REVISED WORK PLAN FOR IMPLEMENTATION OF MONITORED NATURAL ATTENUATION
99 RIDGELAND ROAD
HENRIETTA, NEW YORK

by

Haley & Aldrich of New York
Rochester, New York

for

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File No. 70753-002
Date: January 2003

UNDERGROUND
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ALDRICH

22 January 2003
File No: 70753-002

New York State Department of Environmental Conservation
Region 8
6274 E. Avon-Lima Road
Avon, New York 14414

Attention: Frank Sowers

Subject: Voluntary Cleanup Agreement Work Plan
For Implementation of Monitored Natural Attenuation (MNA)
99 Ridgeland Road
Henrietta, New York 14444

OFFICES

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Dear Mr. Sowers:

This document comprises the *Revised* Remedial Action Work Plan (RAWP) entitled "Work Plan for the Implementation of Monitored Natural Attenuation" describing the proposed remediation activities for the 99 Ridgeland Road property. Note that this Work Plan is revised from an earlier version submitted to NYSDEC, dated June 2002, based on NYSDEC's comments dated 9 December 2002.

Haley & Aldrich is pleased to submit this work plan for the stand-alone remedial strategy at the 99 Ridgeland Road site. This plan follows our "*Revised* Report on VCA Investigations", dated October 2002, and approved by NYSDEC in their letter dated 9 December 2002.

As documented in the Report, historic groundwater monitoring data indicate that natural attenuation processes are reducing chlorinated VOC concentrations, and subsurface conditions exist that are conducive to natural biodegradation. Accordingly, this plan was developed to describe the monitoring activities necessary to track and evaluate continued degradation and provide a schedule for groundwater sampling events.

If you have any questions or require any additional information, please contact us.

Sincerely yours,
HALEY & ALDRICH, INC.

Glenn M. White
Environmental Scientist

Vincent B. Dick
Vice President

Paul M. Tornatore, P.E.
Vice President

Enclosures

Cc: Paul D. Sylvestri, Esq.,
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I. INTRODUCTION

American Siepmann Corporation submitted a report entitled "*Revised* Report on VCA Investigations, 99 Ridgeland, Henrietta, New York", dated October 2002 ("Investigation Report"). The Investigation Report summarized the investigations completed at the site under a Voluntary Cleanup Agreement (VCA) between the New York State Department of Environmental Conservation (NYSDEC) and American Siepmann. The Investigation Report was approved by NYSDEC in their letter dated 9 December 2002. The Report recommended use of Monitored Natural Attenuation (MNA) as a remedial approach after also examining the alternatives of a Reactive Iron, Permeable Reactive Barrier (PRB) or Enhanced Bioremediation as potential remediation technologies for use at the site.

This document summarizes environmental conditions at the site, provides a basis for selection of Monitored Natural Attenuation (MNA) as the stand-alone remedial strategy at the site, evaluates MNA ability to achieve the specified cleanup goal through an engineering analysis, and provides a work plan for implementation of MNA.

1.01 Site Description

The property at 99 Ridgeland Road facility is located at the end of a cul-de-sac extending off Jefferson Road in Henrietta, New York (see Figure 1). The property consists of approximately 1.25 acres improved with an 8,425 square foot, single story building of slab-on-grade, concrete block construction. Its recent ownership includes Florida West Land Corporation and GMC Management Corporation. It is currently being used for office space both for GMC Management, as well as a small computer service company and a land title search company.

Current surrounding land use to the 99 Ridgeland site includes the following:

- West of the site is Interstate 390, beyond which is commercial and light industrial property (Tops Market plaza to the southwest and Morse Sash & Door due west).
- North of the property is a vacant lot, beyond which are railroad tracks and an industrial facility fronting on Brighton-Henrietta Townline Road (Pulsafeeder – a precision pump manufacturing facility).
- East of the site (in order, from immediately adjacent, proceeding easterly) are other commercial/light industrial uses including IKON Office Solutions, Ortho-Clinical Diagnostics (a Johnson & Johnson Co.), HM Cross & Sons (Power Transmission and Materials Handling), and Tru-Green Chem Lawn. Beyond these businesses is a cement plant and Genesee Ford Truck Sales.
- South of the site is commercial retail use consisting of Staples (office supplies) and a vacant retail commercial building, beyond which is Jefferson Road.

No residential use borders the property on any side. The nearest residential use is located approximately 1000 ft. northwest of the property (an apartment building complex).

1.02 Site History

In the past, the rear two-thirds of the site building was comprised of manufacturing and research & development space occupied by American Siepmann Corporation from 1982 until 1991, Cation Corporation, Rochester Abrasives, Inc., and others. American Siepmann manufactured grinding wheels at the subject facility. The manufacturing process mixed epoxy and aluminum oxide dust. American Siepmann also manufactured etch marking equipment utilizing photodevelopers in the manufacturing process.

In addition to American Siepmann and its related companies, several business entities occupied the 99 Ridgeland building. Businesses that may have used industrial or hazardous substances at the 99 and 97 Ridgeland addresses include R.C. Neal Company (industrial supplies), Bridgeport Machine (machine tool distributor), and Everdry Corp. (basement sealing). In addition we understand that subsequent to Seipmann's departure from the building, it was leased to a tile contractor, roughly in the time frame of 1994, during which time drum storage also occurred on the east side of the building.

1.03 Previous Investigations

The following is a summary of the investigation and remediation work that had been performed at this site prior to signing of the VCA in 1999.

Subsurface contamination apparently by chlorinated solvent compounds (trichloroethene and biodegradation products) was discovered at the site during activities associated with an environmental site assessment performed by ERC in early 1993. Subsequent investigations by SAW Environmental Services, Inc. delineated soil and groundwater affected by the chlorinated compounds, primarily along the eastern side of the 99 Ridgeland Road building. Based on the results of these investigations, SAW recommended and performed a soil removal action which involved a reported 185 tons of soil being removed from an area outside the eastern side of the building.

Groundwater monitoring was performed under SAW for over a period of approximately three years from 1995 to 1998. Concentrations over this time frame ranged from non-detect to 2900 ppb. During that time period, three of the five groundwater monitoring wells located on site tended to be non-detect for the chlorinated solvents. Two other wells, MW-3 and MW-4, showed increases in contaminant concentrations early in 1998 that were interpreted to be inconsistent with previous monitoring results (see Figure 2 for well locations).

The Region 8 office of NYSDEC had been involved in the remediation and groundwater monitoring results review of the site. A meeting among the interested parties (site owner, representatives of previous site occupants, and NYSDEC) on 2 September 1998 resulted in NYSDEC indicating that additional borings and groundwater monitoring results were necessary for the area beneath the 99 Ridgeland Road building. This was spurred by the continuing detections in well MW-3, and results of a July 1998 Goresorber investigation of the site which showed apparently-elevated concentrations of the chlorinated compounds beneath the eastern side of the 99 Ridgeland Road building footprint.

Note that three borings had already been performed in the footprint of the building, two by SAW just inside the eastern wall of the building (see SAW July 1998 report, borings IN-1, IN-2), and a third performed by ERC (see report dated March 1993, boring B-5). Of these borings, only the SAW borehole samples detected chlorinated compounds. The compounds were detected generally at concentrations of ≤0.1 ppm, below TAGM 4046 cleanup guidance values.

1.04 Summary of Environmental Conditions

Environmental conditions at the site are as follows:

- Soil contamination is limited to the area immediately surrounding the 99 Ridgeland building with only two locations exhibiting possible results above TAGM 4046 comparison criteria. The compound acetone appeared to possibly exceed TAGM 4046, however it was also detected in the laboratory blank for the sample analytical set. The compound cis-1,2-DCE was detected in one sample, but no published value for the compound exists in TAGM 4046. The value detected exceeds the published value for trans-1,2-DCE a surrogate comparison value. No surface soils data exceeded TAGM levels;

- Groundwater contaminants including TCE and biodegradation breakdown products are present at levels above TOGS 1.1.1 criteria at several site monitoring wells at maximum concentrations of approximately 3 mg/L. Concentrations decrease one to two orders of magnitude at downgradient wells MW-301 and MW-302, and decrease to non-detect at further downgradient well MW-401. Acetone has been detected sporadically at some site wells. The pattern of detection associated with groundwater samples makes it suspect because it tends to be detected in the first one to several sampling events, then not thereafter. Also, it has sporadically been detected in laboratory QA/QC samples. Therefore, its presence as a site-generated contaminant associated with the chlorinated compounds is suspect.

- MNA processes are active at the facility as evidenced by: decreases in concentrations downgradient of the source area, the presence of the complete sequence of biodegradation products, and the results of other geochemical indicators.

- The results of an indoor air quality assessment indicated no CVOCs present above detection limits in samples obtained inside or outside the building. Acetone was detected in both indoor and outdoor samples and the results suggest the presence of this contaminant is an ambient air issue unrelated to the site.

- From an exposure evaluation standpoint, there are no complete pathways for potential surface water, groundwater, indoor vapor or soil via contact, ingestion, or inhalation routes currently or for the sites contemplated use. There is potential for groundwater contact, possibly associated with underground utility excavation, however such routes are controllable through application of administrative controls.

II. REMEDIAL ACTION SELECTION

2.01 Site Remedial Action Objectives

The following are Remedial Action Objectives (RAOs) for the subject site.

- Reduce groundwater contamination levels consistent with 6 NYCRR Section 703.5 and TOGS 1.1.1 to the extent practicable; and
- Prevent significant exposure to contaminated groundwater by the public.

2.02 Description of Proposed Remedy

Monitored Natural Attenuation (MNA) is the proposed stand-alone remedy for groundwater contamination at the 99 Ridgeland site. When correctly evaluated and implemented USEPA deems MNA an acceptable and credible remedy for chlorinated compounds in groundwater (National Resource Council, 2000). It utilizes natural processes, primarily biodegradation, to reduce contaminant concentrations, in this case VOCs, to acceptable levels.

These processes which work to reduce the mass, toxicity, mobility and concentration of VOCs in the soil or water, include the following:

- **Biodegradation**
- **Chemical Stabilization**
- **Dispersion**
- **Sorption**
- **Volatilization**
- **Dilution**

The MNA approach described in this Work Plan is based on recommendations of the National Research Council (NRC) in their publication (2000), "Natural Attenuation for Groundwater Remediation". The reported study finds that natural attenuation is an established remedy for the types of compounds found on the 99 Ridgeland Road site. This work plan describes rigorous groundwater monitoring protocols necessary to ensure that natural attenuation is analyzed properly.

The particular contaminants present at this site (TCE and associated compounds) biodegrade most rapidly under oxygen-poor conditions via a process called reductive dechlorination. This process involves the successive removal of chlorine atoms as compounds such as TCE sequentially degrade to cis-1,2-DCE, vinyl chloride and finally to ethene and ethane. A groundwater monitoring program that is designed to assess the above mentioned processes includes analyses that monitor for:

(1) reduction of chlorinated compounds downgradient of the source area,
(2) presence of biodegradation daughter products,
(3) necessary conditions (oxygen-poor) for the reductive dechlorination processes, and
(4) other geochemical shifts that occur in the aquifer when MNA processes are active.

2.03 Engineering Evaluation of MNA

The processes described above have been discussed with NYSDEC and summarized in the Investigation Report and monthly status reports to NYSDEC. MNA has been documented to be working and sustained at the site as evidenced by the MNA data evaluation and discussion in our investigation report "*Revised* Report on VCA Investigations", dated October 2002 ("Investigation Report"), which was approved and accepted as final by NYSDEC letter dated 9 December 2002. Sampling results from September 2001 (specific analyses were included in this sampling round to evaluate the appropriateness of MNA as a remedial approach for this site) support the conclusion that natural processes are acting to attenuate the site contaminants as evidenced by:

- First, obvious decreases in contaminant concentrations are evident as one moves downgradient of the residual source area (area of remaining highest groundwater concentrations beneath the building after completion of the SAW remedial action in 1995). The most recent dataset from September 2001 shows a 1 to 2 order-of-magnitude decrease in contaminant concentrations from the apparent residual source area (B103-OW) to the downgradient edge of the plume in the vicinity of MW-301 and MW-302. Tables summarizing results from the investigation report are included in Appendix A.

- Second, biodegradation products (cis-1,2-DCE, vinyl chloride, ethene, and ethane) are present at several site wells indicating that biodegradation processes are acting to reduce the concentrations, and that the decreases downgradient of the source area are not just due to dilution and dispersion. The generation of VC, ethene and ethane is also indicative that reductive dechlorination is proceeding through complete degradation of the parent PCE/TCE compounds.

- Third, depressed dissolved oxygen and redox measurements in several site wells indicate moderately reducing (oxygen-poor) conditions. The most reducing conditions are present in wells B103-OW and B105-OW. These are conditions under which the site contaminants degrade most rapidly.

- Fourth, the remainder of the MNA parameters indicate a distinct geochemical shifts which are representative of MNA processes occurring in the aquifer. This shift is particularly evidenced by elevated chloride concentrations within the plume compared with background values.

To further assess the potential of the aquifer to naturally biodegrade site contaminants, biodegradation rates for TCE, cis-1,2-DCE and VC were calculated. These rates were calculated with the procedure described in EPA's Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents (April 1998). EPA recommends a calculation method developed by Buscheck and Alcantar (1995) to determine the first order decay rates of various contaminants. Note that a correction to the calculation equation presented in the EPA protocol was made as suggested by the paper (in progress) by Carey and Weidemeir (2000)[1] and has been incorporated in calculations herein.

Contaminant decay rates were originally calculated in May 2001 using the October 2000 groundwater analytical dataset. Assuming an average hydraulic conductivity of 1.0E-04 cm/sec, the calculated rate (in half-life years) for DCE was 2.22 years. Through the calculation process, it was noted that hydraulic conductivity values have a proportioned linear effect on the calculated decay rate. Therefore, hydraulic conductivity testing was performed in 2001 to refine the estimates.

The biodegradation rates were re-calculated using the 2001 hydraulic conductivity values and the analytical results from the April 2001 groundwater monitoring event. The refined calculated rates are comparable to those that were calculated in May 2001 and are estimated (in half-life years) as follows: TCE - 17.26; DCE - 3.26; VC - 5.7. Copies of the contaminant decay rate calculation sheets are included in Appendix B.

The above-mentioned decay rates fall within the ranges of first order biological decay rates for chlorinated solvents reported by Suarez and Rifai (1999)[2].

2.04 Effectiveness Evaluation

MNA has been evaluated on the basis of its ability to meet the following criteria, excluding cost effectiveness and community acceptance (these two excluded by NYSDEC comments dated 9 December 2002) in accordance with 6NYCRR Section 375-1.10(c):

1. Compliance with applicable and relevant New York State Standards, Criteria or Guidance (SCGs);
2. Overall protectiveness of public health and the environment;
3. Short-term effectiveness;
4. Long-term effectiveness;
5. Reduction of toxicity, mobility, and volume with treatment;
6. Feasibility: A feasible remedy is one that is suitable to site conditions, capable of being performed with available technology, and that considers, at a minimum, implementability and cost-effectiveness;
7. Community acceptance.

- Full compliance with SCGs would require reduction to drinking water standards. While natural attenuation processes will push concentrations in this direction, decrease completely to SCGs is not required to protect public health and the environment. An Exposure Assessment was performed for the site to evaluate the

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[1] G. Carey and T. Wiedemeier, 2000, Clarification of Methods for Calculating First-Order Transformation Rates and Modeling Biodegradation, in preparation.

[2] M. Suarez and H. Rifai, 1999, Degradation Rates for Fuel Hydrocarbons and Chlorinated Solvents in Groundwater, Bioremediation Journal 3(4):337-362 (1999)

potential for a complete pathway to exist by which humans may be exposed to site contaminants. See section 3.5 of the Investigation Report.

Potential exposure pathways were defined. The exposure pathways were evaluated with respect to potential scenarios under which an individual may be exposed to contaminated groundwater, soil, or vapor. No pathways were determined to be complete exposure pathways at the time the assessment was performed. However, new construction is currently underway at the site. Possible scenarios that may produce potential exposure were determined to include possible direct contact with soil and groundwater during utility maintenance or new construction. Proper engineering and administrative controls have been discussed with NYSDEC and are in place during construction activities to protect public health and the environment. Current and contemplated construction activities will not change the defined potential exposure pathways. After construction activities cease exposure pathways will again be incomplete. Natural attenuation will reduce the contaminants to the extent practicable, and will be protective of human health and the environment.

- Overall protectiveness of public health and the environment currently exists due to the incompleteness of exposure pathways and will be maintained in the future with deed restrictions. A draft Declaration of Covenants and Restrictions, which will become part of the remedy, has been submitted to the NYSDEC for approval.

- It has been demonstrated through the lines of evidence discussed above that MNA is already effective in the short-term.

- MNA is effective long-term for the site contaminants. This effectiveness is subject to change only with changes that alter subsurface conditions. The site subsurface environment appears to be stable. There are no present indications that the subsurface environment will undergo changes that would alter anaerobic conditions throughout the life of the proposed remedy. Significant changes to the subsurface environment will be prevented by administrative controls implemented through deed restrictions.

- The natural processes referenced above act to reduce toxicity, mobility and volume of contaminants as evidenced above. The low permeability soil conditions at the naturally inhibit contaminant migration and will provide time for attenuation processes to decrease concentrations of site contaminants.

- MNA is both technically and administratively feasible and is therefore implementable. MNA has no implementation impediments at this site compared to both permeable reactive barriers (PRBs) and enhanced bioremediation technologies, both of which do have implementability impediments at the site. See section 3.6 of the Report.

2.05 Performance Requirements

This section lists specific performance requirements for MNA, which if not achieved may result in modification to the corrective action. The site monitoring plan is discussed in more detail in section III.

- Chlorinated volatile organic compound (CVOC) results for groundwater at well MW-401 must remain below groundwater standards (TOGS 1.1.1). MW-401 is proposed as a sentinel groundwater monitoring location, CVOCs at concentrations above groundwater standards would indicate that the plume is expanding. If two sequential samples result in detections above SCGs, the remedy would be re-evaluated and necessary modifications would be implemented.

- MW-4 and MW-203 are proposed as MNA performance monitoring locations based on the amount of historical data available for each well and their locations with respect to the contaminant plume. Increasing total CVOC concentrations at these locations may indicate that the plume is continuing to expand.

- Total CVOC groundwater concentrations for MW-4 and MW-203 must not exceed the 80% confidence limit calculated from historical analytical data. Historical analytical trends and 80% confidence interval calculations are included in Appendix C. If two sequential samples result in detections above the 80% confidence limit the remedy will be re-evaluated and, if necessary modifications will be implemented.

