GRAFTech International

GRAFTECH INTERNATIONAL HOLDINGS INC.

(Formerly UCAR Carbon Company, Republic Site)

Town of Niagara, Niagara County, New York

POST-CLOSURE LANDFILL SITE MANAGEMENT PLAN FOR SWMF #32N03 (Registry No. 932035)

Prepared by:

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October 23, 2018

(Replaces December 2013 SMP)

SITE MANAGEMENT PLAN REVISION LOG

Table 1 - Revisions to Landfill Site Plans

Revision Number	Submittal Date	Summary of Revision	NYSDEC Approval Date
		• Operation, Maintenance and Monitoring (OM&M) Plan	**November 2009**
1	**December 2013**	• Expanded the OM&M Plan to a Site Management Plan (SMP)	**November 2016**
2	**October 2018**	• Made administrative updates throughout the SMP • Reorganized the SMP and added additional sections, including: – an Executive Summary – a summary of prior site investigations – a summary of the site topology, geology and hydrogeology • Made a correction to Section 5.1 (renumbered) to change the inspection frequency from monthly to quarterly • Revised Section 7.2 (renumbered) to include site change of use provisions • Updated Section 7.3 (renumbered) to eliminate reporting redundancies per the NYSDEC letters dated February 25, 2016 and May 25, 2016	

		• Updated the Appendices and references to the Appendices throughout the SMP	

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ES EXECUTIVE SUMMARY

The following provides a brief summary of the controls implemented for the subject GrafTech Landfill Site, as well as the inspections, monitoring, maintenance and reporting activities covered by this Site Management Plan (SMP). **There is no required Remedial Program or Remedial Action Objectives established for this Landfill Site.** Therefore, GrafTech is submitting this SMP voluntarily to NYSDEC.

[SWMF #32N03; Registry No. 932035] [GrafTech International, Town of Niagara, NY]

Institutional Controls:	1. The property has no use restrictions other than local zoning.	
	2. There is no required Remedial Program or Remedial Action Objectives established for this Landfill Site.	
	3. Implementation of the provisions of this SMP.	
	IC/EC	**Frequency**
Inspections:	Engineered Cap Security Fence Groundwater Wells (Condition and Locks)	Weekly Weekly Quarterly
Monitoring:	Groundwater Monitoring	Annually, in the spring in even years and in the autumn in odd years
Maintenance:	Engineered Cap Security Fence Groundwater Wells	As needed As needed As needed
Notification/Reporting:	Soil Excavation Plan Change of Use Change of Ownership Periodic Review Report	15 days in advance 60 days in advance Within 10 business days Annually in January

Further descriptions of the above program elements are provided below.

1.0 SITE MANAGEMENT PLAN INTRODUCTION

1.1 General

This document is the Site Management Plan (SMP) for the GrafTech International Holdings Inc. (GrafTech) (formerly UCAR Carbon Company Inc.) closed landfill facility, SWMF #32N03 (formerly Republic Site, Registry No. 932035) (Landfill Site), located on Parcel # 130.20-1.1 in the Town of Niagara, Niagara County, New York. The Landfill Site is located off Hyde Park Blvd. behind the former UCAR Carbon Republic Plant (3501 Hyde Park Blvd.). The Landfill Site covers a total area of about 61.6 acres. The closed solid waste management unit covers a 16.48 acres area located in the northeast section of the Landfill Site.

This waste disposal facility was used exclusively by GrafTech (formerly UCAR Carbon Company, and the Carbon Products Division of Union Carbide Corporation) from 1934 until December 1986. In 1978, New York State Department of Environmental Conservation (NYSDEC) issued the state landfill permit No. 32N03, which was renewed as required throughout the active life of the waste disposal facility. The 16.48 acre landfill was closed in accordance with a NYSDEC-approved closure plan under Part 360 Solid Waste Management Facility (SWMF) Guidelines, which included the installation of an engineered cap, completed in June 1987. Groundwater monitoring was conducted at the Landfill Site as part of the state SWMF program requirements.

In 1984, the NYSDEC listed the GrafTech Landfill Site on the Registry for Inactive Hazardous Waste Disposal Facilities pursuant to ECL 27-1305 as a Class 2a site, due to the very small amount of hazardous substances disposed on-site. However, following several subsequent federal and state studies of the Landfill Site, including a Phase I investigation and a Preliminary Site Assessment, it was determined that the Landfill Site does not present a significant threat to the public or to the environment. Further details regarding these past investigations are provided below in Section 2.3 – Landfill Site Investigations History.

NYSDEC subsequently reclassified the Landfill Site in September 1997 from a Class 2a to a Class 4 Inactive Hazardous Waste Site, requiring on-going monitoring (see **Appendix M**). Thus, **there is no Remedial Program required or Remedial Action Objectives established for this Landfill Site** under subpart 375-2 for Inactive Hazardous Waste Disposal Facilities.

There is also no current or past Brownfield Cleanup Agreement (BCA), State Assistance Contract (SAC), Order on Consent, Voluntary Cleanup Agreement (VCA), or required Environmental Easement associated with this Landfill Site.

GrafTech voluntarily submitted the initial proposed SMP to the New York State Department of Environmental Conservation (NYSDEC) Region 9 on December 17, 2013, to bring the Plan in line with the applicable sections of the NYSDEC Program Policy DER-10 Technical Guidance for Site Investigation and Remediation, dated May 2010. The more comprehensive 2013 SMP incorporated and replaced the prior Operation, Maintenance and Monitoring (OM&M) Plan, which the state had previously approved on November 4, 2009. Mr. Glenn May, Environmental Geologist II, NYSDEC, issued a letter on November 17, 2016 (see **Appendix F**) approving GrafTech's proposed December 2013 SMP. This SMP meets the minimum applicable requirements of the provisions of the Inactive Hazardous Waste Site Program, administered by the NYSDEC, Division of Environmental Remediation (DER).

Prior to May 2016, this Landfill Site was being managed under the state programs of both the DERo and the Division of Materials Management (DMM). In 2016, NYSDEC communicated to GrafTech that, going forward, the Landfill Site would be managed solely under the DER programs, thereby eliminating some prior oversight and reporting redundancies (see NYSDEC DMM letter dated February 25, 2016, in **Appendix G**). The changes to the reporting requirements for the Landfill Site as a result of that 2016 NYSDEC decision have been incorporated into Section 7.0 of this revised 2018 SMP.

Due to the above status of the Landfill Site, the scope of this updated 2018 SMP is limited to post-closure management, consisting of Engineering Controls, and

Institutional Controls in the form of a Groundwater Monitoring Plan; an Operation and Maintenance Plan, including the inspection program; contingency plans and notification requirements for soil excavation, change of use, property ownership transfers, and well decommissioning; and annual reporting to the NYSDEC DER in accordance with the state Periodic Review and Reporting (PRR) requirements.

1.2 Landfill Site Resources

GrafTech designates a current employee, contract employee, or third party contractor to be the responsible manager (Designated Manager) for the Landfill Site. GrafTech also has a qualified person on contract (GrafTech-Designated Representative), who functions as the local point-of-contact and is responsible for the day-to-day operations at the Landfill Site, including carrying out the routine site management activities described in this SMP. Additional details are provided below.

All official correspondence from the state concerning the Landfill Site should be provided to the Designated Manager. As of November 2018, the GrafTech Corporate Health, Safety and Environmental Manager is the Designated Manager responsible for managing the Landfill Site. This position is currently filled by Ms. Julianne Snyder. Her contact information is provided below.

Julianne Snyder
Corporate Health, Safety and Environmental Manager
GrafTech International Holdings Inc.
982 Keynote Circle, Brooklyn Heights, OH 44131
Office: 216-676-2304
Email: Julianne.Snyder@GrafTech.com

The Designated Manager is responsible for full conformance with the SMP, including following applicable company procedures to allocate the necessary resources and to contract with third parties for services, as needed, to perform the routine inspections, environmental monitoring and maintenance at the Landfill

Site as described in this Plan; and, whenever necessary, to implement the appropriate corrective actions that adequately and timely address any identified deficiency.

The GrafTech-Designated Representative functions as the local point-of-contact and conducts the day-to-day management activities at the Landfill Site, as further described in this SMP. These responsibilities include conducting the specified site inspections; making or scheduling maintenance and repairs, as needed, to the Engineered Controls; and, responding to neighborhood requests. The GrafTech-Designated Representative is also responsible for communicating to the Designated Manager any site security concerns; when additional resources may be needed; any significant issue that could prevent full conformance with the provisions of this SMP; and, any other important matters concerning the Landfill Site that may be outside the scope of this Plan.

Since 2012, GrafTech has contracted with the National Maintenance Contracting Corporation to provide these services and serve as the GrafTech-Designated Representative. Contact information is provided below:

Mr. Samuel Lehr
National Maintenance Contracting Corp.
5600 Niagara Falls Blvd.
PO Box 258
Niagara Falls, NY 14304
24/7 MOBILE: (716) 695-5042
Fax: (716) 285-3580

The NYSDEC DER, the Niagara County Director Environmental Health, and the Town of Niagara Clerk will be notified should there be a significant change to the above contact information.

SUMMARY OF PREVIOUS LANDFILL SITE INVESTIGATIONS

1.3 Landfill Site Location and Description

The GrafTech closed Landfill Site (Registry No. 932035, SWMF #32N03) is located off Hyde Park Blvd. behind the former Republic Plant (3501 Hyde Park Blvd.) on Parcel #130.20-1.1 in the Town of Niagara, Niagara County, New York. The Landfill Site covers a total area of about 61.6 acres. The capped landfill comprises 16.48 acres in the northeast portion of the Landfill Site.

1.4 Landfill Site Physical Setting (Topography, Geology and Hydrogeology)

NYSDEC conducted a Preliminary Site Assessment (PSA) of the Landfill Site and published a report entitled "Engineering Investigations at Inactive Hazardous Waste Sites in the State of New York, Preliminary Site Assessment, Volume 1, Union Carbide Corporation, Carbon Products Division Site, Site Number 932035, Town of Niagara, Niagara County, New York, April 1995". This site assessment report includes descriptions of the Landfill Site topography, geology and hydrogeology in Sections 3.4.2. and 3.4.3.; excerpts are provided below.

The Landfill Site is located on a flat plain at an elevation of 600 feet above sea level, in a >500 year floodplain. The Niagara Escarpment is located 3 miles north, which has an approximately 250 foot elevation change and runs roughly east and west. A flat plain area extends east of the Landfill Site, which has a slight rise in elevation to the east. The Niagara Gorge is approximately 3 miles away to the southwest.

The geology beneath the Landfill Site contains a relatively thin overburden cover, ranging from about 7 feet thick on the eastern portion of this property, to about 20 feet below the original ground surface on the western portion (excluding the raised landfill that is approximately 30 feet above grade and the layer of fill materials). This confining overburden consists of a layer of up to 18 feet thick glaciolacustrine clay and silt, and a relatively thin layer of glacial till beneath the clay layer. This overburden lies above a fractured Lockport Dolostone bedrock of the Middle Silurian-age Lockport group.

Groundwater is present beneath the site in both the overburden and the bedrock. The saturated zone in the overburden is primarily composed of stratified glaciolacustrine sediments of clay, silt, and sand over a more dense glacial till made up of unsorted clay to cobble-size particles. These clay and till layers are defined as aquitard units, which restrict the migration of perched groundwater, both horizontally and vertically, from reaching the underlying bedrock at a depth of approximately 20 feet. Based on the results of the 1987 study commissioned by GrafTech of its six (6) bedrock groundwater monitoring wells, BW1 – BW6, the predominant bedrock groundwater flow is easterly.

According to the 1995 PSA Report, the bedrock aquifer is the principal source of groundwater in the Niagara Falls area. It should be noted, however, that the 1987 report of the previous NYSDEC investigation of the Landfill Site indicates that area residents obtain drinking water from municipal supplies, sourced by the west branch of the Niagara River, and that the intakes from the river are located more than 3 miles upstream from the Landfill Site. GrafTech has confirmed that the area residents do currently receive their drinking water from the Niagara County Water District and that the source of this water is the Chippawa Channel of the Niagara River.

The Lockport is 80 to 158 feet thick in the area and can be divided into two (2) major water-bearing zones. The upper zone is located in the top 10 to 25 feet of rock, beneath its contact with the overburden. This upper zone is moderately permeable and contains relatively abundant horizontal bedding planes and vertical joints, both of which have been enlarged by dissolution of the dolostone rock matrix and solution cavities left by dissolution of gypsum. The lower water-bearing zone contains low to moderately permeable bedding lanes, of which as many as seven (7) have been identified that are between fine-grained crystalline dolostone layers of low permeability. Hydraulic conductivity of the upper bedrock zone ranges from 1.8×10^{-3} to 5.3×10^{-3} cm/sec, while the lower zones range from 3.53×10^{-4} to 7.06×10^{-4} cm/sec (Maslia and Johnstone 1982).

Most of the recharge to the bedrock aquifer is from the infiltration of rainfall and snowmelt through the overburden. Precipitation in the Niagara Falls area

averages 30 inches per year. Most recharge occurs from November to April when evapotranspiration is lowest (USGS 1987). The rate of recharge depends on the thickness, degree of saturation and permeability of the overlying unconsolidated deposits, which ranges from 4.0×10^{-7} to 9.5×10^{-5} cm/sec. The average annual recharge from precipitation is estimated to be 5 to 6 inches per year (LaSala 1967), but is greater where the bedrock is at or near the surface. Generally, water levels fluctuate less than six (6) feet annually.

The cited PSA report has a lengthy discussion regarding the potential impact of the New York State Power Authority (NYPA) Niagara Hydroelectric Power Plant Project on the GrafTech Landfill Site. The conclusions were that, while the pumping of water from the conduit drainage system of the two (2) power plants does affect the potentiometric surface of the bedrock groundwater in the surrounding area, there is no correlation between the fluctuating water elevations at the power plants and the measured water levels in the monitoring wells at the Landfill Site; thus, indicating that those conduits at the power plants are sufficiently sealed from the surrounding groundwater.

1.5 Landfill Site Investigation History

The U.S. Environmental Protection Agency (EPA) Region 2 and NYSDEC both conducted site investigations at the Landfill Site in the late 1980s. The 1988 EPA report concluded that the site was not a significant source of concerns for the off-site migration of contaminants. NYSDEC published a report entitled "Engineering Investigations at Inactive Hazardous Waste Sites in the State of New York, Phase I Investigations, Union Carbide - Carbon Products Division, Niagara Falls, Niagara County, New York Site Code 932035, January 1987". This report concluded that additional investigation was necessary in order to identify the types and concentrations of disposed materials, and the potential health and environmental hazards. Subsequently, NYSDEC conducted a Preliminary Site Assessment in the 1990s and published a final report entitled "Engineering Investigations at Inactive Hazardous Waste Sites in the State of New York, Preliminary Site Assessment, Union Carbide Corporation, Carbon Products Division, Niagara Falls, Niagara County, New York Site Code 932035,

April 1995". The PSA investigation concluded that the site does not present a significant threat to the public health or to the environment. NYSDEC subsequently reclassified the Landfill Site from a Class 2a to a Class 4 Inactive Hazardous Waste Site in September 1997 (see **Appendix M**), thus requiring continued management. **There are no Remedial Program requirements or Remedial Action Objectives for this Landfill Site.**

2.0 INSTITUTIONAL AND ENGINEERING CONTROLS (IC/EC) PLAN

3.1 Institutional Control

The institutional control in place is the implementation of this SMP that includes a Monitoring Plan, which specifies the groundwater monitoring program; and an Operation and Maintenance Plan, which specifies the routine facility inspections for the engineered cap and the security features of the Landfill Site, site maintenance, and recordkeeping requirements. The inspection and groundwater monitoring programs are designed and conducted to ensure the EC remain in place, are properly maintained and continue to be effective.

Groundwater monitoring for Contaminants of Concern is conducted annually per an established rotating schedule. Further details of the groundwater monitoring program are provided below in subsection 4.1 of Section 4.0 - Monitoring Plan. No soil vapor monitoring program is required for the Landfill Site, based on the results of a prior soil vapor monitoring investigation; details are provided below in subsection 4.2 of Section 4.0 - Monitoring Plan. Facility inspections are performed at determined frequencies, both weekly and quarterly, and are documented. Further details of the site inspection, maintenance and recordkeeping programs are provided below in Section 5.0 - Operation and Maintenance Plan.

3.2 Engineering Controls

The engineering controls (EC) in place at the Landfill Site include a physical barrier, which is an engineered cap installed in 1987 under the SWMF requirements to contain and eliminate potential exposure pathways to

contaminants in the waste disposal area. The engineered cap consists of 18 inches of clay, a 3-inch drainage layer, a 6-inch topsoil layer, and a vegetative cover. While the landfill area is unlined, the underlying clay and till layers have been defined as aquitard units, and therefore act as a naturally-occurring liner.

Another EC employed at the Landfill Site is a security system consisting of an eight (8) foot high metal hurricane-style perimeter fence topped with barb wire, and two (2) gates, which are kept locked to restrict unauthorized access. In addition, the casing on each groundwater monitoring well is equipped with a locking device and padlock, which is kept locked except when drawing samples, to help prevent unauthorized access and potential contamination to groundwater.

3.0 MONITORING PLANS

3.1 Monitoring Plan for Groundwater

The permitted Solid Waste Management Facility at the Landfill Site was closed and capped in 1987. A groundwater monitoring well network was installed at the Landfill Site to conduct site investigations and to monitor the groundwater quality to evaluate the long-term effectiveness of the Engineered Controls. This groundwater monitoring network consisted of twelve (12) on-site wells installed in both the overburden and bedrock. The state installed six (6) additional monitoring wells on-site in 1993. Refer to the eighteen (18) well numbers and locations in **Appendix I**.

Two (2) additional groundwater monitoring wells, GW-10A (overburden) and GW-10B (bedrock), are located outside the Landfill Site perimeter security fencing on neighboring property not owned by GrafTech. Following GrafTech's request during a state inspection of the Landfill Site in May 2010, NYSDEC subsequently reviewed the state records and confirmed that NYSDEC had installed and still owns these two (2) wells. Thus, GrafTech is not responsible to secure, maintain or sample these wells and, therefore, they are not covered under the SMP programs.

