. If, after 30 minutes, the total organic vapor level adjacent to the residential or commercial property has not subsided below 5 PCUs above background, then the Site-Specific HSO will inform the designated HDR project manager and the local emergency response contacts listed in Section 11. The HDR project manager will be responsible for notifying the NYSDEC, NYSDOH, and persons who may be exposed at the residential or commercial properties until after the level of total organic vapors on the properties subsides to below 5 PCUs above background.

8.3.1.2 Particulate.

If COC(s) at the site are associated with soils or sediment which could be released into the air during intrusive activities, particulate monitoring will be conducted with a real-time aerosol monitor (RAM). Background levels of ambient particulate loading, due to wind, will be acquired daily or as necessary through use of the RAM at the upwind perimeter of the site. All RAM readings will be taken at approximately 4 feet above ground surface, to prevent contamination due to foot movement. During intrusive field operations, if the level of particulates in the worker breathing zone exceeds 100 µg/m^3 above background, then the level of particulate will be manually recorded at the downwind perimeter of the work area at 15-minute intervals. If the concentrations of particulates at the downwind perimeter of the work area is 150 µg/m^3 or greater above background, then work activities will cease and dust suppression techniques must be employed to maintain particulate levels below 150 µg/m^3. In addition, the Exclusion Zone will be enlarged as necessary to keep personnel who are not involved with the investigation (and the public) from being exposed to particulate concentrations greater than 150 µg/m^3.

8.4 Noise Monitoring

Noise monitoring will be conducted as required. Hearing protection is mandatory for employees in high noise hazardous areas, such as around operating heavy equipment. As a general rule, sound levels that cause speech interference of normal conversation distance of three feet should require the use of hearing protection. If workers do not need to be standing near high noise sources, they should move away to reduce exposure.

8.5 Odor Control

If odor complaints are received from members of the surrounding community, site activities will be suspended, subsurface openings will be covered, and onsite personnel (in consultation with HDR project manager and the NYSDEC representative) will evaluate an alternative course of action.

9.0 EMPLOYEE TRAINING

9.1 Site Workers

Personnel who will be performing non-hazardous onsite tasks are not required to have been trained according to U.S. Department of Labor OSHA Standard, 29 CFR 1910.120/29 CFR 1926.65 *Hazardous Waste Operations and Emergency Response (also referred to as "HazWoper")*

These workers will have appropriate health and safety training based upon their specific job tasks, activities and exposures.

The Task Manager, Site-Specific HSO, and personnel conducting the field sampling and monitoring for site gases and vapors during intrusive operations (e.g., soil borings) will be trained as required by 29 CFR 1910.120/29 CFR 1926.65, *Hazardous Waste Operations and Emergency Response* to qualify as a hazardous waste site worker and supervisor. Training will include:

- A minimum of 40 hours of initial offsite instruction,
- A minimum of 3 days of actual field experience under the direct supervision of a trained, experienced supervisor,
- An 8-hour "refresher" training period within the past 12 months,
- Additional training that addresses unique or special hazards/operational requirements (e.g. permit-required confined space entry training),
- First aid and CPR. At least one worker currently trained in First Aid/CPR shall be onsite at all times that field activities are occurring.

Onsite management and supervisors who are directly responsible for or who supervise employees will receive at least 8 additional hours of specialized HazWoper management training. Copies of training certificates and dates of attendance will be available through the Site-Specific HSO upon request.

9.1.1 Subcontractor Training

Prior to the start of work operations, the Project Manager will obtain a site-specific HASP from subcontractors working at the site and a written list of subcontractor personnel to be onsite, and written certification from subcontractor management that these workers meet the training requirements for their assigned tasks.

9.1.2 Pre-Entry Orientation Session

Prior to entering the site, project personnel will attend a pre-entry orientation session presented by the Site-Specific HSO. Personnel will verify attendance at this meeting by signing the HASP Review Record provided in the site-specific HASP Addendum. The HASP Review Record will be maintained onsite during the life of the project.

At a minimum, the pre-entry orientation session will cover the contents of this HASP, potential health effects of hazards associated with onsite activities, and the potential hazards presented by unearthing unidentified hazardous materials. Personnel will be instructed in the emergency procedures to include onsite communications and implementation of the site-specific contingency plans.

Visitors entering designated work areas will be subject to applicable health and safety regulations during field operations at the site. The Site-Specific HSO is responsible for briefing the personnel onsite of potential hazards that may be encountered on the site, the presence and location of the site-specific HASP Addendum, and emergency response procedures. Visitors will remain under the direct supervision of the Site-Specific HSO or his/her representative while onsite.

9.2 Site-Specific Training

The Site-Specific HSO will be responsible for developing a site-specific occupational hazard training program and providing training to personnel who are to work at the site. At a minimum, this training will consist of the following topics:

- Names of personnel responsible for site health and safety
- Safety and health hazards at the site
- Proper use and limitations of PPE
- Work practices by which the employee can minimize risk from hazards
- Safe use of engineering controls and equipment on the site
- Acute effects of compounds at the site
- Decontamination procedures.

10.0 MEDICAL SURVEILLANCE

10.1 Medical Examinations

Site workers potentially involved with the field sampling operations who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year must have satisfactorily completed a comprehensive medical examination by a licensed occupational physician within 12 months (or 24 months with the approval of the consulting physician) prior to the start of site operations. When applicable, the date of medical examination of each qualified person will be maintained onsite with the project field team. Medical surveillance protocols must comply with 29 CFR 1910.120/29 CFR 1926.65.