III. GROUNDWATER SAMPLING AND ANALYSIS PLAN

The MNA remedial strategy for 99 Ridgeland includes sampling and analysis for natural attenuation parameters with care given to obtaining samples that are representative of in-situ aquifer conditions. The data obtained from the representative portions of the plume will be compared with site historical conditions to assess the geochemical footprint that is caused by the biochemical processes of natural attenuation. In addition, we will evaluate VOC concentration trends and the presence of biodegradation breakdown compounds. Water level monitoring will be performed at all existing site monitoring wells (not just the wells that are part of the MNA sampling program) on a routine quarterly schedule to track seasonal changes.

3.01 Monitoring Parameters

This MNA monitoring program combines collection of VOC samples (parent and daughter products) and additional biodegradation indicator parameters as follows:

- Volatile organic compounds - collection of parent (trichloroethene) and biodegradation breakdown products (cis-1,2-dichloroethene, vinyl chloride, ethene, and ethane)
- Biodegradation indicators - dissolved oxygen, methane, oxidation-reduction potential, alkalinity, carbon dioxide, electron acceptors (sulfate, sulfide, nitrate, nitrite, dissolved iron, total iron, total manganese), and chloride.
- Additional groundwater quality parameters - pH, temperature, conductivity, and turbidity.

Due to the sensitivity of some groundwater analytical parameters, it is important to measure the following parameters in the field (at the wellhead) according to USEPA protocols. See Appendix A.

FIELD PARAMETERS:

- Alkalinity
- pH
- Conductivity
- Temperature
- Iron (II)
- Redox
- Dissolved Oxygen
- Turbidity

The parameters below will be analyzed in the laboratory.

LABORATORY TESTS:

- Chloride
- Nitrate, Nitrite
- Sulfate, Sulfide

- Total Iron and Total Manganese
- Aromatic and chlorinated hydrocarbons
- Methane, ethane, and ethene
- Dissolved Organic Carbon

Table 1 summarizes the parameters, method of analysis, frequency, and data use of all parameters.

The following QA/QC measures will be followed for the MNA program.

Routine Sampling:

- Field and Method Blank sample analysis at a rate of 10% of the sample event population.
- Analysis of Matrix Spike/Matrix Spike Duplicate and one Duplicate sample per sampling event.

ASP Category B deliverables and Data Usability Summary Report will be performed prior to site or individual well closeout.

3.02 Monitoring Plan

The following monitoring wells will be sampled for natural attenuation parameters. The wells were selected based on our understanding of the distribution of contaminants, contaminant concentration trend analysis performed on each well, and location with respect to property boundaries. The selected wells target areas upgradient, downgradient and within the known source area. The location of the monitoring wells are shown in Figure 1 and are listed below:

- **MW-201** (upgradient from the contaminant plume)
- **B-103-OW** (source area)
- **MW-203** (within the plume)
- **MW-301, MW-302,** (edge of plume, downgradient)
- **B-112-OW, MW-4,** (nearest the southern property boundary)
- **MW-401** (downgradient of the plume)

Note that B-110-OW was intended to be included in this design plan to be used in conjunction with MW-4 to evaluate off-site migration to the south. However, due to construction activities at the site during December 2002, MW-4 and B-110-OW were damaged and lost respectively. MW-4 will be repaired, and a new monitoring well ("B-112-OW") will be installed in place of B-110-OW. B-112-OW will be located further south of the former B-110-OW. The proposed location of B-112-OW is shown on Figure 1. The final location will be determined in the field after construction activities cease.

3.03 Sampling Protocol

Groundwater samples will be collected from the selected monitoring wells listed above utilizing Low Stress/Low Flow Sampling Methods, as described in EPA's Low Flow (Minimal Drawdown) Groundwater Sampling Procedures, EPA/540/S-95/504, April 1996 included in Appendix D. This method will be utilized to obtain natural attenuation parameters that are more representative of in-situ aquifer conditions than samples obtained by conventional purging techniques. A site specific groundwater sampling protocol based on EPA's guidance is included in Appendix E.

3.04 Sampling Schedule

Sampling will occur semi-annually (twice per year) coinciding with typical seasonal high water periods during the months of April or May and seasonal low water periods during September or October. Groundwater collected from the eight monitoring wells referenced above will be analyzed for VOCs semi-annually, and dissolved gases, (ethene, ethane, methane) electron acceptors, chloride and alkalinity annually. Water level monitoring will be performed quarterly to track seasonal changes. If analytical parameters indicate consistent MNA rates of degradation over three years, cessation of sampling or a decrease in sampling frequency will be requested.

IV. REPORTING

4.01 Semi-Annual Reports

Semi-annual reports will be submitted to the Department during July and December. The following items will be included in each semi-annual report:

- A discussion of any deviations from the work plan.
- A tabular summary of the analytical results for the reporting period with comparison to applicable SCGs.
- Groundwater elevation contour maps for the reporting period.
- A brief assessment of the physical condition of each well and a summary description of any repairs that are necessary or were completed during the reporting period.

4.02 Annual Reports

Annual reports will be submitted to the Department during February. The following items will be included in each annual report:

- A description of the remedy and all activities performed during the reporting period, including any problems encountered solutions, significant repairs, and deviations from the work plan.
- Groundwater elevation contour maps for the reporting period.
- A discussion of any significant changes in groundwater flow direction or elevation from historic results.
- Summary tables that include cumulative analytical and field parameter results with comparisons to available SCGs.
- Concentration posting maps for total CVOCs and individual CVOCs in groundwater.
- Comments, conclusions, and recommendations based on an evaluation of the information in the report.
- Certification that all required institutional controls (deed restrictions) are in place.
- Certification that activities at the site have been conducted in compliance with the institutional controls during the past year.
- A copy of the laboratory data packages on a CD in Adobe Acrobat (pdf) format.

V. WASTE MANAGEMENT

Monitoring well purge water will be collected and disposed of through the site sanitary sewer with permission from Monroe County Pure Waters. All personal protective equipment (disposable gloves) and disposable sampling equipment (teflon tubing, filters, bailers) will be disposed of as solid waste.

VI. HEALTH & SAFETY

A Health and Safety plan for the work described herein is included in Appendix F and is comprised of the HASP used previously at this site for site investigation activities including groundwater sampling. All personnel conducting site groundwater sampling will be required to follow the plan.

VII. ENGINEERS STATEMENT

Haley & Aldrich of New York hereby states that the activities, sampling and analyses, proposed in this Work Plan entitled "*Revised* Work Plan For Implementation of Monitored Natural Attenuation, 99 Ridgeland Road, Henrietta, New York", have been reviewed by the undersigned professional engineer licensed in the State of New York. The work proposed herein has been developed in accordance with generally accepted environmental engineering consulting practices.

An original submittal of this Work Plan, dated June 2002, was commented upon by NYSDEC in a letter dated 9 December 2002. This *Revised* Work Plan reflects changes based on the NYSDEC comments.

Paul M.. Tornatore, P.E.
Vice President
Haley & Aldrich of New York

Tables

Table 1. Summary of Natural Attenuation Sampling Parameters
99 Ridgeland Road

FIELD PARAMETERS

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed~Base Laboratory
Water	Alkalinity	Hach Alkalinity test kit model AL AP MG-L	Phenolphthalein method	General water quality parameter used (1) as a marker to verify that all site samples are obtained from the same ground-water system and (2) to measure the buffering capacity of ground water. (3) indicator of biodegradation	Each sampling round	Collect 100 mL of water in glass container.	Field
Water	pH	Field probe with direct reading meter calibrated in the field according to the supplier's specifications.	Field	Aerobic and anaerobic biological processes are pH-sensitive. Lower pH can be indication of biodegradation.	Each sampling round	Measure immediately after purging is complete site using a flow-through cell or over-flow cell.	Field
Water	Conductivity	E120.1/SW9050,	direct reading meter	General water quality parameter used as a marker to verify that site samples are obtained from the same ground-water system.	Each sampling round	Collect 100 to 250 mL of water in a glass or plastic container.	Field
Water	Iron (II) (Fe+2)	Colorimetric Hach Method #8146	Filter if turbid.	May indicate an anaerobic degradation process due to depletion of oxygen, nitrate, and manganese.	Each sampling round	Collect 100 mL and analyze as soon as possible.	Field
Water	Temperature	Field probe with direct reading meter.	Field only	To determine if a well is adequately purged for sampling.	Each sampling round	Read from oxygen meter,	Field
Water	Redox	Field probe with direct reading meter.	Field only, care should be taken to not aerate the sample during sampling.	To determine the redox conditions in groundwater for assessing biodegradation potential.	Each sampling round	Measure immediately after purging is complete site using a flow-through cell or over-flow cell.	Field
Water	Dissolved Oxygen	Field probe with direct reading meter.	Field only, care should be taken to not aerate the sample during sampling.	To determine the level of dissolved oxygen in groundwater (assessing biodegradation potential.)	Each sampling round	Measure dissolved oxygen on site using a flow-through cell or over-flow cell.	Field

Table 1. Summary of Natural Attenuation Sampling Parameters
99 Ridgeland Road

FIXED LABORATORY

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Chloride	EPA 325.1	Mercuric nitrate titration (Ion chromatography (IC) method E300 or method SW9050 may also be used)	General water quality parameter used as a marker to verify that site samples are obtained from the same ground-water system. Final product of chlorinated solvent reduction.	Annually	Collect 250 mL of water in a glass container. **cool to 4°C**	Fixed-base
Water	Nitrate (NO_3^-)	EPA 353.2		Substrate for anaerobic microbial respiration. A decrease in nitrate may indicate that it is serving as an electron acceptor in biodegradation processes.	Annually	Collect to 250 mL of water in a glass or plastic container; **add H_2SO_4 to pH less than 2, cool to 4°C.**	Fixed-base
Water	Nitrite (NO_2^-)	EPA 353.2		Nitrite is measured to compare ratios of nitrate and nitrite to determine extent of denitrification.	Annually	Collect to 250 mL of water in a glass or plastic container; **add H_2SO_4 to pH less than 2, cool to 4°C.**	Fixed-base
Water	Sulfate (SO_4^{2-})	EPA 375.4	If this method is used for sulfate analysis, do not use the field method.	Substrate for anaerobic microbial respiration (sulfanogenesis).	Annually	Collect to 250 mL of water in a glass or plastic container; **cool to 4°C**	Fixed-base
Water	Sulfide (S^{2-})	EPA 375.4		Sulfide is the by-product of sufanogenesis, may indicate that the reductive pathway is possible.	Annually	Collect to 250 mL of water in a glass or plastic container; **cool to 4°C**	Fixed-base
Water	Total Iron and Dissolved and Total Manganese	SW6010	ICP Atomic Emission Spectroscopy	To determine if anaerobic biological activity is solubilizing manganese from the aquifer matrix material. To determine the total amount of iron present in groundwater.	Annually	Collect 100 ml in glass or plastic container rinsed with ground water to be sampled. **Adjust pH to 2 with nitric acid.** Do not insert pH paper or an electrode into the sample.	Fixed Base

Table 1. Summary of Natural Attenuation Sampling Parameters
99 Ridgeland Road

FIXED LABORATORY, CONT'D

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Aromatic and chlorinated hydrocarbons (BTEX, trimethylbenzene isomers, chlorinated compounds)	SW8260A	Analysis may be extended to higher molecular weight alkyl benzenes	Method of analysis for BTEX and chlorinated solvents/byproducts, which are the primary target analytes for monitoring natural attenuation; method can be extended to higher molecular weight alkyl benzenes; trimethylbenzenes are used to monitor plume dilution if degradation is primarily anaerobic.	Semi-Annually	Collect water samples in a 40 mL VGA vial; **cool to 4°C**	Fixed-base
Water	Methane, ethane, and ethene	Kampbell eral., 1989 and 1998 or SW3810 Modified	Method published by researchers at the U.S. Environmental Protection Agency.	The presence of CH_4 suggests BTEX degradation via methanogenesis. Ethane and ethene data are used where chlorinated solvents are suspected of undergoing biological transformation.	Annually	Collect water samples in 50 mL glass serum bottles with gray butyl /Teflon-faced septa and crimp caps, **cool to 4°C.**	Fixed-base
Water	Dissolved Organic Carbon (DOC)	EPA 415.1	UV/Persulfate Oxidation – Dohrmann Analyzer	Used to classify plume and to assess the amount of carbon present to drive reductive dechlorination.	Annually	Collect to two 40 mL vials, **cool to 4°C.**	Fixed Base

NOTES:
1. "Hach" refers to the Hach Company catalog, 1990.
2. "SW" refers to *Standard Methods for the Examination of Water and Wastewater,* 1 8th edition, 1992.
3. "EPA" refers to *Methods for Chemical Analysis of Water and Wastes,* U.S. EPA, 1983.
4. "SW" refers to the *Test Methods for Evaluating Solid Waste, Physical, and Chemical Methods,* SW-846, U.S. EPA, 3rd edition, 1986.

Figures

LEGEND:

- ▲ BORING/WELL LOCATION ("OW" DESIGNATES WELL COMPLETED IN NOVEMBER 1999 UNDER H&A SUPERVISION)
- ⊕ SOIL BORING/MONITORING WELL COMPLETED BY HALEY & ALDRICH, SEPTEMBER 2000.
- ⊖ MONITORING WELL LOCATION COMPLETED BY HALEY & ALDRICH SEPTEMBER 2001
- ⊙ SOIL BORING/MONITORING WELL LOCATION COMPLETED BY HALEY & ALDRICH, FEBRUARY 2002
- ○ MONITORING WELL LOCATION (SAW, 1996)
- ■ PROPOSED MONITORING LOCATION

NOTES:

1. ALL WELL LOCATIONS AND OUTSIDE BUILDING DIMENSIONS WERE MEASURED BY HALEY & ALDRICH PERSONNEL, DECEMBER 1999. WELL LOCATIONS WERE MEASURED OFF OF SITE BUILDING. INSIDE BUILDING DIMENSIONS WERE NOT MEASURED.
2. BORING AND SURFACE SAMPLE LOCATIONS WERE NOT MEASURED AND ARE APPROXIMATE ONLY.
3. SITE BUILDING NOT TO SCALE. FIGURE BASED ON COMPOSITE OF ERC AND SAW SITE PLANS, (1993, 1998).

HALEY & ALDRICH

**UNDERGROUND
ENGINEERING &
ENVIRONMENTAL
SOLUTIONS**

HARTER SECREST & EMERY
99 RIDGELAND ROAD SITE
HENRIETTA, NEW YORK

REVISED MNA WORK PLAN

SCALE: 1" = APPROX. 50'

JANUARY 2003

FIGURE 1

70753-002 MNAWPFIG1R.DWG

Appendix A

APPENDIX A

Groundwater Analytical Summary Tables

American Siepmann Company
99 Ridgeland Ave
Groundwater Analysis Results
VOC Compounds
Updated March 2002
TABLE 5

SAMPLE LOCATIONS																									
ANALYTE	Sample No.:	MW-1										MW-2													TOGS Comparison Values
ORGANICS - 8260	Analytical Dilution	1.00	1.00	NR	NR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	NR	NR	NR	NR	1.00	2.50	1.00	1.00	1.00	1.00	
	Sample Date:	12/19/1995**	4/11/96**	8/96**	12/96**	11/24/1999	3/13/2000	3/13/2000 S	3/13/2000 S	10/2/2000	4/12/2001	12/19/95**	1/29/96**	4/11/1996	6/96**	11/96**	12/96**	2/97**	11/23/1999	11/23/1999	3/13/2000	3/13/2000 S	10/2/2000	4/12/2001	
1,1 - Dichloroethane	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.028***	***0.027***	***0.018***	***0.014***	***0.022***	ND	0.005
Tetrachloroethene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
1,1,1, - Trichloroethane	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.002J	ND	ND	0.001J	ND	ND	0.005
Trichloroethene	8260	ND	ND	ND	ND	***0.0069***	***0.0022J***	0.001J	0.002J	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.016***	***0.016***	***0.014***	***0.011***	ND	ND	0.005
Acetone	8260	ND	ND	ND	ND	ND	ND	***0.007JB***	***0.006JB***	ND	0.021	ND	ND	ND	0.049	ND	ND	ND	ND	ND	0.0069J	0.011B	ND	ND	0.050
2 - Butanone	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
Cis-1,2-Dichloroethene	8260	ND	ND	ND	ND	***0.022***	***0.0067***	0.005J***	0.004J***	ND	ND	ND	***0.012***	***0.0086***	***0.0056***	ND	***0.0075***	***0.0080***	***0.290E***	***0.3***	***0.16***	0.16***	***0.15***	ND	0.005
Trans-1,2-Dichloroethene	8260	ND	ND	ND	ND	0.0016J	ND	0.005J***	0.004J***	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0038J	0.0038J	0.0025J	0.16***	ND	ND	0.005
Toluene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
M+P-Xylene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Methylene Chloride	8260	ND	ND	ND	ND	ND	ND	0.003JB	0.003JB	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.003JB	ND	ND	0.005
Vinyl Chloride	8260	ND	ND	ND	ND	***0.015***	***0.0078***	***0.006J***	***0.005J***	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.0086***	***0.0084J***	***0.0064***	0.004J	0.0052	ND	0.002
Chloroethane	8260	ND	ND	ND	ND	0.0014J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Benzene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.001
Carbon Disulfide	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
1,1 - Dichloroethene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0020J	ND	0.0014J	ND	ND	ND	0.005

SAMPLE LOCATIONS																								
ANALYTE	Sample No.:	MW-3																	MW-4					TOGS Comparison Values
ORGANICS - 8260	Analytical Dilution	10.00	1.00	1.00	NR	NR	NR	NR	NR	NR	5.00	1.00	NR	NR	1.00	5.00	1.00	1.00	NR	NR	1.00	1.00	1.00	
	Sample Date:	12/19/95**	1/29/96**	4/11/90**	6/96**	8/96**	9/96**	11/96**	12/96**	2/97*	11/23/1999	11/23/1999	11/23/1999 S	11/23/1999 SD	3/13/2000	10/2/2000	4/12/2001	9/21/2001	12/96**	2/97**	11/23/1999	3/13/2000	4/12/2001	
1,1 - Dichloroethane	8260	ND	***0.0096***	***0.0053***	***0.0062***	***0.0220***	ND	ND	ND	ND	***0.0078J***	***0.0080***	***0.007J***	ND	0.0023J	ND	ND	ND	ND	ND	0.0023J	0.0039J	ND	0.005
Tetrachloroethene	8260	ND	***0.011***	ND	***0.0066***	***0.0082***	ND	ND	ND	***0.0110***	***0.019J***	***0.020***	***0.021***	***0.016JD***	0.0018J	ND	ND	***0.0065***	ND	ND	ND	ND	ND	0.005
1,1,1 - Trichloroethane	8260	***0.360***	***0.076***	***0.028***	***0.029***	***0.051***	***0.088***	ND	***0.0440***	***0.040***	***0.050J***	***0.051***	***0.057***	***0.044JD***	0.0049J	ND	ND	***0.011***	***0.0061***	ND	0.0021J	0.0025J	ND	0.005
Trichloroethene	8260	***2.90***	***0.620***	***0.220***	***0.330***	***1.100***	***1.100***	***1.000***	***0.630***	***0.440***	***0.720***	***0.660E***	***1.2E***	***0.8D***	***0.096***	***0.32***	***0.058***	***0.19***	***0.0074***	***0.0085***	ND	***0.0054***	ND	0.005
Acetone	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.050
2 - Butanone	8260	0.200	ND	0.016	0.047	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
Cis-1,2-Dichloroethene	8260	***0.490***	***0.100***	***0.056***	***0.075***	***0.130***	***0.320***	***0.190***	***0.160***	***0.160***	***0.230***	***0.220E***	0.33***	0.260D***	***0.036***	***0.098***	***0.013***	***0.037***	***0.043***	***0.049***	***0.030***	***0.045***	ND	0.005
Trans-1,2-Dichloroethene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0024J	0.33***	0.260D***	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Toluene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.012JD***	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
M+P-Xylene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Methylene Chloride	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Vinyl Chloride	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.0065J***	***0.007***	***0.007***	ND	ND	ND	ND	ND	ND	ND	0.0021J	0.003J	ND	0.002
Chloroethane	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.006J***	0.006JJ	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Benzene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.001
Carbon Disulfide	8260	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
1,1 - Dichloroethene	8260	ND	ND	ND	ND	***0.0085***	ND	ND	ND	ND	ND	0.0026J	0.002J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005

