URS

October 21, 2010

Mr. Ronnie Lee, P.E.
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233-7016

Re: Former EMCA Site, Mamaroneck, New York
Site Number 360025
Site Management Plan

Dear Mr. Lee:

Enclosed are two CD (electronic) copies of the *Site Management Plan for the Former EMCA Site, Westchester County, New York* for your use. This transmittal is being made on behalf of Rohm and Haas Company, a wholly owned subsidiary of The Dow Chemical Company.

Sincerely,

URS Corporation

Bruce J. Przybyl
Project Manager

Enc.

cc: Mr. Ed Tokarski, Dow (w/attachments)
Mr. Louis Vetere, Cablevision (w/attachments)
Mr. Nathan Walz, NYSDOH (e-mail of Cover Letter)
Ms. Sally Dewes, NYSDEC (e-mail of Cover Letter)
Town of Mamaroneck Repository (w/attachments)
Town of Mamaroneck Public Library Repository (w/attachments)
File: 11176110/C-1

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Site Management Plan
NYSDEC Site Number: 360025

Former EMCA Site
Mamaroneck, New York

Prepared for:

Rohm and Haas Company, a wholly owned subsidiary of The Dow Chemical Company

Prepared by:

URS
77 Goodell Street
Buffalo, New York 14203

October 2010

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FORMER EMCA SITE

WESTCHESTER COUNTY, NEW YORK

Site Management Plan

NYSDEC Site Number: 360025

Prepared for:

ROHM AND HAAS COMPANY

A WHOLLY-OWNED SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Prepared by:

URS CORPORATION

77 GOODELL STREET

BUFFALO, NEW YORK 14203

Revisions to Final Approved Site Management Plan:

Revision#	Submitted Date	Summary of Revision	DEC Approval Date

OCTOBER 2010

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1.0 INTRODUCTION AND DESCRIPTION OF REMEDIAL PROGRAM

1.1 Introduction

This document is required as an element of the remedial program at the Former EMCA Site (hereinafter referred to as the "site") under the New York State (NYS) Inactive Hazardous Waste Disposal Site Remedial Program, administered by the New York State Department of Environmental Conservation (NYSDEC). Remedial actions and monitoring were conducted at the site in accordance with Order on Consent Index Number A3-0534-1205, which was executed on June 12, 2006.

1.1.1 General

Rohm and Haas Company, a wholly-owned subsidiary of the Dow Chemical Company, entered into an Order on Consent with the NYSDEC to remediate a 0.3-acre property located in the Village of Mamaroneck, Westchester County, New York. This Order on Consent required the Remedial Party, Rohm and Haas Company, to conduct groundwater monitoring, perform an evaluation of vapor intrusion, and conduct contingency remedial actions at the site. Figures showing the site location and boundaries of the site are provided on Figures 1 and 2. The boundaries of the site are more fully described in the metes and bounds site description that is part of the Environmental Easement.

After completion of the remedial work, some contamination[1] was left in the subsurface at this site, which is hereafter referred to as "remaining contamination". This Site Management Plan (SMP) was prepared to manage remaining contamination at the site until the Environmental Easement is extinguished in accordance with ECL Article 71, Title 36. All reports associated with the site can be viewed by contacting the NYSDEC or its successor agency managing environmental issues in New York State.

[1] The contaminants of concern at the site are Freon 113 and its degradation products Freon 123A and Freon 1113 in groundwater.

This SMP was prepared by URS Corporation (URS) on behalf of Rohm and Haas Company (Rohm and Haas), in accordance with the requirements in NYSDEC DER-10 Draft Technical Guidance for Site Investigation and Remediation, dated May 2010, and the guidelines provided by NYSDEC. This SMP addresses the means for implementing the Institutional Controls (ICs) and Engineering Controls (ECs) that are required by the Environmental Easement for this site.

1.1.2 Purpose

This site contains contamination left after completion of the remedial action. The contaminants of concern at the site are Freon 113 and its degradation products 1,2-dichloro-1,1,2-trifluorethane (Freon 123A) and chlorotrifluoroethene (Freon 1113) in groundwater. The water table surface beneath the site varies between approximately 4 and 8 ft below ground surface. Institutional controls have been incorporated into the site remedy to control exposure to remaining contamination during the use of the site to ensure protection of public health and the environment. An Environmental Easement granted to the NYSDEC, and recorded with the Westchester County Clerk, will require compliance with this SMP and all ECs and ICs placed on the site. The ICs place restrictions on site use and mandate that maintenance, monitoring and reporting measures will not be impeded for all ECs and ICs. This SMP specifies the methods necessary to ensure compliance with all ECs and ICs required by the Environmental Easement for contamination that remains at the site. This plan has been approved by the NYSDEC and compliance with this plan by Rohm and Haas shall not be impeded, as required of the grantor of the Environmental Easement and the grantor's successors and assigns. This SMP may only be revised with the approval of the NYSDEC.

This SMP provides a detailed description of all procedures required to manage remaining contamination at the site after completion of the Remedial Action, including (1) implementation and management of all Engineering and Institutional Controls; (2) media monitoring; (3) implementation of optional supplemental treatment; (4) performance of periodic inspections, certification of results, and submittal of Periodic Review Reports; and (5) defining criteria for termination of media monitoring.

To address these needs, this SMP includes three plans: (1) an Engineering and Institutional Control Plan for implementation and management of EC/ICs; (2) a Monitoring Plan for implementation of site monitoring; and (3) a Contingency Treatment Plan establishing a protocol for planning for execution of optional supplemental treatment.

This plan also includes a description of Periodic Review Reports for the regular submittal of data, information, recommendations and certifications to NYSDEC. Failure to comply with this SMP is a violation of Environmental Conservation Law, 6NYCRR Part 375 and the Order on Consent (Index Number A3-0534-1205) for the site, and thereby subject to applicable penalties.

1.1.3 <u>Revisions</u>

Revisions to this plan will be proposed in writing to the NYSDEC's project manager. In accordance with the Environmental Easement for the site, the NYSDEC will provide a notice of any approved changes to the SMP, and append these notices to the SMP that is retained in its files. Changes must be consistent with applicable law and consistent with the Record of Decision.

1.2 <u>Site Background</u>

The former EMCA property is a 0.3-acre site located in a mixed residential/industrial area in the Village of Mamaroneck, New York (Figures 1 and 2). The site was formerly owned and operated by a subsidiary of the Rohm and Haas Company who used it for the manufacture of high conductivity precious metal paste used in circuits. Manufacturing was discontinued in 1988 and the current site owner is Cablevision of Westchester. Site management requires the cooperation of the current site owner, its successor and assigns.

Site investigations revealed that groundwater beneath the site was contaminated with 1,1,2-trichloro-1,2,2 trifluoroethane (Freon 113). The site was listed on the New York Registry of Inactive Hazardous Waste Disposal Sites and an initial Consent Order was signed between the NYSDEC and Rohm and Haas in March 1999.

The site is underlain by unconsolidated glacial and alluvial sand containing zones of gravel, silt and clay. The deepest boring at the site was drilled to a depth of 32 feet below ground surface (bgs). Groundwater occurs under unconfined conditions and the water table beneath the site varies between approximately 4 to 8 feet bgs. The groundwater flow direction is northwest across the site, towards the Sheldrake River (Figure 3).

The contaminants of concern at the site include Freon 113 and its degradation products 1,2-dichloro-1,1,2-trifluorethane (Freon 123A) and chlorotrifluoroethene (Freon 1113). Other volatile organic compounds (VOC)s at elevated concentrations in groundwater immediately upgradient from the site originate from an off-site source. Freon 113 has been detected in groundwater on site at a concentration as high as 18,200 µg/L, in 1988. Significant soil contamination was not found.

Rohm and Haas has taken measures to identify and apply effective remedial technologies to reduce the contaminants of concern in groundwater at the site. In consultation with NYSDEC, an Engineering Evaluation/Cost Analysis (EE/CA) was prepared in 2002 to evaluate remedial options for the site. The EE/CA recommended evaluation of promising alternatives as a pilot study, particularly the injection of vegetable oil to promote anaerobic biodegradation. Injection of zero valent iron was considered as a contingency. The pilot study, conducted in 2003 and 2004, included injection of commercially-prepared, emulsified oil (Edible Oil Substrate – EOS® manufactured by EOS Remediation, Inc. of Raleigh, North Carolina) and a commercially-prepared sodium lactate solution (WILCLEAR™ Sodium Lactate) manufactured by JRW Technologies of Lexana, Kansas.

The injection substantially reduced the concentration of Freon 113 onsite and created conditions favorable for further reductive dechlorination of Freon 113, Freon 123A, and Freon 1113. To build upon the success of the pilot study injections, more widespread injections of EOS® and WILCLEAR™ were undertaken as an Interim Remedial Measure (IRM) in November 2004. The injections significantly reduced the threat to public health and the environment and the NYSDEC adopted No Further Action other than continued groundwater monitoring to assess the effectiveness of previous remedial actions.

The preferred alternative included monitoring of Freon 113, Freon 123A and Freon 1113 until remedial goals are achieved, and additional injections of EOS® and/or WILCLEAR™ only as a contingency based on the results of long-term monitoring. These recommendations were included in the remedy specified by the Record of Decision (ROD), dated March 2005. The ROD, issued by the NYSDEC, concluded that the site no longer poses a threat to human health. The ROD also specified that a vapor intrusion investigation be undertaken to assess the potential for contamination volatilizing from groundwater and intruding into the onsite building. This investigation was completed in March 2009.

The NYSDEC Order on Consent (Index Number A3-0534-1205), signed in June 2006, replaced the initial Order on Consent signed in March 1999. Subsequent to execution of the current Order on Consent in 2006, two supplemental remedial injections were undertaken (in August 2007 and August-September 2009), each targeting residual areas of Freon contamination. Also, the results of the March 2009 Vapor Intrusion Sampling Event were evaluated and presented in a Vapor Intrusion Study Report in June 2009 (URS 2009a). The report concluded that there is no current or anticipated potential future health risk posed due to Freon vapor volatilizing from groundwater and intruding into indoor air at the site. The NYSDEC concurred with this recommendation in September 2009. Groundwater monitoring has been conducted at the site twice per year since the signing of the current Order on Consent.

1.3 Summary of Remedial Investigation and EE/CA Findings

1.3.1 Preliminary and Remedial Investigations

Preliminary site investigations performed by Goldberg-Zoino Associates of New York (GZANY 1988) and Woodward-Clyde Consultants (WWC 1989) involved drilling, installation of groundwater monitoring wells, and sampling and analysis of soil, groundwater, and air (both indoor and outdoor). Results of the investigations revealed that groundwater beneath the northeastern section of the site contained benzene, and chlorinated solvents, including Freon 113 at concentrations above the NYSDEC Class GA Water Quality Standards presented in Technical and Operational Guidance Series (TOGS) 1.1.1, June 1998 (amended April 2000).

URS performed additional fieldwork in October 1999 and July 2000 that included sampling and analysis of soil, soil gas, and groundwater. Hydraulic conductivity testing and groundwater elevation monitoring were also performed. Investigation results were presented in a Remedial Investigation (RI) Report prepared by URS (URS 2000). The RI report characterized site hydrogeology, which is summarized below:

- The site is underlain by unconsolidated glacial and alluvial sand containing zones of gravel, silt, and clay to a depth of 32 feet (ft) below ground surface (bgs), which represents the deepest boring drilled at the site.

- Groundwater occurs under unconfined (water table) conditions and the water table beneath the site varies between approximately 3 and 8 ft bgs. The groundwater flow direction is northwest across the site, towards the Sheldrake River, at a gradient of approximately 0.005 foot/foot (Figure 3).

- Hydraulic conductivity of the water table aquifer ranges between 7 x 10^{-3} centimeters per second (cm/sec) to 2 x 10^{-2} cm/sec.

The RI report and an additional round of groundwater sampling undertaken in July 2001 established the nature and extent of site contamination, which is summarized below (URS 2002).

- Petroleum volatile organic compounds (VOCs, such as benzene), chlorinated VOCs and Freon 113 were detected in vadose zone soil gas. The petroleum VOCs and chlorinated VOCs other than Freon 113 were attributed to offsite sources.

- Ambient air quality (both indoor and outdoor) is not a media of concern based on analyses conducted by ENVIRON (1992) and the New York State Department of Health (NYSDOH 2000).

- Soil contamination was not identified at concentrations above the Recommended Soil Cleanup Objectives presented in NYSDEC Technical and Administrative Guidance Memorandum #4046 *"Determination of Soil Cleanup Objectives and Cleanup Levels"* (NYSDEC 1994).

- Site Groundwater is contaminated by Freon 113 and daughter products 1,2-dichloro-1,1,2-trifluorethane (Freon 123A) and chlorotrifluoroethene, and to a lesser degree, by other chlorinated VOCs and petroleum VOCs (subsequently attributed to off-site upgradient sources and not the subject of this SMP) Groundwater monitoring performed in July 2001 indicated that the principal site-related contaminant of concern in groundwater is Freon 113. Groundwater contaminant concentrations have generally decreased over time.

- The highest concentrations of tetrachloroethene, trichloroethene, 1,1,2-trichloroethane, 1,2-dichloroethene (both isomers), 1,1-dichloroethane, vinyl chloride, and chloroethane in groundwater were detected in upgradient monitoring wells, indicating an upgradient source of these compounds.

- At the time of the RI report, groundwater analytical data for natural attenuation parameters did not provide strong evidence that reductive dechlorination of Freon 113 was occurring in the saturated zone under ambient conditions.

1.3.2 <u>Engineering Evaluation/Cost Analysis</u>

An EE/CA was performed to evaluate remedial options for Freon 113 contamination in groundwater (URS 2002). The remedial action objective established in the EE/CA was to reduce the maximum concentration of Freon 113 in groundwater to a level approaching the New York State groundwater standard (5 micrograms per liter [µg/L] or parts per billion).

The following alternatives were evaluated in detail in the EE/CA:

- Monitored natural attenuation.
- In-situ application of a Hydrogen Release Compound.
- Injection of vegetable oil.
- Injection of zero valent iron (ZVI) using the Ferox® process.
- Injection of ZVI in a guar carrier.

The EE/CA recommended further evaluation of the following promising remedial alternatives using a pilot study at the site:

- Injection of vegetable oil.
- Injection of ZVI in a guar carrier (as a potential contingency).

1.3.3 Pilot Study

A pilot study was conducted between May 2003 and July 2004 to evaluate the effectiveness of emulsified oil injection as a method to stimulate biological processes that result in the reductive dechlorination of Freon 113 in site groundwater.

The following activities were performed:

- Installation of two monitoring wells (MW-06 and MW-07).
- Injection of commercially-prepared emulsified oil (Edible Oil Substrate – EOS®) and commercially-prepared sodium lactate solution (WILCLEAR™ Sodium Lactate).
- A groundwater-monitoring program to establish background conditions and provide analytical data to facilitate evaluation of the technology's effectiveness.

Results of the pilot study indicated that injection of EOS® and sodium lactate was successful in stimulating in-situ anaerobic biodegradation of Freon 113. Monitoring data that supported this assessment include:

- A reduction of Freon 113 concentrations in source area and downgradient wells. Concentrations of Freon 113 and its degradation byproducts (Freon 123A and Freon 1113) in wells before (May 2003) and at the end of (July 2004) the pilot study are depicted on Figure 4.
- An increase of Freon 123A, Freon 1113, and chloride concentrations in source area and downgradient wells.
- Geochemical data (high methane and the absence of sulfate) that indicated the study area shifted towards a more highly reducing environment.

Based on the results of a sampling event on July 22-23, 2004, an additional injection of sodium lactate and emulsified oil was recommended to continue and enhance conditions favorable for continued degradation of site contaminants. Based on this data it was recommended that an interim remedial action (IRA) be conducted at the site and consist of the following elements:

- Injection of sodium lactate at locations similar to where the emulsified oil and sodium lactate were injected during the pilot study.

- Injection of emulsified oil and sodium lactate upgradient of MW-03 to provide for a longer lasting enhancement of the anaerobic conditions at MW-03 and to create conditions favorable for the degradation of site contaminants in the vicinity of MW-02 and MW-06.

- Injection of sodium lactate between MW-03 and MW-07 to supplement conditions favorable for the degradation of contaminants in the downgradient portion of the plume.

- Injection of sodium lactate in the immediate vicinity of GZ-06 to provide conditions favorable for the degradation of contaminants at this upgradient location.

1.4 Summary of Remedial Actions

A total of four remedial injection events were undertaken at the site from 2003 to 2009, three of which were undertaken following completion of the pilot study. These include IRA injections in 2004 and supplemental injections in 2007 and 2009. Injection point locations for all four injection events are shown on Figure 5.

1.4.1 Interim Remedial Action (IRA)

The IRA was conducted in November 2004. The objective of the IRA was to stimulate and maintain biological processes that result in the reductive dechlorination of Freon 113 and daughter products (Freon 123A and Freon 1113) in the saturated zone. Commercially-prepared WILCLEAR™ sodium lactate and EOS® 598B42 emulsified oil were used during the IRA.

The IRA injections were conducted in the following areas: the area encompassing wells MW-02, MW-03 and MW-06; in an area between MW-03 and downgradient well MW-07; and at a separate location surrounding upgradient well GZ-06. WILCLEAR™ and EOS® 598B42 were injected in accordance with the NYSDEC-approved IRA Work Plan dated October 2004 (URS 2004). The injections resulted in a significant decrease of Freon 113 concentrations across the site.

1.4.2 <u>2007 and 2009 Supplemental Injection</u>

The 2003 (Pilot Study) and 2004 (IRA) injections of sodium lactate and emulsified oil substrate were successful in establishing favorable conditions for reductive dechlorination of Freon compounds. The goals of the 2007 and 2009 supplemental injections were to maintain and enhance conditions favorable for anaerobic biological processes and to remediate remaining areas of contamination.

The 2007 Supplemental Injection Work Plan (URS 2007a) was approved by the NYSDEC in June 2007. Injections began in August 2007, after the August 2007 groundwater sampling. Figure 5 shows the locations of the 2007 injections, completed at 29 locations in the saturated zone. A total of more than 6,000 gallons of dilute substrate was injected in the subsurface (URS 2007b).

The 2009 Supplemental Injection Work Plan (URS 2009b) was approved by the NYSDEC in August 2009, and the injections were executed in August and September, one month prior to groundwater sampling undertaken in October 2009. Figure 5 shows the locations of the 39 injection points. Injections were targeted in the vicinity of MW-02, where remaining contamination is highest. Unlike the three previous injections undertaken at the site, 2009 injections were aided with an in-line pulsing tool (Sidewinder®, provided by Wavefront Technologies) to better distribute the injected substrates within the aquifer matrix. A total of approximately 5,560 gallons of dilute substrate was injected in the subsurface (URS 2009c). .

1.4.3 <u>Remaining Contamination</u>

The contamination remaining in groundwater at the site includes three contaminants of concern detected in onsite wells above New York State Groundwater Standards. These are:

- 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)
- 1,2-dichloro-1,1,2-trifluoroethane (Freon 123A)
- chlorotrifluoroethene (Freon 1113)

The wells were last sampled in October 2009. The results of sampling for the three contaminants of concern are summarized on Figure 6.

2.0 ENGINEERING AND INSTITUTIONAL CONTROL PLAN

2.1 Introduction

2.1.1 General

Since remaining contaminated groundwater exists beneath the site, Engineering Controls and Institutional Controls (EC/ICs) are required to protect human health and the environment. This Engineering and Institutional Control Plan describes the procedures for the implementation and management of all EC/ICs at the site. The EC/IC Plan is one component of the SMP and is subject to revision by the NYSDEC.

2.1.2 Purpose

This plan provides:

- A description of all EC/ICs on the site;
- The basic implementation and intended role of each EC/IC;
- A description of the key components of the ICs set forth in the Environmental Easement;
- A description of the features to be evaluated during each required inspection and periodic review; and
- A description of plans and procedures to be followed for implementation of EC/ICs.

2.2 Engineering Controls

2.2.1 Engineering Control Systems

Monitoring of the remaining groundwater contamination at the site will be accomplished by sampling groundwater from a network of monitoring wells established at the site. Remaining contamination is expected to diminish over time as a result of anaerobic biodegradation enhanced by the remedial injections undertaken at the site and by other natural attenuative processes. Monitoring of groundwater will be undertaken as described in the Site Monitoring Plan (Section 3 of the SMP).

2.2.2 Criteria for Completion of Remediation

Groundwater monitoring activities will continue until groundwater contaminant of concern concentrations are consistently at or below NYSDEC standards, defined to be no more than 3 consecutive sampling events. The contaminants of concern and their corresponding NYSDEC standards are given below.

Chemical	Standard
Freon 113	5 μg/L
Freon 123a	5 μg/L
Freon 1113	5 μg/L

If groundwater contaminant levels remain above NYSDEC standards, Rohm and Haas may, in coordination with the NYSDEC, conduct additional remedial actions to reduce the time to achieve standards. A protocol for planning for any additional remedial actions is presented in the Contingency Treatment Plan (Section 4 of the SMP).

2.3 Institutional Controls

A series of Institutional Controls is required by the ROD to prevent future exposure to remaining contamination and to limit use and development of the site to commercial/industrial uses only. Adherence to these Institutional Controls on the site is required by the Environmental Easement. These Institutional Controls are:

- Groundwater shall not be used as a source of potable or process water without water quality treatment as determined by the Westchester County Department of Health;

- Adherence to the SMP, developed pursuant to Order on Consent (Index #A3-0534-1205) between the NYSDEC and Rohm and Haas Company, shall not be impeded.

The site property may not be used for a higher level of use, such as unrestricted or residential use, without an amendment of the Environmental Easement, as approved by NYSDEC. Rohm and

Haas will submit to NYSDEC a written statement that certifies, under penalty of perjury, that: (1) controls employed at the Controlled Property are in place and intact or that any changes to the controls were approved by the NYSDEC; and, (2) nothing has occurred that impairs the ability of the controls to protect public health and environment or that constitute a violation or failure to comply with the SMP. NYSDEC retains the right to access such Controlled Property in a reasonable manner and at reasonable times in order to evaluate the continued maintenance of any and all controls. This certification shall be submitted annually, or an alternate period of time that NYSDEC may allow and will be made by an expert that the NYSDEC finds acceptable.

The Environmental Easement may be extinguished by a release by the Commissioner of the NYSDEC. Such a release will be provided by the NYSDEC within a reasonable timeframe not to exceed 90 days following issuance of NYSDEC's written determination that all phases of the Remedial Program have been completed including operations, maintenance, and monitoring. The criteria of completion of remediation are set forth in Section 2.2.2.

2.4 Inspections and Notifications

2.4.1 Inspections

Inspections of the monitoring well network installed at the site will be conducted at the frequency specified in the SMP Monitoring Plan schedule presented in Section 6. A comprehensive site-wide inspection will be conducted annually. The inspections will determine and document the following:

- Engineering Controls continue to perform as designed;
- Controls continue to be protective of human health and the environment;
- Compliance with requirements of this SMP and the Environmental Easement;
- Achievement of remedial performance criteria;
- Sampling and analysis of appropriate media during monitoring events;
- Site records are complete and up to date; and
- Changes, or needed changes, to the remedial or monitoring system.

Inspections will be conducted in accordance with the procedures set forth in the Monitoring Plan of this SMP (Section 3). The reporting requirements are outlined in the Periodic Review Reporting section of this plan (Section 5).

2.4.2 Notifications

Any change in ownership of the site or the responsibility for implementing this SMP will include the following notifications:

- At least 60 days prior to the change, the NYSDEC will be notified in writing of the proposed change. This will include a certification that the prospective purchaser has been provided a copy of the Order on Consent and the Environmental Easement.

- Within 15 days after the transfer of all or part of the site, the new owner's name, contact representative, and contact information will be confirmed in writing.

2.5 Contingency Plan

Activities that will occur onsite related to execution of the SMP include groundwater sampling, well abandonment, inspections, and contingency remedial actions that may include injection of food-grade substrates with a direct-push drill rig. Field personnel conducting SMP-required activities will adhere to the Health and Safety Plan for Operation, Maintenance and Monitoring and Vapor Intrusion Investigation (URS 2006) for health and safety guidelines. Rohm and Haas may develop a new Health and Safety Plan in the future.

Except during SMP-related activities, there is little possibility of any environmentally related situation or unplanned occurrence related to the remaining contamination. If an unplanned occurrence, environmentally related situation related to environmental issues raised by the Order on Consent, SMP, or Environmental Easement, or safety issue occurs onsite during onsite activities related to execution of the Order of Consent, SMP, or Environmental Easement, prompt contact should be made to appropriate emergency response personnel and appropriate project personnel. Emergency contact numbers are listed on Table 1. This list will be posted prominently at the site during onsite activities and made readily available to all personnel at all times. The nearest hospital facility is the New York United Hospital Medical Center at 406 Boston Post Road, in Port Chester, New York. The directions to this facility are shown on Figure 7. The hospital phone number is 914-934-3000.

3.0 SITE MONITORING PLAN

3.1 Introduction

The Monitoring Plan describes the measures for evaluating the performance and effectiveness of the remedy to reduce or mitigate contamination at the site. This Monitoring Plan may only be revised with the approval of NYSDEC. The components of the ongoing evaluation include groundwater monitoring, reporting, site-wide inspections, and well decommissioning.

3.2 Long-Term Groundwater Monitoring Program

3.2.1 Groundwater Monitoring

The groundwater monitoring program will consist of semi-annual sampling of five long-term monitoring wells: MW-02, -03, -04, -06, and –07R (Figure 8). The wells monitor reductive dechlorination processes in groundwater, provide data to evaluate the need for contingency remedial actions, and provide data to substantiate site closure, the cessation of the remedial action, and the extinguishment of the Environmental Easement. Well construction diagrams for each well are provided in Appendix A. Each well will be sampled for Freon-113, Freon-123a, and Freon-1113 which are listed in Table 2. Except for MW-04, the well farthest downgradient, groundwater sampling will be discontinued at an individual well when remediation goals are achieved at that well for three consecutive monitoring events. The groundwater monitoring program will continue until remediation goals are achieved at all active site monitoring wells.

3.2.2 Sampling Protocols

Each well will be purged before sampling using the low-flow, micro-purge method. Field parameters (pH, oxidation-reduction potential [ORP], conductivity, temperature, dissolved oxygen, and turbidity) will be documented for pre- and post-purge water. These parameters will be measured in a flow-through cell and must be stable prior to sampling. Dedicated/disposable high-density polyethylene (HDPE) and silicone tubing attached to a low-flow pump will be used to collect the groundwater samples from approximately the middle of the screened section. Purging will require the removal of a minimum of one volume of standing water by pumping at a rate of less than one (1) liter per minute. Drawdown of the standing water column should not exceed 0.3 feet. Sampling should commence immediately after purging. Detailed procedures for purging and sampling are described below. The procedures have been developed from the Rohm and Haas guidance: "Protocol for Groundwater Sampling and Analysis" (Appendix B).

Sampling Equipment Cleaning Procedures

All wells to be sampled will be purged by pumping with a low-flow peristaltic pump. All downhole equipment will be dedicated and disposable. Any equipment that is not considered dedicated and disposable (i.e., water level meter) will be decontaminated according to the following procedures:

1) Thoroughly clean with laboratory-grade soap and water, until all visible contamination is gone.
2) Rinse with tap water until all visible evidence of soap is gone.
3) Rinse with deionized water.

Water Level Monitoring

Water levels will be measured from nine monitoring wells (MW-01, -02, -03, -04, -05,-06, -07R, GZ-03 and GZ-06) and two surface water locations along the Sheldrake River (Benchmark B [BM-B] and Benchmark D [BM-D]) and used to construct a potentiometric surface contour map (Figure 8). Previous Sheldrake River gauge locations WS-01, WS-02, and WS-03 have been destroyed and will not be re-established. The groundwater measurements will be taken first from wells that do not contain elevated concentrations of Freon (i.e., the furthest downgradient and upgradient of the Freon plume).

During each monitoring event, water levels in all monitoring wells will be measured using an electronic water level indicator prior to groundwater sampling. Water level measurements will also be recorded during purging and sampling using the procedure presented below.

1) Clean the water level probe and the lower portion of cable following standard decontamination procedures and test the water level meter to ensure that the batteries are charged.

2) Lower the probe slowly into the monitoring well until the audible alarm indicates water.

3) Read depth, to the nearest hundredth of a foot, from the graduated cable using the V-notch (or other mark) on the riser pipe as a reference.

4) Repeat the measurement for confirmation and record the depth to water.

5) Remove the probe from the monitoring well slowly, drying the cable and probe with a clean paper towel.

6) Replace the monitoring well cap and lock the protective cap.

7) Decontaminate the water level meter if additional measurements are to be taken.

Well Purging Procedures

Using the micro-purge method, low pumping rates are used to sample groundwater. Sample aliquots are collected directly from the screened interval without mixing of stagnant water from above the screened interval. In addition, less turbidity is produced with lower pumping rates.

A low-flow peristaltic pump will be used to perform the purging/sampling. Wells must have sufficient yield to be pumped without creating excessive drawdown to avoid sampling the stagnant water column. Basic elements of low-flow sampling are summarized below.

1) The well cover will be unlocked and carefully removed to avoid having any foreign material enter the well. The interior of the riser pipe will be monitored for organic vapors using a combination photoionization/flameionization (PID/FID) detector. If

a reading of greater than 5 parts per million (ppm) is recorded, the well will be vented until levels are below 5 ppm before purging begins.

2) Allow the well to equilibrate to atmospheric conditions prior to measuring the depth to water and other field parameters.