When applicable, medical examinations and consultations must be provided for employees covered by this program on the following schedule:

- Prior to assignment,
- At least annually for employees covered by the program (or 24 months with the approval of the consulting physician, as in the case for HDR employees under this contract based on projected exposures),
- At termination of employment or reassignment to an area where the employee would not be covered if the employee has not been examined within the past 6 months,
- As soon as possible upon the development of signs or symptoms that may indicate an overexposure to hazardous substances or health hazards,
- More frequently if the physician deems such examination necessary to maintain employee health.

10.2 Records

An accurate record of the medical surveillance and exposure will be maintained for each employee for a period of no less than 30 years after the termination of employment, as per 29 CFR 1910.120. Records must include at least the following information about the employee:

- Name and social security number
- Physician's written opinions, recommendations, limitations, and test results
- Employee medical complaints related to hazardous waste operations
- Information provided to the physician by the employee concerning possible exposures, accidents, etc.

Subcontractors must provide medical surveillance information in writing to the Project Manager for their workers prior to mobilization onsite.

10.3 First Aid and Medical Treatment

HDR personnel onsite must report any significant near-miss incident, accident, injury, or illness to the Project Manager and the Task Manager. If required, first aid will be provided by the designated site first aider. Injuries and illnesses requiring medical treatment must be documented. The Task Manager must conduct an accident investigation as soon as emergency conditions no longer exist and first aid and/or medical treatment has been ensured. The accident/incident report must be completed and submitted to a New York Office Safety Coordinator (OSC) for review within 48 hours after the incident if possible and then it will be forwarded to the HDR Corporate Health & Safety Department.

If first aid treatment is required, first aid kits are kept at the Contaminant Reduction Zone. If treatment beyond first aid is required, the injured individual(s) should be transported to the nearest designated medical facility. If the injured employee is not ambulatory, or shows signs of not being in a comfortable or stable condition for transport, then 911 should be called and an ambulance/paramedics should be summoned to provide medical attention. If there is a doubt as to the injured worker's condition, it is best to let the local paramedic or ambulance service examine and transport the worker. If there is any possibility that the illness is due to, or exacerbated by, exposure to a site chemical, the appropriate MSDS's must accompany the injured employee to the medical facility, and receiving medical personnel must be notified prior to the employee's admittance, to prevent accidental contamination of the medical facility (See Section 11.2.4).

11.0 ACCIDENT PREVENTION AND CONTINGENCY PLAN

11.1 Accident Prevention

While field personnel will receive health and safety training prior to the initiation of site activities, individual personnel should be constantly alert for indicators of potentially hazardous situations, and for signs or symptoms in themselves and others that warn of hazardous exposures. Recognition of dangerous situations can avert an emergency. Before daily work assignments, regular meetings should be held. Discussion should include:

- Tasks to be performed
- Time constraints (e.g., rest periods, cartridge changes)
- Hazards that may be encountered, including their effects, how to recognize symptoms and monitor them, concentration limits, or other danger signals
- Emergency procedures.

11.2 Contingency Plan

11.2.1 Emergency Recognition

Prior to work startup, personnel must be familiar with emergency condition identification, notification, and response procedures. **The emergency telephone numbers for local emergency response and reporting organizations and directions and map to the nearest hospital are included in each site-specific HASP Addendum. Hospital Route maps and contact phone numbers will be placed in all project vehicles.**

NOTE:

The site-specific HASP Addendum will be left open to the emergency contacts page at all times during site activities and/or the list will be posted in a conspicuous location. The Task Manager and Site-Specific HSO will rehearse/review emergency procedures and/or applicable site contingencies initially during site orientation and as part of the ongoing site safety program with HDR and subcontractor personnel. Onsite emergencies will ultimately be handled by offsite emergency personnel. Initial response and first-aid treatment, however, will be provided onsite as required.

Person(s) identifying an accident, injury, emergency condition, or a scenario requiring implementation of a response in support of this plan will immediately take actions to report the situation to the Task Manager. Notification may take place by runner, hand-held radio, or telephone. The Task Manager/Site-Specific HSO will initiate the required response based upon the type of incident, following the procedures contained in this Program HASP. A chain-of-command and sign-in sheets for personnel on the site will be established at the beginning of each work day to ensure personnel are accounted for and who will take control should the Task Manager or Site-Specific HSO become injured. The following items constitute those site conditions requiring an emergency response or contingency action in accordance with this Program HASP:

- Fire/Explosion
  - The potential for human injury exists
  - Toxic fumes or vapors are released
  - The fire could spread onsite or offsite and possibly ignite other flammable materials or cause heat-induced explosions
  - The use of water and/or chemical fire suppressants could result in contaminated runoff
  - An imminent danger of explosion exists.

- Heavy Equipment Accident
  - Onsite traffic accident where personal injury has occurred.

- Natural Disaster
  - A rain storm exceeds the flash flood level
  - The facility is in a projected tornado/hurricane path or a tornado/hurricane has damaged facility property

- Severe wind gusts are forecasted or have occurred and have caused damage to the facility.

