

**CORRECTIVE MEASURES STUDY (CMS)
WORKPLAN**

**Former Norton Company/Nashua Tape Products Facility
2600 Seventh Avenue
Watervliet, New York
EPA ID No. NYD 066829599
NYSDEC Index Number: CO 4-20001205-3375**

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SECTION 1.0
INTRODUCTION

This workplan has been prepared to summarize data collection activities proposed in association with a Corrective Measures Study (CMS) at the former Norton Company (Norton)/Nashua Tape Products (Nashua) manufacturing facility located at 2600 Seventh Avenue, Watervliet, New York (see Site Location Map, Figure 1-1). A Site Layout Map is provided as Figure 1-2.

An RCRA Facility Investigation (RFI) Workplan was submitted to the New York State Department of Environmental Conservation (NYSDEC) in September 2002. The principal objectives of the RFI were to: 1) further define the spatial distribution and magnitude of residual subsurface impact associated with the four solid waste management units (SWMUs) identified in the June 4, 2002 New York State Department of Environmental Conservation (NYSDEC) Order on Consent Index No. CO: 4-20001205-3375 and eight other areas of concern (AOCs) identified at the Site; and 2) assess the necessity and scope of future corrective actions, if any, subject to NYSDEC's prior approval. Following discussions between representatives of Saint-Gobain Corporation (Saint-Gobain) and the NYSDEC, the RFI Workplan was finalized in July 2003, and field activities were initiated in August 2003.

A Supplemental RFI Workplan and a Quality Assurance Project Plan (QAPP) were submitted to the NYSDEC in May 2005. The objectives of the Supplemental RFI were to: 1) further define the spatial distribution and magnitude of residual toluene located off site to the north of the Former Tank Farm SWMU; and 2) perform a vapor intrusion evaluation at selected off-site residential properties located along Alden Street. Following a Public Availability Session in September 2005, and procurement of access to residential properties, Supplemental RFI activities were initiated in December 2005.

Following review and approval by the NYSDEC and the New York State Department of Health (NYSDOH), a finalized Addendum to the Supplemental RFI Workplan, which specified additional vapor sampling procedures and contingencies, was submitted to the NYSDEC in January 2006. Off-site vapor sampling activities were conducted in February 2006.

On July 25, 2006, Saint-Gobain and the NYSDEC met to discuss the RFI results, and it was determined that investigative activities were complete. The draft RFI Report was submitted in November 2006. Following additional review and discussions with the NYSDEC and the NYSDOH, the Final RFI Report was submitted in December 2007. After further revisions were submitted in December 2007, the NYSDEC approved the RFI Report on March 31, 2008.

The December 2007 RFI Report (Section 10.0) included a Preliminary Corrective Measure Study (CMS) Report, which: 1) established clean-up objectives and remediation goals; 2) evaluated, and preliminarily ranked and selected, various potential Corrective Measures; and 3) outlined pilot testing activities needed for the final CMS. The conclusions of the December 2007 Preliminary CMS Report are summarized in Section 2.0 of this workplan. The December 2007 RFI Report also included an Interim Ground-Water Monitoring Plan (IGWMP; see Section 11.0 of the RFI Report), which outlined contingencies for interim sampling schedules and remedial actions that will be continued until the CMS is finalized.

The purpose of this CMS Workplan is to provide additional details on the proposed pilot testing activities for NYSDEC review and approval. The principal objectives of the proposed pilot testing activities are to: 1) collect the field data necessary to assess the site-specific effectiveness of the potential Corrective Measure technology identified in December 2007 RFI Report; 2) collect supplemental field data needed to determine the cost-effectiveness and other factors associated with these potential Corrective Measures; 3) collect on-site sub-slab vapor and indoor/outdoor air data requested by the NYSDOH; and 4) complete the removal of sediment present in storm sewer manholes as proposed in the December 2007 RFI Report.