3) Measure the water level below the top of casing with an electronic water level detector. Knowing the total depth of the well, it will be possible to determine the volume of water in the well. Decontaminate the electronic water level detector between wells.

4) Calibrate field instruments (i.e., pH, ORP, specific conductance, dissolved oxygen, PID/FID, and turbidity).

5) In all wells, a low-flow pump will be used to purge the required water volume until stabilization of pH, ORP, specific conductance, dissolved oxygen, and turbidity is attained. Dedicated, new HDPE intake tubing and silicone rotary tubing will be used for each well.

6) Slowly install the HDPE tubing into the well and set the tubing intake to about the midpoint of the well screen.

7) Pump water at less than 1 liter per minute and measure the water level continuously. Adjust the discharge rate until the water level does not drop beyond 0.3 feet.

8) Purge the well until the field parameters have stabilized. The stabilization criteria are: conductivity ± 3% full-scale; pH ± 0.20 standard unit; temperature ± 0.2^{o}C; ORP ± 10 millivolts; dissolved oxygen ± 10%, and turbidity ± 10%.

9) Purging of three well volumes is not necessary if the field parameters are stable. However, at least one (1) well volume must be purged before sampling can begin. During purging, it is permissible to by-pass the flow cell until the groundwater has cleared.

10) Field parameters must be measured continuously using the flow cell.

11) Well purging data will be recorded in the field notebook and on a Well Purging Log (Appendix C).

Groundwater Sampling Procedures

To the extent practicable, well locations will be sampled in order of increasing groundwater contaminant concentrations, based on the prior period's results, to minimize potential for cross-contamination.

Groundwater samples will be collected and handled to minimize the potential for cross-contamination, loss of VOCs, or other interference. Sampling personnel will wear clean latex, nitrile, or other chemical-resistant, non-reactive gloves when handling sampling equipment and containers, and will minimize contact with the sampled groundwater. Care will be taken to prevent contact of the down-hole equipment with the ground or other potential sources of sample contamination. Gloves will be changed between sampling locations.

The following procedures will be followed:

1) Label all sample bottles using a waterproof permanent marker.

2) After well purging is completed, collect a sample into the appropriate containers that contain the required preservatives.

3) Disconnect the flow cell before sampling and reduce pump rate to 100 millimeters per minute. Direct the discharge tubing toward the inside wall of the sample container to minimize volatilization. Fill containers to overflowing and cap.

4) Samples will be wrapped in bubble wrap to prevent breakage and placed on ice in coolers prior to shipment to the analytical laboratory. The analytical laboratory will certify that the sample bottles are analyte-free.

5) Drain, remove and dispose of tubing.

6) Record well sampling data in a field notebook and on the Well Purging Log (Appendix C).

Sample Labeling

Affixed to each sample container will be a non-removable (when wet) label. Apply label and wrap with 2-inch cellophane tape to cover label. The following information will be written on each label with permanent marker:

- Site name
- Sample identification
- Project number
- Date/time
- Sampler's initials
- Sample preservation
- Analysis required

Each sample will be assigned a unique code in accordance with Rohm and Haas Document No. CRG-026a, which, is attached in Appendix D. The code will contain the following six (6) items.

Date	Location	Depth	Preservation	Filtration	Type
20070124	MW-07	V15	U (only used when not preserved)	D (only used when filtered)	N

Sample Shipping

Strict Chain-of-Custody (COC) procedures will be followed for each shipment of samples to the laboratory. A copy of a COC is provided in Appendix C. These procedures document the transfer of custody of the samples from the field to the laboratory. Each COC will provide instructions to the laboratory for analytical parameters for each sample submitted. Blank spaces on the COC will be crossed out. Each COC will be completed in duplicate and the original will be sealed in a zip-lock plastic bag within each sample cooler. The copy will be kept by the sampling technician to document the date and time the samples were transferred to the laboratory. Custody seals will be signed by the person preparing the sample cooler(s) and placed across the lid(s) prior to the sealing of the sample cooler(s) with clear packing tape.

Samples will be shipped either by FedEx or other common carrier or be picked up by a courier and transported directly to the laboratory.

3.2.3 Analytical Program

The analytical program including parameters, methods and quality assurance/quality control (QA/QC) samples is summarized in Table 3. A data usability assessment will be performed on the laboratory data from each semi-annual sampling event.

QA/QC Program

QA/QC requirements will be followed in accordance with Rohm and Haas Guidance CRG-022 – Environmental Data QC Control. The QA/QC protocol is intended to provide guidance to:

- Provide a clear definition of the level of QC required
- Compile QC criteria required by the analytical methodology
- Provide a clear definition of the QA/QC requirements identified

The QC elements are important in determining the precision and accuracy of the test results and to what extent the field samples are representative of the actual field conditions. For this Groundwater Monitoring Program, the QA/QC protocol will follow the Level 3 Criteria Specified in Rohm and Haas Document CRG-022. Table 3 summarizes the frequency and type of QA/QC samples according to analytical methodology. The QA/QC samples that will be obtained in the field and/or prepared by the laboratory are listed below.

- Trip blanks – for VOC liquid samples only
- Field duplicates – determined from the number of primary samples
- Matrix spike & matrix spike duplicates – prepared by the laboratory
- Method blanks – prepared by laboratory
- Sample cooler temperature blanks placed in the cooler to check sample temperatures upon receipt in the laboratory

Following each semi-annual sampling event and after receipt of the analytical data package, URS will independently validate the analytical data packages in accordance with USEPA Region II Data Validation Guidelines. Upon completion of the data validation, a NYSDEC Data Usability Summary Report (DUSR) will be generated, which identifies any QC non-conformances and discusses how they impact the usability of the data.

3.2.4 Monitoring Well Inspection and Maintenance

Long-term monitoring wells will be inspected annually during the second semi-annual sampling event. Inspections will examine the physical conditions of the well casings, surface seals, well caps and locks. Any deficiencies noted will be recorded in a field logbook and on the monitoring well inspection form (Appendix C). Maintenance will be performed as soon as practical so that wells are suitable for their intended purposes.

3.3 Reporting

Rohm and Haas will prepare a semi-annual report after each sampling event for the NYSDEC that provides the following information:

1) Site name and address

2) Consultant performing the sampling (URS)

3) Regulatory Agency involved (NYSDEC)

4) Summary of activities completed and date(s)
    - Description of field procedures performed in accordance with the Monitoring Plan
    - Description of any discrepancies relative to the Monitoring Plan
    - Summary of field measurements
    - Description and summary table of water level data
    - Groundwater elevation contour map

5) Summary table of the analytical results

6) Discussion of the QA/QC results and implications

7) Discussion of significant observations or problems encountered

8) Comments and conclusions based on an evaluation of the analytical results

9) Recommendations regarding future well decommissioning and the need to implement contingency measures.

10) List of Attachments/Appendices (tables, figures, completed field forms, analytical data packages, etc.).

3.4 Well Decommissioning

Site monitoring wells are shown on Figure 8. The following five (5) wells are included in the long-term monitoring program: MW-02, -03, -04, -06, and –07R. All other wells onsite will be decommissioned in accordance with the procedures outlined in Appendix E as soon as it is practical to do so. The long-term monitoring wells, except for MW-04, will be decommissioned on an individual basis when the contaminants of concern are found to be below remediation goals in the subject well for three consecutive monitoring events. MW-04, which is situated to monitor potential downgradient migration, will not be decommissioned until the three Freon compounds that are the subject of this SMP are below remediation goals across the entire monitoring well network.

The NYSDEC will be notified prior to any repair or decommissioning of monitoring wells for the purpose of replacement, and the repair or decommissioning and replacement process will be documented in the subsequent periodic report. Monitoring wells that are decommissioned because they have been rendered unusable will be reinstalled in the nearest available location, unless NYSDEC determines that replacement is unnecessary.

3.5 Site-Wide Inspection

Site-wide inspections will be performed on a regular schedule at a minimum of once a year. During these inspections, an inspection form will be completed (Appendix C). The form will compile sufficient information to assess the following:

- Compliance with all ICs, including site usage;
- An evaluation of the condition and continued effectiveness of monitoring wells;
- General site conditions at the time of the inspection;
- The site management activities being conducted including, confirmation sampling and optional remedial activities; and
- Confirm that site records are up to date.

4.0 CONTINGENCY TREATMENT PLAN

The decision to execute optional contingency measures to further reduce remaining groundwater contamination will be recommended by Rohm and Haas and approved by the NYSDEC. The following criteria will trigger contingency measures:

1) A successive increase of 100-percent or greater in Freon 113 concentrations for two consecutive events at any monitored well, assuming that the remediation goal (5 ug/L) is exceeded in at least one of the monitoring events. For example, a well concentration that increased from 4 ug/L to 8 ug/L and from 8 ug/L to 16 ug/L over two consecutive events would trigger contingency measures.

2) Freon 113 is confirmed at MW-04 at a concentration greater than the remediation goal (5 ug/L).

3) The maximum detected Freon 113 concentration at any well is greater than a maximum target level, as shown below.

YEAR	TARGET MAXIMUM
2011	320 ug/L
2012	160 ug/L
2013	80 ug/L
2014	40 ug/L

Once 40 ug/L is achieved after 2014, Criteria #1 becomes the relevant criteria.

To avoid implementing action unnecessarily based on an anomalous result, results above the particular trigger concentrations listed in the criteria above should be confirmed by prompt resampling while contingency measure planning is underway.

Each monitoring report prepared by Rohm and Haas will evaluate the progress of contaminant reduction. If the parties agree that contingency measures are warranted, then Rohm and Haas will prepare a Contingency Measures Work Plan for NYSDEC review. The contingency measures, once executed, will be documented in the subsequent monitoring report.

Contingency measures may consist of injections of WILCLEAR™ and/or EOS® to stimulate anaerobic biodegradation of the contaminants of concern. If these products are not on the market at the time the contingency measures are considered, then Rohm and Haas will evaluate and submit suitable substitutes for approval. The overall scope and details of the injections will depend on the pattern of remaining groundwater contamination and the specific goals of the contingency measures.

As time passes, other remedial techniques and products may be developed that may be more advantageous for implementation at the site to reduce the remaining groundwater contamination to below remediation goals. Application of alternate technologies would require approval of the evaluation by NYSDEC and approval of a Contingency Measures Work Plan by NYSDEC.

5.0 INSPECTIONS, REPORTING AND CERTIFICATIONS

5.1 Site Inspections

5.1.1 Inspection Frequency

All inspections will be conducted at the frequency specified in the schedule provided in Section 6 of this SMP. At a minimum, a site-wide inspection will be conducted annually. Inspections of monitoring wells may be conducted after a severe condition has taken place, such as a flooding event, that may have had an adverse impact on the monitoring well network.

5.1.2 Inspection Forms, Sampling Data, and Maintenance Reports

All monitoring well inspections will be recorded on the form contained in Appendix C. Additionally, a general site-wide inspection form will be completed during the site-wide inspection (see Appendix C). These forms are subject to NYSDEC revision.

All applicable inspection forms and other records, including all groundwater sampling data generated for the site during the reporting period will be provided in electronic format in the Periodic Review Report.

5.1.3 Evaluation of Records and Reporting

The results of the inspection and site monitoring data will be evaluated as part of the EC/IC certification to confirm that the:

- EC/ICs are in place, are performing properly, and remain effective;
- The Monitoring Plan is being implemented; and
- The site remedy continues to be protective of public health and the environment.

5.2 Certification of Institutional Controls

For each institutional control identified for the site, the person completing the Annual Certification must certify that all of the following statements are true:

- The institutional control employed at this site is unchanged from the date the control was put in place, or last approved by the NYSDEC;
- Nothing has occurred that would impair the ability of the control to protect the public health and environment;
- Nothing has occurred that would constitute a violation or failure to comply with the site management plan for this control;
- Use of the site is compliant with the environmental easement;
- The information presented in the report is accurate and complete; and
- All information and statements in the certification form are true and that if a false statement is made, it is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law.

The signed certification will be included in the Periodic Review Report described below.

5.3 Periodic Review Report

A Periodic Review Report will be submitted to the NYSDEC according to the schedule presented in Section 6. The report will be prepared in accordance with NYSDEC DER-10. Groundwater sampling results will also be incorporated into the Periodic Review Report. The report will include:

- Identification, assessment and certification of all EC/ICs required by the remedy for the site;
- Results of the required annual site inspections;

- All applicable inspection forms and other records generated for the site during the reporting period in electronic format;
- Data summary tables and graphical representations of contaminants of concern by media (groundwater), which include a listing of all compounds analyzed, along with the applicable standards, with all exceedances highlighted. These will include a presentation of past data as part of an evaluation of contaminant concentration trends;
- Results of all analyses, copies of all laboratory data sheets, and the required laboratory data deliverables for all samples collected during the reporting period will be submitted electronically in a NYSDEC-approved format;
- A site evaluation, which includes the following:
    - The compliance of the remedy with the requirements of the site-specific ROD;
    - Any new conclusions or observations regarding site contamination based on inspections or data generated by the Monitoring Plan;
    - Recommendations regarding any necessary changes to the remedy and/or Monitoring Plan; and
    - The overall performance and effectiveness of the remedy.

5.4 Corrective Measures Plan

If any component of the remedy is found to have failed, or if the periodic certification cannot be provided due to the failure of an institutional or engineering control, a corrective measures plan will be submitted to the NYSDEC for approval. This plan will explain the failure and provide the details and schedule for performing work necessary to correct the failure. Unless an emergency condition exists, no work will be performed pursuant to the corrective measures plan until it is approved by the NYSDEC.

6.0 SCHEDULE

A schedule showing the planned timeframe of execution of monitoring and inspection events and the due dates for submission of monitoring reports, periodic review reports, and the annual IC Certification is presented on Figure 9. If required beyond 2013, the frequency of execution will remain the same unless NYSDEC agrees to a request for modification to this schedule (which would necessitate modification of and require NYSDEC approval of an amendment to this SMP). Should monitoring data indicate that the remediation is complete across the site, groundwater monitoring and reporting will be discontinued upon NYSDEC approval of the monitoring report that contains data supporting achievement of the criteria set forth in Section 2. Other elements of the schedule will be discontinued once extinguishment of the Environmental Easement is approved by the NYSDEC.

7.0 REFERENCES

Goldberg-Zoino and Associates of New York (GZANY). 1988. *Assessment of Subsurface Conditions, 605-609 Center Avenue and 604 and 612 Fayette Avenue, Mamaroneck, New York*. 22 July.

NYSDOH. 2000. *Freon 113 Concentrations in Air – July 11, 2000*. (Data Summary Table).

NYSDEC. 1994. "Determination of Soil Cleanup Objectives and Cleanup Goals." *Technical and Administrative Guidance Memorandum* HWR-94-4046. Albany, NY: Bureau of Hazardous Waste Remediation.

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URS. 2002. *Engineering Evaluation/Cost Analysis (EE/CA) Report, Former EMCA Site, Mamaroneck, New York, Draft-Final*. Buffalo, New York. June.

URS. 2004. *Interim Remedial Action Work Plan, Former EMCA Site, Mamaroneck, New York*. Buffalo, New York. October.

URS. 2006. *Operation*, Maintenance and Monitoring Plan, Appendix D. *Health and Safety Plan for Operation, Maintenance and Monitoring and Vapor Intrusion Investigation, Former EMCA Site, Mamaroneck, New York*. Buffalo, New York. October.

URS. 2007a. *Supplemental Injection Work Plan, Former EMCA Site, Mamaroneck, New York*. Buffalo, New York. May.

URS. 2007b. *Groundwater Sampling and Analysis Report, August 2007 Sampling Report and Summary of Supplemental Injection Event, Former EMCA Site, Mamaroneck, New York*. Buffalo, New York. October.

URS. 2009a. *Draft Vapor Intrusion Study Report, Former EMCA Site, Mamaroneck, New York*. Buffalo, New York. June.

URS. 2009b. *2009 Supplemental Injection Work Plan, Former EMCA Site, Mamaroneck, New York*. Buffalo, New York. July.

URS. 2009c. *Groundwater Sampling and Analysis Report, October 2009 Sampling Event, Former EMCA Site, Mamaroneck, New York*. Buffalo, New York. November.

Woodward-Clyde Consultants (WCC). 1989. Risk Assessment, Former EMCA Site, Mamaroneck, New York. 15 July.

Tables

Table 1

Emergency Telephone Numbers and Contact Information for Key Personnel

Name	Affiliation	Address	Phone/Fax	Function
Edward Tokarski	Rohm and Haas Company	3100 State Road Croydon, PA 19021	215-785-7244	Project Manager
Ronald J. Lantzy, PhD, P.G.	Rohm and Haas Company	3100 State Road Croydon, PA 19021	215-785-7456	Fellow
Robert Vaszil	Cablevision of Westchester	Six Executive Plaza Yonkers, NY 10701	203-223-0348	Site Owner Contact
Ronnie Lee, P.E.	NYSDEC	6254 Broadway, 12^{th} Floor Albany, NY 12233	518-402-9615	NYSDEC Project Manager
Bruce J. Przybyl	URS	77 Goodell Street Buffalo, NY 14202	716-923-1102 or 1-800-850-9230 (ext. 1102)	URS Project Manager

Name	Phone
Medical, Fire, and Police:	911
One Call Center:	(800) 272-4480 (3 day notice required for utility markout)
Poison Control Center:	(800) 222-1222
Pollution Toxic Chemical Oil Spills:	(800) 424-8802
NYSDEC Spills Hotline:	(800) 457-7362
New York United Hospital Medical Center:	(914) 934-3000

TABLE 2

FORMER EMCA SITE

GROUNDWATER MONITORING PARAMETERS

Parameter	Method Number	Reference	Preservation	Container
Freon-113, Freon -1113, Freon-123a	8260B	1	HCl to pH < 2, 4°C	2x40 ml vials w/ Teflon Septa
pH	150(1)	1	Field Measurement	HDPE
Temperature	170.1(1)	1	Field Measurement	HDPE
Dissolved Oxygen	360.1(1)	1	Field Measurement	HDPE
Redox Potential	SM 2580B(1)	3	Field Measurement	HDPE

References:

1 NYSDEC Analytical Services Protocol, June 2000.

2 USEPA, R.S. Kerr Environmental Research Laboratory, March 15, 1989.

3 Standard Methods for the Examination of Water and Wastewater, 20th Edition.

Notes:

1 Field instrument, low-flow cell

TABLE 3

FORMER EMCA SITE

SUMMARY OF SAMPLES, QA/QC SAMPLES, AND ANALYTICAL METHODS

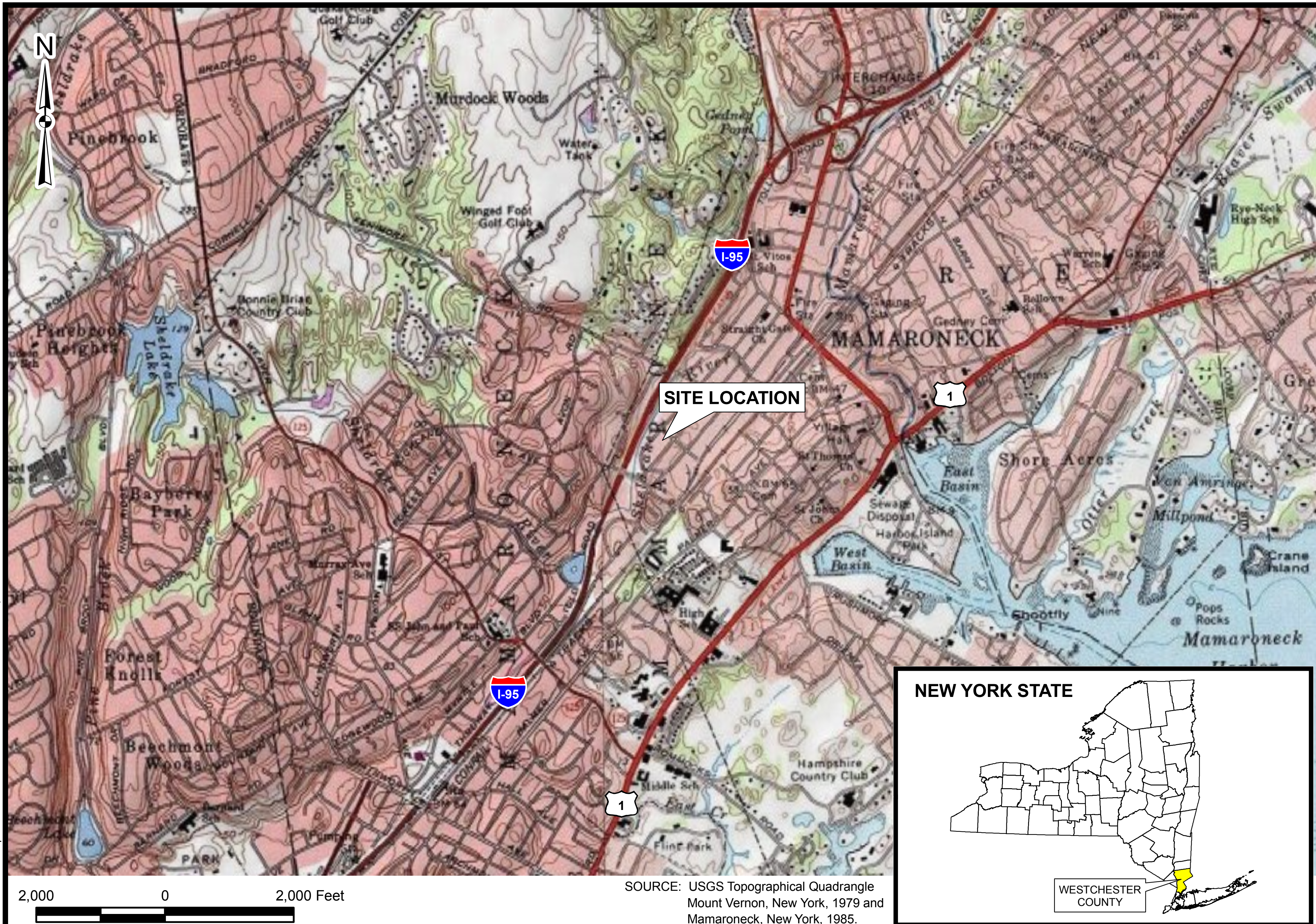
Sample Type	Parameters (Methods)
	Freon-113 Freon-123a Freon-1113 (8260B)
Groundwater	5
QA/QC (estimated)	
Trip Blanks (1)	2
Field Duplicates (2)	1
Matrix Spike	1
Matrix Spike Duplicate	1

Notes:

(1) Trip blanks will be analyzed at a rate of 1 per day for VOC and methane samples.

(2) Field duplicates will be prepared at a frequency of 1 per 10 samples.

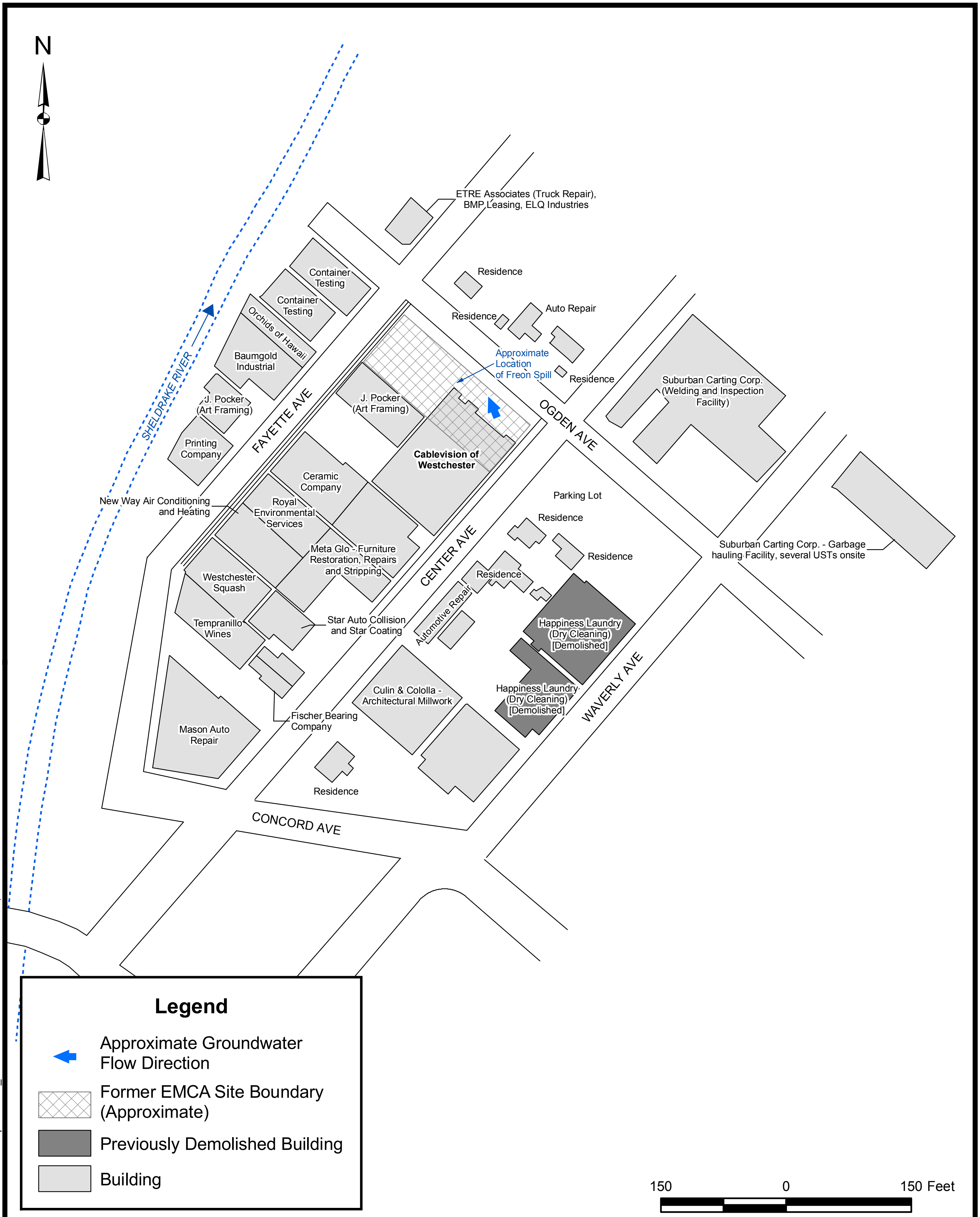
Figures



SOURCE: USGS Topographical Quadrangle Mount Vernon, New York, 1979 and Mamaroneck, New York, 1985.