- Medical Emergency
  - Overexposure to hazardous materials
  - Trauma injuries (broken bones, severe lacerations/bleeding, burns, animal bites)
  - Eye or significant skin contact with hazardous materials
  - Loss of consciousness
  - Heat stress (heat stroke)
  - Heart attack
  - Respiratory failure
  - Allergic reaction.

- Discovery of Unanticipated Hazards (e.g., unmarked utility lines, heavily contaminated material).

Follow-up operations to evaluate and control the source of fire, explosions, and hazardous materials will be performed by the Emergency Coordinator at the site, who will coordinate onsite activities and materials incidents. These will occur only after discussion with the Project Manager and Task Manager. The Task Manager will act as the Emergency Coordinator until the arrival of outside response organizations. If the Task Manager is unable to act as the Emergency Coordinator, then the authority to take action will be transferred to the Site-Specific HSO, or other designee, as indicated in the daily updated chain-of-command.

11.2.2 Pre-Emergency Procedures

The Site-Specific HSO will contact the applicable local emergency response organizations listed in each site-specific HASP Addendum prior to work start to identify the emergency response requirements and commitments required to support this project. The Project Manager, in coordination with the NYSDEC representative, will contact those local authorities potentially required to respond in the event of an onsite emergency incident or contingency. This notification will inform each applicable agency of the start date, anticipated scope of work, and the existence of the Program HASP. A copy of the site-specific HASP Addendum will be made available to each emergency response agency upon request to the Project Manager. At a minimum, the NYSDEC representative, Fire Department, emergency medical services, and hospital will be notified. Emergency activities will be coordinated (as applicable) with the local emergency planning committee, as required in accordance with Superfund Amendments and Reauthorization Act (SARA) Title III requirements.

11.2.3 Emergency Procedures

In the event of an emergency, the information available at that time must be properly evaluated and the appropriate steps taken to implement the emergency response plan. The Task Manager (or Site-Specific HSO if the Task Manager is part of the emergency) will assume command of the situation. He/she will alert the emergency management system per instructions provided in each site-specific HASP Addendum, and evacuate personnel to the pre-designated evacuation location. In a site emergency, the Task Manager (or the Site-Specific HSO (if the Task Manager is not available) must sound an emergency alarm (designated as an air horn or car horn) repeatedly several times, upon hearing work must stop and personnel must move to the pre-designated evacuation location. If the emergency situation cannot be conveyed by word of mouth, a whistle or other horn will be sounded. Three short blasts, separated by a 2-second silence, will be used as the emergency signal. First aid will be administered only to limit further injury and stabilize the victim. The local Emergency Medical Services must be notified immediately if needed. The routes to the nearest hospital are shown in each site-specific HASP Addendum. The Task Manager/Site-Specific HSO will make required notifications to include, but not be limited to, the NYSDEC representative, HDR Project Manager, and HDR Program Manager, as defined in Section 2.2 and site-specific HASP Addendum's and the appropriate federal and state agencies.

Site personnel will have the capability of notifying emergency responders directly from the site using the phone in the company vehicle or in the site support office. In the event of an accident/incident, the HDR project manager should be immediately notified of a reportable accident/incident or contingency. The HDR project manager will complete and submit to HDR's Corporate Health & Safety Department an Accident and Incident Report using the format provided in each site-specific HASP Addendum.

The following information will be provided when reporting an emergency:

1. Name and location of person reporting
2. Location of accident/incident
3. Name and affiliation of injured party
4. Description of injuries, fire, spill, or explosion
5. Status of medical aid and/or other emergency control efforts
6. Details of chemicals involved
7. Summary of accident, including suspected cause and time it occurred
8. Temporary control measures taken to minimize further risk.

This information is not to be released to parties other than those listed in this section and emergency response team members. Once emergency response agencies have been notified, the Project Manager will be notified immediately.

11.2.4 Chemical Exposure

If a member of the field crew demonstrates symptoms of chemical exposure, the procedures outlined below should be followed:

- Another team member (buddy) should remove the individual from the immediate area of contamination. The buddy should communicate to the Task Manager (via voice and hand signals) of the chemical exposure. The Task Manager should contact the appropriate emergency response agency.
- Precautions should be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the chemical should be neutralized or removed if it is safe to do so, or the clothing should be removed and bagged.
- If the chemical has contacted the skin, the skin should be washed with copious amounts of water.

- In case of eye contact, an emergency eye wash should be used. Eyes should be washed for at least 15 minutes.
- An MSDS of any/all suspected chemical contaminant(s) must accompany the injured employee to the medical facility.

Chemical exposure incidents must be reported in writing to the Program HSO. The Site-Specific HSO or Task Manager is responsible for completing the accident report provided in each site-specific HASP.

11.2.5 Personal Injury

Working on outdoor field sites around heavy equipment always presents the possibility of injury. Severe injuries resulting from accidents must be recognized as emergencies and treated as such. If feasible, in the field, at least two people currently trained in first aid/CPR must be present onsite (one is mandatory). This will normally be the Task Manager and Site-Specific HSO.