Proposed pilot testing activities include: 1) collection of soil and ground-water samples to evaluate the cost-effectiveness, disposal options, and practicability of mass removal via soil excavation, and/or enhanced bioremediation in the Former Tank Farm SWMU; 2) field testing of enhanced bioremediation, in-situ chemical oxidation (ISCO), and enhanced fluid recovery (EFR) as possible remedial technologies in or adjacent to the Building Subslab AOC; 3) collection of sub-slab vapor samples and indoor/outdoor air samples from the office area of the Facility; and 4) removal of sewer sediment via EFR with follow-up sewer sediment and sewer water monitoring. Ground-water monitoring will continue in the interim as outlined in the IGWMP.

Pilot testing will be conducted in an iterative manner. Phase I will consist of the installation of monitoring points (smaller diameter wells) and conventional monitoring wells (summarized in Section 3.0) for use during pilot testing in the Building Subslab AOC, and the collection of soil and ground-water samples from these locations plus additional soil boring locations in the Former Tank Farm SWMU (summarized in Section 4.0). Phase II will focus on the field testing of various potential remedial technologies in the Building Subslab AOC such as enhanced bioremediation, ISCO, EFR, and contingent soil vapor extraction in-situ air sparging (SVE/IAS) as discussed in Section 5.0. The scheduling of sub-slab vapor point installation and vapor/ambient air sampling (see Sections 6.0 & 7.0) and sewer EFR/sampling events (Section 8.0) will be independent of the previously described pilot testing activities.

All pilot testing field work will be performed in compliance with applicable OSHA regulations and the site-specific master Health and Safety Plan (HASP) previously provided as Attachment B of the September 2001 Enhanced RFA Workplan. Subcontractors utilized during pilot test activities will develop their own site-specific HASPs that, at a minimum, comply with conditions/protocol identified in the master HASP. Field decontamination procedures are reviewed in Section 9.0 of this Workplan, Quality Assurance/Quality Control (QA/QC) measures are discussed in Section 10.0, and laboratory analyses are summarized in Section 11.0.

Following receipt of the analytical data from all phases of the pilot testing, Saint-Gobain will prepare data summary tables and figures, and schedule a meeting with the NYSDEC to discuss the pilot testing results. Per NYSDEC Order on Consent Index No. CO: 4-20001205-3375, the Commissioner will subsequently notify Saint-Gobain in writing of: 1) the submittal schedule for a CMS that evaluates alternative remedies, if required; or 2) if the NYSDEC and Saint-Gobain agree on the implementation of a pragmatic and presumptive remedy(ies), Saint-Gobain will be directed to submit a focused CMS report that includes a conceptual design for the remedy(ies) within 60 days (see Section 12.0).

SECTION 2.0

RCRA FACILITY INVESTIGATION (RFI) RESULTS: PRELIMINARY CORRECTIVE MEASURES STUDY (CMS) AND REMEDIAL ACTION TECHNOLOGY SCREENING

The Preliminary CMS in the December 2007 RFI Report included: 1) a statement of Corrective Measures objectives and remedial action performance goals; 2) identification of potential treatment areas; 3) identification, and preliminary screening/evaluation of potential treatment technologies; and 4) an outline of proposed feasibility testing necessary for the final CMS. Proposed response actions for the sanitary and storm sewers were also discussed.

2.1 Corrective Measures Objectives

The final Corrective Measures objectives are to achieve New York State soil clean-up standards and ground-water standards/guidelines at all on-site and off-site SWMUs and AOCs. These objectives will be met through a combination of aggressive short-term remedial actions and longer-term monitoring.

2.2 Corrective Measures Performance Goals

The principal Corrective Measures goals for the former Norton/Nashua Site are: 1) to the extent practicable, remove residual toluene source mass present in the soil column and floating free-phase product (FPP) in the area of the former tank farm; 2) reduce the concentration of dissolved-phase toluene beneath the on-site buildings; and 3) prevent future off-site movement of dissolved-phase toluene. Dissolved toluene concentrations are generally declining at the Site, but more aggressive short-term remedial actions are proposed to address localized areas of residual source mass in the overburden (both vadose and saturated zones) with the intent of accelerating the long-term reduction of dissolved ground-water concentrations via natural attenuation.