N:\11172730.00000\DB\GIS\2001\ArcMap\SiteLocation.mxd 5/12/2009 2:52:38 PM Lumb, M

URS	SITE LOCATION MAP	FIGURE 1



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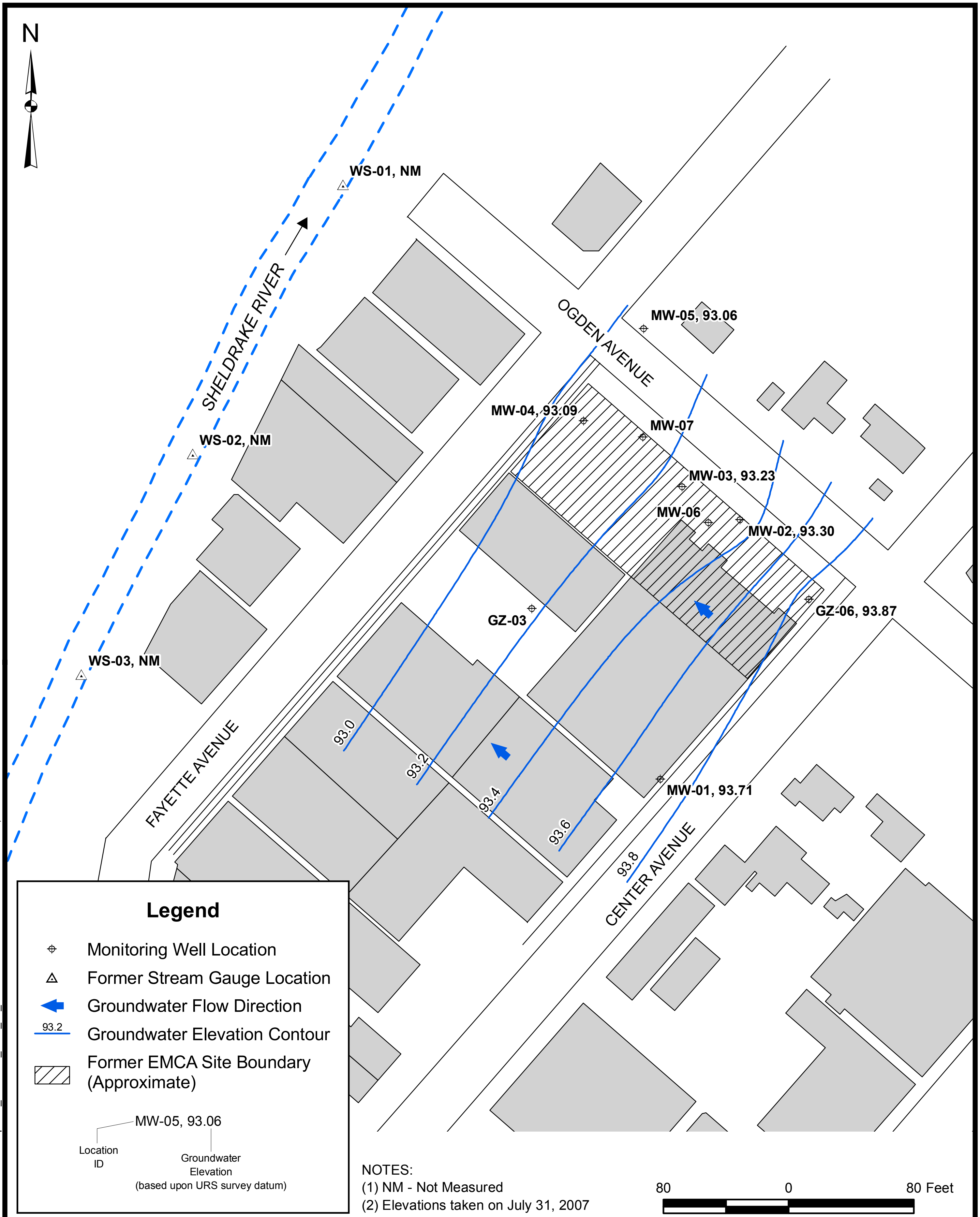
URS

BUILDING LOCATION MAP

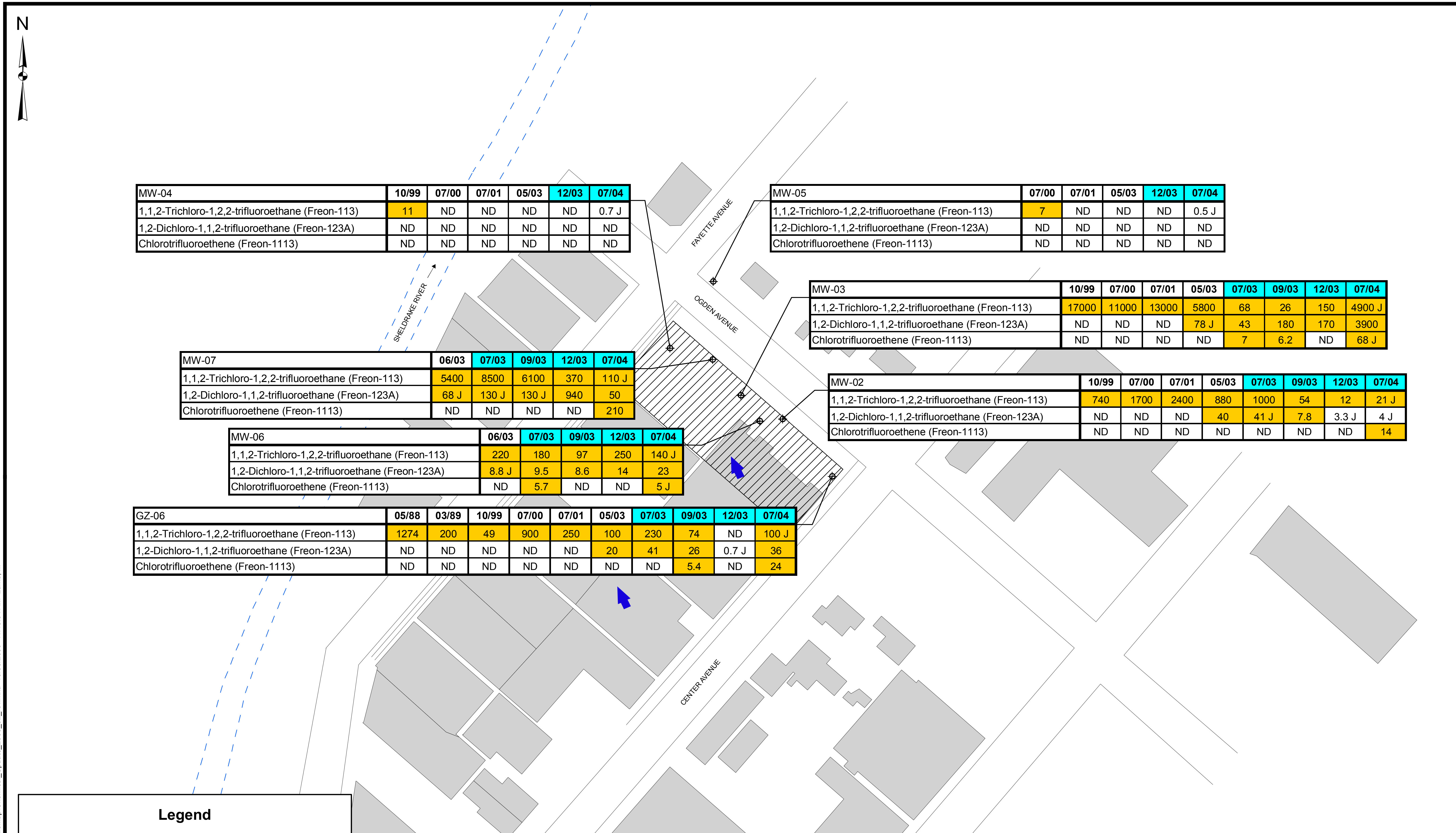
FIGURE 2



URS

GROUNDWATER ELEVATION CONTOUR MAP

FIGURE 3



MW-04	10/99	07/00	07/01	05/03	12/03	07/04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	11	ND	ND	ND	ND	0.7 J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	ND	ND	ND
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	ND	ND

MW-05	07/00	07/01	05/03	12/03	07/04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	7	ND	ND	ND	0.5 J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	ND	ND
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	ND

MW-03	10/99	07/00	07/01	05/03	07/03	09/03	12/03	07/04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	17000	11000	13000	5800	68	26	150	4900 J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	78 J	43	180	170	3900
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	7	6.2	ND	68 J

MW-07	06/03	07/03	09/03	12/03	07/04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	5400	8500	6100	370	110 J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	68 J	130 J	130 J	940	50
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	210

MW-02	10/99	07/00	07/01	05/03	07/03	09/03	12/03	07/04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	740	1700	2400	880	1000	54	12	21 J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	40	41 J	7.8	3.3 J	4 J
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	ND	ND	ND	14

MW-06	06/03	07/03	09/03	12/03	07/04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	220	180	97	250	140 J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	8.8 J	9.5	8.6	14	23
Chlorotrifluoroethene (Freon-1113)	ND	5.7	ND	ND	5 J

GZ-06	05/88	03/89	10/99	07/00	07/01	05/03	07/03	09/03	12/03	07/04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	1274	200	49	900	250	100	230	74	ND	100 J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	ND	ND	20	41	26	0.7 J	36
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	ND	ND	ND	5.4	ND	24

Legend

- Existing Monitoring Well Location
- Generalized Groundwater Flow Direction
- Concentration Exceeds NYSDEC TOGS (1.1.1) Class GA Standards

All Analytical Results are Reported in UG/L

NOTES: ND - Not Detected

07/00 - Pre-Pilot Injection Sampling Dates

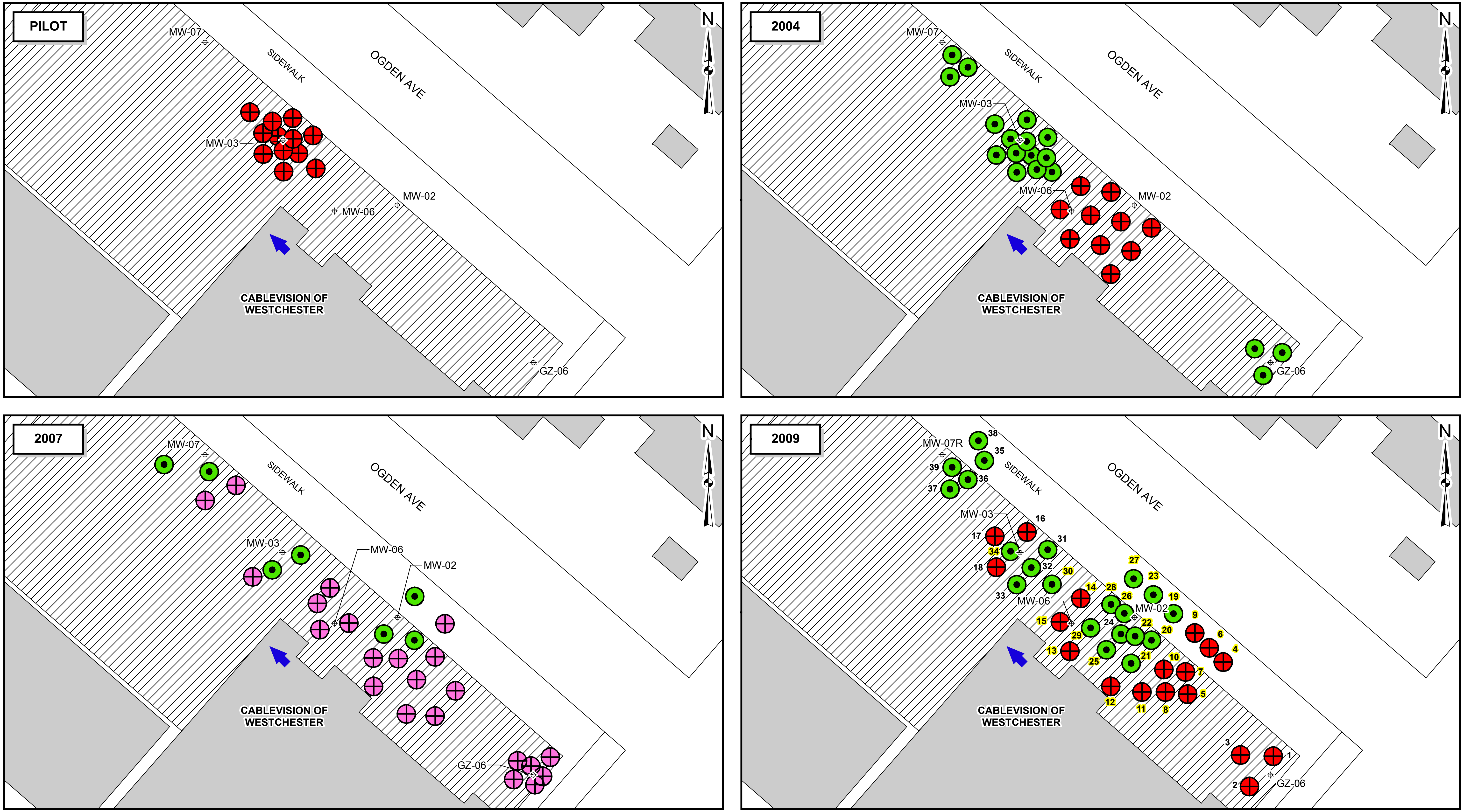
12/03 - Post-Pilot Injection/Sampling Dates

80 0 80 Feet

FORMER EMCA SITE
SUMMARY OF FREON DETECTIONS IN GROUNDWATER
PRE AND POST PILOT STUDY

URS

FIGURE 4



Legend

- Sodium Lactate Only Injection Boring Location
- EOS® and Sodium Lactate Injection Boring Location
- EOS® Only Injection Boring Location
- Monitoring Well Location
- Generalized Groundwater Flow Direction
- Asphalt Parking Lot
- Building

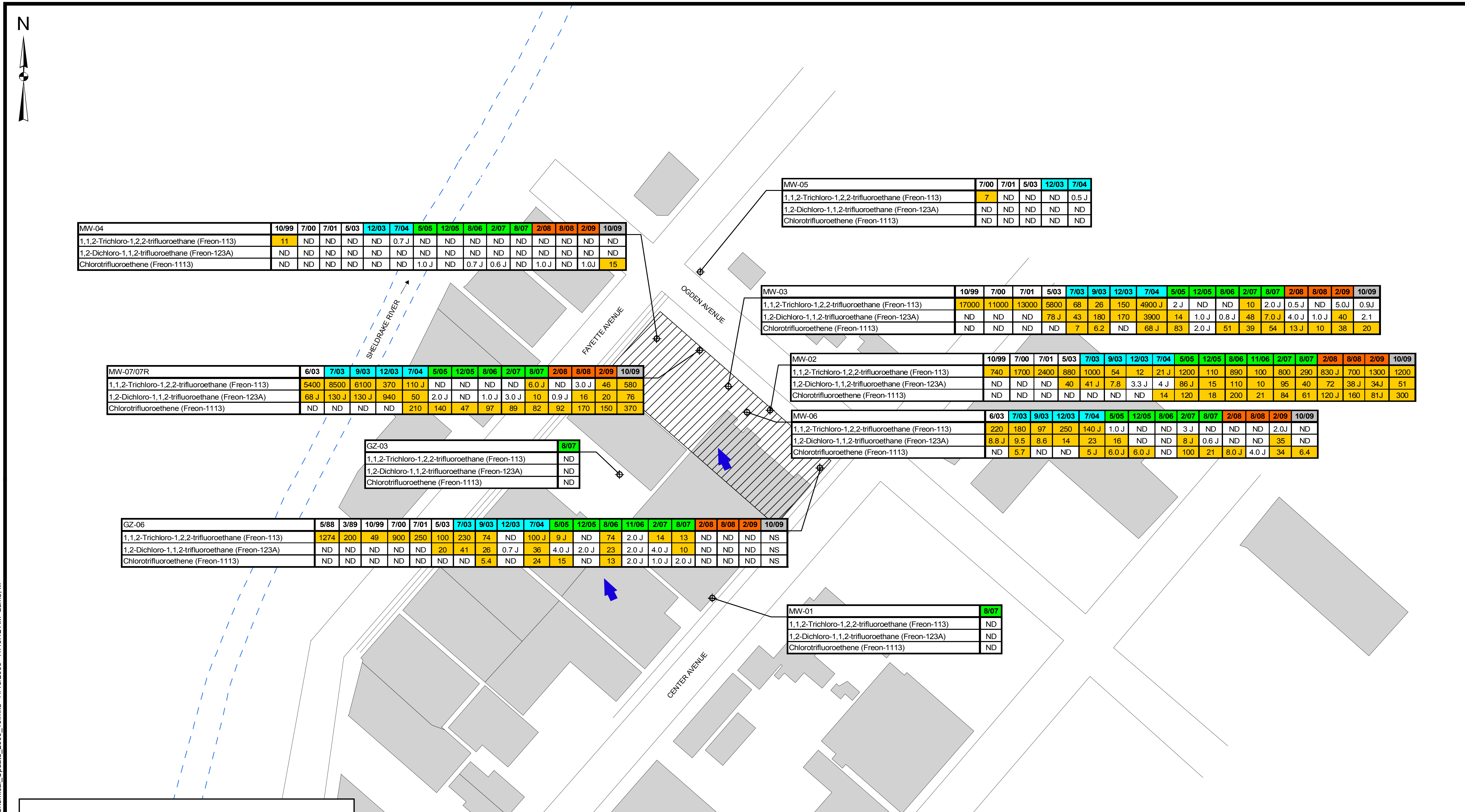
NOTE:
Locations highlighted in yellow indicate where the Sidewinder™ injection pulsing tool was used.

30 0 30 Feet

FORMER EMCA SITE
INJECTION LOCATIONS

URS

FIGURE 5



MW-05	7/00	7/01	5/03	12/03	7/04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	7	ND	ND	ND	0.5 J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	ND	ND
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	ND

MW-04	10/99	7/00	7/01	5/03	12/03	7/04	5/05	12/05	8/06	2/07	8/07	2/08	8/08	2/09	10/09
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	11	ND	ND	ND	ND	0.7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	ND	ND	1.0 J	ND	0.7 J	0.6 J	ND	1.0 J	ND	1.0J	15

MW-03	10/99	7/00	7/01	5/03	7/03	9/03	12/03	7/04	5/05	12/05	8/06	2/07	8/07	2/08	8/08	2/09	10/09
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	17000	11000	13000	5800	68	26	150	4900 J	2 J	ND	ND	10	2.0 J	0.5 J	ND	5.0J	0.9J
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	78 J	43	180	170	3900	14	1.0 J	0.8 J	48	7.0 J	4.0 J	1.0 J	40	2.1
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	7	6.2	ND	68 J	83	2.0 J	51	39	54	13 J	10	38	20

MW-07/07R	6/03	7/03	9/03	12/03	7/04	5/05	12/05	8/06	2/07	8/07	2/08	8/08	2/09	10/09
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	5400	8500	6100	370	110 J	ND	ND	ND	ND	6.0 J	ND	3.0 J	46	580
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	68 J	130 J	130 J	940	50	2.0 J	ND	1.0 J	3.0 J	10	0.9 J	16	20	76
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	210	140	47	97	89	82	92	170	150	370

MW-02	10/99	7/00	7/01	5/03	7/03	9/03	12/03	7/04	5/05	12/05	8/06	11/06	2/07	8/07	2/08	8/08	2/09	10/09
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	740	1700	2400	880	1000	54	12	21 J	1200	110	890	100	800	290	830 J	700	1300	1200
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	40	41 J	7.8	3.3 J	4 J	86 J	15	110	10	95	40	72	38 J	34J	51
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	ND	ND	ND	14	120	18	200	21	84	61	120 J	160	81J	300

MW-06	6/03	7/03	9/03	12/03	7/04	5/05	12/05	8/06	2/07	8/07	2/08	8/08	2/09	10/09
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	220	180	97	250	140 J	1.0 J	ND	ND	3 J	ND	ND	ND	2.0J	ND
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	8.8 J	9.5	8.6	14	23	16	ND	ND	8 J	0.6 J	ND	ND	35	ND
Chlorotrifluoroethene (Freon-1113)	ND	5.7	ND	ND	5 J	6.0 J	6.0 J	ND	100	21	8.0 J	4.0 J	34	6.4

GZ-03	8/07
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	ND
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND
Chlorotrifluoroethene (Freon-1113)	ND

GZ-06	5/88	3/89	10/99	7/00	7/01	5/03	7/03	9/03	12/03	7/04	5/05	12/05	8/06	11/06	2/07	8/07	2/08	8/08	2/09	10/09
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	1274	200	49	900	250	100	230	74	ND	100 J	9 J	ND	74	2.0 J	14	13	ND	ND	ND	NS
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND	ND	ND	ND	ND	20	41	26	0.7 J	36	4.0 J	2.0 J	23	2.0 J	4.0 J	10	ND	ND	ND	NS
Chlorotrifluoroethene (Freon-1113)	ND	ND	ND	ND	ND	ND	ND	5.4	ND	24	15	ND	13	2.0 J	1.0 J	2.0 J	ND	ND	ND	NS

MW-01	8/07
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	ND
1,2-Dichloro-1,1,2-trifluoroethane (Freon-123A)	ND
Chlorotrifluoroethene (Freon-1113)	ND

Legend

Existing Monitoring Well Location

Generalized Groundwater Flow Direction

Concentration Exceeds NYSDEC TOGS (1.1.1) Class GA Standards

All Analytical Results are Reported in UG/L

NOTES:

Well, MW-07, was replaced by well, MW-07R, on September 3, 2009.
ND - Not Detected
NS - Not Sampled because injected substrate was present in the well.
7/00 - Pre-Pilot Injection Sampling Dates
12/03 - Post-Pilot Injection/Pre-IRM Injection Sampling Dates
12/05 - Post-IRM Injection Sampling Dates
2/08 - Post-2007 Supplemental Injection Sampling Dates
10/09 - Post-2009 Supplemental Injection Sampling Dates

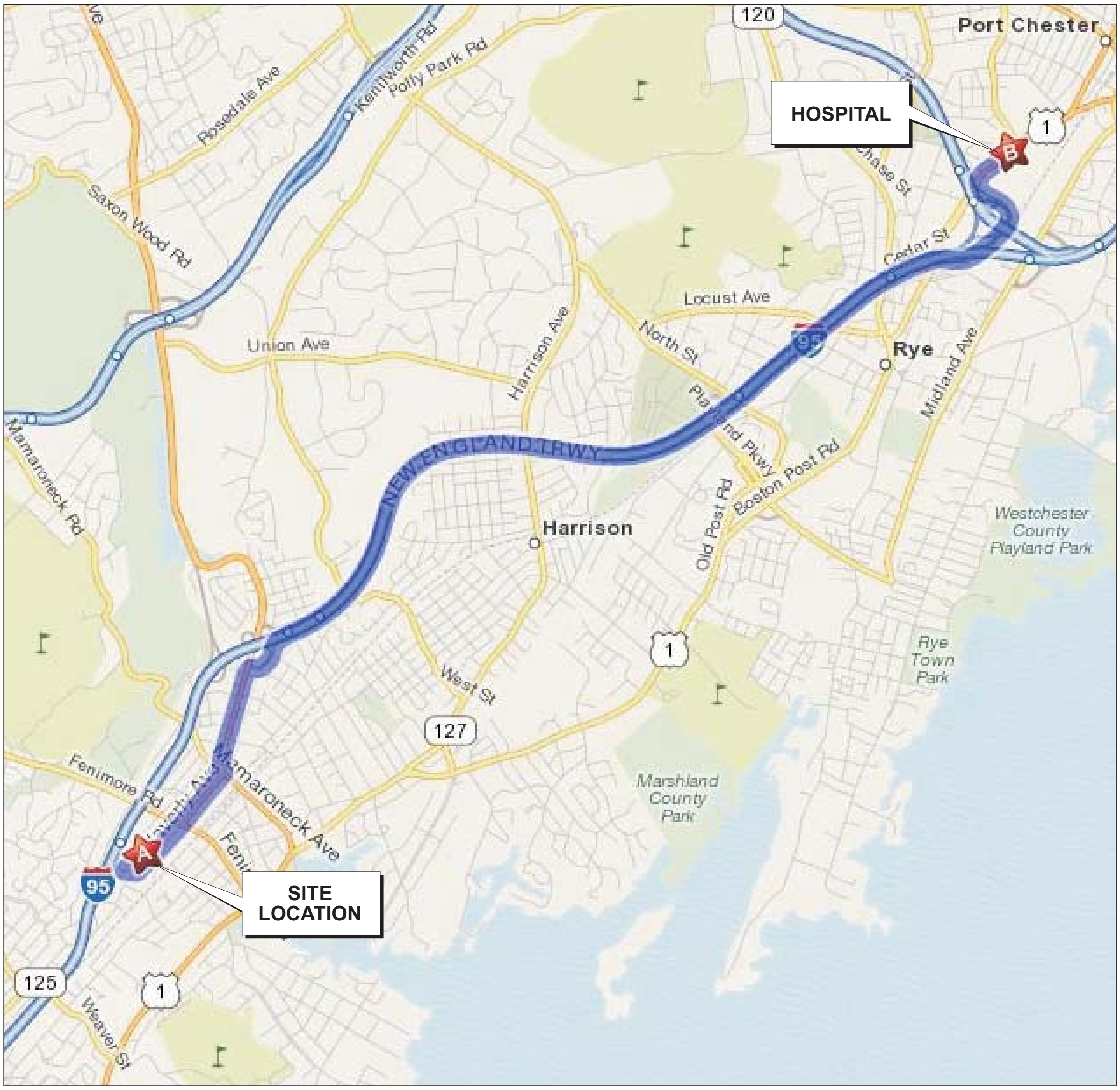
FORMER EMCA SITE
SUMMARY OF FREON DETECTIONS IN GROUNDWATER

URS

FIGURE 6

N:\11172730.00000\DB\GIS\2001\ArcMap\Chemical_Update_2009_10.mxd 11/16/2009 11:49:12 AM Lumb, M

N



Approximate Travel Time: 10 minutes

Approximate Distance: 5.84 miles

Start out going southwest on Center Avenue toward Fayette Avenue. Turn left on Concord Avenue. Turn slight left onto Waverly Avenue. Turn left onto Mamaroneck Avenue. Merge onto I-95 North (New England Thruway). Take US-1 North exit (Exit 21) toward Port Chester. Turn slight right onto Boston Post Road (US-1). Hospital is at 406 Boston Post Road.

New York United
Hospital Medical Center
406 Boston Post Road
Port Chester, New York 10573

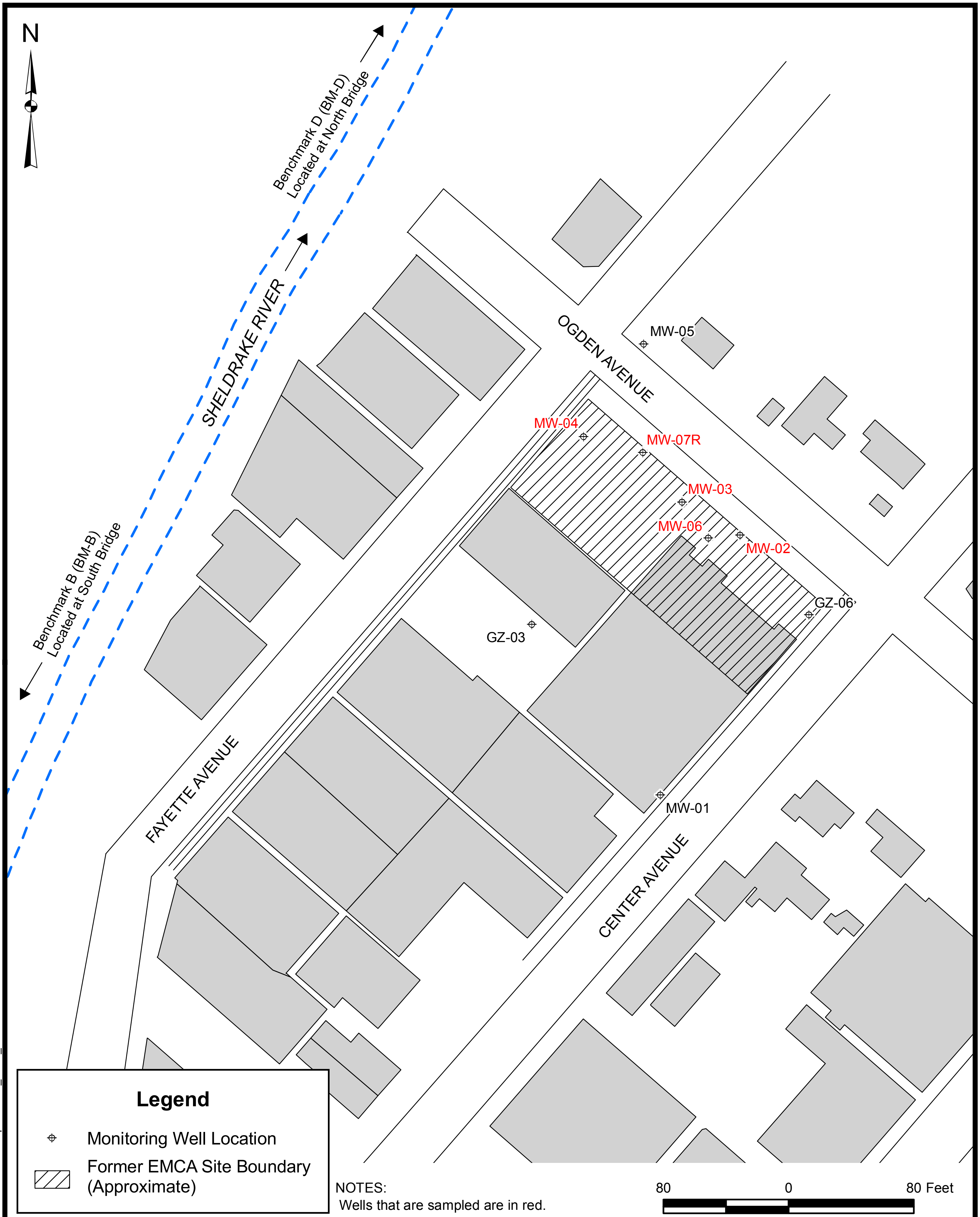
(7914) 934-3000
Emergency - 911

AG20339-11176110-102909-GCM

URS

FORMER EMCA SITE
ROUTE TO THE HOSPITAL

FIGURE 7



Legend

Monitoring Well Location

Former EMCA Site Boundary (Approximate)

NOTES:
Wells that are sampled are in red.