In a medical emergency, the Task Manager (or the Site-Specific HSO if the Task Manager is not available) must sound the emergency air horn or car horn several times, upon which work must stop and personnel must move to the pre-designated evacuation location. If the emergency situation cannot be conveyed by word of mouth, a whistle or other horn will be sounded. Three short blasts, separated by a 2-second silence, will be used as the emergency signal. Personnel currently trained in first aid will evaluate the nature of the injury, decontaminate the victim (if necessary), and initiate first aid assistance immediately and transport if appropriate. First aid will be administered only to limit further injury and stabilize the victim. The local Emergency Medical Services must be notified immediately if needed. The routes to the nearest hospital are shown in each site-specific HASP Addendum, and kept in each site vehicle. Although not anticipated, victims who are heavily contaminated with toxic or dangerous materials must be decontaminated before being transported from the site. Since no hazardous materials are anticipated, a formal decontamination station will not be available; however, there will be an emergency eyewash station in each of the HDR vehicles. Decontamination will consist of removal of contaminated coveralls/clothing, and wrapping the victim in a sheet or other cloth-like material. No persons will re-enter the site of injury/illness until the cause of the injury or symptoms has been determined and controlled. At no time will personnel transport victims to emergency medical facilities unless the injury does not pose an immediate threat to life and transport to the emergency medical facility can be accomplished without the risk of further injury. Emergency Medical Services will be used to transport serious injuries offsite unless deemed otherwise by the Task Manager/Site-Specific HSO.

The accident/incident report must be completed by the Task Manager/Site-Specific HSO and submitted to a New York Office Safety Coordinator (OSC) for review within 48 hours after the incident if possible and then it will be forwarded to the HDR Corporate Health & Safety Department for the following types of incidents:

- Job-related injuries and illnesses
- Accidents resulting in loss or damage to property
- Accidents involving vehicles and/or vessels, whether or not they result in damage to property or personnel
- Accidents in which there may have been no injury or property damage, but which have a high probability of recurring with at least a moderate risk to personnel or property
- Near-miss incidents which could have resulted in any of the conditions defined above.

An accident that results in a fatality or the hospitalization of three or more employees must be reported within 8 hours to the U.S. Department of Labor through the Project Manager. Subcontractors are responsible for their reporting requirements.

In order to support onsite medical emergencies, first aid/emergency medical equipment will be available at the following locations:

• First-aid kit	Company vehicle
• Eye wash	Company vehicle
• Emergency alarm	Horn on the company vehicle
• Copy of the HASP	Company vehicle
• Telephone	Company vehicle.

The eye wash kit must be portable, have a water reservoir of 6 gallon capacity and capable of supplying at least a 15-minute supply of potable water to the eyes.

11.2.6 Operations Shutdown

The Task Manager, Site-Specific HSO, or the Project Manager may mandate operations shutdown. Conditions warranting work stoppage will include (but are not limited to):

- Uncontrolled fire
- Explosion
- Uncovering potentially dangerous buried hazardous materials
- Condition immediately dangerous to life and health or the environment
- Potential for electrical storms
- Treacherous weather-related conditions
- Limited visibility
- Air contaminant concentrations in excess of the action levels contained in Table 2.

Note that Table 2 will be developed for each site-specific HASP Addendum based on the information available on the site. Depending on the compounds that may be present, the action levels may change.

11.2.7 Evacuation Procedures

In the event the site must be evacuated, the following procedures should be followed:

- The Task Manager will initiate evacuation procedures by signaling to leave the site.
- Personnel in the work area should evacuate the area and meet in the common designated area.
- Personnel suspected to be in or near the work area should be accounted for and the whereabouts of missing persons determined immediately.

Further instruction will then be given by the Task Manager.

11.2.8 Procedures Implemented in the Event of a Major Fire, Explosion, or Onsite Health Emergency Crisis

Fire and explosion must be immediately recognized as an emergency. The Site-Specific HSO (or Task Manager if Site-Specific HSO is not available) must sound an emergency signal, and personnel must be decontaminated (if necessary) and evacuated to the pre-designated evacuation location. The procedures for alerting fire/explosion emergencies will be the same as those defined for medical emergencies (Section 11.2.3).

Only persons properly trained in fire suppression and other emergency response procedures will support control activities. Control activities will consist of the use of onsite portable fire extinguishers for limited fire suppression and employee evacuation. Upon sounding the emergency alarm, personnel will evacuate the hazard location and assemble at the designated site meeting area.

Only those site personnel trained in the use of portable fire extinguisher use will attempt to suppress a site fire. Small multipurpose dry chemical extinguishers will be maintained in each HDR vehicle onsite. Fires not able to be extinguished using onsite extinguishers will require the support of the local Fire Department.

The Task Manager should take measures to reduce injury and illness by evacuating personnel from the hazard location as quickly as possible. The Task Manager must then notify the local Fire Department. The Task Manager will determine proper follow-up actions. Site personnel will not resume work during or after a fire/explosion incident until the emergency coordinator has directed that the incident is over and work may resume. During the incident, site personnel will remain outside the incident area and obey the instructions of the Emergency Coordinator.

11.2.9 Emergency Telephone Numbers

Communications will be by telephones located in the HDR vehicle(s) onsite or with site personnel, and field personnel will have access to these telephones to directly contact offsite emergency response organizations. Refer to each site-specific HASP Addendum for a listing of local and regional emergency telephone numbers.

11.3 Spill Containment Procedures

Small incidental spills, i.e., those which cause no injury to personnel or the public, may be cleaned up quickly and easily. For large spills, i.e., those that contaminate personnel or the environment, attend to first aid measures first, stop the source of the spill if possible, and then notify appropriate emergency response services. Response phone number(s) will be listed in the site-specific HASP Addendum.