Twelve (12) of the on-site groundwater wells were monitored from 1987 through 2005, and then seven (7) of these wells were monitored from 2006 through 2017.

Further details of the past monitoring programs for groundwater are provided below.

Between 1987 and 2000, groundwater monitoring was conducted quarterly at all on-site wells. In 2000, the post-closure groundwater monitoring program and the collected groundwater quality data from 1987 to 2000 were reviewed cooperatively by GrafTech and the NYSDEC DER, represented by Mr. Michael Hinton, and the NYSDEC DMM, represented by Ms. Mary McIntosh. Based on that review, a modified groundwater monitoring program was designed to meet the requirements of 6 NYCRR Section 360 for solid waste landfill closures, and to continue to monitor the effectiveness of the established Landfill Site IC/EC in protecting groundwater quality. The modified post-closure groundwater monitoring program, which was implemented from April 2000 to 2005, consisted of semi-annual sampling of twelve (12) on-site monitoring wells for the selected parameters (listed in **Table 2).** (Refer to the letter from Ms. Mary E. McIntosh, NYSDEC DMM, to Mr. Robert Bucci (a former GrafTech Designated Representative), dated January 18, 2000 in **Appendix C**).

In 2005, the post-closure groundwater monitoring program and historical data for the Landfill Site were again reviewed by GrafTech, and Mr. Michael Hinton and Ms. Mary McIntosh of the NYSDEC DER and DMM, respectively, and a modified groundwater monitoring program in conformance with 6 NYCRR Section 360 was approved Pertinent communications regarding the post-closure monitoring requirements include comments received from NYSDEC (see letter from Ms. Mary McIntosh, dated September 20, 2005 in **Appendix D**), and responses from Conestoga-Rovers & Associates (CRA) on behalf of GrafTech (see letter dated November 4, 2005 in **Appendix E)**.

As agreed by the above parties, a revised groundwater monitoring program for the Landfill Site was implemented starting in the autumn 2006 sampling campaign, which consisted of an annual sampling of a network of seven (7) selected on-site wells, including five (5) of the twelve (12) monitoring wells installed by GrafTech (BW-1, BW-2, BW-3, BW-4, and MW-3) and two (2) of the six (6) wells installed by the state (GW-8B and GW-9B). The annual sampling event is

conducted on a staggered schedule, rotating every year between spring and autumn. The annual sampling is completed in the spring of every odd year and in the autumn of every even year. The groundwater samples have been analyzed for the following parameters every year through 2017, using the referenced EPA standard test methods (see **Table 2**).

TABLE 2

PARAMETERS	METHODOLOGY
Volatile Organic Compounds (VOCs)	SW-846 8260B (September 1986 with all subsequent revisions)
Total and Dissolved Iron, Potassium and Zinc	SW-846 6010 (September 1986 with all subsequent revisions)
Ammonia	USEPA 350.1 (March 1983 with all subsequent revisions)
Nitrite	USEPA 353.2 (March 1983 with all subsequent revisions)
Total Kjeldahl Nitrogen (TKN)	USEPA 351.2 (March 1983 with all subsequent revisions)
Turbidity	Field Measurement
Specific Conductance	Field Measurement
pH	Field Measurement
Temperature	Field Measurement

Analytical results are compared to the New York State Class GA water criteria and to the historical monitoring data available for the Landfill Site.

In 2017, following thirty (30) years of post-closure groundwater monitoring, GrafTech evaluated the historical data collected. Subsequently, in January 2018, GrafTech submitted a proposal to NYSDEC in its 2017 Periodic Review Report to again modify its monitoring program by reducing the number of on-site wells being sampled from seven (7) to three (3), and by dropping specific parameters. The NYSDEC communicated in a letter dated February 8, 2018, that it had considered GrafTech's proposal and, after their review of the historical data, trend charts and parameter applicability, approved GrafTech's proposal (see **Appendix H**), with one significant change. In its PRR, the three (3) wells that GrafTech had proposed to continue monitoring were the background well BW-4 and GW-8B, both bedrock wells located upgradient of the Landfill Site along the Niagara Mohawk Right-of-Way; and the bedrock well GW-9B, located at the southern border of the Landfill Site near the residential area on Rhode Island Avenue. NYSDEC instead approved keeping bedrock well BW-3 in the current monitoring program, which is located along the eastern border of the landfill cap, rather than GW-9B located at the southern border of the Landfill Site.

Therefore, starting with the autumn 2018 groundwater monitoring campaign, the modified monitoring program includes the following three (3) bedrock monitoring wells, BW-3, BW-4 and GW-8B. Field measurements for temperature, conductivity, turbidity, dissolved oxygen, pH, and oxidation-reduction potential (ORP) are taken at these monitoring wells to determine when a well has reached stabilization and representative samples can be taken. The samples are analyzed for VOCs, using the referenced EPA standard test methods (refer to **Table 3**). Analytical results are compared to the New York State Class GA water criteria and to the historical monitoring data available for the Landfill Site. Consistent with the former CRA Field Sampling Plan dated 2000, groundwater elevations are measured and recorded at eight (8) on-site bedrock wells (BW-1 through BW-6, GW-8B and GW-9B) during each annual monitoring campaign. A potentiometric contour map for the bedrock groundwater zone in the landfill area and graphs of the historical concentrations for select VOCs are prepared and submitted with the PRR.

The above-described annual groundwater monitoring program is implemented as of 2018, and will continue to be administered in accordance with this 2018 SMP until such time as GrafTech receives direction or approval from the NYSDEC to modify the sampling frequency, parameters, methodologies, etc., or receives the NYSDEC's approval to discontinue the annual monitoring program following their review and assessment of the historical collected data for the Landfill Site.

TABLE 3

PARAMETERS	METHODOLOGY
Volatile Organic Compounds (VOCs)	SW-846 8260C (August 2006, Revision 3, and with all subsequent revisions)
Temperature, Conductivity, Turbidity, Dissolved Oxygen, pH, and Oxidation-Reduction Potential (ORP)	Field Measurements

As of October 2018, GrafTech continues to contract with GHD (formerly CRA) for groundwater sampling services at the Landfill Site. During each annual groundwater monitoring campaign, GHD follows standard recognized field procedures to collect representative groundwater samples, and follows QA/QC and data validation procedures in accordance with state requirements and current recognized industry standards (see **Appendices J and K**). The collected samples are then sent to TestAmerica Lab to be analyzed for the selected parameters using the specified standard analytical procedures. GrafTech subsequently requested clarification from NYSDEC as to the minimum analytical data validation requirements. On June 6, 2018, NYSDEC DER confirmed in writing that Category B Data Deliverables was no longer necessary. Therefore, starting with the 2018 annual groundwater sampling campaign, the analytical data are validated in accordance the with the Category A Data Deliverables standard.

GrafTech reserves the right to enter into contracts with other qualified environmental consulting companies and/or laboratories for the above services. GrafTech will only contract with an accredited laboratory, holding a current

certification in the state's Environmental Laboratory Accreditation Program (ELAP), to provide analytical services for compliance with this groundwater monitoring program.

3.2 Well Decommissioning Plan

There are currently 15 inactive groundwater wells on-site, including eight (8) overburden wells (MW-1, MW-2, MW-3, WW-1, OW-1, OW-2, GW-8A and GW-9A) and seven (7) bedrock wells (BW-1, BW-2, BW-5, BW-6, GW-7B, GW-9B and GW-11B). Several of these wells have not been sampled since 2005 or before, and the well logs for two (2) of the overburden wells (MW-1 and MW-2) indicate that they were installed through the waste body. In the event that GrafTech wants to permanently close any of these inactive wells, it will submit a proposal to NYSDEC for approval. Any well closures will be completed in accordance with applicable state requirements, which currently is the NYSDEC CP-43 Groundwater Monitoring Well Decommissioning Policy.

3.3 Soil Vapor Monitoring

On August 21, 2006, GrafTech received a written request from the NYSDEC to conduct a soil vapor intrusion evaluation at the Landfill site, based on the facts that some chlorinated aliphatic compounds had been detected during the 2005 groundwater sampling event in bedrock wells located along the northern property boundary, and that there are residential properties adjacent to the southern boundary of the site. Despite numerous low risk factors at the Landfill Site, GrafTech agreed to voluntarily perform the requested study along the southern property boundary along Rhode Island Avenue to assess the potential for soil gas presence and migration in the direction of the bordering residential properties.

In October 2006, GrafTech submitted a written Soil Gas Investigation Work Plan for agency approval. The Work Plan conformed to the applicable requirements of the "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" prepared by the New York State Department of Health (February 2005 Public Comment Draft). NYSDEC reviewed that plan in December 2006 and recommended GrafTech add a fourth soil gas probe at the west side near the

access road to the Landfill Site. In January 2007, GrafTech resubmitted a revised written Soil Gas Investigation Work Plan based on agency comments, for their approval. On February 8, 2007, NYSDEC approved the revised Work Plan inclusive of the following three (3) conditions: that the study be completed before March 31, 2007; that a Data Usability Summary Report following the agency guidelines be included; and that a community Fact Sheet was not required unless additional investigation, based on the results of the initial vapor intrusion study, required the performance of off-site work.

NYSDEC was advised of the schedule in advance, and on March 8, 2007, four (4) soil vapor implants were installed along the south fence line of the property in order to collect soil gas samples near the residences along Rhode Island Avenue. On March 26, 2007 these implants were purged for approximately twenty-five (25) minutes. On March 27, 2007, the four (4) soil vapor implants were sampled using one-(1) liter vacuum canisters. The vacuum canisters were allowed to collect soil gas from each implant for a minimum of two (2) hours, and a maximum of three (3) hours; none of the canisters drew in any (or enough) air for analysis. The purge pump was again connected to the implant tubing and the discharge from the pump checked for helium. Again the pump rates dropped to zero (0) cc/min, indicating no soil gas drawn from the implant, and no helium was noted in the discharge from the pump. After a minimum of two (2) hours, the volume of soil vapor drawn into each cylinder at the four (4) sampling locations was insufficient to analyze the contents in the laboratory. The inability to draw soil vapor from any of the implants suggests that the clay soils are too tight to allow migration of vapors. On May 5, 2007, GrafTech submitted the results of the attempted soil vapor sampling event in March 2007 with the conclusion that no threat was posed to neighboring residential properties and recommended that no further action concerning vapor studies was warranted.

On December 29, 2008, the NYSDEC and the New York State Department of Health (NYS DOH) informed GrafTech, in writing, that they had reviewed the submitted Soil Intrusion Evaluation report for the GrafTech Republic Landfill Site report, dated May 2, 2007. Furthermore, both agencies determined that the

potential for soil vapor intrusion into neighboring homes and businesses had been satisfactorily evaluated and concurred with GrafTech's recommendation that no further action is needed at this Landfill Site regarding soil vapor intrusion (see **Appendix L**). Therefore, no vapor intrusion monitoring program is required for this Landfill Site.

4.0 OPERATION AND MAINTENANCE (O & M) PLAN

4.1 Site Inspections and Records

Routine inspections of the facilities and controls at the Landfill Site are conducted and the results are documented by the GrafTech-Designated Representative (refer to **Appendices A and B** for the standard weekly and quarterly inspection forms, respectively). The GrafTech-Designated Representative is responsible for scheduling and managing the routine maintenance, repairs or any other actions needed to correct any deficiencies identified during these periodic inspections.

Details are provided below of the weekly and the quarterly inspection programs.

General Landfill and Site Security Inspections and Records - Weekly

The following areas are to be inspected once per week and the inspection results documented on the standard inspection form (See **Appendix A**).

1) Fence (general condition, evidence of security breaches).
2) Gate (general condition, lock, evidence of security breaches).
3) Cap (general condition, signs of erosion, adequate vegetation).
4) Surrounding area (general condition).
5) Note: should any evidence of a site security breach be found during the above inspections, the groundwater well installations will also be inspected for potential tampering or damage, and those inspections documented on the standard quarterly monitoring well inspection form (see **Appendix B**).

Any noted deficiency will be identified on the inspection record and the corrective action documented on a subsequent inspection record when completed. Any

fence areas that are found to be damaged will also be duly noted on the inspection map.

Groundwater Monitoring Well Inspections and Records - Quarterly

The GrafTech-Designated Representative, or another contracted inspector, inspects all the active on-site GrafTech-owned groundwater monitoring well installations quarterly to ensure they are kept in good condition and are properly secured with a lock. The inspector records his/her name, the date and time of the inspection, the inspection results and any recommended corrective actions (see **Appendix B**).

1) Closed locks on the well casing caps.
2) Outer casing.
3) Concrete seals.

Documentation of any needed corrective actions is recorded on the subsequent inspection record when completed.

Copies of completed inspection forms are made available for review during scheduled NYSDEC site inspections, or copies can be provided upon written request.

4.2 Routine Maintenance and Repairs

Repairs are scheduled with outside contractor(s) as needed to ensure that any deficiencies discovered during the routine inspections are timely corrected.

Lawn mowing and other general care are scheduled, as needed. The area outside of the landfill cap is typically mowed three (3) times per year or more frequently, if needed, depending on the amount of rainfall and other factors affecting the growing season. The capped area is cut a minimum of once per year after September 1st.

General clean-up of any debris along the fence line, etc. is performed, as needed, to keep the Landfill Site clear of any objectionable or unsightly materials.

4.3 Record Retention

Inspection and maintenance records are stored off-site, as there is no adequate document storage facility at the Landfill Site. Completed weekly inspection forms for the requested period of interest are made available to the NYSDEC for review during prescheduled site inspections. Copies of the inspection forms in electronic format will be made available to the state within ten (10) business days of receiving a written request from the NYSDEC. All inspection records are retained for a minimum of three (3) years by GrafTech, by the GrafTech-Designated Representative, or by a document storage service facility under contract with GrafTech.

5.0 PERIODIC REVIEWS AND ASSESSMENTS

5.1 Groundwater Monitoring Data

The groundwater monitoring data is reviewed annually to compare with the applicable state water quality criteria and the prior sampling results. If a discernible negative trend in groundwater quality is observed, the IC/EC and monitoring programs will be reviewed again to ensure that they are still adequate. If the negative trend continues, the potential source(s) of the contaminant(s) will be evaluated to determine the cause(s) and, if appropriate, a corrective action plan developed and implemented. Any proposed amendments to the IC/EC and/or monitoring programs will be discussed and approved by NYSDEC DER, before implementation. See **Appendix I** for the Landfill Site Plan and Groundwater Well Locations for the Post-Closure Monitoring Program.

5.2 Site Management Plan

The SMP is reviewed every five (5) years to ensure that the Plan is current with NYSDEC policies, regulations and recognized best management practices. The first review of the NYSDEC-approved 2013 SMP was due by December 31, 2018. Any changes to the SMP deemed appropriate by GrafTech after conducting each five (5) year review, or at any time in the interim, are timely communicated to the NYSDEC and a revised SMP submitted for approval. All submissions of

proposed revisions to the SMP and subsequent approvals received from NYSDEC is recorded on the SMP revision log.

The first review of the NYSDEC-approved 2013 SMP was completed in October 2018. The appropriate changes have been incorporated into this revised 2018 SMP (refer to the Revision summary located at the beginning of this document).

6.0 NOTIFICATION AND REPORTING REQUIREMENTS

6.1 Soil Excavation Plan Provisions

No soil excavation work plan is included in this SMP because GrafTech has no immediate plans or anticipates any future plans to excavate and/or remove soils from the Landfill Site. GrafTech will prepare and submit a written Soil Excavation Work Plan (EWP) to the NYSDEC for approval, no later than fifteen (15) days prior to commencing such activities, should this situation change at any time in the future.

Such notification will include, as applicable:

- A detailed description of the work to be performed, including the location and areal extent of excavation, plans/drawings for site re-grading, intrusive elements or utilities to be installed below the soil cover, estimated volumes of contaminated soil to be excavated and any work that may impact an engineering control;
- A summary of environmental conditions anticipated to be encountered in the work areas, including the nature and concentration levels of contaminants of concern, potential presence of grossly contaminated media, and plans for any pre-construction sampling;
- A schedule for the work, detailing the start and completion of all intrusive work;
- A summary of the applicable components of this EWP;
- A statement that the work will be performed in compliance with this EWP and 29 CFR 1910.120;

- A copy of the contractor's health and safety plan (HASP), in electronic format;
- Identification of disposal facilities for potential waste streams; and identification of sources of any anticipated backfill, along with all required chemical testing results.

6.2 Property Change of Use and Ownership Transfer Provisions

GrafTech has no immediate plans or anticipates any future plans to divest the Landfill Site or to make any physical alterations or use the Landfill Site for any other purpose, any of which could constitute a "change in use" (definition copied below), and which thus could make it subject to the applicable provisions of the state regulation (6 NYCRR 375-2) developed pursuant to the New York Environmental Conservation Law (ECL) §27-1317.

> "Change of use" means the erection of any structure on a site, the paving of a site for use as a roadway or parking lot, the creation of a park or other recreational facility on a site, any activity that is likely to disrupt or expose contamination or increase direct human or environmental exposure, or any other conduct that will or may tend to prevent or significantly interfere with a proposed, ongoing, or completed remedial program."
> (6 NYCRR 375-2.2)

These provisions require that no person may change the use of an inactive hazardous waste disposal site that has been placed on the Registry without first notifying, in writing, the Commissioners of both the NYSDEC and Health Department at least sixty (60) days before the physical alteration of the land, construction, or change in use is to commence; and without prior written approval from both agencies. In the event that GrafTech's plans change for the Landfill Site, it will comply with the applicable provisions.

Furthermore, should all or part of the Landfill Site be sold in the future, GrafTech will notify NYSDEC within fifteen (15) days of the transfer of ownership, in accordance with 6 NYCRR 375-1.11(d). This notification shall provide, at a minimum, the name of the new owner and the new owner's contact information,

including a contact representative and the contact information for such representative.