N:\11172730.00000\DB\GIS\2001\ArcMap\SitePlan_Wells_rev3.mxd 10/18/2010

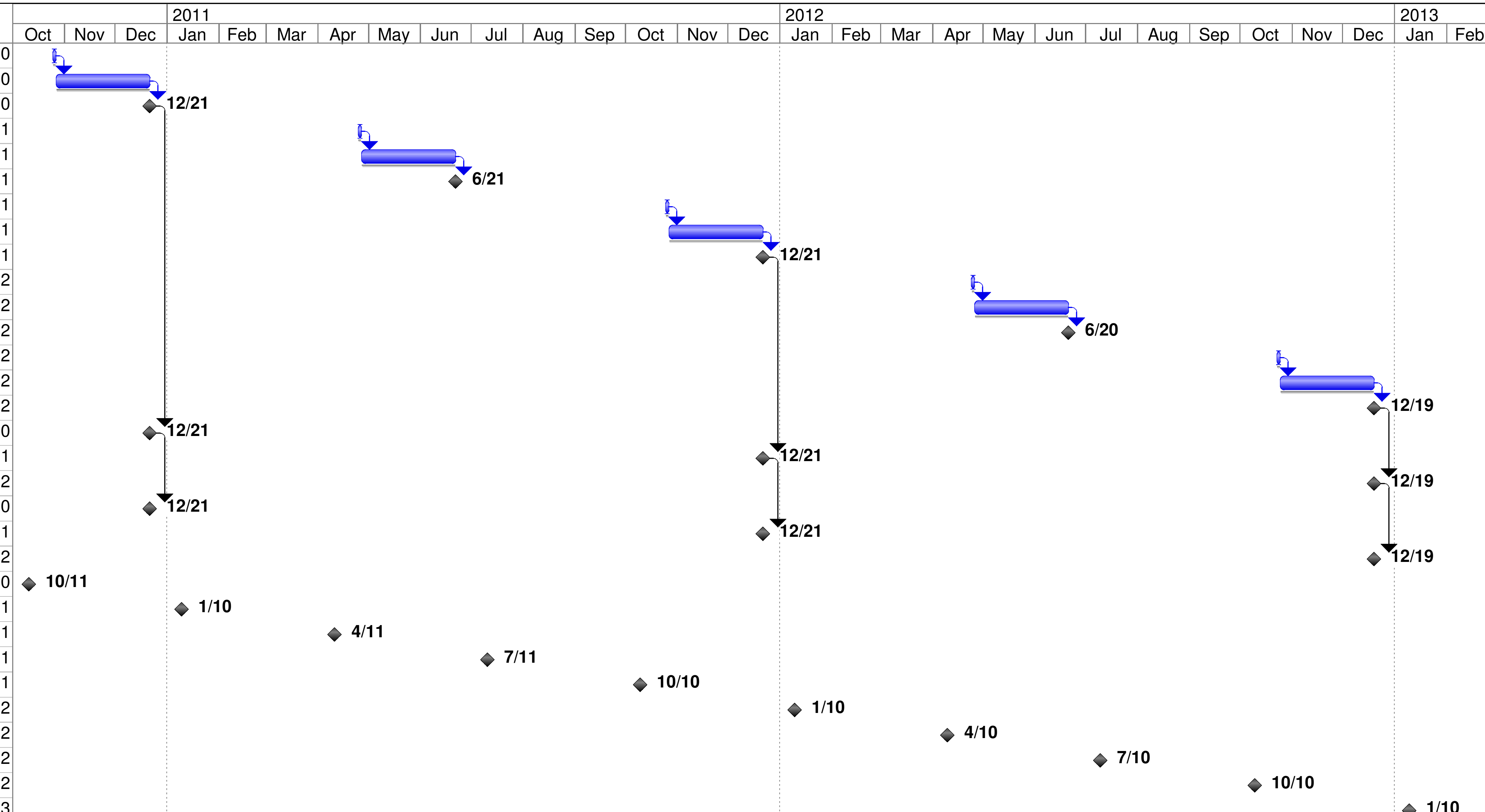
URS

SITE PLAN WITH WELLS

FIGURE 8

FIGURE 9
Site Management Schedule
Former EMCA Site, Mamaroneck NY
NYSDEC Site Number 360025

ID	Task Name	Finish
1	2010 Second Semi-annual Monitoring Event	Tue 10/26/10
2	Laboratory Analysis and Report Preparation	Tue 12/21/10
3	Submit Report to NYSDEC	Tue 12/21/10
4	2011 First Semi-annual Monitoring Event	Tue 4/26/11
5	Laboratory Analysis and Report Preparation	Tue 6/21/11
6	Submit Report to NYSDEC	Tue 6/21/11
7	2011 Second Semi-annual Monitoring Event	Wed 10/26/11
8	Laboratory Analysis and Report Preparation	Wed 12/21/11
9	Submit Report to NYSDEC	Wed 12/21/11
10	2012 First Semi-annual Monitoring Event	Wed 4/25/12
11	Laboratory Analysis and Report Preparation	Wed 6/20/12
12	Submit Report to NYSDEC	Wed 6/20/12
13	2012 Second Semi-annual Monitoring Event	Wed 10/24/12
14	Laboratory Analysis and Report Preparation	Wed 12/19/12
15	Submit Report to NYSDEC	Wed 12/19/12
16	2010 IC/EC Certification to NYSDEC	Tue 12/21/10
17	2011 IC/EC Certification to NYSDEC	Wed 12/21/11
18	2012 IC/EC Certification to NYSDEC	Wed 12/19/12
19	2010 Periodic Review Report to NYSDEC	Tue 12/21/10
20	2011 Peridoic Review Report to NYSDEC	Wed 12/21/11
21	2012 Periodic Review Report to NYSDEC	Wed 12/19/12
22	2010 Q3 Progress Report to NYSDEC	Mon 10/11/10
23	2010 Q4 Progress Report to NYSDEC	Mon 1/10/11
24	2011 Q1 Progress Report to NYSDEC	Mon 4/11/11
25	2011 Q2 Progress Report to NYSDEC	Mon 7/11/11
26	2011 Q3 Progress Report to NYSDEC	Mon 10/10/11
27	2011 Q4 Progress Report to NYSDEC	Tue 1/10/12
28	2012 Q1 Progress Report to NYSDEC	Tue 4/10/12
29	2012 Q2 Progress Report to NYSDEC	Tue 7/10/12
30	2012 Q3 Progress Report to NYSDEC	Wed 10/10/12
31	2012 Q4 Progress Report to NYSDEC	Thu 1/10/13



Project: Site Management Schedule
Date: Mon 8/30/10

Task | Milestone

Appendix A

Well Construction Diagrams

GOLDBERG-ZOINO & ASSOCIATES, INC.
955 CONNECTICUT AVE., BRIDGEPORT, CT
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
U.A. Cablevision
Hauppauge, New York

REPORT OF BORING No. GZ-3
SHEET 1 OF 1
FILE No. H-20152
CHKD. BY

BORING Co. General Borings, Inc.
FOREMAN [illegible]
GZA ENGINEER [illegible]

BORING LOCATION Southwest corner of building
GROUND SURFACE ELEVATION
DATUM
DATE START 2/2/88
DATE END 2/3/88

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

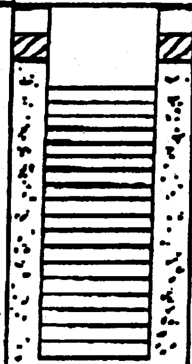
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE:

OTHER:

GROUNDWATER READINGS				
DATE	TIME	WATER	CASING	STABILIZATION TIME
2/5/88		±4'	OUT	0 HRS
2/9/88	11:15	8.38'		4 Days

DEPTH	CASING BLOWS	SAMPLE No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING	REMARKS
						Asphalt - No Sample			HNu	
5		S-1	24/18	5.0-7.0	7/4/6/11	Brown, fine to medium SAND and SILT.	FINE SAND AND SILT		ND	1
10		S-2	24/20	10.0-12.0	24/17/15/26	Brown, fine to medium SAND.	SAND		0.6 ppm	
15		S-3	24/18	13.0-15.0	18/16/16/16	Brown, fine to medium SAND.	±15.0'		0.2 ppm	
							E.O.B.			2
20										
25										
30										
35										
40										



1. Soil samples field screened for volatile organic compounds using an HNu Model PI 101 Photoionization Detector.
ND = Not Detected
2. Equipment Used:
Screen - 10' of 2" 10-slot schedule 40, threaded flush joint PVC. Completed with 6' 2" PVC riser.
Setting - 3' to 13' below grade. Sand ±1' above screen. ±1' Bentonite Seal. Cement seal to grade.
5' protective sleeve ±2' above grade. Capped with Cement seal to grade.

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

S2A

BORING No. GZ-3

GOLDBERG-ZOINO & ASSOCIATES, INC.
955 CONNECTICUT AVE., BRIDGEPORT, CT
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
VA Cablevision
[illegible]

REPORT OF BORING No. GZ-6
SHEET 1 OF 1
FILE No. [illegible]-50195
CHKD. BY

BORING Co. East Coast Drilling
FOREMAN [illegible]
GZA ENGINEER [illegible]

BORING LOCATION Northeast edge of site
GROUND SURFACE ELEVATION [illegible] DATUM [illegible]
DATE START 5/12/88 DATE END 5/12/88

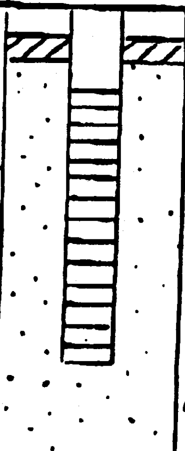
SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER:

GROUNDWATER READINGS

DATE	TIME	WATER	CASING	STABILIZATION TIME
5/2	----	a 5'	OUT	0 hrs.
5/31	----	6.62		19 days

DEPTH	CASING BLOWS	SAMPLE No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING	REMARKS
		S-1	24/18	0-2	7/2/2/3	Brown fine to medium SAND, some organic matter, little silt.	SAND AND SILT		11.7 HNu 3.2 ppm	1
		S-2	24/4	2-4	4/3/2/3	Brown fine to medium Sand, some cobbles, little silt.			3.0 ppm 4.8 ppm	
5		S-3	24/18	4-6	1/1/1/4	Brown fine to medium SAND, trace silt.			14 ppm 8 ppm	
10		S-4	24/20	9-11	4/4/5/3	Brown fine to medium SAND.	SAND		6 ppm 5 ppm	
15		S-5	24/20	13-15	6/6/5/6	Brown fine to medium SAND.	±15' E.O.B.		4.8 ppm 5 ppm	2 3
20										
25										
30										
35										

Soil samples field screened for volatile organic compounds using HNu Model PI 101 11.7 EV Photoionization Detector.
Equipment used: Screen: 10' 2" 10 slot Schedule 40 threaded flush joint PVC. Setting: 3-13' below grade; completed 3' 2" PVC riser; Clean sand backfilled from 13-2' below grade; Bentonite seal placed from 2-1 foot below grade; clean sand placed from 1-1/2 foot below grade. 5' locking steel protective sleeve cemented secure ±2' above grade. 3. Well developed on 5/13/88 using a 1/2-inch trilock hand pump.

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

ZA

BORING No. GZ-6

FIELD BOREHOLE LOG

BOREHOLE NUMBER: MW-01

PROJECT NUMBER: 050035673.00
PROJECT NAME: FORMER EMCA SITE 360025
LOACATION: MAMARONECK, NY
DRILLING CO: ADT
DRILLING METHOD: GEOPROBE: 2" MACRO-CORE
FIELD PARTY: LLOYD/VICTOR
GEOLOGIST: J. VOUGHT
DATE BEGUN: 10/5/99 DATE COMPLETED: 10/5/99

FIELD BOOK NO: —
TOTAL DEPTH: 16.0'
GROUND SURFACE ELEVATION: —

STATIC WATER LEVEL (BLS)

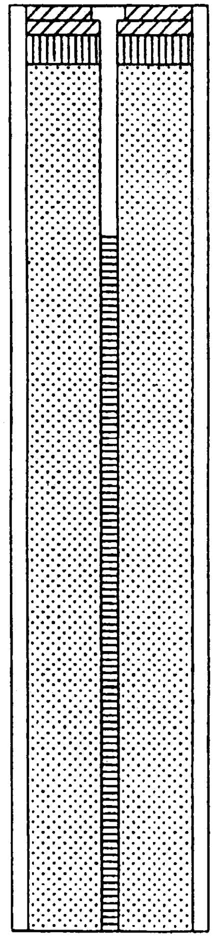
Depth (ft)	6'	

NOTE: Well secured with flushmount casing and locking cap.

DEPTH	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	FID	USCS	% RECOVERY	DESCRIPTION	Well Construct. Details
0.0	4' MAC COR	G-1 0-4'	DRY	7.0 ppm	SM	85	SAND AND SILT: Fine sand, some silt, trace gravel.	Cement/Bentonite; Bentonite; No. 2 Silica sandpack (1' to 16' bgs).
-4.0	4' MAC COR	G-2 4'-8'	MST	8.0 ppm		100	SILT: Silt, some fine sand.	PVC Screen 1" d. 0.010" slot
-5.0					ML			
-6.0			WET					
-7.0					CL		CLAY: Clay, some silt.	
-8.0	4' MAC COR	G-3 8'-12'		10.0 ppm		100		
-9.0					SM		SAND: Fine to coarse sand, trace silt.	
-10.0					SW			
-11.0					SM			
-12.0	4' MAC COR	G-4 12'-16.0'		16.0 ppm	SW	75	SAND: Fine to coarse sand.	
-16.0								

LITHOLOGY

WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER
MW-02

PROJECT NUMBER: 050035673.00
PROJECT NAME: FORMER EMCA SITE 360025
LOACATION: MAMARONECK, NY
DRILLING CO: ADT
DRILLING METHOD: GEOPROBE: 2" MACRO-CORE
FIELD PARTY: LLOYD/VICTOR
GEOLOGIST: J. VOUGHT
DATE BEGUN: 10/5/99 DATE COMPLETED: 10/5/99

FIELD BOOK NO: —
TOTAL DEPTH: 16.0'
GROUND SURFACE ELEVATION: —

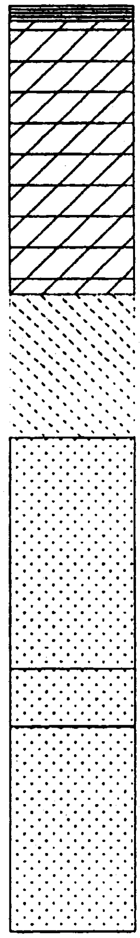
STATIC WATER LEVEL (BLS)

Depth (ft)	6'	

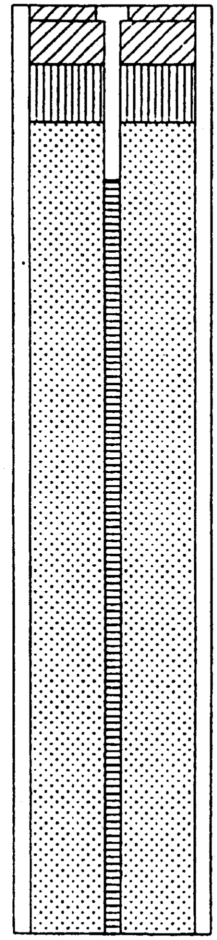
NOTE: Well secured with flushmount casing and locking cap.

DEPTH	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	FID	USCS	% RECOVERY	DESCRIPTION	Well Construct. Details
0.0	4' MAC COR	G-1 0-4'	DRY	10.0 ppm	FILL	58	ASPHALT: First 3" asphalt.	Cement/Bentonite
-1.0							FILL: Brown fill material consisting of fine to medium sand, some silt, trace gravel.	Bentonite Seal
-2.0								No. 2 Silica Sandpack (1' to 16' bgs).
-3.0			MST					PVC Screen (3'-16') 1" diameter 0.010" slot
-4.0	4' MAC COR	G-2 4'-8'		20.0 ppm		100		
-5.0					CL		CLAY: Gray clay, some silt.	
-6.0			WET					
-7.0								
-8.0	4' MAC COR	G-3 8'-12'		50.0 ppm	SP	100	SAND: Gray fine to coarse sand, trace silt.	
-9.0								
-10.0								
-11.0								
-12.0	4' MAC COR	G-4 12'-16'		100.0 ppm	SM	100	SAND: Brown fine to coarse sand, trace silt.	
-13.0							SAND: Gray fine to medium sand, trace to some silt, laminations.	
-14.0								
-15.0								
-16.0								

LITHOLOGY



WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: MW-03

PROJECT NUMBER: 050035673.00
PROJECT NAME: FORMER EMCA SITE 360025
LOACATION: MAMARONECK, NY
DRILLING CO: ADT
DRILLING METHOD: GEOPROBE: 2" MACRO-CORE
FIELD PARTY: LLOYD/VICTOR
GEOLOGIST: J. VOUGHT
DATE BEGUN: 10/5/99 DATE COMPLETED: 10/5/99

FIELD BOOK NO: —
TOTAL DEPTH: 16.0'
GROUND SURFACE ELEVATION: —

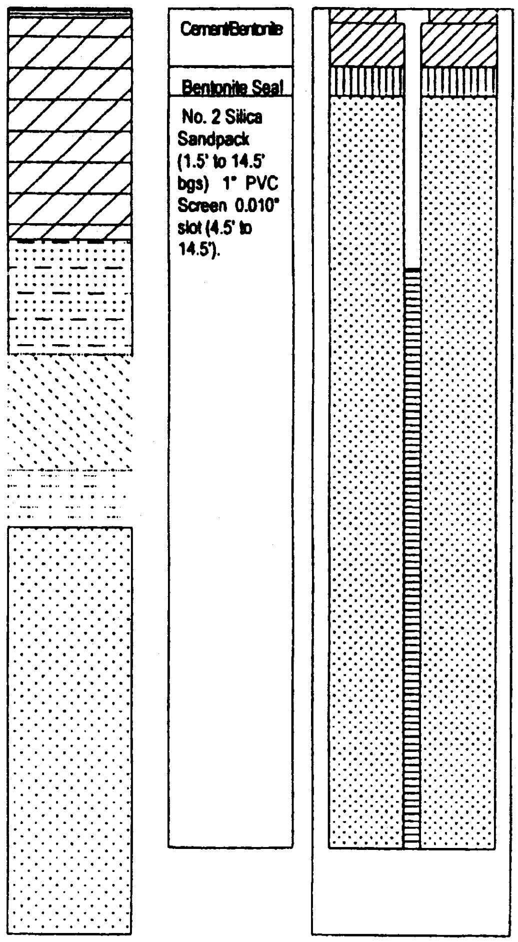
STATIC WATER LEVEL (BLS)

Depth (ft)	6'	

NOTE: Well secured with flushmount casing and locking cap.

DEPTH	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	FID	USCS	% RECOVERY	DESCRIPTION
0.0	4' MAC COR	G-1 0-4'	DRY	7.0 ppm	FILL	83	ASPHALT: First 2" asphalt.
-1.0							FILL: Brown fine to coarse sand, some fine gravel, asphalt and glass, trace cobbles.
-4.0	4' MAC COR	G-2 4'-8'	MST	4.0 ppm	ML	100	SAND AND SILT: Brown silt, trace fine sand.
-6.0			WET		CL		CLAY: Brown clay, some silt.
-8.0	4' MAC COR	G-3 8'-12'		7.0 ppm	ML	88	CLAY AND SILT: Brown silt, some clay.
-9.0					SW		SAND: Brown fine to coarse sand, trace silt.
-12.0	4' MAC COR	G-4 12'-16'		5.0 ppm		100	
-16.0							

LITHOLOGY / Well Construct. Details / WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: MW-04

PROJECT NUMBER: 050035673.00

PROJECT NAME: FORMER EMCA SITE 360025

LOACATION: MAMARONECK, NY

DRILLING CO: ADT

DRILLING METHOD: GEOPROBE: 2" MACRO-CORE

FIELD PARTY: LLOYD/VICTOR

GEOLOGIST: J. VOUGHT

DATE BEGUN: 10/5/99 DATE COMPLETED: 10/5/99

FIELD BOOK NO: —

TOTAL DEPTH: 31.0

GROUND SURFACE ELEVATION: —

STATIC WATER LEVEL (BLS)

Depth (ft)		

NOTE: Well secured with flushmount casing and locking cap.

DEPTH	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	FID	USCS	% RECOVERY	DESCRIPTION	LITHOLOGY	Well Construct. Details	WELL INSTALLATION
0.0	4' MAC COR	G-1 0-4'	DRY	12.0 ppm	FILL	71	ASPHALT: First 3" asphalt.		CementBentonite	
-1.0							FILL: Brown fill material consisting of fine to medium sand, some silt, trace gravel.		Bentonite Seal	
-2.0									No. 2 Silica Sandpack (2' to 14.5' bgs). PVC Screen (4.5'-14.5') 1" diameter 0.010" slot	
-3.0			MST		ML		SILT: Brown silt, some fine sand.			
-4.0	4' MAC COR	G-2 4'-8'		8.0 ppm		100				
-5.0					CL		CLAY AND SILT: Gray silt and clay.			
-6.0			WET		SM		SAND: Fine to coarse sand, trace fine to medium gravel.			
-7.0										
-8.0	4' MAC COR	G-3 8'-12'		3.0 ppm		100				
-9.0										
-10.0					SW					
-11.0										
-12.0	4' MAC COR	G-4 12'-16'		3.0 ppm		100				
-13.0										
-14.0										
-15.0										
-16.0										

FIELD BOREHOLE LOG

BOREHOLE NUMBER: MW-05

PROJECT NUMBER: 050035673.00
PROJECT NAME: FORMER EMCA SITE 360025
LOACATION: MAMARONECK, NY
DRILLING CO: ADT
DRILLING METHOD: GEOPROBE: 2" MACRO-CORE
FIELD PARTY: T. HEBERT
GEOLOGIST: J. VOUGHT
DATE BEGUN: 7/11/00 DATE COMPLETED: 7/11/00

FIELD BOOK NO: —
TOTAL DEPTH: 16
GROUND SURFACE ELEVATION: —

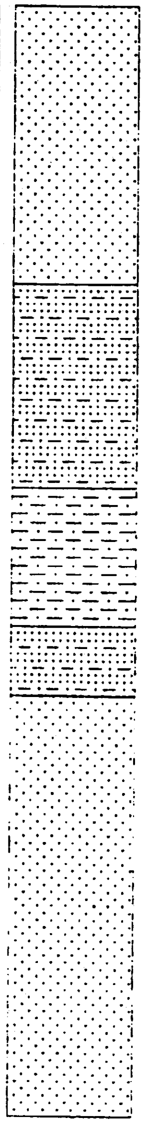
STATIC WATER LEVEL (BLS)

Depth (ft)		

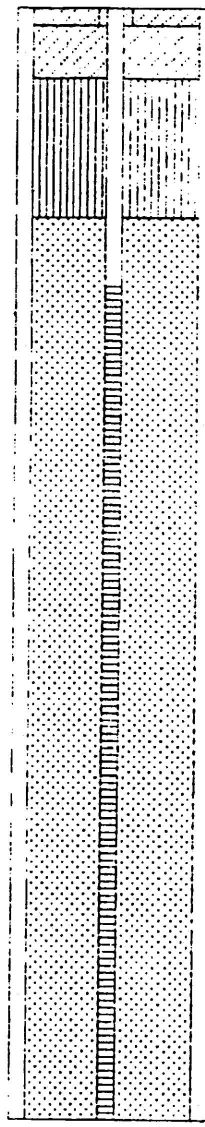
NOTE: Well secured with flushmount casing and locking cap.

DEPTH	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	FID	USCS	% RECOVERY	DESCRIPTION	Well Construct. Details
0.0	Post Hole Digger	NA	DRY	0.0 ppm		NA	SAND: Fine to medium sand, some silt, some fine to course gravel, trace cobbles	GROUTED ANNULUS: Cement/Bentonite
-1.0								BENTONITE: Bentonite Seal
-2.0					FILL			
-3.0								SAND: No. 2 Silica Sandpack (3' to 16' bgs). PVC Screen (4'-16') 1" diameter 0.010" slot
-4.0	4' MAC COR	C-1	MST			90	SAND AND SILT: Fine sand and silt, trace clay	
-5.0					SM			
-6.0								
-7.0			WET		ML		SILT: Silt, some clay	
-8.0	4' MAC COR	C-2				100		
-9.0					SM		SAND AND SILT: Fine to medium sand and silt	
-10.0							SAND: Fine to course sand, trace silt	
-11.0								
-12.0	4' MAC COR	C-3				100		
-13.0								
-14.0								
-15.0								
-16.0								

LITHOLOGY



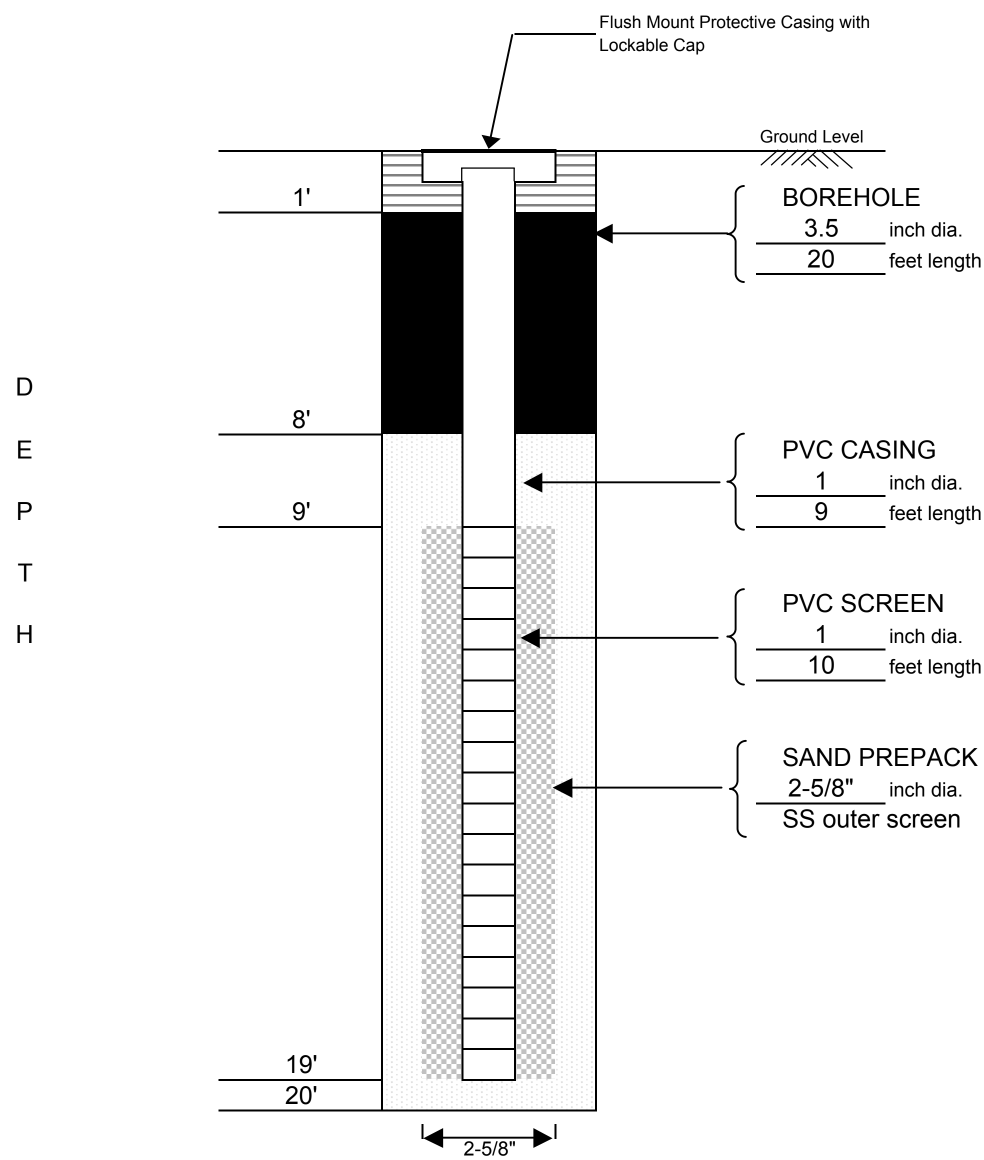
WELL INSTALLATION



DRILLING SUMMARY
Geologist: Steve Moeller
Drilling Company: Zebra Environmental
Driller: L. Caballero
Rig Make/Model: Geoprobe
Date: 6/9/2003

GEOLOGIC LOG

Depth(ft.)	Description
0-0.5	Asphalt
0.5-1	Sand & Gravel subbase
1-4	Sand with gravel over silty-Clay
4-20	Sand, well graded, trace to some gravel



WELL DESIGN

CASING MATERIAL		*SCREEN*	
Surface:	6" dia. Steel flush mount road box	Type:	1" PVC
Monitor:	1" sch. 40 PVC	Slot Size:	

FILTER MATERIAL	
Type: see note 2	Setting: 8' - 20'

SEAL MATERIAL	
Type: Bentonite	Setting: 1' - 8'

NOTES:

(1) CETCO C/S Granular bentonite
(2) 20.30 Silica Sand (Florida) by Standard Sand & Silica Co.

LEGEND

- Concrete
- Bentonite Seal(1)
- Silica Sandpack(2)

Client **Rohm & Haas Company**	**Location: Former EMCA Site**	**Project No.:**	**11172730**
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:**	**MW-06**

N:\11172730.00000\Excel\Well Const (MW06-MW07).xls\MW-6

DRILLING SUMMARY

Geologist: Tim Ifkovich

Drilling Company: Zebra Environmental

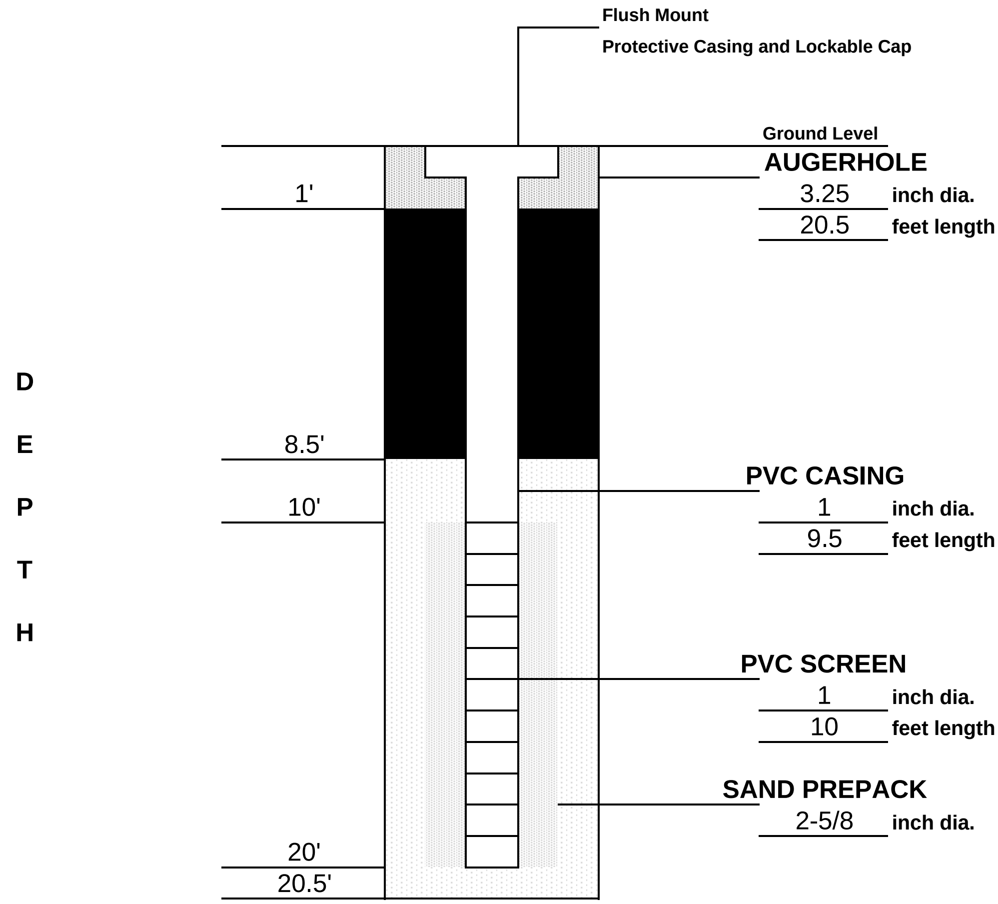
Driller: E. Moraitis

Rig Make/Model: Geoprobe

Date: 9/3/2009

GEOLOGIC LOG

Depth(ft.)	Description
0-0.7	Asphalt & sand, silt, clay subbase.
0.7-1.7	Sand, silt, clay, trace gravel
1.7-4	(f-c) Sand, trace gravel. Loam at approx. 4'
4-12	silty Clay, trace (f) Sand grades to layered (f-m-c) Sand.
12-16	(f) Sand, trace (m-c) sand
16-20	(vf-f) Sand, trace (m) sand



WELL DESIGN

CASING MATERIAL		*SCREEN MATERIAL*		*FILTER MATERIAL*	
Surface:	6" dia. Steel flush mount road box	**Type:**	1" PVC	**Type:** #2 Sand	**Setting:** 8.5' - 20.5'
Monitor:	1" sch. 40 PVC	**Slot Size:**			

SEAL MATERIAL

Type:	**Setting:**
Bentonite	1' - 8.5'

COMMENTS:

MW-07 was destroyed during repaving of the parking lot. MW-07R was installed as a replacement well ~2 feet over from MW-07s original position.