Spills of hazardous materials or wastes which are listed by EPA as having a reportable quantity value must be reported to appropriate federal, state, and local agencies if a reportable quantity or greater is released. The Task Manager is responsible for determining the appropriate agencies for notification purposes prior to work startup.

TABLES

TABLE 1

CHARACTERISTICS OF CHEMICALS FOUND ON THE SITE

COMPOUND	SYNONYMS	ACGIH TLV (ppm)	NIOSH REL (ppm)	OSHA PEL (ppm)	NIOSH IDLH (ppm)	LEL (% at °F)	UEL (%)	FLASH POINT (ºF)	Specific Gravity	VP (mm at ºF)	IP (eV)	VD	SOLU. (%)	RESP.	CHEM. PROT. CLOTH.	TOXIC EFFECTS
Antimony	Stibium; Antimony black; Regulus	0.5 mg/m³	0.5 mg/m³	0.5 mg/m³	50 mg/m³	NA	NA	NA	6.69	0	NA	-	insol	yes	Any barrier	Irrit eyes, skin, nose, throat, mouth; cough; dizz; head; nau, vomit, diarr; stomach cramps; insom; anor; unable to smell properly
Arsenic	Arsenia	0.01 mg/m³ A1, BEI	C 0.002 mg/m³ CA	0.01 mg/m³	Ca 5 mg/m³	NA	NA	NA	5.73	0	NA	-	insol	yes	PSC	Ulcerations of nas septum; derm; GI disturb; peri neur, resp irrit, hyperpig of skin, [carc]
Benzene	Benzol; Cyclohexatriene; Coal tar Naphtha; Phenylhydride	0.5, ST 2.5 A1,skin, BEI	CA 0.1, ST 1	1, ST 5	Ca 500	1.2	7.8	12	0.88	75	9.24	2.8	0.07%	yes	PVA, SS	Irrit eyes, skin, nose, resp sys; dizz, head, nau, staggered gait; anor, lass; derm; bone marrow depres; [carc]
Benzoic acid	Benzenecarboxylic Acid; Phenylformic Acid;nDracylic Acid	-	-	-	-	-	-	250	1.32	-	-	4.21	slight	-		Dyspnea; derm; eye irrit
Beryllium	Glucinum; RCRA Waste #P015	(0.002 mg/m³, A1)	Ca <0.0005 mg/m³	0.002, C 0.005 mg/m³	Ca 4 mg/m³	NA	NA	NA	1.85	0	NA	-	insol	yes	PSC	Berylliosis (chronic exposure); anor, low-wgt, lass, chest pain, cough, clubbing of fingers, cyan, pulm insufficiency; irrit eyes; derm; [carc]

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CHARACTERISTICS OF CHEMICALS FOUND ON THE SITE

COMPOUND	SYNONYMS	ACGIH TLV (ppm)	NIOSH REL (ppm)	OSHA PEL (ppm)	NIOSH IDLH (ppm)	LEL (% at °F)	UEL (%)	FLASH POINT (ºF)	Specific Gravity	VP (mm at ºF)	IP (eV)	VD	SOLU. (%)	RESP.	CHEM. PROT. CLOTH.	TOXIC EFFECTS
Cadmium Dust	Cadmium metal	0.01 mg/m³ tot,0.002 mg/m³ resp, A2, BEI	Ca	0.005 mg/m³	Ca 9 mg/m³	NA	NA	NA	8.65	0	NA	3.88	insol	yes	Any barrier	Pulm edema, dysp, cough; chest tight, subs pain; head; chills, musc aches; nau, vomit, diarr; anos; emphy; prot; mild anemia; [carc]
Carbon monoxide	Carbon oxide; Flue gas; Monoxide	25 BEI	35, C 200	50	1200	12.5	74	NA gas	gas	>35 atm	14.01	0.97	2%	yes	NL, Frostbite	Head, tachypnea, nau, lass, dizz, conf, halu; cyan; depress S-T segment of electrocardiogram, angina, syncope
Chlorodiphenyl (42% chlorine)	Aroclor 1242; PCB; Polychlorinated biphenyl	1 mg/m³ skin	Ca 0.001 mg/m³	1 mg/m³ skin	Ca 5 mg/m³	NA	NA	NA	1.39 @ 77° F	0.001	?	8.90	insol	yes	Butyl, Neoprene, Teflon, Viton	Irrit eyes; chloracne; liver damage; repro effects; [carc]
Chlorodiphenyl (54% chlorine)	Aroclor 1254; PCB; Polychlorinated biphenyl	0.5 mg/m³ skin A3	Ca 0.001 mg/m³	0.5 mg/m³ skin	Ca 5 mg/m³	NA	NA	NA	1.38 @ 77° F	0.0000 6	?	11.24	insol	yes	Butyl, Neoprene, Teflon, Viton	Irrit eyes; chloracne; liver damage; repro effects; [carc]
Chromium (II) and (III) compounds	Synonyms vary depending upon the specific Cr(II) or Cr(III) compounds	0.5 mg/m³ A4	0.5 mg/m³	0.5 mg/m³	250 mg/m³/ 25 mg/m³	-	-	-		-	-	-	-	yes	PSC	Irrit eyes; sens derm
Chromium metal	Chrome, Chromium	0.5 mg/m³ A4	0.5 mg/m³	1 mg/m³	250 mg/m³	NA	NA	NA	7.14	0	NA	1.79	insol	yes	NR	Irrit eyes, skin; lung fib (histologic)

