NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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Via E-mail and Regular Mail

June 15, 2018

Erez Halevah
President
American Cleaners Inc.
Route 211E
Middletown, NY 10940

Re: Remedial Action Work Plan (RAWP)
American Cleaners Inc. Site No: V00461
Middletown, Orange County

Dear Mr. Halevah,

The New York State Department of Environmental Conservation (Department) in consultation with The New York State Department of Health (NYSDOH) has reviewed Remedial Action Work Plan (RAWP) dated January 2018 and is hereby approved.

Attached is a copy of the Department's Decision Document (DD) for the site. Please ensure that a copy of the approved RAWP and DD is placed in the document repository(ies).

The Department requests that a pre-construction meeting (at the site) be scheduled with the project consultants and subcontractors just prior to commencing the implementation of the approved RAWP. Also American Cleaners must not undertake any field activity pursuant to the RAWP until the Department has issued a fact sheet announcing the commencement of the remedial action. Please provide the Department at least three weeks' advance notification of your expected mobilization date to enable a fact sheet to be prepared and distributed.

If you have any questions, please contact Parag Amin at 518-402-9648 or write at parag.amin@dec.ny.gov.

Sincerely,

George W. Heitzman, P.E.
Director, Remedial Bureau C
Division of Environmental Remediation

Enclosure:

ecc w/encl: J. Jansen, Jansen Engineering, PLLC (jolanda@jansen-engineering.com)
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ENGINEER'S REPORT

REMEDIAL ACTION WORK PLAN: GROUNDWATER ENHANCED BIOREMEDIATION Operable Unit #2

for

AMERICAN CLEANERS, INC.
360 Route 211 East
Middletown, NY 10940

NYSDEC Site Number V-00461-3

January 2018

Prepared by:

Jansen Engineering, PLLC
72 Colburn Drive
Poughkeepsie, NY 12603

and

Mid-Hudson Geosciences
1003 Route 44/55
P.O. Box 32
Clintondale, NY 12515-0032

I, Jolanda G. Jansen certify that I am currently a NYS registered professional engineer and that this Remedial Action Work Plan RE: Groundwater Enhanced Bioremediation was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

1/10/2018

Jolanda G. Jansen, P.E.
NYS Lic. No. 068972-1

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1.0 Introduction and Purpose

The American Cleaners site at Middletown, NY has been in the volunteer cleanup program since December 2001. Since 2012 significant progress has been made in evacuating the level of tetrachloroethylene (PCE) contamination in sub-slab soil and vapor conditions beneath the concrete floor. A sub-slab soil vapor extraction system with one-horsepower regenerative blower and carbon treatment was installed on September 24, 2012 as a remedy for cleanup of the soil vapor and soil beneath the building The soil and soil vapor is considered Operating Unit #1 (OU#1). Groundwater which is outside the footprint of the building is defined as Operating Unit #2 (OU#2). Cleanup of groundwater by natural attenuation has not been effective, although PCE-breakdown products have been observed in the groundwater.

Groundwater was sampled in 2010 and 2012. At those times the highest Tetrachloro-ethylene (PCE) concentrations were detected in samples from MW26 at 2600 and 2200 µg/L. In those samples and others from the same sampling event, small concentrations of PCE breakdown products such as cis-1,2-Dichloroethylene (cis12DCE) and Trichloroethylene (TCE) were detected. The presence of the breakdown products suggested that there were natural bacteria breaking down the PCE. Most recently (April 13, 2017), PCE was detected at 1800 µg/L in MW26. Comparison of the spatial distribution of concentrations over the period of 2010 to 2017 indicates that the configuration and location of the PCE plume has changed very little. Concentrations have declined, but not sufficient to predict cleanup by natural attenuation within a decade. For that reason with respect to time and space, an effective and speedy remedy is sought to cleanup the existing levels of PCE in the plume.

1.1 Site Description

American Cleaners of Middletown is actually located in the Town of Wallkill, about 0.4 miles east of the Middletown City Boundary at 360 Route 211E at the Caldor-Lloyds Mall (Figure 1-1). The Town of Wallkill is the shopping center for central and western Orange County because most of the shopping and commercial development in the 1980s to present has occurred in the Town, which geographically wraps around the northern, northwestern and northeastern area of the City of Middletown.

The Orange County Real Property Tax map location of the American Cleaners site is designated as Section 50, Block 2, Lot 36.2, an area of approximately 0.435 acres in the Town of Wallkill, NY. The American Cleaners building is located on the Caldor-Lloyds Mall in the northwest corner of the Mall property. The mall area is on the south side of Route 211 East and is accessible via Schleman Road. At Route 211, Schleman Road on the south side becomes Silver Lake-Scotchtown Road on the north side. Upon entering the Mall on Schleman Road, American Cleaners is to the right (west). The Caldor Mall and American Cleaners is also accessible from Carpenter Avenue.

The Caldor-Lloyds Mall lies on land with a slope to the north toward Route 211, so that the major buildings for Caldor and Lloyds were overlooking the main road and parking areas were in front of the buildings on land sloping to the north. At the time in 1982

when the American Cleaners building was constructed, Lloyd's Store was located less than 0.02 miles from the northwest corner. Lloyds was an original all-in-one grocery store and department store under one roof with gasoline and an automotive service department built in the early 1960s. Lloyds went out of business in 1996 and was demolished by 2001 as shown on air photos. The main Caldor Building is located south and east of American Cleaners facing north toward NYS Route 211. Friendly's Ice Cream and Restaurant is located to the east directly in front of the Caldor Building. Caldor went out of business several years ago and the majority of the building has been vacant for some time. Neighboring properties include MHV Credit Union to the northeast within the Caldor Mall. To the northwest, Cheeseburger Paradise (now vacant) and a former Video Store (now vacant) were constructed in the 1990s in part of the old Lloyd's parking lot. The location of the original Lloyd's store is now mostly parking lot with another Bank Building on the west end and a Shop Rite grocery store farther to the west.

During construction of Cheeseburger Paradise and the Video Store, additional fill was used to raise the elevation of the land surface where the buildings and parking lots are located. Consequently, the slope between those two buildings and Route 211 is steeper than before and considerable storm drainage infrastructure was installed to collect sheet runoff from the roof drains and parking lots. The storm water flows out of a large opening next to Route 211 and the northeast corner of the Cheeseburger Paradise parking lot and the northwest corner of the MHV Credit Union parking lot. Another drainage pipe conducts subsurface drainage from American Cleaners beneath a gully between the parking lots. When the drainage emerges at the surface, the water flows as a steam a few hundred feet east and then goes under Route 211 and joins a stream flowing northeast toward Silver Lake. The elevation of Silver Lake is shown as 518 feet above mean sea level on the USGS Middletown 7.5 minute quadrangle Figure 1-1). The ground elevation the Caldor building is approximately 580 feet and at the American Cleaners building is about 550 feet.

1.2 Site History

In 1982, Mr. Halevah designed and constructed a one-story building, specifically for operation of a dry-cleaning establishment (Figures 1-2 and 1-3). From 1982 to date, the building has been in continuous operation for dry-cleaning, customer drop-off, and customer pick-up. The design for dry-cleaning services was planned with a customer counter across the front of the store and five 4-feet deep by 5-feet wide trenches running from the front of the store to the rear. The trenches are designed to provide maximum hanging capacity on three tiers of clothes rods running from front to back. The clothes-hanger rods can be reached by the employees to store and retrieve customers' garments. Cleaning, washing, drying, steaming and pressing equipment is placed around the perimeter of the store.

The chemical of concern, Tetrachloroethylene (or tetrachloroethene or perchlorethylene and known in the vernacular as "perc" or "PCE"), has been used at the site since 1982. Unintentional and unregulated releases of PCE began in 1982 when PCE-saturated filters were placed in the dumpster outside the back of the building for disposal with

trash and garbage. The dry-cleaning processing equipment was updated periodically on the following schedule:

1982-1992 First Generation Equipment
1992-1997 Third Generation Equipment
1997-Present Fourth Generation Equipment

Starting in 1982, the PCE used in dry-cleaning operations was delivered in 55-gallon drums. The PCE was pumped from the drums into the "washers." At some time in the 1980s, delivery of PCE changed to delivery by truck with a hose transferring PCE from the truck to the dry-cleaning machines. Truck delivery of PCE is similar to that of fuel oil and the driver sets up the hose and monitors the operation from the truck. On one delivery occasion, the hose nozzle broke and an unknown quantity of PCE was spilled on the asphalt near the back door of the building. The spilled PCE flowed downslope on the parking lot and pooled at the northern curb of the parking lot about 35 feet away from and parallel to the north wall of the building. The use of PCE was approximately 75 to 100 gallons per week from 1982 until 1997. Since 1997, American Cleaners at Middletown has used less than 200 gallons of PCE per year because "fourth-generation" technology has greatly reduced the use. At some time, the PCE delivery method changed from tank trucks back to 55-gallon drums, probably coincident with the installation of "fourth-generation" equipment.

In 2000 the underground storage tank (UST) for fuel oil storage at the back of the building was replaced with a new tank closer to the north end of the building (for locations see Figure 5-1). A site investigation and post-excavation sampling indicated the presence of petroleum contamination, resulting in a spill reported to NYSDEC Region 3 (Spill No. 9912516). The spill was cleaned up as mentioned below.

1.3 Previous Investigations

Original investigations were conducted at the site by HRP while replacing an underground storage tank, excavating soil from the old tank location and installing a tank in a new location. Both heating oil tank locations were at the back of the American Cleaners building. The old tank was closer to the back door and the new tank is closer to the northwest corner of the building. Shortly after the tank replacement, Anson Environmental conducted a study of the extent of PCE contamination. Those early reports included:

- Phase I Environmental Site Assessment for Caldor Shopping Center, by HRP Associates (October 1999)
- Phase II Environmental Investigation Report By HRP Associates assisted by Anson Environmental (April 18, 2000) including documentation of March 4, 2000 replacement of heating oil UST.

The RIR prepared by Mid-Hudson Geosciences (2010) was based in part on previous work documented in the following work plans and reports prepared by Berninger Environmental:

- Site-Specific Health and Safety Plan (Berninger, September 2002)
- Voluntary Investigation Work Plan (Berninger, March 2003)
- Voluntary Cleanup Program Interim Report (Berninger, Nov 2003)
- Voluntary Cleanup Program Report (Berninger, April 2006)
- Supplemental Investigation Work Plan (Berninger, May 2008)
- Proposed Supplemental Investigation Work Plan (Berninger, Sep. 2008)
- Quality Assurance/Quality Control Project Plan stated in Work Plans by Berninger Environmental, Inc. (date unknown)

The majority of the work proposed in the May 2008 work plan was completed by Berninger prior to the takeover of consulting tasks by Mid-Hudson Geosciences. At Berninger's soil boring locations, soil sampling and installation of monitoring wells were not completed. Mid-Hudson Geosciences reviewed the work plan and prepared an alternative work plan for NYSDEC review dated July 22, 2009. The plan was approved and the fieldwork conducted in November 2009. Eight new monitoring wells were installed at the soil boring locations. A complete round of ground water samples were taken in January 2010 as well as soil and sediment samples from the storm water drainage system next to Route 211.

At the time of the preparation of the 2010 RIR, the investigative work had consisted of collection of soil samples, groundwater samples and soil gas samples around the American Cleaners building and in the parking lots between American Cleaners and the Cheeseburger Paradise Restaurant and between American Cleaners and the MHV Credit Union Building (the original location closer to Route 211 at the same elevation as the Cheeseburger Paradise Restaurant and the vacant Video Store). Ambient air samples and sub-slab gas sample were taken at the HMV Credit Union Bank, the Cheeseburger Paradise Restaurant and the vacant Video Store Building (figure 5-7). The RIR provided summaries and interpretations of that data for use in selecting appropriate remedial actions. The findings of the RIR (2010) are summarized in section 5.1.2 below so the data and maps can be compared with new information.

Reports prepared by Mid-Hudson Geosciences included:
- Remedial Investigation Report (April 10, 2010)
- Remedial Action Selection Report (June 19, 2010)

In 2011, NYSDEC required a NYS licensed PE to prepare a Soil Vapor Extraction Design Plan and subsequently in 2012 a Remedial Action Work Plan. Those two reports were prepared by Geovation Engineering, P.C of 2016 Route 284, PO Box 513. Slate Hill, NY 10973 and signed and stamped by Robert Zimmer, P.E. NYS License Number 082496-1 as listed below:

- Soil Vapor Extraction Design Plan prepared by Geovation Engineering, P.C. (November 15, 2011)
- Remedial Action Work Plan prepared by Geovation Engineering, P.C. (February 22, 2012)

In May of 2012, the engineering responsibilities were assumed by Jolanda G. Jansen, P.E. (NYS License Number 068972-1) of Jansen Engineering, PLLC of 72 Colburn Drive, Poughkeepsie, NY 12603. Reports prepared by Jansen Engineering and Mid-Hudson Geosciences include:

- Remedial Investigation Work Plan: Re-Evaluation of On-Site Contamination (June 2012)
- Modification to February 2012 Remedial Action Work Plan (September 2012)
- Modification 2 for February 2012 Remedial Action Work Plan (October 29, 2012)
- The Supplememtal Remedial Investigation Report (May 2013) presented the laboratory analyses resulting from the work proposed in those three documents and interpretation of the results in light of on-site contamination and remediation.

Currently the site is working under a schedule to complete the Voluntary Cleanup Program by March 31, 2018. The groundwater cleanup proposed in this work plan is required to complete the schedule.

1.4 Summary of Remedy

An RI/AAR Report was recently (November 2017) submitted to NYS DEC. Beside the NO-Action Alternative, In-Situ methods of chemical oxidation and bioremediation were evaluated. The project team of Jansen Engineering, Mid-Hudson Geosciences, and Core Down Drilling has experience with both types of in-situ groundwater remediation. Based on chemical properties and costs evaluated in the IR/AAR comparison, bioremediation with bioaugmentation is the proposed remedy for the groundwater. Regenesis products will be injected into the top 5 feet of groundwater on-site and the active emulsion and bacteria will migrate down gradient with groundwater. Injectio points will be on the upgradient side of the building, near the old dumpster location, downgradient from the building and near the highest concentrations within the existing plume. The horizontal distance will be 10 to 15 feet between injection points.

1.5 Contemplated Use

The building was originally built for a dry cleaning establishment with special features such as a utility trench around the interior of the exterior wall and the 4 foot by 4-foot long trenches in the floor of the building, constructed to maximize space for clothing on hangers. The intent of the owner is to continue to use the building for dry cleaning and laundry with adjustments for customer preference and needs

2.0 Work Plan Objective and Rationale

Two remedial action objectives were identified to attain the goal of restoring the site to pre-contaminant conditions to the extent feasible in the Remedial Investigation Report (Section 8.4) with respect to groundwater. At a minimum, the remedies shall eliminate or mitigate all significant threats to public health and the environment presented by the contamination identified at the site through the proper application of scientific and

engineering principles. The following protective remedial objectives were considered appropriate, if significant threats to public health can be substantiated:

Remedial Action Objective #1 - Public Health Protection of Groundwater

§ Prevent people from drinking groundwater with contaminant levels exceeding drinking water standards.
§ Prevent contact with contaminated groundwater.
§ Prevent inhalation of contaminants from groundwater.

Remedial Action Objective #2 - Environmental Protection of Groundwater

§ Restore the groundwater aquifer to meet ambient groundwater quality criteria, to the extent feasible.
§ Prevent discharge of contaminated groundwater to surface water.
For each of the preventive objectives for groundwater, mitigating measures already exist because the groundwater is at a depth of 9 to 12 feet below grade and the groundwater does not discharge to surface water. The restorative measure may not be needed if the site groundwater is similar in quality to the ambient groundwater in the neighborhood.

3.0. On-Site and Off-Site Groundwater Investigation and Proposed Remedial Concept

3.1 Groundwater Sampling for VOCs in Monitoring Wells

Monitoring wells were sampled in January 2010, July 2012, and April to June 2017 as summarized in Table 4 and Table 17. After the 2010 sampling event, the DEC project manager suggested sampling the downgradient wells to the north of the American Cleaners building. The spatial distribution of the sampling results are shown with contours for the concentrations for the chemical of concern PCE in Figure 5-5 and Figure 5-18. By comparison of the concentrations of PCE shown in Table 17, one can observe that the highest value at MW26 in the center of the plume (Figures 5-5 and 5-18) is very slowly declining from 2400 to 2200 to 1800 µg/L over the course of 7 years. Essentially the plume is pretty much in the same place with slightly lower concentrations. The downgradient end of the plume has remained at the location of Monitoring Well T7, which was later replaced with MW34 after T7 was paved over.

In the 2010 and 2012 lab reports, small concentrations of PCE breakdown products such as cis-1,2-Dichloroethylene (cis12DCE) and Trichloroethylene (TCE) were detected. The presence of the breakdown products suggested that there were natural bacteria breaking down the PCE. However, the fact that the central part of the plume had not declined much indicates that natural attenuation will take many years to achieve cleanup. For that reason, as mentioned in section 1.0, an in-situ treatment method was sought to cleanup the PCE plume in a timely manner

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3.2 Consideration of In-situ Remediation of PCE in Groundwater

Two common methods of remediation were considered: (1) chemical oxidation or (2) bioremediation with or without bioaugmentation. Because current concentrations of PCE range from ND to 1800 µg/L or parts per billion, a method of treating such low concentrations of PCE over a limited area was sought. Treatment of such low concentrations is considered "polishing" because it is usually employed after much higher concentrations of VOCs have been reduced by a rapid acting industrial strength chemical agent. The existing "Plume" is approximately 350 feet long and width of approximately 50 feet near the south side of the American Cleaners Building. The injected treatment fluid will have to come in contact with groundwater with low concentrations of dissolved PCE in the 4-foot thick transmissive water-bearing zone over an area of 17,500 square feet or a volume of 70,000 cubic feet of sediments with a porosity of perhaps 10 percent containing groundwater. The reactivity of a chemical oxidation agent or virility of bacterial dechlorinating emulsion will have to be long-lived to move with natural groundwater flow from the injection borings to downgradient contaminated locations. However, at this site, locations directly above the plume are available for injection because there are no buildings directly over the plume. There are some underground utility lines, but their locations are well known and they can be avoided. Once the remedial agents reach the PCE-contaminants, the chemical oxidation or biological dechlorination will occur. Downgradient movement of the treatment products will likely take less than three years to travel from the American Cleaners Building under the parking lots downgradient to MW34, where the end of the plume was detected in July 2017 and at T7 in 2012as indicated by all VOCs reported as "ND" by York Analytical Laboratories. The proposed remedy is likely to fulfill the need cleanup the low level plume over the course of less than three years.

Chemical Oxidation was considered using a Regenesis product called PersulOX. After serious consideration and working on a plan to inject that material into the ground at American Cleaners, that remedy was disqualified because in a webinar on April 30, 2014, two managers (Drew Baird and Scott Mullin) at Regenesis stated that chemical oxidation with PersulfOX or RegenOX is not appropriate to "polish" groundwater or rid groundwater of such low concentrations of VOCs detected at the American Cleaners site. Also PersulfOX is highly corrosive and caustic and requires special handling. The persistence of PersulfOX in the groundwater is of limited time and space and often requires more than one injection.

By comparison, bioremediation using Regenesis products appear have a high probability for cleanup of the low PCE concentrations both on-site and off-site over a period of two to five years.

3.3 Selected Remedy: Bioremediation and Bioaugmentation

Because bioremediation is suitable for "polishing" and the chemical oxidation remedies are not, and there is no detection of *Dehalococcoides* sp bacteria in the groundwater, bioremediation with bioaugmentation is the selected remedy for groundwater. Bioaugmentation is the addition of live bacteria culture to the groundwater in addition to regular bioremediation by injection of a reducing environment with emulsion oils.

4.0 On-Site and Off-Site Groundwater and Proposed Remedial Action

The groundwater SCGs are protective of groundwater via the soil to groundwater migration pathway (i.e., soil leaching and groundwater transport). For groundwater, standards and/or guidance values from the NYSDEC (1998) Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations were used to identify constituents of potential concern. Specifically, Class GA standards and guidance values of 5 µg/L was used to screen groundwater data for exceedances of the chemical of concern, Tetrachloroethylene (PCE). That standard and guidance value is considered protective of drinking water sources.

The following sections describe proposed remedial measures to meet the SCOs for groundwater at the American Cleaners, Middletown, NY site.

Characteristics of the Regenesis products are provided here. The processes of mixing and injection of those products into the top four feet of the water table are described using the Geoprobe®. Monitoring of the movement of the materials in the groundwater will be accomplished by measuring water quality parameters in the monitoring wells. Groundwater sampling will show changes in concentration of PCE. Criteria for the identifying the successful cleanup of on-site and off-site groundwater are identified below. Detailed stratigraphy and groundwater conditions are well defined for the plume area (Figures 4-1 and 4-2). Using such data, the fluids can be injected directly into the optimum depth interval within the target water-bearing zone in the plume.

4.1 Regenesis Bioremediation and Bioaugmentation Products

Two Regenesis products are considered appropriate to treat the groundwater beneath the American Cleaners site and downgradient properties: 3-D MicroEmulsion and Bio-Dechlor Inoculum.

Appendix Numbers in this Report for Regenesis Products			
	Brochure	MSDS	Application Instructions
3-D Microemulsion (3DMe™)	1	3	5
Bio-Dechlor Innoculum Plus (BDI Plus™)	2	4	6

3-D MicroEmulsion (3DMe™) is a factory emulsified electron-donor material used to facilitate anaerobic reductive dechlorination of chlorinated solvents by microbial action in groundwater. The product is a mixture of organic chemicals classified as HRC-PED (Hydrogen Release Compound – Partitioning Electron Donor). The mixture is made up of neutralized fatty acids, glycerol tripolylactate, and glycerol. 3-D MicroEmulsion is a liquid with a consistency similar to milk. The emulsion is characterized by three stages of active ingredients with three overlapping periods of time release for each electron donor material

(1) lactate,	0 to 1 year
(2) polylactate	0.3 to 2.2 years
(3) free fatty acids with fatty acid esters.	1 to 5 years

This overlapping periods of activity provide a cost effective treatment because it will create an anaerobic reducing environment for a significant period of time while the material migrates downgradient with natural groundwater flow.

The 3-D MicroEmulsion product is mixed with water and injected into Geoprobe® borings. The material is generally innocuous with neutral pH and non-corrosive and non-caustic properties. The most hazardous characteristic of the product is that if it is spilled, it can be very slippery on surfaces; but it can be easily washed off with water. The material readily degrades and hydrolyses within hours. The product is diluted with water before it is injected into the subsurface.

Bio-Dechlor Inoculum (BDI Plus™) is a mixture of ***Dehalococcoides sp*** bacteria. Regenesis indicates that it "has been shown to stimulate rapid and complete dechlorination of compounds such as tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC)." Members of the genus ***Dehalococcoides*** are capable of driving the dechlorination chain of reactions of chloroethenes, such as PCE, to the end product of harmless ethane. At this time, it is not known exactly which dechlor species are associated with each sequential breakdown reaction, but the Regenesis inoculum consists of several species and is proven effective at promoting the entire breakdown of PCE to ethane.

The BDI Plus product is a murky, yellow to gray liquid with a musty odor. The live bacteria culture comes in a keg or canister pressurized to 10-15 psi with nitrogen to maintain a reducing (non-oxygen) environment in the container. The container must be kept at 2° to 3°C until the material is injected into the ground. The culture is miscible with water, so it can be diluted to appropriate levels at the site. The water that the culture is mixed with is first aerated with nitrogen to remove the oxygen from the water to make sure the water will maintain the anaerobic conditions for the survival of the bacteria.