Interim Corrective Measures (ICMs) are not necessary at the former Norton/Nashua Site because there is no imminent hazard to human health or the environment. However, at the request of the NYSDOH, an indoor air investigation will be conducted in the office area to evaluate this potential exposure pathway (see Sections 6.0 & 7.0).

The primary on-site COC (and the only off-site COC) is toluene. Selected remedial actions for toluene may also be effective at addressing minor concentrations of the other COCs present at the Site; however, the focus of the pilot testing is toluene. Pilot and/or bench-scale testing will be conducted to determine short-term remedial performance goals and target concentrations.

2.3 Target Treatment Areas

Soil and ground-water data collected as part of this investigation indicate that COC impact at the site is generally limited to the “smear zone” and shallow ground water (approximate depth eight to ten feet). Based on toluene impact (distribution and magnitude) and physical accessibility for treatment, two main target treatment areas were identified in vadose and saturated overburden soils at the Site (see Figure 2-1): 1) the Former Tank Farm SWMU; and 2) beneath the floor of the main on-site buildings in the Building Subslab AOC.

2.4 Selected Corrective Measure Alternatives for Pilot Testing

The following corrective measures alternatives were identified as feasible for primary treatment via the Technology Screening Matrix presented in the December 2007 RFI Report: 1) in the Building Subslab AOC: enhanced bioremediation, monitored natural attenuation (MNA), in-situ chemical oxidation (ISCO), and enhanced fluid recovery (EFR); and 2) in the Former Tank Farm SWMU: enhanced bioremediation, soil excavation, ISCO. The Corrective Measures Alternative(s) identified for each AOC are summarized in Table 2-1.

The primary remedial action alternative selected for dissolved toluene in both on-site target areas was enhanced bioremediation. Pilot testing is required to determine the effectiveness of this technology and to establish short-term remedial performance goals and target concentrations. If pilot testing indicates that enhanced bioremediation will not achieve the necessary remedial action performance goals, then ISCO technology, identified as a feasible alternative for both target areas, will be pilot tested as a potential remedial technology. EFR will be evaluated as an alternative primary or secondary remedial technology for areas of dissolved toluene under the building.

Soil excavation in the former tank farm area was identified as a feasible technology through the Technology Screening Matrix, but additional contractor information is necessary to determine the cost-effectiveness of this technology. If soil excavation is conducted and post-excavation sampling indicates significant residual source mass remains in the former tank farm area, an additional primary remedial action, such as enhanced bioremediation or ISCO, may also be necessary in the former tank farm area. If soil excavation is not conducted in the former tank farm area, ISCO bench testing data will be reviewed to evaluate its potential use as the primary remedial technology in this area.

Passive FPP recovery (via petrophilic socks) with a contingency for EFR was selected as the proposed FPP removal technology in the former tank farm area. However, measurable FPP has not been detected following a single EFR event and the implementation of passive FPP recovery (via petrophilic socks) on an interim basis in the former tank farm area.

Available data indicate that intrinsic attenuation is effectively managing the fringe of the dissolved toluene plume in the on-site SWMUs/AOCs. Reduction of residual source mass via the primary (and contingent secondary) remedial actions will result in diminished dissolved-phase toluene mass discharge/flux, thereby reducing the potential for off-site migration. MNA will ultimately be used to achieve the on-site project Corrective Measure objectives.

The primary Corrective Measure proposed for the Off-Site AOC is MNA. Overall decreasing concentration trends demonstrate that natural attenuation is actively reducing dissolved toluene in the off-site areas, and on-site remedial actions may accelerate these trends. If future monitoring data indicate that off-site toluene concentrations are increasing or do not demonstrate continued decreasing trends then it will be necessary to evaluate enhanced technologies for the Off-Site AOC.

2.5 Feasibility Testing

As discussed in the December 2007 RFI Report, pilot testing is required in the two on-site treatment areas to: 1) validate the results of the RFI Technology Screening Matrix; 2) determine appropriate design criteria for the development of remedial system equipment specifications, where applicable; and 3) establish performance goals. The results of the bench-scale testing and/or pilot testing will be used to prepare the final CMS/focused CMS report.