LEGEND

Cement/Bentonite Grout

Bentonite Seal

Silica Sandpack

Client: Rohm & Haas Company	**Location:** Former EMCA Site	**Project No.:**	**11172730**
URS Corporation	**MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:**	**MW-07R**

Appendix B

Rohm and Haas

Protocol for Groundwater Sampling and Analysis

PROTOCOL FOR GROUNDWATER SAMPLING AND ANALYSIS

Rohm and Haas Company

18 November 2000

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TABLES

FIGURES

1.0 Introduction

This protocol provides guidance for implementation of the Corporate Standard for Groundwater Protection, EHSS210.002. It is to be used by Environmental Consultants and Rohm and Haas as a tool to assist in compliance with regulatory groundwater monitoring requirements, and it is the protocol to be used by site personnel who do monitoring tasks to fulfill site obligations under the Corporate Standard for Groundwater Protection.

This protocol outlines procedures and defines equipment for the collection of representative groundwater samples from monitoring wells. The procedures outlined in this protocol are intended to be general in nature, and may not apply in every case. A Site-Specific Work Plan (SSWP) must be developed to meet the data quality objectives for the project. Deviations or modifications to the protocol procedures can be addressed in the SSWP.

Detection limits and selection of appropriate analytical methods are addressed in the development of the Data Quality Objectives in the SSWP. These criteria should be determined by someone experienced in groundwater quality determinations and/or the analytical laboratory.

After collection, the representative samples must be sent to a capable laboratory having either:

A. a "Master Services Agreement" with Rohm and Haas for environmental analyses, or

B. the recommendation of the site Environmental Consultant as having demonstrated a record of performance (recognized laboratory certification) and ability to conduct U.S. EPA equivalent methods.

2.0 Related Standards and Protocol

Additional guidance to assist the design and implementation of comprehensive groundwater sampling and analysis programs at Rohm and Haas facilities is included in the following appendixes to this protocol.

Appendix A: Guideline for Preparation of a Site-Specific Work Plan for Groundwater Sampling and Analysis.
Appendix B: Protocol for Preparation of Health and Safety Plans by Environmental Contractors.
Appendix C: Chart for determining Groundwater Monitoring Frequency
Appendix D: Guideline for Determining Data Quality Objectives

Appendix E: Rohm and Haas Data Reporting Format for Field Sampling Results for Data Base Entry

3.0 Environmental, Health and Safety Considerations

The Protocol for Groundwater Sampling and Analyses must be carried out according to a predetermined Environmental, Health, and Safety (EHS) Plan and/or Health and Safety Plan (HASP).

A. Site personnel must do the work under a specific written site procedure which includes appropriate EHS guidance and instruction.
B. Environmental Contractors must have a site-approved HASP for all field activities. The HASP protocol, which is outlined in Appendix B of this document, defines the considerations that must be addressed, which, in general, include:

  1) Safe work procedures consistent with site safety protocols.
  2) Personal protection equipment (PPE) consistent with assessment of known or potential groundwater contaminants.
  3) Disposal procedures for various media, decontamination rinses, and used PPE.

The HASP must be approved and signed by the contractor's Health and Safety Officer or the equivalent EHS individual, and reviewed with the appropriate Rohm and Haas site and project manager.

The HASP must be provided to all field personnel and reviewed with the project manager prior to beginning work, with emphasis on all safety and environmental protection precautions during the well maintenance and sampling tasks.

4.0 Sampling Equipment

To the extent practicable, groundwater monitoring wells will be sampled using dedicated equipment, such as a dedicated bailer, a pre-cleaned disposable bailer, peristaltic pumps with dedicated down-hole tubing, dedicated submersible pumps, dedicated low-flow bladder pumps, or other suitable sampling equipment acceptable to regulatory agencies. The use of dedicated equipment for groundwater collection will minimize the need for decontamination of sampling equipment between sampling locations and the potential for cross-contamination. Equipment made from inert, non-reactive materials such as Teflon®, stainless steel, or other suitable materials will be used to the extent practicable. The advantages and disadvantages of various groundwater sampling devices are discussed in Table 1.

When non-dedicated bailers are used for sampling, they will be thoroughly cleaned prior to use in each well. The equipment will be washed using the following procedure: 1) start with a solution of a non-phosphate detergent and water, 2) triple rinse with fresh water, 3) rinse with deionized water, 4) finish with a rinse with the appropriate reagent grade decontamination solution (see Table 2) and, 5) air dry. Prior to using a cleaned bailer in the field, it will be rinsed with deionized water. A procedure will be used to ensure that non-dedicated bailers are not reused before cleaning. Bailer cords, made of nylon or other suitable material, will be changed prior to use in each well.

If submersible pumps are used to sample multiple wells, the discharge hoses, pump, and cable should be cleaned prior to initial use and after each pumping well as follows:

1) External surfaces will be brushed free of all loose material, washed with non-phosphate detergent and tap water, and rinsed with clean tap water;

2) Internal surfaces will be cleaned by first placing the pump in a clean container of detergent solution and then a second container of clean tap water and allowing the pump to operate for a period of at least three pump volumes;

3) All rinse water will be collected in suitable containers and transported to an appropriate on-site treatment or disposal facility; and

4) The pump, discharge hose, and cable will be wrapped in new plastic sheeting for transportation and storage.

5.0 Groundwater Sampling

5.1 Project Coordination

Prior to mobilization to the field for the sampling program, project personnel will review the Site-Specific Work Plan to ensure collection of all necessary field data and conformance with the procedures described below. If practical, analytical data from the previous sampling event should be reviewed to identify the order in which wells are to be purged and sampled (i.e., recommend sampling in order of increasing constituent concentration). All necessary equipment will be procured and/or prepared for use. A sample Equipment Checklist of items typically used during groundwater sampling is provided in Table 3.

The project manager should review sampling program objectives and determine detection limits needed for comparison with applicable risk-based criteria, Maximum Contaminant Limits (MCLs), or other standards. The sampling program will be coordinated with the laboratory to ensure that properly prepared sample kits are available and that analytical methods and laboratory procedures will achieve the necessary detection limits. The sample kits will include all necessary sample containers with closures and appropriate preservatives; wet ice coolers; indelible water-proof labels; and chain-of-custody/analysis request forms.

Documentation of sampling events will be written in ink and maintained as a permanent record. Field notes will be written in a bound field notebook, with pages numbered sequentially, appropriately dated, and signed. In addition, water-level measurements, well purging records, and documentation of on-site testing of groundwater during sampling can be recorded on standardized forms designed to meet the needs of the facility and subsequent data management needs. These forms can be developed by the facility and included in the SSWP. Samples of representative forms, are presented on Figures 1 and 2 and include:

1) Groundwater Monitoring Sampling Record
2) Chain of Custody Record

Information to be recorded during the sampling event includes: identification of sampling personnel, identification of wells measured/sampled, dates and times of measurement/sample collection, weather conditions, results of static water level measurements; deficiencies in the physical condition of wells noted during well inspections; purging/sampling methods and volumes; results of field water quality measurements; volume of sample collected; analyses to be performed; container type; and sample preservatives.

At all monitoring wells at a site, the presence or absence of non-aqueous phase liquids (NAPLs) will be determined and noted on a static water level survey form (see Figure 3 for example form). Equipment for measuring NAPL thickness is listed in Section 5.2.1.

Generally, NAPLs are suspected to be potentially present if dissolved concentrations in the groundwater exceed 1% of the solubility of the pure constituent. If mobile NAPLs are present, they are commonly discovered during development of a well or during the first few sampling events, when phase-separated fluids are observed in the bailer or a sheen is noticed on groundwater removed from the well. Wells with a measurable thickness of NAPL or with a distinctive sheen in discharge water are generally not sampled for dissolved constituents because: 1) the presence of NAPL confirms that groundwater at the monitoring well is affected, and 2) results of analysis of dissolved-phase constituents are frequently non-representative because of mixing of NAPL with the groundwater during sampling.

5.2 Sampling Procedures

Unless otherwise specified in the SSWP, sampling will be performed by a team of two or more persons with experience in environmental sampling. The senior member of the team will be responsible for complete documentation of sampling. Prior to beginning sampling activities, clean plastic sheeting will be spread on the ground at the well. Each groundwater sampling episode will include the sequence of tasks outlined below.

5.2.1 Static Water Level Survey

Prior to well purging and sample collection, static water levels will be measured with an electronic water level indicator or other suitable device in all designated wells during each sampling episode. Between wells, the static water level measuring probe and line that contacted the well will be: 1) wiped with a paper towel soaked with methanol or rinsed with a wash bottle, 2) rinsed with deionized water, and 3) air dried. An example of a form used to record static water levels is shown in Figure 3.

Any wells in which evidence of non-aqueous phase liquids (NAPLs) is, or previously has been detected will be sounded using an electronic interface probe, transparent bailer, weighted string, or other suitable device to permit measurement of the thickness of any NAPL accumulation.

5.2.2 Well Integrity Inspection

All monitoring wells installations will be completed with a protective casing and locking cap. Wells will be unlocked prior to initiating sampling procedures and re-locked when sampling is completed and at any time the sampling team leaves the area.

Wells will be inspected as required by regulatory permit or site policy to confirm well integrity and identify needed repairs. Well inspections should note any observed deficiencies in the condition of the well casing, cap/protective cover, surface pad/guard posts, and dedicated sampling equipment, if applicable. Any deficiencies will be noted in the field records and brought to the attention of Rohm and Haas upon completion of each sampling event. Annually, wells will be sounded to total depth to detect the presence of silt accumulation at the base of the well or other obstruction.

5.2.3 Well Purging

Purging Equipment and Methods: Wells to be sampled will be purged by pumping or bailing prior to sample collection. Acceptable pumps include pneumatic pumps, inertial, electric submersible, peristaltic, diaphragm, and centrifugal pumps. When non-dedicated bailers or pumps are used for purging, they will be thoroughly cleaned prior to use in each well, consistent with the cleaning procedures outlined in Section 4.0.

Purge Volumes: Prior to purging, the static water level of the well will be measured to the nearest 0.01 foot using a clean water-level indicator. The total depth of the well can be obtained from facility records or measured, if not available. The height of the water column (i.e., total well depth - depth to water) will be used to determine the well casing storage and the minimum required purge volumes. A well casing volume is defined as the height of the water column times gallons per foot (gpf) stored in the well casing (0.16 gpf for 2-inch diameter casing, and 0.65 gpf for 4-inch diameter casing), and can be calculated as follows:

$$\text{Casing Volume} = [\pi\ (\text{well radius, ft})^2 (\text{water column height, ft})] * (7.4805\ \text{gal/ ft}^3) = \text{gallons}$$

Substituting values to calculate the volume of a one-foot length of two-inch diameter well casing:

$$\text{Casing Volume} =[\ 3.14159\ (\text{2-inch}/2 * 1\ \text{ft}/12\ \text{inches})^2 (1\ \text{ft})]\ (7.4805\ \text{gal/ ft}^3) = 0.16\ \text{gallons}$$

Wells will be considered purged when the following two criteria are satisfied: 1) a minimum of three casing volumes of fluid are removed and the parameters have stabilized as specified in the SSWP, or 2) the well is effectively dried out by the removal of less than three casing volumes. Wells which dry out prior to removal of three casing volumes may be sampled when recharge produces enough water to yield the required sample volumes.

Management of Purge Water: All purge water will be collected in suitable containers and disposed as specified in the SSWP.

5.2.4 Low-Flow Sampling

In some instances, low-flow groundwater sampling (aka Micro-Purging), may be an appropriate sampling method for collection of groundwater samples. Using this method, low pumping rates are used to sample groundwater directly from the screened interval without mixing of stagnant water from above the screened interval during the sampling process. In addition, less turbidity is produced with lower pumping rates, usually allowing samples analyzed for total metals to be collected without filtering, in accordance with EPA protocol.

The method usually requires dedicated sampling pumps (typically bladder-type pumps with a control box to regulate flow rates) and is usually employed for long-term monitoring programs. If non-dedicated equipment is used, a 24-hour wait after installation of the pump is recommended before sampling. In addition, wells must have sufficient yield to be pumped without creating excessive drawdown to avoid sampling the stagnant water column.

Sampling equipment and advantages and disadvantages of the method are described in Table 1. A description of low-flow sampling procedures is contained in "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures" by Robert W. Puls and Michael Barcelona (EPA/540/S-95/504, April, 1996). Basic elements of low-flow sampling are summarized below:

1) Set pump in the middle of the screened interval and pump at a rate of 0.5 to 0.1 liters per minute. The purging rate should equal the sampling rate.
2) Do not exceed a rate of 0.25 liters per minute when sampling for volatiles.
3) Monitor water levels during purging and sampling at least once every 3 to 5 minutes. Drawdown must stabilize and not exceed 0.1 M (0.32 ft).
4) Monitor stabilization parameters with a flow-through cell with consecutive readings taken 3 to 5 minutes apart. Based on experience, wells typically stabilize after 2 to 3 liters of groundwater have been removed. Guidance indicates stabilization is achieved when:

    - Specific Conductance ± 3%
    - pH ± 0.2 S.U.
    - Dissolved Oxygen ± 10%
    - Redox Potential ± 10 mv
    - Turbidity ± 10%

5) Document all purge times, volumes, water level and parameter measurements.

The contractor should check to see if state or local guidance exists for low-flow purging and sampling that supersedes EPA guidance.

5.2.5 Groundwater Sample Collection

Sampling Order of Wells and Timing of Sample Collection: To the extent practical, well locations will be sampled in order of increasing groundwater constituent concentrations in order to minimize potential for cross-contamination. The suggested parameter bottle filling order is: volatiles, semi-volatiles, pesticides/herbicides, total organic halogens, inorganics, and metals.

Sampling should be conducted as soon as practicable following purging, preferably within a few hours and on the same day. In the event that a well has been purged, but can not be sampled on the same day (e.g., if sampling activities are curtailed after purging, but before sample collection, by weather or other unavoidable disruptions) the well can be sampled up to 24 hours following completion of purging without further purging.

Filtering of Samples: According to EPA protocol, groundwater samples collected for analyses of total metals should not be filtered prior to preservation by acidification. In some instances, turbidity present in collected groundwater can result in acidification of suspended sediments and anomalously high values for total metals. If necessary, additional samples can be collected and filtered prior to preservation to evaluate the effect of sample turbidity on total metals concentrations. To best approximate total metals concentrations in a filtered sample, filtering should be performed with an in-line 0.45 micron filter using a peristaltic pump or other type of sampling pump and clean silicon or other appropriate tubing. If the sample is collected by bailer, the sample is placed in a single, clean container large enough for all the filtered sample volume. Filter the sample directly from the container to the laboratory prepared bottles using a peristaltic pump with an in-line 0.45 micron filter. Filtration of the sample should be done immediately if total metals are to be analyzed. Because field conditions and sampling program objectives vary between Rohm and Haas sites, protocol for sample filtering will be addressed in Site Specific Work Plans, as appropriate.

Groundwater Sample Handling: Groundwater samples will be collected and handled to minimize the potential for cross-contamination, loss of volatile constituents, or other interference. Sampling personnel will wear clean latex, nitrile or other chemical resistant, non-reactive gloves when handling sampling equipment and containers, and will minimize contact with the sampled groundwater. Care will be taken to prevent contact of the bailer, cord, or other down-hole equipment with the ground or other potential sources of sample contamination. Gloves will be changed between sampling locations.

Groundwater samples will be collected using pumps at low flow rates (i.e. <0.3 gpm). When bailers are used, they will be lowered slowly into the well and decanted carefully to minimize agitation. Samples for analysis of volatile compounds will not be collected using peristaltic or other pumps which can aerate the samples. Samples requiring filtration will be filtered in the field with a new disposable filter, or filtered in the laboratory, as appropriate.

Sample jars will be packed in bubble wrap (or other suitable material) to prevent breakage, and retained in wet ice coolers pending transport to the laboratory with adequate ice to maintain samples at a temperature of approximately 4°C until received by laboratory. Coolers that are to be shipped by Federal Express (or an equivalent carrier) or shipped by air will not be accepted by the carrier if they are leaking fluid; therefore, ice must be packed in leak-proof bags or cool packs used to prevent leakage of fluids from the coolers. Purge volume information, field parameter test results, and other sample information will be recorded in the field sample form (see Figure 1 for an example).

Special Considerations for Volatile Organic Compound Sampling: The proper collection of samples for dissolved VOCs requires minimal disturbance of the sample to limit volatilization and subsequent loss of volatiles from the sample. Sample retrieval systems suitable for the valid collection of volatile organic samples include: 1) positive-displacement bladder pumps, 2) gear-driven submersible pumps, 3) inertial (tubing and check valve pumps), 4) syringe samplers, 5) bailers, and 6) Kabis Sampler®.The principal objective is to provide a valid sample for analysis that has been subjected to a minimal amount of turbulence. The following procedures should be followed when collecting VOA samples:

1) Open the vial, set the cap in a clean place, and place the proper amount of preservative (HCL) in the vial or use vials with preservative already added by the laboratory.
2) Fill the vial to the top until a convex meniscus forms on the top of the vial. Do not overfill the vial.
3) Check that the cap has not been contaminated and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not over-tighten and break the cap.
4) Invert the vial and tap gently. If an air bubble appears, remove the lid, add water from the well to top off the sample, and close again. It is important that no entrapped air remains in the sample vial.
5) Place collected samples in the cooler immediately upon collection and ensure that the samples remain at 4°C but do not allow them to freeze.
6) Group VOA samples of similar concentration in common coolers and laboratory sample batches for reduced likelihood of cross contamination during transport and laboratory analysis. It is

recommended that samples be shipped or delivered to the laboratory daily. The holding time for preserved VOC samples, under most protocols, is 14 days.

On-Site Testing of Temperature, Specific Conductance, and pH: For specified projects (as identified in the SSWP) a sample of groundwater will be collected for immediate analysis of temperature, specific conductance, and pH at the well site. The calibration of the specific conductance meter will be checked using a standard solution at a minimum prior to each sampling episode to verify its accuracy. Specific conductance meters out of calibration by 10% or more will not be used. The pH meter will be calibrated as required based on the type of meter that is used in accordance with the manufacturer's recommendations. A two point calibration is recommended with a third buffer value approximately midpoint used as a check between the two calibration buffers. Buffer values should be chosen to fit the range of expected groundwater pH. Laboratory measurements of specific conductance and/or pH made within one hour of sample collection may augment field measurements, in the event of field instrument malfunction or other factors.

Sample Containers, Preservatives, and Labels: Samples will be collected in clean, method-specified containers, with appropriate preservatives. Sample containers and preservatives will be supplied by the analytical laboratory. Appropriate sample containers and preservatives for common analyses are specified on Table 4. Pending use, the sample containers will be stored with lids secured in a clean cooler or box.

Once a sample has been collected, the sample container lid will be secured and a water-proof adhesive label affixed. The label will be filled out in accordance with the requirements listed on the CRG Website under the heading Naming and Labeling Conventions and will include at a minimun the Sample Code, time and date of collection, and sampler's initials. The samples will be retained in a cooler as described above pending transport to the laboratory.

Sample Custody Control and Shipment and Receipt of Samples: Sampling personnel will be responsible for the care of collected samples until the containers have been transferred to the custody of the laboratory or courier, preferably no more than 24 hours after collection. Sampling personnel will assure that the collected samples are in the sampler's physical possession, in view at all times, or stored in a secure area to prevent tampering.

After sample collection, the chain-of-custody/analysis request forms will be filled out in ink in legible handwriting and will accompany the samples throughout all phases of shipment and handling. Figure 2 presents an example of a chain-of-custody/analysis request form. The chain of custody

Form must bear a unique Identification Code and include a list of the Sample Codes of the samples collected, the collection time and date, the analyses requested and method number, the container type and size, and the preservative. The sample cooler will be sealed with a custody seal to ensure integrity, The custody seal will be affixed to the cooler such that the cooler can not be opened without breaking the seal. The labeling conventions for the Samples, the Chain of Custody, and the Cooler ID are provided on the CRG Website under the heading of Naming and Labeling Conventions.

Upon delivery of samples to the laboratory or courier, the sampler will retain a copy of the chain-of-custody/laboratory request form, signed by the sampler and laboratory personnel indicating the date and time the sample was relinquished and received. A copy of the chain-of-custody form showing all signatures from the sampler to the laboratory will be incorporated in the permanent project record.

6.0 Field Quality Assurance and Control

Field QA/QC procedures include the collection of additional samples to measure the effectiveness of the sampling procedures. The following types of QA/QC samples shall be incorporated into a SSWP.

Trip Blank: Trip blanks for VOA's will be prepared by the laboratory. One VOA vial per sample shipping container or cooler will be filled with Type II reagent-grade water, transported to the site with the empty sample bottles, carried with the sample bottles during all sampling activities, and returned to the laboratory for analysis. Contaminants found in the trip blank can be attributed to interaction between the sample and the container, possible contamination due to diffusion of constituents through the septa, or contamination introduced by the laboratory. At a minimum, one trip blank will be analyzed per sampling event and should not be shipped back to the laboratory until the last shipment of samples is sent. Preferably, one Trip Blank will be included with each shipment of a multi-shipment sampling event.

Field Blank: A field blank consists of a VOA vial filled with organic-free water, including necessary preservative, or a set of bottles for all parameters to be analyzed, depending on the data quality objectives specified by the SSWP. The field blank bottle(s) are set out with the bottle caps off near the well most downwind of the sample area in accordance with the ambient wind direction. Contaminants found in the field blank can be attributed to the ambient conditions in the vicinity of the sample location. A field blank should be collected during each sampling event where ambient conditions could influence parameter concentration. Frequency will be one per day of sampling.

Equipment Blank: An equipment blank consists of a bottle set, including necessary preservatives, that is filled with deionized water rinsate from the decontaminated equipment used for sampling (i.e., rinse water will be poured from a bailer, or water will be pumped through a pump and tubing). Contaminants found in the equipment blank can be attributed to leaching from the sample tubing or equipment or to incomplete decontamination of the sample equipment. An equipment blank is collected during sampling events for each sampling matrix, at a frequency of one per day of sampling or one every twenty samples, which ever is the higher frequency. This must be performed only when non-dedicated equipment is used.

Duplicate Sample: A field duplicate sample consists of a bottle set, including necessary preservatives, that is filled from one of the sampled wells and assigned a sample identification as described on the CRG Website in the section on Naming and Labeling Conventions. The well number that corresponds to the duplicate sample will be recorded in field documentation, but not divulged to the analytical laboratory. A field duplicate sample must be collected for every twenty field samples or once per day of sampling which ever is more frequent to meet EPA field sampling QC requirements. The duplicate sample provides a measure of precision, or reproducibility of the sample result. Precision, as a relative percent deviation (RPD), will be calculated according to the following equation:

$$RPD\% = \frac{(R1-R2)}{(R1+R2)(0.5)} * 100\%$$

Matrix Spike: For each matrix sampled and sampling batch (every 20 samples), enough sample needs to be collected from one location so as to allow the laboratory to prepare one matrix spike and one matrix spike duplicate for each analytical method employed. Check with the laboratory for any extra volume required.

Control Sample: A control sample contains a known concentration of a sample parameter and can be purchased from a laboratory supply house or prepared internally, as appropriate. The concentration of a control sample should be in the range anticipated in the facility groundwater so that its concentration is above the method detection limit but does not exceed the calibration limits used to perform the analyses of facility groundwater. The control blank provides a measure of the accuracy of the laboratory results. The frequency and types of control samples will be specified in the SSWP.

The results of analyses of trip blanks, field blanks, and equipment blanks can be used to evaluate sampling procedures and identify external sources of contamination that may influence analytical results. Acceptance criteria for precision of analyses of duplicate samples will be determined by the facility and included in the SSWP. Acceptable accuracy for control samples is method dependent and also subject to the performance acceptance criteria of the particular laboratory that is used. General method performance guidelines can be reviewed in the QC portion of each of the applicable EPA SW-846 series methods. If controls are to be used for a sampling event or as part of a long-term monitoring program, acceptance criteria will be established by Rohm and Haas and communicated to the laboratory prior to a sampling event(s).

TABLE 1

ADVANTAGES AND DISADVANTAGES OF VARIOUS GROUNDWATER SAMPLING EQUIPMENT

Protocol for Groundwater Sampling and Analysis

Rohm and Haas Company

Conventional Purge and Sampling Equipment		
Equipment	**Advantages**	**Disadvantages**
Bailer	* Widely acceptable. * No power needed. * Portable and easy to use. * Inexpensive; it can be dedicated to a well reducing the chances of cross-contamination. * Minimum outgassing of volatiles while sample is in bailer. * Readily available. * Effective for removing small volumes of purge water.	*Time consuming, especially for large-diameter wells and great depth to water. *Transfer fo sample may cause aeration.
Kabis Sampler ™	* No power needed. * No purging of well required. * Minimum outgassing of volatiles or disturbance of water column within well screen. * Can sample discrete depth of an aquifer within screened interval. * Rapid sampling - reduced labor costs. * No purge water to manage/dispose. * Total cost less than alternative methods.	* New technology. * Recently gaining acceptance. * Sample volume is limited, can repeat sample for additional volume. * Capital cost is greater than bailer & pumps.
Submersible Pump	* Portable; can be used in an unlimited number of wells. * Can achieve relatively high pumping rates. * Generally reliable, does not require priming, and useful deptl is not limited by maximum suction lift. * Can be used to sample from depths greater than 10.	* Potential effects on analysis of trace organics. * Heavy and cumbersome. * Expensive. * Susceptible to damage from silt or sediment. * Impractical on low-yielding shallow wells.
Non-Gas Contact Bladder Pump (pneumatic)	* Maintains integrity of sample. * Easy to use.	* Difficult to clean if not used as a dedicated pump. * Useful to max. depth of 100 ft. * Requires instrument-grade gas supply. * Expensive.
Suction Pumps (diaphragm, peristaltic, and centrifugal)	* Portable, inexpensive, and readily available	* Useful to maximum depth of 25 ft. * Vacuum can cause loss of volatile organic constituents. * Pump must be primed and vacuum is often difficult to maintain. * Aeration of discharge stream may cause pH modification
Inertial Pumps (foot valve and tubing)	* Waterra-type pump is inexpensive and readily available * Rapid method for purging relatively shallow wells * Inexpensive dedicated pump.	* Useful to max. depth of 70 ft. * May be time consuming and is labor intensive. * Waterra pump is most effective in 2-inch diameter wells.

Low Flow (Minimal Drawdown) Groundwater Sampling		
Equipment	**Advantages of Low Flow Sampling**	**Disadvantages of Low Flow Sampling**
* Dedicated Bladder Pump * Bladder Pump Control Box * Water Level Measuring Device * In-Line Flow Analyzer	* Increases sampling consistency. * Lower turbidity may eliminate the need for filtration. * Reduced purging time. * Much less purge water to handle. * Avoids decontamination of non-dedicated equipment. * Do not need equipment blanks.	* Does not work for very low-yielding wells. * Higher initial cost. * Training required. * Bladder pumps require gas supply to operate.