4.2 Bioremediation and Bioaugmentation by Subsurface Injection

Regenesis recommends injection of the liquid bioremediation mixtures of emulsion and bacteria into the top four feet of the sandy aquifer using direct push equipment (Geoprobe®). The target aquifer is the transmissive water-bearing zone with a uniform thickness of four feet (vertical) as shown on the Fence Diagram (Figure 4-1) and North-South Cross Section (Figure 4-2). The injection points are recommended to be placed 15 feet apart as shown in Figure 5-6. Sixteen injection points are arranged to cover the upgradient side of the building, the original dumpster location, the tanker truck hose spill location and the highest concentration area in the center of the plume near MW26. The instructions for handling and mixing the Regenesis products are included in Appendix 5 and 6. Actually, each injection location consists of two Geoprobe® borings, one for injection of the emulsion and a second for the injection of the bacteria. They are not injected at the same time and a waiting period such a week to a few months can be

implemented. In this case, injection within a week or two will occur to stimulate immediate cleanup of the chlorinated VOCs.

All of the injection points for emulsion will be installed and treated first. One day for mobilization and setup will be required followed by about 4 days of injection. Then the injection of the bacteria will require a second mobilization and is expected to take much less time because the volume to be injected is significantly less. The bioremediation injection with Geoprobe setup is shown in Figure 6.

The 3DMe™ will be delivered to the site in four 400 pound drums. The 12 liters of BDI plus™ bacteria culture will be delivered in one or more coolers with nitrogen-pressurized canisters. A separate batch of bioremedial material will be mixed for each injection point according to the Regenesis application instructions.

Regenesis has recommended injection of 100 pounds (13 gallons) of 3DMe™ for each injection point (Table 5). Regenesis recommends dilution of the factory shipped product in the range of 1 percent to 10 percent. Our previous experience at American Cleaners Kingston, dilution factor of approximately 8% was used for the 3-DMe™. Pumping 190 gallons into the subsurface within one hour was an efficient injection procedure. The period of time required to pump the fluids into the subsurface with the high pressure GS2000 pump. Hence, the actual mixture of the 3DMe will be determined empirically in the first injection wells.

When the Geoprobe® assembly is in place, the vertical zone of 3DMe™ injection will be the top 4 feet of the aquifer approximately 5 to 9 feet below ground surface. The top of the aquifer is deeper to the north. From the Fence Diagram (Figure 4-1) and North-South Cross Section (Figure 4-2) the depth of the aquifer can be accurately estimated for each injection point. Also the thickness of the aquifer is shown to be quite constant at four feet. As described above, the rate of injection will be determined by the capability of the water-bearing zone to accept the rate of flow. Assuming injection of approximately 200 gallons per point, the following table summarizes the required time for pumping rates. While the fluid is injected, the drill rods of the Geoprobe® are raised about four feet to distribute the material within the top four feet of the aquifer. The resistance to acceptance to the pumping will be observed in each injection boring and the appropriate pump used. The high pressure pump will be used where the resistance is great and the submersible pump will be used where it can accomplish the task.

Comparison of Injection Rates & Times	
Pumping Rate of Injection	Time to Inject 200 gallons
5 gpm	40 minutes
10 gpm	20 minutes
15 gpm	15 minutes
20 gpm	10 minutes

Experience at American Cleaners Kingston demonstrated that the high pressure pump took 45 to 108 minutes, averaging about 50 minutes to pump 175 to 195 gallons of the

3DMe™ mixture. The faster submersible pump was able to pump into the sandy formation at Kingston at less than 30 minutes. A combination of pumping with the GS2000 and a submersible was used by switching from one to the other. Both pumps will be available on site for the proposed injection tasks.

Regenesis recommends a ratio of BDI plus to water of 1 liter to 10 gallons, or for our specific site 0.75 liters to 7.5 gallons of water. The water for BDI plus™ has to be aerated with nitrogen to assure that the water is oxygen free. Only 120 gallons of the nitrogen treated water will be needed for the 16 injection points. However, since it is recommended to fill the annular space with water to prevent air from reaching the bacteria, additional water aerated with nitrogen will be needed for that purpose. The water can be aerated while the boring is being advanced with the Geoprobe®. The inoculum solution is injected at a rate of approximately 2 gallons per foot, while raising the rod in one foot intervals.

4.3 Monitoring of Bioremediation On-site and Off-site

Monitoring the movement of remedial chemicals and cultures will be achieved with two types of groundwater testing: (1) monitoring of field parameters using a Horiba U-10 and other electronic meters; and (2) groundwater sampling and laboratory analyses for VOCs using US EPA method SW 846 8260B.

4.3.1 Field Parameter Monitoring

After the bioremediation products are placed in the aquifer, the groundwater will be monitored to detect the movement of the reducing emulsion and bacteria entrained in the natural groundwater flow system. Since the injection points are on-site, the products should be detected within days in the on-site monitoring wells. Water quality parameters such as Oxidation-Reduction Potential (ORP), Dissolved Oxygen (DO), pH, and Sulfate Ion Concentration will be measured with field instrumentation prior to injection and at one month intervals after injection. Periodic measurement of those parameters should indicate the arrival of the reducing environment of the 3-DMe and associated bacteria in downgradient locations. Typical plume arrival is expected with a build-up followed by decline in water quality parameters and PCE concentrations. That phenomenon is a result of the processes of hydrodynamic dispersion and diffusion while the reducing emulsion mixes with the natural groundwater system and arrives at the sampling point somewhat diluted with higher concentrations following.

4.3.2 Groundwater Sampling

Baseline sampling of all 12 monitoring wells (those surveyed by Lanc & Tully, August 2017). After the two bioremediation injection events, a proposed schedule of sampling is provided in Table 6. The timing between successive sampling events becomes longer with eight events planned over five years after injection. Most of the events will sample just the 6 downgradient wells. However, the total 12 wells will be sampled three times including the baseline sampling before injection. All samples will analyzed for

Volatile Organic Compounds by US EPA Method SW846-8260B by a New York State approved laboratory, most likely York Analytical Laboratories.

Groundwater sampling will conducted by following the US EPA Low Stress (Low Flow) Purging and Sampling Procedure for Collection of Ground Water Samples from Monitoring Wells (US EPA Region 1, April 23, 2010, Revision). A peristaltic pump and dedicated or new tubing will be used to purge each well prior to sampling. The method produces a limited amount of purge water while achieving equilibrium of water quality parameters by repeated measurements and a very low pumping rate, thereby assuring a fresh sample of groundwater from the surrounding formation. The following steps describe the method:

- At 3-5 minute intervals, depth to water is measured with a water level indicator
- Rate of flow and volume of water pumped is measured with a calibrated 1000-milliliter cylinder and a watch with second hand;
- Pumping rate of flow is established at 0.1 to 0.4 liters per minute using a variable speed peristaltic pump with dedicated ¼ inch tubing, pre-measured for each well;
- For the same time interval, water quality parameters are measured including pH, conductivity, turbidity, dissolved oxygen, temperature, and oxidation reduction potential, During the purging process, stabilization of field indicator parameters includes less than the following percentage change over three sets of successive measurements made with the Horiba:
  - Turbidity 10%
  - Dissolved Oxygen 10%
  - Specific Conductance 3%
  - Temperature 3%
  - PH + / - 0.1 units
  - ORP / Eh +/- 10 millivolts.
- After about 20 minutes, when the water quality parameters usually stabilize, samples are collected in 40-milliliter glass vials with HCl preservative.
- After measuring those water quality parameters, the purge water is saved for disposal.
- Quality Assurance samples are collected as follows: one trip blank originating from York Laboratories, one equipment blank passed through a length of clean ¼-in ID food grade polyethylene tubing, matrix spike and matrix spike duplicate samples.
- All samples are shipped with ice paks and chain of custody to York Analytical Laboratories for analyses by US EPA Method 8260 for the full list of analytes. The NYSDEC ASP Category B data package will be requested.
- A small sample of water will be collected and used to analyze for sulfate ions Using a portable field meter (Hanna Instruments Colorimetery / Refractometry HI 96751and Reagent HI 93751).

After five years have passed, cleanup is expected to be complete. It is expected that the PCE concentrations will comply with the groundwater standard of 5 µg/L in all 12 of the monitoring wells. The decision document will define the specific requirements for

cleanup of the American Cleaners Middletown and a Periodic Review Report (PRR) will be prepared and submitted to NYS DEC when such criteria are met.

5.0 Concomitant Procedural Plans

Concomitant procedural plans include the contributory plans associated with the remedial action work plan such as the QA/QC Plan, the Health and Safety Plan, and the Community Air Monitoring Plan as described or referenced below.

5.1 QA/QC Plan

The quality assurance/ quality control plan is concerned with the laboratory analytical procedures for the specific samples for the subject site as outlined in Table 6. Data validation is the process of reviewing the lab procedures to assure the precision and accuracy and usability of the VOC concentrations reported by the laboratory. . In addition to the monitoring well samples, duplicate, MS, MSD, trip and equipment blanks will be sent to the lab. A NYSDOH environmental laboratory approved program (ELAP)-approved laboratory will analyze the groundwater samples for Volatile Organic Compounds using EPA method SW-846-8260B. The QA/QC groundwater samples include, duplicate samples, trip blanks, equipment blanks, matrix spike samples, and matrix spike duplicate samples. NYS DEC Category B analytical data will be requested on the chain of custody. The final laboratory report and Category B (NY ASP B) laboratory deliverables will be sent to a Data Validation subcontractor to prepare a Data Usability Summary Report (DUSR). Such report will identify and discuss any pertinent data limitations for use of the data.

5.2 Health and Safety Plan

The Health and Safety Plan for field work at the American Cleaners Middletown location was updated for this RAWP and is included here as Appendix 7.

5.3 Community Air Monitoring Plan

The Community Air Monitoring Air Plan for field work at the American Cleaners Middletown location has been updated for this RAWP and is included here as Appendix 8. Air monitoring was conducted during the soil excavation work by the back door.

6.0 Groundwater Remediation Schedule

Baseline monitoring well sampling can be done anytime before the inject work begins. The equipment is on hand and ready to be used.

Injection of the Bioremedial 3-DMicroemulsion material can start within 2 weeks of approval. Core Down Drilling is available as early as February 1, 2018. That allows time for shipment of the product from Regenesis and assembling all of the tanks and pumps and other apparatus to inject the material through the Geoprobe® rods, and allows time to get this project onto the Driller's schedule. Injection of the microemulsion

is estimated to take 4 to 5 days depending on the dilution of the product. Injection of the Regenesis Bio-Dechlor Inoculum Plus™ will require a second mobilization of the Geoprobe® with significantly less equipment and will require 2 to 3 days.

Measurement of water quality parameters will be taken in all monitoring wells prior to injection and within a week after injection of the bioremediation products. Water quality parameters will be measured approximately as follows:

Year 1	4 times per year
Year 2	3 times
Year 3	2 times
Year 4	1 time
Year 5	1 time

The groundwater sampling schedule for monitoring wells is defined in Table 6. Volatile Organic Compounds will be analyzed by US EPA method SW846 8260B.

7.0 Reporting

The remedial action report will be prepared and submitted to NYS DEC within 45 days of the completion of the remedial activities.

Sampling reports will be prepared and transmitted to DEC within 2 weeks of receipt of laboratory reports. Measurement of field parameters will be submitted and will be summarized for all reports in each successive report to determine if there are any trends in the data.

The periodic reports will summarize all of the measurements to date so that trends can be easily identified. When evidence of remediation is observed, permission from DEC will be requested to close and decommission the appropriate phase of cleanup as defined in DER-10.

A Final Engineer's Report will be prepared to summarize all of the remedial work, sampling, and data validation. Other post remedial injection reporting tasks are listed in the RI/AAR and project schedule.

8.0 Project Organization

Resumes for project engineer, Jolanda G. Jansen, P.E.; project manager, Katherine J. Beinkafner, Ph.D., CPG; Geoprobe® owner-operator Andrew Bellucci of Core Down Drilling, and bioremediation specialist Todd Syska, and assistant project geologist Paul Rubin are included in Appendix 9: Investigation Personnel. See the bottom of page 1 in the Health and Safety Plan (Appendix 7) for more information on organization.

9.0 References

FINAL DER-10 TECHNICAL GUIDANCE FOR SITE INVESTIGATION AND REMEDIATION, May 3, 2010, New York State Department of Environmental Conservation, Division of Environmental Remediation, 232 pages.

US EPA Low Stress (Low Flow) Purging and Sampling Procedure for Collection of Ground Water Samples from Monitoring Wells (US EPA Region 1, April 23, 2010, Revision)

Remedial Investigation/ Alternative Analysis Report: Operable Unit #2 Groundwater, November 2017, American Cleaners Middletown NYSDEC Site No. V-00461-3.

Table 3
Northing, Easting, and Elevation for Selected Wells
American Cleaners Middletown, NY
Survey by Lanc & Tully (August 2017)

Middletown June 20, 2017 Water Levels
Water Levels measured by Mid-Hudson Geosciences
NA = depth to water not measured, no key for padlock

Well	Northing	Easting	Top Elev	Water Depth	Water Elev
MW21	954817.9838	521356.8871	549.11	1.65	547.46
MW1B	954832.1367	521294.8986	547.4	4.51	542.89
MW30	954836.3527	521268.689	546.75	5.87	540.88
MW22	954866.362	521207.7179	547.98	NA	#VALUE!
MW5	954868.9672	521256.4848	545.02	5.19	539.83
MW3	954911.2229	521252.4507	543.09	5.91	537.18
MW25	954940.5845	521250.8271	541.25	3.87	537.38
MW26	954962.562	521271.2141	541.07	3.89	537.18
T5	955001.3221	521243.2946	542.18	11.54	530.64
MW33	955050.0633	521257.5219	541.11	10.31	530.8
MW32	955088.0694	521289.4206	538.76	7.76	531
MW34	955194.4379	521264.5928	536.09	10.35	525.74

Table 4
(RIR 4/10 Table 4)
Summary of PCE (Tetrachloroethylene) and Other Volatile Organic Compounds (VOCs)
Detected in Groundwater, Surface Water and Sediments using EPA Method 8260
No entry in data matrix indicates analyte Not Detected (ND).
Units of Measurement are ug/L for water and ug/kg for sediments.
Remedial Investigation Report, April 2010, Sampling Dates: January 14-17, 2010
American Cleaners, Inc. Caldor Lloyds Mall, 340 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP Site V-00461-3
From York Analytical Laboratories Report #10010484, dated January 25, 2010
Complete Laboratory Reports are contained in Appendix D of this Report
Prepared by Mid-Hudson Geosciences and Jansen Engineering, PLLC

Well Identification	PCE	TCE	cisDCE	vinyl chloride	methylene chloride	napthalene	MTBE
MW1B					3JB	2JB	
MW4					3JB		
MW2	110				3JB		
MW5	240	11	5J		5JB		
MW6	280				13JB		
MW7	69	7	3J		3JB		
MW3	430	10J	15J		13JB		6J
T1					3JB		
T2	Not Sampled						
T3	18	2J	1J		3JB		
T4	1J				6JB		
T5	47	4J	24		3JB	2JB	
T6					3JB		
T7			1J		4JB		
T8					4JB		
T9					3JB		
MW21					2JB		
MW22	42				4JB		
MW24					4JB		
MW24dup					3JB		
MW25	910	19	22		4JB	4JB	
MW26	2600	64	64	2	4JB		
MW28	270	24	25		3JB		
MW31					4JB		
MW30	110						

Storm Water Samples from Drainage Channel south of Route 211	
SW1	3JB
SW2	3JB

Sediment Samples from Drainage Channel south of Route 211	
SED1	12JB
SED2	10JB

Blanks	
Trip Blank	3J
EquipBlank	3J

Notes: "J" indicates estimated concentration, less than Reporting Limit, greater than Method Detection Limit.
"B" indicates analyte detected in blank.

Table 5: Design Parameters for Bioremediation with Bioaugmentation
Using Regenesis Products
Site: American Cleaners, Caldor Plaza, 360 Route 211 East, Middletown, NY 10940
Note: The variable amount of water for dilution of the 3DMicroemulsion will be determined emphirically in the field

Design Specifications

Injection Point Spacing	15 feet
Number of Injection Points	16
Top of Injection Interval (water table)	10 feet below surface
Bottom of Injection Interval	15 feet below surface
Vertical Treatment Interval	5 feet
Linear Footage of Geoprobe® Drilling	
For Injecton of Both Products	240 feet
For Separate Injection of 2 Products	480 feet

Product Quantities

3DMicroemulsion	1600 pounds in four 55 gallon drums, 400 pounds per drum
Bio-Dechlor Inoculum Plus	12 liters

Field Mixing / Injection Ratios

3DMicroemulsion

Per Injection Point	For 16 Total Points
13 gallons (= 100 pounds)	208 gallons (= 1600 pounds)

Water

Variable	Per Injection Point	For 16 Total Points
For 10% solution	117 gallons	1872 gallons
For 1% solution	1287 gallons	20592 gallons
Optimal For 2.5% solution	507 gallons	8112 gallons

Product + Water

Per Point	For 16 Points
130 gallons	2080 gallons
1300 gallons	20800 gallons
520 gallons	8320 gallons

Bio-Dechlor Innoculum Plus

Per Injection Point	For 16 Total Points
0.75 liters (= 0.1875 gallons)	12 liters (= 3 gallons)

	Per Injection Point	For 16 Total Points
Re: Instructions	7.5 gallons	120 gallons

Per Point	For 16 Points
7.7 gallons	123.2 gallons

Table 17
Summary of PCE and other Chlorinated Volatile Organic Compounds
Detected in Groundwater, Surface Water, and Sediments using US EPA Method 8260B
American Cleaners, Caldor Plaza, 360 Route 211, Middletown, NY 10940
NYSDEC DER VCP Site V-00461-3
Summary of Sampling Events of July 2003, November 2005, January 2010, July 2012, and Apr-Jun 2017
All Laboaratory analyses were conducted by York Analytical Laboratories
120 Research Drive, Stratford, CT 06615
All Laboratory Reports are included in Appendix
Alll Data Useability Summary Reports areincluded in a separate Appendix.
Prepared by Mid-Hudson Geosciences and Jansen Engineering, PLLC
ND = Not Detected at method detection limit,
"J" = estimated concentration, less than Reporting Limit, but greater than detection limit.
All concentrations are reported in Micrograms/Liter or (µg/L)

	July2003			January 2010			July 2012			Apr-Jun 2017		
MW ID	PCE	TCE	DCE	PCE	TCE	DCE	PCE	TCE	DCE	PCE	TCE	DCE
MW1B	ND	ND	ND	ND	ND	ND						
MW2	1100 J	ND	ND	110	ND	ND						
MW3	1700J	31	72	430	10J	15J						
MW4	6J	ND	ND	ND	ND	ND						
MW5	4000J	11	32	240	11	5J						
MW6	530	ND	ND	280	ND	ND						
MW7	1100	18	18	69	7	3J						
	Nov 2005						July 2012			Apr-Jun 2017		
	PCE	TCE	DCE	PCE	TCE	DCE	PCE	TCE	DCE	PCE	TCE	DCE
T1	2J	ND	ND	ND	ND	ND						
T2												
T3	870	16	25	18	2J	1J						
T4	1000	24	79	1J	ND	ND						
T5	1200	41	160	47	4J	24	47	4J	24	340	ND	ND
T6	ND	ND	ND	Nd	ND	ND						
T7	1	ND	64	ND	ND	1J	ND	ND	ND	paved over, see MW34		
T8	ND	ND	ND	ND	ND	ND						
T9	ND	ND	ND	ND	ND	ND						
MWSSW	ND	ND	ND									
Swdrain	5	ND	ND									
SW1				ND	ND	ND						
SW1				ND	ND	ND						
SED1				ND	ND	ND						
SED2				ND	ND	ND						
MW21				ND	ND	ND						
MW22				42	ND	ND						
MW24				ND	ND	ND						
MW24dup				ND	ND	ND						
MW25				910	19	22	1300	17	15	570		
MW26				2600	64	64	2200	58	64	1800		
MW28				270	24	25	250	14	43	paved over, see MW32		
MW30				110	ND	ND						
MW31				ND	ND	ND						
MW32										260	32	28
MW32dup										250	25	32
MW33										200	19	23
MW34										ND	ND	ND

Notes: SW1 and SW2 are suface water samples from strom drainage on the south side of Route 211 downgradient from Site.
No entry indicates no sample was collected during that sampling event.
SED1 and SED 2 = sediment samples from drainage channel on south side of Route 211
"dup" = duplicate sample
MWSSW = monitoring well next to storm water drainage grate near northeast corner of building
Swdrain = sample collected from water in the drainage way accessable from the surface collection grate

Table 6
Groundwater Sampling to Monitor Enhanced Bioremediation
Schedule and Quality Assurance
American Cleaners, Middletown , NY
NYS DEC DER Voluntary Cleanup Program Site No. V-00461-3
Prepared by Mid-Hudson Geosciences and Jansen Engineering, PLLC
January 2018

Event	Months after Remedy	Number of Wells to Sample	Number of Sample Quality Assurance Samples				
			Trip	Equipment	Duplicate	Matrix Spike	MS Duplicate
1	-1	12	1	1	1	1	1
2	4	6	1	1	1	1	1
3	8	6	1	1	1	1	1
4	14	12	1	1	1	1	1
5	20	6	1	1	1	1	1
6	28	6	1	1	1	1	1
7	36	6	1	1	1	1	1
8	48	12	1	1	1	1	1
9	60	6	1	1	1	1	1

Sample Quality Assurance Quantification	
Parameter	Groundwater
Sample Preservation	zero head space cool at 4^{o}C
Sample Container Volume	40 ml
Sample Container Type	clear glass vial
Sample Holding Time	14 days
Sample Storage in Field	Cooler with ice paks
Transport to Laboratory	Cooler with fresh ice paks

Note: 12 monitoring wells were surveyed by Lanc and Tully (August 2017).
6 of those wells are downgradient and will be sampled when the schedule calls for 6.