Provisions will also be made to timely transfer management responsibilities for the Landfill Site to the new owner, including the routine site inspections, and the required notifications and reports to the NYSDEC. GrafTech will provide site related documentation to the new owner, including a copy of the approved SMP, with any proposed updates; the completed inspection reports; the last PRR submitted to the NYSDEC; and the signed IC/EC certification for the period of time between January 1st of the year of the transfer of ownership, and the property sale closing date.

The new owner will be responsible for complying with all provisions of the SMP from the date of closing the sale transaction, including submittal of the PRR to the NYSDEC by the established due date for the calendar year in which the property is divested, and meeting the IC/EC certification requirements.

Furthermore, should GrafTech divest the Landfill Site, the new Owner will also be responsible to meet the sixty (60) day pre-notification requirements in addition to all other applicable change of use requirements of 6 NYCRR 375-2, if a change of use is planned for the site. The date of the change of ownership, the date of document transfer from GrafTech to the new owner, and the change of use designation, if applicable, will be reported by the new owner in the first PRR submitted to the NYSDEC, following the closure of the sale transaction for the Landfill Site.

6.3 Emergency Action Notification

Notification of actions undertaken in response to an emergency situation for which prior written notice could not be provided to the NYSDEC is made in accordance with applicable provisions of DEC-10 Policy Section 1.4 Notifications part (d) and 6 NYCRR 375-1.5(b)1. Emergency situations include weather-related or other natural disasters that disturb potentially contaminated soils.

These notifications include an initial verbal report to the NYSDEC DER Site Project Manager by noon of the next business day, upon knowledge by the GrafTech Designated Manager of any condition posing an emergency at the Landfill Site. A follow-up written letter is provided within seven (7) business days.

6.4 Periodic Review and Reporting (PRR)

The Landfill Site management activities and documentation are periodically reviewed and evaluated to confirm that they conform to the criteria outlined in this SMP. These evaluations are documented in a PRR to be prepared and submitted annually to NYSDEC by the established deadline. The PRR summarizes the results of the site inspections and includes a tabular summary of the groundwater monitoring data for the report period, including the parameters tested and the applicable standard test methods. The PRR also includes a field report prepared by the sampler and a laboratory analytical report, which includes the sampling results, chain-of-custody log and QA/QC data. The PRR also includes a written IC/EC certification, in a reporting format approved by the NYSDEC, which is signed by a Qualified Environmental Professional (QEP), as in defined in 6 NYCRR Part 375, attesting that the established IC/EC are in place, are performing properly and have remained effective during the certification period. In the event such certification cannot be provided due to a failure of the established IC/EC, GrafTech will timely notify the NYSDEC and submit a work plan and a schedule to implement appropriate corrective measures.

The PRR also provides related conclusions and any recommendations for modification(s) to the IC/EC, and report on any corrective measures taken during the reporting period. If applicable, the PRR will document a change of use and/or a property transfer to a new owner, as set forth in chapter 6.2.1(c) of the NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation, dated May 2010, and in conformance with 6 NYCRR-375-1.11(d) (or another applicable subsequent rule(s) or publication(s)).

If a property transfer and/or a change in use took place for the Landfill Site within the subject reporting year, the date of the change of ownership, the date(s) of document transfer from GrafTech to the new owner, and the change of use designation, if applicable, will be reported by the new owner in the first PRR submitted to the NYSDEC following the closure of the sale transaction.

The annual PRR is submitted to the NYSDEC DER Region 9, care of the Project Manager, for the certification period, i.e., the subject calendar year, by the due date stipulated by the state (typically within forty-five (45) days after issuance of the 45-Day Reminder Notice by the Albany office), or before any other reporting deadline stipulated by the NYSDEC by formal notification or via other written communication to GrafTech's Designated Manager for the Landfill Site (including electronic forms). The PRR contains the required documentation, including a summary of the annual groundwater sampling results and the signed IC/EC certification form, and is provided in an electronic format acceptable to NYSDEC DER (currently a searchable PDF format report file is submitted by email).

APPENDIX A

Weekly General Landfill and Site Security Inspection Report Form

WEEKLY GENERAL LANDFILL AND SITE SECURITY INSPECTION REPORT

Date	Time	Inspector Name

FENCE AREA	OK	DAMAGED	REPAIR DATE	REMARKS
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				

GATE	OK	DAMAGED	REPAIR DATE	REMARKS
1				
2				
3				

SECURITY-RELATED ENGINEERED CONTROLS COMMENTS: (Check for condition, damage, signs of security breach)

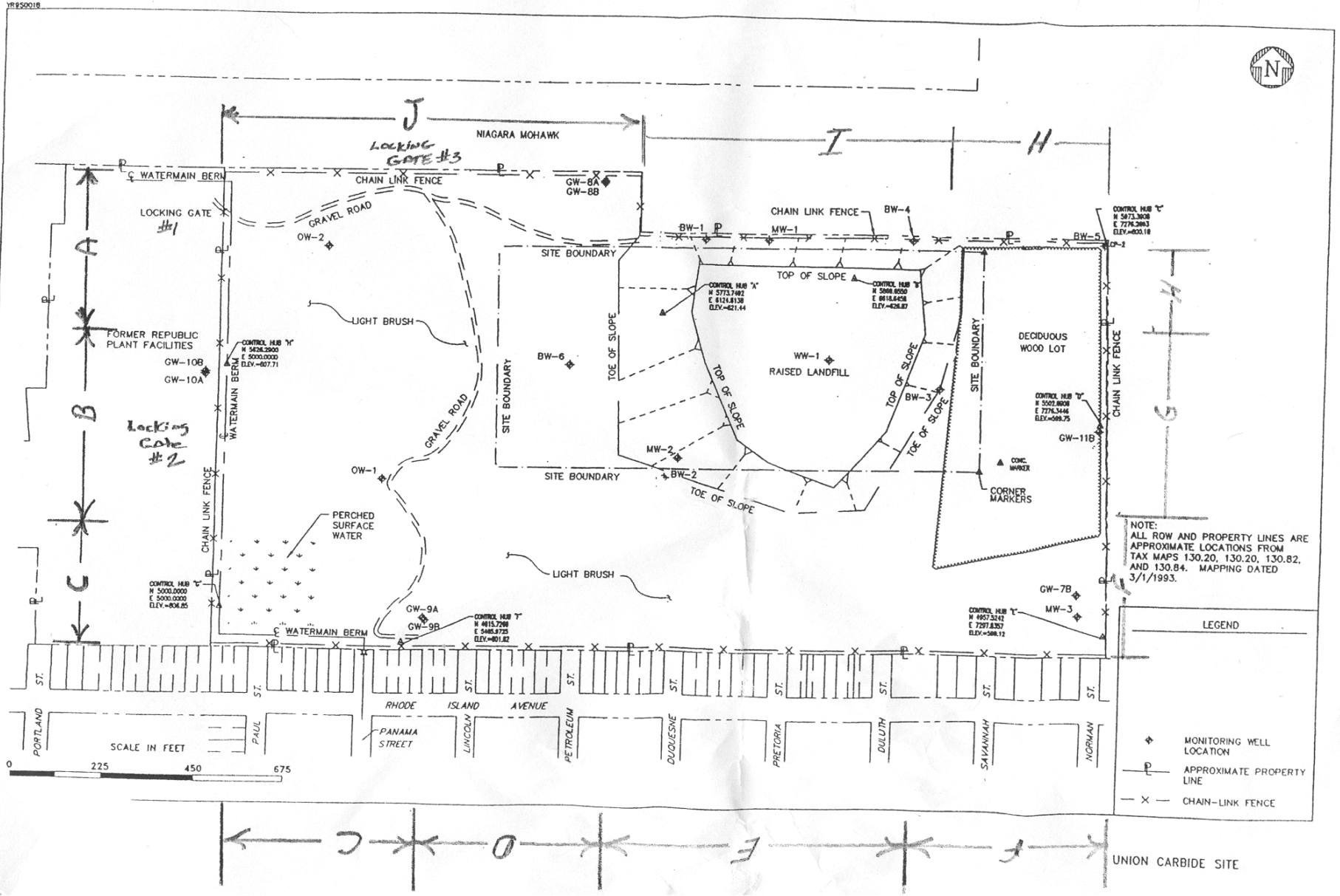
CAP COMMENTS: (Check for erosion and adequate vegetation)

SURROUNDING AREA COMMENTS: (Check for condition, damage, signs of security breach)

RECORD THE DATE(S) THAT THE ENTIRE CAP WAS MOWED:_____

IN THE EVENT THAT ANY SIGN OF A SITE SECURITY BREACH IS IDENTIFIED DURING THE ABOVE SITE INSPECTIONS, COMPLETE A FULL GROUNDWATER MONITORING WELL INSPECTION AND DOCUMENT RESULTS USING THE QUARTERLY GROUNDWATER WELL INSPECTION REPORT FORM (APPENDIX B) AND ATTACH TO THIS FORM.

LANDFILL SITE MANAGEMENT PLAN FOR SWMF #32N03 (REGISTRY NO. 932035)



APPENDIX B

Quarterly Groundwater Well Inspection Report Form and Map

QUARTERLY GROUNDWATER WELL INSPECTION REPORT

GRAFTECH WELLS

WELL I.D. NUMBER	WELL I.D. TAG INTACT (YES/NO)	LOCK CONDITION	OUTER CASING CONDITION	CONCRETE SEAL CONDITION	COMMENTS
MW1-78					
MW2-78					
MW3-79					
BW1-86					
BW2-86					
BW3-86					
BW4-86					
BW5-86					
BW6-86					
WW1-86					
OW1-88					
OW2-88					

ON-SITE WELLS INSTALLED BY NYSDEC

(Installed Sept./Oct. 93)

WELL I.D. NUMBER	WELL I.D. TAG INTACT (YES/NO)	LOCK CONDITION	OUTER CASING CONDITION	CONCRETE SEAL CONDITION	COMMENTS
GW7B-93					
GW8A-93					
GW8B-93					
GW9A-93					
GW9B-93					
GW11B-93					

Note:

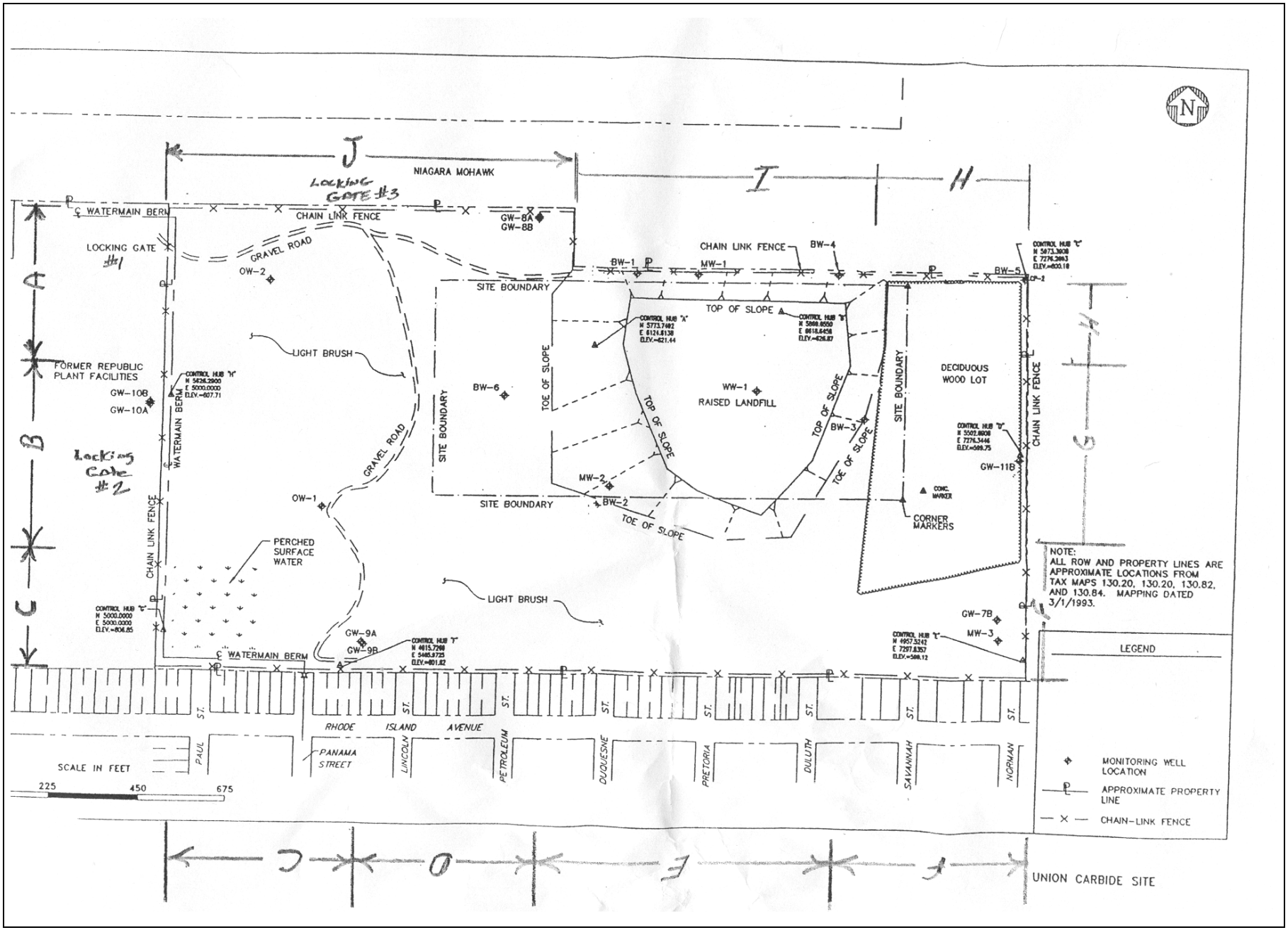
MW wells are installed in the overburden.

BW wells are bedrock wells.

GWA wells are installed in the overburden.

GWB wells are bedrock wells.

OW and WW wells are overburden wells installed with the screen above the till layer.



LANDFILL SITE MANAGEMENT PLAN FOR SWMF #32N03 (REGISTRY NO. 932035)

APPENDIX C

Letter from Mary E. McIntosh, Eng., NYSDEC (Dated January 18, 2000)

New York State Department of Environmental Conservation
Division of Solid and Hazardous Materials, Region 9
270 Michigan Avenue, Buffalo, New York, 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.state.ny.us

John P. Cahill
Commissioner

January 18, 2000

Mr. Robert Bucci
Site Manager
UCAR Carbon Company Inc.
P.O. Box 887
Niagara Falls, New York 14302-0887

Dear Mr. Bucci:

UCAR Republic Solid Waste
Management Facility #32N03

Thank you for your letter of October 25, 1999 regarding the monitoring program at the UCAR closed Republic Landfill. As you are aware, both the Division of Solid Materials and the Division of Environmental Remediation have wells on the site and an interest in the post-closure monitoring program. Mr. Michael Hinton of the Division of Environmental Remediation and I met to discuss how the concerns of both programs can be met in a monitoring program that will be both efficient and comprehensive. We are requesting that the following program be implemented:

1. Sample all of the on-site wells once initially (wells GW-7B, GW-8A, GW-8B, GW-9A, GW-9B, GW-10A, GW-10B, GW-11B under the Environmental Remediation program, and wells BW-1, BW-2, BW-3, BW-4, BW-5, BW-6, MW-1, MW-2, MW-3 under the Solid Materials Program for Part 360 baseline volatile organics using method 8260.

2. If volatile organics are not detected in the Environmental Remediation Program wells, eliminate all of them except well GW-9B from the monitoring program.

3. Perform semi-annual (twice yearly) sampling at wells BW-1, BW-2, BW-3, BW-4, BW-5, BW-6, MW-1, MW-2, MW-3 and GW-9B, as indicated on the attached table.

This program will satisfy the monitoring concerns of both programs and represents a reduction from the quarterly program now being conducted at the site. If you have any questions, or wish to meet to discuss this proposal further, please contact me at 851-7220. Thank you.

Yours truly,

Mary E. McIntosh
Engineering Geologist II

MEM:lj

Attachment

cc: Mr. Mark Hans, Regional Solid Materials Engineer
Mr. Michael Hinton, Environmental Engineer II

a:bucci.mem

APPENDIX D

Letter from Mary E. McIntosh, Eng., NYSDEC (Dated September 20, 2005)

LANDFILL SITE MANAGEMENT PLAN FOR SWMF #32N03 (REGISTRY

New York State Department of Environmental Conservation
Division of Solid and Hazardous Materials, Region 9
270 Michigan Avenue, Buffalo, New York, 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.dec.state.ny.us

Denise M Sheehan
Commissioner

September 20, 2005

Mr. James K. Kay, P. Eng.
Conestoga-Rovers and Associates
23271 George Urban Blvd.
Depew, New York 14043

Dear Mr. Kay:

UCAR Carbon Landfill
#32NO3

This office has reviewed your submission of July 27, 2005 in support of a reduction in the monitoring program for the closed UCAR Carbon Landfill. You have requested, on behalf of the company, a reduction to annual sampling in four wells for volatile organics only. The following comments have been generated by myself as a representative of the Division of Solid and Hazardous Materials, and Mr. Michael Hinton of the Division of Environmental Remediation (please note that our respective divisions were reversed in the report):

1. The report does not contain the correct class GA standards for several parameters. In Table 3 the standard for iron is listed as 300 mg/l, but it is really 300 ug/l or .3 mg/l. The standard for zinc is listed as 300 mg/l but it is really 2000 ug/l or 2 mg/l. The standard for ammonia is listed as no standard, but the standard is 2000 ug/l or 2 mg/l. Because of the incorrect standards applied, several of the conclusions from the review of the monitoring data are erroneous. For example, the report states that in 6 of the 11 wells currently monitored, the concentrations of constituents of concern are currently lower than the water quality criteria cited. In reality, most of the wells exhibit elevated levels of one or more of the parameters. Many of the wells exhibit elevated levels of iron (MW-1, MW-3, GW-8B, GW-9B, BW-1, BW-2, BW-3, BW-4, BW-5, and BW-6). Ammonia is elevated in wells MW-1 and BW-4. Zinc is elevated in wells BW-1 and BW-4.

2. The Division of Environmental Remediation investigated the area north of UCAR for other sources of the contaminants detected in wells along the north property boundary, and no alternate source was found. The Division of Environmental Remediation sent a copy of this report to UCAR.