TABLE 2

DECONTAMINATION SOLUTIONS

Protocol for Groundwater Sampling and Analysis

Rohm and Haas Company

Type of Hazard	Name of Solution	Remarks
Amphoteric-acids and bases	Sodium bicarbonate	5-15% aqueous solution
Inorganic acids, metal processing wastes, heavy metals	Sodium carbonate	Good water softener, 10-20% aqueous solution
Solvents and organic compounds, oily, greasy unspecified wastes	Trisodium phosphate	Good rinsing solution of detergent, 10% aqueous solution
Pesticides, fungicides, cyanides, ammonia, and other non-acidic inorganic wastes	Calcium hypochlorite	Excellent disinfectant, bleaching and oxidizing agent, 10% aqueous solution
Other Types of Decontamination Solutions		
Other Detergents and Aqueous Surfactants Phosphate-free laboratory detergent (Alconox, Liquinox), Pennsalt 91, Oakite, Gunk, Clorox		
Solvents 1,1,2-Trichloroethane, bis-2-ethyl-hexyl acetate, pesticide-grade isopropanol/acetone/methanol/hexane, heptane (nonhydrogen bonding), alcohol, naphtha, beta-propiolactone, carbon tetrachloride, 8% formalinethylene, 8% hexachloromelamine, 1, 2-dichloroethane (in solution), Quadcoat		
Other Solutions 10% nitric acid, 0.1 N/10%/20% hydrochloric acid		
Water Potable/tap water (demonstrated to be analyte-free), distilled water, deionized water, reagent-grade distilled and deionized water		

Source: Adapted from Devinny *et al.* 1990; Mickam *et al.* 1989

Location (Unit/Area): ____________________

Table 3

Sampling Date(s): ______________

Groundwater Sampling Event Checklist

PRE-SAMPLING DAY CHECKLIST

TWO WEEKS BEFORE:

- [ ] Order standards for control samples
- [ ] Notify the government agencies prior to scheduled sampling, if required

ONE WEEK BEFORE:

- [ ] Fill out sampling event information form
- [ ] Prepare Chain of Custody Form
- [ ] Fill out lab bottle request form & order bottles
- [ ] Print bottle labels and prepare bottles for Control samples as needed
- [ ] Fill out data management checklist
- [ ] Create event in the computer Data Management System
- [ ] Generate Field Sampling Record and fill in event information
- [ ] Check sampling supplies
- [ ] Schedule manpower to conduct sampling

DAY BEFORE:

- [ ] Review Work Plan
- [ ] Check in bottle order
- [ ] Charge batteries for in-well pumps, if needed
- [ ] Print sample labels for wells, blanks, etc. and submit paperwork to sampling team

COMMENTS:

FORMS AND LABELS

- [ ] Site map with well locations indicated
- [ ] Chain of Custody Form
- [ ] Field Sampling Form
- [ ] Labels
- [ ] Depth to Water Measurement Form
- [ ]

SAMPLING DAY EQUIPMENT CHECKLIST

- [ ] pH buffers
- [ ] Conductivity Standard
- [ ] pH meter, calibrated
- [ ] Conductivity meter, calibration checked
- [ ] Extra batteries for meters
- [ ] Water level indicator, battery checked
- [ ] Watch with second hand or stop watch (to measure pump flow)
- [ ] Groundwater sampling equipment
- [ ] Coolers with sample bottles and preservatives
- [ ] Cooler with Trip Blank from contract lab, labeled
- [ ] Thermometers, one for each cooler
- [ ] Disposable cups
- [ ] Paper towels
- [ ] Liter/Quart containers with lids
- [ ] New plastic sheeting
- [ ] Disposable gloves, latex
- [ ] Disposable gloves, rubber
- [ ] Tape/dispenser, pens, markers
- [ ] Personal Protection Equipment
- [ ] Hand calculator
- [ ] Tool Box
- [ ] New Trash bags
- [ ] First aid equipment
- [ ] Well pump controller boxes (as needed)
- [ ] Well padlocks (in case of replacement needed)
- [ ] Field Blank filled with Deionized Water, labeled
- [ ] Appropriate solvent for decontamination of equipment
- [ ] Deionized water
- [ ] Squeeze bottles filled with decontamination solvent and deionized water
- [ ] Buckets marked in measurement increments (for bailing & measuring purge water)
- [ ] Appropriate tubing as needed for wells with dedicated pumps
- [ ] Drums and/or other containers for purge water
- [ ] Large plastic funnels for purge water containers, as needed
- [ ] Ice
- [ ] Well keys
- [ ] Work Plan
- [ ] Health and Safety Plan (HASP)

Table 4

Sample Handling Guide

For Laboratory Analysis

Parameter	Suggested Sample Amount (Water/Liquids) *Mililiters*	(Solids/Soil) *Grams*	Container Type *Bottle/Cap*	Preservative *Water*	*Solid*	Holding Time Days[1] *Water*	*Solid*
Inorganic and Miscellaneous Parameters							
Ammonia-Nitrogen (NH_3-N)	2000	50	Plastic or Glass/Plastic	H_2SO_4, 4°C	4°C	28	28 [2]
Biochemical Oxygen Demand (BOD)	1000	NA	Plastic or Glass/Plastic	4°C	4°C	2	NA
Chemical Oxygen Demand (COD)	50	NA	Plastic or Glass/Plastic	H_2SO_4, 4°C	4°C	28	NA
Chloride, Total	100	50	Plastic or Glass/Plastic	4°C	4°C	28	28/28[2]
Chlorine, Residual	100	NA	Plastic or Glass/Plastic	4°C	NA	Onsite	NA
Chromium, Hexavalent	100	400	Plastic/Plastic	4°C	4°C	1	30/4[1]
Coliform Bacteria	125	NA	Sterile Plastic	4°C	NA	1	NA
Corrositivity by pH	100	50	Plastic or Glass/Plastic	4°C	4°C	1	14 [2]
Corrositivity to Steel(Organic Liquids)	1000	NA	Plastic or Glass/Plastic	4°C	NA	NA	NA
Cyanide, Total and Amenable	250	50	Plastic or Glass/Plastic	NaOH, 4°C	4°C	14	14
Fluoride	150	50	Plastic or Glass/Plastic	4°C	4°C	28	28/28[2]
Halogens, Total Organic (TOX)	300	50	Amber Glass/Teflon	H_2SO_4, 4°C	4°C	28	28
Ignitability (Flashpoint)	500	500	Glass/Teflon	4°C	4°C	14	14 [2]
Mercury	300	50	Plastic or Glass/Plastic	HNO_3	4°C	28	28
Metals (except Hex Chromium and Mercury)	200	50	Plastic or Glass/Plastic	HNO_3	None	180	180
Metals, TCLP	500	200	Glass/Teflon	4°C	4°C	180/180[2,5]	180/180[2,5]
Nitrate/Nitrite	100	50	Plastic or Glass/Plastic	H_2SO_4, 4°C	4°C	28	28/28[2]
Nitrite	100	NA	Plastic or Glass/Plastic	4°C	NA	2	NA
Nitrogen, Total Kjedahl (TKN)	500	30	Plastic or Glass/Plastic	H_2SO_4, 4°C	4°C	28	28
Oil and Grease	1000	100	Glass/Plastic	H_2SO_4, 4°C	4°C	28	28
Organic Carbon, Total (TOC)	100	50	Plastic or Glass/Plastic	H_2SO_4, 4°C	4°C	28	28
pH	100	50	Plastic or Glass/Plastic	4°C	4°C	Onsite	14 [2]
Phenols	2000	50	Plastic or Glass/Plastic	H_2SO_4, 4°C	4°C	28	28 [2]
Phosphorus, Orthophosphate	200	50	Plastic or Glass/Plastic	4°C	4°C	2	14/2 [2]
Phosphorus, Total	200	50	Plastic or Glass/Plastic	H_2SO_4, 4°C	4°C	28	28 [2]
Reactivity (Cyanide/Sulfide)	50	50	Glass/Teflon	4°C	4°C	14	14 [2]
Solids	400	50	Plastic or Glass/Plastic	4°C	4°C	7	14 [2]
Specific Conductance	100	50	Plastic or Glass/Plastic	4°C	4°C	28	28 [2]
Sulfate	200	50	Plastic or Glass/Plastic	4°C	4°C	28	28 [2]
Sulfide	100	50	Plastic or Glass/Plastic	Zinc Acetate, 4°C	4°C	7	7
Sulfite	500	NA	Plastic or Glass/Plastic	EDTA, 4°C	NA	Onsite	NA
Surfactants	1000	NA	Plastic or Glass/Plastic	4°C	NA	2	NA
Organic Parameters							
Dioxins/Furans	2000	200	Amber Glass/Teflon	4°C	4°C	30	30
Herbicides	4000	200	Amber Glass/Teflon	4°C[3]	4°C	7/40	14/40
PCBs			Amber Glass/Teflon	4°C[3]	4°C	7/40	14/40
Pesticides			Amber Glass/Teflon	4°C[3]	4°C	7/40	14/40
Petroleum Hydrocarbons, Total (TPH)	120 (VOA[4])	50	Glass/Plastic	HCL, 4°C	4°C	14	14
Semivolatiles	4000	200	Amber Glass/Teflon	4°C[3]	4°C	7/40	14/40
Semivolatiles, TCLP	4000	200	Amber Glass/Teflon	4°C	4°C	14/7/40[6]	14/7/40[6]
Volatiles	120 (VOA[4])	100	Glass/Teflon	HCL, 4°C[3]	4°C	14	14
Volatiles, TCLP	120 (VOA[4])	100	Glass/Teflon	4°C	4°C	14/14	14/14

Footnotes:
1. When two values are given, the first is extraction holding time followed by the analysis holding time.
2. Denotes a lab holding time. Regulatory specification is either "As Soon As Possible" or not given.
3. Sodium Thiosulfate (NaS2O3) is added if samples contain residual chlorine.
4. VOA is a 40 ml glass vial with a teflon lined septa which should be filled with no headspace. 120 mls = 3 vials.
5. Except Mercury which is 28/28.
6. The first value is the TCLP extraction holding time, following by the semivolatile extraction and analysis times.

NOTES: Source: 40CFR Part 136 Tables IA, IB, IC, ID, IE, and Table II
See *Test Methods for Evaluating Solid Waste* (EPA SW-846) for lab methods and sampling protocol.

Figure 1
Ground Water Monitoring Sampling Record

Date:	
Event Name:	
Location:	
Event Purpose:	
Wind Speed/Direction:	
Weather Temp. & Conditions:	

Evacuation Factors:
2" Sch. 40 PVC = 0.163 gallon per foot
3" Sch. 40 PVC = 0.367 gallon per foot
4" Sch. 40 PVC = 0.653 gallon per foot
2.2" Fiberglass pipe = 0.197 gallon per foot

Sampling Team Signatures: ______________________

WELL I.D.	WATER LEVEL	WELL EVACUATION	Calibration Check	Sample Time	pH	TEMP.	COND.	TURB.	OBSERVATIONS & COMMENTS APPEARANCE
Name: Type: U B D (circle one) Dup. Name: Gradient: Up Down	Measurement Time: ____ Total Depth, TOC, ft.: ____ Depth to Water, TOC, ft.: ____ ength of Water Column, ft. ____	Casing Diam., in. ____ Time Begin Purge: ____ Casing Vol., gal. ____ Time End Purge: ____ Calc. Evac. Vol. ____ Vol. Purged, gal. ____ Purge Method: B P O Dry: Y N (circle one)	Calibration Check (pH):						pH Recalibrated? Y N Conductivity Checked? Y N
Name: Type: U B D (circle one) Dup. Name: Gradient: Up Down	Measurement Time: ____ Total Depth, TOC, ft.: ____ Depth to Water, TOC, ft.: ____ ength of Water Column, ft. ____	Casing Diam., in. ____ Time Begin Purge: ____ Casing Vol., gal. ____ Time End Purge: ____ Calc. Evac. Vol. ____ Vol. Purged, gal. ____ Purge Method: B P O Dry: Y N (circle one)	Calibration Check (pH):						pH Recalibrated? Y N Conductivity Checked? Y N
Name: Type: U B D (circle one) Dup. Name: Gradient: Up Down	Measurement Time: ____ Total Depth, TOC, ft.: ____ Depth to Water, TOC, ft.: ____ ength of Water Column, ft. ____	Casing Diam., in. ____ Time Begin Purge: ____ Casing Vol., gal. ____ Time End Purge: ____ Calc. Evac. Vol. ____ Vol. Purged, gal. ____ Purge Method: B P O Dry: Y N (circle one)	Calibration Check (pH):						pH Recalibrated? Y N Conductivity Checked? Y N
Name: Type: U B D (circle one) Dup. Name: Gradient: Up Down	Measurement Time: ____ Total Depth, TOC, ft.: ____ Depth to Water, TOC, ft.: ____ ength of Water Column, ft. ____	Casing Diam., in. ____ Time Begin Purge: ____ Casing Vol., gal. ____ Time End Purge: ____ Calc. Evac. Vol. ____ Vol. Purged, gal. ____ Purge Method: B P O Dry: Y N (circle one)	Calibration Check (pH):						pH Recalibrated? Y N Conductivity Checked? Y N
Name: Type: U B D (circle one) Dup. Name: Gradient: Up Down	Measurement Time: ____ Total Depth, TOC, ft.: ____ Depth to Water, TOC, ft.: ____ ength of Water Column, ft. ____	Casing Diam., in. ____ Time Begin Purge: ____ Casing Vol., gal. ____ Time End Purge: ____ Calc. Evac. Vol. ____ Vol. Purged, gal. ____ Purge Method: B P O Dry: Y N (circle one)	Calibration Check (pH):						pH Recalibrated? Y N Conductivity Checked? Y N

Definitions

Sample Type: U = Unknown (Well, Pond, etc.)
B = Blank
D or Dup. = Duplicate

Purge Method: B = Bailer
P = Pump
O = Other

Initial Instrument Calibrations: Time: ____________

pH 7 = ____________ pH 4 = ____________ Conductivity 1000 umhos/cm Standard
pH 10 = ____________ pH 7 = ____________ = ____________
pH 8 = pH 6 = (Calibration Check only)

Notes:

Last Date Updated: 11/3/99

q:\sheops/gwsw/forms/sampling/crg-015a.xls

Figure 2

Chain of Custody ID Code: ____________________ Designated Lab: ____________________

Container ID Code: ____________________ PO No.: ____________________

CHAIN OF CUSTODY RECORD

Release No.:

Date:

CHARGE #:

REQUESTOR(S):

Total Number of Sample Points: [ ]

SAMPLING TEAM (Print):

KIND OF SAMPLES:

PURPOSE/PROJECT NAME:

SAMPLE LOCATION:

SAMPLE IDENTIFICATION	COLLECTION		ANALYSIS REQUESTED METHOD NUMBER	CONTAINER SIZE/TYPE	SAMPLE PRESERVATIVE	LAB JOB/PROJECT # SAMPLE NUMBER
	DATE	TIME				

OTHER REMARKS:

☐ MSDS Included ☐ Control Standard Instructions Included

DATE RESULTS REQUESTED

(Date):

CHAIN OF SAMPLE POSSESSION

Sampler(s) Signature(s)	Relinquished by:	Received by:
	(Signature, Date, & Time)	*(Signature, Date, & Time)*
	Relinquished by:	Received by:
	(Signature, Date, & Time)	*(Signature, Date, & Time)*
	Relinquished by:	Received by:
	(Signature, Date, & Time)	*(Signature, Date, & Time)*
	Relinquished by:	Received by:
	(Signature, Date, & Time)	*(Signature, Date, & Time)*

Temperature of sample container before shipping to lab _______

Temperature of samples upon arrival at laboratory: _______

Figure 3

Static Water Level and NAPL Thickness Survey Form

Monitoring Well Number	Date of Measurement	Casing Elevation	Depth to LNAPL (ft)	Depth to Groundwater (ft)	LNAPL Thickness (ft)	Corrected GW Elevation (ft)	Comments

NOTES:

(1) Assumed Specific Gravity of LNAPL, if present, is 0.79 (typical hydrocarbon LNAPL). If the Specific Gravity of the NAPL is not known, a sample can be collected and Specific Gravity measured.

(2) Potentiometric surface elevation correction for LNAPL = TOC - DTW + (Specific Gravity X LNAPL Thickness). (TOC = Top of Casing, DTW = Depth to Water)

(3) No potentiometric surface elevation correction needed for DNAPL.

Appendix C

Field Forms

LOW FLOW GROUNDWATER PURGING/SAMPLING LOG

Project: ______________________ Site: ______________ Well I.D.: ______________

Date: ________ Sampling Personnel: ______________________ Company: URS Corporation

Purging/ Sampling Device: ______________________ Tubing Type: ______________ Pump/Tubing Inlet Location: Midpoint of Saturated Screen

Measuring Point: Below Top of Riser Initial Depth to Water: __________ Depth to Well Bottom: __________ Well Diameter: __________ Screen Length: __________

Casing Type: PVC Volume in 1 Well Casing (liters): __________ Estimated Purge Volume (liters): __________

Sample ID: ______________________ Sample Time: ______________ QA/QC: ______________

Sample Parameters: ____

Notes: ____

PURGE PARAMETERS

TIME	pH	TEMP (^{0}C)	COND. (mS/cm)	DISS. O_2 (mg/l)	TURB. (NTU)	ORP (mV)	FLOW RATE (ml/min.)	DEPTH TO WATER (btor)
Tolerance:	**0.1**	**---**	**3%**	**10%**	**10%**	**+ or - 10**	**---**	

Information: WATER VOLUMES--0.75 inch diameter well = 87 ml/ft; 1 inch diameter well = 154 ml/ft; 2 inch diameter well = 617 ml/ft; 4 inch diameter well = 2470 ml/ft ($vol_{cyl} = \pi r^2 h$)

CHAIN OF CUSTODY RECORD

URS

PROJECT NO.	SITE NAME
SAMPLERS (PRINT/SIGNATURE)	

TESTS

BOTTLE TYPE AND PRESERVATIVE

LAB ____________

COOLER ______ of ______

PAGE ______ of ______

DELIVERY SERVICE: ______________ AIRBILL NO.: ______________

LOCATION IDENTIFIER	DATE	TIME	COMP/ GRAB	SAMPLE ID	MATRIX	TOTAL NO.# OF CONTAINERS									REMARKS	SAMPLE TYPE	BEGINNING DEPTH (IN FEET)	ENDING DEPTH (IN FEET)	FIELD LOT NO.# (IRPIMS ONLY)

MATRIX CODES	AA - AMBIENT AIR SE - SEDIMENT SH - HAZARDOUS SOLID WASTE	SL - SLUDGE WP - DRINKING WATER WW - WASTE WATER	WG - GROUND WATER SO - SOIL DC - DRILL CUTTINGS	WL - LEACHATE GS - SOIL GAS WC - DRILLING WATER	WO - OCEAN WATER WS - SURFACE WATER WQ - WATER FIELD QC	LH - HAZARDOUS LIQUID WASTE LF - FLOATING/FREE PRODUCT ON GW TABLE
SAMPLE TYPE CODES	TB# - TRIP BLANK SD# - MATRIX SPIKE DUPLICATE	RB# - RINSE BLANK FR# - FIELD REPLICATE	N# - NORMAL ENVIRONMENTAL SAMPLE MS# - MATRIX SPIKE	(# - SEQUENTIAL NUMBER (FROM 1 TO 9) TO ACCOMMODATE MULTIPLE SAMPLES IN A SINGLE DAY)		

RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED BY (SIGNATURE)	DATE	TIME	SPECIAL INSTRUCTIONS
RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED FOR LAB BY (SIGNATURE)	DATE	TIME	

Distribution: Original accompanies shipment, copy to coordinator field files

URSF-075C/1 OF 1/CofCR/GCM

URS

77 GOODELL STREET
BUFFALO, NEW YORK 14203
PHONE: (716) 856-5636

MONITORING WELL INSPECTION FORM

SITE NAME: ______________________

JOB#: ______________________

DATE: ______________________

TIME: ______________________

WELL ID: ______________________

EXTERIOR INSPECTION

PROTECTIVE CASING: ______________________

LOCK/HASP: ______________________

HINGE/ LID: ______________________

WELL PAD: ______________________

BOLLARDS: ______________________

LABEL/ID: ______________________

OTHER: ______________________

INTERIOR INSPECTION

WELL RISER: ______________________

ANNULAR SPACE: ______________________

WELL CAP: ______________________

WATER LEVEL (ft): ______________________

DEPTH TO BOTTOM (ft): ____________ HARD/SOFT BOTTOM: ____________

OTHER: ______________________

COMMENTS: ______________________

SIGNATURE INSPECTOR: ____________ SIGNATURE APPROVAL: ____________

LOCK KEY # ______________________

Rohm and Hass
Visual Inspection/Certification Form

Date: ______________
Time: ______________

Weather/Temperature: ____

Are the Institutional Controls (ICs) in place, performing properly and are remaining effective? **YES / NO** If "**NO**" please explain below:
Is the Monitoring Plan being implemented? **YES / NO** If "**NO**" please explain below:
Does the site remedy continue to be protective of the public health and the environment? **YES / NO** If "**NO**" please explain below:
Have the ICs remained in place and intact since the controls were put in place, or last approved by the New York State Department of Environmental Conservation (NYSDEC)? **YES / NO** If "**NO**" please explain below:
Has anything occurred at the site that would impair the ability of the controls to protect the public health and environment? **YES / NO** If "**YES**" please explain below:
Has anything occurred at the site that would constitute a violation or failure to comply with the site management plan for these controls? **YES / NO** If "**YES**" please explain below:

Rohm and Hass
Visual Inspection/Certification Form

Has access to the site been provided to the NYSDEC on an "at-will" basis? **YES / NO** If "**NO**" please explain below:
Is the groundwater at the site being used as a source of potable/process water without water quality treatment as determined by the Westchester County Department of Health? **YES / NO** If "**YES**" please explain below:
Has the Site Management Plan been adhered to? **YES / NO** If "**NO**" please explain below:
Is the Site being used as residential or other unrestricted uses? **YES / NO** If "**YES**" please explain below:

I certify, as the Owner's Designated Site Representative, that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law.

Signature

Name

URS Corporation
77 Goodell St.
Buffalo, NY 14203
Tel: 716-856-5636
Fax: 716-856-2545

Appendix D

Rohm and Haas

Corporate Remediation Group

Naming Conventions

CRG Naming Conventions

Code Specification - Field Generated Samples

The Code assigned to a Sample at the time it is collected is a critically important part of the data management system and therefore should conform to the following specification.

The code must be unique and contain the following six (6) items.

[date location depth preservation filtration type]

-The date: use the format "YYYYMMDD"
("YYYY"=four-digit year, "MM"=two-digit month, and "DD"=two-digit day)

20020103 for 3 January 2002

This form of the date is used so that samples will sort chronologically.

-The location: use the location code that has been assigned to the location where the sample was taken e.g. MW-21 (see restrictions below)

-The depth at which the sample was taken:

--for wells, use the depth in the well where the pump inlet was located prefixed with a "V" for Vertical e.g. V25

--for soil samples use the "V" prefix followed by the sampled range e.g. V2-4

--for samples from wells where the vertical depth of the sample is not known, use the "V" prefix followed by the depth of the midpoint of the screened interval followed by the character "@" e.g. V34@. The @ symbol indicates that the depth was derived and is not a measured value.

-The use of preservation:

--for samples that would normally be preserved, such as VOA samples and metals samples, but where it is desired to collect an unpreserved sample, indicate that the sample is unpreserved by including the character "U" in the sample code immediately after the depth entry.

--for samples that would normally be unpreserved, such as SVOC samples, but where it is desired to collect a preserved sample, indicate that the sample is preserved by including the character "P" in the sample code immediately after the depth entry.

-The use of filtration:

if the sample is filtered, place a "D" in the code immediately in front of the sample type to indicate that the sample contains only Dissolved components.

-The sample type: e.g. "N" for a normal environmental sample

(see Table 1 below for other sample type codes)

Restrictions:

Currently the sample code is limited to 40 characters by a field length limitation in the EQuIS database. If you construct a sample code and it exceeds the 40 character limit, contact CRG to determine how to contract the sample code while assuring that the code remains unique. Refrain from using spaces in the code and use dashes only in the location code and depth range.

Experience has shown that certain characters cause a problem with lab LIMS data systems and therefore should not be used in the location codes or the sample codes. (see the list below)

The following characters must not be present in the sample code:

ampersand	&	back quote	`
backslash	\	dollar sign	$
double quotes	"	pipe or vertical bar	|
semi colon	;	single quotes	'
colon	:	any parenthesis or brackets	{}, (), []
forward slash	/	asterisk	*
greater than	>	lest than	<
question mark	?	curly quotes	“ ”

Note: This limitation on acceptable characters is the principal reason that the previous convention of placing parentheses around the depth was replaced with the current convention of using a "V" prefix. (PTC, 2/1/02)

Normal "Field" Samples

Examples of Some Typical Sample Codes

-A NORMAL environmental sample from well MW-21 from a depth of 25 feet on 3 Jan 2002.

20020103MW-21V25N

Note: Depth numbers should be reported in the depth unit typically used at the site i.e. feet when measurements are in feet, meters when the measurements are in meters.

-A pair of NORMAL environmental samples, one that contains the normal preservative called for by the usual sampling procedure and the other in which the preservative has intentionally not been added.

20020103MW-21V25N with normal preservative
20020103MW-21V25UN without preservative

-A NORMAL environmental sample that has been filtered.

20020103MW-21V25DN

-A NORMAL environmental sample where the preservative which is normally added has NOT been added and the sample has been filtered.

20020103MW-21V25UDN

-A NORMAL environmental soil sample taken from the depth interval of 2 to 4 feet at soil sample location SS-34.

20020103SS-34V2-4N

-An historical NORMAL environmental sample taken from a well but where the sample depth was unknown. The depths to the top/bottom of the well screen was 10/20.

20020103MW-21V15@N

"Field" Quality Control Samples

The following sample types relate to Quality Performance by the "Lab" and are covered under the heading "Lab Quality Control Samples":

Trip Blanks	Method Blanks
Blind Samples	Blank Spikes
Matrix Spikes	Blank Spike Duplicates
Matrix Spike Duplicates	Lab Control Samples
Lab Replicates	Surrogates
	Internal Standards

Field Duplicates

A field duplicate is given the same code as the normal sample except that the designation "FD" is used instead of "N".

20020103MW-21V25FD

Field Blanks

Field Blanks are labeled with the date, site code, and the designation "FB".

20020103LTGFB.

When there is more than one field blank for a given day, a unique sequence number should be added.

20020103LTGFB-1

Equipment Blanks

Equipment Blanks are labeled with the date, the site code (for example LTG for the Lauterbourg, France site. See Table 2 below.), and the suffix "EB".

20020103LTGEB

If there were more than one Equipment Blank for a given day, a unique sequence number should be added.

20020103LTGEB-1

Rinse Water

Rinse Water samples are labeled with the date, the site code (for example LTG for the Lauterbourg, France site. See Table 2 below.), and the suffix "RW".

20020103LTGRW

Well Construction Materials

Samples of materials used in the boring and installation of a well are labeled with the date, the site code (for example LTG for the Lauterbourg, France site. See Table 2 below.), and the suffix "MB". These materials include drilling muds, drilling water, grout, cement, sand, etc.

20020103LTGMB

Lab Sample Designation

Each lab has its own system for identifying samples as they come into the lab from the field. This designation for each sample analyzed is placed on the SMP EDD along with the date the sample arrived in the lab. The lab also adds to the SMP EDD the Lab Project Number and the Rohm and Haas Purchase Order Number under which the analyses are being performed.

"Lab" Quality Control Samples

The following sample types relate to Quality Performance in the "Field" and are covered under the heading of "Field Quality Control Samples".

Field Duplicates	Equipment Blanks
Field Blanks	Rinse Waters
	Well Construction Materials

The following naming conventions will be used to generate unique sample codes to identify Lab Quality Control Samples. These designations will be used in each of the EQuIS Imports, CRG SMP, CRG TRSQC, and CRG BAT, to describe and track the measured analytical results associated with these samples.

Trip Blanks

Trip Blanks are labeled with the date, site code, and the designation "TB".

20020103LTGTB

When there is more than one trip blank for a given day, a unique sequence number should be added.

20020103LTGTB-1

Blind Samples:

In some cases a sample, for QA/QC purposes, will have to be submitted to the lab with a "blind" sample code. The blind code must be unique and the field staff must make an entry in their field logbook cross-referencing this blind code with the correct CRG sample code for that sample. When the results return from the lab, the cross-reference will allow them to enter the the results into the database under the correct CRG sample code rather than the blind code.

Matrix Spikes

A matrix spike sample is given the same code as the normal sample which is its parent except that the designation "MS" is used instead of "N".

20020103MW-21V25MS

Note: When the work plan indicates that matrix spike and matrix spike duplicate samples are both to be taken, separate containers must be prepared by the lab for each of these samples. Past practice of using a single container to hold the material for both these samples has been discontinued and the sample type designation "MSD" eliminated.

Matrix Spike Duplicates

A matrix spike duplicate is given the same code as the normal sample which is its parent except that the designation "SD" is used instead of "N".

20020103MW-21V25SD

Note: When the work plan indicates that matrix spike and matrix spike duplicate samples are both to be taken, separate containers must be prepared by the lab for each of these samples. Past practice of using a single container to hold the material for both these samples has been discontinued and the sample type designation "MSD" eliminated.

Lab Replicates

When the lab runs a replicate analysis on a sample, a new sample code is assigned to the sample which consists of the original sample code with the added ending "LR".

Parent Sample Code

20020103MW-21V25N

Lab Replicate Code

20020103MW-21V25NLR

Method Blanks

The sample code is constructed using the convention of the lab doing the analysis followed by "MB".

Normal Lab Code
04-12-03-564
Sample Code
04-12-03-564MB

Blank Spikes

The sample code is constructed using the convention of the lab doing the analysis followed by "BS".

Normal Lab Code
04-12-03-564
Sample Code
04-12-03-564BS

Blank Spike Duplicates

The sample code is constructed using the convention of the lab doing the analysis followed by "BSD".

Normal Lab Code
04-12-03-564
Sample Code
04-12-03-564BSD

Lab Control Samples

The sample code is constructed using the convention of the lab doing the analysis followed by "LCS".