SAMPLE LOCATIONS																																				
ANALYTE	Sample No.:	B101-OW				B103-OW											B105-OW									B110-OW		B-111-OW								TOGS Comparison Values
ORGANICS - 8260	Analytical Dilution	2.50	5.00	5.00	2.00	2.5	10.00	NR	NR	10.00	1.00	20.00	5.00	NR	1.00	20.00	5.00	10.00	5.00	1.00	10.00	2.00	NR	5.00	5.00	1.00	1.00	1.00	20.00	NR	NR	1.00	1.00	1.00	1.00	
	Sample Date:	11/23/1999	11/23/1999	3/13/2000	4/12/2001	11/23/1999	11/23/1999	11/23/1999 S	11/23/1999 SD	3/13/2000	3/13/2000 S	3/13/2000 SD	10/2/2000	10/2/2000 SD	4/12/2001	9/21/2001	11/24/1999	11/24/1999	3/13/2000	3/13/2000 S	3/13/2000 SD	10/2/2000	4/12/2001 S	4/12/2001	9/21/2001	11/24/1999	3/13/2000	11/23/1999	11/23/1999	11/23/99 S	11/23/99 SD	3/13/2000	3/13/2000 S	10/2/2000	4/12/2001	
1,1 - Dichloroethane	8260	***0.047***	***0.050***	***0.037***	***0.015***	***0.018***	***0.018J***	***0.024***	ND	***0.031J***	***0.026***	***0.023JD***	ND	ND	ND	ND	***0.013J***	***0.014J***	***0.0091J***	***0.007J***	ND	ND	0.003S	ND	ND	0.0022J	0.0016J	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Tetrachloroethene	8260	ND	ND	ND	ND	***0.015***	***0.012J***	***0.007J***	ND	***0.061***	***0.06***	***0.033JD***	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
1,1,1 - Trichloroethane	8260	ND	ND	ND	ND	***0.0085J***	ND	0.004J	ND	***0.076***	***0.083***	***0.058JD***	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Trichloroethene	8260	***0.480***	***0.54***	***0.5***	***0.31***	***0.340***	***0.300***	***0.360E***	***0.280D***	***0.830***	***0.880E***	***0.590D***	***0.14***	***0.13 SD***	***0.07***	***0.3***	***0.310***	***0.310***	***0.025J***	***0.019***	***0.017JD***	ND	0.003S	ND	***0.011***	0.0019J	0.0025J	0.0016J	ND	0.008J	ND	ND	ND	ND	ND	0.005
Acetone	8260	***0.130***	***0.140***	0.053J	ND	***0.250***	***0.140J***	***0.081***	ND	ND	0.011B	***0.093JBD***	ND	ND	ND	ND	***0.068J***	***0.085J***	ND	***0.005JB***	***0.050JB***	ND	ND	ND	ND	***0.062***	ND	***2.300E***	***2.00***	***3.300E***	***1.60D***	***0.13***	***0.120B***	ND	ND	0.050
2 - Butanone	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
Cis-1,2-Dichloroethene	8260	***0.620E***	***0.70***	***0.43***	***0.24***	***1.200E***	***1.200***	2.70E***	1.500D***	***1.800***	1.70E***	1.80D***	***2.2***	***2.2 D***	***1.3***	***2.6***	***1.2E***	***1.200***	***0.900***	0.910E***	0.980D***	***0.3***	***0.55S***	***0.75D***	***.75D***	***0.0061***	***0.0077***	0.0028J	ND	0.003J***	ND	0.0013J	ND	ND	ND	0.005
Trans-1,2-Dichloroethene	8260	0.0029J	ND	ND	ND	***0.014***	***0.014J***	2.70E***	1.500D***	***0.02J***	1.70E***	1.80D***	ND	ND	ND	ND	***0.030***	***0.030J***	***0.027***	0.910E***	0.980D***	***0.015***	***0.014S***	***0.02***	***0.015***	ND	ND	ND	ND	0.003J***	ND	ND	ND	ND	ND	0.005
Toluene	8260	ND	ND	ND	ND	ND	ND	ND	***0.026BDJ***	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.030BDJ***	ND	ND	ND	ND	0.005
M+P-Xylene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Methylene Chloride	8250	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.002JB	***0.085JBD***	ND	ND	ND	ND	ND	ND	ND	0.002JB	***0.046JBD***	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.005JB***	ND	ND	0.005
Vinyl Chloride	8260	***0.0068J***	***0.0075J***	ND	ND	***0.082***	***0.081***	***0.16***	***0.069DJ***	***0.12***	***0.088***	***0.078JD***	***0.33***	***0.24 SD***	ND	***0.28***	***0.130***	***0.140***	***0.1***	***0.071***	***0.077JD***	***0.076***	***0.089S***	***0.13D***	***0.16***	0.0044J	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.002
Chloroethane	8260	ND	ND	ND	ND	0.0036J	ND	0.004J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Benzene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	***0.002J***	ND	ND	ND	ND	ND	0.001
Carbon Disulfide	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0022J	0.003J	ND	ND	*
1,1 - Dichloroethene	8260	***0.018***	***0.019J***	***0.014J***	ND	0.0038J	ND	0.003J	ND	***0.018J***	***0.012***	ND	ND	ND	ND	ND	ND	ND	ND	0.001J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005

SAMPLE LOCATIONS																							
ANALYTE	Sample No.:	MW-201			MW-202		MW-203					MW-204			MW-205			MW-301		MW-302		MW-401	TOGS Comparison Values
ORGANICS - 8260	Analytical Dilution	1.00	1.00	1.00	1.00	1.00	10.00	NR	NR	10.00	5.00	10.00	NR	1.00	10.00	1.00	NR	5.00	NR	1.00	NR	1.00	
	Sample Date:	10/2/2000	4/12/2001	9/21/2001	10/2/2000	4/12/2001	10/2/2000	10/2/2000 SD	4/12/2001 S	4/12/2001	9/21/2001	10/2/2000	10/2/2000 SD	4/12/2001	10/2/2000	4/12/2001	4/12/2001 S	9/21/2001	9/21/2001 S	9/21/2001	9/21/2001 S	2/21/2002	
1,1 - Dichloroethane	8260	ND	ND	ND	ND	ND	ND	***0.025 SD***	***0.028S***	ND	ND	ND	ND	ND	ND	ND	ND	***0.015***	***0.011***	ND	ND	ND	0.005
Tetrachloroethene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
1,1,1, - Trichloroethane	8260	ND	ND	ND	ND	ND	ND	ND	***0.050S***	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0039	ND	ND	ND	0.005
Trichloroethene	8260	ND	ND	ND	ND	ND	***1.20***	***1.1 SD***	***1.15S***	***1.4***	***0.32***	ND	ND	ND	ND	ND	0.004S	***0.21***	***0.724***	ND	ND	ND	0.005
Acetone	8260	***0.16***	ND	ND	***0.1***	ND	ND	ND	ND	ND	ND	***0.48***	***0.39 SD***	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.050
2 - Butanone	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
Cis-1,2-Dichloroethene	8260	ND	ND	ND	ND	ND	***1.200***	***1.2 SD***	***1.7S***	***1.6***	***0.63***	ND	ND	ND	ND	ND	0.004S	***0.53D***	***0.716***	***0.027***	***0.018***	ND	0.005
Trans-1,2-Dichloroethene	8260	ND	ND	ND	ND	ND	ND	ND	***0.010S***	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Toluene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
M+P-Xylene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Methylene Chloride	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Vinyl Chloride	8260	ND	ND	ND	ND	ND	***0.2***	***0.15 SD***	***0.087S***	***0.12***	***0.081***	ND	ND	ND	***0.0089***	ND	ND	***0.11***	ND	ND	ND	ND	0.002
Chloroethane	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Benzene	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.001
Carbon Disulfide	8260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
1,1 - Dichloroethene	8260	ND	ND	ND	ND	ND	ND	ND	***0.0197S***	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005

NOTES:

1. *Results expressed in milligrams per liter (ppm)*
2. Groundwater samples collected by Haley & Aldrich on November 23 & 24, 1999, 13 March 2000, 12 April 2001, and 21September 2001.
3. H&A Samples were analyzed at Columbia Analytical Services, Rochester, New York. NYSDEC samples were analyzed at Lozier Analytical.
4. "J" - indicates an estimated value. The flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
5. "E" - indicates the compound detected exceeded the calibration limit of the laboratory instrument
6. "**" - indicates groundwater samples collected by SAW Environmental in 1995, 1996 & 1997
7. Bold & Italic values indicate apparent exceedance of TOGS 1.1.1 values (TOGS 1.1.1 dated June 1998).
8. "NR" - indicates that dilution values were not recorded on data sheet.
9. "*" - indicates that no TOGS value is currently available for 2-Butanone or Carbon Disulfide
10. "S" indicates the sample was split with NYSDEC, this is NYSDEC's result from an independent lab.
11. "D" indicates sample diluted.
12. "***" indicates that NYSDEC results do not differentiate between Cis and Trans-1,2-DCE.
13. "B" - indicates the same parameter was detected in the method blank in the laboratory

Appendix B

APPENDIX B

Contaminant Decay Rate Calculation Sheets

Calculation of First Order Decay Rates
99 Ridgeland Road, Henrietta, NY

Second Verion: 5/23/01
created by NLC

Buscheck and Alcantar (1995) developed an equation to determine first order decay rates

$$\lambda=V_c/4\alpha_x\{[1+2\alpha_x(k/V_x)]^2-1\}$$

where:
lambda= first order biological rate constant
Vc= retarded contaminant velocity in the x direction
alpha= dispersivity
k/Vx= slope of line formed by making a ln-linear plot of contaminant concentration versus distance downgradient along the flow path.

The following variables were assumed:
Vc (and therefore hydraulic conductivity, retardation factor, and porosity- see below)
alpha

Vc: need a hydraulic conductivity (k), a gradient, and a retardation factor.
Vc= U/R
where U=kI: U= gw velocity and I= gradient
Fetter (1994, page 98) states that typical k values for glacial-lacusterine deposits range from 1x10-3 to 1x10-6 cm/sec
Fot the site we will use :

K=	1.00E-04 cm/sec	or	for K=1.0E-05	1.00E-05
K=	3.28E-06 ft/sec	or		3.28E-07
k=	**2.83E-01 ft/day**			**2.83E-02**

I= change in head of water/change in distance between 2 measured points
Using B-105-OW and MW-204 water level date of 4/11/01

I=	**0.016 ft/ft**		
n=(porosity)	**0.15**		
U=	**0.0302 ft/day**	U=	**0.003024 ft/day**

Pankow and Cheery (1996, page 246) state that typical retardation factors for chlorinated compounds is on the order of 1-3
site soils generally consist of sandy and clayey silts so we will use R= 2

Vc=	**0.0151 ft/day**	Vc=	**0.001512 ft/day**

Buscheck and Alcantar state that alpha is roughly 5% of the plume length
The plume is measured to be approx. 120 feet long
alpha= 6 ft

to determine the value for k/Vc, plot DCE values over a distance between wells (see "Plot" sheet of this file)
based on plot on next sheet, using a linear regression, slope of the line is determined to be
k/Vx= -0.0447

Solving for Lambda where k=1.00E-04 cm/sec:

lambda=		
Vc/4alpha=	0.0006	1/day
2alpha(k/Vx)=	-0.5364	
1-2alpha(k/Vx)=	1.5364	
squared=	2.36052496	
minus 1	1.36052496	
lambda=	8.57E-04	

Solving for Lambda where k=1.00E-05 cm/sec:

lambda=		
Vc/4alpha=	6.29921E-05	1/day
2alpha(k/Vc)=	-0.5364	
1-2alpha(k/Vc)=	1.5364	
squared=	2.36052496	
minus 1	1.36052496	
lambda=	8.57E-05	

T1/2=ln 2/lambda
The half life= 0.693/lambda

T1/2=	809	days
	2.22	**years**

Using k= 1.00E-05
The half life= 0.693/lambda

T1/2=	8.09E+03	days
	22.15	**years**

Calculation of First Order Decay Rates- VC
99 Ridgeland Road, Henrietta, NY

Updated version: 10/12/01
created by NLC / VBD 5/30/01

Buscheck and Alcantar (1995) developed an equation to determine first order decay rates

$$\lambda = V_c/4\alpha_x\{[1+2\alpha_x(k/V_x)]^2 - 1\}$$

where:
lambda= first order biological rate constant
Vc= retarded contaminant velocity in the x direction
alpha= dispersivity
k/Vx= slope of line formed by making a ln-linear plot of contaminant concentration versus distance downgradient along the flow path.

The following variables were calculated based on site data/information:
Vc (and therefore retardation factor, and porosity- see below)
alpha

Vc: need a hydraulic conductivity (k), a gradient, and a retardation factor.
Vc= U/R
where U=kI: U= gw velocity and I= gradient
K was measured on 9/20/01. The value used here is an average of 4 wells.

K=	1.2E-04	cm/sec	or
K=	3.94E-06	ft/sec	or
k=	**3.40E-01**	**ft/day**	

I= change in head of water/ distance between 2 measurements (wells)
Using B-105-OW and MW-301 water level data of 9/20/01

I=	**0.04**	**ft/ft**
n=(porosity)	**0.15**	
U=	**0.0899**	**ft/day**

Pankow and Cherry (1996, page 246) state that typical retardation factors for chlorinated compounds is on the order of 1-3
Site soils generally consist of sandy and clayey silts so we will use a midlevel value for R= 2
Therefore:
Vc= 0.0450 ft/day

Buscheck and Alcantar state that alpha is roughly 5% of the plume length
The plume is measured to be approx. 165 feet long. Therefore:
alpha= 8.25 ft

To determine the value for k/Vc, plot TCE values over a distance between wells (see "Plot" sheet of this file)
based on plot on next sheet, using a linear regression, slope of the line is determined to be
k/Vx= -0.007

Solving for Lambda where k=1.2E-04 cm/sec:

Vc/4alpha=	0.0014	1/day
2alpha(k/Vx)=	-0.1155	
1-2alpha(k/Vx)=	1.1155	
squared=	1.24434025	
minus 1	0.24434025	
lambda=	3.33E-04	

Half-Life:
T1/2=ln 2/lambda
The half life= 0.693/lambda

T1/2=	2082	days
	5.70	**years**

Appendix C

APPENDIX C

80% Confidence Interval Calculations

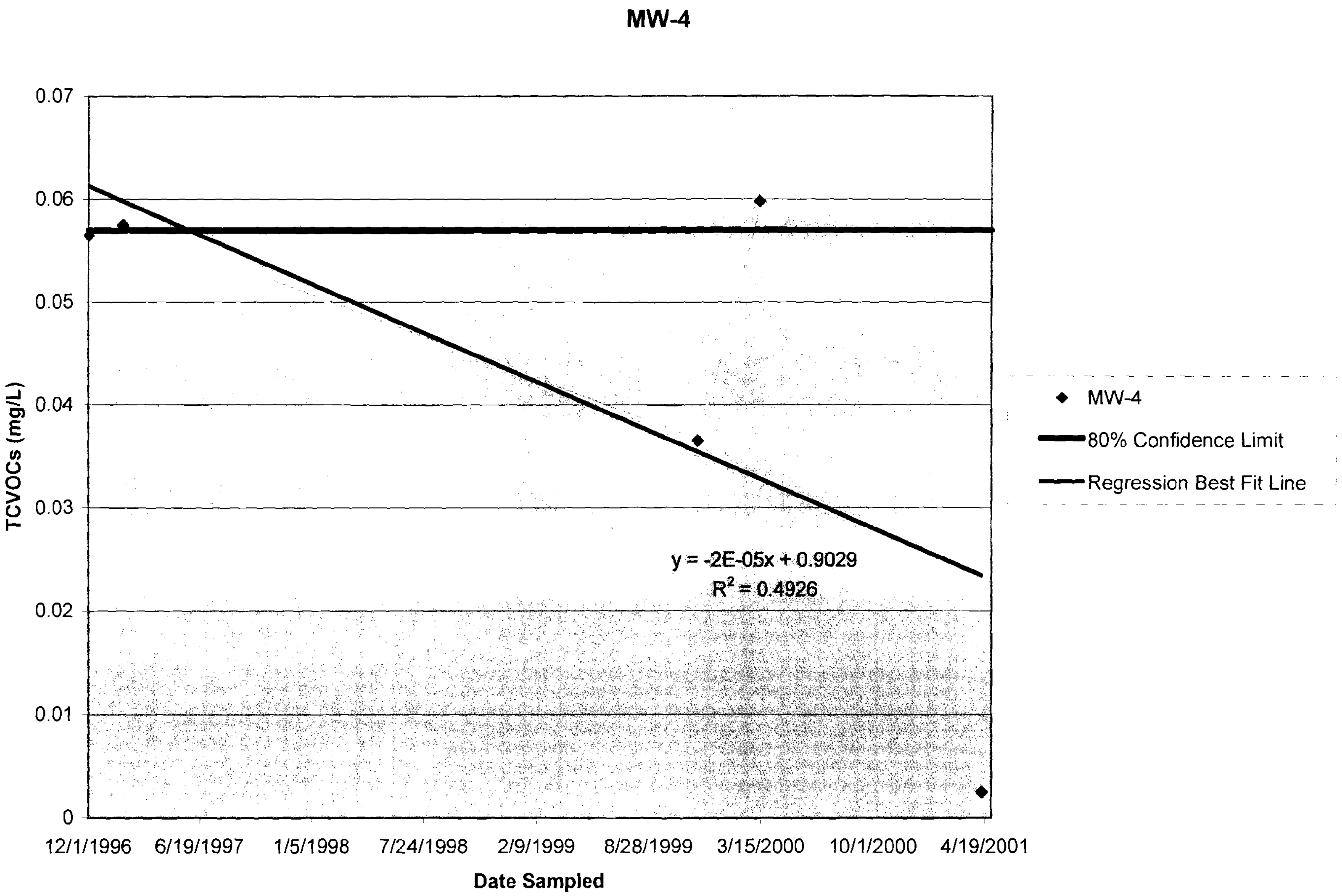
80% CONFIDENCE INTERVAL CALCULATIONS

CVOCs	**MW-203**		
Date Sampled	10/2/2000	4/12/2001	9/21/2001
1,1 - Dichloroethane	ND	ND	ND
Tetrachloroethene	ND	ND	ND
1,1,1, - Trichloroethane	ND	ND	ND
Trichloroethene	***1.20***	***1.4***	***0.32***
Cis-1,2-Dichloroethene	***1.200***	***1.6***	***0.63***
Trans-1,2-Dichloroethene	ND	ND	ND
Methylene Chloride	ND	ND	ND
Vinyl Chloride	***0.2***	***0.12***	***0.081***
Chloroethane	ND	ND	ND
1,1 - Dichloroethene	ND	ND	ND
Total CVOCs	2.60	3.1	1.03