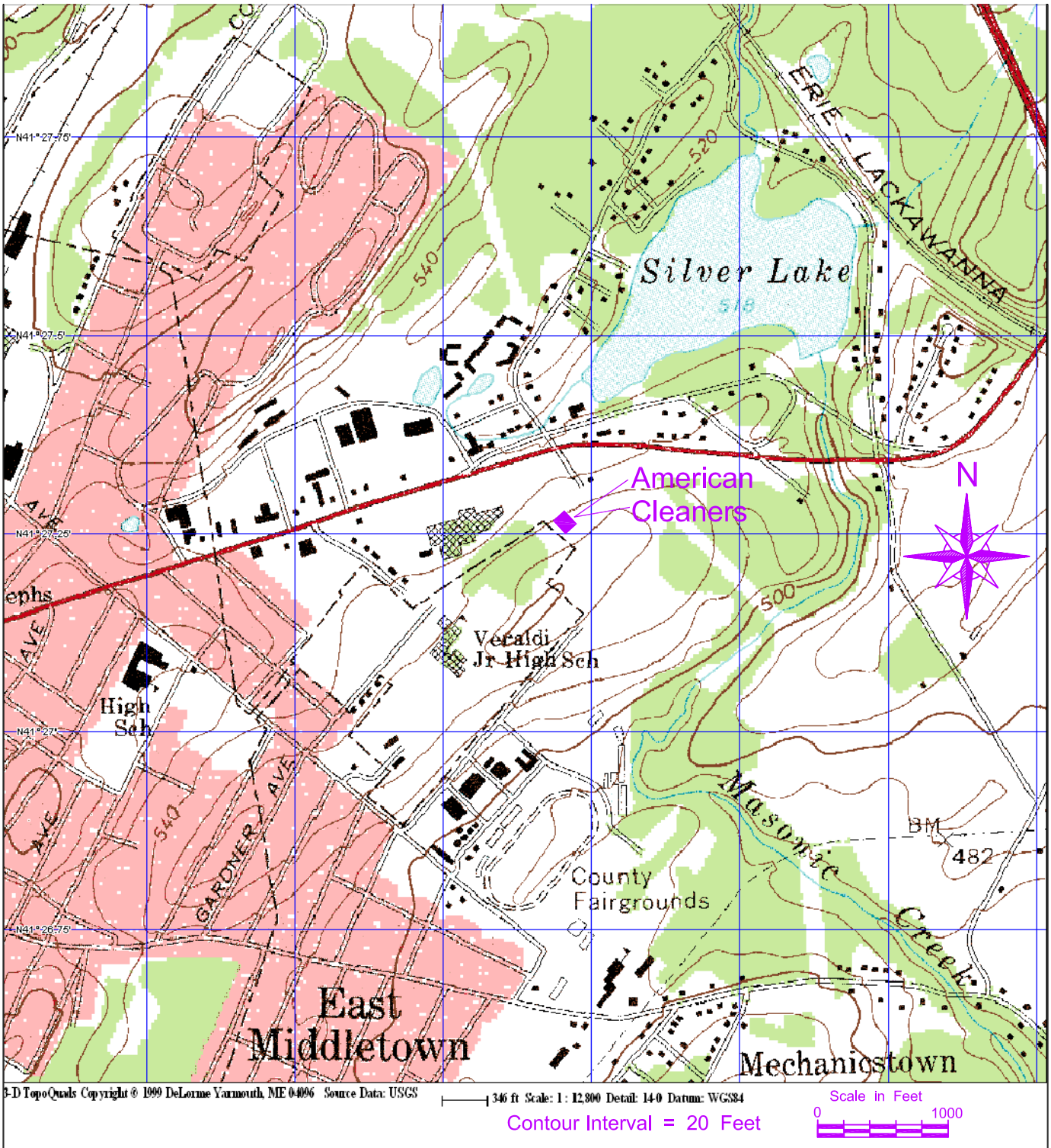

Figure 1-1. Site Location Map
USGS 7.5 Minute Quadrangle: Middletown, NY
American Cleaners at Caldor Lloyds Mall
340 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP V-00601-3, February 22, 2010

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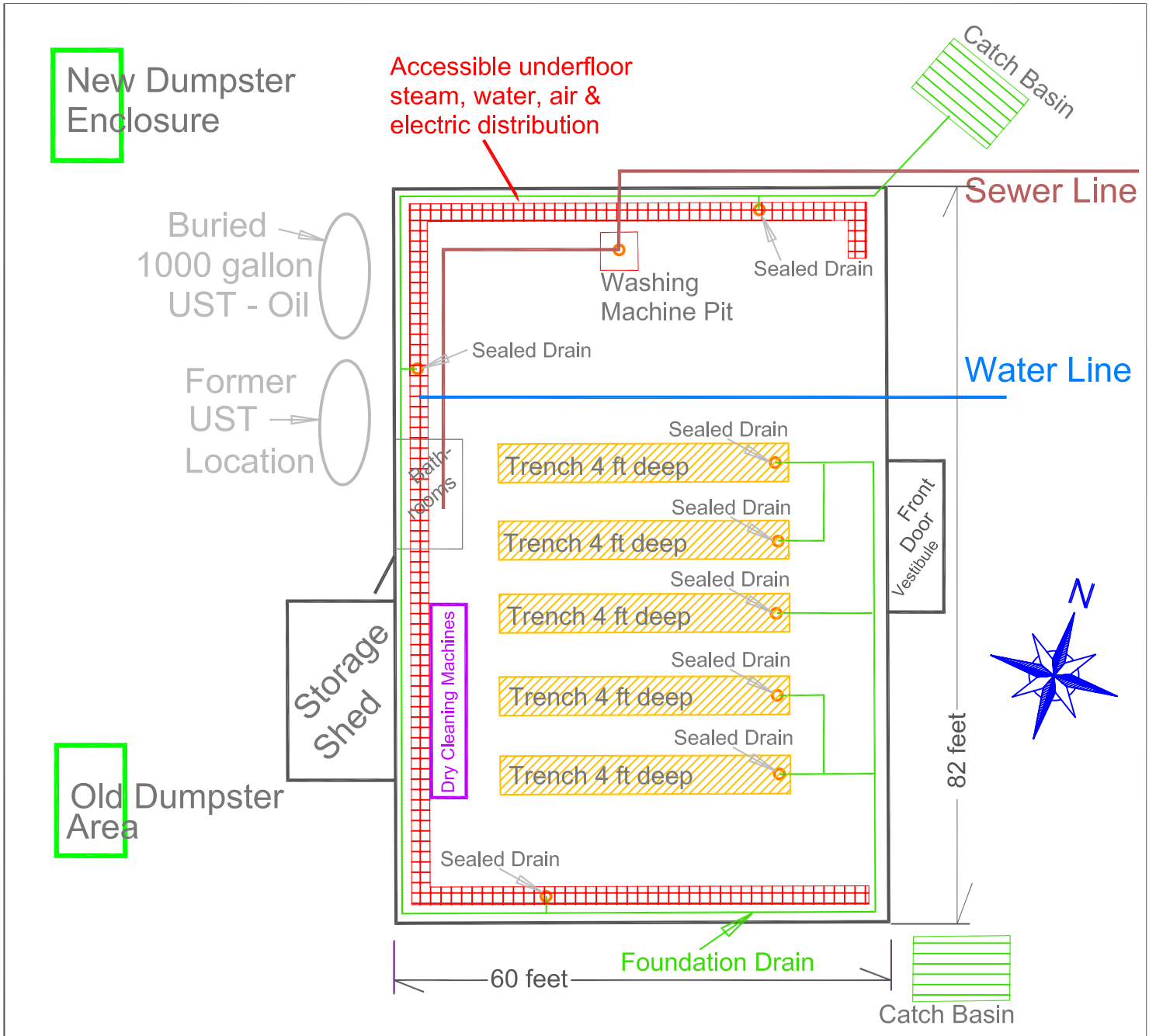

Figure 1-2. Site Plan of Building, Utilities, & Special Features Constructed for Dry-Cleaning Operations
American Cleaners at Caldor Lloyds Mall
360 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP V-00461-3, February 22. 2010

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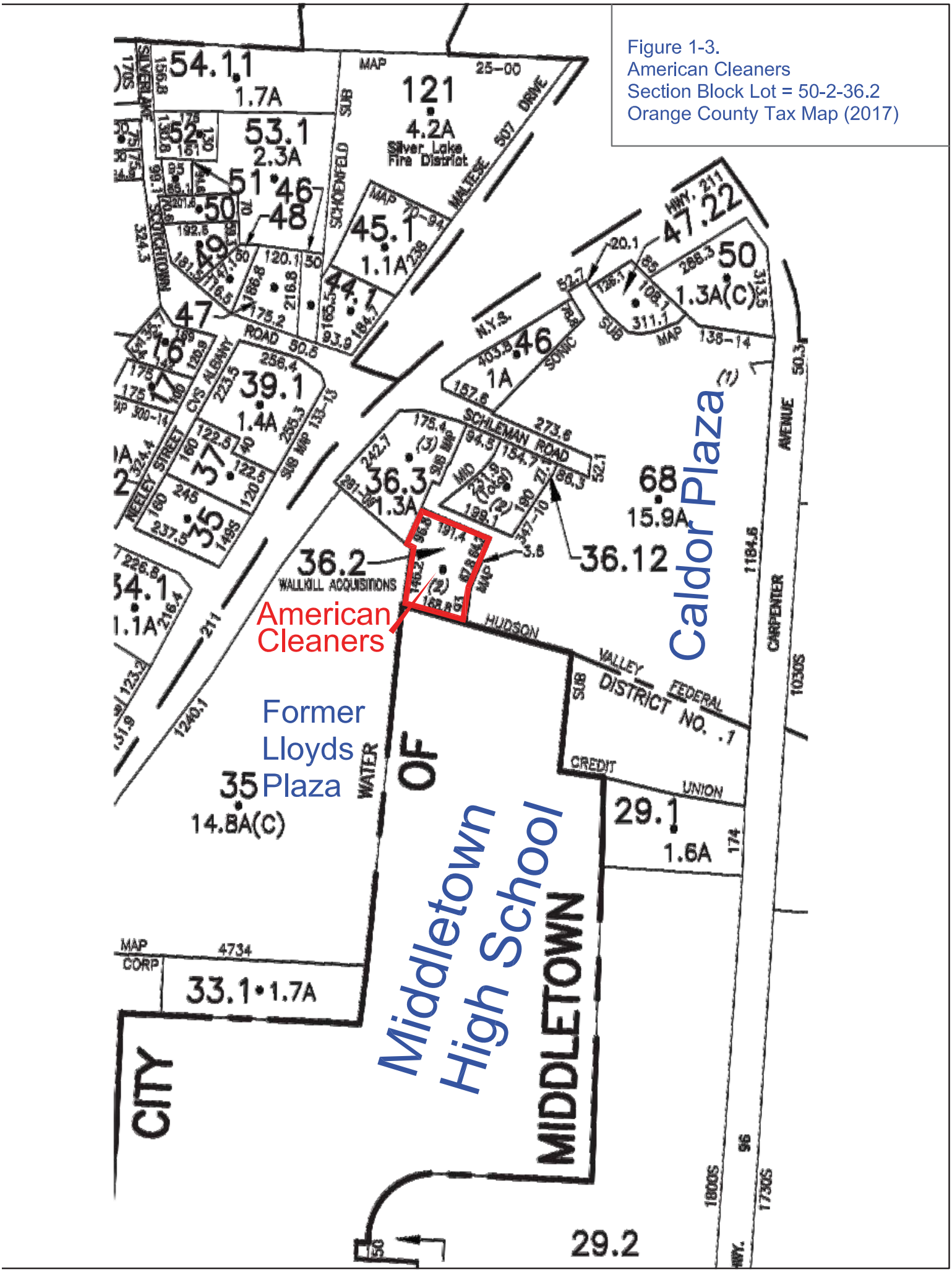

Figure 1-3.
American Cleaners
Section Block Lot = 50-2-36.2
Orange County Tax Map (2017)

Figure 4-1. Stratigraphic Fence Diagram

Compiled from Soil Boring Logs and Water Level Measurements in Monitoring Wells.
Perspective: Looking south and uphill from Route 211 toward the American Cleaners building.

American Cleaners at Caldor Lloyds Plaza
360 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP V-00461-3, Feb 2010

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N

Vertical Scale in Feet: 0, 2, 4, 6, 8, 10

Vertical Exaggeration = 3 X

Horizonal Scale in Feet (between Wellheads): 0, 20, 40, 60, 80, 100

AMERICAN CLEANERS

Building Footprint

MHV CREDIT UNION

CHEESE-BURGER PARADISE RESTAURANT

BEI-02 — EOB=11.5 ft

MW21 — EOB= 8 ft — Surface Infiltration; DRY; Transmissive; DRY; Water-Bearing Zone; Unconfined Water Table

MW30 — EOB=8 ft — Surface Infiltration; DRY; Transmissive Water-Bearing; Potentiometric Surface

MW22 — FILL; DRY; Potentiometric Surface

T-1 — EOB=19 ft — FILL; DRY; Transmissive Water-Bearing Zone; DRY

MW25 — EOB= 12 — Potentiometric Surface; Transmissive Water-Bearing Zone; DRY

T-8 — Soil Boring Log Not Available — EOB=18 ft — Potentiometric Surface; Transmissive Water-Bearing Zone; DRY

MW26 — EOB= 16 ft — DRY; Transmissive; DRY; Water-Bearing Zone; Potentiometric Surface

T-2 — Soil Boring Log Not Available — EOB= 8 ft — FILL; Old Buried Blacktop

T-3 — FILL; Buried Old Blacktop; Potentiometric Surface; Transmissive Water-Bearing Zone; DRY

T-5 — Soil Boring Log Not Available — EOB=20 ft — Potentiometric Surface

T-4 — Soil Boring Log Not Available — EOB=20 ft

MW24 — EOB= 20 ft — FILL; Potentiometric Surface; Old Buried Blacktop; DRY; Transmissive; Transmissive Water-Bearing Zone; DRY

MW31 — FILL; Potentiometric Surface; DRY; EOB=24 ft

T-6 — EOB=20 ft — BEDROCK Black Shale

MW28 — EOB=16 ft — Surface Infiltration; DRY; Transmissive Water-Bearing Zone; DRY; Potentiometric Surface; Transmissive; DRY; Transmissive Water-Bearing Zone; DRY

LEGEND

Well Name

Stratigraphic Column from Boring Log

0 Color-Coded Strata
2
4 Potentiometric Surface
6
8
10 End of Boring
EOB=10 ft

Lithologies and Water Content: Dry or Saturated (wet)

	DRY	WET
Clay		
Silt		
Sandy Silt Silty Sand		
Sand		
Rock Fragments or Gravel		

Interpretive Correlations Between Wells based on Comparison of Boring Logs

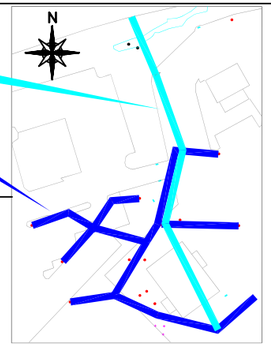
- Transmissive Water-Bearing Zone
- Dry Unconsolidated Sediments
- Fill Material
- Buried & Weathered Blacktop
- Potentiometric Surface (January 14-17, 2010)

Figure 4-2. North-South Cross Section

Compiled from soil boring logs and water level measurements from monitoring wells.
Perspective: Looking west from Plaza Entrance.

American Cleaners at Caldor Lloyds Plaza
360 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP V-00461-3, Feb 2010

Location Map for Fig 4-2 North-South Cross Section
Fig 4-1 Fence Diagram



Horizonal Scale in Feet (between Wellheads)
0 20 40 60 80 100

SOUTH — **NORTH**

Elevation in Feet Relative to Mean Sea Level
550 540 530 520 510

American Cleaners Building

MW21 — Parking — Surface Infiltration — Water Table — Transmissive — DRY — EOB=8 ft

Parking — MW26 — Surface Infiltration — Weed Patch — Lloyds Lane — MW28 — Surface Infiltration — West MHV Credit Union Parking Lot — T-7

DRY — DRY — Transmissive Water-Bearing Zone — DRY — Potentiometric Surface — Transmissive Water-Bearing Zone — DRY — EOB=14 ft

DRY — ? ? ? FILL — Potentiometric Surface — ? — Extrapolated Transmissive Water-Bearing Zone — DRY — EOB=16 ft

Vertical Infiltration — Stormwater Drainage Channel — Retaining Wall — Route 211 — Bouldery Fill — Projected Potentiometric Surface — Interpreted Transmissive Water-Bearing Zone — ? ? — Note: Elevations north of T-7 are estimated. — EOB=18 ft

Soil Boring Log Not Available

LEGEND

Vertical Exaggeration = 6 X

Stratigraphic Column from Boring Log

Well Name

0 — Color-Coded Strata
2
4 — *Potentiometric Surface*
6
8
10 — End of Boring
EOB=10 ft

Lithologies and Water Content: Dry or Saturated (wet)

	DRY	WET
Clay		
Silt		
Sandy Silt Silty Sand		
Sand		
Rock Fragments or Gravel		

Interpretive Correlations Between Wells based on Comparison of Boring Logs

- *Transmissive Water-Bearing Zone*
- Dry Unconsolidated Sediments
- Fill Material
- Blacktop
- *Potentiometric Surface (January 14-17, 2010)*

⇨ Direction of Groundwater Flow

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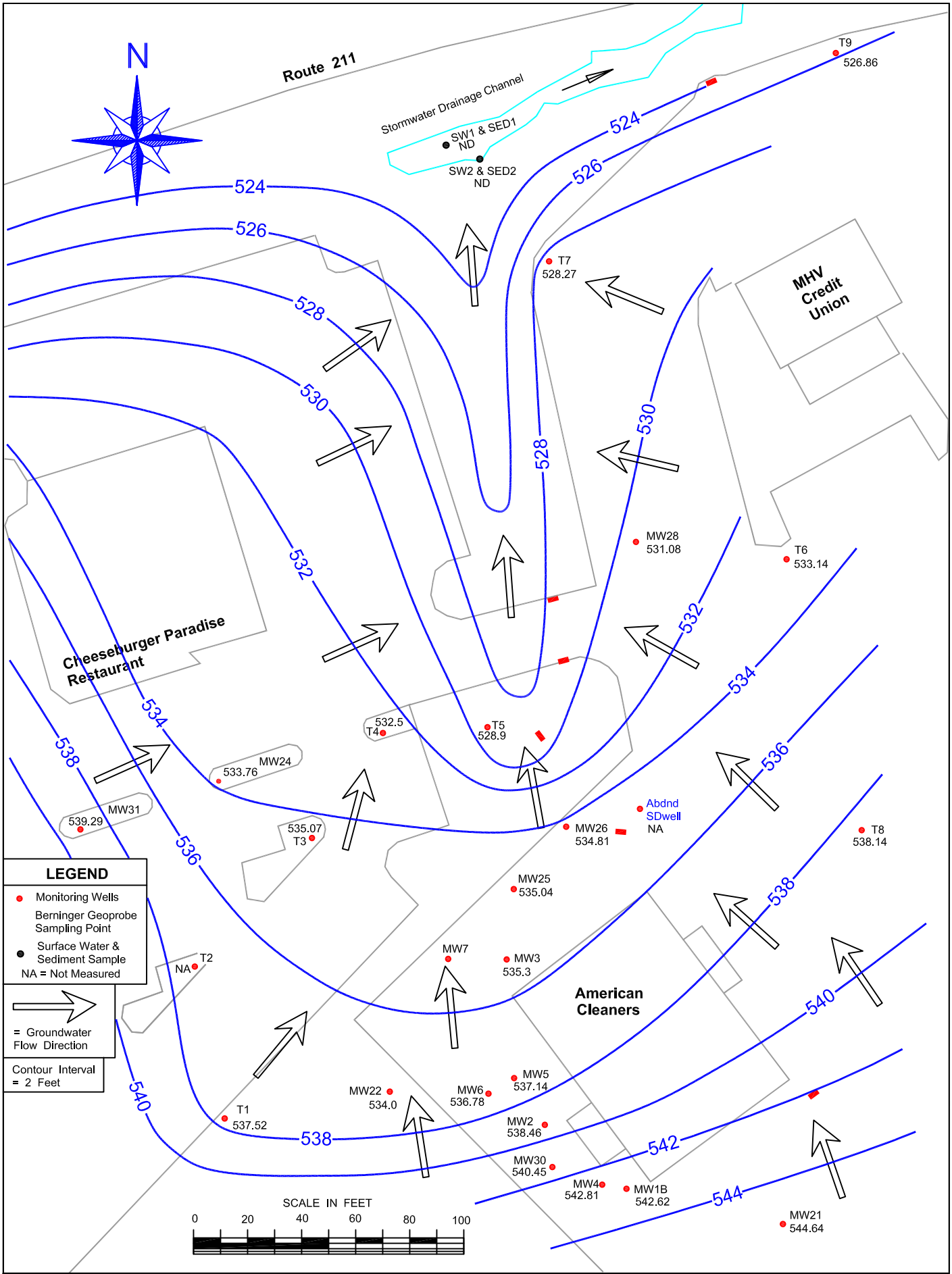

Figure 4-5. Contour Map of Groundwater Elevations for January 14-17, 2010, Measurements taken during Mid-Hudson Geosciences Sampling Event. Elevations in Feet relative to mean sea level.

American Cleaners at Caldor Lloyds Mall
340 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP V-00461-3, Feb 2010

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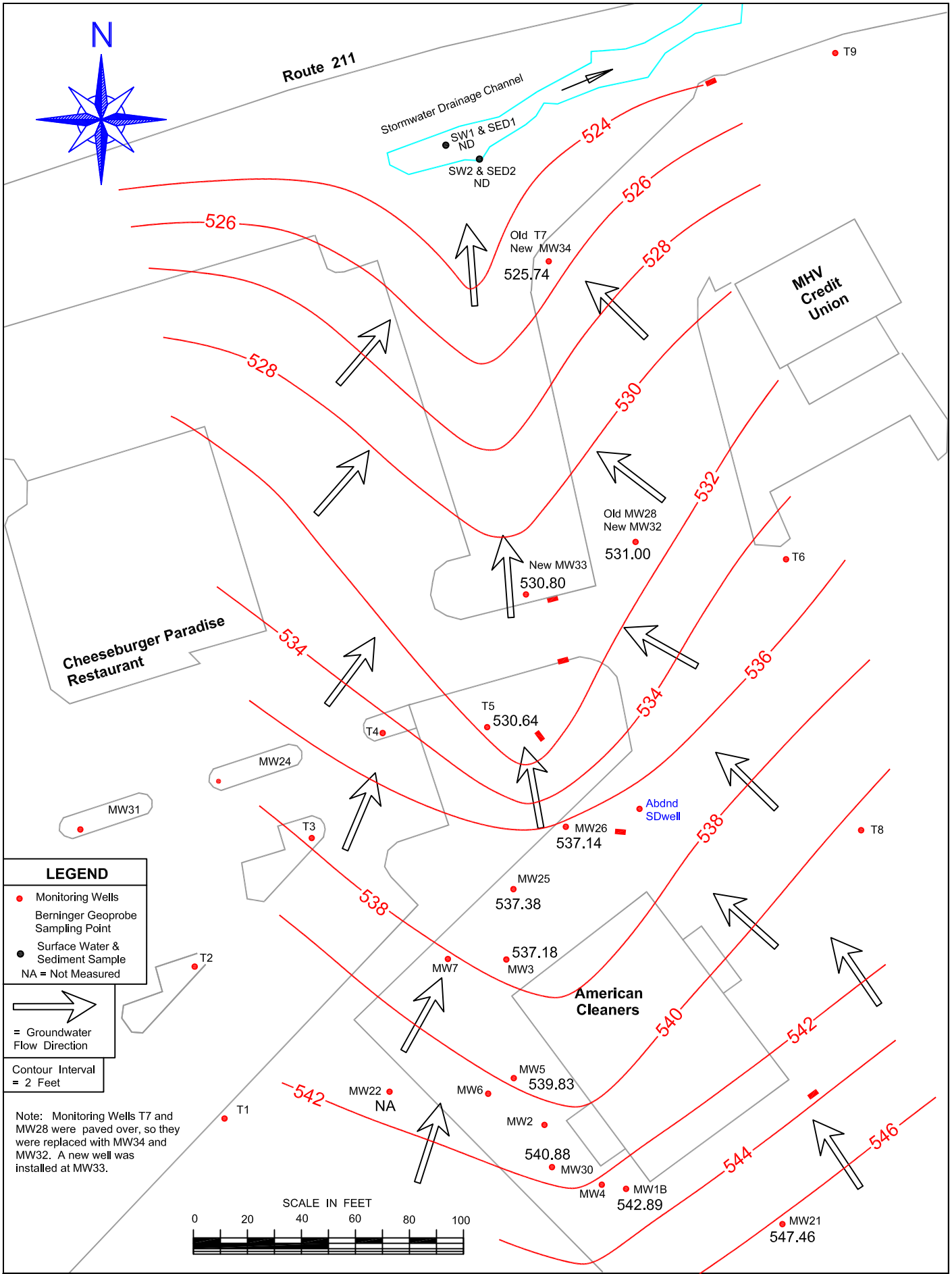

Figure 4-6. Contour Map of Groundwater Elevations June 20, 2017, Measurements taken during Mid-Hudson Geosciences Sampling Event. Elevations in Feet relative to mean sea level.