Normal Lab Code
04-12-03-564
Sample Code
04-12-03-564LCS

Surrogates

Surrogates are reported along with the results for a sample and therefore fall under the sample code of that sample. The Surrogate result type is designated as "SUR" and the surrogate recoveries are reported in the QC results section, not in the sample analytical results section.

Internal Standards

Internal Standards are reported along with the results for a sample and therefore fall under the sample code of that sample. The Internal Standard result type is designated as "IC" and the measured values are compared to the Standard in the QC results section, not in the sample analytical results section.

Chain of Custody (COC) Form Identifiers

Each page of the COC form should contain a unique identifier for that Form clearly indicated on the Form. The following identifier format is recommended.

YYYYMMDDLabCOC-X

where X is a sequential number unique on that day (e.g., 1, 2, 3, etc.) "YYYY"=four-digit year, "MM"=two-digit month, and "DD"=two-digit day, and "Lab" is the Lab Code for the Lab doing the analyses.

"YYYYMMDD" represents the date on which the samples were packaged and shipped or relinquished to the LAB The sequential number is used to indicate the number of forms (pages) prepared on a single day

For two Containers going to the STL Lab in Edison on 3 February 2002

20020203STL-EDCOC-1

20020203STL-EDCOC-2

Cooler Identification Code

Each Container that carries samples to the analytical laboratory should have a unique container code and that code should appear on the Chain of Custody. Any convention is acceptable so long as the identifier is unique. The following format is suggested.

YYYYMMDDLabBOX-Z

where Z is a sequential number unique on that day (e.g., 1, 2, 3, etc.) "YYYY"=four-digit year, "MM"=two-digit month, and "DD"=two-digit day, and "Lab" is the Lab Code for the Lab doing the analyses.

"YYYYMMDD" represents the date on which the container was packaged and shipped to the Lab The sequential number is used to indicate the number of the cooler prepared on the same day

For two Containers going to the STL Lab in Edison on 3 February 2002

20020203STL-EDBOX-1

20020203STL-EDBOX-2

Table 1

Sample Type Codes

Code	Description
AB	Ambient Conditions Blank
D	Dissolved (indicates filtered sample)
EB	Equipment Blank (rinse water after washing)
FB	Field Blank
FD	Field Duplicate
FR	Field Replicate
FS	Field Spike
MB	Material Blank (for background, baselines)
MS	Matrix Spike
N	Normal Environmental Sample
P	Preserved Sample (when normally unpreserved)
RD	Regulatory Duplicate; Split
RW	Rinse Water (before washing equipment)
SD	Matrix Spike Duplicate
TB	Trip Blank
U	Unpreserved Sample (when normally preserved)

Table 2

Rohm and Haas Site Codes

ACM	ACIMA SWITZERLAND
AMF	AMERSFOORT NETHERLANDS
ANJ	ANJOU QUEBEC
AWP	ANTWERP BELGIUM
API	APIZACO MEXICO
VA	ARLINGTON VA
GRC	ATHENS GREECE
NZL	AUCKLAND NEW ZEALAND
THA	BANGKOK THAILAND
BAR	BARCELONA SPAIN
BRQ	BARRANQUILLA COLOMBIA
BEI	BEIJING CHINA
BEJ	BERHC
BLM	BLOOMINGDALE IL
BOG	BOGOTA COLOMBIA
BMB	BOMBAY INDIA
BRM	BREMEN GERMANY
BRB	BRISBANE AUSTRALIA

BR	BRISTOL PA
BRS	BROSSARD QUEBEC
BUD	BUDAPEST HUNGARY
ARG	BUENOS AIRES ARGENTINA
CAL	CALGARY ALBERTA
AUS	CAMBERWELL AUSTRALIA
CAP	CAPE CANAVERAL FL & BAHAMAS
CAS	CASTRONNO (VARESE) ITALY
CTC	CHARLOTTE TECH CNT
CNY	CHAUNY FRANCE
TWN	CHIAYI HSIEN TAIWAN
CHW	CHIC HTS WHSE
CHT	CHICAGO HTS PLANT
KIL	CHICAGO IL - KILBOURN
CGO	CHICAGO IL - RIVERSIDE
CIC	CICERO IL
CIP	CILEGON INDONESIA
CIN	CINCINNATI OH
CLK	CLARKSON ONTARIO
DMK	COPENHAGEN DENMARK
COR	CORNATION CAN
CED	CORP ENG BRISTOL
CRY	CROYDON ENGLAND
CRO	CROYDON PA
DAY	DAYTON OH
HOU	DEER PARK TX
DFZ	DELFZJIL NETHERLANDS
DET	DETROIT MI
DEW	DEWSBURY ENGLAND
ME	DUBAI MIDDLE EAST
ELK	ELK GROVE IL
ELM	ELMA WA
ELS	ELSTON PLANT CHICAGO
HON	FAR EAST HONG KONG
FSN	FOSHAN CHINA
FRK	FRANKFURT GERMANY
FRE	FRESNO CA
GRL	GARLASCO ITALY
GTL	GEELONG AUSTRALIA LAB
GEE	GEELONG AUSTRALIA PLT
GLN	GLENDALE AZ
SAL	GRAND SALINE TX
GRM	GRANGEMOUTH SCOTLAND
GRT	GRANTSVILLE UT
GRV	GREENVILLE SC
GDL	GUADALAJARA MEXICO
HAY	HAYWARD CA

HO	HOME OFFICE PHILA
HUT	HUTCHINSON KS
ILE	ILES-DE-LA-MADELEINE QUEBEC
TUR	ISTANBUL TURKEY
JAC	JACAREI BRAZIL
JKT	JAKARTA INDONESIA
JCC	JAPAN ACRYLIC CHEM
JAR	JARROW ENGLAND
KNK	KANKAKEE IL
PAK	KARACHI PAKISTAN
KNX	KNOXVILLE TN
LMI	LA MIRADA CA
BAY	LA PORTE TX
LDK	LANDSKRONA SWEDEN
LAN	LANSING IL
LSP	LAS PINAS PLT PHILIPPINES
LTG	LAUTERBOURG FRANCE
LIN	LINDBERGH ALBERTA
LST	LONE STAR PLANT
LGB	LONG BEACH CA
LA	LOS ANGELES CA
LVL	LOUISVILLE KY
LOU	LOUISVILLE KY
MAL	MALAYSIA
PHN	MANILA PHILIPPINES
MAN	MANISTEE MI
MDL	MEDELLIN COLOMBIA
MEM	MEMPHIS TN
MEX	MEXICO CITY MEXICO
MIL	MILAN ITALY
MWK	MILWAUKEE WI
MGV	MONTGOMERYVILLE PA
MOS	MOSCOW RUSSIA
MSP	MOSS POINT MS - EM
MSS	MOSS POINT MS - P2
MOZ	MOZZANICA ITALY
MZZ	MOZZATE ITALY
CHI	MT. PROSPECT IL
IND	MUMBAI INDIA
NAN	NANTONG CHINA
WEK	NEW IBERIA LA (WEEKS)
NWK	NEWARK CA
NTF	NEWTOWN PA FARM
AND	NORTH ANDOVER, MA
CLE	NORTH OLMSTED OH
OJB	OJIBWAY ONTARIO
ORR	ORR ROAD NC

OSA	OSAKA JAPAN
FRP	PAINESVILLE OH (FAIRPORT)
PAR	PARIS FRANCE
PRN	PARONA ITALY
PAT	PATERSON, NJ
CMP	PAULINIA BRAZIL
PER	PERTH AMBOY NJ
PHL	PHILADELPHIA PA
PLT	PLANT CAN
PTE	POINTE CLAIRE QUEBEC
PUG	PUGWASH NOVA SCOTIA
QPU	QINGPU PLANT
RED	READING PA
FLY	READING PA (FLYING HILLS)
REG	REGINA SASKATCHEWAN
RGW	RINGWOOD IL
RIT	RITTMAN OH
ROB	ROBECHETTO ITALY
RCH	ROCHESTER HILLS MI
RDL	RODEL INC
ROM	ROMANO D'EZZELINO ITALY (PULVERLAC)
ROS	ROSWELL GA
SLC	SALT LAKE CITY LIT
COS	SAN JOSE COSTA RICA
CHL	SANTIAGO CHILE
BRA	SAO PAULO BRAZIL
SMY	SEMOY FRANCE
KOR	SEOUL SOUTH KOREA
SHA	SHANGHAI CHINA
GCT	SHANGHAI CHINA (GCTC)
SER	SHANGHAI EAST RH CO
SHP	SHIPLEY
SFE	SHIPLEY FAR EAST - TOKYO
SVL	SILVER SPRINGS NJ
SNG	SINGAPORE (NAC)
SGP	SINGAPORE (PLANT)
STC	SINGAPORE TECH CNT
SMA	SOMA PLANT JAPAN
SOA	SOUTH AFRICA
SPB	SPARTANBURG SC
SH	SPRING HOUSE PA
STL	ST LOUIS MO
STP	ST PAUL MN
STR	STRULLENDORF GERMANY
SYD	SYDNEY AUSTRALIA
TAI	TAIPEI TAIWAN

TYO	TOKYO JAPAN
TOL	TOLUCA MEXICO
TOY	TOYO MRTN-TOKYO JAPAN
TUD	TUDELA SPAIN
TUS	TUSTIN CA
MTN	UNASSIGNED LOCATION CODES
VLB	VALBONNE FRANCE
VNA	VIENNA AUSTRIA
VSP	VILLERS ST. PAUL FRANCE
WTX	WALLER TX
WAR	WARRINGTON ENGLAND
WRS	WARSAW IN
ALX	WEST ALEXANDRIA OH
WH	WEST HILL ONT CAN
DEL	WILMINGTON DE
WIN	WINDSOR ONTARIO
WOB	WOBURN MA
WST	WOODSTOCK, IL
WYV	WYTHEVILLE VA
NG	Y NAGOYA JAPAN
ZRT	ZARATE ARGENTINA

Appendix E

Groundwater Monitoring Well Decommissioning Procedures

CP-43:Groundwater Monitoring Well Decommissioning Policy

New York State Department of Environmental Conservation

DEC POLICY

Issuing Authority: Commissioner Alexander B. Grannis	
Date Issued: November 3, 2009	**Latest Date Revised:**

I. Summary:

Groundwater monitoring wells provide essential access to the subsurface for scientific and engineering investigations (including monitoring wells installed for leak detection purposes). To a degree, every monitoring well is an environmental liability because of the potential to act as a conduit for pollution to reach the groundwater. To limit the environmental risk, a groundwater monitoring well must be properly decommissioned when its effective life has been reached. This document provides procedures to satisfactorily decommission groundwater monitoring wells in New York State. This policy also pertains to other temporary wells such as observation wells, test wells, de-watering wells and other small diameter, non-potable water wells. It does not pertain to water supply wells.

II. Policy:

Environmental monitoring wells should be decommissioned when:

1. they are no longer needed and re-use by another program is not an option; or
2. the well's integrity is suspect or compromised.

The method for decommissioning will be determined based upon well construction and environmental parameters. The method selected must be designed to protect groundwater and implemented according to current best engineering practices while following all applicable federal, state and local regulations. *Groundwater Monitoring Well Decommissioning Procedures* shall be maintained as an addendum to this policy.

This policy is applicable to all New York State Department of Environmental Conservation (DEC) programs that install, utilize and maintain monitoring wells for the study of groundwater, except monitoring wells for landfills regulated under 6 NYCRR Part 360 decommissioned in accordance with those regulations [*see* 6 NYCRR 360-2.11(a)(8)(vi)] and wells installed under the Oil, Gas and Solution Mining Law, Environmental Conservation Law Article 23. There is no specific time frame to dictate when to decommission a well; timing is dependent upon the use and condition of the well and shall be determined on an individual basis. Best professional judgment must be exercised when using the decommissioning procedures. Outside of DEC use, this policy is mandatory when incorporated into the specifications of a state contract, an Order on Consent or a permit. In all other situations, it shall serve as guidance.

III. Purpose and Background:

This document establishes a monitoring well decommissioning policy and provides technical guidance. Synonyms for well decommissioning include “plugging,” “capping” and “abandoning. For consistency, only the term “decommissioning” is used within this document.

Unprotected, neglected and improperly abandoned monitoring wells are a serious environmental liability. They can function as a pollution conduit for surface contaminants to reach the subsurface and pollute our groundwater. They also can cause unwanted mixing of groundwater, which degrades the overall water quality within an aquifer. Improperly constructed, poorly maintained or damaged monitoring wells can yield anomalous poor data that can compromise the findings of an environmental investigation or remediation project. Unneeded or compromised monitoring wells should be properly decommissioned in order to prevent harm to our groundwater.

Since 1980, the DEC has installed, directed or overseen the installation of thousands of monitoring wells throughout New York for various state and federal programs, such as Superfund, solid waste, Resource Conservation and Recovery Act (RCRA), spill response, petroleum bulk storage and chemical bulk storage. This guidance addresses the environmental liability associated with this aging network of wells.

Within its boring zone, a successfully decommissioned well prevents the following:

1. Migration of existing or future contaminants into an aquifer or between aquifers;
2. Migration of existing or future contaminants within the vadose zone;
3. Potential for vertical or horizontal migration of fluids in the well or adjacent to the well; and
4. Any change in the aquifer yield and hydrostatic head, unless due to natural conditions.

Monitoring well construction in New York varies considerably with factors such as age of the well, local geology and either the presence or absence of contamination. The predominant type of monitoring well in New York is the shallow, watertable monitoring well constructed of polyvinyl chloride plastic (PVC). The best method for decommissioning should be selected to suit the conditions and circumstances. Each decommissioning situation is to be evaluated separately using this guidance before a method is chosen and implemented.

IV. Responsibility:

The Division of Environmental Remediation (DER) is responsible for updating this policy and the *Groundwater Monitoring Well Decommissioning Procedures* (addendum) in consultation with the Division of Solid and Hazardous Materials (DSHM) and the Division of Water (DOW). Compliance with the guidance does not relieve any party of the obligation to properly decommission a monitoring well. Oversight responsibility will be carried out by the DEC Regional Engineer.

V. Procedure:

Groundwater Monitoring Well Decommissioning Procedures, the addendum to this policy, provides guidance on proper decommissioning of monitoring wells in New York State.

VI. Related References:

- Groundwater Monitoring Well Decommissioning Procedures, October 1986. Prepared by Malcolm Pirnie, Inc. for the New York State Department of Environmental Conservation, Division of Environmental Remediation.

- Standard Guide for the Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities, ASTM D 5299-99. American Society for Testing and Materials (ASTM). Philadelphia. 2005.

- 6 NYCRR Part 360 Solid Waste Management Facilities, New York State Department of Environmental Conservation, Division of Solid and Hazardous Materials.

- Specifications for Abandoning Wells and Boreholes in Unconsolidated Materials, New York State Department of Environmental Conservation, Region 1 - Water Unit, undated.

- Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells, EPA 600/4-89/034, United States Environmental Protection Agency (EPA).

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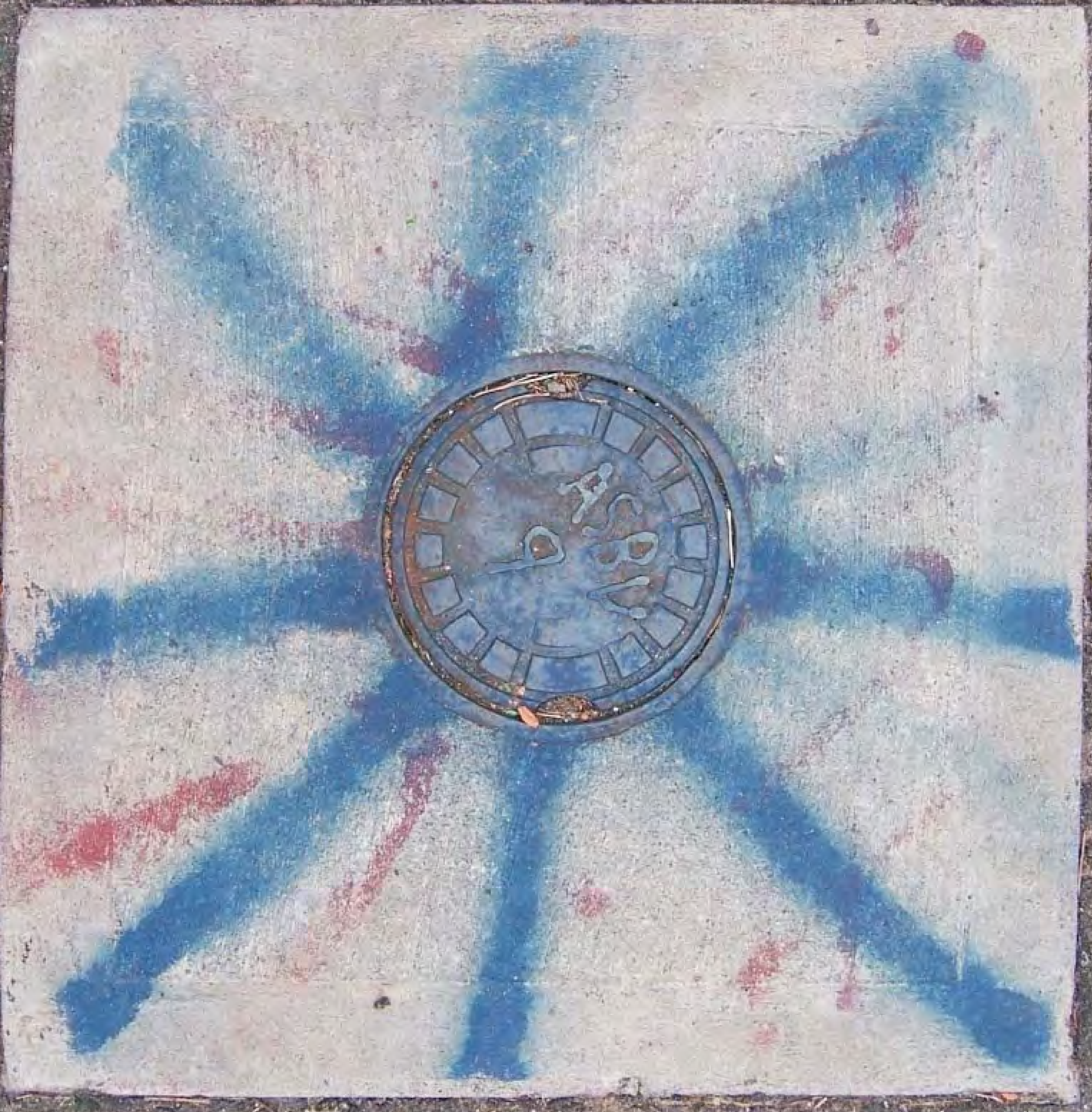
Final - August 2009

GROUNDWATER MONITORING WELL DECOMMISSIONING PROCEDURES



New York State Department of Environmental Conservation
Division of Environmental Remediation

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INTRODUCTION

This document, *Groundwater Monitoring Well Decommissioning Procedures,* is the addendum to CP-43, Groundwater Monitoring Well Decommissioning Policy, which provides acceptable procedures to be used as guidance when decommissioning monitoring wells in New York State. Please note that this document does not address some site-specific special situations that may be encountered in the field. Compliance with the procedures set forth in this document does not relieve any party of the obligation to properly decommission a monitoring well.

Unprotected, neglected and improperly abandoned monitoring wells are a serious environmental liability. They can function as a pollution conduit for surface contaminants to reach the subsurface and pollute our groundwater. They also can cause unwanted mixing of groundwater, which degrades the overall water quality within an aquifer. Improperly constructed, poorly maintained or damaged monitoring wells can yield anomalous poor data that can compromise the findings of an environmental investigation or remediation project. Unneeded or compromised monitoring wells should be properly decommissioned in order to prevent harm to our groundwater.

Previous versions of this guidance have been issued since 1995. Originally developed as a specification for well decommissioning at Love Canal, the procedures were rewritten to make them applicable across the state. From an engineering standpoint, the guidance has changed very little. Most situations do not require a complex procedure.

If you have any questions, please contact Will Welling at (518) 402-9814.

Sincerely,

Gerald J. Rider, Jr., P.E.
Chief, Remedial Section D
Remedial Bureau E
Division of Environmental Remediation

1.0 PREPARATION

If an unneeded monitoring well remains in good usable condition, an alternative to decommissioning might be the reuse by another agency program. DEC encourages reuse in situations where a well will continue to be used and cared for responsibly.

When reuse is not an option, the first step in the well decommissioning process is to review all pertinent well construction information. One must know the well depth and construction details. GPS coordinates and permanent labeling (if available) will be useful in confirming the well to be decommissioned. An inspection must be performed prior to decommissioning in order to verify the construction and condition of each well. Specific details and subsurface conditions form the basis for decisions throughout the decommissioning process.

Well Details

1. Is the well a single stem riser (all one diameter)?
2. Is the well a simple overburden well (no penetration into bedrock)?
3. Does the well riser consist of telescoping diameters of pipe which decrease with depth?
4. Is the well seal compromised (leaking, inadequate or damaged)?
5. If the well is PVC, is it 25 feet or shallower and not grouted into rock?
6. Can the riser be pulled and is removal of the well desired?
7. Is the well a bedrock well?
8. If the monitoring well is a bedrock well, does it have an open hole?
9. Is there a well assembly (riser and screen) installed within the bedrock hole?

Subsurface Conditions

10. Is the soil contaminated?
11. Does the well penetrate a confining layer?
12. If the well penetrates a confining layer, might overdrilling or casing pulling cause contamination to travel up or down through a break in the confining layer?
13. Does the screened interval cross multiple water-bearing zones?

For additional collection and verification of information, the "Monitoring Well Field Inspection Log" (Figure 1) can be used during a field inspection. After the well has been located and the information gathered, one is ready to select the decommissioning procedure in accordance with Section 2.

Special conditions, such as access problems, well extensions through capped and covered non-Part 360 landfills and seasonal weather patterns affecting construction, should be assessed in the planning stage. Decommissioning work requiring the use of heavy vehicular equipment on landfill caps should be scheduled during dry weather (if possible) so as to minimize damage to the cover. If work must be performed during the spring, winter or inclement weather, special measures to reduce ruts should be employed to maintain the integrity of a completed landfill cover system. As an example, placement of plywood under vehicular equipment can eliminate deep ruts that would require repair.

2.0 DECOMMISSIONING METHODS

The primary rationale for well decommissioning is to remove any potential groundwater pathway. A secondary rationale, often important to the property owner or owner of the well, is to physically remove the well. Removed well materials may be recycled and will not interfere with future construction excavation. The previous versions of these decommissioning procedures have stressed that physical removal of the well by pulling is preferable to leaving casing in the ground. Due to the added effort, expense and risk involved with pulling, the decision of whether to pull or not should be a separate consideration aside from selecting the sealing procedure.

One should select a decommissioning procedure that takes into account the geologic and hydrogeologic conditions at the well site; the presence or absence of contamination in the groundwater; and original well construction details. The selection process for well decommissioning procedures is provided by the flow chart, Figure 2. Answers to the questions in the preceding section are the input for this flow chart. The four primary well decommissioning methods are:

1. Grouting in-place;
2. Perforating the casing followed by grouting in-place;
3. Grouting in-place followed by casing pulling;
4. Over-drilling and grouting with or without a temporary casing.

In a complex situation, one or more decommissioning procedures may be used for different intervals of the same well.

The remainder of Section 2 discusses the well decommissioning methods and the selection process. Refer to Figure 2 for a flow chart diagram of the complete procedure selection process. The DEC Project Manager has the discretion to deviate from the flow chart, (Figure 2), based on site conditions and professional judgment.

2.1 Grouting In-Place

Grouting in-place is the simplest and most frequently used well decommissioning method and grouting itself is the essential component of all the decommissioning methods. The grout seals the borehole and any portion of the monitoring well that may be left in the ground. Because dirt and foreign objects can fall into an open well, whenever possible a well should be sealed first with grout before attempting subsequent decommissioning steps.

For the purpose of these decommissioning procedures, the well seal is defined as the bentonite seal above the sand pack. Aside from obvious channeling by in-flowing surface water around the well, an indication of the well seal integrity may be obtained through review of the boring logs and/or a comparison of groundwater elevations if the well is part of a cluster. Any problems noted on the boring logs pertaining to the well seal, such as bridging of bentonite pellets or running sands, or disparities between field notes (if available) and the well log would indicate the potential for a poor (compromised) well seal.

If the well seal is not compromised and there is no confining layer present, a single-stem, 2-inch PVC, monitoring well can be satisfactorily decommissioned by grouting it in-place. If the seal is compromised, casing perforation may be called for as discussed in Section 2.2.

As discussed in Section 2.4 and its sub-sections, this method is specified for the bedrock portion of a well, and is used for decommissioning small diameter cased wells. Grouting in-place involves filling the casing with grout to a level of five feet below the land surface, cutting the well casing at the five-foot depth, and removing the top portion of the casing and associated well materials from the ground. The casing must be grouted according to the procedures in Section 6. In addition, the upper five feet of the borehole is filled to land surface and restored according to the procedures described in Section 7.

For open-hole bedrock wells, the procedure involves filling the opening with grout to the top of rock according to the procedures in Section 5. A thicker grout may be required to fill any bedrock voids. If excessive grout is being lost down-hole, consider grouting in stages to reduce the pressure caused by the height of the grout column.

The standard mix with the maximum amount of allowable water will be required to penetrate the well screen and sand pack when a well assembly has been installed within a bedrock hole. For an assembly such as this, the grout should be mixed thinly enough to penetrate the slots and sand pack. The grout mixes are discussed in Sections 6.1 and 6.2.

2.2 Casing Perforating/Grouting In-Place

Casing perforation followed by grouting in-place is the preferred method to use if there is poor documentation of the grouting of the well annulus, or the annulus was allowed to be back-filled with cuttings. The grout will squeeze through the perforations to seal any porous zones along the outside of the casing. The procedure involves puncturing, cutting or splitting the well casing and screen followed by grouting the well. A variety of commercial equipment is available for perforating casings and screens in wells with four-inch or larger inside diameters. Due to the diversity of applications, experienced contractors must recommend a specific technique based on site-specific conditions. A minimum of four rows of perforations several inches long around the circumference of the pipe and a minimum of five perforations per linear foot of casing or screen is recommended (American Society for Testing and Materials, Standard D 5299-99, 1999). After the perforating is complete, the borehole must be grouted according to the procedures in Section 6 and the upper five feet of borehole restored according to the procedures in Section 7.

2.3 Casing Pulling

Casing pulling should be used in cases where the materials of the well assembly are to be recycled, or the well assembly must be removed to clear the site for future excavation or re-development. Casing pulling is an acceptable method to use when no contamination is present; contamination is present but the well does not penetrate a confining layer; and when both contamination and a confining layer are present but the contamination cannot cross the confining layer. Additionally, the well construction materials and well depth must be such that pulling will not break the riser. When contamination is likely to cross the confining layer during pulling, a temporary casing can be used. See Section 2.4.

Casing pulling involves removing the well casing by lifting. Grout is to be added during pulling; the grout will fill the space once occupied by the material being withdrawn. An acceptable procedure to remove casing involves puncturing the bottom of the well or using a casing cutter to cut away the screen, grouting, using jacks to free casing from the hole, and lifting the casing out by using a drill rig, backhoe, crane, or other suitable equipment. Additional grout must be added to the casing as it is withdrawn. Grout mixing and placement procedures are provided in Section 6. In wells or well points in which the bottom cannot be punctured, the casing or screened interval will be perforated or cut away prior to being filled with grout. This procedure should be followed for wells installed in collapsible formations or for highly contaminated wells.

At sites in which well casings have been grouted into the top of bedrock, the casing pulling procedure should not be attempted unless the casing can be first cut or freed from the rock.

2.4 Over-Drilling

Over-drilling is the technique used to physically remove an entire monitoring well, its sand pack and the old grout column and fill. In situations where PVC screens and risers are expected to sever and removal of all well materials is required, over-drilling will be required. Over-drilling is called for when a riser can't be pulled and it penetrates a confining layer. Compared to the other procedures, over-drilling is the least common method of well decommissioning.

A "temporary casing" may be necessary when extraordinary conditions are present, such as a high concentration of mobile contaminants in the overburden, depth to water is shallow, there is poor construction documentation or shoddy construction practices. The approach involves installing a large diameter steel casing around the outside of the well followed by drilling / pulling /grouting within this casing. The casing is withdrawn at the end of pulling, grouting and (perhaps) drilling. If the confining layer is less than 5 feet thick, the casing should be installed to the top of the confining layer. Otherwise, it is installed to a depth of 2 feet below the top of the confining layer. After the outer casing has been set, the well can be removed and grouted through pulling if possible or removed and grouted by drilling inside the casing.

Over-drilling is used where casing pulling is determined to be unfeasible, or where installation of a temporary casing is necessary to prevent cross-contamination, such as when a confining layer is present and contamination in the deeper aquifer could migrate to the upper aquifer as the well is pulled. The over-drilling method should:

- Follow the original well bore;
- Create a borehole of the same or greater diameter than the original boring; and
- Remove all of the well construction materials.

In over-drilling the difficulty lies in keeping the augers centered on the old well as the bit is lowered; it will tend to wander off. As a precaution, the well column should be filled with grout before over-drilling. Then without allowing the grout to dry, the driller proceeds with over-drilling the well. Grouting first guarantees that if the drill wanders off the old well and the effort is less than 100% successful, the remaining well portion will at least have been grouted. There are many methods for over-drilling. Please note that the following methods are not suitable for all types of casing, and the advice of an experienced driller should be sought.