3. The report notes that vinyl chloride was detected in well BW-3 up to 26 ug/l, but this value is not shown in Table 3. What was the sampling date on which this level was recorded?

4. The report states that the concentration of cis-1,2-DCE has ranged between 20 and 27 ug/l. Table 3 shows that a concentration of 14 ug/l was recorded.

5. Due to the incorrect groundwater standards used in the evaluation of the data, we do not agree with Conestoga-Rovers conclusions that only 4 wells exhibit consistent presence of compounds of concern at concentrations exceeding water quality criteria, with these compounds limited to volatile organics. Therefore we cannot agree to Conestoga-Rovers proposed changes in the monitoring program. The Department will allow a reduction in the frequency of monitoring to annual for the following wells: BW-1, BW-2, BW-3, BW-4, MW-3, GW-8B, and GW-9B. These wells must be sampled for the same list of parameters currently sampled for at the site (Part 360 volatiles, ammonia, iron (total and soluble), potassium (total and soluble), zinc (total and soluble), nitrite, TKN, turbidity, groundwater elevation, pH, specific conductance, and temperature. The timing of the annual sampling shall be rotated yearly between spring and fall, so that one year sampling will be done in the spring, and the next year it will be done in the fall. A sampling event must occur in every calendar year.

If you have any questions on the program hereby approved by the Department, please contact me at (716) 851-7220.

Yours truly,

Mary E. McIntosh, C.P.G.
Engineering Geologist II

MEM:dcg
mcm\kay.ltr

cc: Mr. Mark Hans, Regional Solid Materials Engineer
Mr. Michael Hinton, Environmental Engineer II
Mr. Robert Bucci, UCAR
Ms. Carol Barron, Conestoga-Rovers

APPENDIX E

Letter from Carol Barron for James K. King, Conestoga-Rovers & Assoc. (CRA) in response to NYSDEC Letter Dated 9/20/05 (Dated November 4, 2005)

CONESTOGA-ROVERS
& ASSOCIATES

2371 George Urban Blvd., Depew, New York 14043
Telephone: 716-206-0202 Facsimile: 716-206-0201

November 4, 2005

Reference No. 5513

Ms. Mary E. McIntosh, C.P.G.
Engineering Geologist II
NYSDEC
270 Michigan Avenue
Buffalo, New York 14203-7226

Dear Ms. McIntosh:

Re: Responses to NYSDEC Comments Dated September 20, 2005
UCAR Republic SWMP No. 32N03

The enclosed responses to NYSDEC comments dated September 20, 2005, regarding the post-closure monitoring program review for the above-referenced site are being submitted by Conestoga-Rovers & Associates on behalf of UCAR Carbon Corporation. Included with the responses is a groundwater analytical data table showing the corrected groundwater quality criteria as cited in the comment letter.

It is our understanding from the comment letter that the approved modified monitoring program consists of the following:

> Annual sampling of seven wells (BW-1, BW-2, BW-3, BW-4, MW-3, GW-8B, and GW-9B) with analysis of the samples for Part 360 volatiles, ammonia, iron (total and soluble), potassium (total and soluble), zinc (total and soluble), nitrite, TKN, turbidity, groundwater elevation, pH, specific conductance, and temperature. Monitoring will be rotated between the spring and fall seasons such that one year sampling will be conducted in the spring and the next year it will be conducted in the fall. Sampling will be conducted once in each calendar year and reporting will be submitted annually following receipt and review of the groundwater analytical data.

The next monitoring event will be conducted in the fall of 2006.

Yours truly,

CONESTOGA-ROVERS & ASSOCIATES

Carl Barron for

James K. Kay, P. Eng.

JKK/dl/13
Encl.

c.c.: M. Hans, NYSDEC
M. Hinton, NYSDEC
R. Bucci, UCAR
C. Barron, CRA

APPENDIX F

Letter from NYSDEC to GrafTech Approving the 2013 SMP

(Dated November 17, 2016)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, NY 14203-2915
P: (716) 851-7220 I F: (716) 851-7226
www.dec.ny.gov

November 17, 2016

Ms. Juanita Bursley
Senior Manager, Corporate Environmental Risk Management
GrafTech International Holdings Inc.
6100 Oak Tree Boulevard
Suite 300 Park Center I
Independence, Ohio 44131

Dear Ms. Burlsey:

GrafTech International Holdings Inc.
NYSDEC Site Nos. 932035 & 32N03
Niagara, Niagara County, New York

It has recently come to my attention that the Site Management Plan (SMP) submitted by Graftech International Holdings Inc. in December 2013 was never formally approved by the New York State Department of Environmental Conservation (NYSDEC). As a result, I completed a detailed review of the SMP and found it to be acceptable with the caveat that the submittal of a separate annual groundwater monitoring report to the NYSDEC's Division of Materials Management is no longer required (NYSDEC letter dated February 25, 2016 from Mr. Glenn May to Ms. Juanita Bursley). This letter, therefore, transmits formal NYSDEC approval of the December 2013 Site Management Plan.

Please note that Ms. Mary McIntosh has been promoted and is now a Regional Spill Geologist for the NYSDEC's Division of Environmental Remediation in Region 9.

Should you have any questions, please feel free to contact me at (716) 851-7220.

Sincerely yours,

Glenn M May

Glenn M. May, CPG
Environmental Geologist II

GMM: tm

ecc: Ms. Mary McIntosh, NYSDEC, Division of Environmental Remediation, Region 9
Mr. Peter Grasso, NYSDEC, Division of Materials Management, Region 9
Mr. Brian Sadowski, NYSDEC, Division of Environmental Remediation, Region 9

APPENDIX G

Letter from NYSDEC DMM to GrafTech re DER Oversight

(Dated February 25, 2016)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, NY 14203-2915
P: (716) 851-7220 I F: (716) 851-7226
www.dec.ny.gov

February 25, 2016

Ms. Juanita Bursley
Senior Manager, Corporate Environmental Risk Management
GrafTech International Holdings Inc.
6100 Oak Tree Boulevard
Suite 300 Park Center I
Independence, Ohio 44131

Dear Ms. Burlsey:

GrafTech International Holdings Inc.
NYSDEC Site Nos. 932035 & 32N03
Niagara, Niagara County, New York

In an effort to eliminate separate and sometimes duplicate reporting to two divisions (Division of Materials Management and Division of Environmental Remediation) within the New York State Department of Environmental Conservation (NYSDEC), the NYSDEC has decided that site management and reporting should be consolidated under one division. As such, future reporting should be to the Division of Environmental Remediation. All information historically submitted to Ms. Mary McIntosh in the Division of Materials Management should now be included in the annual Periodic Review Reports submitted to the Division of Environmental Remediation.

This reporting will fulfill GrafTech's reporting requirements under Part 360-2.15.

Should you have any questions, please feel free to contact me at (716) 851-7220.

Sincerely yours,

Glenn M. May

Glenn M. May, CPG
Environmental Geologist II

GMM: tm

ecc: Ms. Mary McIntosh, NYSDEC, Division of Materials Management, Region 9
Mr. Peter Grasso, NYSDEC, Division of Materials Management, Region 9
Mr. Brian Sadowski, NYSDEC, Division of Environmental Remediation, Region 9

APPENDIX H

Letter from NYSDEC to GrafTech Approving the 2017 PRR and the Proposed Modified Groundwater Monitoring Program

(Dated February 8, 2018)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, NY 14203-2915
P: (716) 851-7220 I F: (716) 851-7226
www.dec.ny.gov

February 8, 2018

GrafTech International Holdings, Inc.
Juanita M. Bursley
982 Keynote Circle
Brooklyn Heights, OH 44131

Dear Ms. Bursley:

Site Management (SM) Periodic Review Report (PRR) Response Letter
GrafTech International Holdings Inc., Niagara
Niagara County, Site No.: **932035**

The Department has reviewed your Periodic Review Report (PRR) and IC/EC Certification for the period of December 31, 2016 to December 31, 2017.

The Department hereby accepts the PRR and associated Certifications. We have also considered GrafTech's proposals to reduce the monitoring program, drop specific parameters and to only analyze for VOC's. After a review of historical data, trend plots and parameter applicability, GrafTech's proposals are approved. Therefore, going forward, the monitoring program will be reduced from seven to three wells. Wells MW-3, BW-1, GW9B and BW-2 will be eliminated. Wells BW-3, GW-8B and BW-4 will be kept. Parameters of Potassium, Zinc, TKN, Total Iron, Dissolved Iron and Ammonia will be eliminated. VOC's will be kept and the only analysis to run.

The frequency of Periodic Reviews for this site is 1 year, your next PRR is due on January 30, 2019. You will receive a reminder letter and updated certification form approximately 75-days prior to the due date. Regardless of receipt or not, of the reminder notice, the next PRR including the signed certification form, is still due on the date specified above.

If you have any questions, please contact me at 716-851-7220 or e-mail: brian.sadowski@dec.ny.gov.

Sincerely,

Brian Sadowski
Project Manager

BS/tm

ec: Mary McIntosh, RSG, Buffalo
Glenn May, EGII, CPG, Buffalo

APPENDIX I

Landfill Site Plan Drawing

SKW-5
SKW-5A
N
0
225ft
GW-8A
GW-8B
DIRT ROAD
OW-2
BW-1
MW-1
BW-4
BW-5
TOP OF SLOPE
RAISED
LANDFILL
WW-1
BW-6
BW-3
WOOD
LOT
GW-10B
GW-10A
FORMER REPUBLIC
PLANT FACILITIES
GW-11B
MW-2
SITE BOUNDARY
OW-1
BW-2
TOE OF SLOPE
PERCHED
SURFACE
WATER
3B
GW-7B
MW-3
GW-9A
GW-9B
PORTLAND
ST. PAUL
PANAMA
LINCOLN
RHODE
PETROLEUM
ISLAND
DUQUENSE
AVENUE
PRETORIA
DULUTH
SAVANNAH
NORMAN

LEGEND

GW-7B ● PSA MONITORING WELL

PROPERTY LINE

FENCE

figure 2.1

SITE PLAN AND SAMPLE LOCATIONS
UNION CARBIDE SITE
Niagara Falls, New York

CRA

05513-00(001)GN-NF002 JUN 16/2000

APPENDIX J

GHD Field Training Manual, Section 7.0, Water Sampling Standard Operating Procedures

(Revision 0, dated July 1, 2015)

GHD Field Training Manual

Section 7.0
Water Sampling Standard Operating Procedures
A. Groundwater
B. Residential
C. Surface Water

(T104)

200010 | Report No 2 | Revision 0 | July 1 2015

Please Adhere to the Following Quality System Training Requirements:

- Employees who are required to conduct a specific field activity must be properly certified to do the work.
- This involves reviewing the SOP and completing the online training course and exam.
- Employees must also conduct this field work under supervised conditions on at least three occasions, and must be certified by a qualified mentor. Only then can an employee conduct a specific field activity on their own. This is documented on a Field Method Training Record (QSF-021).
- Complete the QSF-021 and forward it to trainingrecords-northamerica@ghd.com.
- Please note that three topics are discussed in this SOP. A separate QSF-021 is required for each topic:
  - Groundwater Sampling
  - Residential Water Sampling
  - Surface Water Sampling

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Quality System Forms Index

7. Water Sampling (Groundwater, Residential, and Surface Water) Standard Operating Procedures

7.1 Introduction

Groundwater, residential, and surface water sampling are conducted in order to characterize the groundwater and surface water quality at a site. Standard Operating Procedures (SOPs) are presented herein for the collection of groundwater and surface water samples from:

- Monitoring wells
- Residential wells
- Surface water bodies

This guideline is not intended to provide the basis for designing a groundwater or surface water monitoring program, but instead assumes that a groundwater and/or surface water monitoring program has already been designed. It is also assumed that a site-specific Work Plan has been established and that a GHD representative is preparing to mobilize to the site.

Groundwater and surface water sampling procedures vary from project to project due to:

- Different chemicals of concern.
- Different guidance provided by local, provincial/state, and/or federal regulatory agencies with jurisdiction at the site.
- The specific objectives of the project.

It is essential that all groundwater, residential, and surface water sampling activities conform to local, state/provincial, and federal regulations. Therefore, it is essential that the GHD representative carefully reviews the Work Plan requirements. The primary goal of groundwater, residential, and surface water sampling is the collection of samples representative of the hydrostratigraphic unit and/or surface water body. It is necessary to use appropriate sampling techniques to collect representative samples that provide reliable and reproducible results in accordance with the Work Plan and all relevant regulations.

The remainder of this section is organized as follows:

- Section 7.2 Background
- Section 7.3 Planning and Preparation
- Section 7.4 Safety and Health
- Section 7.5 Quality Assurance/Quality Control
- Section 7.6 Equipment Decontamination
- Section 7.7 Field Procedures for Groundwater Sampling

- Section 7.8 Field Procedures for Residential Sampling
- Section 7.9 Field Procedures for Surface Water Sampling
- Section 7.10 Follow-Up Activities
- Section 7.11 References

7.2 Background

The objective of a groundwater and residential monitoring program is to obtain samples that are representative of existing groundwater conditions, or samples that retain the physical and chemical properties of groundwater in the hydrostratigraphic unit. Surface water sampling is performed to collect samples that are representative of physical and chemical properties of surface water bodies. Improper sampling and transport practices will cause compounds of interest to be removed or added to a sample prior to analysis. The importance of proper and consistent field sampling methods cannot be over emphasized. It is equally important that proper documentation occurs throughout the sampling program.

The most important aspect of groundwater sampling is the collection of groundwater samples that are free of suspended silt, sediment, or other fine-grained material. Fine-grained material has a variety of chemical compounds sorbed to the particles or has the ability to sorb chemicals from the aqueous phase. This causes a bias in the subsequent analytical results. Reproducible and reliable analytical data are invaluable to a groundwater monitoring program. GHD frequently criticizes the sampling activities completed by others due to the collection and analyses of turbid samples. This SOP discusses sampling protocols that typically achieve sediment-free samples.

When sampling for monitored natural attenuation (MNA) parameters, more stringent protocols are followed to ensure sediment-free samples that are representative of the total mobile load (i.e., dissolved and naturally suspended particles). Low-flow purging (LFP) techniques are strongly recommended, if not mandated, when collecting groundwater samples for MNA parameters. The LFP techniques detailed in Section 7.7.5.3 are in accordance with United States Environmental Protection Agency (USEPA) LFP procedures (Puls and Barcelona, 1996).

Groundwater sampling is required for various reasons, including:

- Investigating potable or industrial water supplies
- Tracking contaminant plumes
- Investigating a site with suspected groundwater contamination

Groundwater is usually sampled from in-place wells, installed either temporarily or permanently. Municipal, industrial, or residential wells may also be sampled during an investigation. When completing residential well sampling it is important that representative samples are collected. Poor or incorrect sampling techniques will result in erroneous results. Incorrect results disclosed to the public will create a false impression, making it difficult to change the perception when correct results are reported.

Groundwater and residential sample collection are performed from non-impacted to most impacted locations. This eliminates the potential for cross-contamination. A review of all historical analytical data is performed to ensure the exact sampling sequence.

Surface water sampling locations are selected based on many factors including:

- The study objectives
- The location of point source discharges
- The location of no-point source discharges and tributaries
- The presence of structures (e.g., bridges, dams)
- Accessibility

Surface water sampling should be performed from downstream to upstream locations. This ensures that surface water sampling activities do not cause suspended sediments to bias samples collected downstream.

7.3 Planning and Preparation

Prior to groundwater, residential, and surface water sampling:

1. Review the Work Plan, project documents, and Site-Specific Health and Safety Plan (HASP) with the Project Manager/Coordinator.
2. Review the Quality Assurance Project Plan (QAPP) with the Project Coordinator and Project Chemist to determine Quality Assurance/Quality Control (QA/QC) and decontamination requirements.
3. Complete a Field Equipment Requisition Form (QSF-014). Assemble all sampling equipment and supplies required per the Groundwater Sampling Equipment and Supply Checklist (Form SP-05). The Project Planning, Completion, and Follow-Up Checklist (Form SP-02) should be used for guidance throughout the project.
4. Assemble the site plan, well logs, and previous sampling/purging data required for the sampling event. Determine the exact number and locations of wells to be sampled.
5. Obtain all forms to record purging and sampling activities (Forms SP-06, SP-08, and SP-09).
6. Confirm with the Project Manager/Coordinator that a Property Access/Utility Clearance Data Sheet (QSF-019) has been completed. For residential sampling, ensure that homeowners have been notified of the intended sampling event. Confirm the presence of any dogs on site, modify the site-specific Job Safety Analysis, if there is a dog.
7. Arrange access to the site. Obtain all well and site keys. Consider site access conditions (e.g., snow).
8. For surface water sampling consider if hazards exist due to deep/fast moving water, difficult access, and if additional GHD personnel are required for safety and health reasons.

9. For residential sampling contact homeowners to make arrangements for a site visit, arrange for site dog to be removed from all areas where a GHD employee will be working. The client of another party may be responsible for making arrangements.

10. Complete a Vendor Evaluation Form (QSF-012) and file in the Project file for any Vendors that do not have full approval status or are not listed on the Approved Vendor List (QSL-004). Completion of a Safety and Health Schedule (QSF-030 for Canadian work; QSF-031 for U.S. work) is necessary for all Vendors who complete field services. Prior to mobilization on site, the Vendor must submit the form to the Regional Safety and Health Manager for review and approval (if not already posted on QSL-004).

11. Contact the GHD Chemistry group to arrange:

    - SSOW (Simplified Scope of Work)
    - Laboratory
    - Sample containers delivery
    - Preservatives if required
    - Filtration information if required
    - Coolers
    - Shipping details
    - Sample starting date
    - Expected duration of sampling program

12. If several sampling events are planned, evaluate with the client the benefit of purchasing and installing dedicated sampling equipment. Dedicated purging and sampling equipment reduces potential cross-contamination and reduces decontamination requirements. At a minimum, sample tubing is dedicated to each well and is left secured in the well for future use. For LFP it is recommended that each well is dedicated with a bladder pump and tubing to eliminate well disturbance.