American Cleaners at Caldor Lloyds Mall
340 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP V-00461-3, Feb 2010

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N

Route 211

Stormwater Drainage Channel

SW1 & SED1
ND

SW2 & SED2
ND

T9
ND

T7
PCE=ND
disDCE=1J

MHV Credit Union

Cheeseburger Paradise Restaurant

MW28
PCE=270
TCE=24
disDCE=25

T6
ND

T4
PCE=1J

T5
PCE=47
TCE=4J
disDCE=24

MW24
ND

MW31
ND

T3
PCE=18
TCE=2
disDCE=24

Abdnd
SDwell
Not Sampled

MW26
PCE=2600
TCE=64
disDCE=64
VC=2

T8
ND

MW25
PCE=910
TCE=19
disDCE=22

0
200
400
800
1200
1600
2000
2400

LEGEND

Monitoring Wells

Contour Interval as shown on lines.

= Groundwater Flow Direction superimposed from Figure 4-5

T2
Not Sampled

MW7
PCE=69
TCE=7
disDCE=3J

MW3
PCE=430
TCE=10J
disDCE=15J
MTBE=6J

American Cleaners

MW5
PCE=240
TCE=11
disDCE=5J

MW22
PCE=42

MW6
PCE=280

MW2
PCE=110

MW30
PCE=110

T1
ND

MW4
ND

MW1B
ND

MW21
ND

SCALE IN FEET
0 20 40 60 80 100

Figure 5-5. Isopleth Map of PCE Concentrations (in ug/L) in Groundwater, Mid-Hudson Geoscience January 2010 Sampling Event.

American Cleaners at Caldor Lloyds Mall
340 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP V-00461-3, Feb 2010

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(845) 883-5866
rockdoctor@optonline.net

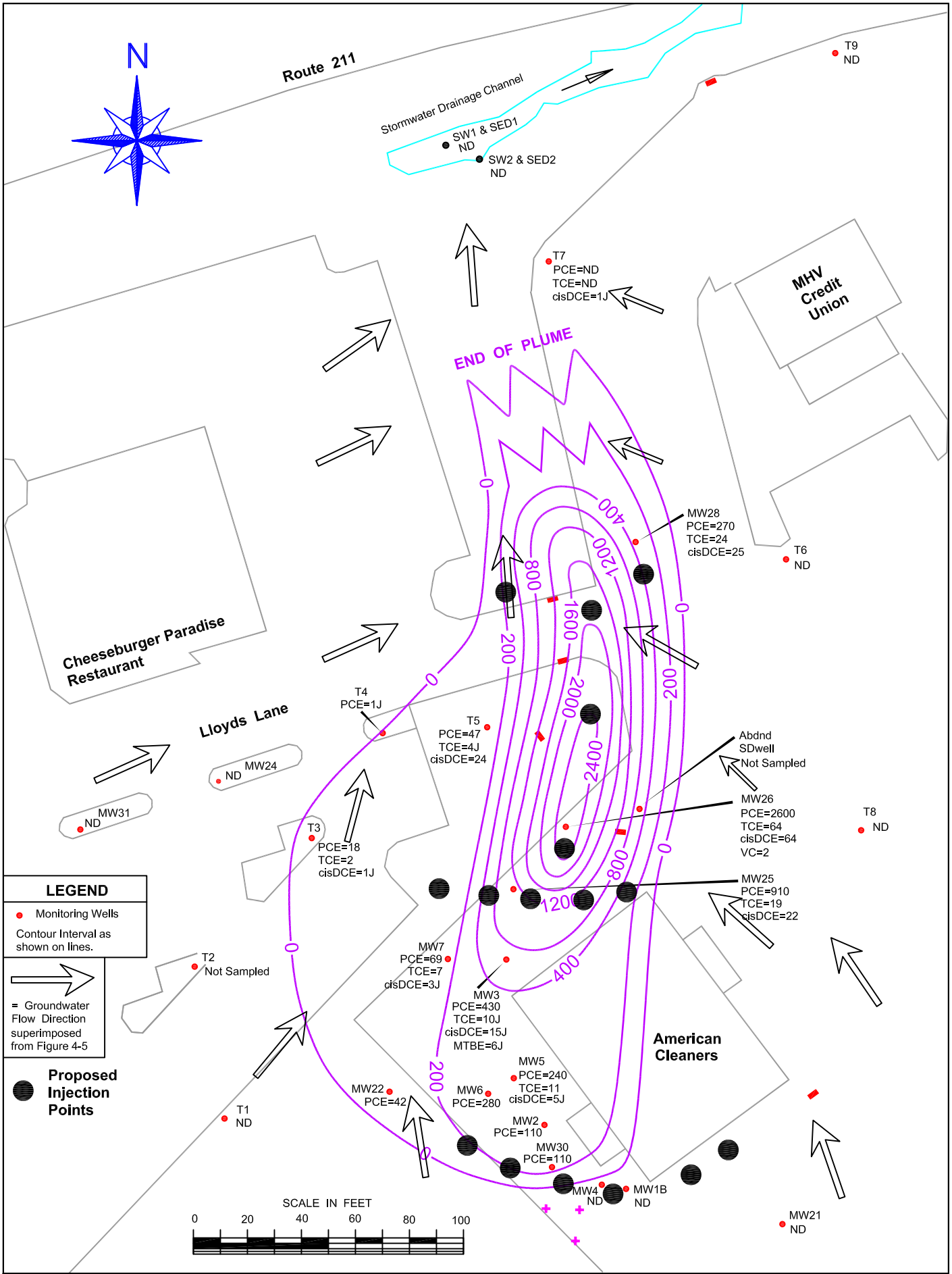

Figure 5-6. Proposed remedial injection points with PCE plume shown with 2010 groundwater sampling points and PCE concnetrations (ug/L).

American Cleaners at Caldor Lloyds Mall
340 Route 211 East, Middletown, NY 10940
NYSDEC DER VCP V-00461-3, Feb 2010

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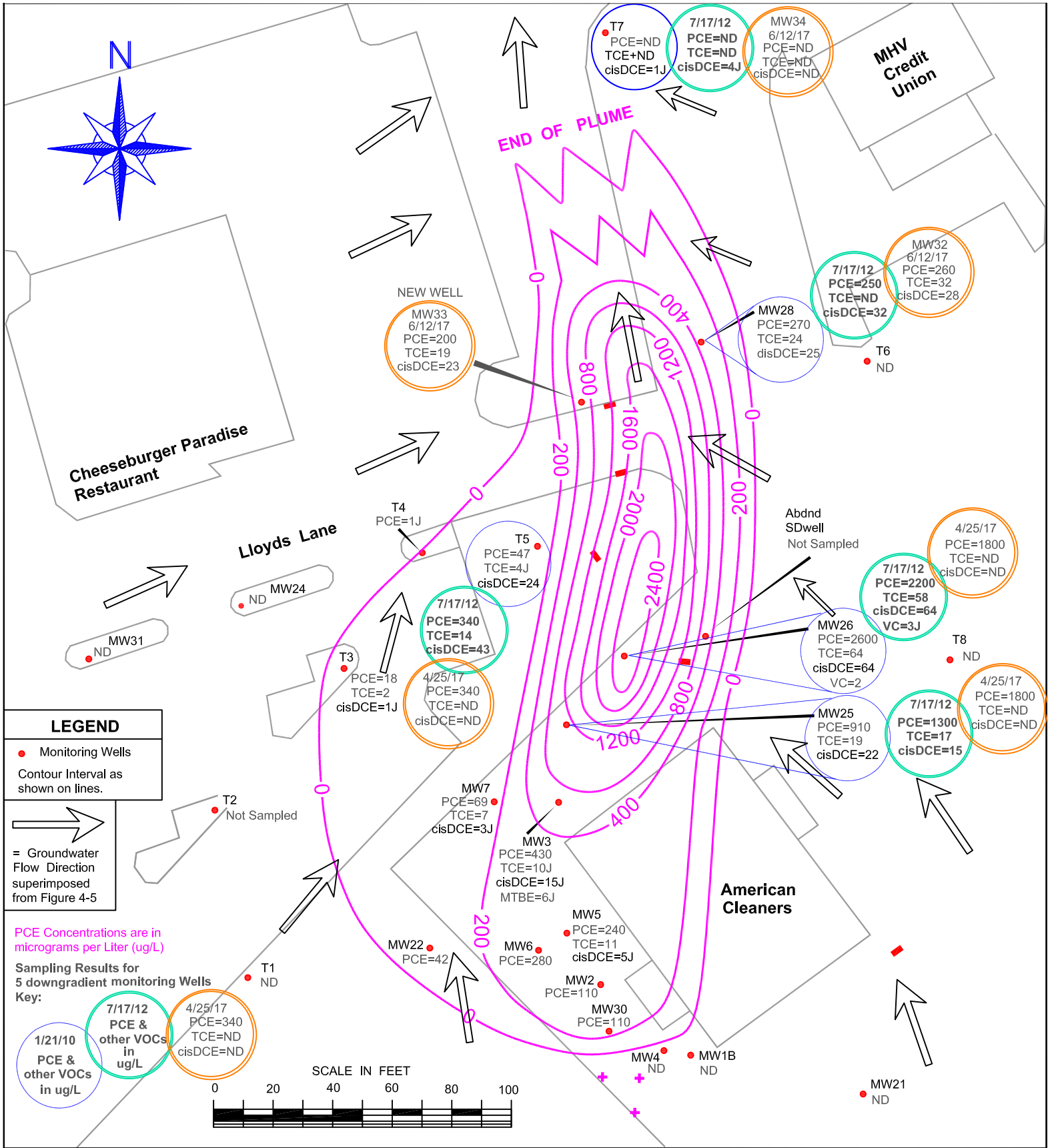

Figure 5-18. PCE Plume in January 2010 showing 2010, 2012, and 2017 VOC concentrations for 5 down-gradient monitoring wells, shown in circles, plus replacement wells for those paved over and new MW33.

American Cleaners at Caldor Lloyds Mall
340 Route 211 East, Middletown, NY 10940
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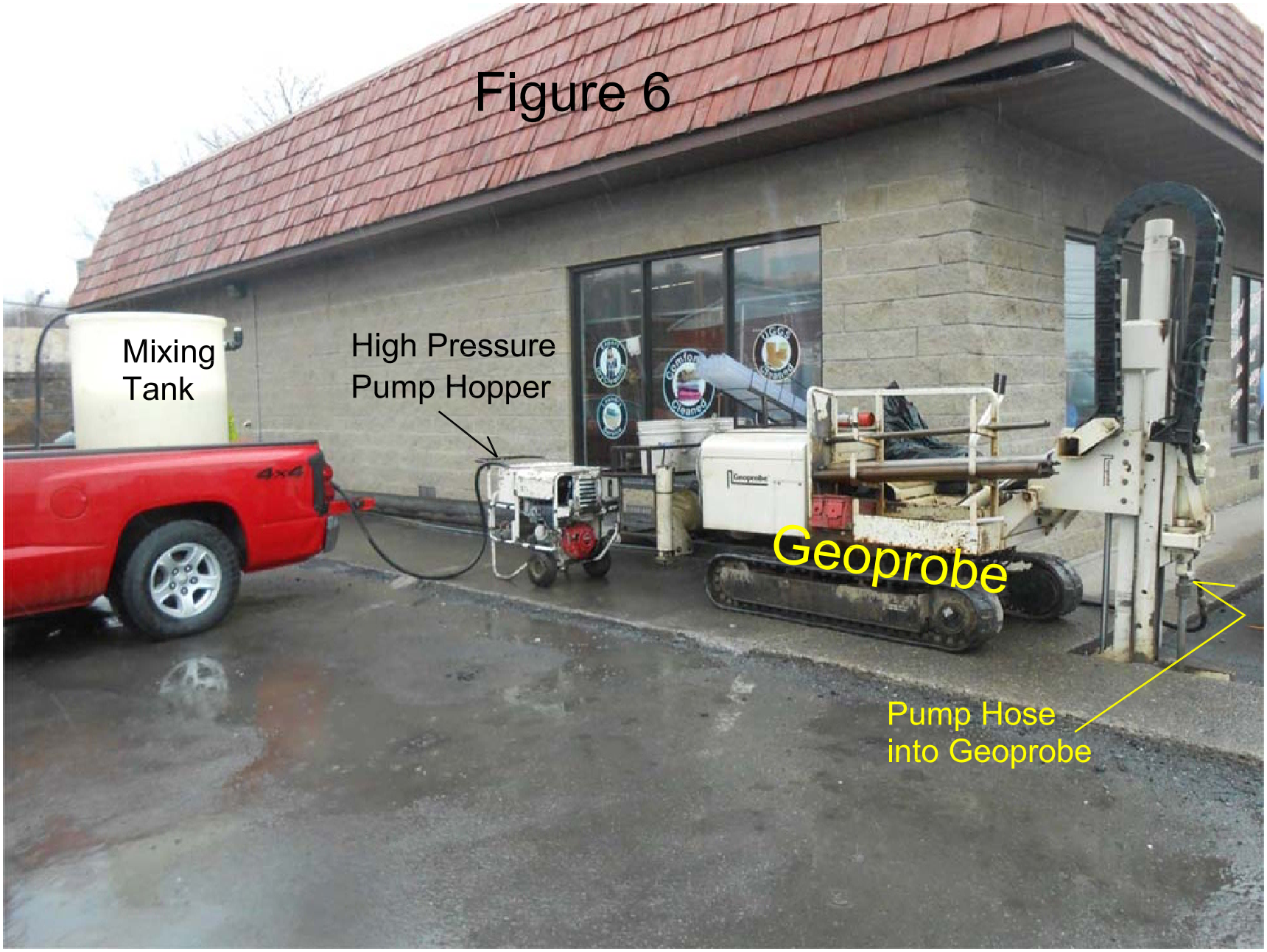

P29. The entire injection setup can be seen here. The 3-D MicroEmulsion is pumped into the hopper of the high pressure pump which pumps it into the drill rod in the ground. 4/15

3-D MicroEmulsion® FACTORY EMULSIFIED

STAGED RELEASE, pH NEUTRAL, FACTORY EMULSIFIED ELECTRON DONOR

DESCRIPTION

Factory emulsified 3-D Microemulsion is a unique electron donor material that offers an engineered, 3 stage electron donor release profile, pH neutral chemistry and is delivered on-site as a factory emulsified material. This new molecule also exhibits a novel hydrophile-lipophile balance (HLB) which provides maximum subsurface distribution well beyond that of emulsified vegetable oils.

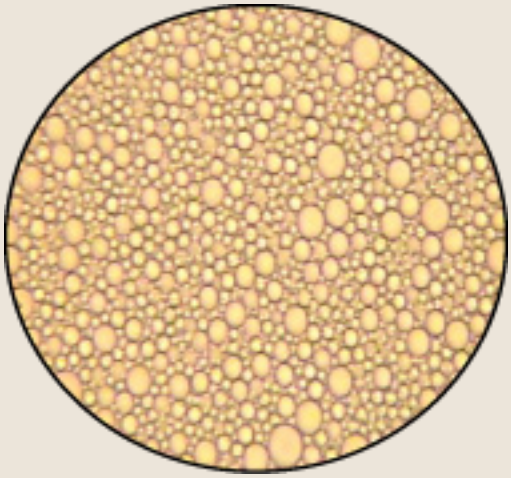

FIGURE 1: Microscopic view of factory emulsified 3-D Microemulsion.

FEATURES & BENEFITS

- **3 Stage Electron Donor Release Profile Avoids Multiple Re-applications Saving Time and Money**

This feature optimizes start to finish timing of the enhanced reductive dechlorination process through an immediate, mid-range and long-term electron donor release. Without a 3 stage release profile, bioremediation efforts are inefficient, causing gaps in electron donor supply and requiring multiple injections. Factory emulsified 3-D Microemulsion offers a 3 stage electron donor release for optimal results (Figure 2).

Stage 1 - Immediately available free lactic acid (lactate) is fermented rapidly

Stage 2 - Controlled-release lactic acid (lactate esters and polylactate esters) are metabolized at a more controlled rate

Stage 3 - Free fatty acids and fatty acid esters are converted to hydrogen over a mid to long-range timeline giving factory emulsified 3-D Microemulsion an exceptionally long electron donor release profile

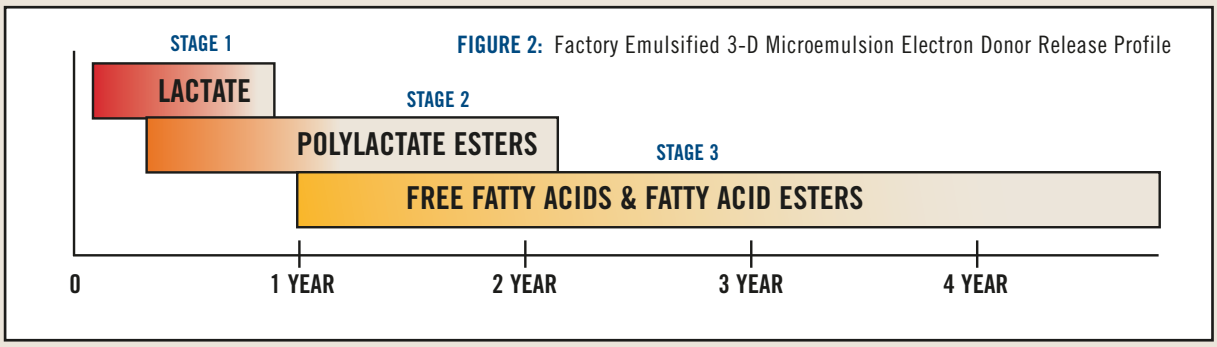

FIGURE 2: Factory Emulsified 3-D Microemulsion Electron Donor Release Profile

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Advanced Technologies for Contaminated Site Remediation

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3-D MicroEmulsion® FACTORY EMULSIFIED

STAGED RELEASE, pH NEUTRAL, FACTORY EMULSIFIED ELECTRON DONOR

FEATURES & BENEFITS

- **A Unique Hydrophile/Lipophile Balance (HLB) Enhances Distribution and Limits Reduction in Hydraulic Conductivity**

  The HLB feature allows the product to distribute in the subsurface via micellar movement. During this process, microscopic colloidal aggregates (micelles) continuously propagate from areas of high concentration to those of lower concentration moving the factory emulsified 3-D Microemulsion electron donor material into areas beyond those affected by the initial injection. This enhanced distribution mechanism allows for greater spacing between injection points and less time required for material application. Additionally, due to its unique hydrophile-lipophile balance, applications of factory emulsified 3-D Microemulsion have not resulted in the significant aquifer blockage as seen with the use of emulsified oil products.

- **Highly Efficient Application Designs**

  When designing an *in situ* remediation project with factory emulsified 3-D Microemulsion, application designs are based on mass balance and stoichiometric demand from the contaminant, competing electron acceptors and a minimum total organic carbon (TOC) loading. This often results in a more efficient dosing requirement compared to design methods employed by other electron donor suppliers.

FIGURE 3: A 2000 lb. tote of factory emulsified 3-D Microemulsion. The material can be delivered in drums, totes or tanker trucks.

- **Neutral pH**

  Neutral pH minimizes potentially harmful impacts to beneficial biodegrading microorganisms required to metabolize chlorinated contaminants. This feature can be highly valuable when the microemulsion is used in conjunction with pH-sensitive commercial bioaugmentation cultures

- **Injection-Ready Formulation, Simple and Easy Application**

  3D Microemulsion is delivered on-site as a factory emulsified, injection-ready product. It can be applied as delivered or further diluted and mixed with additional site water to form a higher-volume ready-to-inject microemulsion. This material can be applied through a variety of application techniques including permanent or temporary injection wells and direct-push points.

- **Choose from a Range of Packaging Options**

  Factory emulsified 3-D Microemulsion can be delivered in 400 lb. drums, 2000 lb. totes and large volume tanker trucks making shipping, receiving and application on any site simple and convenient (Figure 3).

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Accelerate the process of complete dechlorination

Bio-Dechlor INOCULUM (Dechlorinating Microbes)

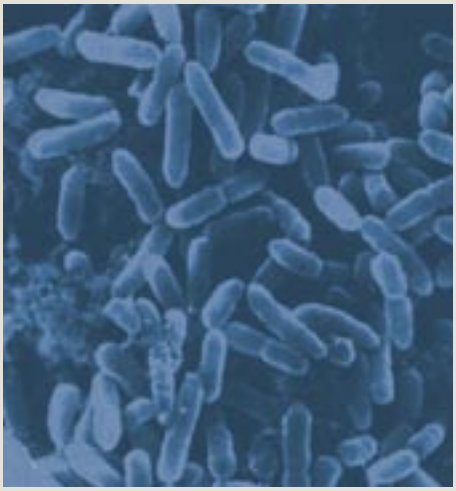
BIO-DECHLOR INOCULUM

BIOAUGMENTATION TO ACCELERATE THE PROCESS OF COMPLETE DECHLORINATION

Bio-Dechlor INOCULUM® is an enriched natural microbial consortium containing species of *Dehalococcoides* sp. (DHC). This microbial consortium has since been enriched to increase its ability to rapidly dechlorinate contaminants during in situ bioremediation processes. Bio-Dechlor INOCULUM has been shown to stimulate the rapid and complete dechlorination of compounds such as tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC). The most current culture of Bio Dechlor INOCULUM PLUS(+) now contains microbes capable of dehalogenating halomethanes (e.g. carbon tetrachloride and chloroform) and haloethanes (e.g. 1,1,1 TCA and 1,1, DCA) as well as mixtures of these halogenated contaminants.

Bio-Dechlor INOCULUM PLUS(+) is provided in a liquid form and is designed to be injected directly into the contaminated subsurface. Once in place, this microbial consortium works to accelerate the extant rate of chlorinated ethene degradation. When faced with an insufficient quantity of critical dechlorinating microbes, Bio-Dechlor INOCULUM PLUS(+) supplies many beneficial chlorinated solvent degraders including the all important DHC required to achieve complete and rapid dechlorination.

This microbial consortium is compatible with most electron donors however it is often optimized with the addition of any of Regenesis' Hydrogen Release Compound (HRC®) products.



SPECIES OF *DEHALOCOCCOIDES* SP. (DHC)

BIO-DECHLOR CENSUS

DETECTION AND QUANTIFICATION OF *DEHALOCOCCOIDES* (DHC) IN THE SUBSURFACE

The advent of modern biotechnology has allowed the development of unique and rapid genetic assays for the detection of microorganisms. Bio-Dechlor CENSUS℠, an example of this advance, offers a state-of-the-art technique for the quantitative detection of *Dehalococcoides*, the microbe shown to be required for complete biodegradation of higher chlorinated compounds through to ethene.[1, 2]

Existing analytical technologies offer only a crude qualitative assessment (+/-) of the presence of the required *Dehalococcoides* species. These tests utilize a common technique known as the Polymerase Chain Reaction (PCR), whereby traces of DNA specific only to microbes of interest (their "fingerprint") are amplified from environmental samples such that they can be detected. This approach, unfortunately, does not allow for specific quantification of the existing and present microbial population, leaving the environmental professional with insufficient information for complete site assessment and management.