- Conventional augering (i.e., a hollow stem auger fitted with a pilot bit). The pilot bit will grind the well construction materials, which will be brought to the well surface by the auger.
- A conventional cable tool rig to advance "temporary" casing having a larger diameter than the original boring. The cable tool kit is advanced within the casing to grind the well construction materials and soils, which are periodically removed with large diameter bailer. This method is not applicable to bedrock wells.

- An over-reaming tool with a pilot bit nearly the same size as the inside diameter of the casing and a reaming bit slightly larger than the original borehole diameter. This method can be used for wells with steel casings.

- A hollow-stem auger with outward facing carbide cutting teeth having a diameter two to four inches larger than the casing.

Prior to over-drilling, the bottom of the well should be perforated or cut away, and the casing filled with grout as with casing removal by pulling.

In all cases above, over-drilling should advance beyond the original bore depth by a distance of half a foot to ensure complete removal of the construction materials. Oversight attention should be focused on the drill cuttings, looking for fragments of well materials. Absence of these indicators is a sign that the drill has wandered off the well. If wandering is suspected, having previously filled the well with grout, the remaining portion which cannot be over-drilled can be considered grouted in-place. When the over-drilling is complete, grout should be tremied within the annular space between the augers and well casings. The grout level in the borehole should be maintained as the drilling equipment and well materials are sequentially removed. As with all the other methods, the upper five feet of borehole should be restored according to the procedures in Section 7.

3.0 SELECTION PROCESS AND IMPLEMENTATION

The decommissioning procedure selection flow chart, Figure 2, is to be used to select decommissioning methods. The selection process first identifies the basic monitoring well type. There are only two types of monitoring wells described in this guidance, overburden wells and bedrock wells. Bedrock wells typically have an overburden portion which in the selection process is to be treated as an overburden well. Techniques are specified for wells based upon their type and the other physical conditions present. Decommissioning techniques called for by the selection process have their practical limits; construction details dictate when a well stem can be pulled without breaking and when it cannot be pulled. The DEC project manager has the discretion to deviate from the flow chart, (Figure 2), based on site conditions, budgetary concerns and professional judgment. The remainder of this section will discuss types of monitoring wells in various settings along with recommended decommissioning techniques.

3.1 Bedrock Wells

Referring to Figure 2 and Section 2.1, if the well extends into bedrock, the rock hole portion of the well is to be grouted in-place to the top of the rock. The grout mix, however, may vary according to the conditions. A thicker grout may be required to fill voids and a thinner grout may be necessary to penetrate well screen and sand pack. Refer to the grout mixture specifications given in Section 6.1 and 6.2.

Prior to grouting, the depth of the well will be measured to determine if any silt or debris has plugged the well. If plugging has occurred, all reasonable attempts to clear it should be made before grouting. The borehole will then be tremie grouted according to Section 6.4 from the bottom of the well to the top of bedrock to ensure a continuous grout column.

After the rock hole is grouted, the overburden portion of the well is decommissioned using appropriate techniques described below. If the bedrock extends to the ground surface, grouting can extend to the ground surface or to slightly below so that the site can be restored as appropriate in accordance with Section 7.

3.2 Uncontaminated Overburden Wells

For overburden wells and the overburden portion of bedrock wells, the first factor in determining the decommissioning method is whether the overburden portion of the well exhibits contamination, as determined through historical groundwater and/or soil sampling results. If the overburden is uncontaminated, the next criteria considers whether the well penetrates a confining layer. In the case that the overburden portion of the well does not penetrate a confining layer, the casing can either be tremie-grouted and pulled or tremie grouted and left in place. As a general rule, PVC wells greater than 25-feet deep should not be pulled unless site-specific conditions or other factors indicate that the well can be pulled without breaking. If the well cannot be pulled, the well should be grouted in-place as accordance with Sections 2.1 and 2.2.

If a non-telescoped overburden well penetrates a confining layer, the casing should be removed by pulling (if possible) in accordance with Section 2.3. If the casing cannot be removed by pulling, the well should be grouted in-place or where complete removal is required, removed by over-drilling. Over-drilling will be based upon the site-specific conditions and requirements. If pulling is attempted and fails (i.e., a portion of the riser breaks) the remaining portion of the well should be removed by using the conventional augering procedure identified in Section 2.4. Note that if the riser is broken during pulling, it is highly unlikely that the driller will be able to target it to over-drill it. This is the reason why all wells should be grouted first. In all cases, after the well construction materials have been removed to the extent possible, the borehole will be grouted in accordance with Section 6 and the upper five feet will be restored in accordance with Section 7.

3.3 Contaminated Overburden Monitoring Wells/Piezometers

Contamination in the overburden plays a role in the selection process. Any contamination present in the overburden must not be allowed to spread as a result of the decommissioning construction. For wells and piezometers suspected or known to be contaminated with light non-aqueous phase liquid (LNAPL) and/or dense non-aqueous phase liquid (DNAPL), often referred to as “product,” the decision to decommission the well should be reviewed. Such gross contamination is a special condition and requires design of the decommissioning procedure. If decommissioning is determined to be the proper course of action, measurement of the non-aqueous phase liquid volume will be determined and this liquid will be removed.

If an overburden well (or the overburden portion of a bedrock well) is contaminated with LNAPL, DNAPL and /or dissolved fractions as indicated by historical sampling results, one must evaluate the potential for contamination to cross an overburden confining layer (if one exists) during decommissioning. A rock or soil horizon of very low permeability is known as a confining layer. Contamination in the overburden lying above a confining layer is a significant condition to recognize. To prevent mobile contaminants from crossing a confining layer during pulling or over-drilling, a temporary casing should be installed to isolate the work zone. One should follow the procedure selection flow chart. Some contaminated conditions call for over-drilling or a specially designed procedure.

A well in contaminated overburden may be grouted in-place as long as the grout fully seals the well and boring zone. If a well in contaminated overburden was constructed allowing formation collapse as annular backfill or if the well has a compromised well seal, one must either physically remove the well or thoroughly perforate the riser and grout it in-place.

If physical removal of the well is required and the overburden contaminants are likely to be dragged upward or downward during decommissioning, a temporary casing should be used to seal off the construction work zone. Casing pulling and overdrilling can be safely accomplished within the temporary casing. Section 2.4 discusses the temporary casing technique.

3.4 Telescoped Riser

If the riser is telescoped in one or more outer casings, the decommissioning approach depends upon the integrity of the well seal. If there is no evidence that the well seal integrity is compromised, the riser should be grouted in-place in accordance with Sections 2.1 or 2.2 and the upper 5 feet of the well surface should be restored in accordance with Section 7. If indications are that the well seal is not competent, it will be necessary to design and implement a special procedure to perforate and grout or remove the well construction materials. The presence and configuration of the outer casing(s) will be specific in the individual wells and will be a key factor in the decommissioning approach. The special procedure must mitigate the potential for cross-contamination during removal of the well construction materials.

4.0 LOCATING AND SETTING-UP ON THE WELL

Prior to mobilizing to decommission a monitoring well, one should notify the property owner and/or other interested parties including the governing regulatory agency. It is advisable that when at the well location, one should review the proposed well decommissioning procedure. Verify well locations and identification by their identifying markers and GPS coordinates. Lastly, verify the depth of each well with respect to depth recorded on the well construction log.

5.0 REMOVING THE PROTECTIVE CASING

Most monitoring wells installed in non-traffic locations are finished with an elevated, protective casing (guard pipe) and a concrete rain pad. Wells at gasoline stations, usually being in high-traffic areas, are typically finished with a flush-mount, curb box and protective 8" dia steel inspection plate rather than a stick-up riser. The curb box is usually easily removed from around the flush-mount well before pulling or over-drilling. In the case of stick-up wells, the riser pipe may be bonded to the guard pipe and rain pad. When the protective casing and concrete pad of a stick-up monitoring well are "yanked out," a PVC riser will typically break off at the bottom of the guard pipe several feet below grade. Once this happens, it may become impossible to center a drill rig upon the well. The riser may become splintered and structurally unstable for pulling. Unless grouted first, the well may fill with dirt. Before pulling a casing or over-drilling a well, a method must be devised for removing these protective surface pieces without jeopardizing the remaining decommissioning effort.

Generally, unless the protective casing is loose and can be safely lifted off by hand, *one* *should fill the monitoring well with grout before removing the outer protective casing.* This will ensure that the well is properly sealed regardless of any problems later when removing the protective casing. Remove the protective casing or road box vault initially only if the stick-up or vault will interfere with subsequent down-hole work which must be done before grouting. This down-hole work may include puncturing, perforating or cutting the screen or riser. But as a general procedure don't remove the protective casing or road box until after initial grouting is complete.

The procedure for removing the protective casing of a well depends upon the decommissioning method specified for the monitoring well. The variety of protective casings available preclude developing a specific removal procedure but often one can simply break up the concrete seal surrounding the casing and jack or hoist the protective casing out of the ground. A check should be made during pulling to ensure that the inner well casing is not being hoisted with the protective casing. If this occurs, the well casing should be cut off after the base of the protective casing is lifted above the land surface. At well locations where the riser has been extended, the burial of a previous concrete pad may require the excavation of soil to the top of the concrete pad to remove the well.

Steel well casing should be removed approximately five feet below the land surface so as to be below the frost line and out of the way of any subsequent shallow digging. The upper five feet of casing and the protective casing can be removed in one operation if a casing cutter is used.

Waste handling and disposal must be consistent with the methods used for the other well materials unless an alternate disposal method can be employed (i.e., steam cleaning followed by disposal as non-hazardous waste).

6.0 SELECTING, MIXING, AND PLACING GROUT

This section gives recipes for the “standard grout mixture” and the thicker “special grout mixture.” Mixing and placing grout is also discussed in this section. The goal of well decommissioning is to eliminate the capability of water to travel up or down within the volume of the former well and its boring. Success depends upon the correct grout mixture and placement where it is needed. There are two types of grout mixes that may be used to seal monitoring wells: a standard mix and a special mix. Both mixes use Type 1 Portland cement and four percent bentonite by weight. However, the special mix uses a smaller volume of water and is used in situations where excessive loss of the standard grout mix is possible (e.g., highly-fractured bedrock or coarse gravels).

6.1 Standard Grout Mixture

For most boreholes, the following standard mixture will be used:

- One 94-pound bag Type I Portland cement;
- 3.9 pounds powdered bentonite; and
- 7.8 gallons potable water.

Slightly more water may be used in order to penetrate a sand pack when a well screen transects multiple flow zones. This mixture results in a grout with a bentonite content of four percent by weight and will be used in all cases except in boreholes where excessive use of grout is anticipated. In these cases a special thicker mixture will be used.

6.2 Special Mixture

In cases where excessive use of grout is anticipated, such as high permeability formations and highly fractured or cavernous bedrock formations, the following special mixture will be used:

- one 94-pound bag type I Portland cement;
- 3.9 pounds powdered bentonite;
- 1 pound calcium chloride; and
- 6.0-7.8 gallons potable water (depending on desired thickness).

The special mixture results in a grout with a bentonite content of four percent by dry weight. It is thicker than the standard mixture because it contains less water. This grout is expected to set faster than the Standard Grout Mixture due to the added calcium chloride. The least amount of water that can be added for the mixture to be readily pumpable is 6 gallons per 94-pound bag of cement.

6.3 Grout Mixing Procedure

To begin the grout-mixing procedure, calculate the volume of grout required to fill the borehole. If possible, the mixing basin should be large enough to hold all of the grout necessary for the borehole.

Mix grout until a smooth, homogeneous mixture is achieved. Grout can be mixed manually or with a mechanized mixer. Colloidal mixers should not be used as they tend to excessively decrease the thickness of the grout for the above recipes.

6.4 Grout Placement

This guidance requires that grout be placed in the well from the bottom to the top by means of a "tremie." A tremie is a pipe, a hose or a tube extending from the grout supply to the bottom of the well. The tremie delivers the grout all the way down through the water column without its being diluted and mixed with the water that may be present in the well. The tremie pipe or tube is withdrawn as (or after) the well is filled with grout.

Using the tremie, grout is placed in the borehole filling from the bottom to the top. Two-inch and larger wells should use tremie tubing of not less than 1-inch diameter. Smaller diameter wells will call for a smaller tremie pipe. Grout will then be pumped in until the grout appears at the land surface (when grouting open holes in bedrock, the grout level only needs to reach above the bedrock surface). Any groundwater displaced during grout placement, if known to be contaminated, will be contained for proper disposal.

At this time the rate of settling should be observed. If grouting the well in place, the well casing remains in the hole. But if the decommissioning method has involved down-hole tools such as hollow-stem augers or temporary casing for overdrilling, these will be removed from the hole. As each section is removed, grout will be added to keep the level between 0 and 5 feet below grade. If the grout level drops below the land surface to an excessive degree, an alternate grouting method must be used. One possibility is to grout in stages; i.e., the first batch of grout is allowed to partially cure before a second batch of grout is added.

As previously described in Section 5.0, the outer protective casing "stick-up" should be removed only after a well has been properly filled with grout. This will ensure that the well is properly sealed regardless of any breakage which may occur when removing the stick-up. It is important to reiterate that when either casing pulling or over-drilling are required, due to the uncertainty of successfully pulling a well or over-boring a well, we insist that the driller tremie grout the well first. Then without allowing the grout to dry, the driller proceeds with pulling the casing or over-drilling the well.

Upon completion of grouting, ensure that the final grout level is approximately five feet below land surface. A ferrous metal marker will be embedded in the top of the grout to indicate the location of the former monitoring well. Lastly, a fabric "utility" marking should be placed one foot above the grout so an excavator can see it clearly.

7.0 BACKFILLING AND SITE RESTORATION

The uppermost five feet of the borehole at the land surface should be filled with material physically similar to the natural soils. The surface of the borehole should be restored to the condition of the area surrounding the borehole. For example, concrete or asphalt will be patched with concrete or asphalt of the same type and thickness, grassed areas will be seeded, and topsoil will be used in other areas. All solid waste materials generated during the decommissioning process must be disposed of properly.

8.0 DOCUMENTATION

A form which may be used in the field to record the decommissioning construction is included as Figure 3. Additional documentation may be required by a DEC project manager and samples are included in Appendix A. Programs within the DEC that maintain geographic data on monitoring wells strive to keep that data up to date. Owners of these data sets must be notified when a well is decommissioned. Historical groundwater quality data is linked to monitoring well locations so when a well is decommissioned, existing GIS data must be updated to reflect that fact but the coordinate location in the GIS database should not be eliminated. A metal detector may not be able to detect a deeply buried marker so if this locator is important for future utility runs or foundations, a map should be submitted to the property owner and the town engineer showing the decommissioned well locations. Global Positioning System (GPS) coordinates should be indicated on this map. Lastly, whatever documentation is produced should be provided to the property owner, the DEC, and all other parties involved.

9.0 FIELD OVERSIGHT

Over-drilling requires careful observation to detect whether the drill has wandered off the well. Grout preparation and tremie work should be carefully observed. The successful implementation of a decommissioning work plan depends upon proper direction, observation and oversight. Methods to be employed must be clearly worked through and all parties must understand what they have to do before going into the field. Flexibility is allowed where necessary but the work effort must be thorough and effective to protect our groundwater.

10.0 RELATED REFERENCES

- *Groundwater Monitoring Well Decommissioning Procedures*, October 1986. Prepared by Malcolm Pirnie, Inc., for the New York State Department of Environmental Conservation, Division of Environmental Remediation.

- American Society for Testing and Materials, A.S.T.M. D 5299-99, Standard Guide for the Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities. A.S.T.M.. Philadelphia. 2005.

- New York State Department of Environmental Conservation, Division of Solid and Hazardous Materials, 6 NYCRR Part 360, Solid Waste Management Facilities.

- New York State Department of Environmental Conservation, Region I - Water Unit, Specifications for Abandoning Wells and Boreholes in Unconsolidated Materials, undated.

- United States Environmental Protection Agency, The Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells, EPA 600/4-89/034.

FIGURES

APPENDICES

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FIGURE 1

MONITORING WELL FIELD INSPECTION LOG

FIGURE 1

SITE NAME:

SITE ID.: ______
INSPECTOR: ______
DATE/TIME: ______
WEll ID.: ______

MONITORING WELL FIELD INSPECTION LOG
NYSDEC WELL DECOMMISSIONING PROGRAM

	YES	NO
WELL VISIBLE? (If not, provide directions below)		
WELL I.D. VISIBLE?		
WELL LOCATION MATCH SITE MAP? (if not, sketch actual location on back).....................		

WELL I.D. AS IT APPEARS ON PROTECTIVE CASING OR WELL: ....

	YES	NO
SURFACE SEAL PRESENT?		
SURFACE SEAL COMPETENT? (If cracked, heaved etc., describe below)		
PROTECTIVE CASING IN GOOD CONDITION? (If damaged, describe below)		

HEADSPACE READING (ppm) AND INSTRUMENT USED.. ______
TYPE OF PROTECTIVE CASING AND HEIGHT OF STICKUP IN FEET (If applicable) ______
PROTECTIVE CASING MATERIAL TYPE: .... ______
MEASURE PROTECTIVE CASING INSIDE DIAMETER (Inches): ....

	YES	NO
LOCK PRESENT?		
LOCK FUNCTIONAL?		
DID YOU REPLACE THE LOCK?		
IS THERE EVIDENCE THAT THE WELL IS DOUBLE CASED? (If yes,describe below)		
WELL MEASURING POINT VISIBLE?		

MEASURE WELL DEPTH FROM MEASURING POINT (Feet): .... ______
MEASURE DEPTH TO WATER FROM MEASURING POINT (Feet): .... ______
MEASURE WELL DIAMETER (Inches): .... ______
WELL CASING MATERIAL: .... ______
PHYSICAL CONDITION OF VISIBLE WELL CASING: .... ______
ATTACH ID MARKER (if well ID is confirmed) and IDENTIFY MARKER TYPE .... ______
PROXIMITY TO UNDERGROUND OR OVERHEAD UTILITIES.. ______

DESCRIBE ACCESS TO WELL: (Include accessibility to truck mounted rig, natural obstructions, overhead power lines, proximity to permanent structures, etc.); ADD SKETCH OF LOCATION ON BACK, IF NECESSARY.

DESCRIBE WELL SETTING (For example, located in a field, in a playground, on pavement, in a garden, etc.) AND ASSESS THE TYPE OF RESTORATION REQUIRED.

IDENTIFY ANY NEARBY POTENTIAL SOURCES OF CONTAMINATION, IF PRESENT (e.g. Gas station, salt pile, etc.):

REMARKS:

FIGURE 2

DECOMMISSIONING PROCEDURE SELECTION

NYSDEC Monitoring Well Decommissioning Procedure Selection

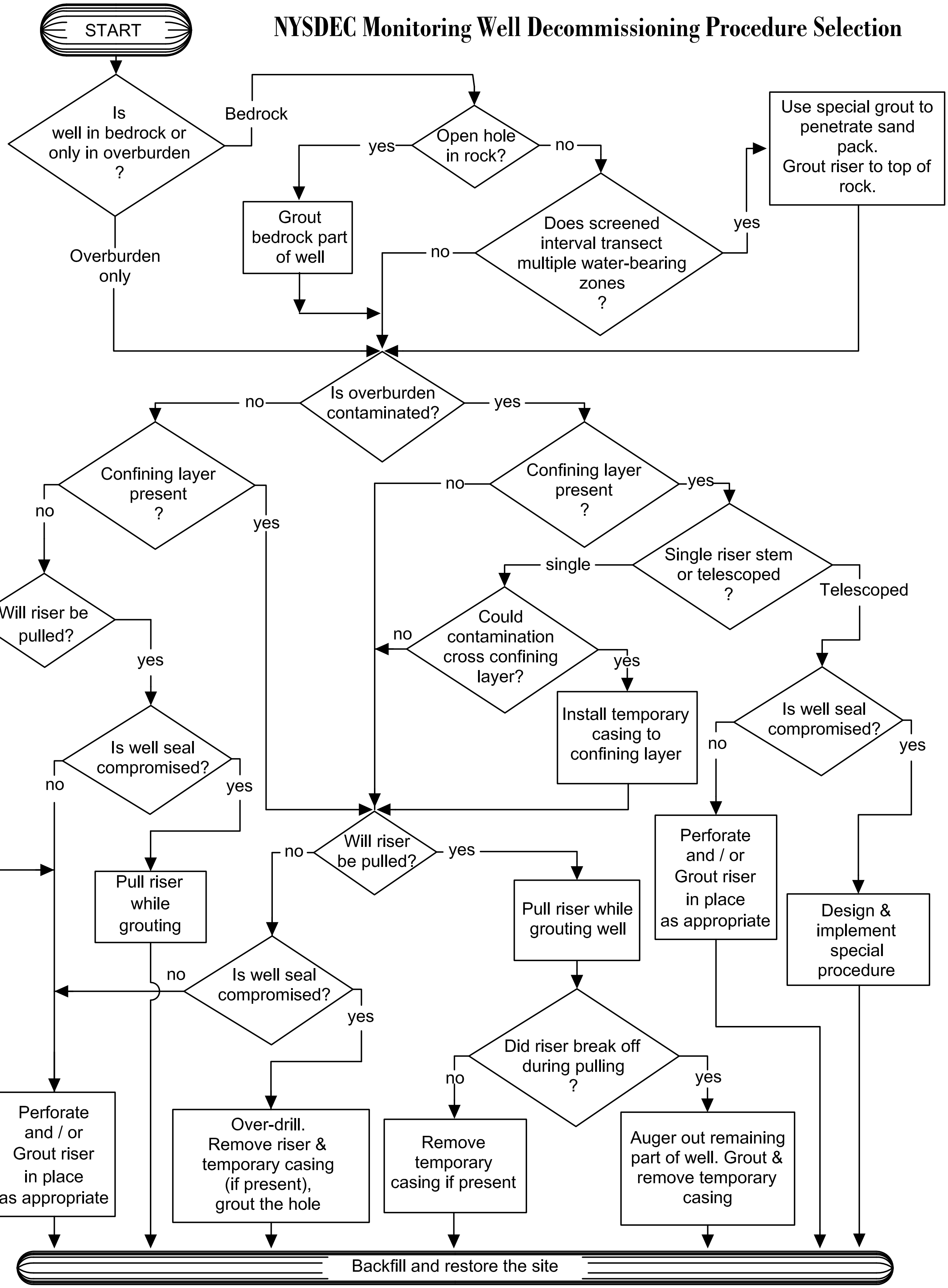


FIGURE 2

FIGURE 3

WELL DECOMMISSIONING RECORD

FIGURE 3

WELL DECOMMISSIONING RECORD

Site Name:	Well I.D.:
Site Location:	Driller:
Drilling Co.:	Inspector:
	Date:

DECOMMISSIONING DATA
(Fill in all that apply)

OVERDRILLING

Interval Drilled	
Drilling Method(s)	
Borehole Dia. (in.)	
Temporary Casing Installed? (y/n)	
Depth temporary casing installed	
Casing type/dia. (in.)	
Method of installing	

CASING PULLING

Method employed	
Casing retrieved (feet)	
Casing type/dia. (in)	

CASING PERFORATING

Equipment used	
Number of perforations/foot	
Size of perforations	
Interval perforated	

GROUTING

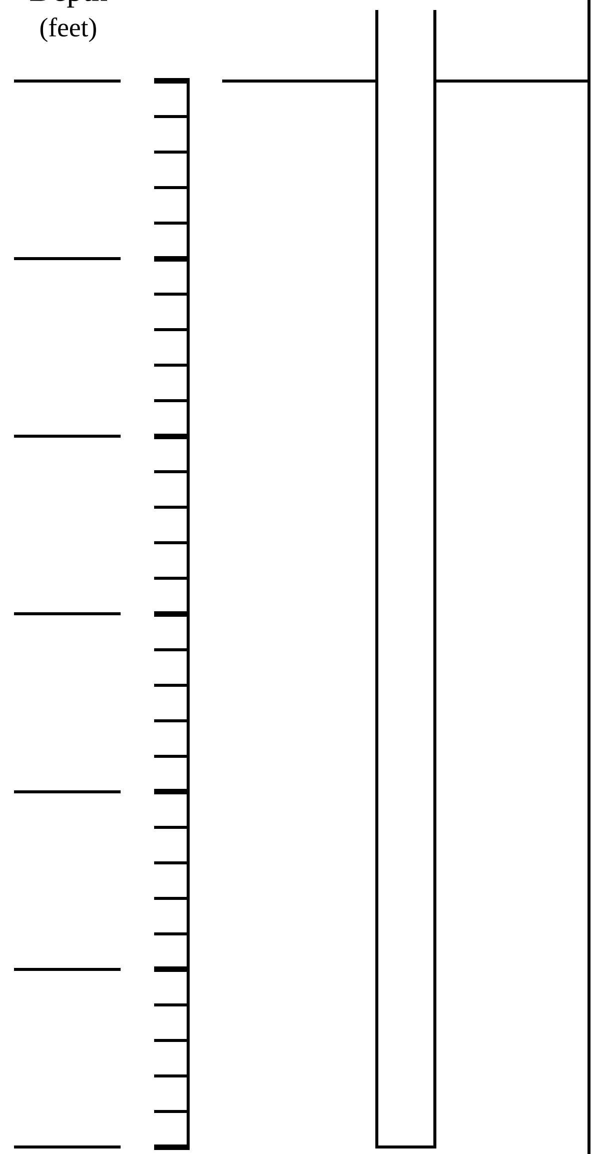
Interval grouted (FBLS)	
# of batches prepared	

For each batch record:

Quantity of water used (gal.)	
Quantity of cement used (lbs.)	
Cement type	
Quantity of bentonite used (lbs.)	
Quantity of calcium chloride used (lbs.)	
Volume of grout prepared (gal.)	
Volume of grout used (gal.)	

WELL SCHEMATIC*

Depth
(feet)



COMMENTS:

* Sketch in all relevant decommissioning data, including: interval overdrilled, interval grouted, casing left in hole, well stickup, etc.

Drilling Contractor

Department Representative

APPENDIX A - REPORTS

APPENDIX A1 - INSPECTOR'S DAILY REPORT

APPENDIX A2 - PROBLEM IDENTIFICATION REPORT

APPENDIX A3 - CORRECTIVE MEASURES REPORT

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Appendix A1

Inspector's Daily Report

CONTRACTOR:
ADDRESS:

TELEPHONE:
LOCATION ______________________ FROM __________ TO __________
WEATHER ______________________ TEMP ______ A.M. ______ P.M. ______ DATE __________

CONTRACTOR'S WORK FORCE AND EQUIPMENT

DESCRIPTION	*H*	*#*	*DESCRIPTION*	*H*	*#*	*DESCRIPTION*	*H*	*#*	*DESCRIPTION*	*H*	*#*
Field Engineer						Equipment			Front Loader Ton		
Superintendent			Ironworker			Generators			Bulldozer		
						Welding Equip.					
Laborer Foreman			Carpenter								
Laborer									Backhoe		
Operating Engineer			Concrete Finisher								
Carpenter						Paving Equip. & Roller					
						Air compressor					

SEE REVERSE SIDE FOR SKETCH YES ☐ NO ☐

WORK PERFORMED:

PAY ITEMS

CONTRACT		STA		DESCRIPTION	QUANTITY	REMARKS
Number	ITEM	FROM	TO			

TEST PERFORMED:
PICTURES TAKEN:

VISITORS:

QA PERSONNEL
SIGNATURE

REPORT NUMBER
SHEET ______ Of ______

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PROBLEM IDENTIFICATION REPORT

Date ______________________

Project ______________________ Job Number __________

Contractor ______________________

Subject ______________________

Day

Su	M	T	W	Th	F	Sa

Sky/Precip.	Clear	Partly Cloudy	Cloudy	Rainy	Snow
TEMP.	<32F	32-40F	40-70F	70-80F	80-90F
WIND	No	Light	Strong		
HUMIDITY	Dry	Mod.	Humid		

PROBLEM DESCRIPTION Reference Daily Report Number 1: ______________________

PROBLEM LOCATION - REFERENCE TEST RESULTS AND LOCATION (Note: Use sketches on back of form as appropriate):

PROBABLE CAUSES: ______________________

SUGGESTED CORRECTIVE MEASURES: ______________________

APPROVALS:

QA ENGINEER: ______________________

PROJECT MANAGER: ______________________

Distribution:

1. Project Manager
2. Field Office
3. File
4. Owner

QA Personnel
Signature: ______________________

MEETINGS HELD AND RESULTS

REMARKS

REFERENCES TO OTHER FORMS

SKETCHES

SAMPLE LOG

SAMPLE NUMBER

APPROXIMATE LOCATION OF STOCKPILE

NUMBER OF STOCKPILE

DATE OF COLLECTION

CLIMATIC CONDITIONS

FIELD OBSERVATION

SHEETS OF

CORRECTIVE MEASURES REPORT

Date ______________________

Project ______________________ Job Number __________

Contractor ______________________

Subject ______________________

Day	Su	M	T	W	Th	F	Sa

Sky/Precip.	Clear	Partly Cloudy	Cloudy	Rainy	Snow
TEMP.	<32F	32-40F	40-70F	70-80F	80-90F
WIND	No	Light	Strong		
HUMIDITY	Dry	Mod.	Humid		

CORRECTIVE MEASURES TAKEN (Reference Problem Identification Report No.): ______________________

RETESTING LOCATION: ______________________

SUGGESTED METHOD OF MINIMIZING RE-OCCURRENCE: ______________________

SUGGESTED CORRECTIVE MEASURES: ______________________

APPROVALS:

QA ENGINEER: ______________________

PROJECT MANAGER: ______________________

Distribution:

1. Project Manager
2. Field Office
3. File
4. Owner

QA Personnel
Signature: ______________________