Standard Deviation	1.087511
Sample Size	3
Average	2.250
80% Confidence Interval	0.804653
Upper 80% Confidence Limit	3.055
Lower 80% Confidence Limit	1.446

CVOCs	**MW-4**				
Date Sampled	12/1/1996	2/1/1997	11/23/1999	3/13/2000	4/12/2001
1,1 - Dichloroethane	ND	ND	0.0023 J	0.0039 J	ND
Tetrachloroethene	ND	ND	ND	ND	ND
1,1,1, - Trichloroethane	***0.0061***	ND	0.0021 J	0.0025 J	ND
Trichloroethene	***0.0074***	***0.0085***	ND	***0.0054***	ND
Cis-1,2-Dichloroethene	***0.043***	***0.049***	***0.030***	***0.045***	ND
Trans-1,2-Dichloroethene	ND	ND	ND	ND	ND
Methylene Chloride	ND	ND	ND	ND	ND
Vinyl Chloride	ND	ND	0.0021 J	0.003 J	ND
Chloroethane	ND	ND	ND	ND	ND
1,1 - Dichloroethene	ND	ND	ND	ND	ND
Total CVOCs	0.0565	0.0575	0.0365	0.0598	0.0025

Standard Deviation	0.011846
Sample Size	5
Average	0.050
80% Confidence Interval	0.006789
Upper 80% Confidence Limit	0.057
Lower 80% Confidence Limit	0.043


MW-4
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
TCVOCs (mg/L)
12/1/1996
6/19/1997
1/5/1998
7/24/1998
2/9/1999
8/28/1999
3/15/2000
10/1/2000
4/19/2001
Date Sampled
y = -2E-05x + 0.9029
R^2 = 0.4926
◆ MW-4
80% Confidence Limit
Regression Best Fit Line

APPENDIX D

Groundwater Sampling Procedure EPA/540/S-95/504, April 1996

United States
Environmental Protection
Agency

Office of
Research and
Development

Office of Solid Waste
and Emergency
Response

EPA/540/S-95/504
April 1996

EPA Ground Water Issue

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

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

Background

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

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I. Introduction

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

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Walter W. Kovalick, Jr., Ph.D.
Director

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

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

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

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

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

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

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

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

II. Monitoring Objectives and Design Considerations

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

A. Data Quality Objectives (DQOs)

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

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

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

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

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

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

B. Sample Representativeness

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

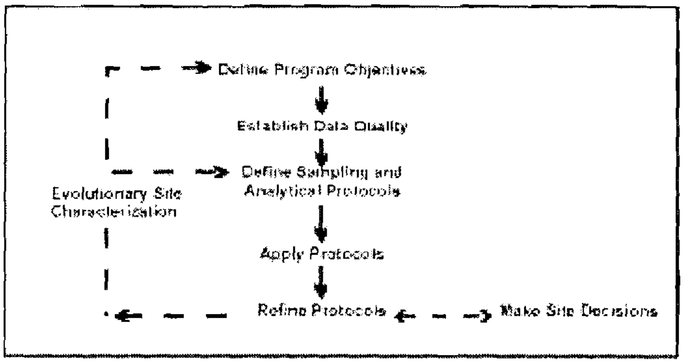

Figure 1. Evolutionary Site Characterization Model

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

1) Questions of Scale

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

2) Target Parameters

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

C. Sampling Point Design and Construction

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

1) Compatibility with Monitoring Program and Data Quality Objectives

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

2) Flexibility of Sampling Point Design

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

3) Equilibration of Sampling Point

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

III. Definition of Low-Flow Purging and Sampling

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

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

A. Low-Flow Purging and Sampling

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

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

B. Water Quality Indicator Parameters

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

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

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

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

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

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

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

Some disadvantages of low-flow purging are:

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

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

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

A. Sampling Recommendations

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

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

The following are recommendations to be considered before, during and after sampling:

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

B. Equipment Calibration

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

C. Water Level Measurement and Monitoring

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

D. Pump Type

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

1) General Considerations

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

2) Advantages and Disadvantages of Sampling Devices

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

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

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

E. Pump Installation

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

F. Filtration

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

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

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

G. Monitoring of Water Level and Water Quality Indicator Parameters

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

H. Sampling, Sample Containers, Preservation and Decontamination

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

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

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

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

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

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

I. Blanks

The following blanks should be collected:

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

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

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

V. Low-Permeability Formations and Fractured Rock

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

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

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

1. Low-Flow Purging and Sampling with Pumps

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

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

2. Passive Sample Collection

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

B. Fractured Rock

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

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

VI. Documentation

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

VII. Notice

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Figure 2. **Ground Water Sampling Log**

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

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

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

Measuring Point __________________ **Other Infor** ____

____

Sampling Personnel ____

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

Type of Samples Collected

____

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

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

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

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

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

Measuring Point __________________ **Other Infor** ____

____

Sampling Personnel ____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

____

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

APPENDIX E

Site Specific Sampling Protocol

Monitored Natural Attenuation Groundwater Sample Collection Protocol for 99 Ridgeland Road, Henrietta, New York

I. INTRODUCTION

This document describes procedures for collection of groundwater samples as part of the Monitored Natural Attenuation (MNA) program at the 99 Ridgeland site. MNA programs require obtaining groundwater samples that are indicative of actual aquifer conditions. Conventional purging and sampling procedures may cause aeration of groundwater and volatilization of organic compounds. The methods described in this document, when performed properly, will reduce the likelihood of groundwater samples becoming impacted by purging and sampling activities. In general, low-flow groundwater purging and sampling procedures should be employed to avoid aquifer stress, oxygenation of the water in the monitoring well, and contaminant loss from volatilization. In-line flow-through monitoring equipment will be used to monitor aquifer stabilization during purging and for collection of many "field" groundwater analytical parameters. Well construction at the site will not allow the use of an EPA recommended, submersible, bladder type pump for groundwater purging and sampling because the well diameters are too small. Groundwater purging and sampling will be performed at the site using the Waterra™ "Inertial Pumping System".

II. BACKGROUND

As defined by USEPA, Monitored Natural Attenuation (MNA) is a combination of physical, chemical and biological processes including biodegradation, sorption, dilution, diffusion, dispersion, volatilization, and chemical transformation that act to reduce measurable contaminant concentrations in the subsurface environment. Some of the processes, namely biodegradation and chemical transformation, are destructive and act to reduce contaminant mass.

To assess the extent to which the above processes are active in an aquifer, it is important to obtain groundwater samples that are representative of aquifer conditions. Research has shown that conventional purging and sampling procedures (high flow rate, removal of 3-5 well volumes, sample collection with bailers) can cause pressure changes and aeration that can strip volatile organic compounds from groundwater samples (Pennino, 1988). These methods can also provide misrepresentative data on aquifer conditions particularly important in MNA evaluations, such as dissolved oxygen and redox.

This document describes appropriate purging and sampling procedures for the 99 Ridgeland site, summarizes the recommended list of groundwater analytical parameters, and provides recommendations for appropriate analytical procedures including analysis of some parameters at the wellhead immediately after purging. A sampling form is included with this procedure and will be used to record water level and field parameter measurements to monitor for stabilization of groundwater conditions during purging.

III. SAMPLING EQUIPMENT

Well construction at the site will not allow the use of an EPA recommended, submersible, bladder type pump for groundwater purging and sampling because the well diameters are too small. Groundwater purging and sampling will be performed at the site using the Waterra™ "Inertial Pumping System" that consists of ½-inch OD, 3/8-inch ID, High Density Polyethylene (HDPE) tubing fitted with a stainless steel foot-valve.

To preserve consistency in operation of the inertial pump system a portable lever pumping mechanism (Waterra™ "Lever Pump", pictured on the attached page) will be employed. This actuator can be fastened to wells completed as stick-ups or used with a stand for flush-mount completions. The lever handle is adjustable and can be set at the desired stroke length that best accommodates each well. The stroke length should straddle the center of the screened interval at each well. The operation of the inertial pump is explained in detail on the attached page. VOC samples at the site will be collected using the method and narrow diameter "VOC Tubing" described in detail on the attached page. After determining the recharge rate of the well the number of strokes per time interval that achieves a low flow pumping rate of <0.5 L/min will be established for each well.

IV. SAMPLING

- Synoptic water level measurements will be obtained prior to purging activities. Water level measurements will be recorded to 0.01 ft. Well depth will initially be obtained from well logs and measured only after sampling is complete so not to disturb settled solids at the at the bottom of the well.

- Wells will be purged and sampled in order of increasing chemical concentrations.

- Equipment calibration, sampling documentation, sample bottle filling, preservation, and shipping will be conducted in accordance with the site-specific QA/QC measures described in section III of the Work Plan.

- Personal protective equipment will be donned in accordance with the requirements of the site-specific Health and Safety Plan.

- Well purging via Waterra tubing and associated foot-valve will begin at a rate of 100 to 500 milliliters per minute (mL/min) which correlates to 0.03 to 0.13 gallons per minute. This pumping rate should cause little or no water level drawdown in the well (< 0.1 m or 3.9 inches) and the water level should stabilize.

- Water level measurements and the following select water quality indicator parameters will be obtained and recorded every three to five minutes.

  Precautions will be taken to avoid air entrainment in Waterra tubing. Pumping rates will, if needed, be reduced to a minimum to avoid drawdown and ensure stabilization of indicator parameters.

In low-yielding wells, where 100 mL/min exceeds the entrance rate of groundwater the tubing will remain in place and the water level should be allowed to recover repeatedly until there is sufficient volume in the well to permit collection of samples. Under these low-yield conditions, it may become difficult to maintain an adequate water volume in the flow-through cell described in the next step. If low-yield conditions occur samples for laboratory analysis only will be collected. Field parameters will not be measured.

- While purging the well, measurements of water quality indicator parameters utilizing an in-line flow-through cell will be collected every three to five minutes until parameters have stabilized. Stabilization has been achieved when three successive readings are within the following tolerances noted in the table below.

Parameter	Stabilization Level (3 successive readings within)
Turbidity	+10% and final value between 5 and 10 NTU
Specific conductance	+3%
pH	±0.1
Dissolved oxygen (DO)	±10%
Redox potential (Eh)	±10mv

In general, the order of stabilization is pH, temperature and specific conductance, followed by redox potential, dissolved oxygen, and turbidity (USEPA, 1996). The following minimum subset of parameters will be used to determine stabilization during purging at the 99 Ridgeland site: **pH, specific conductivity and DO**. Turbidity and DO are typically the last parameters to stabilize.

The following table provides typical ranges of the various field parameters. Field data collected during purging should be compared against these values and, if substantial differences exist, the accuracy of the meter should be verified to rule out potential operational problems with the equipment.

Parameter	Typical Range of Values
Turbidity	10 - 500 NTU
Specific conductance	50 - 500 mS
pH	6 - 9
Dissolved oxygen (DO)	ND - 9 mg/L
Redox potential (Eh)	-250 - +400 mV

If stabilization is not achieved after purging a maximum of 20 well screen volumes (i.e. 8 gallons, calculated assuming 5 feet of 1.25-inch diameter screen) purging should continue only if the purge water remains visually turbid and appears to be clearing, or if stabilization parameters are varying slightly outside of the stabilization criteria listed above and appear to be approaching stabilization. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria (EPA/540/S-95/504, April 1996).

- Sampling will take place in the following order:

    1. Volatile organic compounds
    2. Gas sensitive parameters (e.g. ethene, ethane, methane) and other wellhead parameters (e.g. Fe^{+2}). Note that for MNA programs collection of Fe^{+2} is performed at the wellhead using a colorimetric kit (i.e. Hach). Other wellhead parameters such as alkalinity and carbon dioxide should also be obtained at this time.
    3. Dissolved organic carbon
    4. Sulfate/Sulfide, nitrate/nitrite, and chloride
    5. Total Iron and Manganese

  Refer the project sampling and analysis plan (section III of the Work Plan) and Table I to determine which analytes will be measured in the field (wellhead) and which will be submitted to a fixed-base laboratory. Not all parameters will be obtained during each sampling event. The actual parameters collected will be based on the project requirements described in section III of the Work Plan.

- The flow-through cell will be bypassed during sampling.

- All sample containers should be filled by allowing the Waterra tubing discharge to gently flow down inside the container with minimal turbulence. As each sample bottle is collected, the bottle will be labeled with the following information then placed into a cooler with the proper temperature control.

  Sample number/ID
  Date and time
  Parameters to be analyzed
  Project Reference ID
  Samplers initials

- After collection of the samples, tubing will be properly decontaminated and dedicated to the well for future sampling events. Tubing will not be hung down-well during storage.

- Final water level and well depth measurements will be recorded.

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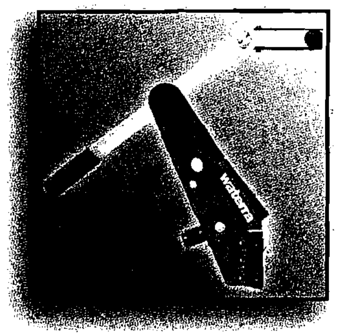
National Research Council, 2000. Natural Attenuation for Groundwater Remediation, pp. 176-77.

2



SIMPLICITY

inertial pump operation

1. Tubing/Valve assembly is installed in well. Water level inside tubing rises to that in well.
2. A rapid upstroke closes the footvalve and lifts the water column inside the tubing a distance equal to the stroke.
3. At the end of the upstroke, the water column continues to rise due to its momentum. A further column of water is thus simultaneously drawn into the tube.
4. Pushing the tubing down immediately after the upstroke forces a further column of water into the tubing due to the inertia of the water column.
5. The cycle is repeated and water rises in pulses to discharge at the surface.

VOC sample collection

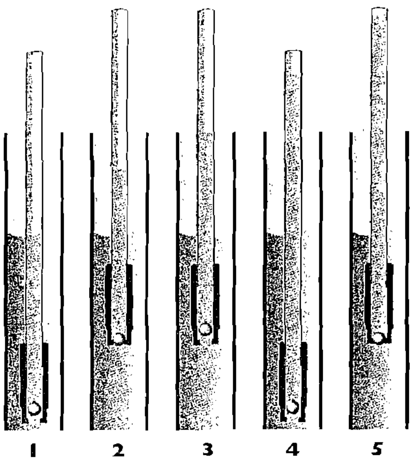
The method for collecting volatile samples with the Inertial Pump is very simple and all that is required is 8 feet of narrow diameter **VOC Tubing**.

After purging the well, approximately 7 feet of the VOC Tubing is inserted inside the Standard Flow or High Flow pump's tube, leaving about one foot protruding out the end of the pump's tubing. Once the VOC tube has been inserted into the pump's tube, the pump can be operated again. After a few moments of pumping, water will flow from both tubes and will continue as long as the pump is actuated. When pumping is stopped, the pump's tubing will cease to produce water. However, the VOC tube will continue to flow, operating as a siphon, drawing water down to the level standing in the pump's tubing. This siphon action can easily be used to collect small samples for volatile analysis as the flow from the narrow tube is steady, laminar and easily directed into a glass vial.

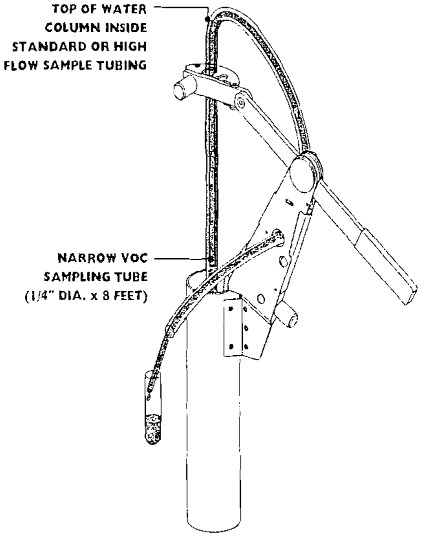
There is no loss of volatile organic compounds as is commonly associated with suction pumps, as the siphon action is generated by gravity flow. In addition, the sample is drawn from below the surface of the water level in the pump's tubing, ensuring that it has not been aerated.

These VOC tubing accessories should be dedicated to the monitoring well where they are used or they should be disposed of in order to avoid decontamination procedures or cross contamination.