Regenesis now offers a solution to the quantification dilemma, Bio-Dechlor CENSUS. This census of critical microorganisms is a proprietary analysis and is provided by specialized laboratories in the environmental industry. Bio-Dechlor CENSUS utilizes a process termed "Real-Time PCR" in which the DNA amplification step is actually quantified with a fluorescent signal, indicating the number of target microbes in the sample (Figure 1). This valuable quantitative information allows environmental professionals to properly assess project sites for the potential for natural biodegradation of chlorinated contaminants and the degree of bioaugmentation that may be required.

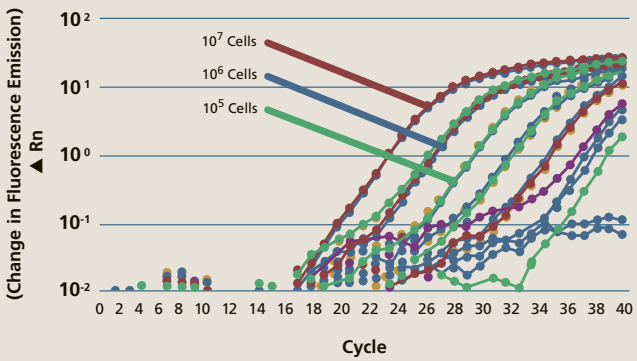


FIGURE 1: REAL-TIME PCR AMPLIFICATION OF 10-FOLD DILUTIONS OF GENOMIC DNA DERIVED FROM *DEHALOCOCCOIDES*

1. Maymo-Gatell, X.; Y-T Chien; J.M Gossett; S.H. Zinder, Science 1997, 276, 1568-1571.
2. Löffler, F.E.; Q. Sun; J. Li; J.M. Tiedje; Applied Environmental Microbiology 2000, 66(4), 1369-1374.

REGENESIS
Advanced Technologies for Groundwater Resources

Material Safety Data Sheet (MSDS)

Bio-Dechlor INOCULUM PLUS (BDI PLUS™)

SECTION 1 - MATERIAL IDENTIFICATION AND INFORMATION

Material Name: DHC microbial consortium (SDC-9) MSDS #: ENV 1033

Date Prepared: 1/05/2006 CAS #: N/A (Not Applicable)

Prepared By: Simon Vainberg Formula #: N/A

Material Description: Non-hazardous, naturally occurring non-altered anaerobic microbes and enzymes in a water-based medium.

SECTION 2 - INGREDIENTS

Components	%	OSHA PEL	ACGIH TLV	OTHER LIMITS
Non-Hazardous Ingredients	100	N/A	N/A	N/A

SECTION 3 - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point: 100°C (water) Specific Gravity (H_2O = 1): 0.9 - 1.1

Vapor Pressure @ 25°C: 24 mm Hg (water) Melting Point: 0°C (water)

Vapor Density: N/A Evaporation Rate (H_2O = 1): 0.9 - 1.1

Solubility in Water: Soluble Water Reactive: No

pH: 6.0 - 8.0

Appearance and Odor: Murky, yellow to grey water. Musty odor.

SECTION 4 - FIRE AND EXPLOSION HAZARD DATA

Flash Point: N/A

Flammable Limits: N/A

Extinguishing Media: Foam, carbon dioxide, water

Special Fire Fighting Procedures: None

Unusual Fire and Explosion Hazards: None

SECTION 5 - REACTIVITY DATA

Stability: Stable

Conditions to Avoid: None

Incompatibility (Materials to Avoid): Water-reactive materials

Hazardous Decomposition Byproducts: None

SECTION 6 - HEALTH HAZARD DATA

HEALTH EFFECTS

The effects of exposure to this material have not been determined. Safe handling of this material on a long-term basis will avoid any possible effect from repetitive acute exposures. Below are possible health effects based on information from similar materials. Individuals hyper allergic to enzymes or other related proteins should not handle.

Ingestion: Ingestion of large quantities may result in abdominal discomfort including nausea, vomiting, cramps, diarrhea, and fever.

Inhalation: Hypersensitive individuals may experience breathing difficulties after inhalation of aerosols.

Skin Absorption: N/A

Skin Contact: May cause skin irritation. Hypersensitive individuals may experience allergic reactions to enzymes.

Eye Contact: May cause eye irritation.

FIRST AID

Ingestion: Get medical attention if allergic symptoms develop (observe for 48 hours). Never give anything by mouth to an unconscious or convulsing person.

Inhalation: Get medical attention if allergic symptoms develop.

Skin Absorption: N/A

Skin Contact: Wash affected area with soap and water. Get medical attention if allergic symptoms develop.

Eye Contact: Flush eyes with plenty of water for at least 15 minutes using an eyewash fountain, if available. Get medical attention if irritation occurs.

NOTE TO PHYSICIANS: All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this material may have occurred.

SECTION 7 - SPILL AND LEAK PROCEDURES

Reportable quantities (in lbs of EPA Hazardous Substances): N/A

Steps to be taken in case of spill or release: No emergency results from spillage. However, spills should be cleaned up promptly. All personnel involved in the cleanup must wear protective clothing and avoid skin contact. Absorb spilled material or vacuum into a container. After clean-up, disinfect all cleaning materials and storage containers that come in contact with the spilled liquid.

Waste Disposal Method: No special disposal methods are required. The material may be sewered, and is compatible with all known biological treatment methods. To reduce odors and permanently inactivate microorganisms, mix 100 parts (by volume) of SDC-9 consortium with 1 part (by volume) of bleach. Dispose of in accordance with local, state and federal regulations.

SECTION 8 - HANDLING AND STORAGE

Hand Protection: Rubber gloves.

Eye Protection: Safety goggles with side splash shields.

Protective Clothing: Use adequate clothing to prevent skin contact.

Respiratory Protection: Surgical mask.

Ventilation: Provide adequate ventilation to remove odors.

Storage & Handling:
Material may be stored for up to 3 weeks at 2-4°C without aeration.

Other Precautions: An eyewash station in the work area is recommended.

3-D Microemulsion (3DMe)™
MATERIALS SAFETY DATA SHEET

Last Revised: March 26, 2007

Section 1 – Material Identification

Supplier:

REGENESIS
1011 Calle Sombra
San Clemente, CA 92673
Phone: 949.366.8000
Fax: 949.366.8090
E-mail: info@regenesis.com

Chemical Name(s):	• Glycerides, di-, mono [2-[2-[2-(2-hydroxy-1-oxopropoxy)-1-oxopropoxyl]-1-oxopropoxy]propanoates] • Propanoic acid, 2-[2-[2-(2-hydroxy-1-oxopropoxy)-1-oxopropoxy]-1-oxopropoxy]-1,2,3-propanetriyl ester • Glycerol
Chemical Family:	**Organic Chemical**
Trade Name:	**3-D Microemulsion (3DMe)™**
Synonyms:	**HRC Advanced™ HRC-PED (Hydrogen Release Compound – Partitioning Electron Donor)**
Product Use:	**Used to remediate contaminated groundwater (environmental applications)**

Section 2 – Chemical Identification

CAS#	Chemical
823190-10-9	**HRC-PED**
61790-12-3 or 112-80-1	**Fatty Acids (neutralized)**
201167-72-8	**Glycerol Tripolylactate**
56-81-5	**Glycerol**

Regenesis – 3-D Microemulsion MSDS

Section 3 – Physical Data

Melting Point:	**Not Available (NA)**
Boiling Point:	**Not determined (ND)**
Flash Point:	**> 200 ºF using the Closed Cup method**
Density:	**0.9 -1.1 g/cc**
Solubility:	**Slightly soluble in acetone. Insoluble in water.**
Appearance:	**Amber semi-solid.**
Odor:	**Not detectable**
Vapor Pressure:	**None**

Section 4 – Fire and Explosion Hazard Data

Extinguishing Media: **Use water spray, carbon dioxide, dry chemical powder or appropriate foam to extinguish fires.**

Water May be used to keep exposed containers cool.

For large quantities involved in a fire, one should wear full protective clothing and a NIOSH approved self contained breathing apparatus with full face piece operated in the pressure demand or positive pressure mode as for a situation where lack of oxygen and excess heat are present.

Section 5 – Toxicological Information

Acute Effects: **May be harmful by inhalation, ingestion, or skin absorption. May cause irritation. To the best of our knowledge, the chemical, physical, and toxicological properties of the 3-D Microemulsion have not been investigated. Listed below are the toxicological information for glycerol, lactic acid and fatty acid.**

RTECS#

MA8050000

Glycerol

Irritation Data:

SKN-RBT 500 MG/24H MLD	**85JCAE-,207,1986**
EYE-RBT 126 MG MLD	**BIOFX* 9-4/1970**
EYE-RBT 500 MG/24H MLD	**85JCAE-,207,1986**

Regenesis – 3-D Microemulsion MSDS

Section 5 – Toxicological Information (cont)

Toxicity Data:	**ORL-MUS LD50:4090 MG/KG**	**FRZKAP (6),56,1977**
	SCU-RBT LD50:100 MG/KG	**NIIRDN 6,215,1982**
	ORL-RAT LD50:12,600 MG/KG	**FEPRA7 4,142,1945**
	IHL-RAT LC50: >570 MG/M3/1H	**BIOFX* 9-4/1970**
	IPR-RAT LD50: 4,420 MG/KG	**RCOCB8 56,125,1987**
	IVN-RAT LD50:5,566 MG/KG	**ARZNAD 26,1581,1976**
	IPR-MUS LD50: 8,700 MG/KG	**ARZNAD 26,1579,1978**
	SCU-MUS LD50:91 MG/KG	**NIIRDN 6,215,1982**
	IVN-MUS LD50:4,250 MG/KG	**JAPMA8 39,583,1950**
	ORL-RBT LD50: 27 MG/KG	**DMDJAP 31,276,1959**
	SKN-RBT LD50: >10 MG/KG	**BIOFX* 9-4/1970**
	IVN-RBT LD50: 53 MG/KG	**NIIRDN 6,215,1982**
	ORL-GPG LD50: 7,750 MG/KG	**JIHTAB 23,259,1941**

Target Organ Data: **Behavioral (headache), gastrointestinal (nausea or vomiting), Paternal effects (spermatogenesis, testes, epididymis, sperm duct), effects of fertility (male fertility index, post-implantation mortality).**

Only selected registry of toxic effects of chemical substances (RTECS) data is presented here. See actual entry in RTECS for complete information on lactic acid and glycerol.

Fatty Acids

Acute oral (rat) LD50 value for fatty acids is 10000 mg/kg. Aspiration of liquid may cause pneumonitis. Repeated dermal contact may cause skin sensitization.

Section 6 – Health Hazard Data

One should anticipate the potential for eye irritation and skin irritation with large scale exposure or in sensitive individuals. Product is not considered to be combustible. However, after prolonged contact with highly porous materials in the presence of excess heat, this product may spontaneously combust.

Handling: **Avoid continued contact with skin. Avoid contact with eyes.**

In any case of any exposure which elicits a response, a physician should be consulted immediately.

First Aid Procedures

Inhalation: **Remove to fresh air. If not breathing give artificial respiration. In case of labored breathing give oxygen. Call a physician.**

Ingestion: **No effects expected. Do not give anything to an unconscious person. Call a**

physician immediately. DO NOT induce vomiting.

Section 6 – Health Hazard Data (cont)

Skin Contact:	**Flush with plenty of water. Contaminated clothing may be washed or dry cleaned normally.**
Eye Contact:	**Wash eyes with plenty of water for at least 15 minutes lifting both upper and lower lids. Call a physician.**

Section 7 – Reactivity Data

Conditions to Avoid:	**Strong oxidizing agents, bases and acids**
Hazardous Polymerization:	**Will not occur.**
Further Information:	**Hydrolyses in water to form lactic acid, glycerol and fatty acids.**
Hazardous Decomposition Products:	**Thermal decomposition or combustion may produce carbon monoxide and/or carbon dioxide.**

Section 8 – Spill, Leak or Accident Procedures

After Spillage or Leakage:	**Neutralization is not required. The material is very slippery. Spills should be covered with an inert absorbent and then be placed in a container. Wash area thoroughly with water. Repeat these steps if slipperiness remains.**
Disposal:	**Laws and regulations for disposal vary widely by locality. Observe all applicable regulations and laws. This material may be disposed of in solid waste. Material is readily degradable and hydrolyses in several hours.**

No requirement for a reportable quantity (CERCLA) of a spill is known.

Section 9 – Special Protection or Handling

Should be stored in plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass containers.

Protective Gloves:	**Vinyl or Rubber**
Eyes:	**Splash Goggles or Full Face Shield. Area should have approved means of washing eyes.**
Ventilation:	**General exhaust.**
Storage:	**Store in cool, dry, ventilated area. Protect from incompatible materials.**

Regenesis – 3-D Microemulsion MSDS

Section 10 – Other Information

This material will degrade in the environment by hydrolysis to lactic acid, glycerol and fatty acids. Materials containing reactive chemicals should be used only by personnel with appropriate chemical training.

The information contained in this document is the best available to the supplier as of the time of writing. Some possible hazards have been determined by analogy to similar classes of material. No separate tests have been performed on the toxicity of this material. The items in this document are subject to change and clarification as more information becomes available.

9/5/17 Appendix 5

3-D Microemulsion® Installation Instructions

Introduction

3-D Microemulsion® (3DME), a form of HRC Advanced®, should ONLY be applied as a high- volume, microemulsion. In this form it offers greater physical distribution of the 3DME material across a larger potential radius from a single injection point. The production of a 3DME emulsion involves the on-site, volumetric mixing of 10 parts water with 1 part delivered 3DME concentrate to form the injection-ready 3DME. This microemulsion suspension can then be injected directly or further diluted to a predetermined ratio of 3DME to water. The following instructions provide details in the production and installation of 3DME.

Material Overview Handling and Safety

3DME concentrate is shipped and delivered in 4.25-gallon buckets. Each bucket has a gross weight of approximately 32 pounds. Each bucket contains 30 pounds of 3DME concentrate (net weight) and a nominal volume of 3.7 gallons. At room temperature, 3DME concentrate is a liquid material with a viscosity of approximately 500 centipoise, roughly the equivalent of pancake syrup. The viscosity of 3DME is not temperature sensitive above 50 °F (10 °C). However, below 50 °F the viscosity may increase significantly. If the user plans to apply the product in cold weather, consideration should be given to heating the material to above 60 °F so that it can be easily handled. 3DME concentrate should be stored in a warm, dry place that is protected from direct sunlight. It is common for stored 3DME concentrate to settle somewhat in the bucket, a quick pre-mix stir by a hand held drill with a paint or "jiffy mixer" attachment will rapidly re-homogenize the material. 3DME concentrate is non-toxic, however field personnel should take precautions while handling and applying the material. Field personnel should use appropriate personal protection equipment (PPE) including eye protection. Gloves should be used as appropriate based on the exposure duration and field conditions. A Material Safety Data Sheet is provided with each shipment. Personnel who operate field equipment during the installation process should have appropriate training, supervision, and experience and should review the MSDS prior to site operations.

Micro-Emulsion Production 3DME to Water Ratio

3DME concentrate should be mixed with water on a volume to volume (v/v) basis to produce a micro-emulsion starting at 10 parts water: 1 part 3DME. Although microemulsions can be easily produced using greater water volumes than 10 parts, e.g. 20 to 50 parts water to 1 part 3DME, the initial microemulsion should never be produced below a ratio of less than 10 parts water: 1 part 3DME v/v.

WARNING: Do not attempt to produce a microemulsion at less than 10 parts water to 1 part 3DME ratio v/v. This will produce an undesirable and unstable solution. The field production of 3DME is a very simple procedure; however, it is critical that the user follow the mixing directions outlined below. Never attempt to add water to the 3DME as this will produce an undesirable and unstable large emulsion. Always add the 3DME to a large volume of water.

As indicated previously the 10:1 ratio of water to 3DME v/v is the minimum water ratio that can be used, a greater ratio (more dilute solution) can easily be achieved and is governed by: A) the volume of

3DME required to treat the estimated contaminant mass, B) the pore volume in which the material is applied, C) the time available for installation (gallons/pump rate), and C) the estimated volume of 3DME that the target zone will accept over the time period allocated for installation.

Conceptually, although a higher volume of water to volume of 3DME will produce a larger volume of the suspension, it will lower the concentration of 3DME per gallon of solution. Thus, the benefit of using a high water/3DME v/v ratio in order to affect a greater pore volume of the subsurface aquifer is offset by the dilution of the 3DME per unit volume of suspension as well as by the limitations of the subsurface hydraulic conductivity and effective porosity (capacity of the aquifer to accept the volume of 3DME microemulsion).

It is important that the user plan in advance the v/v 3DME/water ratio to be employed at a project site. The resulting volume of solution will dictate the site water requirements and the time required for injection, etc. If upon injection of greater than 10:1 3DME microemulsion, the subsurface does not readily accept the volume of solution as designed, the user can adjust downward the v/v water to 3DME ratio until a more concentrated suspension is produced (this solution should never drop below the required 10 parts water: 1 part 3DME v/v production ratio).

For more information on designing a 3DME/water ratios to meet specific site conditions, please contact REGENESIS Technical Services.

Direct Push Application Requirements

One of the best methods to deliver the 3DME microemulsion into the subsurface is to pressure inject the solution through direct-push rods using hydraulic equipment, or to pressure inject/gravity feed the microemulsion into the dedicated injection wells. The use of low cost push points or temporary injection points allows the applier to more cost effectively distribute the 3DME material across shallow sites by employing multiple points per site. In the case of treating deep aquifer sites, the use of the microemulsion applied via dedicated injection wells is likely to be the most cost effective remediation approach. Please note that this set of instructions is specific to direct-push equipment. Please contact REGENESIS Technical Services to assist you with dedicated injection well applications.

In general, REGENESIS strongly recommends application of the 3DME microemulsion using an injection pump with a minimum delivery rate of three gallons per minute (gpm) and a pressure rating of between 150 to 200 pounds per square inch (psi).

Note: The injection pump requirements are different than the requirements of the mixing pump (see Mixing to Generate 3DME Microemulsion). High pressure, positive displacement pumps and progressive cavity pumps are appropriate for injecting 3DME. For low permeability lithologies (clay, silt) higher pressure pumps (800-1600 psi) may be necessary, while for more permeable lithologies (gravel, sand) a lower pressure pump may be adequate.

Examples of appropriate pumps are: Rupe Models 6-2200, 9-1500 and 9-1600 (positive displacement), Geoprobe® GS- 2000 (positive displacement) and DP-800 (progressive cavity), Yamada (air diaphragm), Moyno (progressive cavity), and Wilden (air diaphragm). Delivery rate is a critical factor in managing installation time and costs. Generally, higher delivery rates (>6 gpm) are more cost effective for these types of applications but pump selection should be on a site specific basis and account for the volume of 3DME solution and specific aquifer conditions present at the site.

The installation of the 3DME microemulsion should span the entire vertical contaminated saturated thickness. If the vertical extent of the application is confined to a limited interval, then the microemulsion should be placed across a vertical zone extending a minimum of one-foot above and one-foot below the screened interval of monitoring wells that are being used to evaluate the performance of the project.

Producing the 3DME Microemulsion

The application of 3DME requires the creation of a microemulsion. Technically the optimal suspension is an 3DME-in-water suspension containing microemulsions. Before beginning the mixing procedure the user should have in mind the desired water to 3DME ratio v/v desired.

It is critical that the microemulsion be produced using a high-shear apparatus such as a high speed centrifugal pump. The shearing provided by the vanes in these types of pumps is sufficient to form and maintain a homogeneous milky emulsion. This pump will be a different pump than that used to inject the 3DME microemulsion into the subsurface. If the user is uncertain as to requirements for the pump or the applicability of a certain pump, please contact REGENESIS Technical Services. REGENESIS typically suggests using a water trailer/pump apparatus commonly found at equipment rental facilities. REGENESIS recommends using a Magnum Products LLC model MWT500 or equivalent water trailer (fitted with centrifugal recirculation pump). This “trash pump” or transfer pump is an ideal high shear pump and the water tank (400 gallons) serves as an excellent mixing tank.

To ensure that proper microemulsion suspension is generated REGENESIS suggests a two-step process that simply requires mixing at least 10 parts water to 1 part 3DME concentrate using water at a temperature ≥ 60 °F.

Step 1. REGENESIS recommends that the 3DME concentrate in each bucket be re- homogenized using a drill equipped with a paint or “jiffy” mixer attachment as minor settling may have occurred during shipment.

Step 2. To calculate the volume of water necessary to produce a 10:1 v/v microemulsion, each bucket of 3DME concentrate containing 3.7 gallons of material should be mixed with 37 gallons of water.

Example: 6 buckets x 3.7 gallons 3DME concentrate/bucket yields a total of 22.2 gallons of 3DME concentrate. Thus, a 10:1 v/v solution will require 222 gallons of water (22.2 gallons 3DME concentrate x 10 gallons water yields 222 gallons of water). A nominal total volume microemulsion would result from the summation of the 3DME concentrate volume (22.2 gallons) and the water volume (222 gallons). This yields a total fluids delivery volume of approximately 244 gallons.

The previously calculated water volume (222 gallons) should be transferred into an appropriately sized mixing tank. The water should be circulated by the high shear centrifugal pump and each of the six 3DME buckets slowly poured into the tank. Each bucket of 3DME concentrate should be poured at a slow rate (approx. 1 minute per bucket) and the contents of the tank continually recirculated using the high hear centrifugal pump. A period of 1-2 minutes should be allowed between addition of each subsequent bucket of 3DME concentrate to allow the centrifugal pump to continue to shear and mix the water/3DME concentrate. Upon addition of the entire volume of 3DME concentrate the pump

should remain on to allow the solution mixture to recirulate. The recirculation of the 3DME microemulsion should continue until the material is injected to maintain microemulsion consistency.

Application of microemulsion Using Direct-Push Methods

1. Prior to the installation of the microemulsion, any surface or overhead impediments should be identified as well as the location of all underground structures. Underground structures include but are not limited to: utility lines, tanks, distribution piping, sewers, drains, and landscape irrigation systems.
2. Planned installation locations should be adjusted to account for all impediments and obstacles.
3. Pre-mark the installation locations, noting any points that may have different vertical application requirements or total depth.
4. Set up the direct-push unit over each specific point and follow the manufacturer's standard operating procedures (SOP). Care should be taken to assure that probe holes remain vertical.
5. For most applications, REGENESIS suggests using drive rods with an O.D. of at least 1.25-inches and an I.D. of at least 0.625-inches I.D (Geoprobe or equivalent). However, the lithologic conditions at some sites may warrant the use of larger 2.125-inch O.D./1.5-inch I.D. drive rods.
6. The most typical type of sub-assembly currently being used is designed for 1.25-inch direct-push rods and is manufactured by Geoprobe. Other brands of drive rods can also be used but require the fabrication of a sub-assembly that allows for a connection between the pump and drive rod.
7. For mixing large volumes of the microemulsion, REGENESIS recommends using a Magnum Products LLC model MWT500 water trailer (fitted with centrifugal recirculation pump) or equivalent unit. However, single large volume poly tanks are adequate. We suggest filling the tank with an appropriate quantity (e.g. from the example above 222 gallons) of water before start of mixing operations. The tank should be configured so that both a hose and a fire hydrant or larger water tank can be connected to it simultaneously and filled with water quickly and easily. This will dramatically reduce the time needed to fill the tank with mixing water.
8. REGENESIS highly recommends preparing the microemulsion before pushing any drive rods into the subsurface. NOTE: best if the microemulsion is produced a single day application volumes.
9. After the microemulsion mixing/shearing step has been completed as described above, the microemulsion is ready to be applied. Check to see if a hose has already been attached to the inlet side of the centrifugal pump. If this has not been done, do so now.
10. If a non-water trailer tank is being used for mixing the microemulsion a stand alone centrifugal pump and hose system should be used for the shearing and mixing operations.
11. Advance drive rods through the ground surface, as necessary, following SOP.
12. Push the drive rod assembly with an expendable tip to the desired maximum depth. REGENESIS suggests pre-counting the number of drive rods needed to reach depth prior to starting injection activities to avoid any miscalculations.
13. After the drive rods have been pushed to the desired depth, the rod assembly should be withdrawn three to six inches. The expendable tip can be dropped from the drive rods, following SOP.
14. If an injection tool is used instead of a direct-push rod with an expendable tip, the application of material can take place without any preliminary withdrawal of the rods.
15. In some cases, introduction of a large column of air may be problematic. This is particularly the case in deep injections (>50 ft) with large diameter rods (>1.5-inch O.D.). To prevent the injection of air into the aquifer during the application, fill the drive rods with 3DME emulsion after they have been pushed to the desired depth and before the disposable tip has been dropped or before the injection tip is operational.