TABLE 1

CHARACTERISTICS OF CHEMICALS FOUND ON THE SITE

COMPOUND	SYNONYMS	ACGIH TLV (ppm)	NIOSH REL (ppm)	OSHA PEL (ppm)	NIOSH IDLH (ppm)	LEL (% at ℉)	UEL (%)	FLASH POINT (ºF)	Specific Gravity	VP (mm at ºF)	IP (eV)	VD	SOLU. (%)	RESP.	CHEM. PROT. CLOTH.	TOXIC EFFECTS
Coal tar pitch volatiles	Synonyms vary depending upon the specific compound (e.g. benzo(a)pyrene, phenanthrene, acridine, chrysene, anthracene & pyrene). Note: NIOSH considers coal tar, coal tar pitch and creosote to be coal tar products	0.2 mg/m³ A1	Ca 0.1 mg/m³	0.2 mg/m³	Ca 80 mg/m³	-	-	405		-	-	-	-	yes	PSC	Derm, bron, [carc]
Copper		(1 mg/m³)	1 mg/m³	1 mg/m³	100 mg/m³	NA	NA	NA	8.94	0	NA	2.19	insol	yes	PSC	Irrit eyes, nose, pharynx; nasal septum perf; metallic taste; derm
p-Cresol	para-Cresol, 4-Methyl phenol	(5) skin	2.3	5 skin	250	1.1 @ 300℉	?	187	1.04	0.11 @ 77℉	8.97	3.7	2%	Yes	SS	rrit eyes, skin, muc memb; CNS effects; conf, depres, resp fail; dysp, irreg rapid resp, weak pulse; eye, skin burns; derm; lung, liver kidney, pancreas damage
1,1-Dichloroethane	Ethylidene chloride; 1,1-Ethylidene dichloride; Asymmetrical dichloroethane	100 A4	100	100	3000	5.4	11.4	2	1.18	182	11.06	3.42	0.6%	yes	NL	Irrit skin; CNS depres; liver, kidney, lung damage
1,2-Dichloroethylene	Acetylene dichloride, cis-Acetylene dichloride, trans-Acetylene dichloride, sym-Dichloroethylene	200	200	200	1000	5.6	12.8	36-39	1.27 @ 77° F	180-265	9.65	3.4	0.4%	yes	Teflon, Viton, SS	Irrit eyes, resp sys; CNS depres

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COMPOUND	SYNONYMS	ACGIH TLV (ppm)	NIOSH REL (ppm)	OSHA PEL (ppm)	NIOSH IDLH (ppm)	LEL (% at °F)	UEL (%)	FLASH POINT (ºF)	Specific Gravity	VP (mm at ºF)	IP (eV)	VD	SOLU. (%)	RESP.	CHEM. PROT. CLOTH.	TOXIC EFFECTS
Ethylbenzene	Ethylbenzol, Phenylethane	100, BEI, ST 125 A3	100, ST-125	100	800	0.8	6.7	55	0.87	7	8.76	3.7	0.01%	yes	Viton	Irrit eyes, skin, muc memb; head; derm, narco, coma
Bis(2-ethylhexyl)phthalate	Di-sec-octyl phthalate; Di-n-ethylhexyl phthalate; DEHP; DOP; Di(2-Ethylhexyl)phthalate; Octyl phthalate	5 mg/m³ A3	Ca 5, ST 10 mg/m³	5 mg/m3	Ca 5000 mg/m3	0.3 @ 474° F	?	420	0.99	<0.01	?	-	0.00003 % @ 75° F	yes	NR	Irrit eyes; muc. Memb
Hydrogen sulfide	Hydrosulfuric acid, sewer gas, Sulfuretted hydrogen	(1, ST 15)	C 10	C 20, P 50	100	4.0	44.0	NA gas	Gas	17.6 atm	10.46	1.19	0.4%	yes	Teflon, Frostbite	Irrit eyes, resp sys; apnea, coma, convuls; conj, eye pain, lac, photo, corn vesic; dizz, head, lass, irrity, insom; GI dist; liq: frostbite
Lead	Lead metal, Plumbum	0.05 mg/m³ A3, BEI	0.05 mg/m³	0.050 mg/m³	100 mg/m³	NA	NA	NA	11.34	NA	-	7.14	insol	yes	Any barrier	Weak, lass; insom; facial pallor; anor, low-wgt; malnut; constip, abdom pain, colic; anemia; gingival lead line; tremor; para wrist, ankles; encephalopathy; kidney disease; irrit eyes; hypotension