2.6 Sewer SWMUs Corrective Measures

Treatment of the sewer SWMUs is considered separate and unique from other soil/ground-water issues at the former Norton/Nashua Facility. The December 2007 RFI Report (see Section 5.7 of the RFI Report) determined that the storm and sanitary sewer lines and associated bedding are not current pathways for the off-site transport of toluene or other volatile organic compounds (VOCs). However, polyaromatic hydrocarbons (PAHs) exceeding corresponding State standards were found in RFI sewer sediment samples, and to a lesser degree, sewer water samples. Proposed measures target the removal of sediments from the storm sewers to eliminate the potential off-site transport of PAHs (see Section 8.0).

SECTION 3.0

INSTALLATION OF GEOPROBE BORINGS, SMALL DIAMETER MONITORING POINTS, AND CONVENTIONAL MONITORING WELLS

Although a number of ground-water monitoring points/wells have been installed at the former Norton/Nashua Site, additional monitoring points are needed to provide the proper spatial arrays for pilot testing purposes. A limited number of conventional monitoring wells (two-inch to four-inch diameter) are needed to allow the deployment of the downhole remediation equipment proposed for testing; i.e., oxygen delivery technology. Smaller-diameter monitoring points (one-inch diameter) will be utilized for additional ground-water sampling, liquid-level monitoring, vapor monitoring, and/or vacuum/pressure gauging. Using a Geoprobe rig to install the smaller-diameter monitoring points will also allow the efficient collection of supplemental soil samples that will be used for bench testing and other vendor purposes.

3.1 Proposed Pilot Test Boring/Monitoring Point/Well Locations

The installation of pilot test borings/monitoring locations is proposed in the following areas of the on-site SWMUs and AOCs (see Figure 3-1): 1) between the main building and the former tank farm; 2) along the north wall of Building #61 (east of the former solvent lines) in the Building Subslab AOC (designated “west” test area); and 3) approximately 60 feet south of the north wall of Building #61 (north of the storm sewer line along a line of east-west I-beams) in the Building Subslab AOC (designated “east” test area). These three locations were selected to encompass areas of maximum residual toluene impact to soil and ground-water, but were also spaced far enough apart to allow concurrent testing activities in two or more areas. The monitoring array installed in each area will vary depending on the specific remedial technology proposed for pilot testing in that area.

3.1.1 Proposed Pilot Test Borings - Former Tank Farm SWMU

Based on RFI soil and ground-water sampling data (see the December 2007 RFI Report), the highest levels of residual toluene are found in the vicinity of the Former Tank Farm SWMU. Currently, remnants of the concrete containment walls prevent drilling access in the former tank farm; however, conditions just south of the tank farm wall should be representative of residual toluene impact to soil and ground water in the Former Tank Farm SWMU.

Seven pilot test boring/monitoring locations are proposed between the main building and the wall of the former tank farm (see Figure 3-1). These borings will be used to collect soil and ground-water samples, and monitor pilot testing for the following remedial technologies: 1) ISCO; 2) soil excavation; and possibly, 3) EFR.

Baseline soil samples for ISCO and soil excavation (see Section 4.0) will be collected from the seven borings proposed for this area. Three of the borings will be converted into small diameter ground-water monitoring points (see Section 3.2). These points, in combination with proposed monitoring points just south of the building wall (see next section), and existing monitoring well MW-14 and monitoring points MP-2 & MP-3, will provide a monitoring array of eight to ten potential sampling points (see Figure 3-1) surrounding the area proposed for ISCO (and possibly EFR) pilot testing activities.

3.1.2 Proposed Pilot Test Borings - Building Subslab AOC (west)

Five small-diameter monitoring points are proposed along or near the north wall of Building #61 (east of the former solvent lines) in the Building Subslab AOC (see Figure 3-1) to monitor enhanced bioremediation pilot testing of the following remedial technology: C-Sparge/Perzone system, Kerfoot Technologies, Inc. (Kerfoot) of Mashpee, MA. This technology also requires the installation of a proprietary “sparge” well (will not be available for sampling or monitoring) that is used to introduce ozone into the ground water.