16. Transfer the appropriate quantity of the microemulsion from the water trailer to the working/ application pump hopper or associated holding tank.
17. A volume check should be performed prior to the injection of the microemulsion. Determining the volume discharged per unit time/stroke using a graduated bucket and stopwatch or stroke counter.
18. Start the pump and use the graduated bucket to determine how many gallons of micro- emulsion are delivered each minute or stroke per unit volume.
19. Connect the 1.25-inch O.D., 1-inch I.D. delivery hose to the pump outlet and the appropriate sub-assembly. Circulate the microemulsion through the hose and the sub-assembly to displace any air present in the system.
20. Connect the sub-assembly to drive rod. After confirming that all of the connections are secure, pump the microemulsion through the delivery system to displace water or other fluids in the rods.
21. The pump engine RPM and hydraulic settings should remain constant throughout the day to maintain a constant discharge rate.
22. The material is now ready to be installed in the subsurface. Use the pumps discharge rate as calculated in step 18 to determine the withdrawal rate of the drive rods needed for the application.
23. Slowly withdraw the drive rods using Geoprobe Rod Grip or Pull Plate Assembly (Part AT1222-For 1.25-inch drive rods). While slowly withdrawing single lengths of drive rod (3 or 4 feet), pump the pre-determined volume of microemulsion into the aquifer across the desired treatment interval.
24. Remove one or two sections of the drive rod at a time. The drive rod may contain some residual material, REGENESIS suggests placing it in a clean, empty bucket and allowing the material to drain. Eventually, the material recovered in the bucket should be returned to pump hopper for reuse.
25. Observe any indications of aquifer refusal such as “surfacing” around the injection rods or previously installed injection points. If aquifer acceptance appears to be low, allow enough time for the aquifer to equilibrate prior to removing the drive rod.
26. Repeat steps 19-25 until treatment of the entire contaminated vertical zone has been achieved.
27. Install an appropriate seal, such as bentonite, above the microemulsion injection zone. The seal should span across the entire vadose zone. Depending on soil conditions and local regulations, a bentonite seal using chips or pellets can be used. If the injection hole remains open more than three or four feet below the ground surface sand can be used to fill the hole and provide a base for the bentonite seal. The installation of an appropriate seal assures that the microemulsion remains properly placed and prevents contaminant migration from the surface. If the microemulsion continues to “surface” up the direct-push borehole, an oversized disposable drive tip or wood plug/stake can be used to temporarily plug the hole until the aquifer equilibrates and the material stops surfacing.
28. Remove and clean the drive rods as necessary.
29. Finish the borehole at the surface as appropriate (concrete or asphalt cap, if necessary).
30. Periodically compare the pre- and post-injection discharge rates of the microemulsion in the pump hopper or holding tank using any pre-marked volume levels. If volume level indicators are not on the pumps hopper or holding tank use a pre-marked dipstick or alternatively temporary mark the hopper or holding tank with known quantities/volumes of water using a carpenter’s grease pencil (Kiel crayon).
31. Move to the next probe point, repeating steps 11-29.

Helpful Hints

1. Application in Cold Weather Settings

As discussed in the Material Overview, Handling, and Safety section, cold weather tends to increase the viscosity of 3DME as well as decrease the ease of microemulsion formation.

To optimize an application in cold weather settings REGENESIS recommends maintaining the 3DME concentrate and the associated water at a temperature ≥60oF (16oC). The following procedures can be used to facilitate the production and installation of a 10:1 v/v 3DME microemulsion.

- Raise and maintain the temperature of the HRC-A to at least 60 °F (16 °C) prior to mixing with water. A hot water bath can be used to heat up the 3DME concentrate buckets. A Rubbermaid fiberglass Farm Trough Stock Tank (Model 4242-00-GRAY) has been used for this process. This trough can hold up to 16 buckets of 3DME concentrate.
- Hot water (approximately 130-170 °F or 54-77 °C) should be added to the tank after the buckets of 3DME have been placed inside. The hot water should be delivered from a heated pressure washer (Hotsy® Model No. 444 or equivalent) or steam cleaner unit.
- It is equally critical that a moderate water temperature (>60 °F or 16°C) be used in the production of the microemulsion. If on-site water supply is below 60 °F use a hot water or steam cleaner to generate a small volume (e.g. 5-10% of total water volume) of hot water (130–170 °F/54-77 °C). This small volume of hot water should be added to remaining cold water volume to raise the total volume temperature to >60 °F. When the 3DME concentrate and water each reach a minimum temperature of 60 °F or 16 °C the two materials are ready for mixing.
- Upon achieving a minimum temperature of 60 °F or 16 °C (approximately 10-20 minutes). When the 3DME and the associated water volumes have reached a minimum temperature of 60 °F or 16 °C (approximately 10-20 minutes) they are ready for mixing.
- In exceptionally harsh winter temperature settings use of a separate insulated pump containment structure and insulated delivery hoses may be necessary.
- Use a pump with a heater unit.
- Periodically check the temperature of the material in the hopper.
- Re-circulate the 3DME microemulsion through the pump and hose to maintain temperature adequate temperatures.
- Care should be taken to avoid the re-circulation of material volumes that exceed the volume of the pump hopper or holding tank.

Table 1: Equipment Volume and 3DME microemulsion Weight per Unit Length of Hose (Feet)

Equipment	Volume	Product Weight
1-inch OD; 0.625-inch ID hose (10 feet)	0.2 gallon	1.6 lbs.
1.25-inch OD; 0.625-inch ID drive rod (3 feet):	0.05 gallon	0.4 lbs.
1.25-inch OD; 0.625-inch ID drive rod (4 feet):	0.06 gallon	0.5 lbs.

2. Pump Cleaning

For best results, use a heated pressure washer to clean equipment and rods periodically throughout the day. Internal pump mechanisms and hoses can be easily cleaned by re-circulating a solution of hot water and a biodegradable cleaner such as Simple Green through the pump and delivery hose. Further cleaning and decontamination (if necessary due to subsurface conditions) should be performed according to the equipment supplier's standard procedures and local regulatory requirements.

Note: Before using the Rupe Pump, check the following:

- Fuel level prior to engaging in pumping activities (it would be best to start with a full tank)
- Remote control/pump stroke counter LCD display [if no display is present, the electronic counter will need to be replaced (Grainger Stock No. 2A540)]
- Monitor pump strokes by observing the proximity switches (these are located on the top of the piston).

3. Bedrock Applications

When contaminants are present in competent bedrock aquifers, the use of direct-push technology as a delivery method is not possible. REGENESIS is in the process of developing methods for applying 3DME via boreholes drilled using conventional rotary techniques. To develop the best installation strategy for a particular bedrock site, it is critical that our customers call the Technical Services department at REGENESIS early in the design process.

The microemulsion can be applied into a bedrock aquifer in cased and uncased boreholes. The microemulsion can be delivered by simply filling the borehole without pressure or by using a single or straddle packer system to inject the material under pressure. Selection of the appropriate delivery method is predicated on site-specific conditions. The following issues should be considered in developing a delivery strategy:

- Is the aquifer's hydraulic conductivity controlled by fractures?
- Backfilling may be the better delivery method in massive, unfractured bedrock. This is particularly true in an aquifer setting with high permeability and little fracturing (such as that found in massive sandstone).
- Down-hole packer systems may be more advantageous in fractured bedrock aquifers.
- In this case the fracture type, trends, and interconnections should be evaluated and identified.
- Are the injection wells and monitoring wells connected by the same fractures?
- Determine if it is likely that the injection zone is connected to the proposed monitoring points.
- If pressure injection via straddle packers is desired, consideration should be given to the well construction. Specific issues to be considered are:
- Diameter of the uncased borehole (will casing diameter allow a packer system to be used under high pressures?).
- Diameter of the casing (same as above).
- Strength of the casing (can it withstand the delivery pressures?).
- Length of screened interval (screened intervals greater than 10 feet will require a straddle packer system).

For further assistance or questions please contact REGENESIS Technical Services at 949.366.8000

9/5/17 Appendix 6

BIO-DECHLOR INOCULUM

Bio-Dechlor INOCULUM PLUS (BDI PLUS®) Installation Instructions:

General Guidelines

Bio-Dechlor INOCULUM PLUS (BDI PLUS®) is an enriched natural microbial consortium containing species of Dehalococcoides. This microbial consortium has since been enriched to increase its ability to rapidly dechlorinate contaminants during *in situ* bioremediation processes. BDI PLUS has been shown to stimulate the rapid and complete dechlorination of compounds such as tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC). BDI PLUS also contains microorganisms capable of degrading chloromethanes (carbon tetrachloride and chloroform) as well as chloroethanes like trichloroethane (TCA).

Recent trends in engineered bioremediation indicate that the treatment of chlorinated solvent contamination sometimes results in slow or incomplete degradation of the intermediate compounds. When faced with this circumstance, bioaugmentation with a microbial consortium such as BDI PLUS offers a solution to accelerate or simply make possible the complete dechlorination of these otherwise recalcitrant compounds.

REGENESIS® believes that the best approach to install BDI PLUS into the subsurface is by direct-push methods. This allows for the BDI PLUS solution to be applied directly into the aquifer material and provides greater coverage/treatment over the life of the project. As a minimum, the following equipment will be needed to perform this type of installation:

- Direct-push drilling unit
- Grout pump (e.g. Geoprobe GS 2000)
- Appropriate hose assembly including a fitting that links a hose from the grout pump to the direct-push rods (provided by REGENESIS with shipment)
- One or more 55+ gallon water drums, fitted with an appropriate lid that has at least one bung hole (number of drums depends on size of application)
- Rotary transfer pump (or equivalent) with appropriate amount of hose to connect from 55-gal drum to hopper of grout pump (similar to Grainger No. 1P893, Fill-Rite model #FR112GR)
- Compressed Nitrogen gas tank with appropriate regulator (0 to 15 pounds per square inch (psi). A 300-ft^3 tank should be sufficient for discharge of concentrated or non-concentrated kegs and for nitrogen sparging to deoxygenate batch water.
- Pressure washer (or equivalent) for cleaning

Material Packaging and Safety

BDI PLUS is a mixture of living bacteria including members of the Dehalococcoides genus that are capable of anaerobically degrading chlorinated contaminants. The culture has been tested to ensure that it is free of the most common pathogenic bacteria, but like all living cultures it should be handled with due care to prevent contamination of work surfaces or field personnel.

During installation activities, REGENESIS recommends that field personnel use at least level “D” personal protection equipment (PPE). A Materials Safety Data Sheet (MSDS) is sent with each shipment and should be reviewed before proceeding with installation activities.

BIO-DECHLOR INOCULUM

Warning

- The BDI PLUS container is pressurized to 10 to 15 psi with nitrogen before shipping
- Wear suitable eye protection, gloves, respirator and protective clothing
- Gas cylinders used to dispense culture MUST be equipped with a proper pressure regulator
- During operation DO NOT exceed the containers maximum working pressure of 15 psi

Unpacking

1. Carefully remove the container from shipping cooler and stand upright. DO NOT use the plastic sight tube as a handle.
2. Carefully check the container, connectors, valves and tubing for any damage or defects. If defects or damage is observed, do not use. Report any damage to REGENESIS at 949.366.8000. A back up set of quick connects is provided in the packaging material.
3. Check and ensure that all valves are in the CLOSED position.

Storage

If the schedule of bacteria application requires adding the bacteria over a period of more than one day, the keg(s) should be stored at a temperature 2-4 °C, but freezing must be avoided. This can normally be achieved by storing the kegs under ice in the provided coolers. Keg should be pressurized with Nitrogen to pressure 10- 15 psi. before storing to ensure a tight seal on the keg cap.

Culture Keg in Cooler

Shipping

After completion of operation, please, ship cooler with keg and all attachments back to the following address:

Shaw Environmental, Inc.
17 Princess Road, Lawrenceville, NJ 08648

Specific Installation Procedures

1. The BDI PLUS must be added to the previously prepared “oxygen-free” water before it is installed in the subsurface. The desired amount of BDI PLUS should be carefully discharged into the 55-gal drum containing the appropriate amount of “oxygen free” water. The tables provided below indicates the amount of water that a given amount of BDI PLUS should be mixed with.
   The BDI PLUS must be added to “oxygen-free” water before it is installed in the subsurface. To ensure that the water has reached the desired anoxic state prior to mixing with BDI PLUS an appropriate amount of nitrogen sparging into the 55-gal drum containing a given amount of water at least one hour prior to adding the BDI PLUS. To ensure that a sufficient quantity of “oxygen free” water is available throughout the day, a large trough of “nitrogen sparged” water can be prepared and additional 55-gal drums can be filled from this trough. The water in the trough can be transferred to the 55-gal drums where the BDI is mixed with the water using a primed transfer pump.

Nitrogen sparging is accomplished by a gas sparging device equivalent to a fish tank aerator. Adjust the 300ft^3 nitrogen tank pressure regulator to 3-5 psi and immerse the gas sparger to the bottom of the drum or trough. By internal convection and oxygen stripping processes, the oxygen levels should diminish within an hour. Be careful to not consume too much gas and not have nitrogen to empty the kegs. Keeping an eye on tank pressure loss and dissolved oxygen level will indicate when one can trim down on the sparge pressure and conserve the nitrogen.

BDI PLUS Dilution Chart

Volume of BDI PLUS	Volume of Water
5 liters	50 gal
1 liter	10 gal

Volume of BDI PLUS Concentrate	Volume of Water
0.5 liters	50 gal
0.1 liter	10 gal

2. The drive rod assembly should be fitted with a disposable tip on the first drive rod and pushed down to the desired depth. This process should be done in accordance with the manufacturer's standard operating procedure (SOP).
3. A sub-assembly connecting the delivery hose to the drive rods and pump should be used. The sub-assembly should be constructed in a manner that allows for the drive rods to be withdrawn while the material is being pumped.
4. Prior to connecting the hose to the sub-assembly a volume check should be completed to determine the volume and weight of product displaced with each pump stroke.
5. After the drive rods have been pushed to the desired depth, the rod assembly should be with drawn three to six inches so that the disposable tip has room to be dropped.
   a. If an injection tool is used instead of an expendable tip, the application of material can take place without any preliminary withdrawal of the rods.
6. Fill the annular space of the drive rods with water. This will minimize the amount of air introduced to the system.
7. Insert the telescoping suction pipe on the rotary transfer pump into a bung hole on the lid of the 55-gal drum and make sure that the pipe reaches the bottom of the drum. If possible, attach the suction pipe to the bung hole with the 2" bung adapter to ensure that the pump remains securely in place while pumping the Bio-Dechlor INOCULUM mixture from the drum to the pump hopper.
8. Attach the hose to the outlet of the rotary transfer pump making sure that the opposite end of the hose reaches the pump hopper. Open the opposite bung hole on the drum lid to prevent a vacuum then pump the desired amount of BDI PLUS solution into the hopper of the pump.
9. Connect the hose from the grout pump to the drive rod assembly.
10. Start pumping the BDI PLUS product solution.
11. The initial volume of BDI PLUS solution pumped should only be enough to displace the water within the drive rods. Once this is done the actual injection can start.
12. Begin withdrawing the drive rods, in accordance with the manufacturer's SOP, and start pumping the BDI PLUS solution simultaneously. The dosage should be 0.1 liter per vertical foot or 1 gallon per vertical foot if prepared using the BDI dilution chart. The withdrawal rate should be such that it allows theappropriate quantity of material to be injected into each vertical foot of aquifer being

treated. The withdrawal rate should be slow to avoid creating a vacuum. This vacuum can potentially pull a small volume of material to the surface if the drive rods are withdrawn too quickly.

13. In less permeable soils such as clays and silts, there may be difficulty accepting the volume of estimated material. In this case REGENESIS recommends using a "step-wise" application approach. For this approach we suggest withdrawing the drive rods in one-foot increments and then injecting the quantity of material required per vertical foot.
14. Look for any indications of aquifer refusal such as:
    - Excessive pump noise or application pressure spikes (e.g. squealing)
    - Surfacing of material through the injection point ("blow-by") If acceptance appears to be an issue it is critical that the aquifer is given enough time to equilibrate before breaking down the drive rods and/or removing the hose. The failure to do this can lead to excessive back flow of the BDI PLUS material on personnel, equipment, and the ground surface.
15. If BDI PLUS solution continues to "surface" after the drive rods have been completely removed from the borehole a plug may be necessary. Large diameter disposable tips or wood stakes have been used successfully for this purpose.
16. Drive rods should be disconnected after one rod (typically 4 feet in length) has been withdrawn. The drive rods should be placed in a bucket (or equivalent) after they have been disconnected.
17. Complete the installation of the BDI PLUS solution at the designated application rate across the entire targeted vertical interval.
18. After the injection is completed, an appropriate seal should be installed above the vertical interval where the BDI PLUS solution has been placed to prevent contaminant migration. Typically, bentonite powder or chips are used to create this seal. However, consultants should review local regulations before beginning field installation activities to confirm that this approach can be used.
19. Complete the borehole at the surface as appropriate using concrete or asphalt.
20. Repeat steps 7 through 19 until the entire application has been completed. If additional drums of de-oxygenated water are required, prepare as suggested in Step 1.
21. Prior to the installation of BDI PLUS, all surface and overhead impediments should be identified as well as the location(s) of any underground structure(s). Underground structures include but are not limited to: utility lines (gas, electrical, sewer, etc), drain piping, and landscape irrigation systems.
22. The planned injection locations should be adjusted in the field to account for impediments and obstacles.
23. The actual injection locations should be marked prior to the start of installation activities to facilitate the application process.
24. Using an appropriate pump to install the BDI PLUS product is very critical to the success of the application as well as the overall success of the project. Based on our experience in the field, REGENESIS strongly recommends using a pump that has a pressure rating of at least 1,000 psi and a delivery rate of at least 3 gallons per minute. If the application involves both HRC and BDI PLUS, two separate pumps may be required to facilitate the process. The pump used to deliver HRC to the subsurface should be in accordance with the specifications outlined in the General Guidelines section of the HRC Installation Instructions.

Additional Information

The internal workings of the grout pump can be cleaned easily by recirculating a solution of hot water and a biodegradable cleaner (e.g. Simple Green) through the pump and delivery hose(s). If additional cleaning and decontamination is required it should be conducted in accordance with the manufacturer's SOP and local regulatory requirements.

Note: REGENESIS assumes that all of the material (microorganisms) sent to a site for installation purposes will be used for that particular project and that no material (microorganisms) will be left over at the conclusion of the installation activities.

For Enhanced Bioremediation injection of fluids into subsurface and groundwater testing and monitoring at

New York State Department of Environmental Conservation,
Hazardous Waste Voluntary Cleanup Site No. V-00461-3
American Cleaners Store, 360 Route 211 East, Middletown, NY10940 Orange County, NY

A. SITE DESCRIPTION

Site: American Cleaners Store, Dry Cleaning and Customer Service
Date of Plan: January 15, 2018
Location: East Side of Route 211, in separate building at the southern end of Caldor Plaza or Shopping Center, East of MHV Federal Credit Union, accessed from the Plaza Entry and across a parking area
Hazards: Tetrachloroethene (PCE or Perc) was used in the dry cleaning process, A spill occurred in the parking area behind (south) of the building and waste PCE was placed in the dumpsters behind the building prior to hazardous waste control. PCE has migrated downward into the unconsolidated overburden sediments beneath the parking lot and under the building. PCE vapors have been detected beneath the building and beneath the pavement in downgradient locations. Dissolved PCE has been detected in groundwater sampled from Monitoring Wells around the building and downgradient toward Route 211. Ambient air gas sampling with Summa Canisters has shown no indoor air, outdoor air or subslab vapors contaminated with PCE above NYS DOH standards in the AC Building, the MHV Federal Credit Union, Cheeseburger Paradise Restaurant, nor the Vacant Video Store. Oil and gasoline spills were reported at the former Lloyds supermarket and gas station and auto service store to the south. The Lloyd buildings were demolished and spill remediation activities have not been investigated, nor impacts on AC evaluated.
Topography: The building lies at an elevation of approximately 560 feet above sea level on a slight slope to the north downward toward Route 211. Route 211 lies at an elevation approximately 520 feet. The MHV Federal Credit Union is northeast of AC at an elevation of approximately 550 feet and Cheeseburger Paradise is at a similar elevation to the northwest. The main building of the Caldor Plaza or Caldor Shopping Center lies on top of a ridge at an elevation of approximately 580 feet and elongated
Weather Conditions: Due to the hillside location and open fetch from the north and west, weather tends to be more windy than on lower ground. Prevailing winds are generally from the west or northwest.
Additional Information: American Cleaners continues to function as a dry cleaning operation with standard use of regulated solvents and standard operating procedures, which reduce human exposure and spillage of materials.

B. **WORK PLAN OBJECTIVES**: To mix on-site chemical materials with water and inject into the groundwater plume of tetrachloroethene contamination. The materials will be injected using a geoprobe to advance into the subsurface materials and inject into the 4-foot transmissive water-bearing zone at depths prom 5 to 10 feet below ground surface. The fluid mixtures will be pumped through the geoprobe using either a high pressure or submersible pump. The borings will be backfilled and sealed with a mixture of sand and bentonite at the surface.

C. **ONSITE ORGANIZATION AND COORDINATION** – The following personnel are designated to carry out the stated job functions on site. (Note: One person may carry out more than one job function.)

Health and Safety Officer ……. Katherine J Beinkafner, PhD, CPG
Project Engineer …… Jolanda G. Jansen, P.E.
Driller ……Andrew Bellucci, Core Down Drilling
Bioremediation Specialist . ..…… ……...Todd Syska
Assistant Geologist ……... Paul Rubin
American Cleaners Owner and Site Manager …… . Erez Halevah
NYSDEC Oversite and Project Manager ……..…Paul Patel, P.E.

All site visitors will also be given an introduction to the Health and Safety plan and relevant site procedures.

All personnel arriving or departing the site should log in and out with the Katherine Beinkafner or Erez Halevah. All activities on site must be cleared through the Katherine or Erez.