13. Evaluate sample notification needs with the Project Coordinator. Have the regulatory groups, client, landowner, GHD personnel, and laboratory been notified of the sampling activities?

14. Evaluate containment and disposal requirements for purge waters.

15. Plan sampling activities to ensure that wells that historically go dry or have poor recharge fit into the sampling program. This will reduce the time required for sample collection.

16. Plan the sequence of sampling activities to reduce the potential for cross-contamination. For groundwater sampling, start with clean wells and progress to impacted wells. For surface water sampling, start downstream and progress upstream.

7.4 Safety and Health

GHD is committed to conducting field activities in accordance with sound safety and health practices. GHD adheres to high safety standards to protect the safety and health of all employees,

subcontractors, customers, and communities in which they work. The safety and health of our employees takes precedence over cost and schedule implications.

Field personnel are required to implement the Safety Means Responsibility Awareness Teamwork (SMART) program as follows:

- Assure the HASP is specific to the job and approved by a Regional Safety & Health Manager.
- Confirm that all HASP elements have been implemented for the job.
- A Job Safety Analysis (JSA) for each task has been reviewed, modified for the specific site conditions, and communicated to all appropriate site personnel. The JSAs are a component of the HASP.
- Incorporate Stop Work Authority; Stop, Think, Act, Review (STAR) process; Safe Task Evaluation Process (STEP); Observations process; Near Loss and Incident Management process in the day-to-day operations of the job.
- Review and implement applicable sections of the GHD Safety & Health Policy Manual.
- Confirm that all site personnel have the required training and medical surveillance as defined in the HASP.
- Be prepared for emergency situations, locating safety showers, fire protection equipment, evacuation route, rally point, and first aid equipment before you begin working, and make sure that the equipment is in good working order.
- Maintain all required Personal Protective Equipment (PPE), safety equipment, and instrumentation necessary to perform the work effectively, efficiently, and safely.
- Be prepared to call the GHD Incident Hotline at 1-866-529-4886 for all involving injury/illness, property damage, vehicle incident, and/or significant Near Loss.

It is the responsibility of the Project Manager to:

- Ensure that all GHD field personnel have received the appropriate health and safety and field training and are qualified to complete the work.
- Provide subcontractors with a Job Hazard Analysis to enable them to develop their own HASP.
- Ensure that all subcontractors meet GHD's (and the Client's) safety requirements.

7.5 Quality Assurance/Quality Control

A well-designed QA/QC program will:

- Ensure that data of sufficient quality are obtained, for proper site management decisions or remediation design.
- Allow for monitoring of staff and contractor performance.
- Verify the quality of the data for the regulatory agency.

It is important to note that a QA/QC program should be developed on a site-specific basis. QA/QC requirements are discussed in Section 3.9.

7.6 Equipment Decontamination

Equipment decontamination procedures for a groundwater, residential, or surface water monitoring program will be described in detail in the site-specific Work Plan or in the QAPP.

Equipment is decontaminated between sampling locations and prior to leaving the site. Upon completion of the sampling program, all equipment is decontaminated at the site and then returned clean to the appropriate field equipment manager.

For most groundwater, residential, and surface water sampling programs, sampling equipment (e.g., pumps, bailers, water level indicators) is typically cleaned as follows:

1. Wash with clean potable water and laboratory detergent, using a brush as necessary to remove particulates.
2. Rinse with tap water.
3. Rinse with deionized water.
4. Air dry for as long as possible.

If required, the following steps may be added when sampling for Volatile Organic Compounds (VOCs) and metals:

1. Rinse with 10 percent nitric acid (only if samples are to be analyzed for metals).
2. Rinse with deionized water.
3. Rinse with appropriate solvent (pesticide grade isopropanol, methanol, acetone, hexane, if required).
4. Rinse again with deionized water.
5. Air dry for as long as possible.
6. Wrap samplers in aluminum foil to prevent contamination.

Caution:	Check the QAPP to confirm the cleaning protocol. Use of incorrect cleaning protocol could invalidate chemical data.

7.6.1 Purge Water and Decontamination Fluid Disposal

Project-specific disposal methods for purged groundwater and decontamination fluids are determined by the Project Manager during the sampling program's planning and preparation stage (see Section 7.3), but may include:

1. Off-site treatment at private treatment/disposal facility or publicly owned treatment facilities (sanitary sewer).
2. On-site treatment at a client-operated facility.
3. Direct discharge to the surrounding ground surface, allowing infiltration to the underlying subsurface.
4. Direct discharge to an impervious pavement surface allowing for evaporation.

Options 3 and 4 are permitted only after careful review of these practices and the anticipated site conditions. Under no circumstances shall GHD personnel aggravate an existing condition or spread contamination into clean areas.

Decontamination fluids (specifically cleaning solvents/acids) are segregated and collected separately from wash water and purge water. Often small volumes of solvents used during the course of a groundwater, residential, or surface water sampling program will evaporate if left in an open pail. If evaporation is not possible, off-site disposal need to be arranged.

7.7 Field Procedures for Groundwater Sampling

The typical series of events that takes place for a groundwater sampling program is:

1. Well identification and inspection
2. Air monitoring
3. Water level monitoring
4. Well depth sounding
5. Well volume calculation
6. Purging and sampling equipment installation
7. Well purging and stabilization monitoring
8. Sample collection, sample preparation, completion of chain-of-custody, (COC) sample packaging
9. Final water level monitoring (if required), purging, sampling equipment removal, secure the well
10. Equipment decontamination
11. Field note completion and review
12. Sample shipment and COC distribution
13. Purged groundwater and decontamination fluid disposal
14. Sample record documentation, equipment return
15. Completion and distribution of appropriate forms

It is recommended that new plastic sheeting be placed on the ground around the well to prevent contamination of purging and sampling equipment and accessories (e.g., pumps, hoses, rope.).

7.7.1 Well Identification and Inspection

At sites with numerous wells or wells nests, misidentification of wells has occurred. The GHD representative must be alert to the possibility of potential cap switching, mislabeled wells, or unlabeled well locations.

Determine proper well location and identification by comparing the well log details to the measured well depths (i.e., total well depth, casing diameter, casing stick-up, or stick-down distances), field tie-ins, and site plan.

Once well identification has been established, complete a thorough well inspection:

1. Determine if the well cap and lock are secure, and check for vandalism.
2. If no lock is present, dedicate a new lock to the well location.
3. Examine the integrity of the surface seal.
4. Check for cracks, evidence of frost heave, or subsidence in the vicinity of the well.
5. Examine the integrity of the protective casing. Ensure that the casing can be closed and locked.
6. If required, re-label the well to assist in future identification.
7. If the well is installed with dedicated sampling equipment, check for cracks or leaks in tubing, and worn or frayed rope.
8. Record all the well inspection details in the field book to document well conditions and suitability for groundwater sampling activities.
9. Forward the well inspection results to the Project Coordinator, especially if repairs are required.

7.7.2 Air Monitoring

Prior to removing a well cap, measure the breathing space above the well with a photoionization detector (PID) to establish background of undifferentiated organic vapor levels. Repeat this process once the well cap has been removed. If either of the PID levels exceed the air quality criteria established in the HASP, air-purifying respiratory (APR) protection or a supplied air system is required. Also take a PID reading inside the riser pipe. This PID reading is a good indication of elevated chemical or non-aqueous phase liquids (NAPL) presence. Report all elevated PID levels to the Project Coordinator immediately to determine if additional health and safety and personnel protective equipment is required. The HASP will provide the required action levels and PPE.

7.7.3 Water Level Monitoring/Well Depth Sounding

Prior to commencing well purging and groundwater sampling, the water level is measured for hydraulic monitoring and to determine the well volume. Typically, a complete round of water level measurements is taken at a site to establish groundwater conditions prior to initiating well purging or groundwater sampling activities.

A watertight cap provides an airtight seal on the casing and the water level positioned in the casing area. The cap creates a vacuum or pressurized condition in the casing section which can support or depress the water column in the well casing. This can produce an artificially high or low water level in the well casing. This effect can cause a few inches or feet of error in the static water level. Once the cap is removed, allow the pressure to stabilize for about a half hour. Measure the water level

frequently to ensure that stabilization of the water level has occurred. Once the water level has stabilized (i.e., is static) the correct water level may be measured.

A number of instruments are available to measure groundwater levels. GHD typically uses:

- Battery-operated water level indicators (i.e., audible and/or visual identification of water level)
- Battery-operated oil/water interface probes (i.e., audible and/or visual identification of water levels and presence of NAPL)
- Electronic transducers (numerous manufacturers) and recording devices for long-term hydraulic monitoring
- Stevens™ recorders (both float and electronic instrumentation) for long-term hydraulic monitoring

Section 8.0 describes in detail the equipment and monitoring techniques for water level measurements.

Well depth sounding is often required to confirm well identification, evaluate the accumulation of sediment in the well bottom, or assist in determining the standing well volume. Sounding is performed using a water level indicator or a measuring tape with a weighted end. The water level indicator or weighted tape is lowered to the bottom of the well and a comparison is made of the installed well depth versus the measured well depth. The presence of excessive sediment or drill cuttings may warrant redevelopment of the well prior to well purging and groundwater sampling activities.

The total well depth is compared to the original installed total well depth. If the well screen is more than 50 percent blocked by accumulated sediment, the well is redeveloped prior to the next groundwater sampling event. Report all wells requiring redevelopment to the Project Coordinator. Well depth sounding is performed on an annual or biannual basis if the well is equipped with a dedicated pump.

For LFP, well depth measurement is performed to ensure proper pump intake placement. The used of a wide-based probe, such as a weighted tape, is necessary to minimize penetration and disturbance of accumulated sediment. The measuring device is lowered slowly through the water column to the well bottom to minimize mixing of the stagnant well casing water and disturbance of sediment.

Note: Don't forget that decontamination procedures apply to the water level monitoring equipment as well as the groundwater sampling equipment. If well sounding is performed, the entire measuring device must be thoroughly decontaminated prior to re-use. Measuring the well depth with certain water level indicators may damage the probe seal. Therefore, a tape with a weighted end should be used to measure well depth.

7.7.4 Well Volume Calculation

Prior to commencing well purging, the volume of water in the well must be known to determine the volume of groundwater to be removed. A well volume is defined as the volume of water contained in

the well screen and casing (and in the case of an open bedrock hole, the volume of water in the open corehole and possibly in the well casing). To determine the standing water volume in a well:

1. Calculate the distance from the bottom of the well to the static water level.
2. Measure the inside diameter of the well or casing. Obtain the volume of standing water in the well using the following formula:

   V = $\pi r^2 h$ (7.48 U.S. gallons/cubic feet) (1 liter/1,000 cubic centimeters)

   Where:

   V = volume of water in gallons or liters

   π = 3.142

   r = radius of well casing (feet or meters)

   h = depth of water column in the well (feet or meters)

Typical 1 - Foot Casing Volumes	
Diameter (inches)	Gallons (U.S.) of Water Per Foot of Casing
1.5	0.09
2	0.16
3	0.37
4	0.65
6	1.47

Typical 1 Meter Casing Volumes		
Diameter		Litres per Meter of Casing
(inches)	6 (cm)	
1.5	3	1.14
2	5	2.02
3	8	4.56
4	10	8.11
6	15	18.24

7.7.5 Well Purging and Stabilization Monitoring

7.7.5.1 Typical Method

Prior to initiating groundwater sample collection, the wells is purged of the standing stagnant groundwater volume. This volume is not representative of the groundwater in the hydrostratigraphic unit. Purging is performed until the water in the well is representative of the actual conditions in the hydrostratigraphic unit. Stabilization is usually achieved by the removal of three to five times the volume of standing water in the well (USEPA convention). Purging is considered complete once purged groundwater is free of sediment and field parameters including specific conductance, temperature, and turbidity are stable. Stabilization is achieved when field measurements for specific conductance and temperature are within a range of plus or minus 10 percent of the average for the

last three readings. Field measurement for pH should be within a range of plus or minus 0.1 pH unit of the average for the last three readings, and groundwater turbidity values should be less than 5 nephelometric turbidity units (NTU) (guidance value only). Once the number of well volumes required to achieve stabilization is established, the volume required to reach stabilization for future sampling events is reduced or eliminated. Extended purging of a well will generally result in achieving sediment-free groundwater conditions.

During purging, if stabilization has not occurred after removal of five well volumes, purging is continued until ten well volumes have been removed. If stabilization still has not been achieved, stabilization may be dropped as a pre-condition to groundwater sampling. The Project Coordinator should be notified that stabilization has not occurred after the removal of ten well volumes.

At high yielding wells, removing three to five well volumes is usually sufficient prior to initiating groundwater sampling. For low yield wells (i.e., wells that pump dry after one well volume) it is necessary to purge the well dry on three successive days, unless the well recovers to full static conditions in a shorter time. If the recharge is relatively high, groundwater sampling will be initiated once the well has fully recovered to static groundwater conditions, or to a level that is sufficient to collect the necessary groundwater sample volume.

Note: Purging of dry wells should be scheduled to begin on Monday or Tuesday, to reduce weekend requirements.

Turbidity of purged groundwater is evaluated by a visual examination for sediment/silt presence or by using a nephelometer which physically measures groundwater turbidity in NTUs. Generally, a turbidity value of 50 NTU or less is acceptable, although some regulatory agencies have established lower criteria (i.e., less than 5 NTU). If 50 NTU is not achieved, filtration of samples may be required. LFP can generally result in turbidity values less than 5 NTU.

Note: Agitation of the water column within the well will increase turbidity. Therefore, bailers and inertia pumps (Waterra™) are of limited use for collecting sediment-free samples. The tubing of peristaltic pumps must be secured to prevent movement of the tubing within the water column which would disturb sediment. The best method to reduce sediment disturbance is low-volume non-agitation pumping (i.e., bladder pump).

Well purging is accomplished using dedicated equipment or by using either peristaltic, bladder, or other approved purging methods. Purging and sampling equipment are dependent on the total well depth. Bailing can be used for well purging but this method stirs up sediment and increases the purging effort required before stabilization is achieved. Equipment available for well purging is discussed in Section 7.7.7. Monitoring equipment used during well purging includes a water level indicator, pH meter, thermometer, conductivity meter, and turbidity meter.

7.7.5.2 Purging Entire Water Column

The purging equipment is lowered into the top of the standing water column. Well purging is completed from as close to the top of the water column as possible, not from the well bottom, unless poor well recovery occurs. Purging from the top of the water column moves water from the formation through the well screen of the well and into the well casing. This allows for the entire

static volume to be removed. Purging at depth in the water column does not remove water above the pump intake and results in the collection of unrepresentative samples.

If required, the pump intake can be adjusted. If the recovery rate is greater than the pumping rate, the pump should remain suspended until the required purged volume has been removed. If the recovery rate is less than the pumping rate, the pump should be lowered to ensure the removal of the required well volume.

7.7.5.3 Low-Flow Purging (LFP) Technique

LFP purging results in minimal drawdown during well purging, so less purging is required before formation water is removed. The volume required for purging using LFP is significantly reduced. LFP results in less agitation and mobilization of sediments compared to traditional sampling techniques.

A pre-cleaned stainless steel bladder pump equipped with a Teflon™ bladder is strongly recommended for LFP. The discharge line should be polyethylene or Teflon™ lined tubing with an inside diameter of 1/4 or 3/8 inch (6 or 10 mm). Check the Work Plan or QAPP to ascertain the proper bladder and discharge tubing. Smaller discharge tubing ensures that the tubing remains filled with water and reduces air bubbles at low purging rates. The airline to the pump is generally 1/4-inch (6 mm) inside diameter polyethylene tubing. The pump is secured to nylon rope and positioned in the well so that the pump intake is set at the mid-point of the well screen, or a minimum of 2 feet (0.6 m) above the bottom of the well or accumulated sediment level. It is important that the rope, airline, and discharge tubing are measured prior to installation in the well. The bladder pump and tubing are lowered very slowly through the water column to minimize mixing of the stagnant well casing water and to minimize the agitation of sediment into suspension, which would increase the purging time. It is recommended, and in some instances regulated, that pump installation occurs at least 24 hours prior to initiating LFP. It is recommended that a bladder pump be dedicated to the well for regular monitoring events.

During LFP, the pumping rate should be between 100 and 500 milliliters per minute (mL/min). It is recommended that initial pumping be conducted at a lower rate to limit drawdown in the well. During purging, groundwater levels are measured to maintain a maximum 0.4 foot (0.1 m) of drawdown. The pumping rate can be gradually increased during LFP. Pumping rate increases will be dependent on the drawdown and the stabilization of field parameters discussed below. Pumping rate adjustments should occur in the first 15 minutes of purging. After this time the pumping rate should remain constant and flow rate adjustments should be avoided. During purging, the pumping rate and groundwater level should be measured at least every 10 minutes. It is recommended that water level measurements occur at 5-minute intervals.

During LFP, stabilization of the purged groundwater is required to ensure the collection of representative groundwater samples from the formation and not from the stagnant water in the well casing. Field parameters including pH, temperature, specific conductance, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity should monitored during LFP. The measurement of these field parameters is used to evaluate if stabilization of the purged groundwater has occurred prior to the collection of groundwater samples. The field measurements should be measured and recorded at 5-minute intervals. Groundwater stabilization is considered

achieved when three consecutive readings for each of the field parameters, taken at 5-minute intervals, are within the following limits:

pH	±0.1 pH units of the average value of the three readings
Temperature	±3 percent of the average value of the three readings
Conductivity	±0.005 milliSiemen per centimeter (mS/cm) of the average value of the three readings for conductivity <1 mS/cm and ±0.01 mS/cm of the average value of the three readings for conductivity >1 mS/cm
ORP	±10 millivolts (mV) of the average value of the three readings
DO	±10 percent of the average value of the three readings
Turbidity	±10 percent of the average value of the three readings, or a final value of less than 5 NTU

During LFP, field parameters are measured using a flow-through cell apparatus. At the start of LFP the purge water is visually inspected for clarity prior to connecting to the flow-through cell. If the purge water is turbid, LFP continues until the purge water is visually less turbid prior to connecting to the flow-through cell. Field parameters may be obtained using individual meters or a multiple meter unit; however, the use of a flow-through cell is highly recommended. All meters must be calibrated daily in accordance with the manufacturer's and GHD's calibration instructions, and a calibration record maintained in a standard GHD field book.