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COMPOUND	SYNONYMS	ACGIH TLV (ppm)	NIOSH REL (ppm)	OSHA PEL (ppm)	NIOSH IDLH (ppm)	LEL (% at ℉)	UEL (%)	FLASH POINT (ºF)	Specific Gravity	VP (mm at ºF)	IP (eV)	VD	SOLU. (%)	RESP.	CHEM. PROT. CLOTH.	TOXIC EFFECTS
Mercury compounds (as Hg)	Mercury; Mercury metal; Colloidal mercury, Elemental mercury, Quicksilver	0.025 mg/m³, A4,skin, BEI	0.05,C 0.1 mg/m³skin	C 0.1 mg/m³	10 mg/m³	NA	NA	NA	13.6	0.0012	?	6.93	insol	yes	PSC	Irrit eyes, skin; cough, chest pain, dysp, bron pneuitis; tremor, insom, irrity, indecision, head, lass; stomatitis, salv; GI dist, anor, low-wgt; prot
Methane	Methyl hydride; Marsh gas	1000	-	-	-	5	15	gas	-	0.55	-	0.6	-	-		Simple asphyx; explosion hazard
Naphthalene	White tar, Tar camphor, Naphthalin	10, ST 15 skin, A4	10, ST 15	10	250	0.9	5.9	174	1.15	0.08	8.12	4.4	0.003%	yes	Teflon	Irrit eyes; head, conf, excitement, mal; nau, vomit, abdom pain; irrit bladder; profuse sweat; jaun; hema, renal shutdown; derm; optical neuritis, corn damage
Nickel metal and other compounds (as Ni)	Nickel, Nickel metal: Elemental metal, Nicke catalyst	1.5 mg/m³, A5	0.015mg/m³ Ca	1 mg/m³	Ca 10 mg/m³	NA	NA	NA	8.90	0	NA	-	insol	yes	PSC	Sens derm; allergic asthma; pneu; [carc]
Particulates, respirable	"Inert" dusts, Nuisance dusts, PNOR	3 mg/m³	-	5 mg/m³	N.D.	-	-	-	-	-	-	-	-	yes	NR	Irrit eyes, skin, throat, upper resp sys
Particulates, total	"Inert" dusts, Nuisance dusts, PNOR	10 mg/m³	-	15 mg/m³	N.D.	-	-	-	-	-	-	-	-	yes	NR	Irrit eyes, skin, throat, upper resp sys

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CHARACTERISTICS OF CHEMICALS FOUND ON THE SITE

COMPOUND	SYNONYMS	ACGIH TLV (ppm)	NIOSH REL (ppm)	OSHA PEL (ppm)	NIOSH IDLH (ppm)	LEL (% at ºF)	UEL (%)	FLASH POINT (ºF)	Specific Gravity	VP (mm at ºF)	IP (eV)	VD	SOLU. (%)	RESP.	CHEM. PROT. CLOTH.	TOXIC EFFECTS
Selenium	Elemental selenium, Selenium alloy	0.2 mg/m³	0.2 mg/m³	0.2 mg/m³	1 mg/m³	NA	NA	NA	4.28	0	NA	-	insol	yes	PSC	Irrit eyes, skin, nose, throat; vis dist; head; chills, fever; dysp, bron; metallic taste, garlic breath, GI dist; derm; eye, skin burns
Silver	Metal: Silver metal: Argentum; Synonyms of soluble compounds vary depending upon the specific compound	0.1 mg/m³ metal 0.01 mg/m³ soluble cpds	0.01 mg/m³	0.01 mg/m³	10 mg/m³	NA	NA	NA	10.49	0	NA	3.72	insol	yes	PSC	Blue-gray eyes, nasal septum, throat, skin; irrit, ulceration skin; GI dist
Tetrachloronaphthalene	Halowax, Nibren wax, Seekay wax	2 mg/m³	2 mg/m³ skin	2 mg/m³ skin	50 mg/m³	?	?	410	1.59-1.65	<1 mm	?	9.17	insol	yes	PSC	Acne-form derm; head, lass, anor, dizz; jaun, liver inj
Thallium		0.1 mg/m³ skin	0.1 mg/m³ skin	0.1 mg/m³ skin	15 mg/m³	NA	NA	NA		-	-	3.10	-	yes	PSC	Nau,diarr,abdom pain, vomit; ptosis; strabismus; peri neuritis, tremor; retster tight, chest pain; pulm edema; sez, chorea, psychosis; liver, kidney damage; alopecia; pares legs
Toluene	Methyl benzene, Methyl benzol, Phenyl methane, Toluol	20 BEI A4	100, ST-150	200, C-300, P-500	500	1.1	7.1	40	0.87	21	8.82	3.1	0.07% @ 74 ºF	yes	PVA, Teflon, Viton, SS	Irrit eyes, nose; lass, conf, euph, dizz, head; dilated pupils, lac; anxi; musc ftg; insom; pares; derm; liver, kidney damage