D. **ONSITE CONTROL**

The Health & Safety Officer has been designated to coordinate access control and security on site. Because hazardous or toxic waste is beneath the ground surface, the work zone will be defined by traffic cones, which define a safe perimeter. No one should enter the work zone without the acknowledgement of the driller or project manager. A hot zone will be defined if a need arises. The decontamination zone will be a special area where drill equipment is cleaned or safety gear is changed. If indeed, hazardous or toxic waste is detected through monitoring, the safety zones will immediately be established by the Health & Safety Officer.

A safe perimeter will be established with orange traffic cones and yellow or orange caution tape and will move with the drill rig from drill location to drill location. No unauthorized person should be within this area.

The onsite Command Post will be at the American Cleaner's front door if an emergency arises or at the back of the former Credit Union if the front door is unsafe. The staging area for drilling or other site operations will be on the north side of the building near the front so that people inside can see the equipment and workers outside.

The prevailing wind conditions are from the north and northwest, so the command post is upwind from the Work Zone, except in the case of drilling one upgradient well and work near the dumpsters.

E. HAZARD EVALUATION

The following substance(s) are known or suspected to be on site. The primary hazards of each are identified.

Substances Involved	Concentrations (If Known)	Primary Hazards
Tetrachloroethene	ND to 7800 ug/L in groundwater ND to 580,000 ug/m^3 in Soil Gas	

The following additional hazards are expected on site: uneven parking lot and paved areas, often wet areas or ice in winter, pot holes, weeds and overgrowth off the pavement.

Hazardous Substance Fact Sheet for tetrachloroethene is attached.

For INJECTION OF ENHANCED BIOREMEDIATION FLUIDS, the MSDS Documents are in Appendix 3 for 3-D Microemulsion and Appendix 4 for Bio-Dechlor Inoculum Plus.

F. PERSONAL PROTECTIVE EQUIPMENT

Based on evaluation of potential hazards, the following levels of personal protection have been designated for the applicable work areas or tasks:

Location	Job Function	Level of Protection
Work Zone	Drilling, Sampling	D until higher levels needed.
Contamination	N/A	A B C D Other
Reduction Zone	N/A	A B C D Other

Specific protective equipment for each level of protection is as follows:

Level A	Fully encapsulating suit, SCBA (disposable coveralls)
Level B	Splash gear (type), SCBA
Level C	Splash gear (type), Full-face canister respirator
Level D	**Hard Hats, Gloves, Safety Steel-toe Boots, Safety Glasses, Long sleeve shirts, long work pants.**

The following protective clothing materials are required for the involved substance(s):

Substance (Chemical Name)	Material (material name, e.g. Viton)
none at this time	none at this time

If air-purifying respirators are authorized, (filtering medium) is the appropriate canister for use with the involved substances and concentrations. A competent

individual has determined that all criteria for using this type of respiratory protection have been met. Appropriate canister type will be filled in if dust, hazardous gas or vapors are detected on site.

No changes to the specified levels of protection shall be made without the approval of the site safety officer and the project team leader.

G. ONSITE WORK PLANS

The work party and any substitutes will be listed on the Signature Page of this Health and Safety Plan.

H. COMMUNICATION PROCEDURES

All other onsite communications will use voice commands.
Personnel in the Work Zone should remain in constant contact with or within sight of the Project Team Leader. Any failure of communication or accident or emergency requires an evaluation of whether personnel should leave the Work Zone.
Continuing Intermittent Horn BEEPING is the emergency signal to indicate that all personnel should leave the Work Zone and meet at the Command Post.

The following standard hand signals will be used in case of failure voice communications:

Hand gripping throat ---------- Out of air, can't breathe
Grip partner's wrist or ---------- Leave area immediately
both hands around waist
Hands on top of head ---------- Need assistance
Thumbs up ---------- OK, I am all right, I understand
Thumbs down ---------- No, negative

I. DECONTAMINATION PROCEDURES

Personnel and equipment in contact with contaminated soil or groundwater upon leaving the Work Zone shall be thoroughly decontaminated. The standard level "C" decontamination protocol shall be used with the following decontamination stations (if needed):
Emergency decontamination will include the following stations (if needed):

Equipment Drop
Outer Garment, Boots, and Gloves Wash and Rinse
Outer Boot and Glove Removal
Canister or Mask Change
Boot, Gloves and Outer Garment Removal
Face Plate Removal
Field Wash

The following decontamination equipment is required:

Buckets with Brushes
Gallons of Distilled or Bottled Water
Detergent
Benches
Plastic on Ground & Plastic Bags for Disposable items
Spare Canisters for Respirators

Detergent and water will be used as the decontamination solution.

J. SITE-SPECIFIC SAFETY AND HEALTH PLAN

1. The Site Safety Officer and is directly responsible to the Project Team Leader for safety recommendations on site.
2. Emergency Medical Care

Emergency Medical Service: Immediate Medical Care
111 Maltese Drive
Middletown, NY
(845) 342-4774

Hospital with Emergency Room: Orange Regional Medical Center
County Route 67, 707 East Main Street (See map to Hospital)
Middletown, NY 10940
(845) 333-1000

Ambulance Service: Regional EMS (845) 343-2345
Or Mobile Life Support (845) 343-1212

The following First-aid equipment is on site:
First-aid kit
Emergency eyewash
Emergency shower spray

List of emergency phone numbers:

Agency/Facility	Phone #	Contact
Police	845 343-3151	City of Middletown Police
Fire	845 343-7131	Silver Lake Volunteer Fire Co. 26 Maltese Dr, Middletown
Hospital	845 333-1000	Orange Regional Medical Ctr
Ambulance	845 343-2345	Regional EMS
	845 343-1212	Mobile Life Support

3. Environmental Monitoring (see attached Contingency Plan)

The following environmental monitoring instruments shall be used on site (cross out if not applicable) at the specified intervals.

Meter		Monitoring Frequency
Combustible Gas Indicator	-	excavation and fresh exposures
HNU/Microtip (VOCs)	-	excavation and fresh exposures

The following will be monitored if a relevant contingency plan is invoked:

Oxygen Monitor	-	continuous / hourly / daily / other
Colorimetric Tubes	-	continuous / hourly / daily / other
Air Temperature/Thermometer	-	continuous / hourly / daily / other
Radioactivity Meter	-	continuous / hourly / daily / other

4. Emergency Procedures (should be modified as required for incident)
The following standard emergency procedures will be used by onsite personnel. The Site Safety Officer shall be notified of any onsite emergencies and be responsible for ensuring that the appropriate procedures are followed.

Personnel Injury in the Work Zone: Upon notification of an injury in the Exclusion Zone, the designated emergency signal, continuing horn beeping shall be sounded. All site personnel shall assemble at the Command Post. The rescue team will enter the Work Zone (if required) to remove the injured person to safety. The Site Safety Officer and Project Team Leader should evaluate the nature of the injury, and the affected person should be decontaminated to the extent possible prior to movement. The onsite EMT shall initiate the appropriate first aid, and contact should be made for an ambulance and with the designated medical facility (if required). No persons shall reenter the Work Zone until the cause of the injury is determined.

Personnel Injury in the Support Zone: Upon notification of any injury in the Support Zone, the Project Team Leader and Site Safety Officer will assess the nature of the injury. If the cause of the injury or loss of the injured person does not affect the performance of site personnel, operations may continue, with the onsite EMT initiating the appropriate first aid and necessary follow-up as stated above. If the injury increases the risk to others, the designated emergency signal, continuing intermittent horn beeping shall be sounded and all site personnel shall move to the decontamination line for further instructions. Activities on site will stop until the added risk is removed or minimized.

Fire/Explosion: Upon notification of a fire or explosion on site, the designated emergency signal continuing intermittent horn beeping shall be sounded and all site personnel assembled at the Command Post. The fire department shall be alerted and all personnel moved to a safe distance from the involved area.

Personal Protective Equipment Failure: If any site worker experiences a failure or alteration or protective equipment that affects the protection factor, that person and his/her buddy shall immediately leave the Work Zone. Reentry shall not be permitted until the equipment has been repaired or replaced.

Other Equipment Failure: If any other equipment on site fails to operate properly, the Project Team Leader and Site Safety Officer shall be notified and then determine the effect of this failure on continuing operation on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel shall leave the Work Zone until the situation is evaluated and appropriate actions taken.

5. PERSONAL MONITORING

The following personal monitoring will be in effect on site.

Personal exposure sampling: Total VOCs will be measured with an hnu DL-101 or photovac microtip HL-2000 or HL-3000 or MiniRAE- 2000 at the well bore or monitoring wells or soil sampling locations to assess the safety of the breathing zone.

Medical monitoring: The expected air temperature will be (50°F). If it is determined that heat stress monitoring is required (mandatory if over 70°F) the following procedures shall be followed: monitoring body temperature, respiration rate, pulse rate. If a level of personal Protection higher than C is required, continuous outdoor temperature monitoring will be a standard operating procedure and will be described in the revision of this Plan.

For Enhanced Bioremediation injection of fluids into subsurface and groundwater testing and monitoring at

New York State Department of Environmental Conservation,
Hazardous Waste Voluntary Cleanup Site No. V-00461-3
American Cleaners Store, 360 Route 211 East, Middletown, NY10940 Orange County, NY

Health and Safety Plan Acknowledgement and Agreement Page

I acknowledge I have reviewed a copy of this Health and Safety Plan for American Cleaners Middletown Site, understand it, and agree to comply with its provisions.

►Health and Safety Officer _____
Name Company
_____/_____/_____
Date Signature EMT? CPR? FirstAid?FirstResponder?

► _____ _____
Position Name Company
_____/_____/_____
Date Signature EMT? CPR? FirstAid?FirstResponder?

► _____ _____
Position Name Company
_____/_____/_____
Date Signature EMT? CPR? irstAid?FirstResponder?

► _____ _____
Position Name Company
_____/_____/_____
Date Signature EMT? CPR? FirstAid?FirstResponder?

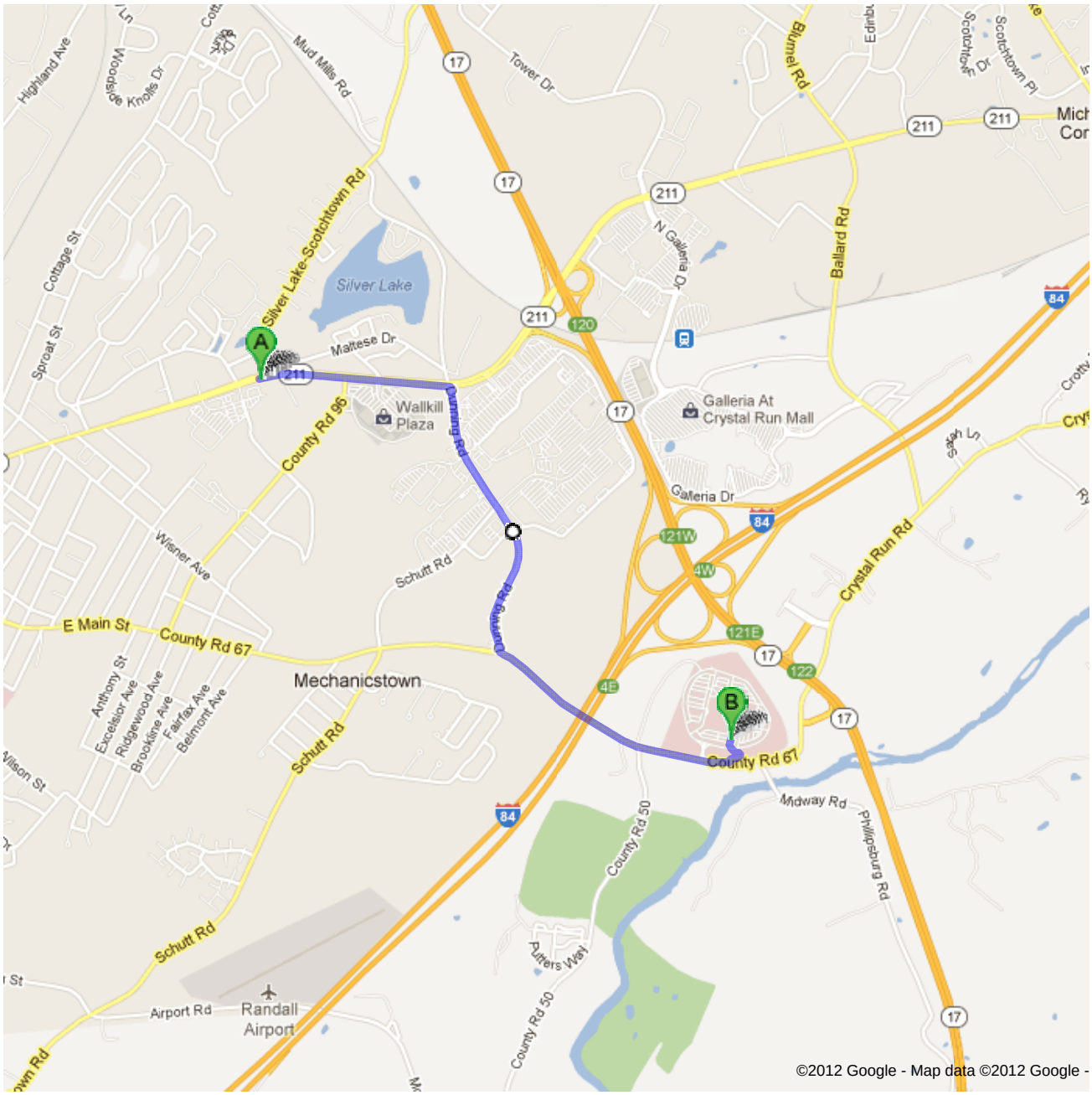
► _____ _____
Position Name Company
_____/_____/_____
Date Signature EMT? CPR? FirstAid?FirstResponder?

List of emergency phone numbers:

Agency/Facility	Phone #	Contact
Police	845 343-3151	City of Middletown Police
Fire	845 343-7131	Silver Lake Volunteer Fire Co. 26 Maltese Dr, Middletown
Hospital	845 333-1000	Orange Regional Medical Ctr
Ambulance	845 343-2345	Regional EMS
	845 343-1212	Mobile Life Support

Google

Directions to Orange Regional Medical Center
707 E Main St, Middletown, New York 10940 - (
845) 333-1000
2.2 mi – about **7 mins**



360 New York 211, Middletown, NY 10940

1.	Head **east** on **NY-211 E** toward **Silver Lake Scotchtown Rd** About 1 min	go 0.5 mi total 0.5 mi
2.	Turn right onto **County Rd 92/Dunning Rd** About 3 mins	go 0.8 mi total 1.4 mi
3.	Turn left onto **County Rd 67/E Main St** About 2 mins	go 0.8 mi total 2.1 mi
4.	Turn left	go 0.1 mi total 2.2 mi

Orange Regional Medical Center
707 E Main St, Middletown, New York 10940 - (845) 333-1000

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Directions weren't right? Please find your route on maps.google.com and click "Report a problem" at the bottom left.

For Enhanced Bioremediation WorkPlan including injection of fluids into the subsurface and groundwater sampling and monitoring at

New York State Department of Environmental Conservation,
Hazardous Waste Voluntary Cleanup Site No. V-00461-3
American Cleaners Store, 360 Route 211 East, Middletown, NY10940 Orange County

Community air monitoring consists of two types of monitoring: continuous and periodic. Specific meters are required to monitor air. A photo-ionization detector (PID) is used to measure VOCs in air and a particulate meter is used to monitor dust. NYSDOH and NYSDEC provide specific guidelines to respond to monitoring measurements.

Continuous Monitoring will be conducted for the ground intrusive activities identified in the RIWP such as advancement of soil borings and installation of monitoring wells. Since these tasks will be performed outdoors in a public parking lot, continuous monitoring will be conducted 5 to 150 feet downwind of the boring / well locations avoiding any exhaust from machinery. A data recording Hnu (photo-ionization) meter will be used to monitor the VOCs in the air. Particulate dust will be monitored with a DataRAM™. The equipment will be calibrated at least once each day or in accordance with manufacturers' recommendations.

Periodic monitoring for VOCs will be conducted during the non-intrusive tasks of well development and collection of groundwater samples from monitoring wells. Readings will be taken with the Hnu meter when the cap of the monitoring well is first opened to determine if VOCs have accumulated above the water table inside the well casing. Readings will be obtained while the purge water is accumulating in the graduated cylinder to ascertain if VOCs are degassing from the pump discharge water.

The following two sections are from the generic CAMP in Appendix 1A in the back of the DER-10 manual (November 2009). They describe what actions to take based on monitoring results reaching specific measurement levels.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous

readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and DOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

For Enhanced Bioremediation WorkPlan including injection of fluids into the subsurface and groundwater sampling and monitoring at

New York State Department of Environmental Conservation,
Hazardous Waste Voluntary Cleanup Site No. V-00461-3
American Cleaners Store, 360 Route 211 East, Middletown, NY10940 Orange County

3. All readings must be recorded and be available for State (DEC and DOH) personnel to review.

For Enhanced Bioremediation injection of fluids into subsurface and groundwater testing and monitoring at

New York State Department of Environmental Conservation,
Hazardous Waste Voluntary Cleanup Site No. V-00461-3
American Cleaners Store, 360 Route 211 East, Middletown, NY10940 Orange County, NY

Resumes for

Jolanda G. Jansen
Todd Syska
Paul Rubin
Core Down Drilling
Katherine Beinkafner

RESUME

Jolanda G. Jansen, P.E. 72 Colburn Drive, Poughkeepsie, NY 12603

Education

Bachelor of Civil Engineering, University of Canterbury, Christchurch, New Zealand, 1975
Juris Doctor, Pace University School of Law, 2010

Engineering Liscense

New York State #068972-1, 1992

Professional Experience

Owner, 2009 – present, **Jansen Engineering, PLLC**
Key Projects: Sustainability Master Plan, Camphill Village, Columbia County
Project Manager, 2007 – 2008, **Hudson Valley Development Group, LLC**
Key Projects: 26 Home Cluster Subdivision with Central Sewer
4-story School to Condo Conversion
Project Manager, 2001 – 2007, **Spectra Engineering, P.C.**
Key Projects: Vassar College Student Housing, Site Plan
150 unit townhouse complex, WWTF and Site Plan
Bright Horizons Children's Center, Site Plan
Subdivisions throughout Dutchess and Ulster County
Project Manager, 1996 – 2001, **Hayward and Pakan Associates**
Key Projects: Buddhist Monastery Master Plan
Seventh Day Adventist Camp, WWTF
Staff Engineer, 1994 – 1996, **Morris Associates**
Assistant Engineer, 1987 – 1994, **Hayward and Pakan Associates**
Assistant Surveyor, 1986 – 1987, **Kemble Surveying**

Special Skills

AutoCAD, bilingual Dutch

Community Service

Coordinator, 2002 – 2009, **Hudson Valley Smart Growth Alliance**

Coordinated conferences on the following topics: SEQRA & Green Building, Sustainable Energy Infrastructure, Magnetizing Downtowns, Planning for Biodiversity; Building Green; Smart Growth – Smart Jobs; Transit Oriented Development; Wind Power; Transfer of Development Rights; Cost of Sprawl; Decentralized Wastewater Systems; Strengthening our Hamlets, Villages and Cities; Affordable Housing and Smart Growth Successes.

Public Speaking

Sustainability Knowledge Exchange with the Netherlands, 2009

Carbon Neutral Community Planning in the Netherlands, 2008

Reducing the Carbon Footprint of Used-Water Treatment, 2008

Innovative Wastewater Treatment in Dutchess County, 2007

References

Available upon request

Paul A. Rubin

414 E. Kerley Corners Rd.; Tivoli, New York 12583 (845-657-8111)
E-mail contact: hydroquest@yahoo.com

EDUCATION:

M.A. - Geology, May 1983, State University of New York at New Paltz. Major fields of study: Hydrogeology, Water Quality and Pollution, Structural Geology, Photogeologic Interpretation. Thesis topic: *Hydrogeology and Structure of the Shawangunk Mountains, Ulster County, NY.*
B.A. - Anthropology, minor Geology, May 1977. State University of New York at Albany.

EXPERIENCE:

HYDROLOGIST/HYDROGEOLOGIST/GEOLOGIST:

1993 - Present

Independent Geologic & Hydrologic Consultant. Consulting firm: *HydroQuest.*
Provide hydrologic, geologic and land use technical consulting services to environmental groups, Towns, business associations, law firms, and individuals. Assist groups in identifying issues and developing strategies designed to protect groundwater and surface water resources, community character, and wildlife habitat.

***HydroQuest* work includes SEQRA reviews, review and analysis of consultant reports and environmental impact statements (EISs); environmental scoping report preparation; contaminant characterization and geologic investigations; technical coordination of scientific case development for environmental groups and attorneys; field characterizations; gas pipeline assessments; stream and wetland evaluations; hydrologic and geologic mapping; water quality assessments; watershed delineations; viewshed analyses; slope analyses; aquifer analyses; hydrogeologic analyses; regulatory assessments; GIS map preparation; public presentations; technical presentations to judges; coordination work with attorneys and Technical Committees; direction and coordination of sub-contract work as needed; strategy development; panel member at Town meetings with legislators; press interactions; report and affidavit preparation. Authored numerous reports and affidavits on gas drilling & hydraulic fracturing.**

Recent project work examples include hydrogeologic analyses of well field pumping tests designed to assess impacts on groundwater and surface water from major projects; assessment of karst aquifers & groundwater vulnerability; photogrammetric analyses; hydrogeologic assessments of spring water sources being considered for bottled water use; hydrogeologic-aquifer analysis of a groundwater supply proposed for a Shawangunk Ridge retreat center; SEQRA assessments; assessment of a gas field impoundment liner failure; river flooding, mine impact, land & cell tower evaluations; MTBE contaminant transport evaluation; FL-GA-AL gas pipeline route environmental analysis; rattlesnake migration analyses; geologic analysis of cause of United Flight 93 granite monument failure; and flood frequency and earthquake probability analyses.

KARST HYDROLOGIST

2004 - April 2007

Howe Caverns, Inc. Cobleskill, New York. 2nd largest natural tourist attraction in NYS. Conducted hydrologic and geologic research, produced professional GIS maps and figures, developed educational programs and materials, developed new tourist route, trained guides, provided land use assessments and recommendations, advised the Board of Directors on land use concerns including potential water quality degradation and potential blast-related impacts to cave. Developed and proposed revenue generating strategies. Coordinated with outside educational institutions, professional geologists, learning institutions, and scout groups. Formerly worked in this position half-time prior to change in ownership.

INSTRUCTOR:

Jan. 2001-Dec. 2004 **SUNY Ulster, Stone Ridge, New York.**
Taught ArcGIS, Environmental Geology, Geology, Hydrology, Geography, and Crime Analysis. Coordinator of a Geographic Information Systems certificate program. Developed, obtained, and completed a NYSDEC grant to assess assorted hydrologic and environmental aspects of the Black Creek watershed in Ulster County. Supervision and oversight of numerous professional adult "students", directed GIS-based technical presentations, and coordinated and produced grant products.

College of the Atlantic, Bar Harbor, Maine.
Taught a two week graduate level summer field hydrology and environmental science course for several years, including Rosgen stream assessment.

HYDROLOGIST:

New York City Department of Environmental Protection (NYCDEP), Division of Drinking Water Quality Control, Shokan, New York.