During LFP the meter readings are monitored for evidence of meter malfunction. The following are common indicators of meter malfunctions:

- DO above solubility (e.g., oxygen solubility is approximately 11 milligrams per liter (mg/L) at 10°C) may indicate a DO meter malfunction.
- Negative ORP and DO less than 1 to 2 mg/L may indicate either an ORP or a DO meter malfunction (i.e., should have positive ORP and DO less than 1 to 2 mg/L under oxidizing conditions).
- Positive ORP and DO less than 1 mg/L may indicate either an ORP or a DO meter malfunction (i.e., should have a negative ORP and DO less than 1 mg/L under reducing conditions).

Meter calibration fluids should be available for meter recalibration in the field. Spare meters should also be available for meter replacement if necessary.

Note: DO levels exceeding the solubility of oxygen in water are erroneous and are indicative of meter malfunction or poor sampling techniques causing turbulence and aeration. DO concentrations cannot exceed:

9 mg/L at 20°C 10 mg/L at 15°C 11 mg/L at 10°C 14 mg/L at 1°C

Stabilization will be considered complete when the field parameters have stabilized as indicated in the above table. Purging will continue if stabilization does not occur, until a maximum of 20 screen volumes has been removed. LFP causes groundwater to be drawn from a significant distance above or below the pump intake. Therefore, the screen volume is based on a 5-foot (1.5 m) screen length. After the removal of 20 screen volumes, purging will continue if the purged water remains

visually turbid and appears to be clearing. Also purging will continue if the field parameters vary only slightly outside of the stabilization criteria and appear to be approaching stabilization.

If the recharge to the well is insufficient to conduct LFP, the well should be pumped dry and allowed to recharge sufficiently for the collection of the groundwater sample volume. Wells purged dry are required to meet the stabilization criteria detailed above.

7.7.5.4 Sampling Techniques

Upon completion of purging, with groundwater stabilization and clarity meeting the applicable protocol described above, groundwater sample collection can proceed. Generally the field parameters of pH, temperature, and specific conductance are monitored first, then any other required field measurements.

Samples are collected directly from the purging pump, when possible, or an alternate device (i.e., pump or bailer) may be installed or used. If new sampling equipment is installed, the first few bails or discharge volumes should be discarded to allow acclimation of the sampling equipment with the groundwater.

Samples are typically collected from the pump or bailer with the discharged groundwater collected directly in the appropriate sample containers. The interior of the bottle or cap must not be touched or handled in anyway. New gloves (i.e., disposable nitrile gloves or equivalent) should be worn for the collection of each sample. Caps from sample bottles must not be placed on the ground or in pockets to eliminate the possibility of cross-contamination.

Descriptions of the various equipment and sampling methods for the collection of groundwater samples are contained in Section 7.7.7.

The following describes the main activities involved in the collection of groundwater samples.

7.7.5.5 Order of Sample Collection

Groundwater samples are collected and containerized in the order following volatilization sensitivity:

1. VOCs
2. Semi-volatile organic compounds (SVOCs)
3. Total organic carbon
4. Total organic halides
5. Extractable organics
6. Total metals
7. Dissolved metals
8. Phenols
9. Cyanide
10. Sulfate and chloride

11. Nitrate and ammonia
12. Microbiological parameters
13. Radionuclides

QA/QC requirements for groundwater sampling are described in detail in Section 3.9.

7.7.6 Sample Acquisition and Transfer

If groundwater sample collection is performed using a pump, the flow rate must not exceed 100 mL/min during the collection of groundwater samples for VOCs. The low flow rate will reduce the possibility of degassing samples. During the collection of groundwater into the sample container or filtration device, minimize agitation and aeration of the sample. Groundwater samples are transferred directly into the sample container for submittal to the laboratory. Groundwater samples should not be collected in larger containers and subsequently transferred to smaller sample containers; however, on occasion this will be required for filtration or sample composting. During VOC sample collection, samples must not be collected, handled, or containerized near or in the vicinity of a running motor or exhaust which may contaminate the samples.

Groundwater samples for VOCs are collected in laboratory supplied 40 mL glass vials. The vials are filled to the top until a meniscus is formed, then topped with a Teflon™-lined cap. To prevent the loss of volatiles, it is important that no air bubbles or headspace are present in the sample container. Inverting and tapping the vial will check for the presence of air bubbles. If air bubbles are present, the sample should be topped off again and resealed. This process may only be performed a maximum of twice, at which time the sample must be discarded and the sample retaken. If preservatives were present in the bottle from the laboratory, a new sample vial must be used.

Note: Gas bubbles that appear in VOC containers after sample collection may be a result of degassing or reaction with preservative. If this occurs, note this occurrence on the chain-of-custody. Re-sampling is not required in most cases.

During sample collection ensure groundwater samples are preserved according to laboratory requirements. If required and supplied by the laboratory, preserve the samples in accordance with the QAPP. Some laboratories pre-preserve bottles so that once the groundwater sample is added the preservation is completed. In either case, it is advisable to check sample preservation using litmus paper. Using litmus paper ensures that groundwater sample preservation has been completed to the proper pH as required by the QAPP. If preservation of a sample does not meet the requirements of the QAPP, it may be necessary to add additional preservative, or note on the chain-of-custody that incomplete sample preservation has occurred.

Once sample collection is complete, samples are placed in a cooler on ice to maintain a sample temperature no more than 4°C.

7.7.6.1 Sample Labels/Sample Identification

Label all groundwater samples with the following, written in indelible ink:

1. A unique sample number (see Section 3.9 for guidance)
2. Date and time
3. Parameters to be analyzed
4. Job number
5. Sampler's initial

Secure the label to the bottle. It is recommended that bottle labels be covered with wide clear tape to protect the label during sample packing and shipment. Pack glassware in appropriate packing material to deter breakage during sample packing and shipment. Sample labels can be prepared in advance in GHD offices that have label-generating programs.

An example of a groundwater sample log entry is provided on Figure 3.8.

Section 3.9 details sample labeling requirements for environmental sampling programs. Section 3.9 also details COC requirements and sample shipment requirements.

7.7.7 Purging/Sampling Equipment

GHD maintains a wide variety of purging and sampling equipment for well purging and groundwater sample collection. The groundwater sampler should be familiar with purging and sampling equipment and understand equipment limitations and proper use. Some equipment is very useful for well purging (i.e., high flow rates) but is not permissible for LFP or for sampling sensitive parameters (e.g., VOCs cannot be collected with a submersible (turbine) or suction pump). If the groundwater sampler understands the various equipment operation and limitations, the proper selection of purging and sampling equipment is made, which will minimize the purging and sampling duration and maximize productivity.

Caution:	Gas powered equipment requires special attention to ensure that staff hauling these units do not cause equipment or sample contamination. Frequent changes of disposable glove as well strict separation of sampling crew tasks (i.e., those handling pumps and hoses do not contact generator or are involved in any refueling activities) are required.

The following subsections describe the equipment available for groundwater sampling, the equipment use, approximate flow rates, and advantages and disadvantages of the equipment.

7.7.7.1 Peristaltic Pumps

A peristaltic pump is acceptable for purging wells and for most groundwater sample analytes. The groundwater sampler must ensure that a peristaltic pump is acceptable to regulatory agencies with local jurisdiction for VOC and SVOC sample collection. The QAPP will provide sampling requirements.

A peristaltic pump is capable of lifting water from a maximum depth of 25 feet (7.6 m) below ground surface or the pump, whichever is greater. A peristaltic pump is a self-priming, low volume, suction pump which consists of a rotor with ball bearing rollers. Flexible silicon tubing is inserted around or in the pump rotor and squeezed in place by the heads as they revolve in a circular pattern. The section of silicon tubing must not exceed 3 feet (0.9 m) in length. Additional rigid polyethylene or Teflon™ tubing is attached to the flexible tubing and placed in the well. Another piece of rigid tubing is attached to the discharge end of the flexible silicon tubing to facilitate sample collection. The entire length of rigid and flexible silicon tubing is dedicated to the well for future use. The tubing is typically tied and suspended in the well. The flexible or rigid tubing is not reused in other wells because cross-contamination will occur.

Note: Often a length of tubing is accidentally dropped into a well and can be difficult to retrieve. Retrieval can be accomplished by sending another piece of tubing down the well overlapping the lost section of tubing. Once in place, rotate the tubing, essentially wrapping or corkscrewing the lost tubing and new tubing together. After a number of turns are completed pull the tubing, hopefully with the lost section wound around the new piece. Repeat the procedure until successful.

Liquid is pulled into the tubing by the peristaltic pump through the creation of a vacuum as the rotor head turns. An advantage of using a peristaltic pump is that no pump parts come in direct contact with the sample. A peristaltic pump is capable of providing low flow sampling rates (i.e., typically less than 500 mL/min) with less agitation than other suction pumps. However, it is important that the tubing is secured during pumping to prevent the tubing from moving and causing agitation. A peristaltic pump also allows for regulation of the flow rate by increasing or decreasing the rotor head speed.

Peristaltic pumps are small and easily mobilized to remote sample locations. They require minimal setup, and do not require decontamination between sample locations. The disadvantages of a peristaltic pump are its limited lift and flow capabilities and the limited ability to collect VOC and SVOC samples. If VOC or SVOC sampling, check the QAPP to see if sampling with a peristaltic pump is allowed. Also check with regulatory agencies with local jurisdiction to see if the use of a peristaltic pump for collection of VOC and SVOC samples is acceptable. If using a peristaltic pump for purging, and the collection of VOCs and SVOC samples with the peristaltic pump is not acceptable, it is common to collect the initial VOC and SVOC analytes with a stainless steel bottom loading bailer. The peristaltic pump can then be used to collect the remaining sample analytes.

Peristaltic pumps are becoming more popular for LFP. However, it should be noted that a peristaltic pump may cause degassing, pH modification, and possible VOC loss.

7.7.7.2 Suction Pumps

A number of suction pumps (e.g., centrifugal) exist that can be used for purging applications only. A suction pump draws water through a suction line by creating a vacuum in the suction line or hose. Once drawn into the pump, the groundwater comes into direct contact with the pump rotor/pumping chamber area and it is therefore undesirable for groundwater sampling due to high groundwater agitation. Decontamination of suction pumps is extremely difficult. As with peristaltic pumps, most suction pumps have a limited lift capability of about 25 feet (7.6 m). Larger suction pumps, like

2-inch (5 cm) trash pumps, can achieve high flow rates under low hydraulic head. Flow rates of 15 to 20 U.S. gallons per minute (USgpm) (57 to 76 liters per minute [L/min]) can be achieved. This high flow rate minimizes purging time. New or dedicated suction line should be used at each well if a suction pump is used for purging.

Large suction pumps are also useful for well development, in conjunction with agitation and surging.

Large suction pumps are not suited for LFP due to degassing, pH modifications, VOC loss, and lack of flow adjustment.

Caution: The groundwater sampler must prevent the siphoning of purged water from a bulk container back into the well. For example, the following scenario is possible: Joe Sampler has completed purging well 'xyz' and has turned off the 2-inch trash pump. The trash pump discharge line is inserted into a wastewater tank and is submerged below the tank water level. As Joe prepares his glassware and sample pump, the wastewater tank contents are siphoned back into the well. This can result in cross contamination with water from other sites/wells which have been purged either:

- into the tank
- through the pump
- through the discharge line

All discharge lines/groundwater purge pumps must be provided with a check valve to prevent this situation.

Drilling rig pumps including Moyno, progressive cavity, bean, and mud pumps can be used for well purging and well development.

Suction pumps are a useful tool for high rate purging and well development. They require no additional equipment other than a suction line and discharge line for each well. They are mobile and easily transported around and between sites. Suction pumps are limited to use in wells with less than 25 feet (7.6 m) of lift, are difficult to decontaminate, and are unsuitable for sample collection. Large suction pumps are not suitable for LFP.

7.7.7.3 Submersible Pumps

A submersible pump generally provides high discharge rates for purging at depths beyond the capabilities of a suction pump. Based on its size, a submersible pump can pump water from substantial depths at very high pumping rates and can provide higher groundwater extraction rates than other methods. At high pumping rates, a submersible pump can cause agitation and aeration. This results in some submersible pumps not being suitable for the collection of groundwater samples for VOC and SVOC analysis.

Adjustable rate submersible pumps, constructed of stainless steel or Teflon™, are suitable and approved for LFP provided low flow rates are maintained.

The submersible pump, including the electrical cable and lowering cable, must be decontaminated between wells in accordance with the Work Plan or QAPP.

A submersible pump installed in bedrock or in a deep well should be attached to rigid piping (i.e., 3/4-inch (1.9 cm) steel) to allow for pulling or pushing of the pump. The pump may need to be pushed or pulled to the appropriate installation depth, past tight spots in the well, and when affixing the electrical cable and lowering the cable/safety line. Even when rigid piping is used, a safety line must be attached to the pump in case the piping becomes unthreaded or the pump connection is lost.

Submersible pumps can provide high flow rates that are useful for deep well or large diameter well purging activities. They tend to be labor intensive because of decontamination problems, power supply, and discharge piping size. Some submersible pumps are not suitable for some sample analytes. Small submersible pumps (i.e., 2-inch (5 cm) Grundfos™) have the proper construction and have adjustable flow rates, making them suitable for LFP.

7.7.7.4 Air Lift Pumps

An air lift pump operates using compressed air or nitrogen. The compressed air or nitrogen comes into direct contact with the groundwater and forces groundwater from the pump chamber through a series of check balls into the discharge line. An air lift pump operates on alternate pump discharge and pump recharge cycles. The pump and recharge cycles are controlled using a control box at ground surface. Air lifting is possible from deep depths with moderate to low flow rates (2 to 3 USgpm [7.6 to 11.5 L/min]) depending on the pump installation depth, static head, discharge tubing diameter, and air supply pressure.

Since the air or nitrogen comes in direct contact with the groundwater, an air lift pump should not be used for the collection of groundwater samples for VOC and SVOC analysis.

An air lift pump is a good tool for deep well purging and development. If an air lift pump is used for purging, an alternate sampling method will be required (e.g., bailers or bladder pump) for the collection of VOC and SVOC groundwater samples.

7.7.7.5 Bladder Pumps

Bladder pumps, as with air lift pumps, are driven by compressed air or nitrogen but the air or nitrogen does not come in contact with the groundwater. The contact between the air or nitrogen and the groundwater is eliminated by the presence of a Teflon™, polyethylene, or natural rubber bladder. The pump operation, as with the air lift pump, is cyclic and is controlled using a control box at ground surface. The control box controls the pump filling and discharge time. Because the air or nitrogen does not come in direct contact with the groundwater, and there is limited groundwater agitation and degassing, a bladder pump is the best sampling equipment for the collection of groundwater samples for VOC and SVOC analysis.

Bladder pump operation is very quiescent, causing little formation and well disturbance. By using a bladder pump, collecting a sediment-free groundwater sample is easily achieved. An adjustable rate bladder pump should be used for LFP. Bladder pumps generally are only able to achieve a maximum pumping rate of 1.5 USgpm (5.7 L/min). It is important to note that flow rates should be reduced in deep well applications.

Well purging and sampling can be performed using a bladder pump. Once sampling is completed, the pump should be disassembled and decontaminated in accordance with the Work Plan or QAPP prior to use in other wells. The sample tubing is generally 1/4- or 3/8-inch (6 or 10 mm) diameter polyethylene or Teflon™ lined polyethylene tubing. The air line is generally 1/4-inch (6 mm) polyethylene tubing. The sample and air line tubing are typically suspended in the well for future use (dedicated). At some sites a complete sampling system (bladder pump, discharge tubing, and air line) is dedicated to each well.

Bladder pumps provide excellent sample quality and are useful in deeper sampling applications. There are no analyte restrictions. Bladder pumps are strongly recommended for LFP applications.

Bladder pumps require additional equipment including control box, compressed air or nitrogen, and tubing. The setup of a bladder pump is quite labor intensive unless a dedicated system is in place. Decontamination of a bladder pump requires pump disassembly and re-assembly. Finally, bladder pumps are not capable of high flow rates, thus purging times tend to be increased slightly.

7.7.7.6 Inertia Pumps

An Inertia pump or Waterra™ pump is a manually operated or mechanically driven pump which uses only a foot valve on the sample/purge tubing. "Jerking" the sample/purge tubing with the attached foot valve removes groundwater from the well. The rapid lifting and lowering action of the tubing imparts an inertia to the water column within the sample/purge tubing. This causes the water column to rise to ground surface and discharge from the end of the sample/purge tubing. The foot valve holds the water column in the tubing during the lifting process and allows groundwater to enter the sample/purge tubing during the lowering, or down stroke.

GHD owns both manual and mechanical gas-powered inertia systems. Flow rates with inertia pumps are variable and are dependent on cycle speed, tubing size, foot valve size, well depth, and depth to groundwater. The inertia pump is a useful method for purging and for collection of most groundwater sample analytes. Acceptability of VOC and SVOC sampling with inertia pumps is gaining approval in selected areas. Prior to using an inertia pump as a sampling device, check the sampling requirements in the QAPP, or obtain approval from the Project Coordinator.

Inertia pumps are useful for the extraction of dense non-aqueous phase liquids (DNAPL). The only equipment that is exposed to the gross contamination is the foot valve and a small section of the sample/purge tubing. On most projects, the foot valve and sample/purge tubing are dedicated to the well.

Inertia pumps tend to cause extensive disturbance to the water column. The vigorous lifting and lowering of the inertia pump tends to make it difficult to collect sediment-free groundwater samples. Therefore, inertia pumps are not suitable for LFP.

7.7.7.7 Bailers

A bailer is a manual sampling device consisting generally of a hollow tube (e.g., Teflon™, PVC, or stainless steel) with a lower check ball that permits water entry and prevents water loss. The bailer is lowered slowly into the well. This allows water to enter the bailer through the bottom, and the weight of the water inside the bailer closes the check ball when the bailer is retrieved from the well.