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CHARACTERISTICS OF CHEMICALS FOUND ON THE SITE

COMPOUND	SYNONYMS	ACGIH TLV (ppm)	NIOSH REL (ppm)	OSHA PEL (ppm)	NIOSH IDLH (ppm)	LEL (% at °F)	UEL (%)	FLASH POINT (ºF)	Specific Gravity	VP (mm at ºF)	IP (eV)	VD	SOLU. (%)	RESP.	CHEM. PROT. CLOTH.	TOXIC EFFECTS
1,1,1-Trichloroethane	Methyl chloroform; 1,1,1-TCA	350, ST 450, A4, BEI	C 350	350	700	7.5	12.5	?	1.34	100	11.00	4.55	0.4%	yes	PVA, Viton, SS	Irrit eyes, skin; head; lass; CNS depres; poor equi; derm; card arrhy; liver damage
Trichloroethylene	Ethylene trichloride, TCE, Trichloroethene; Trilene	10, ST 25, A2	Ca 25	100, C-200, P-300	Ca 1000	8 @ 77°F	10.5 @ 77°F	?	1.46	58	9.45	4.5	0.1%	yes	PVA, Viton, SS	Irrit eyes, skin; head, vertigo; vis dist, lass, dizz; tremor; drow, nau, vomit; derm; card arrhy; pares; liver inj; [carc]
m-Xylene	meta-Xylene; 1,3-Dimethylbenzene	100, ST 150, A4, BEI	100, ST 150	100	900	1.1	7.0	82	0.86	9	8.56	3.7	slight	Yes	PSC	irrit eyes, skin, nose, throat; dizz, excitement, drow, inco, staggering gait; corn vacuolization; anor, nau, vomit, abdom pain; derm
o-Xylene	ortho-Xylene, 1,2-Dimethylbenzene	100, ST 150, A4, BEI	100, ST 150	100	900	0.9	6.7	90	0.88	7	8.56	3.7	0.02	yes	PSC	Irrit eyes, skin, nose, throat; dizz, excitement, drow, inco, staggering gait; corn vacuolization; anor, nau, vomit, abdom pain; derm
p-Xylene	para-Xylene, 1,4-Dimethylbenzene	100, ST 150, A4, BEI	100, ST 150	100	900	1.1	7.0	81	0.86	9	8.44	3.7	0.02%	Yes	PSC	rrit eyes, skin, nose, throat; dizz, excitement, drow, inco, staggering gait; corn vacuolization; anor, nau, vomit, abdom pain; derm

TABLE 1

CHARACTERISTICS OF CHEMICALS FOUND ON THE SITE

COMPOUND	SYNONYMS	ACGIH TLV (ppm)	NIOSH REL (ppm)	OSHA PEL (ppm)	NIOSH IDLH (ppm)	LEL (% at °F)	UEL (%)	FLASH POINT (ºF)	Specific Gravity	VP (mm at ºF)	IP (eV)	VD	SOLU. (%)	RESP.	CHEM. PROT. CLOTH.	TOXIC EFFECTS
Zinc oxide dust		2, ST 10 mg/m³	5, C 15 mg/m³	tot 15,resp 5 mg/m³	500 mg/m³	NA	NA	NA	5.61	0		2.81	0.0004 @ 64°F		NR	Metal fume fever; chills, musc ache, nau, fever, dry throat, cough, lass; metallic taste; head; blurred vision; low back pain; vomit; mal; chest tight, dysp, rales, decr pulm func

TABLE 2 AIRBORNE CONSTITUENT ACTION LEVELS

Parameter	Reading	Action
Total Organic Vapors (PID or FID)	0 ppm to <1 ppm	Normal operations; record breathing zone monitoring measurements every hour.
	>1 ppm to 5 ppm	Increase recording frequency to at least every 15 minutes, and use benzene colorimetric detector tube to screen for the presence of benzene.
	>5 ppm to <50 ppm	Upgrade to Level C personal protective equipment, continue screening for benzene; contact HDR Program Manager (PM) and Health and Safety Officer (HSO).
	>50 ppm	Stop work; evacuate confined spaces/work area; investigate cause of reading; contact HDR PM and HSO.
Benzene (Colorimetric Tubes)	>1 ppm	Stop work; evacuate confined spaces/work area; investigate cause of reading; contact HDR PM and HSO.
Total Particulate (Real-Time Particulate Monitor-Nepholemetric)	0 to 0.100 mg/m^3 above background	Normal operations; if >0, investigate source; monitor continuously.
	>0.100 mg/m^3 above background	Initiate wetting of work area to control dust; upgrade to Level C (HEPA Filtrers) if dust control measures do not control dust within 15 minutes; monitor downwind impacts.
	>0.15 mg/m^3 above background in breathing zone or at downwind perimeter of work area	Stop work; investigate cause of reading; contact HDR PM and HSO.
Oxygen (Portable Gas Monitor)	>19.5% to <23.5%	Normal operations; if not at background (20.8%), investigate source; monitor continuously.
	<19.5%	Stop work; evacuate confined spaces/work area; investigate cause of reading; ventilate area; contact HDR PM and HSO.
	>23.5%	Stop work; evacuate confined spaces/work area; investigate cause of reading; ventilate area; contact HDR PM and HSO.
Flammable Vapors (Portable Gas Monitor)	0% to <5% LEL	Normal operations; if >0, investigate source; monitor continuously.
	>5% to <10 %	Investigate source; ventilate if confined space, monitor continuously.
	>10% LEL	Stop work; evacuate confined spaces/work area; investigate cause of reading; ventilate area; contact HDR PM and HSO.
Carbon Monoxide (Portable Gas Monitor)	0 ppm to <20 ppm	Normal operations; if >0, investigate source; monitor continuously.
	>20 to <35 ppm	Investigate source; ventilate if confined space, monitor continuously
	>35 ppm	Stop work; evacuate confined spaces/work area; investigate cause of reading; ventilate area; contact HDR PM and HSO.
Hydrogen Sulfide (Portable Gas Monitor)	0 ppm to <1 ppm	Normal operations; if >0, investigate source; monitor continuously.
	>1 ppm	Stop work; evacuate confined spaces/work area; investigate cause of reading; ventilate area; contact HDR PM and HSO.