HOW IT WORKS



VOC SAMPLING KIT



Appendix F

APPENDIX F

Environmental Health & Safety Plan

REVISED ENVIRONMENTAL HEALTH & SAFETY PLAN
99 RIDGELAND ROAD
HENRIETTA, NEW YORK

by

Haley & Aldrich of New York
Rochester, New York

for

Harter, Secrest & Emery
Rochester, New York

File No. 70753-000
Date: May 2002

ENVIRONMENTAL HEALTH AND SAFETY REQUIREMENTS

TABLE OF CONTENTS

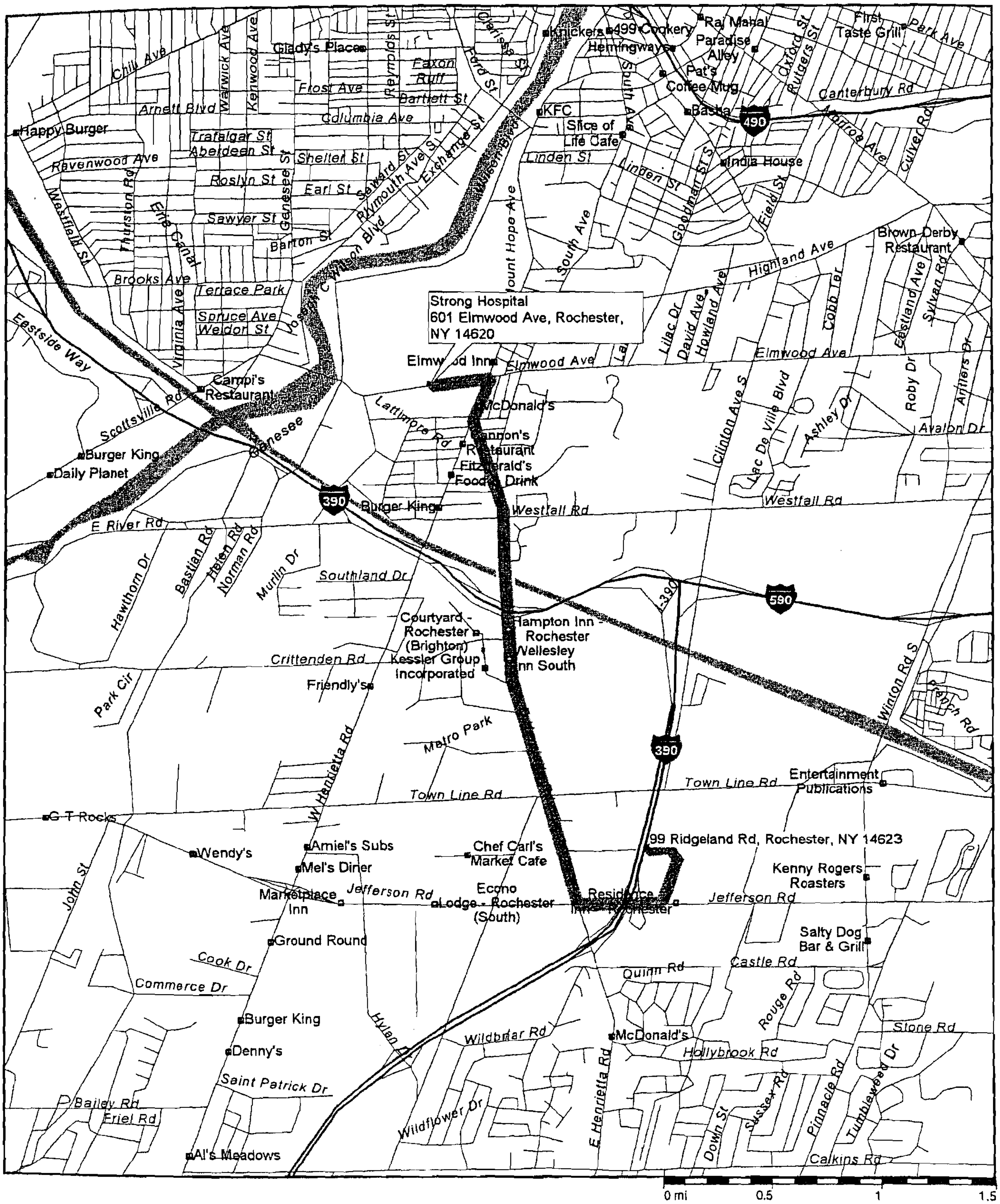
* Task-specific pages are non-paginated to allow for duplication.

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

EMERGENCY PHONE NUMBERS

Monroe County Emergency Services	**911**
Ambulance Service	**911**
Fire Department	**911**
Police Department	**911**
Haley & Aldrich of New York Project Manager	
Vince Dick	321.4207
Haley & Aldrich of New York Health & Safety Representative	
Bob Mahoney	321.4235
Project Contact	
Paul Sylvestri, Esq.	231-1194
Occupation Health Physician	275-7795
Dr. Bruce Barron Strong Memorial Hospital 601 Elmwood Avenue Rochester, New York	
CHEMTREC (CHEMICAL TRANSPORTATION EMERGENCY CENTER)	**1-800-424-9300**
Hospital	
Strong Memorial Hospital 601 Elmwood Avenue Rochester, New York Emergency Dept. (map next page)	275-4511
Poison Control	
Strong Memorial Hospital	275-5151
New York State Department of Health	
David Napier	423-8042
Monroe County Health Department	
Joe Albert	274-6904
New York State Department of Environmental Conservation - Region 8- Frank Sowers	226-5357



MICROSOFT AUTOMAP

Streets Plus

Map Title 1

Map Title 2

TASK MODIFICATIONS AND PLAN APPROVAL

LIST BELOW EACH MODIFICATION TO THIS PLAN AND DATE MODIFIED

1.

2.

THE FOLLOWING SIGNATURES CONSTITUTE APPROVAL OF THIS HEALTH & SAFETY PLAN. THIS PLAN SHOULD NOT BE DEVIATED FROM WITHOUT PRIOR WRITTEN OR VERBAL APPROVAL.

THIS PLAN APPROVED BY: **REVISIONS:**

H&A BRANCH HEALTH & SAFETY MANAGER	DATE	INITIAL/DATE	INITIAL/DATE
Vince Dick PROJECT MANAGER	DATE	INITIAL/DATE	INITIAL/DATE

HEALTH AND SAFETY BRIEFING:

I HAVE READ, UNDERSTOOD AND AGREE TO FOLLOW THIS HEALTH & SAFETY PLAN.

REVISIONS:

NAME	SIGNATURE	DATE	INITIAL/DATE	INITIAL/DATE
NAME	SIGNATURE	DATE	INITIAL/DATE	INITIAL/DATE
NAME	SIGNATURE	DATE	INITIAL/DATE	INITIAL/DATE
NAME	SIGNATURE	DATE	INITIAL/DATE	INITIAL/DATE
NAME	SIGNATURE	DATE	INITIAL/DATE	INITIAL/DATE
NAME	SIGNATURE	DATE	INITIAL/DATE	INITIAL/DATE
NAME	SIGNATURE	DATE	INITIAL/DATE	INITIAL/DATE

I. INTRODUCTION

This document comprises the Environmental Health and Safety Plan to be followed by Haley & Aldrich for environmental projects to be conducted at 99 Ridgeland Road, Henrietta, New York. The scope of work covered by this Health and Safety Plan (HSP) includes installation of borings and monitoring wells onsite and sampling of groundwater from onsite wells. Other parties performing field work shall provide a health and safety plan for their specific activities.

The provisions of this HSP are mandatory for all personnel assigned to the activities described in the work plan for this project. The Health and Safety procedures contained in this document have been developed for the activities associated with this project and will be periodically reviewed and revised as necessary to keep them current and technically correct.

The requirements set forth in this HSP are minimum health and safety protocols and duties to be adhered to and enforced during environmental investigation activities described in the following sections.

Plan Organization

Occupational Safety and Health Administration (OSHA) regulations under 29 CFR 1910.120 require that a project specific health and safety plan be developed for RCRA and CERCLA related hazardous materials/waste investigations and activities. This plan has been developed to meet these requirements and related OSHA criteria such as, but not limited to, respiratory protection, eye and hearing protection, trenching/excavation safety and confined space entry. This plan includes hazard evaluation, engineering controls, administrative controls, personal protective equipment (PPE), monitoring procedures, decontamination procedures, and emergency response provisions to meet the OSHA requirements above.

The plan is organized into two parts. The first part (Section II) contains task-specific health and safety procedures. It is intended to be updated and revised as new tasks are added to the project or new information becomes available which modifies task-specific health & safety needs. The second part (Section III) describes general health and safety procedures and information that applies to all tasks. Personal exposure limits (PELs), odor thresholds and hazardous compound physical properties appear in Table 1. Monitoring instrument action levels and appropriate level of protection responses appear in Table 2. **EMERGENCY CONTACTS AND PHONE NUMBERS ARE LISTED IMMEDIATELY FOLLOWING THE TABLE OF CONTENTS.**

II. TASK SPECIFIC HEALTH & SAFETY PROCEDURES

2.1 MASTER TASK LIST

This section describes health & safety procedures specific to individual tasks associated with the project. Additional task description sheets shall be developed and added to this section as necessary.

A master list of the tasks included in this section is provided below.

Task Name

1 installation of borings and monitoring wells
2 sampling of monitoring wells
3
4
5

2.2 TASK-SPECIFIC HEALTH AND SAFETY REQUIREMENTS (Task 1)

X Initial
___ Revision

Task Name(s)*:
Installation of borings and monitoring wells

Task Description:
Install borings to a depth to be determined in the field; install one well.

Duration:
1 day

Media Affected: _ air x soil __ surface water __ waste x groundwater

Area Within Site Where Task(s) to be performed: southwest side of property

HAZARD EVALUATION (check all that apply)

CHEMICAL HAZARDS:**

CHARACTERISTICS:

FLAMMABLE/COMBUSTIBLE
CORROSIVE
REACTIVE
TOXIC
X VOLATILE (TCE, DCE, and Acetone Noted in Soil, GW)
EXPLOSIVE
RADIOACTIVE
UNKNOWN
OTHER ___________

TYPE:

___ SOLID/DUST
X LIQUID/MIST
___ SLUDGE
X GAS/VAPOR/FUMES
X ORGANIC
___ HEAVY METAL
___ INORGANIC
___ PESTICIDE
___ PCB
___ ACID
___ BASE
X CARCINOGEN
___ FUEL/PETROLEUM PRODUCT
___ OTHER

PHYSICAL HAZARDS:

___ ACTIVE MANUFACTURING SITE
___ CONFINED SPACE ENTRY
X ELECTRICAL EQUIPMENT
___ EXCAVATION/TRENCHING
X UNDERGROUND UTILITIES
___ OVERHEAD UTILITIES
___ OPEN WATER
___ TEMPERATURE EXTREMES
X NOISE
___ ASBESTOS
___ OTHER _____

* May include individual or related tasks for which hazards and health and safety requirements are common. Refer to General Health and Safety Procedures (Section III) as necessary).

** Verify that compounds that may be encountered are listed in Table 1.

2.2 TASK-SPECIFIC HEALTH AND SAFETY REQUIREMENTS (Task 2)

X Initial
___ Revision

Task Name(s)*:
Sampling of monitoring wells

Task Description:

Duration:
2 Days

Media Affected: _ air x soil x surface water __ waste x groundwater

Area Within Site Where Task(s) to be performed: building interior & exterior

HAZARD EVALUATION (check all that apply)

CHEMICAL HAZARDS:**

CHARACTERISTICS:

FLAMMABLE/COMBUSTIBLE
CORROSIVE
REACTIVE
TOXIC
X VOLATILE
EXPLOSIVE
RADIOACTIVE
UNKNOWN
OTHER ___________

TYPE:

___ SOLID/DUST
X LIQUID/MIST
___ SLUDGE
X GAS/VAPOR/FUMES
X ORGANIC
___ HEAVY METAL
___ INORGANIC
___ PESTICIDE
___ PCB
___ ACID
___ BASE
X CARCINOGEN
___ FUEL/PETROLEUM PRODUCT
___ OTHER

PHYSICAL HAZARDS:

___ ACTIVE MANUFACTURING SITE
___ CONFINED SPACE ENTRY
___ ELECTRICAL EQUIPMENT
___ EXCAVATION/TRENCHING
___ UNDERGROUND UTILITIES
___ OVERHEAD UTILITIES
___ OPEN WATER
___ TEMPERATURE EXTREMES
___ NOISE
___ ASBESTOS
___ OTHER ______

* May include individual or related tasks for which hazards and health and safety requirements are common. Refer to General Health and Safety Procedures (Section III) as necessary).

** Verify that compounds that may be encountered are listed in Table 1.

B. PROTECTIVE AND CONTROL MEASURES

ENGINEERING CONTROLS:

VENTILATE AREA
DISCONNECT/CLEAN OUT LINES
SLOPE EXCAVATION
SHORE EXCAVATION
____ ELIMINATE IGNITION SOURCES
____ TAPE OFF AREA
POST WORK/WARNING SIGNS
PLASTIC SHEETING IN AREA
(CIRCLE TYPE)
X DESIGNATE NO SMOKING AREA
ESCAPE LADDER
UTILITY CLEARANCES OBTAINED
____ (DIG SAFE CONTACTED)
X PRIVATE UTILITIES CLEARED
LINES SHIELDED/DE-ENERGIZED
LOCKED & TAGGED OUT
____ LIFE JACKETS/BARRICADES NEAR WATER
HEAT OR AIR CONDITIONING SOURCE FOR TEMPERATURE EXTREMES
OTHER

LEVEL OF PROTECTION

MODIFIED D (HOW MODIFIED):
LEVEL D
MODIFIED C (HOW MODIFIED) ____
____ LEVEL C
____ MODIFIED B (HOW MODIFIED) ____
____ LEVEL B

PERSONAL PROTECTIVE EQUIPMENT:

X SAFETY GLASS
____ EYE/FACE SHIELD
X GLOVES (CIRCLE TYPES) INNER LATEX INNER COTTON, NEOPRENE, BUTYL, PVC SILVER SHIELD, OTHER
____ DUCT TAPE
X EAR PROTECTION
____ EAR PLUGS, EAR PHONES
X BOOTS (CIRCLE TYPE) STEEL TOE, DISPOSABLE COVERS, LATEX, WADERS, OTHER ____
____ TYVEK COVERALL
____ SARANEX COVERALL
____ HARD HAT
____ RESPIRATOR (INDICATE TYPE OF CARTRIDGE) ____
X FIRE EXTINGUISHER
X FIRST AID KIT
LOUD SIGNALING DEVICE (CIRCLE TYPE) AIR HORN, WHISTLE
____ FLASHLIGHT
____ SAFETY SHOWER/EYE WASH
____ WALKIE-TALKIE
____ OTHER: ____
____
____

C. ENVIRONMENTAL MONITORING

	Equipment	Action Thresholds*	Level of Protection
	HNU (CIRCLE ONE) 10.2 EV 11.7 EV		
X	PHOTOVAC MICROTIP (10.6 EV)	per Table 2	____
	OVA		____
	EXPLOSIMETER/02 METER		____
	RADIATION METER		____
	HYDROGEN CYANIDE METER		____
	PHOTOVAC GC		____
	DRAEGER TUBE ____		____
	RESPIRABLE DUST MONITOR		____
____	OTHER		____

Frequency

____ BREATHING ZONE
____ PERIMETER

* List only those differing from or in addition to Table 2.

D. DECONTAMINATION EQUIPMENT AND PROCEDURES

DECONTAMINATION EQUIPMENT:

_X_ TAP WATER
____ DISTILLED WATER
____ HEXANE
____ METHANOL
____ ACETONE
_X_ ALCONOX
_X_ BRUSHES
____ PLASTIC SHEETING
_X_ DISPOSAL BAGS
____ WASH TUBS (HOW MANY) ________
_X_ PAPER TOWELING
____ STEAM CLEANER

SITE CONTROL/DECONTAMINATION PROCEDURES:

DISTINGUISHING FEATURES WHICH DELINEATE ZONES AND APPROXIMATE DIMENSIONS IN FEET:

EXCLUSION ZONE - wellhead area

CONTAMINATION REDUCTION ZONE -

SUPPORT ZONE -

DECONTAMINATION PROCEDURES WHICH ARE TO OCCUR IN:

EXCLUSION ZONE - Remove gross contamination & PPE in exclusion zone & dispose of based on analytical results

CONTAMINATION REDUCTION ZONE -

SUPPORT ZONE -

E. EMERGENCY RESPONSE

SEE EMERGENCY CONTACTS LISTED IMMEDIATELY FOLLOWING THE TABLE OF CONTENTS.

TABLE 1
HAZARD MONITORING
(CIRCLE SITE CONTAMINANTS OF CONCERN, WRITE ADDITIONAL CONTAMINANTS ON NEXT PAGE)

SITE OF CONTAMINANTS OF CONCERN	ROUTES OF EXPOSURE	IDLH	PEL	TLV	PID	FID	ODOR THRESHOLD	IRRITATION THRESHOLD	ODOR DESCRIPTION
Acetone	R,I,C	20000	750	750	9.69	60	13	---	Chem, sweet, pungent
Benzene	R,A,I,C	Ca	1	10	9.25	150	4.68	---	Solvent
Carbon tetrachloride	R,A,I,C	Ca	2	Skin 5	11.47	10	50	---	Sweet, pungent
Chlorobenzene	R,I,C	2400	75	75	9.07	200	0.68	---	Almond like
Chloroform	R,I,C	Ca	2	10	11.42	65	50	E4096	Sweet
Cyanides (as CN)	R,A,I,C	50 mg/m^3	5 mg/m^3	5 mg/m^3	---	---	---	---	Faint almond odor
o-Dichlorobenzene	R,A,I,C	1700	Cv30	Cv30	9.06	50	0.3	E 20-30	Pleasant, aromatic
p-Dichlorobenzene	R,I,C	1000	75	75	8.94	---	0.18	E 80-160	Distinct, aromatic mothball-like
1,1-Dichloroethane	R,I,C	4000	100	200	---	80	200	---	Distinct
1,2-Dichloroethane	R,I,A,C	Ca	1	10	11.12	80	88	---	Chloroform
1,1-Dichloroethylene	R,I	Ca	1	5	*	40	190	---	---
1,2-Dichloroethylene	R,I,C	4000	200	200	9.65	50	0.085	---	Ether-like, acrid
Ethanol	R,A,I,C	---	1000	1000	10.48	25	10	---	Sweet
Ethylbenzene	R,I,C	2000	100	100	8.76	100	2.3	E 200	Aromatic
Ethylene Glycol vapor	R,A,I,C	---	Cv 50	Cv 50	---	---	---	---	---
Formaldehyde	I,C	Ca	3	1	10.88	---	0.83	E 0.5	Hay
Gasoline	R,I,C	---	300	300	---	---	---	---	---
Hexane, n-isomer	R,I,C	5000	50	50	10.18	70	130	E,T 1400-1500	Mild, gasoline-like
Hydrogen Cyanide (as CW)	R,A,I,C	50	10	SkCv-10	13.69	---	0.58	---	Bitter almonds
Methanol	R,I,C	25000	Sk 200	Sk 200	10.84	12	1000	---	Sweet
MEK	R,I,C	3000	200	200	9.48	80	5.4	---	Acetone-like
Methyl Chloroform (1,1,1-TCA)	R,I,C	1000	350	350	**	105	20-100	---	Chloroform-like
Methylene Chloride	R,I,C	Ca	500	50	11.35	100	25-50	E 5000	Ether-like
Methyl Mercaptan	R,C	400	Cv 0.5	0.5	9.44	---	---	---	Garlic, Rotten Cabbage
MIBK (Hexone)	R,I,C	3000	50	50	---	---	---	---	Pleasant
Naptha (coal tar)	R,I,C	10000	100	---	---	---	---	---	Aromatic
Naphthalene	R,A,I,C	500	10	10	8.14	---	0.3	E 15	Mothball-like