April 1993-Jan. 2001 **Conducted research and field studies designed to assess the water quality of watersheds. Responsible for directing geologic research designed to assess the sources, geomorphic context and best management practices (BMPs) related to sediments causing turbidity water pollution problems. Hydrologic and geologic work included geologic mapping of glacial sediments, field evaluation of stream channel armoring, morphologic characterization of stream channels (including Rosgen analyses), bedload transport studies, assessment of critical shear stresses, particle size analysis, stream gauging, water quality sampling and trend analysis, chemical and sediment loading calculations, graphic production, report preparation and technical presentations. Assisted other governmental divisions in evaluating lands for possible purchase, conducted geotechnical assessments of structurally unstable stream reaches, evaluated BMP designs. Supervised several Research Assistants.**

RESEARCH SCIENTIST:

Martin Marietta Energy Systems, Inc. April 1993 under contract with the U.S. Dept. of Energy; Oak Ridge National Lab; Environmental Sciences Division, Oak Ridge, TN.

Aug. 1991-April 1993 **Responsible for hydrogeologic evaluation of groundwater issues (e.g., characterization, monitoring network setup, data analysis, remedial design evaluation) at multiple Oak Ridge Reservation hazardous waste sites. Developed and documented conceptual model of carbonate and shallow storm flow systems comprising pathways of rapid contaminant transport. Work also involved characterization of hydrologic and geochemical trends and thermal infrared photo analysis. Presented results of research at conferences, as well as to DOE management and State and Federal officials.** ***Served in a Resource Management Organization as the hydrologic lead for the Environmental Sciences Division.***

HYDROGEOLOGIST:

New York State Attorney General's Office; Environmental Protection Bureau, Albany, New York.

Feb. 1983-Aug. 1991 **Responsible for the design, protocols, coordination, implementation, evaluation, characterization and remediation of many major water and soil contamination sites throughout New York State (e.g., Love Canal, Superfund sites). Designed, performed and supervised chemical field sampling at hazardous waste sites. Evaluated geotechnical and chemical data sets.**

Primary responsibilities included coordination of multiple companies along with their respective legal and scientific consultants. Worked with all parties involved to produce test plans and consent decrees to facilitate site remediation. Responsible for the management of the testing, site characterization and technical assessment. Worked with attorneys on summary judgment motions, complaints, trial preparation and depositions. Attorney General's spokesperson at public meetings. Expert witness at SEQRA hearings. Testimony given before the Assembly Standing Committee on Environmental Conservation and Grand Jury. Worked with DOL staff and attorneys to develop office initiatives (e.g., Racketeering; bottled water contaminants). Initiation, development and drafting of legislation.

Supervision of personnel: expert witnesses, consultants, research assistants, interns. Responsible for selection, job descriptions, work schedules, and products.

HYDROGEOLOGIST:

Stone & Webster Engineering Corp., Geotechnical Division, Boston, Massachusetts.

Oct. 1981-Feb. 1983 **Directly responsible for the planning, preparation, execution, and analysis of pumping tests and a fluid sampling program designed to investigate deep basin groundwater characteristics for the siting of a nuclear waste repository within the Permian Basin of the Texas panhandle. Planned, managed, coordinated, directed, and provided oversight of field operations of a multi-million dollar project, inclusive of acidizing geologic formations. Sub-contractors included Halliburton, Schlumberger, and others.**

ACTIVITIES:

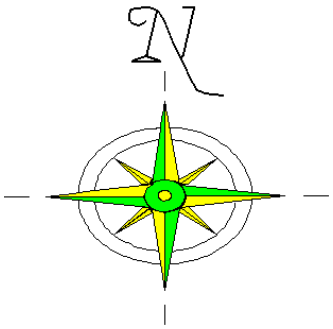
Hiking, kayaking, geologic and hydrologic research, and exploration. Former Captain: Albany-Schoharie County Cave Rescue Team. Made a Fellow of the National Speleological Society in recognition of karst research and water resource protection.

PUBLICATIONS & REPORTS **Over 50 technical publications and over 100 reports and affidavits, many for private clients, environmental groups, towns, and law firms. Projects include land, wetland, water quality, and species protection; aquifer and watershed characterization; mine proposals; development proposals; contaminant assessments; stream hydrology grant work; and flood risk. Some reports are confidential. Leader of geology conference field trips for groups including the New York State Geological Association, the American Institute of Professional Geologists, the Hudson-Mohawk Professional Geologists' Association, the National Ground Water Association, the National Speleological Society, GSA, and the International Association of Geochemists and Cosmochemists.**

Todd J, Syska Inc
106 Spruce Lane
Clinton Corners
NY 12514

845-706-8000

todd@syska-inc.com



September 20, 2013

Re: Work Plan, Site specific details,

Resource Evaluation Well:

Using a Geoprobe and sampling equipment with an approximate diameter of 2.25”, resource evaluation wells will be installed on the site to collect representative soil and groundwater samples at the required depth.

Monitoring Well Installation: Open Bore Hole Method:

Should soil sampling or other activities result in an open bore hole of sufficient depth for the installation of the monitoring well the required lengths of, one inch schedule 40, PVC screen and riser will be placed in the open bore hole. NSF approved sand will then be added to the bore hole in sufficient quantity so that the top of the sand layer is at a hight of one to two feet above the top of the screen interval. The purpose of this sand is to insure that the bentonite seal, which will be installed next, is not in contact with the screen interval. A bentonite seal of at least six inches will be placed on top of the sand pack to prevent infiltration of surface water in to the bore hole. If required, additional, permanent, well protection such as a manhole or steel casing will be installed.

Monitoring Well Installation: Closed Bore Hole Method:

If soil sampling is not required or should the bore hole collapse during the sampling activities, 2.25 inch diameter steel casing, with an inside diameter slightly larger than the well materials, will be driven to the depth required for well installation. The end of the steel casing will contain a sacrificial steel point to prevent soil from entering the casing while being driven. One inch schedule 40 PVC well screen and riser pipe will then be placed inside this steel casing and the steel casing withdrawn leaving the sacrificial point and the well materials in the bore hole. As the casing is being withdrawn the natural formation will be allowed to collapse around the well screen and riser pipe leaving the formation, as much as possible, in an undisturbed state. The bore hole will then be checked to determine the hight of the natural sediments in contact with the screen and riser. If necessary, NSF approved sand will be added to insure that the well screen is covered by at least one to two feet of material so that the bentonite seal,

Drillers Initials _____

which will be installed next, is not in contact with the screen interval. A bentonite seal of at least six inches will be installed to prevent infiltration of surface water in to the bore hole. If required, additional, permanent, well protection such as a manhole or steel casing will be installed.

Decommissioning Wells:

Should investigation activities result in excess “Resource Evaluation Wells” being installed on the subject property, which will not be converted to permanent monitoring wells, these excess wells will be decommissioned using the following procedures. All PVC well materials installed will be removed from the well. The, well void will be filled to within 18 inches of the surface using previously removed, soil cuttings. A six inch bentonite seal will then be installed on top of the cuttings. The remainder will be filled with natural soils or followed by 6 inches of concrete trawled flush with the original surface.

Materials Disposal:

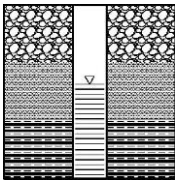
Excess drill cuttings, which are not reinstalled in bore hole from which they came, will be retained in appropriate containers and tested to determine proper disposal in accordance with all applicable federal, state, and local laws, rules, and regulations.

Should off site waste disposal be necessary, the property owner, responsible for the investigation will submit documentation of appropriate waste disposal pursuant to all applicable federal, state, and local laws, rules, and regulations.

End of Work Plan:

Drillers Initials _____

Core Down Drilling, LLC
PO Box 763
Brewster, NY 10509
845-625--3401



Services Provided

- Macro core and dual tube soil sample systems via Geoprobe® 54DT and 7822DT drill rigs
- Standard Penetrating Test via 2" split spoon advanced through 4.25" or 6.25" Hollow Stem Augers
- Falling Head Tests
- Monitoring Well installation up to 6" in diameter
- Chemical / remedial additive injection capabilities via Geoprobe® GS2000 injection pump
- Well Abandonments
- Soil Vapor Point installation
- Sub Slab Depressurization System installation

Core Down Drilling, LLC – Project Experience

Permanent 2-inch Well Installation, Former Manufactured Natural Gas Plant

CDD advanced 6.25" hollow stem auger drill string via Geoprobe® 7822DT to 25-feet below ground surface. Installation of 2-inch pre-pack Johnson® well screen across the water table through drill string. Wells finished as flush mounted 8-inch road boxes in high truck traffic area of the site. *(Client: The Chazen Companies)*

In Situ Chemical Oxidation (ISCO) Injections, Former Machine Shop, Upstate NY

CDD advanced multiple 1-inch and 2-inch monitoring wells across site into the water table where a solvent release had occurred. CDD performed chemical mixing and application of potassium permanganate under the direction of the consultant. Multiple rounds of permanganate applications over the course of one year. *(Client: SEBI)*

Standard Penetrating Test (SPT) Geotechnical Drilling, NYC Roads

Perform continuous SPT sampling to depths up to 20-feet below ground surface at active construction site for roadway improvements in NYC borough. Drilling data used for subgrade design for roadway improvements. *(Client: Applemon Corp.)*

Hydrogen Peroxide Injections, Active Construction Site in Yonkers, NY

Inject hydrogen peroxide for petroleum release throughout an active construction site via Geoprobe® 54DT drill rig and Geoprobe® GS2000 injection pump. Work performed in conjunction with site construction activities and at the directive of the consultant. Returned to site for post-application well installation for groundwater sampling. *(Client: Ecosystems Strategies, Inc.)*

Sub-slab Depressurization System (SSDS) Installation Support, Retail Plaza, Tennessee

Assist client with installation of an SSDS inside a dry-cleaning tenant space and abutting tenant spaces. Install extraction wells, vacuum monitoring points, radon fans and PVC pipe chases. Assist client with system diagnostic testing *(EBI Consulting).*

Sediment Sampling, Hudson River

Collect numerous discrete sediment samples from a boat and docks in the Hudson River in advance of proposed dredging activities of a marina. Hand tooling used to collect discrete samples for organic sediments. *(Client: Ecosystems Strategies, Inc.)*

RESUME

KATHERINE J. BEINKAFNER, Ph.D., CPG

Geologist/Hydrogeologist

Mid-Hudson Geosciences
1003 Route 44/55; P.O.Box 332
Clintondale, NY 12515-0332

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EXPERTISE: Investigation & Remediation of Subsurface Contaminants
Groundwater, Hydrology, and Wetland Studies
Environmental Regulatory Compliance, HazMat
QA, Senior Review, Expert Testimony
Surface and Borehole Geophysics
Computer Modeling of Groundwater Systems
Petroleum Geology, Geophysical Log Analysis, 3-D Mapping

EMPLOYMENT EXPERIENCE:

1997-1998	Sr. Hydrogeologist	Ballard Engineering, PC, New City, NY
Fall 1996	Adjunct Professor	Ramapo College, Mahwah, NJ
1991-1993	Sr. Hydrogeologist	EA Engineering, Newburgh, NY
1989-1991	Sr. Hydrogeologist	Dames & Moore, Pearl River, NY
Fall 1987	Adjunct Professor Groundwater-Hydrology	Rutgers, The State University of New Jersey, Newark Newark, NJ
1986-1987	Senior Consulting Hydrogeologist	Milton Chazen Engineering Associates Poughkeepsie, NY
1984-1986	Senior Reservoir Geologist	Lawrence-Allison West, Operations Contractor for Naval Petroleum Reserve #3, Casper, WY
1985	Dipmeter Consultant	Terrasciences, Inc., Lakewood, CO
1980-1984	Senior Development Geologist	Sohio Petroleum Company San Francisco, CA
1979	Summer Geologist	ARCO Oil and Gas Company Midland, TX
1979	Consulting Petroleum Geologist	Kirby Exploration Co. Houston, TX
1975	Adjunct Teaching Geologist	College of St. Rose Albany, NY
1972-1979	Scientist (Oil & Gas Geology)	Geological Survey, New York State Museum & Science Service, State Education Dept. Albany, NY 12234
1969-1972	Junior Scientist (Oil & Gas Geology)	Geological Survey (same as above)
1966-1968	Physics Teacher	F. D. Roosevelt H. S., Hyde Park, NY

EDUCATION:

1961-1965	S.U.N.Y. at New Paltz New Paltz, NY 12560	B.A. (Geology) M.A. (Geology)
1965-1966	Rensselaer Polytechnic Institute Troy, NY 12180	Geophysics
1968-1969	University of Pennsylvania Philadelphia, PA 19104	M.S. (Physics)
1977-1980	Syracuse University Syracuse, NY 13210	Ph.D. (Geology)

PUBLICATIONS:

Beinkafner, K.J., 2000, Increasing Water Resources with a Horizontal Well, Illinois Mountain, Highland Water District, Highland, NY: National Groundwater Association Eastern Focus Conference, Newburgh, NY October 5, 2000, 10:40 AM

UNPUBLISHED REPORTS:

"Geologic Interpretation of Dipmeter Logs," joint author with Andy Bengtson, SOHIO Petroleum Company, San Francisco, 1984.

"Log Analysis for (Petroleum) Wells Using Computer Hardware and Software, based on Terra Sciences log analysis and mapping software, Lawrence Allison West, 1985.

"Quantitative Geologic Model, Northern Second Wall Creek Reservoir," Lawrence Allison West, Casper, Wyoming, 1986.

"Radionuclide Transport to Human Access Locations, Transport Mechanism – groundwater and surface water (for Illionis LLRWSF License Application)," Dames and Moore, 1991.

"Subsurface Investigation Report, Town of New Paltz Landfill, Ulster County, New York." Mid-Hudson Geosciences, 1991.

"Sharkey Landfill Remedial Design, Groundwater Flow Model," Burns and Roe Industrial Services Co., 1991.

"Hydrogeologic Study of Wallkill Public Water Supply Watershed and Aquifer (Critical Environmental Area)," Mid-Hudson Geosciences, 1992.

"Ecological Risk Assessment of Benzene and Barium, Liquid Disposal Inc. Site, Michigan." EA Engineering, 1993.

"Complying with Hazardous Waste Laws and Requirements in New York State" notes for short course sponsored by NYS DOT Bureau of Environmental Analysis and Mid-Hudson Geosciences (Katherine Beinkafner), 1993 and 1994.

"Hydrogeologic Investigation: Van Etten Mobil Station, Liberty, New York." Mid-Hudson Geosciences, 1994.

"Closure Investigation Report for Youmans Flats Landfill in Harriman State Park: Geologic, Hydrogeologic, Gas Venting, and Vector Study," 2 Volumes. Mid-Hudson Geosciences, 1995.

"Groundwater Resources in the Town of Gardiner, Ulster County, New York." Mid-Hudson Geosciences, 1995.

“Designing, Conducting and Analyzing Aquifer Tests Applicable to New York State’s Hydro-Geologic Conditions” Mid-Hudson Geosciences in conjunction with Hydrogeologic, Inc. and HKS Environmental, Inc. 1997 for 4-day NYS DEC training course.

“Hydrogeologic Investigation of Underground Fuel Oil Tank at Highland High School, 320 Pancake Hollow Road, Highland, NY NYSDEC Spill No. 97-06013” Mid-Hudson Geosciences,1998.

“Hydrogeology of Leipold Field, Ellenville Central School District, Edwards Place, Ellenville, NY” Mid-Hudson Geosciences, 1998.

“Investigation Summary and Remedial Plan Site No. 18 NYCDOT Nott Avenue Garage, Addendum No. 1” for NYC Dept. of Design & Construction, Ballard Engineering PC, March 20, 1998.

“Investigation Summary and Remedial Plan Site No. 13 NYCDOT Brookville Yard,” for NYC Dept. of Design and Construction, Ballard Engineering PC, April 12, 1998.

“Investigation Summary and Remedial Plan Site No. 11 NYCDOT Flatlands Garage Addendum No. 1” for NYC Dept. of Design & Construction, Ballard Engineering PC, February 4, 1998.

“Final Site Investigation Report for Irvington Waterfront Park … Village of Irvington, Weschester County, NY” (NYS DEC Brownfields Program)Chapters on Physical Characteristics of the Site, Nature and Extent of Contamination, Contaminant Fate and Transport, and Exposure Assessment, Ecosystems Strategies, Inc. March 18, 1998.

“Report: Phase I: Exploration and Assessment for Development of Groundwater Resources on Illinois Mountain Watershed Property, Highland Water District, Highland, NY” Mid-Hudson Geosciences, December 1, 1999.

“Report: 72-Hour Pumping Test, Sunset Ridge Subdivision, Phillipsburg Road, Town of Goshen, Orange County”, NY for Clients of Lanc & Tully Engineers by Mid-Hudson Geosciences, July 29, 2002.

“Shawangunk Recharge Area and Groundwater Management Plan” for New York-New Jersey Trail Conference by Mid-Hudson Geosciences, September 2002.

“Report: Aquifer Protection Study, Town of Hurley, Ulster County, NY” for Environmental Conservation Commission, Town of Hurley, Ulster County, December 2003, revised June 2004.

“Pumping Test Report for High Meadow School, Stone Ridge, NY” prepared for James L. Reynolds, Architect and Barry Medenbach, PE, Stone Ridge, NY October 28, 2004.

Letter Reports: “Hydrogeologic Analysis of Operation of Proposed Septic System Project,” “Hydrogeologic Analysis of Rainstorm and Operation of Proposed Septic System Project,” “Hydrogeologic Analysis of Water Table Variation During Monitoring Period, “ and “Method of Calculating Hydraulic Conductivity from Slug Testing, Addendum to Hydrogeologic Analysis of Operation of Proposed Septic System, Project: Plaza South, Newtown,” CT for PW Scott, PE of Brewster,NY, April through October 2005.

Several Papers RE: “Calculations and Actions for Pesticide Remediation in Former Orchards, now Residential Subdivisions in Orange County:” Greiner and Wildflower Vista Subdivisions, BCM Development in Town of Newburgh, Palladino and Double R Subdivisions, as a subcontractor to William L. Going & Associates, Pine Bush, NY, 2004-2005.

“Review of FEIS (November 18, 2004) and DEIS (July 28, 2004) for Proposed Mushroom Production and Processing Facility by Yukiguni Maitake Manufacturing Corporation of America in the Town of Mamakating” and “Review of DEIS (July 28, 2004) for Proposed Mushroom …” and associated testimony at Planning Board Hearings for Bashakill Area Assocation, Wurtsboro, NY, April through October 2005. Other Reports: “Evaluation and Assessment of Design of a Process Wastewater Infiltration System” May 2009. “Groundwater Mounding Analysis beneath the Process Wastewater Infiltration Basin” August 2009. “Special Conditions Associated with NYSDEC Issuance of Yukaguni Maitake Permits”

September 2009.

"Report: Aquifer Protection Study, Town of Marbletown, Ulster County, NY," for Environmental Conservation Commission, Town of Marbletown, Stone Ridge, NY, September 2005.

Report: "Geologic Assessment of Hudson Landing Site, Kingston, NY", Recommending stormwater management practices to protect groundwater from potential contamination by flow into karst pathways, Ecosystems Strategies, Inc. November 2007.

Reports concerning proposed Ulster Manor Project in Town of Ulster: "Comments for the Ulster Manor FEIS RE: Soils and Geology including evidence of Karst Features on site, Surface water, Wetlands and Groundwater Resources, July 2008. "Comments on 'Dworkin's Letter 11/8/08" RE: Ulster Manor indicating confirmation of Karst Features on site and needed mitigation measures, Ecosystems Strategies, Inc. December 2008.

Reports submitted to US EPA for Industrial Hazardous Waste Site: Former General Switch, Middletown, NY (as subcontractor to Ecosystems Strategies, Inc.): "Well Installation and Remedial Selection Report" (October 2007). "Evaluation of Cone of Depression and Capture Zone for Bedrock Well" July 2010. Short Term Pumping Test to Evaluate Use of Overburden Well" March 2011, ."Evaluation of Potential Matrix Diffusion Studies to Expedite Remediation of Chlorinated Solvents in Bedrock" at General Switch (2/13).

Report: "Review of Draft Environmental Impact Statement (DEIS) for Warwick Views Subdivision, submitted by Warwick Views, LLC to Town of Warwick Planning Board" March 2010.

Additional Reports Prepared in conjunction with Paul A. Rubin dba HydroQuest: "Karst Hydrology #1" June 2010, "Karst Hydrology #2" August 2010, "Revision of DEIS and Public Review Recommended"

Letter Report and Public Hearing Testimony (addressed to Planning Board Chairman Martin Lonstein, Town of Wawarsing,108 Canal Street, PO Box 671,Ellenville, NY 12428-0671*):* "Review of Draft Environmental Impact Statement for Proposed Mahamudra Buddhist Hermitage, Cragsmoor, NY**"** (June 30, 2006), on behalf of Cragsmoor citizens group December 26, 2006.

"Review of Environmental Impacts of Geologic Conditions and Steep Slopes on the West Side of Byram Lake with Respect to Seven Springs Draft Environmental Impact Statement" prepared for private client August2008).

Report: "Review of Draft Environmental Impact Statement, Section 3.2 Groundwater & Appendix E for Seven Peaks At Mountain Road" Town of Mamakating, Sullivan County, NY (Dated January 22, 2010, prepared by The Chazen Companies), review by Mid-Hudson Geosciences for Basha Kill Area Association (Feb 9, 2010).

Letter Report and Expert Testimony at Public Hearing (addressed to: Hon. William R. Weaver, Supervisor, Town Board, Town of North Castle, 15 Bedford Road, Armonk, NY 10504) "Hydrological Concerns for the Site Plan and Project Design for Proposed Maintenance Garage 7 Round House Road @ Hobby Farm Road, Town of North Castle, Westchester County, New York" Prepared by JMC, John Meyer Consulting PC, dated 04/09/2010 In Consideration of a Special Use Permit representing neighborhood residents(6/2010)

Report: Geology and Hydrology Sections of "Lower Rondout Creek Interim Stream Management Plan" for Clearwater, *pro bono* coauthor with Jolanda Jansen (October 27, 2011).

Draft Summary Report: "Rinzler Proposed Subdivision Property, Prospect Hill Road, Town of Blooming Grove, Orange County, NY" (Pumping tests and well treatment in deep low recharge wells) for William L Going and Associates (December 29, 2011).

Review of "United Water New York, Inc. Application for Haverstraw Long-term Water Supply Project" Mid-Hudson Geosciences prepared with HydroQuest submitted to NYS Department of State, Secretary of State Cesar A. Perales on behalf of Rockland Water Coalition (April 20, 2012**).**

Report: "Carbonate Rock Area. Municipal Code suggestions for testing carbonate areas for karst terrain and potential environmental impacts" for Town of Rosendale (*pro bono*, July 2012)

Report: "Analysis of C&D Debris Collected at 290 Tarbell Road, Town of Wallkill, Orange County, NY on 4/3/13" Mid-Hudson Geosciences with William L. Going and Associates for private client (April 26, 2013).

Engineer's Report: "Supplemental Remedial Investigation Report for American Cleaners, Inc. Middletown, NY NYSDEC Site No. V-00461 Voluntary Cleanup Program" prepared by Jansen Engineering, PLLC and Mid-Hudson Geosciences (May 10, 2013).

Pumping Test Workplans and Reports for Remediation of Hazardous Waste Site, Bronx, NY for EcoSystems Strategies, Poughkeepsie, NY.

PROFESSIONAL AFFILIATIONS: American Association of Petroleum Geologists
American Institute of Professional Geologists
National Ground Water Association
Hudson Mohawk Professional Geologists Association

PROFESSIONAL HONORS: Fellow of Geological Society of America

PROFESSIONAL CERTIFICATION:

Petroleum Geologist Number 2683 by American Association of Petroleum Geologists
Professional Geological Scientist Number 6611 by American Institute of Professional Geologists