A rope or cable is affixed to the bailer to allow the lowering and retrieval of the bailer from the well. Bailing tends to be disruptive to the water column and formation. Obtaining sediment-free groundwater samples using a bailer tends to be difficult, if not impossible. VOCs and SVOCs, as well as other analytes can be collected using a bailer, but it is important that these analytes be as sediment-free as possible. The compatibility of the bailer material and groundwater analytes should be reviewed and approved prior to using a bailer for the collection of groundwater samples. Generally, Teflon™ bailers are acceptable for the collection of most analytes.

Power winches with overhead tripods are available to assist in purging and sampling deep or large volume wells.

Flow rates attained using a bailer is a function of the bailer size and retrieval frequency. Retrieval frequency is dependent on well depth, water depth, and well recharge rate. Bailing is not practical for deep wells or for the removal of large well volumes.

A bailer is a useful tool for well development as the surging action from the bailer insertion and removal from the well promotes sediment suspension and subsequent removal. However, obtaining completely sediment-free samples, or samples below 50 NTU, is difficult if not impossible using a bailer.

A bailer provides representative samples once the well has been adequately developed and purged. A bailer is not suitable for LFP. Rope used for bailing must be kept off the ground and free of other contaminating material that could be introduced to the well. Rope can either be dedicated to the well for future use or discarded.

7.7.7.8 Passive Diffusion Bags

When sampling with diffusion bags the well must be fully developed using an alternate method.

A diffusion bag is a polyethylene bag that contains deionized water. The bag is attached to an appropriate length of rope or cable in order to be submerged to the appropriate depth (indicated in the Work Plan, QAPP, or as instructed by the Project Coordinator). Cable or rope used to suspend diffusion bags can be dedicated to the well for future use or discarded.

Once submerged to the appropriate depth, the diffusion bag is left in the well for an extended period of time, usually 14 days, to allow the bag to equilibrate with the water in the well. The use of diffusion bags eliminates well purging prior to sampling. Placement of multiple diffusion bags in a well allows for vertical groundwater profiling.

Diffusion bags are a low cost method for the collection of groundwater samples. Advantages include:

- No purge water to dispose of.
- No equipment decontamination between wells.
- Simple logistics and operation.
- Reduction in personnel and exposure times.
- Samples collected are representative of formation water adjacent to well.

- Allow for vertical profiling of water column.
- Appropriate for long-term monitoring programs.

The disadvantage of diffusion bags is the length of equilibrium time, generally 14 days. Currently, there are membranes available for diffusion bags suitable for the collection of groundwater samples for select SVOC, and metals analyses. However, there are no membranes currently available for polychlorinated biphenyls (PCBs).

Note: Handle diffusion bags only when wearing clean nitrile or surgical gloves.

7.7.8 Filtering of Groundwater Samples

Filtering is an important process to remove suspended particulate that affect sample results. Filtration of groundwater samples is generally limited to metals analysis.

Filtering can be completed in the field using in-line filters or a vacuum filter kit. Filtering of samples can also be completed by the laboratory, in which case the samples must not be preserved and must be at the laboratory in at least 24 hours of sample collection.

7.8 Field Procedures for Residential Sampling

7.8.1 General

When sampling potable water supply wells it is important to ensure that the samples collected are representative of the aquifer being sampled. Poor or incorrect sampling techniques will result in erroneous sample results that can be disclosed to the public. Incorrect sample results may make any changes in the public perception hard to accomplish when correct results are reported.

7.8.2 Field Procedures

The requirements of a residential well sampling program should be reviewed with the Project Coordinator prior to initiating sampling activities. While similar field procedures used in groundwater sampling (including documentation, sample identification, date, time, etc.) are required in residential well sampling, additional procedures are also required.

Prior to collection of groundwater samples from a residential well, the well must be purged to ensure that samples collected are representative of the formation. Purging removes standing water from the well casing, pipes, and pressure or holding tank. Purging of a residential well requires the removal of one well volume. If access to the well is not available to determine the well volume, purging for a period of 15 to 30 minutes is generally sufficient. Field measurements for pH, conductivity, and temperature are recorded during purging activities until the readings indicate that stabilization has occurred.

Sampling of residential wells is generally performed using the existing pumping system. However, GHD purging and sampling equipment can be used. It is important that only designated **clean** purging and sampling equipment be used for residential well sampling. The use of the existing pumping system is preferred, as this is more representative of the water quality provided to the

residence. Using the existing pumping system also minimizes the possibility of damaging the well and existing pumping system when installing additional purging and sampling equipment.

If GHD equipment is used for residential well sampling, it must be cleaned prior to and between use with a bleach and deionized water solution wash followed by a thorough deionized water rinse.

> Note: In addition to the special technical procedures noted, GHD personnel must be aware of this unique situation of conducting sampling at private residences. Special care must be taken to be polite and courteous at all times. Offer only necessary information and maintain a clean work area that is returned to pre-sampling conditions. Personnel should have proper identification available, and only remain in areas long enough to complete the required tasks.

Taps selected for residential well sampling should be located as close to the well as possible. Locate the taps before any treatment systems and, if possible, the pressure tank. It is important to note, if possible, all water treatment devices in operation at the residence including:

- Water softeners
- Filtration units
- Ultraviolet light
- Reverse osmosis
- Distillers
- Chlorinators

Leaking taps that allow water to flow from the stem of the valve handle and around the tap should not be used as sampling locations. Aerators, strainers, and hose attachments should be removed prior to sampling. Maintain a steady flow of water during sampling activities to avoid pressure fluctuations that may cause sheets of microbial growth lodged in the pipes to break loose. Open the cold water tap for a period of 15 to 30 minutes to allow for the complete purging of the pumping system. Maintain a smooth-flaring water stream at a low to moderate pressure without splashing. Do not change the flow rate. Changes in the flow could dislodge particles in the pipes or faucet.

When sampling for microbiological parameters, the end of the faucet must be flame sterilized. During residential well sample, never place caps from sample containers on the ground or in a pocket. Instead, hold the sample container in one hand and the sample container cap in the other. Be very careful not to touch the inside of the sample container cap. Wear new disposable gloves at each sampling location and following contact with a potential contaminant source. The inside of the sample bottle must not be touched with bare hands or allowed to contact the surface of the faucet.

7.8.3 Field Notes for Residential Sampling

Full documentation of each residential well is required and includes:

1. Well depth
2. Casing construction and diameter

3. Well installation date if known
4. Pumping system configuration
5. Piping system construction (e.g., copper, lead-joint, ABS)
6. Presence of treatment devices

Obtain the name and exact mailing address for all residence or well owners, as well as home and work telephone numbers. This information is required to inform the residence or well owner of the results of the sampling activities.

Document residential well sampling activities in a standard GHD field book. Figure 3.8 provides typical residential well sampling field note requirements. Note that additional documentation of well details, treatment devices, piping system, and special circumstances are required in the field book in addition to the sample log entry.

7.9 Field Procedures for Surface Water Sampling

7.9.1 General

Surface water sampling is performed to obtain samples for surface water bodies that are representative of existing surface water conditions.

Surface water sampling locations for surface water quality and groundwater interaction studies are selected based on the following:

1. Study objectives
2. Location of point surface discharges
3. Non-point source discharges and tributaries
4. Presence of structures (e.g., bridge, dam)
5. Accessibility

During surface water sampling it is important to obtain samples that are not impacted by the re-suspension of sediment produced because of improper or poor surface water sampling techniques.

7.9.2 Surface Water Sample Location Selection

Prior to conducting surface water sampling activities, the first requirement is the consideration and development of surface water sampling locations. It is important that all surface water sampling locations be selected in accordance with the Work Plan and described to and discussed with the Project Coordinator.

Bridges and piers are good locations for surface water sampling locations since they provide easy access and permit water sampling across the entire width of the surface water body. The JSA for sampling from bridges must include a traffic management plan to assure the employee has considered using a spotter, signage, cones, and flags to warn car traffic of the work adjacent to the

roadway. Wading for surface water samples increases the chances of disturbance of sediments from the floor of the surface water body.

When wading for surface water samples in lakes, ponds, streams, and slow moving rivers be aware of potential safety and health risks. A life vest and safety line must be worn at all times where footing is unstable or when sampling in fast moving or more than 3 feet (0.9 m) deep. A two-person team is required for most surface water sampling activities, a Project Manager must approve a one person sampling team. If the site conditions require the use of the life vest and safety line, the two people involved in the sampling must be competent swimmers.

Surface water samples must be collected with no suspended sediments. Surface water samples are collected commencing with the furthest downstream location to avoid sediment interference with upstream locations.

7.9.2.1 Rivers, Streams, and Creeks

Surface water samples are generally collected in areas of surface water bodies that are representative of the surface water body conditions. Representative surface water samples will usually be collected in sections of surface water bodies that have a uniform cross section and flow rate. Mixing is influenced by turbulence and water velocity, therefore the selection of surface water sampling locations immediately downstream of a riffle area (i.e., fast flow zone) will ensure good vertical mixing. These locations are also likely areas for deposition of sediment since this occurs in areas of decreased flow velocity.

Surface water sampling locations should not be established in areas near point source discharges including tributaries, industrial effluents, and municipal effluents. Surface water sampling of these source discharge points can be performed to assess the impact of these source areas on overall surface water quality.

Sample tributaries as close to the mouth as possible. It is important to select surface water sample locations considering the impact downstream, including tributary flow and sediment.

In all instances, properly document all surface water sampling locations in a standard GHD field book. Documentation may include photographs and tie-ins to known structures.

7.9.2.2 Lakes, Ponds, and Impoundments

The surface water in lakes, ponds, and impoundments has a greater tendency to be stratified than water in rivers and streams. Lack of mixing in these surface water bodies may require additional surface water sample collection. Extreme turbidity variances may occur where highly turbid surface water courses enter a lake or pond. Therefore, each layer of the stratified surface water column may need to be considered separately. Stratification is generally a result of water temperature differences, with cooler heavier water being trapped below warmer water.

Surface water sample locations for lakes, ponds, and impoundments should adequately represent the conditions of the surface water body. All intakes and outflows that may provide biased surface water representation should be identified and documented. Surface water sample locations with adjacent structures (e.g., banks, piers) may also provide biased samples, as the potential for boundary flow and eddies exists.

The number of surface water sample locations on lakes, ponds, or impoundments will vary depending on the purpose of the investigation, as well as the size and shape of the surface water body. In ponds and small impoundments a single surface water sample should be collected at the deepest point. In naturally formed ponds, the deepest point is usually near the center of the surface water body. In impoundments the point is usually near the dam.

In lakes and larger impoundments, several sub-samples should be taken to form a single composite sample. These vertical surface water sampling locations are collected along a pre-determined grid.

In irregular shaped lakes with several bays and covers that are protected from the wind, additional surface water samples are required to properly represent surface water quality at various locations in the lake. Additional surface water samples should be taken at discharges, tributaries, and other factors or sources that are suspected of affecting the surface water quality.

In all instances, properly document all surface water sampling locations in a standard GHD field book. Documentation may include photographs and tie-ins to known structures.

7.9.3 Sampling Equipment and Techniques

When collecting surface water samples, direct dipping of the sample container into the stream or water is acceptable unless the sample container contains preservatives. If preserved, a pre-cleaned unpreserved sample container should be used to collect the surface water sample. The surface water sample is then transferred to the appropriate preserved sample container. When collecting surface water samples, submerse the inverted bottle to the desired sample depth and tilt the opening of the sample container upstream to fill. During surface water sample collection, wading or movement may cause sediment deposits to be re-suspended and can result in biased samples. Wading is acceptable if the stream has a noticeable current and the samples are collected directly in the sample container when faced upstream. If the stream is too deep to wade in or if addition samples must be collected at various depths, additional sampling equipment will be required. Surface water samples should be collected about 6 inches (15 cm) below the surface, with the sample bottles being completely submerged. Taking the surface water sample at this depth eliminates the collection of floating debris in the sample container.

Surface water sample collection where the flow depth is less than 1 inch (<2.5 cm) requires the use of special equipment to eliminate sediment disturbance. Surface water sampling may be conducted with a container then transferred to the appropriate sample container, or collection may be performed using a peristaltic pump. A small excavation in the stream bed to create a sump for sample collection can also be considered but should be prepared in advance to allow all the sediment to settle prior to surface water sampling activities.

Teflon™ bailers can be used for surface water sampling if it is not necessary to collect surface water samples at specific depths. A bottom loading bailer with a check ball is sufficient. When the bailer is lowered through the water, the water is continually displaced through the bailer until the desired depth is reached. The bailer is retrieved and the check ball prohibits the release of the collected surface water sample. Bailers are not suitable in surface water bodies with strong currents, or where depth-specific sampling is required.

For discrete and specified depth surface water sampling, and the parameters to be monitored do not require a Teflon™ coated sampling device, a standard Kemmerer or Van Dorn sampler can be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the sampler ends open while the sampler is being lowered. The sampler is lowered in a vertical position to allow water to pass through. The Van Dorn sampler is plastic and is lowered in a horizontal position. For both samplers, a messenger is sent down a rope when the sampler has reached the required depth. The messenger causes the stopper on the sampler to close. The sampler is then retrieved and the surface water sample can be collected through a valve. DO sample bottles can be filled by allowing overflow using a rubber tube attached to the valve. During depth-specific surface water sampling, take care not to disturb bottom sediments.

Glass beakers or stainless steel cups may also be used to collect surface water samples if parameter interference does not occur. The beaker or cup must be rinsed at least three times with the surface water sample prior to sample collection.

All equipment must be thoroughly decontaminated as outlined in Section 7.6.

7.9.4 Field Notes for Surface Water Sampling

Use a standard GHD field book to record daily surface sampling activities, describe surface water sampling locations, sampling techniques, and, if applicable, provide a description of photographs taken. Visual observations are important and provide valuable information when interpreting surface water quality results. Observations include:

1. Weather conditions
2. Stream flow directions
3. Stream physical conditions (width, depth, etc.)
4. Tributaries
5. Effluent discharges
6. Impoundments
7. Bridges
8. Railway trestles
9. Oil sheens
10. Odors
11. Buried debris
12. Vegetation
13. Algae
14. Fish and other aquatic life
15. Surrounding industrial areas

The following factors should be considered for surface water sampling:

1. Predominant Surrounding Land Use: Observe the prevalent land use type in the vicinity and note any other land uses in the area which, although not dominant, may potentially affect surface water quality.
2. Local Watershed Erosion: Note the existing or potential erosion of soil in the local watershed and its movement into the stream. Erosion can be rated through visual observation of watershed stream characteristics including increases or decreases in turbidity.
3. Local Watershed Non-Point Source Pollution: This refers to problems or potential problems other than erosion and sedimentation. Nonpoint source pollution can be diffuse agricultural and urban runoff. Other factors may include feed lots, wetlands, septic systems, dams, impoundments, and mine seepage.
4. Estimated Stream Width: The estimated distance from shore at a transect representative of the stream width in the area.
5. Estimated Stream Depth: Riffle (rocky area), run (steady flow area), and pool (still area). Estimate the vertical distance from the water surface to the bottom of the surface water body at a representative depth at three locations.
6. High Water Mark: Estimate the vertical distance from the bank of the surface water body to the peak overflow level, as indicated by debris hanging in bank or flood plain vegetation, and deposition of silt. In instances where bank flow is rare, high water marks may not be evident.
7. Velocity: Record or measure the stream velocity in a representative run area.
8. Dam Present: Indicate the presence or absence of a dam upstream or downstream of the surface water sampling location. If a dam is present, include specific information detailing the alteration of the surface water flow.
9. Channelized: Indicate if the area surrounding the surface water sampling location is channelized.
10. Canopy Cover: Note the general proportion of open to shaded areas which best describes the amount of cover at the surface water sampling location.

7.10 Follow-Up Activities

The following should be performed once groundwater, residential, and surface water sampling is completed:

1. Double check the Work Plan and QAPP to ensure all samples and QA/QC samples have been collected and confirm with the Project Coordinator.
2. Decontaminate all equipment at the site then return clean to the appropriate office equipment manager.
3. Dispose of purge water and cleaning fluid as specified in the Work Plan.
4. Notify the contract laboratory when the samples should arrive. Enclose a completed chain-of-custody in each cooler.

5. Complete and file the appropriate forms and data sheets. Also file the field notes. For groundwater, residential, and surface water sampling these forms include:
    - Project Planning, Completion, and Follow-Up Checklist (Form SP-02)
    - Well Development, Purging, and Sampling Form (Form SP-06)
    - Sample Collection Data Sheet - Groundwater Sampling Program (Form SP-08)
    - Monitoring Well Record for Low-Flow Purging (if performed) (Form SP-09)
6. Return site and well keys.

7.11 References

For additional information pertaining to groundwater sampling activities the user of this manual may reference the following:

ASTM D5474 Guide for Selection of Data Elements for Groundwater Investigations

ASTM D4696 Guide for Pore-Liquid Sampling from the Vadose Zone

ASTM D5979 Guide for Conceptualization and Characterization of Groundwater Systems

ASTM D5903 Guide for Planning and Preparing for a Groundwater Sampling Event

ASTM D4448 Standard Guide for Sampling Groundwater Wells

ASTM D6001 Standard Guide for Direct-Push Water Sampling for Geoenvironmental Investigations.