SITE OF CONTAMINANTS OF CONCERN	ROUTES OF EXPOSURE	IDLH	PEL	TLV	PID	FID	ODOR THRESHOLD	IRRITATION THRESHOLD	ODOR DESCRIPTION
Octane	R,I,C	5000	300	300	9.9	80	48	---	Gasoline-like
Pentachlorophenol	R,A,I,C	150mg/m^3	0.5mg/m^{3}sk	0.5mg/m^{3}sk	---	---	---	---	Pungent when hot
Phenol	R,A,I,C	250	Sk5	Sk5	8.5	---	0.04	E.N.T 68	Medicinal
Propane	R,C	20000	1000	Asphyx.	10.95	80	16000	---	Natural gas odor
Stoddard Solvent (Mineral Sprits)	R,CI,I	5000	100	100	*	---	1	E 400	Kerosene-like
1,1,2,2-Tetrachloroethane	R,A,I,C	Ca	Sk1	1	11.1	100	1.5	---	---
Tetrachloroethylene	R,I,C	Ca	25	50	9.32	70	4.68	N.T513-690	Ether, Chloroform-like
Toluene	R,A,I,C	2000	100	100	8.82	110	2.14	E 300-400	Mothballs
Trichloroethylene	R,I,C	Ca	50	50	9.47	70	21.4	---	Solventy, chloroform-like
Turpentine	R,A,I,C	1900	100	100	---	---	200	E.N 200	Pine like
Vinyl Chloride	R	Ca	1	5	9.995	---	3000	---	Ethereal
Xylenes	R,A,I,C	1000	100	100	8.56/8.44	111/116	1.1	E.N.T. 200	Aromatic
Asbestos	R	Ca	0.2fibr/cc	0.2fibr/cc	---	---	---	---	---
Dichlorodifluoromethane (Freon 12)	R,C	50000	1000	1000	11.97	15	---	---	---
Hydrogen peroxide	R,I,C	75	1	1	11	---	---	---	Sharp
MEK peroxide	R,I,C	---	Cv 0.7	Cv 0.2	---	---	---	---	---
PCBs-42% Chlorine	R,A,I,C	Ca	1mg/m^{3}Sk	1mg/m^{3}Sk	---	---	---	---	Mild, hydrocarbon
PCBs-54% Chlorine	R,A,I,C	Ca	0.5mg/m^{3}Sk	0.5mg/m^{3}Sk	---	---	---	---	Mild, hydrocarbon
Styrene	R,I,C	5000	50	---	8.47	85	0.047	E 200-400	Rubber, solvent
Styrene monomer	R,I,C	---	---	50	---	---	200	---	Aromatic
Aluminum - metal dust	R,I,C	---	15mg/m^3	10mg/m^3	---	---	---	---	---
- soluble salts	R,I,C	---	2mg/m^3	2mg/m^3	---	---	---	---	---
Arsenic	R,A,I,C	Ca	0.01mg/m^3	0.2mg/m^3	---	---	---	---	---
Barium:soluble compounds	R,I,C	250mg/m^3	0.5mg/m^3	0.5mg/m^3	---	---	---	---	---
Berylium & compounds	R	Ca	0.002mg/m^3	0.002mg/m^3	---	---	---	---	---that he hasn't seen a spec for this yet
Cadmium dusts	R,I	Ca	0.2mg/m^3	0.05mg/m^3	---	---	---	---	---
(Proposed value)				0.01mg/m^3	---	---	---	---	---
Chromium:									
Metal & insoluble salts	R,I	500mg/m^3	1mg/m^3	0.5mg/m^3	---	---	---	---	---

SITE OF CONTAMINANTS OF CONCERN	ROUTES OF EXPOSURE	IDLH	PEL	TLV	PID	FID	ODOR THRESHOLD	IRRITATION THRESHOLD	ODOR DESCRIPTION
Soluble salts	I,C	250mg/m^3	0.5mg/m^3	0.05mg/m^3	---	---	---	---	---
Copper - dust & mist	R,I,C	---	1mg/m^3	1mg/m^3	---	---	---	---	---
Lead - arsenate	R,I,C	Ca	0.05mg/m^3	0.15mg/m^3	---	---	---	---	---
- inorg. dust & fume	R,I,C	---	0.05mg/m^3	0.15mg/m^3	---	---	---	---	---
- chromate	R,I,C	---	---	0.05mg/m^3	---	---	---	---	---
Manganese & compounds	R,I	10000mg/m^3	C-5mg/m^3	5mg/m^3	---	---	---	---	---
Mercury & inorg. comp.	R,A,C	28mg/m^3	Cv0.1mg/m^3	0.1mg/m^3		---	---	---	---
- (organo) alkyl comp.	R,A,I,C	10mg/m^3	0.01mg/m^3	0.01mg/m^3	---	---	---	---	---
Nickel - metal, insoluble	R,I,C	Ca	1mg/m^3	1mg/m^3	---	---	---	---	---
- soluble comp.	R,I,C	Ca	0.1mg/m^3	0.1mg/m^3	---	---	---	---	---
Portland cement	R,I,C	---	10mg/m^3	10mg/m^3	---	---	---	---	---
Selenium compounds	R,A,I,C	100mg/m^3	0.2mg/m^3	0.2mg/m^3	---	---	---	---	---
Silver - metal	R,I,C	---	0.01mg/m^3	0.1mg/m^3	---	---	---	---	---
- soluble comp.	R,I,C	---	---	0.01mg/m^3	---	---	---	---	---
Thallium, soluble	R,A,I,C	20mg/m^3	0.1mg/m^{3}Sk	0.1mg/m^{3}Sk	---	---	---	---	---
Tin, metal & inorganic comp. except oxides	R,C	400mg/m^3	2mg/m^3	2mg/m^3	---	---	---	---	---
Tin, organic compounds	R,A,I,C	200mg/m^3	0.1mg/m^3	0.1mg/m^{3}Sk	---	---	---	---	---
Zinc chromates, as Cr	R,I,C	---	Cv0.1mg/m^3	Cv0.1mg/m^3	---	---	---	---	---
Zinc oxide dust	R,I,C	---	10mg/m^3	10mg/m^3	---	---	---	---	---

Notes: All units in ppm unless otherwise noted.

E = Eyes
N = Nose
T = Throat
SK = Skin
Cv = Ceiling value
Ca = Carcinogen

R = Respiratory (Ihhalation)
A = Skin Absorption
I = Ingestion
C = Skin and/r Eye Contact
* = Use 10.2 eV lamp
** = Use 11.7 eV lamp

vbd:gmc

TABLE 2

MONITORING METHOD, ACTION LEVELS AND PROTECTIVE MEASURES

INSTRUMENT	HAZARD	ACTION LEVEL(1)	ACTION RESPONSE
Respirable Dust Monitor	Contaminant Particles	> 0.05 mg/m^3	Level C Protection
OVA, HNU(2), Photovac Microtip	Organic Vapors	Background	Level D
		3 ppm > background or lowest OSHA permissible exposure limit, whichever is lower, or as modified for this task (see Section C in 2.2.2)	Level C, site evacuation may be necessary for specific compounds (see Section C in 2.2.2)
		50 ppm over background unless lower values required due to respirator protection factors	Level B(3)
Explosimeter(4)	Explosive Atmosphere	10% Scale Reading	Proceed with work
		10-15% Scale Reading	Monitor with extreme caution
		> 15% Scale Reading	Evacuate site
O_2 Meter(5)	Oxygen Deficient Atmosphere	19.5% O_2	Monitor with caution
		19.5% - 25% O_2	Continue with caution
		< 19.5% O_2	Evacuate site; oxygen deficient
		> 22% O_2	Evacuate site; fire hazard
Radiation Meter(6)	Ionizing Radiation	0.1 Millirem/Hour	If > 0.1, radiation sources may be present(7)
		$\geq$ 1 Millirem/Hour	Evacuate site; radiation hazard
Draeger Tube	Vapors/Gases	Species Dependent > 1 ppm Vinyl Chloride > 1 ppm benzene > 1 ppm 1,1-DCE	Consult manual for concentration/toxicity/detection data. Upgrade to Level C and evacuate. Upgrade to Level B if concentrations of compounds exceed thresholds shown at left.
GC	Organic Vapors	3 ppm > background or lowest OSHA permissible exposure limit, whichever is lower	On site monitoring or tedlar bag sample collection for laboratory analysis

Notes:
1. MONITOR BREATHING ZONE
2. CAN ALSO BE USED TO MONITOR SOME INORGANIC SPECIES.
3. POSITIVE PRESSURE DEMAND SELF CONTAINED BREATHING APPARATUS
4. LOWER EXPLOSIVE LIMIT (LEL) SCALE IS 0-100%. LEL FOR MOST GASSES IS 15%.
5. NORMAL ATMOSPHERIC OXYGEN CONCENTRATION AT SEA LEVEL IS ~ 20%.
6. BACKGROUND GAMMA RADIATION IS ~ 0.01 - 0.02 MILLIREMS/HOUR.
7. CONTACT HALEY & ALDRICH OF NEW YORK HEALTH AND SAFETY STAFF IMMEDIATELY.

III. GENERAL HEALTH & SAFETY PROCEDURES

3.1 ADMINISTRATIVE CONTROLS

A. Initial Health and Safety Training

Personnel will not be permitted to participate in or supervise field activities until they have been trained to a level required by their job function and responsibility. Haley & Aldrich employees, contractors, subcontractors, and consultants who have the potential to be exposed to contaminated materials or physical hazards must complete the training described in the following sections.

B. 40-Hour Health and Safety Training

This basic course provides instruction on the nature of hazardous waste work, protective measures, proper use of personal protective equipment, recognition of signs and symptoms which might indicate exposure to hazardous substances, and decontamination procedures. It is required for all personnel working on-site, such as equipment operators, general laborers, electricians, plumbers, supervisors, management, etc. who may be potentially exposed to hazardous substances, health hazards, or safety hazards consistent with 29 CFR 1910.120. The course must be conducted by a qualified instructor in accordance with 29 CFR 1910.120.

C. 8-Hour Annual Refresher Training

Personnel with 40-hour health and safety training are required to attend an annual 8-hour refresher course to remain current in their training. This course must also be conducted by a qualified instructor in accordance with 29 CFR 1910.120.

D. 8-Hour Supervisor Training

On-site management and supervisors directly responsible for or who supervise employees engaged in hazardous waste operations must have eight additional hours of Supervisor training in accordance with 29 CFR 1910.120. This course includes, but is not limited to, elements appropriate to supervising hazardous waste related projects (e.g., accident reporting/investigation, regulatory compliance, work practice observations, auditing, emergency response procedures, etc.).

E. Additional Training for Specific Projects

Contractors will ensure their personnel have received additional training on specific instrumentation, equipment, confined space entry, construction hazards, etc., as necessary to perform their duties. This specialized training will be provided to personnel before engaging in the specific work activities.

F. Documentation of Training

The Contractor/Consultant Project Manager will be responsible for maintaining and providing to H&A documentation of its employees' compliance with required training. H&A will only allow properly trained and qualified personnel to perform work at the site.

3.2 MEDICAL SURVEILLANCE PROGRAM

A. Purpose

The Medical Surveillance Program is conducted to provide an initial baseline of the worker's health. Subsequent medical exams are used to monitor the worker's continued well being. The implementation of a medical surveillance program is the responsibility of the contractor/subcontractor employer.

B. Requirements

Medical surveillance is required by the Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120 (f): Hazardous Waste Site Operations and Emergency Response. The Contractor/Consultant's medical surveillance program must meet or exceed these regulatory requirements.

These regulatory requirements include the determination by a physician that the individual being examined is physically able to use respiratory protection and is able to perform the work defined within the specific job description. The capability of an individual to perform the specified work will be determined from examinations that may include:

- ☐ Medical and occupational history, and past gastrointestinal, hematologic, renal, cardiovascular, reproductive, immunological, and neurological problems as well as a history of respiratory disease and personal smoking habits;
- ☐ Physical examination, including blood pressure measurements;
- ☐ Pulmonary function test (FVC and FEV1);
- ☐ Chest x-ray;
- ☐ ECG (Electrocardiogram);
- ☐ Eye examination and visual acuity;
- ☐ Audiometry;
- ☐ Urinalysis; and
- ☐ Blood chemistry: Hematology, serum analyses, heavy metals toxicology.

C. Periodic Monitoring

All personnel are required to have a physical examination within the 12 months prior to the beginning of their work on-site. This period may be shortened if the Contractor/Consultant Medical Consultant deems this appropriate. The physician performing the physical will insure the requirements of 29 CFR 1910.120(f) are fulfilled. Documentation attesting to current medical monitoring compliance must be maintained on-site by the Contractor/Consultant Safety Officer.

3.3 SITE CONTROLS

A. Work Site Access Control

Access to client property is dependent upon site-specific conditions under owner permission and will be controlled by the Haley & Aldrich Project Manager. It will be the Contractor/Consultant Project Manager's responsibility to control access to a site by means of temporary barriers such as flagging tape or fencing. The barrier will be inspected daily for integrity and adequacy by the Contractor/Consultant Site Coordinator.

For sites requiring Level C to Level A PPE (personal protective equipment) the area of field operations will be subdivided into three distinct areas. The extent of these areas is task and location specific. Access to each zone will be controlled with fencing and/or plastic flagging tape. The three areas are defined as:

☐ Exclusion Zone

The exclusion zone is the area where the highest potential for exposure by dermal or inhalation routes exists. Personal protective equipment is required and a daily log will be kept of all personnel entering this zone. The exclusion zone will be marked off with barricades or barrier tape which will be placed a minimum of 50 feet from the active work area. This 50 foot minimum may be altered in the Task-Specific Health & Safety Requirements (Section II) depending upon actual site layout. During field operations this boundary may be expanded by the Contractor/Consultant Site Coordinator based upon observations and/or monitoring measurements. Whenever possible, all field work should be performed upwind from potential contaminant sources.

☐ Contamination Reduction Zone

The contamination reduction zone is the area immediately adjacent to the exclusion zone. The probability of dermal and inhalation exposure is lower than in the exclusion zone. Typically, contamination reduction zones include facilities for personnel or equipment decontamination. Personal protective equipment worn in the exclusion zone may not be worn outside the contamination reduction zone except during emergencies.

☐ Support Zone

Support zones cover all areas outside the contamination reduction zone. Typically, the support area includes facilities for a lunch area, office spaces, and clean equipment and material storage. Protective clothing worn in the exclusion zone may not be worn in a support zone except in emergencies. Emergency contacts are listed immediately following the Table of Contents.

B. Visitors:

☐ Visitors and subcontractors entering the site are subject to the same requirements as contractor and consultant personnel and will only be permitted in the immediate area of active operations (i.e., exclusion zone) after receiving written approval from the Contractor/Consultant Project Manager, and supplying a written agreement to comply with this HSP.

☐ A visitors log will be kept by the Contractor/Consultant Site Coordinator or other designated person.

☐ Visitor vehicles are restricted to support zones.

C. Unauthorized Personnel

All established procedures and actions are designed to prohibit unauthorized entry to the work sites. However, if security is violated, the following actions will be taken:

☐ Unauthorized personnel found within any active site will be reported to the Contractor/Consultant Project Manager, Safety Officer, and Site Coordinator, Haley & Aldrich Project Manager, and Haley & Aldrich Operations Safety Representative.

☐ Unauthorized personnel found in the exclusion zone will be escorted through the contamination reduction zone and will be subject to all decontamination procedures established in the project-specific HSP.

☐ Any unauthorized personnel entering an active site will be escorted from the facility by Haley & Aldrich Security. No re-entry will be permitted.

3.4 ENGINEERING CONTROLS

Engineering controls will be the method of preference to control health and safety hazards. Examples of engineering controls are:

☐ The use of excavation equipment to take samples from trenches;

☐ The use of cover material (soil) to suppress vapor emissions;

☐ The use of air conditioning in heavy equipment cabs to mitigate operator heat stress; and

☐ The use of ventilation equipment to eliminate hazardous atmospheres from confined spaces.

Administrative controls and personal protective equipment will be used where engineering controls are not feasible or are inadequate. Administrative controls include the exclusion of unnecessary personnel from hazardous areas. It should be noted that scheduled job rotation is not an acceptable administrative control to reduce employee exposure to airborne chemicals.

The hazard control methods to be employed must be described in the task-specific health & safety requirements where they deviate from those described here. As a project progresses, changes to these methods may be necessary. All such changes will be documented as addenda to the task-specific health & safety procedures.

A. Standard Safe Work Practices

Standard safe work practices applicable to most site activities are listed below. Additional safe work practices unique to specific site tasks must be included in the task-specific health & safety requirements

1. All field personnel must inform the Contractor/Consultant Site Coordinator or designated representative before entering work areas so that their presence can be recorded.

2. Workers must utilize the "buddy system": at least two members of the field crew (including subcontractor personnel) must be in visual contact with each other on-site whenever work is to be performed. If this is not possible, two-way radios will be used.

3. Eating, drinking, chewing gum or tobacco, smoking, or any other activity that increases the probability of hand-to-mouth transfer of contaminated material will not be permitted at the work site.

4. All personal safety equipment and protective clothing will be worn in conformance with Section 3.7 of this HSP.

5. Disposable outer coveralls, boots and gloves will be secured at the wrists and legs, and there will be closure of the suit around the neck.

6. Individuals getting wet to the skin with chemically contaminated liquids must remove clothing and wash the affected area immediately at a location to be identified in the task-specific health & safety requirements. Clothes wet with such liquids, must be changed. Any skin contact with such liquids, whether considered safe or not, will be dealt with immediately and as completely as possible. Medical attention should be sought as necessary.

7. Hands must be washed before eating, drinking, smoking and before using toilets at the facilities provided.

8. Avoid contact with surfaces either suspected or known to be contaminated, such as puddles, mud, or other discolored surfaces. Store equipment on elevated or protected surfaces to reduce the potential of incidental contamination.

9. Only remove personal protective equipment in the contamination reduction zone per Section A of Section 3.3.

10. Place all disposable coveralls, gloves, and cartridges in appropriate receptacles at the end of every shift or sooner, as directed by the Contractor/Consultant Site Coordinator.

11. Inspect all non-disposable clothing (i.e. hard hat liner, work gloves, cotton overalls) for contamination in the contamination reduction zone. Any clothing found to be contaminated will be decontaminated or disposed of in a manner approved by the Contractor/Consultant Site Coordinator.

12. Report all injuries to the Contractor/Consultant Site Coordinator, Haley & Aldrich Project Manager. An accident report or equivalent must be completed by the Contractor/Consultant Site Coordinator and submitted to the Haley & Aldrich Operations Safety Representative or Project Manager for appropriate follow-up.

13. The presence or consumption of alcoholic beverages or illicit drugs on GMC property or during the work day is strictly forbidden.

14. Spillage or splashing of contaminated materials must be prevented. Spills must be contained and follow up calls made as appropriate for the release.

15. Be alert to unsafe conditions or acts and notify the Contractor/Consultant Site Coordinator.

16. Workers need to be familiar with the work area and surroundings, including:

    - ☐ Wind direction in relation to the work area;
    - ☐ Accessibility of associates, equipment, vehicles;
    - ☐ Available communications;
    - ☐ Hot zone (areas of known or suspected contamination);
    - ☐ Site access;
    - ☐ Nearest water sources.