Based on vendor information, the C-Sparge/Perozone system is an active technology that has a relatively isotropic influence (i.e., the primary treatment area is not significantly influenced by ground-water flow); therefore, monitoring points have been located to provide adequate coverage for determining the system's radius of influence (ROI) while minimizing potential disruption to ongoing warehouse activities. The sparge point will be installed immediately adjacent to a hydrogen peroxide holding tank and system control panel mounted on the north wall. Proposed monitoring points will be located along the north wall 15 feet and 30 feet west, 10 and 20 feet east of the "sparge" point (see Figure 3-1), and one point will be located 20 feet to the south. (Note: Former Tank Farm SWMU monitoring points approximately 7.5 feet and 22.5 feet north of the "sparge" well may also be suitable for pilot test monitoring purposes.)

3.1.3 Proposed Pilot Test Borings - Building Subslab AOC (east)

Three small-diameter monitoring points, and two (2) two-inch diameter monitoring wells are proposed for installation approximately 60 feet south of the north wall of Building #61 (north of the storm sewer line) in the Building Subslab AOC (see Figure 3-1) to monitor enhanced bioremediation pilot testing of the following remedial technology: in-situ submerged oxygen curtain (iSOC) system manufactured by inVentures Technologies, Inc. (inVentures) of Fredericton, New Brunswick. This monitoring array will also be used for EFR pilot testing.

Based on vendor information, the iSOC system is a passive technology that can be influenced by ground-water flow direction, and the vendor recommends the installation of two iSOC devices to provide adequate coverage for determining the ROI. The iSOC devices can be installed downhole in conventional monitoring wells; however, a standard oxygen tank is required. To minimize potential disruption to ongoing warehouse activities, the oxygen tank and iSOC wells will be secured to an adjacent to structural I-beam, if possible, or installed in an alternate area that can be temporarily isolated from forklift traffic.

Proposed monitoring points will be located 10 feet north, approximately 20 feet northeast, and approximately 25 feet east of the iSOC points (see Figure 3-1). If possible, existing well MP-11 will also be incorporated for monitoring purposes (or an additional monitoring point will be installed 10 feet east of the iSOC points).

3.2 Installation of Small-Diameter Ground-Water Monitoring Points

Small-diameter ground-water monitoring points will be installed via Geoprobe drilling rig. Geoprobe borings will be installed to approximately ten feet below the level of the water table (or to refusal) to allow for seasonal ground-water fluctuations. Total monitoring point depths are anticipated to range from 15 to 20 feet.

Geoprobe “pre-pack” well and filter kits constructed of one-inch diameter Schedule 40 PVC riser and screen (fifteen feet 0.010-inch slot size), bottom plug, and sand pack will be installed in the boreholes, sealed with approximately one to two feet of bentonite, and then grouted to the surface. Any recovered soils will be temporarily stored in 55-gallon drums prior to characterization and proper disposal.

Each ground-water monitoring point will be completed with a bolt-down, flush-mounted vault anchored by a concrete skirt (or cemented into the surrounding building slab), and equipped with a locking gripper-plug to prevent unauthorized access. Following installation, each ground-water monitoring point will be properly developed to remove fine-grained sediments from the sand pack and screen, and surveyed to existing site benchmark elevations. Well development water will be staged and processed in a similar manner as ground-water sampling purge water (described in Section 4.6).

3.3 Monitoring Well Installation

Monitoring wells will be installed via standard hollow-stem auger (HSA) methods to a depth of 20 feet (or bedrock refusal if less). Drill cuttings will be temporarily stored in 55-gallon drums prior to characterization and proper disposal.

Proposed monitoring wells will be constructed of approximately 10 feet of Schedule 40 4-inch diameter PVC well screen (0.010 inch slot) installed across the water table (approximate depth 10 feet) to allow for any seasonal fluctuations, and completed with solid Schedule 40 4-inch diameter PVC well riser to the surface. Clean silica sand (#1 or #2) will be used to fill the well annulus to at least one foot above the top of the screened interval. A one to two-foot thick bentonite seal will be installed above the gravel pack to prevent surface infiltration, and the remaining well annulus will be grouted to surface.