For additional information pertaining to surface water sampling, the user of this manual may reference the following:

ASTM D5358 Practice for Sampling with a Dipper or Pond Sampler

ASTM D4489 Practices for Sampling of Waterborne Oils

ASTM D3325 Practice for the Preservation of Waterborne Oil Samples

ASTM D4841 Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents

ASTM D4411 Guide for Sampling Fluvial Sediment in Motion

ASTM D4823 Guide for Core-Sampling Submerged, Unconsolidated Sediments

ASTM D3213 Practice for Handling, Storing, and Preparing Soft Undisturbed Marine Soil

ASTM D3976 Practice for Preparation of Sediment Samples for Chemical Analysis

ASTM E1391 Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing

ASTM D4581 Guide for Measurement of Morphologic Characteristics of Surface Water Bodies

ASTM D5906 Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths

ASTM D5073 Practice for Depth Measurement of Surface Water

APPENDIX K

Example of GHD's Standard QA/QC Data Review and Validation Procedures for the Annual Groundwater Sampling Campaign

(Dated October 10, 2018)

Memorandum

October 10, 2018

To:	Maggie Popek	Ref. No.:	005513
From:	Deb Andrasko/mkd/20-NF	Tel:	716-297-6150

Subject: **Analytical Results and Reduced Validation**
Annual Groundwater Monitoring Program
GrafTech International Holdings, Inc.
Niagara Falls, New York
September 2018

1. Introduction

This document details a validation of analytical results for groundwater samples collected in support of the Annual Groundwater Monitoring Program at the Niagara Falls, New York Site on September 11, 2018. Samples were submitted to TestAmerica Laboratories, Inc., located in Amherst, New York. A sample collection and analysis summary is presented in Table 1. The validated analytical results are summarized in Table 2. A summary of the analytical methodology is presented in Table 3.

Standard GHD report deliverables were submitted by the laboratory. The final results and supporting quality assurance/quality control (QA/QC) data were assessed. Evaluation of the data was based on information obtained from the chain of custody form, finished report forms, method blank data, recovery data from surrogate spikes/laboratory control samples (LCS)/matrix spikes (MS) and field QC samples.

The Quality Assurance/Quality Control (QA/QC) criteria by which these data have been assessed are outlined in the analytical method referenced in Table 3 and applicable guidance from the document entitled "USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review", USEPA 540-R-08-01, June 2008, subsequently referred to as the "Guidelines" in this Memorandum.

2. Sample Holding Time and Preservation

The sample holding time criterion for the analysis is summarized in Table 3. Sample chain of custody documents and analytical reports were used to determine sample holding times. All samples were prepared and analyzed within the required holding times.

All samples were properly preserved, delivered on ice, and stored by the laboratory at the required temperature (0-6°C).

3. Laboratory Blank Analyses

Method blanks are prepared from a purified matrix and analyzed with investigative samples to determine the existence and magnitude of sample contamination introduced during the analytical procedures.

For this study, laboratory method blanks were analyzed at a minimum frequency of 1 per 20 investigative samples and/or 1 per analytical batch.

All method blank results were non-detect, with the exception of a low concentration of carbon disulfide in one of the blanks. The associated sample result was non-detect and would not require qualification.

4. Surrogate Spike Recoveries

In accordance with the method employed, all samples, blanks, and QC samples analyzed for Volatile Organic Compounds (VOCs) are spiked with surrogate compounds prior to sample analysis. Surrogate recoveries provide a means to evaluate the effects of laboratory performance on individual sample matrices.

All samples submitted for VOC determinations were spiked with the appropriate number of surrogate compounds prior to sample analysis.

Surrogate recoveries were assessed against laboratory control limits. All surrogate recoveries met the laboratory criteria.

5. Laboratory Control Sample Analyses

LCS are prepared and analyzed as samples to assess the analytical efficiencies of the method employed, independent of sample matrix effects.

For this study, LCS were analyzed at a minimum frequency of 1 per 20 investigative samples and/or 1 per analytical batch.

The LCS contained all compounds of interest. All LCS recoveries were within the laboratory control limits, indicating acceptable analytical accuracy.

6. Matrix Spike/Matrix Spike Duplicate (MS/MSD) Analyses

To evaluate the effects of sample matrices on the preparation process, measurement procedures, and accuracy of a particular analysis, samples are spiked with known concentrations of the analytes of concern and analyzed as MS/MSD samples. The relative percent difference (RPD) between the MS and MSD is used to assess analytical precision. If the original sample concentration is significantly greater than the spike concentration, the recovery is not assessed.

MS/MSD analyses were performed as specified in Table 1.

The MS/MSD samples were spiked with all compounds of interest. All percent recoveries and RPD values were within the laboratory control limits, indicating good analytical accuracy and precision.

7. Field QA/QC Samples

The field QA/QC consisted of one trip blank sample, and one field duplicate sample set.

7.1 Trip Blank Sample Analysis

To evaluate contamination from sample collection, transportation, storage, and analytical activities, a trip blank was submitted to the laboratory for VOC analysis. All results were non-detect for the compounds of interest.

7.2 Field Duplicate Sample Analysis

To assess the analytical and sampling protocol precision, a field duplicate sample set was collected and submitted "blind" to the laboratory, as specified in Table 1. The RPDs associated with these duplicate samples must be less than 50 percent for water samples. If the reported concentration in either the investigative sample or its duplicate is less than five times the reporting limit (RL), the evaluation criterion is one times the RL value for water samples.

The field duplicate results were in agreement, demonstrating acceptable sampling and analytical precision.

8. Analyte Reporting

The laboratory reported detected results down to the laboratory's MDL for each analyte. Positive analyte detections less than the RL but greater than the MDL were reported as estimated (J) in Table 2 unless qualified otherwise in this memorandum. Non-detect results were presented as non-detect at the RL in Table 2.

9. Conclusion

Based on the assessment detailed in the foregoing, the data summarized in Table 2 are acceptable without qualification.

Table 1

Sample Collection and Analysis Summary
Annual Groundwater Monitoring Program
GrafTech International Holdings, Inc.
Niagara Falls, New York
September 2018

					Analysis	
Sample Identification	**Location**	**Matrix**	**Collection Date (mm/dd/yyyy)**	**Collection Time (hr:min)**	**VOCs**	**Comments**
WG-5513-091118-DT-004	BW-3	Water	09/11/2018	13:05	X	MS/MSD
WG-5513-091118-DT-002	BW-4	Water	09/11/2018	12:20	X	
WG-5513-091118-DT-003	BW-4	Water	09/11/2018	12:20	X	FD (WG-5513-091118-DT-002)
WG-5513-091118-DT-001	GW-8B	Water	09/11/2018	11:25	X	
TB-5513-091118-DT	-	Water	09/11/2018	-	X	Trip Blank

Notes:

-	-Not applicable
FD	- Field Duplicate sample of sample in parentheses
MS/MSD	- Matrix Spike/Matrix Spike Duplicate
VOCs	- Volatile Organic Compounds

Table 2

Analytical Results Summary
Annual Groundwater Monitoring Program
GrafTech International Holdings, Inc.
Niagara Falls, New York
September 2018

Sample Location:			BW-3	BW-4	BW-4	GW-8B
Sample ID:			WG-5513-091118-DT-004	WG-5513-091118-DT-002	WG-5513-091118-DT-003	WG-5513-091118-DT-001
Sample Date:			9/11/2018	9/11/2018	9/11/2018 (Duplicate)	9/11/2018
Parameters	**Units**	**NYSDEC**				
Volatile Organic Compounds		**Class GA Criteria/TOGS**				
1,1,1-Trichloroethane	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	ug/L	5	1.0 U	3.4 J	2.5	1.0 U
1,1,2-Trichloroethane	ug/L	1	1.0 U	10 U	1.0 U	1.0 U
1,1-Dichloroethane	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
1,1-Dichloroethene	ug/L	5	1.0 U	4.7 J	3.9	0.43 J
1,2-Dichloroethane	ug/L	0.6	1.0 U	10 U	1.0 U	1.0 U
1,2-Dichloropropane	ug/L	1	1.0 U	10 U	1.0 U	1.0 U
2-Butanone (Methyl ethyl ketone) (MEK)	ug/L	50	10 U	100 U	10 U	10 U
2-Hexanone	ug/L	50	5.0 U	50 U	5.0 U	5.0 U
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK)	ug/L	--	5.0 U	50 U	5.0 U	5.0 U
Acetone	ug/L	50	4.0 J	100 U	3.6 J	3.2 J
Benzene	ug/L	1	1.0 U	10 U	1.0 U	1.0 U
Bromodichloromethane	ug/L	50	1.0 U	10 U	1.0 U	1.0 U
Bromoform	ug/L	50	1.0 U	10 U	1.0 U	1.0 U
Bromomethane (Methyl bromide)	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
Carbon disulfide	ug/L	60	1.0 U	10 U	1.0 U	1.0 U
Carbon tetrachloride	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
Chlorobenzene	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
Chloroethane	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	ug/L	7	1.0 U	**12**	**10**	1.0 U
Chloromethane (Methyl chloride)	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	ug/L	5	1.0 U	**1000**	**940**	**21**
cis-1,3-Dichloropropene	ug/L	0.4 (1)	1.0 U	10 U	1.0 U	1.0 U
Dibromochloromethane	ug/L	50	1.0 U	10 U	1.0 U	1.0 U
Ethylbenzene	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
Methylene chloride	ug/L	5	1.0 U	**5.5 J**	1.0 U	1.0 U
Styrene	ug/L	5	1.0 U	10 U	1.0 U	1.0 U
Tetrachloroethene	ug/L	5	1.0 U	**390**	**410**	1.0 U
Toluene	ug/L	5	1.0 U	10 U	0.89 J	1.0 U
trans-1,2-Dichloroethene	ug/L	5	1.0 U	10 U	**5.3**	1.0 U
trans-1,3-Dichloropropene	ug/L	0.4 (1)	1.0 U	10 U	1.0 U	1.0 U
Trichloroethene	ug/L	5	1.0 U	**650**	**640**	4.7
Vinyl chloride	ug/L	2	**2.5**	**150**	**180**	**3.5**
Xylenes (total)	ug/L	5	2.0 U	20 U	1.0 J	2.0 U

Notes:

(1) - Criteria applies to sum of cis- and trans-1,3dichloropropene
U - Not detected at the associated reporting limit
J - Estimated concentration
\- - Not applicable
TOGS - Technical and Operational Guidance Series
Boxed value is greater than regulatory limit

Table 3

Analytical Method and Holding Time
Annual Groundwater Monitoring Program
GrafTech International Holdings, Inc.
Niagara Falls, New York
September 2018

Parameter	Method	Matrix	Collection to Analysis (Days)
Volatile Organic Compounds	SW-846 8260C	Water	14

Notes:

SW-846 - "Test Methods for Solid Waste/Physical Chemical Methods," SW-846, 3rd Edition, September 1986 (with all subsequent revisions)

APPENDIX L

Letter from Michael J. Hinton, P.E., NYSDEC DER Approving the Soil Vapor Intrusion Evaluation Report

(Dated December 29, 2008)

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York, 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.dec.state.ny.us

December 29, 2008

Mr. Robert Bucci
GrafTech
3344 Wildwood Drive
Niagara Falls, New York 14304

Dear Mr. Bucci:

Soil Vapor Intrusion Evaluation Report
UCAR Republic Site, Registry No. 932035
Town of Niagara, Niagara County

The New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYS DOH) have reviewed the Soil Intrusion Evaluation at the UCAR Republic Site report dated May 2, 2007. We have determined that the potential for soil vapor intrusion into neighboring homes and business' has been satisfactorily evaluated and we concur with your recommendation that no further action is needed at this site regarding soil vapor intrusion.

We appreciate your patience while we were evaluating your report. If you have any questions please call me at 716-851-7220.

Sincerely yours,

Michael J. Hinton

Michael J. Hinton P.E.
Environmental Engineer II
Region 9, Buffalo Office

MJHi\dcg
hinton\bucci-dec1.ltr

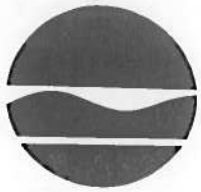
cc: Mr. Gregory Sutton, NYSDEC, Region 9
Ms. Mary McIntosh, NYSDEC, Region 9
Mr. Thomas Festa, NYSDEC, Albany (Code 7013)
Mr. Matthew Forcucci, NYS DOH, Buffalo
Ms. Juanita Bursley, Senior Manager Corporate Environmental Protection, UCAR

APPENDIX M

Notification from NYSDEC re Inactive Hazardous Waste Disposal Site Registry Classification Change from 2a to 4

(Dated August 27, 1997)

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010



John P. Cahill
Commissioner

UCAR Carbon Company, Inc.
3625 Highland Avenue
Niagara Falls, New York 14302

Dear Sir/Madam:

As mandated by Section 27-1305 of the Environmental Conservation Law (ECL), the New York State Department of Environmental Conservation (NYSDEC) must maintain a Registry of all inactive disposal sites suspected or known to contain hazardous waste. The ECL also mandates that this Department notify the owner of all or any part of each site or area included in the Registry of Inactive Hazardous Waste Disposal Sites as to changes in site classification.

Our records indicate that you are the owner or part owner of the site listed below. Therefore, this letter constitutes notification of change in the classification of such site in the Registry of Inactive Hazardous Waste Disposal Sites in New York State.

DEC Site No.: 932035
Site Name: Union Carbide Corp., Carbon Prod. Div.
Site Address: Hyde Park Boulevard, Niagara, New York 14303

Classification change from 2a to 4

The reason for the change is as follows:

- Though Trichloroethene (TCE) was found in groundwater on the north boundary of the site, it has been shown by soil gas and surface soil sampling to originate from an area just north of the site (corridor for high tension power lines). Documentation indicates that waste was disposed in the landfill but no significant threat could be found. Further, the site is capped and monitored by Division of Solid Waste. It is recommended, however, that future Solid Waste monitoring include scans for Trichloroethane (TCA) and the newly installed wells be included in the monitoring plan.

Enclosed is a copy of the New York State Department of Environmental Conservation, Division of Environmental Remediation, Inactive Hazardous Waste Disposal Site Report form as it appears in the Registry and Annual Report, and an explanation of the site classifications. The Law allows the owner and/or operator of a site listed in the Registry to petition the Commissioner of the New York State Department of Environmental Conservation for deletion of such site, modification of site classification, or modification of any information regarding such site, by submitting a written statement setting forth the grounds of the petition. Such petition may be addressed to:

John P. Cahill
Commissioner
New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233-0001

For additional information, please contact me at (518) 457-0747.

Sincerely,

Robert L. Marino
Chief
Site Control Section
Bureau of Hazardous Site Control
Division of Environmental Remediation

Enclosures

THE FOLLOWING ARE THE PRIORITY AND CLASSIFICATION CODES ASSIGNED TO ALL INACTIVE HAZARDOUS WASTE SITES IN NEW YORK STATE

1 - Causing or presenting an imminent danger of causing irreversible or irreparable damage to the public health or environment - immediate action required.

2 - Significant threat to the public health or environment - action required.

2a - Temporary classification assigned to sites that have inadequate and/or insufficient data for inclusion in any of the other classifications.

3 - Does not present a significant threat to the public health or environment - action may be deferred.

4 - Site properly closed - requires continued management.

5 - Site properly closed, no evidence of present or potential adverse impact - no further action required.

D1 - No hazardous waste disposal has been documented.

D2 - Remedial construction actions and/or monitoring programs have been completed and approved by NYSDEC and all hazardous wastes was removed.

D3 - a) Site identification numbers have been consolidated; or

b) Sites were numbered incorrectly; or

c) Sites were added in error and subsequently removed.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL REMEDIATION 8/27/97
INACTIVE HAZARDOUS WASTE DISPOSAL REPORT

CLASSIFICATION CODE: 4 REGION: 9 SITE CODE: 932035
EPA ID: NYD002106896

NAME OF SITE : Union Carbide Corp., Carbon Prod. Div.
STREET ADDRESS: Hyde Park Boulevard
TOWN/CITY: COUNTY: ZIP:
Niagara Niagara 14303

SITE TYPE: Open Dump- Structure- Lagoon- Landfill-X Treatment Pond-
ESTIMATED SIZE: 64 Acres

SITE OWNER/OPERATOR INFORMATION:
CURRENT OWNER NAME....: U.C.A.R. Carbon Co., Inc.
CURRENT OWNER ADDRESS.: PO Box 887, 3625 Highland Ave., Niagara Fa
OWNER(S) DURING USE...: Union Carbide Corporation
OPERATOR DURING USE...: Union Carbide Corp.
OPERATOR ADDRESS.....: PO Box 886, Niagara Falls, NY
PERIOD ASSOCIATED WITH HAZARDOUS WASTE: From 1940's To 1987

SITE DESCRIPTION:
The area east of Hyde Park Blvd. and north of Rhode Island Avenue was used for the graphite, concrete, packaging material and general plant rubble disposal. Also, dust from air pollution control facilities was dumped on the site. A DEC Part 360 permit is in effect. The facility closed in 1988.
A Phase I Investigation Report and a Preliminary Site Assessment (PSA) Task 1 Report were completed in 1987 and 1991, respectively.
Right to Know (RTK) documents disposal of spent sludge from TCE degreasing, (F001 Waste) and solid Halowax, (D003 Waste).
The PSA was completed in 1996 and no significant threat from this site could be found. The site is a capped landfill that is being monitored by the Division of Solid and Hazardous Materials. It has been recommended however, that the wells installed during the PSA be included in the monitoring program and that future monitoring include scans for TCA.

HAZARDOUS WASTE DISPOSED:

TYPE	QUANTITY (units)
spent sludge from TCE degreasing (F001)	approx. .02 tons
Halowax (D003)	approx. .16 tons
hexachlorobenzene	unknown

SITE CODE: 932035

ANALYTICAL DATA AVAILABLE:
Air- Surface Water-X Groundwater-X Soil- Sediment-

CONTRAVENTION OF STANDARDS:
Groundwater-X Drinking Water- Surface Water- Air-

LEGAL ACTION:

TYPE..: State- Federal-
STATUS: Negotiation in Progress- Order Signed-

REMEDIAL ACTION:

Proposed- Under design- In Progress- Completed-
NATURE OF ACTION:

GEOTECHNICAL INFORMATION:
SOIL TYPE: Glacial Till over limestone
GROUNDWATER DEPTH: 5-15 feet

ASSESSMENT OF ENVIRONMENTAL PROBLEMS:

Possible leachate from facility unlikely to pick up any contaminants due to nature of material disposed at site. Groundwater analysis shows some elevation of phenolics, however, this should not result in an environmental problem. The facility has been closed, including capping and deed restraints. This site is being monitored.

ASSESSMENT OF HEALTH PROBLEMS:

Area residents are served by public water. Upgradient groundwater contamination has been identified. Surface soil contains elevated concentrations of PAHs (up to 2000 mg/kg). However, the landfill is fenced and closed, thereby limiting the possibility of direct contact exposures.