17. The number of personnel and equipment in the exclusion zone must be kept to a minimum.

18. Wastes generated during work activities must be disposed of in accordance with state, federal, and local, regulations.

B. Safe Work Permits/Hot Work Permits

Safe Work Permits are to be obtained from the GMC Management Operations Safety Representative before any work is done that involves:

- ☐ Entering vessels, tanks, pits, trenches, manholes, or other confined spaces.
- ☐ Exposure to toxic or infectious material or to abnormal temperatures or pressures when such exposures are outside the employee's daily routine.
- ☐ Using explosives for blasting or demolition.
- ☐ Using flammable or combustible coatings inside buildings. Application of combustible paints by brush or roller is excluded.
- ☐ Excavating and trenching.
- ☐ Working in elevated areas such as roofs.
- ☐ Using temporary heating devices.
- ☐ Working in designated safe work permit areas.

Hot Work Permits are to be obtained from the facility before any work is done that involves:

- ☐ Operating gasoline powered vehicles or equipment inside buildings.
- ☐ Cutting, welding, lead burning, tar kettles, or similar work involving open flames or very high temperatures. In explosion prone areas, this includes any potential source of ignition, such as electric hand tools.

C. Working in Confined Spaces

A confined space, as defined by OSHA, is any space having a limited means of egress which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere.

Confined spaces are also areas where occupants are rendered isolated from help in case of need. Confined spaces include, but are not limited to: Ovens, tanks, vessels, bins, boilers, ducts, sewers, pipe chases, manholes, underground utility vaults, tunnels, pipelines, excavations, and trenches.

If waste activities require entrance into a confined space, strict Health and Safety protocol must be followed. Prior to any confined space work activities, written authorization must be obtained (see Section B of Section 3.4).

1. Confined Space Entry

- ☐ A Safe Work Permit will be issued by facility prior to entry into the confined space. This permit must be completed including the signatures of the Contractor/Consultant Safety Officer and Haley & Aldrich Operations Safety Representative.

☐ Only authorized, trained personnel may enter a confined space.

☐ Open flame devices will not be used to open frozen or otherwise shut manhole covers, hatches or doors. Hot water or steam will be used to remove ice and snow holding such openings closed.

2. Confined Space Ventilation

The confined space will be ventilated to prevent the accumulation of:

☐ Flammable vapors above 10% of the Lower Explosive Limit.

☐ Concentrations of combustible dust.

☐ Toxic and other contaminants in the atmosphere above one half of the TLV.

3. Safety Concerns

A standby employee will be stationed outside the entrance to the confined space to observe or communicate with the employee at all times. Communications (visual, voice, or signal line) will be maintained between all individuals present. The standby employee will be trained and equipped to initiate rescue operation.

D. Utility Clearance

Utility clearance will be obtained by the Contractor/Consultant Project Manager from GMC Management Facilities personnel and any local utilities and the appropriate Town or Village authority before the start of any drilling or excavation conducted at the site.

☐ Other local utility clearance can be obtained by calling the toll-free hotline Dig Up Alert at (800) 962-7962 and record the "reference number" for possible future use.

☐ All utilities in the work area should be staked at least two weeks prior to the start of work.

☐ All activities must be explained in detail to the respective utility by the Contractor/Consultant Site Coordinator. For some activities, such as blasting, the utility may request to have a representative at the site to expedite emergency response.

3.5 DRILLING SAFETY

Drilling and sampling activities present several potential hazards. Minimizing these hazards requires strict adherence to safe operating procedures.

A. Drill Crews

Drillers will be responsible for the safe operation of the drill rig as well as their crew's adherence to the requirements of the project-specific HSP. The driller must ensure that all safety equipment is in proper condition and is properly used. The members of the drill crew will follow all instructions of the driller, wear all appropriate personal protective equipment, and be aware of the hazards and applicable control procedures.

B. Rig Inspection

Each day, prior to the start of work, the drill rig and associated equipment will be inspected by the driller. The following checks will be made:

☐ Vehicle condition: Check proper operation of brakes, lights, steering mechanism, and horn.

☐ Equipment storage: All equipment such as auger flights, split spoon samplers, hammers, hand tools, etc. will be properly stored in an appropriate location and will be secured before moving the rig.

☐ Wire rope, Cat Line: All wire rope, cable and Cat Line will be inspected for signs of wear such as broken wires, a reduction in rope diameter, abrasion, or signs of rust. Worn, frayed, or otherwise damaged wire, rope or cable will be replaced.

☐ Safety equipment: Each rig will have at least one fire extinguisher (Type B/C) and one First Aid Kit.

C. Rig Set-Up

Each drill rig will be properly blocked and leveled prior to raising the derrick. The rig will be moved only after the derrick has been lowered. The leveling jacks will not be raised until the derrick has been lowered.

Blocking provides a more stable drilling structure by evenly distributing the weight of the rig. Proper blocking ensures that a differential settling of the rig does not occur. Wooden blocks, at least 12 by 12 inches and four to eight inches thick, are recommended and should be placed between the jack swivels and the ground. The emergency brake will be engaged and the wheels that are on the ground chocked.

Site drilling will comply with the following rules:

☐ Before drilling, the Contractor/Consultant Site Coordinator will ensure an adequate safety zone around the drill rig and associated operations.

☐ Before drilling, the existence of underground utilities in the work area will be determined and conspicuously marked (See Section D of Section 3.4).

☐ If drilling is conducted in the vicinity of overhead power lines, proper distance will be maintained between the drill rig and the lines as per OSHA 29 CFR 1926, Subpart N. The proper distance or shielding technique will be stated in the project-specific HSP.

D. General Operating Procedures

The operator of the drill rig will only operate from the position of the controls. If the operator must leave this position, the transmission must be in neutral.

When working on the derrick platform, the drill crew should not guide drill rods or pipe into racks by taking hold of a moving line. Materials should not be stored or transported within the derrick. Pipe, drill rods, auger flights, hammers, and other drilling tools should be stored in racks and chained in place. During drilling, penetration hammers will be placed at a safe location on the ground.

E. Emergency Procedure for Electrical Contact

If a drill rig contacts an electrical line, it may or may not be insulated from the ground by its tires. Death or serious injury will result if a person touches the rig and the ground simultaneously.

☐ Under most circumstances, the operator and other personnel on the seat of the vehicle should remain seated and not leave the vehicle. Do not move or touch any part, particularly a metallic part, of the vehicle or drill rig.

☐ If it is determined that the rig should be vacated, all personnel should jump clear and as far as possible from the rig. Do not step off--jump off, and do not hang on the vehicle or any part of the rig when jumping clear.

☐ If you are on the ground, stay away from rig and do not let others get near the vehicle. Seek assistance immediately by calling the local emergency services contact. Emergency phone numbers are listed on page iii of this HSP.

3.6 EXCAVATION AND TRENCHING SAFETY

A. General Excavation and Trenching Safety

The following is a list of minimum requirements for trenching and excavating. Each excavation/trench/shoring project is different, therefore the Contractor/Consultant Project Manager is responsible for evaluating site specific conditions and making appropriate provisions in the task-specific health and safety requirements (Section II) in conformance with 29 CFR 1926 Subpart P - Excavations.

☐ Contact the proper utilities to obtain clearance. Prior to work, review the utilities in the area and be sure they have been staked properly (See Section D of Section 3.4). Before work begins, a Safe Work Permit must be obtained from (NA) Operations Safety Representative as per Section B of Section 3.4.

☐ Be aware that trenches and excavations deeper than four feet are considered confined spaces and require additional safety precautions, such as shoring. If an excavation exceeds four feet in depth, contact the Haley & Aldrich Operations Safety Representative to review the original Safe Work Permit and ensure that it is adequate.

☐ The walls and faces of all excavations and trenches more than four feet deep, in which an employee is exposed to danger from moving ground, will be guarded by a shoring system, sloping of the ground, or some other equivalent means. The design of shoring systems must be done by a registered Professional Engineer as per 29 CFR 1926 Subpart P.

☐ For excavations or trenches in which an employee may be required to enter, excavated or other material will be effectively stored and retained at least two feet or more from the edge of the excavation or trench.

☐ Daily inspections of excavations will be made by the Contractor/Consultant Site Coordinator. If evidence of possible cave-ins or slides is apparent, all work in the excavation will cease until the necessary precautions have been taken to safeguard employees.

☐ Trenches more than four feet deep will have ladders or steps located so as to require no more than 25 feet of lateral travel.

☐ Hard hats and other personal protective equipment will be worn at all times during any type of excavating or trenching operation.

☐ Determine soil composition (e.g., through soil sampling, soil maps, etc.) and other relevant site conditions, with special emphasis on conditions conducive to cave-ins.

☐ Monitor the atmosphere in and around trenches on a regular basis to check for explosive, toxic or otherwise dangerous gases and vapors.

☐ The Contractor/Consultant Project Manager will insure that all employees involved in the excavation activity have appropriate training in safe trenching practices, with emphasis on factors such as:

- utility line identification
- cave-in prevention measures
- recognition of conditions which may cause cave-ins
- means of egress from trench

☐ Water will not be allowed to accumulate in any excavation. Utilize ditches, dikes, pumps, or other means to keep surface water out of trenches.

☐ All open excavations must be well marked and barricaded.

B. Cave-In Hazards

The following conditions increase the likelihood of cave-in:

- ☐ Soil materials composed of unconsolidated, uncompacted, and/or rounded particles (See 29 CFR 1926 Subpart P - Excavation Standard). Special care must be used when trenching in areas which have previously been excavated and backfilled.
- ☐ Soils which have a high water content, or have been subjected to freeze-thaw or frost-heaving.
- ☐ Loading of trench walls by adjacent equipment, supplies, structures, "back-dirt" piles, etc.
- ☐ Vibration due to equipment operating near excavations.
- ☐ Trench walls that are steeper than the angle of repose of the material composing the walls.
- ☐ Deep trenches (i.e., high trench walls).

The following precautions should be used to prevent cave-ins in all trenches in excess of 4 ft. deep. These precautions should also be used in trenches less than 4 ft. deep whenever those site conditions just listed indicate the likelihood of a cave-in:

- ☐ Sloping: Trench walls should be sloped to the correct angle of repose.
- ☐ Shoring: Vertical trench walls (unless composed of solid rock) must be shored and braced, or restrained with movable trench boxes, to prevent cave-in. Shoring systems must be designed by a registered professional engineer and meet accepted engineering requirements.

3.7 PERSONAL PROTECTIVE EQUIPMENT

Protective clothing and respiratory protection help protect workers from chemical hazards. Although personal protective equipment is the least preferred method, it may be necessary if engineering controls and work practices are inadequate in preventing workers from coming in contact with potential hazards. Personal protective equipment (PPE) will be selected for the potential hazards anticipated and detailed in the task-specific health & safety requirements.

Personnel at the work site will have their own appropriate and properly fitted safety equipment and protective clothing. Safety equipment and protective clothing will be used as directed by the Contractor/Consultant Safety Officer. All such non-disposable equipment and clothing will be kept clean and maintained in proper condition. All PPE will be supplied by the contractors and their subcontractors. Haley & Aldrich will only provide PPE to Haley & Aldrich employees. Personnel will be trained in the use of the required protective equipment and equipment will be properly fitted. The levels of protection to be used on-site will be based on applicable OSHA and Environmental

Protection Agency (EPA) regulations, GMC requirements, environmental sampling data, site conditions, and other factors. It will be the responsibility of the Contractor/Consultant Safety Officer to select the most effective PPE based on the anticipated hazards of the task.

A. Levels of Protection

The following is a description of the specific requirements of various levels of PPE in conformance with EPA nomenclature.

1. Level A Protection

Level A provides the highest level of respiratory and skin protection. Based on site contaminants, historical sampling, and operational data, utilization of this level of protection is not anticipated. This level of protection is anticipated only in extreme situations beyond the scope of this document, (i.e., HazMat Response).

2. Level B Protection

Level B should be worn when the highest level of respiratory protection, but a lesser level of skin protection, is required. It is the minimum level of protection required to conduct any initial field work. Once sampling data (soil, water, or air) has been collected and analyzed, the necessity of this level of protection may be re-evaluated, ***as set forth in Table 2.***

Level B Personal Protective Equipment (not limited to the following):

☐ Supplied-air respirator (MSHA/NIOSH approved):

a) Pressure-demand, self-contained breathing apparatus

or

b) Pressure-demand, airline respirator with escape bottle.

☐ Chemical protective clothing: Chemically resistant to anticipated contaminants, (e.g. Saranex or polyethylene coated Tyvek, Chemrel, or Chem-Tuff).

☐ Gloves (outer): Chemically resistant to anticipated contaminants.

☐ Gloves (inner)

☐ Boots (outer): Chemically resistant to anticipated contaminants.

☐ Hard hat*

☐ 2-Way radio communications* (intrinsically safe).

☐ Joints between gloves, boots, and suit must be taped to ensure an adequate seal.

* The need for these items is dependent upon the work to be performed and will be chosen by the Contractor/Consultant Safety Officer.

3. Level C Protection

Level C protection with an air-purifying respirator should be worn routinely in an atmosphere only after the air contaminant(s) is (are) identified, concentrations measured and the criteria for wearing air-purifying respirator met. Generally, Level C provides the same level of skin protection as Level B, but a lesser degree of respiratory protection.

<u>Level C Personal Protective Equipment</u>:

☐ Air-purifying respirators, full-face, (half-face with appropriate safety glasses or goggles when potential for liquid splashes is low), canister or cartridge equipped (MSHA/NIOSH approved).

☐ Chemical protective clothing: Chemically resistant to anticipated contaminants, e.g. Saranex or polyethylene coated Tyvek, Chemrel, or Chem-Tuff.

☐ Gloves (outer): Chemically resistant to anticipated contaminants.

☐ Gloves (inner).

☐ Boots (outer): Chemically resistant to anticipated contaminants.

☐ Hard hat*

☐ 2-Way radio communications* (intrinsically safe).

☐ Joints between gloves, boots, and suit must be taped to ensure an adequate seal.

* The need for these items is dependent upon the work to be performed and will be chosen by the Contractor/Consultant Safety Officer.

Criteria for Selection of Level C:

Meeting all of the following criteria permits use of Level C protection:

☐ Oxygen concentrations not less than 19.5% or no greater than 22% by volume.

☐ Personnel inhalation exposure will be reduced by the respirator below the substance's Threshold Limit Value (TLV)/Permissible Exposure Limit (PEL) or XEL, whichever is lowest and the concentration is within the service limit of the canister/cartridge.

☐ Atmospheric contaminant concentrations do not exceed IDLH levels, (See Table 1).

☐ Atmospheric contaminants, splashes, or other direct contact will not adversely affect any body area left unprotected by chemically resistant clothing.

☐ Job functions do not require self-contained breathing apparatus.

☐ Atmospheric contaminant concentrations are not in excess of Level C action criteria, (See Table 2).

4. Level D Protection

Level D is the minimum level of protection to be used during any site activities and does not provide respiratory or skin protection.

Level D Personnel Protective Equipment:

☐ Coveralls or work uniform.

☐ Gloves*

☐ Substantial leather chemical-resistant boots or shoes (steel toe and shank is highly recommended).

☐ ANSI Z87 safety glasses.

Chemical splash goggles*.

☐ Hard hat*.

☐ Disposable/reusable footwear covers*

* The need for these items is dependent upon the work to be performed and will be chosen by the Contractor/Consultant Safety Officer.

Criteria For Selection of Level D:

Meeting any of these criteria allows use of Level D protection:

☐ No contaminants are present.

☐ Work functions preclude splashes, immersion, or potential for unexpected inhalation of any hazardous chemicals.

Level D protection is a minimum work uniform. It can be worn only in areas where the possibility of contact with contamination is minimal.

B. Personal Protective Equipment (PPE) Selection

PPE selection will be based on the task and the nature of hazards (type of contaminants, duration of exposure), engineering controls, and the work practices that are anticipated. The selected equipment will provide protection from the chemicals suspected to be present and which demonstrate the potential for skin exposure. The PPE chosen for each task will be specified in the task-specific health & safety requirements.

C. Changes in PPE

The Contractor/Consultant Safety Officer will make the decision to upgrade or downgrade the levels of protection. The decision will be primarily based on the results of the air monitoring performed during site activity.

3.8 AIR MONITORING

A. Air Monitoring Scope

The Contractor/Consultant Site Coordinator will ensure periodic air monitoring is conducted during site operations. Should any monitoring indicate concentrations in excess of established action levels, the Contractor/Consultant Site Coordinator will notify Contractor/Consultant Safety Officer and will implement appropriate action to protect project personnel, Haley & Aldrich employees, and the nearby community.

Periodic air monitoring for volatile compounds will be performed during the activities for which inhalation has been identified as a potential exposure route. These activities include, but are not limited to:

☐ Drilling and soil sampling.

☐ Excavation of contaminated soil for remediation.

☐ Construction activities involving excavation in areas of known or potential soil or groundwater contamination.

☐ Pump tests where organic vapors were detected during well installation or water samples.

☐ Well sampling and hand bailing.

The Contractor/Consultant Site Coordinator should make use of both real time direct reading instruments and laboratory analysis of samples obtained by either grab, filter, sorbent, or wet contaminant collection techniques to measure chemical concentrations. Specific equipment is described in Section D in Section 3.8 of these Requirements.

B. Sample Locations

1. Personal Monitoring

Personal monitoring will take place at times proposed by the Contractor/Consultant Safety Officer or Site Coordinator and specified in the task-specific health & safety requirements. In scheduling personal monitoring, consideration will be given to collecting samples at times of maximum potential exposure. Samples will be collected in the employees' breathing zone (9 inch radius hemisphere centered at the nose and forward of the shoulders) utilizing direct reading instruments, flow controlled personal sampling pump, or diffusion type dosimeters.

Scheduled personal samples utilizing sampling pump/sorbent tubes or diffusion type dosimeters should be used to collect full-shift exposure data. If the active operations do not require a full shift work schedule, the sample should be collected for the duration of the active operations. Emphasis should be placed on sampling employees in the exclusion zone, however, employees involved in decontamination procedures will be sampled as well. Additional requirements for personal sampling will be specified in the task-specific health and safety requirements.

Non-scheduled personal samples will be collected as directed by the Contractor/Consultant Safety Officer.

2. Perimeter ***and Community Air*** Monitoring

Real-time air monitoring for volatile organic compounds will also be conducted on a regular basis (e.g., ***every 30 minutes***) at the upwind and downwind site perimeters (exclusion zone as described in Section A in Section 3.3) ***to provide for community health protection***. If total organic vapor concentrations attributable to excavation, drilling or other activities conducted at the site, exceed, ***at the perimeter, a level of***

5 ppm above background breathing zone concentrations, then work activity must be halted and monitoring continued. ***Engineering controls will be instituted as appropriate to abate detected levels.*** If organic vapor concentrations remain sustained at the perimeter, work activities will remain halted and air samples taken to determine the chemical species present. ***Notification of regulatory agencies (NYSDEC and NYSDOH) will also be performed.*** The air samples may be analyzed on-site with a portable GC. Work activities at the site will proceed only after the following conditions are met:

☐ Sustained organic vapor levels at the perimeter fall below the ***5 ppm limit***, or

☐ The concentration of the organic compounds obtained from the air sampling are within their TLV's.

C. Sample Methods

1. Integrated Sampling

The Contractor/Consultant Safety Officer will determine if there is a project specific need for integrated sampling and include a detailed sampling plan in the task-specific health & safety requirements.

2. Real Time Sampling

Real time monitoring will be conducted with a photoionization detector equipped with an 11.7 eV lamp or a flame ionization detector as specified in the task-specific Health & Safety section (see Section C in Section 2.2). These instruments are capable of detecting the volatile organic chemical compounds identified in Table 1 to an approximate lower detection limit of 1 ppm. The OSHA TLV's for the compounds listed in Table 1 are at or above the detection limit of the proposed equipment. The rapid response of these instruments allows for quick determination of airborne concentrations and therefore, subsequent changes in the safety procedures can be implemented if needed (See Section D in Section 3.8). Refer to Section C in Section 2.2 for frequency of environmental monitoring.

D. Air Monitoring Equipment

1. Direct Reading Instruments

The instruments used for air monitoring activities may include, but are not limited to, those listed below. The Contractor/Consultant Safety Officer will make the decision as to which instruments must be on a project specific basis.

☐ A flame ionization detector (FID) equal or superior to Foxboro organic vapor analyzer (OVA) Model 128.

☐ A combustible gas indicator/oxygen meter equal or superior to MSA Model 260 or 360.

Note: During environmental activities, the potential for creating a flammable atmosphere will be monitored, (e.g., prior to confined space entry, initial operations with atmospheres having the potential to exceed IDLH.) Please refer to Table 2 of this HSP for Action Levels.

Each instrument must be intrinsically safe where warranted. Each will be calibrated and maintained in accordance with the manufacturer's recommendations. Calibration records will be maintained in a daily field logbook.

2. Integrated Sampling Equipment/Techniques

Variable flow, belt mounted personal sampling pumps may be used in conjunction with the appropriate sample media to provide exposure estimates where real time analysis is inadequate. The following equipment/techniques may be used:

☐ Diffusion or Permeation Type Dosimeters

☐ Analysis of Sorbents

3. Specialized Monitoring Equipment and Analyses

Specialized sampling instruments and analyses (e.g.,H_2S monitors, solid sorbents, sampling bags) will be used on project sites on an "as needed" basis as determined by the site conditions, sampling history at the site, and the type of work to be performed. The Contractor/Consultant Safety Officer will determine the need for specialized equipment or analyses on a project specific basis and include thorough descriptions of sampling plans/procedures and equipment operation and maintenance in the task-specific health & safety requirements.

4. Spare Monitoring Equipment

Appropriate spare monitoring equipment will be made available either on the Project Site or at a location in the project area, as determined by the Contractor/Consultant Safety Officer. The location of spare equipment will be included in the task-specific health & safety requirements. Field activities will be suspended if the properly calibrated field monitoring instrumentation is not available.

E. Record Keeping

A Field Logbook will be maintained by the Contractor/Consultant Site Coordinator. It will be updated daily. The entries will include:

☐ Task description and date

☐ Location of work site

- ☐ Personnel involved:
  - ➤ Name
  - ➤ Function
  - ➤ Level of personal protection (any change in level of protection will be recorded at the time of implementation)
- ☐ Health and Safety instrumentation calibration:
  - ➤ Instrument name (OVA, LEL, etc.)
  - ➤ Serial number
  - ➤ Calibration information (i.e. calibration gas)
  - ➤ Instrument setting (OVA span set)
  - ➤ Time of calibration
- ☐ Meteorological information
  - ➤ Type of day (sunny, cloudy, rain, etc.)
  - ➤ Wind speed and direction (estimate)
  - ➤ Temperature
- ☐ Events of the day in chronological order.
- ☐ Health and safety instrumentation readings
  - ➤ Breathing zone concentrations
  - ➤ Time
  - ➤ Sample concentration with corresponding identification number
- ☐ Any unusual occurrences, problems or observations
- ☐ Signature of writer

Field Logbook Health and Safety entries, data sheets, etc. will be reviewed by the Contractor/Consultant Safety Officer on a regular basis. Upon review, each log book will be signed to demonstrate that the data has been reviewed and approved.

F. Summary of Action Levels

Project action levels will be determined by the Contractor/Consultant Safety Officer based upon site conditions and information and will be presented in the task-specific health & safety requirements. The levels defined in Tables 1 and 2 of this HSP will serve as guidelines for project action levels.

3.9 HEAT AND COLD STRESS

A. Heat Stress

Heat stress occurs in several forms. By order of increasing severity, they are:

1. Heat Rash
2. Heat Cramps
3. Heat Exhaustion
4. Heat Stroke

The potential for a worker to develop heat stress is related to the ambient temperature, relative humidity, and the nature of the work being performed. The Contractor/Consultant Safety Officer must include project specific information on heat stress identification, care and prevention procedures in the task-specific health & safety requirements (Section 2).

B. Cold Stress

Cold stress, as well as heat stress, occurs in different forms. By order of increasing severity, they are:

1. Trench Foot
2. Frostbite
3. Hypothermia

The potential for a worker to develop cold stress is related to the ambient temperature, wind chill, protective clothing, and the nature of the work being performed. The Contractor/Consultant Safety Officer must include project specific information on cold stress identification, care and prevention procedures in the task-specific health & safety requirements (Section 2).

3.10 DECONTAMINATION

Personnel and equipment are subject to decontamination procedures when exiting the exclusion zone. No contaminated material will be removed from the exclusion zone without undergoing proper decontamination procedures.

A. Personnel Decontamination

No personal protective equipment will be removed from the exclusion zone without proper decontamination or placement in a disposal receptacle.

Specific personal decontamination procedures must be detailed in the task-specific health & safety requirements (Section 2). The following are guidelines for developing personnel decontamination procedures contained in the task-specific health & safety requirements (Section 2):

1. Tools, etc. will be dropped off onto a plastic sheet in the exclusion zone for subsequent re-use or decontamination.

2. The boot wash station will consist of two plastic or metal tubs, two garden sprayers, and a boot brush. One sprayer will contain a detergent water mixture, the other will contain clean water.

3. The outer layer of disposable protective clothing will be removed by removing outer boots, outer gloves, hood, tape, etc., and placed in a receptacle for disposal. Clothing will be removed by "peeling" off while turning it inside-out. This will minimize contact with possible contamination on the outer surface.

4. Respirators will be removed and cartridges placed in a receptacle for disposal.

5. Inner gloves will be removed by rolling off the hand while turning them inside-out and placed in a receptacle for disposal.

6. If highly toxic, skin-corrosive or skin-absorbable materials are known or suspected to be present, personnel must shower before exiting the site.

   NOTE: The Contractor/Consultant Site Coordinator will ensure established personnel decontamination procedures are properly implemented and enforced.

B. Equipment Decontamination

Equipment, including drill rigs, will arrive at the site free of debris and contamination. Equipment will be cleaned and decontaminated before departure from the site. Decontamination chemically contaminated equipment will be performed at a minimum of Level C protection for steam cleaning and hydro-washing.

Specific equipment decontamination procedures will be based upon the type of work being performed and anticipated levels of contamination. The following items are guidelines for the establishment of equipment decontamination procedures to be included in the task-specific health & safety requirements:

1. All equipment that has been in the exclusion zone or the contamination reduction zone will be visually inspected and/or wipe sampled to assess the extent of contamination.

2. Sensitive instrumentation should be handled in a manner which will minimize the potential of exposure to hazardous soils and liquids. This care in handling will greatly reduce the amount of decontamination required. Should the conditions in the exclusion zone present an extreme potential for contamination, instrumentation may be wrapped in plastic.

3. All hand tools, safety equipment, and heavy equipment will be decontaminated before leaving the site. (e.g. high pressure, low volume hot water washed, steam cleaned, brushed with low phosphate detergent, and water rinsed.)

4. Heavy equipment must have visible residues removed in the exclusion zone. Wheels, wheel wells and cabs of vehicles must be cleaned before equipment is removed from the exclusion zone. The equipment may then be moved to a more centrally located decontamination pad for more extensive decontamination. This move must be accomplished in a manner that will prevent the spread of

contamination along the travel path. A detailed plan for necessary equipment relocation must be included in the task-specific health & safety requirements (Section 2).

5. If warranted and required by the Project Work Plan, samples such as equipment blanks will be taken and submitted for project related analysis to confirm the decontamination procedures.

C. Location of Decontamination Areas

Decontamination areas for project equipment and personnel will be designated by the Haley & Aldrich Project Manager by the following guidelines:

☐ Each decontamination area will be sited to have access to water and electrical (GFCI protected) supplies as necessary for the decontamination process.

☐ Access to the decontamination area(s) will be limited and controlled.

☐ The specific decontamination area(s) for each project will be clearly defined in the task-specific health & safety requirements.

UNDERGROUND
ENGINEERING &
ENVIRONMENTAL
SOLUTIONS

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HALEY &
ALDRICH

14 July 2003
File No: 70753-002

New York State Department of Environmental Conservation
Region 8
6274 E. Avon-Lima Road
Avon, New York 14414

Attention: Frank Sowers, P.E.

Subject: Voluntary Cleanup Agreement Work Plan ***Addendum***
For Implementation of Monitored Natural Attenuation (MNA)
99 Ridgeland Road
Henrietta, New York 14444

Dear Mr. Sowers:

This letter serves as an addendum to the Voluntary Cleanup Agreement "Work Plan For Implementation of Monitored Natural Attenuation" (MNA Work Plan), dated January 2003. This addendum details an active sub-slab depressurization system intended for installation at the above referenced site. The installation of the sub-slab depressurization system is in response to a request made by NYSDOH during discussions with NYSDEC concerning approval of the MNA Work Plan. In our discussions with you during May and June 2003 regarding agency review of the MNA Work Plan, we understand NYSDOH requested additional work with respect to sub-slab soil vapor at the facility.

We understand that NYSDOH requested that either soil vapor confirmation sampling or installation of a sub-slab depressurization system in the area of known soil contamination, be performed to allow approval of the MNA Work Plan. Considering the cost of soil vapor sampling and the fact that the NYSDOH could not provide specific guidance on soil vapor comparison criteria in the event VOCs were detected, the volunteer has agreed to pursue the installation of a sub-slab depressurization system. The intended system is described below.

The system consists of a vent with an in-line regenerative blower that will draw air from beneath the concrete slab effectively lowering the sub-slab air pressure relative to the indoor air pressure. This system will facilitate the collection of sub-slab soil vapor to prevent potential VOC migration to indoor air, and safely vent the vapor to the atmosphere. The system will be installed in the central corridor in the vicinity of monitoring well B-103-OW (see Figure 1 attached). This area of the building is common to the separate leased space in the building and represents the only readily accessible installation location.

OFFICES
Boston
Massachusetts
Cleveland
Ohio
Dayton
Ohio
Denver
Colorado
Detroit
Michigan
Hartford
Connecticut
Los Angeles
California
Manchester
New Hampshire
Newark
New Jersey
Portland
Maine
San Diego
California
Tucson
Arizona
Washington
District of Columbia

Groundwater from B-103-OW historically contained concentrations of the following site compounds of concern: TCE, cis-DCE and VC (see the *Revised* Report on VCA Investigations, dated October 2002). Recall that past air quality sampling did not detect any of these compounds in either indoor air or ambient outdoor air. Regardless, the system will be installed and will exhaust soil vapor from below the building footprint.

The system is shown on Figure 1. The original building is single slab-on-grade construction. We understand that a passive sub-slab vent system was installed below the new building addition to the south constructed in 2002-2003.

The proposed sub-slab depressurization system will be installed as follows. A 3-inch diameter hole will be cut through the concrete floor to a depth of 1-inch below the slab into the sub-slab granular fill. A 3-inch PVC pipe will be installed to conduct soil vapor vertically from below the slab to the utility space above the drop ceiling and then horizontally piped to an exhaust point on the west sidewall of the building. The vent pipe will be extended above the roofline and terminated with a rain cap.

An in-line regenerative blower (110v) will be installed above the ceiling. All components of the system will be in compliance with applicable mechanical, electrical, building, plumbing, energy and fire prevention codes, standards, and regulations of the local jurisdiction. Subsequent to system installation, sub-slab pressure will be measured using a digital manometer to verify that that the system lowers sub-slab pressure below the building ambient interior pressure. Sub-slab pressure will be tested through one or more additional ports drilled through the slab in the hallway. Sub-slab pressure will be checked two times per year during groundwater sampling events. Sub-slab pressure readings will be reported in semi-annual and annual reports submitted according to the MNA Work Plan.

We trust this Addendum will meet the expectations of NYSDOH and NYSDEC. If so, we request that NYSDEC issue an approval letter for the MNA Work Plan and this Addendum. We anticipate installation can be completed within 1-3 weeks of receipt of NYSDEC's written approval.

If you have any questions or concerns please do not hesitate to contact us.
Sincerely yours,

HALEY & ALDRICH OF NEW YORK

Jonathan D Babcock

Glenn M. White
Environmental Scientist

Jonathan D. Babcock, P.E.
Senior Engineer

Vincent B. Dick
Vice President

STATE OF NEW YORK
JONATHAN D. BABCOCK
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LICENSED PROFESSIONAL ENGINEER

Attachment: Figure 1 – Sub-slab Depressurization System Detail

Xc: Gunter Borrosch, American Seipmann
Paul Sylvestri, Esq., Harter, Secrest & Emery

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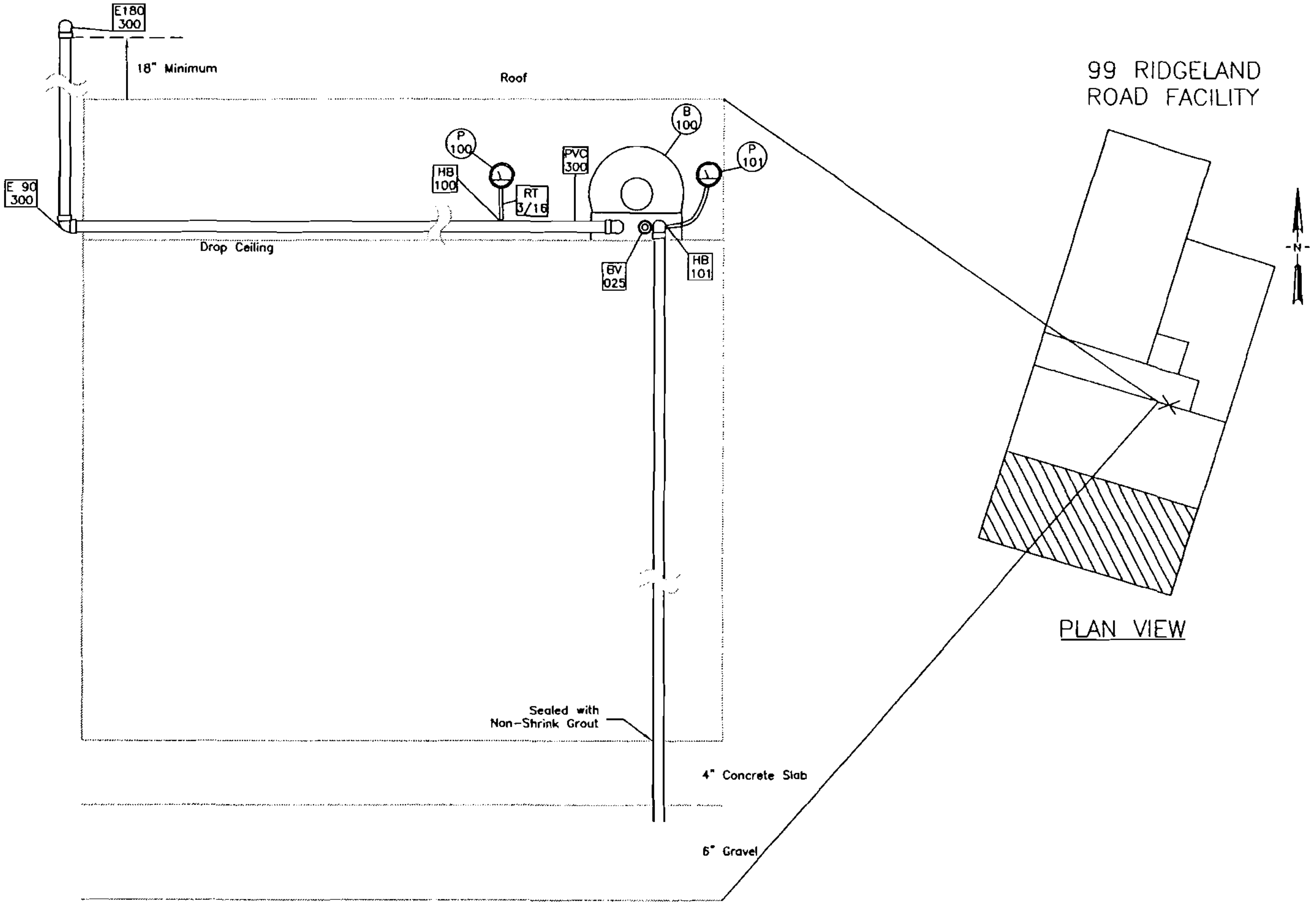

PROFILE VIEW

PLAN VIEW

Mechanical and Instrumentation Schedule

PIPE

TAG	ITEM DESCRIPTION
PVC 300	3" Diameter Pipe Schedule 40 PVC
RT 3/16	3/16" ID Tygon Tubing

BLOWER

TAG	ITEM DESCRIPTION
B 100	Regenerative Blower Grainger Stock #4Z749 0-19.5 CFM/0-15 in. Water

FITTINGS

TAG	ITEM DESCRIPTION
E90 300	3" Diameter 90° Elbow Schedule 40 PVC
E180 300	3" Diameter 180° Elbow Schedule 40 PVC
HB 100	3/16" OD Brass Hose Barb
BV 025	1/4" Ball Valve with Hose Barb

GAUGES

TAG	ITEM DESCRIPTION
PI 101	Magnehelic Pressure Gauge (Suction) Grainger Stock #1W479 0 to −20 In. Water Column
PI 100	Magnehelic Pressure Gauge (Discharge) Grainger Stock #1W479 0 to 20 In. Water Column

KEY:

☐ Original building, single slab-on-grade construction

▨ Building addition, constructed 2002-2003

HALEY & ALDRICH

HARTER SECREST & EMERY
99 RIDGELAND ROAD SITE
HENRIETTA, NEW YORK

SUB-SLAB DEPRESSURIZATION
SYSTEM DETAIL

DRAWING NOT TO SCALE

JULY 2003

FIGURE 1