Proposed monitoring wells in areas with restricted access (indoor locations) may be installed via a Geoprobe rig converted to advance hollow-stem augers. Wells installed via Geoprobe will be completed as outlined above, but substituting 2-inch (versus 4-inch) diameter PVC well materials, and alternatively, Geoprobe “pre-pack” well and filter pack kits may be used to complete these wells.

Each wellhead will be finished with a bolt-down, flush-mount vault secured by a 2-foot by 2-foot concrete skirt (smaller concrete skirts will be used inside the buildings). Each well will be equipped with a locking gripper-plug to prevent unauthorized access.

The newly installed monitoring wells will be properly developed to remove fine particulate matter from the screened interval. Well development water will be staged and processed in a similar manner as ground-water sampling purge water (described in Section 4.6).

After the completion of each bore hole (and prior to leaving the site), all equipment that has been exposed to site soils or ground water will be decontaminated utilizing an Alconox wash and tap water rinse. The handling and disposal of liquids generated during the decontamination process is discussed in Section 9.0.

3.4 Monitoring Point/Well Survey

The newly installed monitoring points/wells will be surveyed to establish horizontal position and vertical elevation. Survey information will be used to revise future site base maps depicting monitoring locations, ground-water flow maps, isoconcentration maps, and other summary figures as appropriate.

SECTION 4.0

COLLECTION OF SOIL AND GROUND-WATER SAMPLES

4.1 Geoprobe Boring Soil Collection and Field Screening Methods

Soil samples for baseline characterization and vendor use will be collected from all of the borings proposed for the Former Tank Farm SWMU. Additional soil characterization in the Building Subslab AOC is unnecessary because: 1) extensive soil characterization was performed in this AOC as part of the RFI activities documented in the RFI Report approved by the NYSDEC on March 31, 2008; and 2) remedial actions under consideration for this AOC are limited to ground-water (vs. soil) treatment technologies. However, soil samples will be collected from one boring in each of the Building Subslab AOC pilot testing areas to confirm previous field observations.

Continuous soil samples will be obtained via Geoprobe recovery “sleeves” (i.e., disposable four-foot acetate liners placed in the macro-core sampler). Each liner sleeve will be extracted by the Geoprobe, opened with a liner or utility knife, and screened with a photoionization detector (PID) to select the portion of the recovered soil sample that will immediately be placed in appropriate bottleware for possible laboratory analysis.

Samples collected for VOC analysis will not be composited and will be packed to minimize headspace in the container (refer to Table 4-1 for other details). A small sample (approximately 100 grams) of the remaining soil exhibiting the highest PID reading in the Geoprobe liner will be placed in a sealable plastic bag, shaken for 15-30 seconds, and allowed to equilibrate to ambient temperature for several minutes before piercing the bag to obtain a PID reading (MiniRae2000 [or equivalent], calibrated twice-daily or after any two hour break, equipped with a 11.6 eV lamp).

After field screening to collect soil samples for laboratory analysis, remaining soil in the recovered Geoprobe liner will be used for field descriptions. Soil sample field descriptions will include assessment via Unified Soil Classification System (USCS) for 1) composition, 2) consistency and density, 3) color, 4) moisture content, 5) grain size/sorting, and 6) presence/absence of staining, discoloration, and odors.

Geoprobe bore holes that are not converted to ground-water monitoring points (see Section 3.2) will be abandoned by backfilling with any remaining soil cuttings followed by hydrated bentonite chips. The surface will be restored with cold patch or concrete as applicable. Any excess soil cuttings will be temporarily stored in 55-gallon drums prior to characterization and proper disposal.

At the completion of each bore hole (and prior to leaving the site), all equipment that has been exposed to site soils or ground water will be decontaminated utilizing an Alconox wash and tap water rinse. The handling and disposal of liquids generated during the decontamination process is discussed in Section 9.0.

4.2 Geoprobe Soil Sample Analyses

Soil samples will be collected in appropriate laboratory bottleware (see Table 4-1), properly labeled, logged on a chain-of-custody form, and maintained at 4°C until laboratory receipt. Soil samples from the four borings in the Former Tank Farm SWMU will be analyzed for VOCs via EPA Method 8260 plus heptane and tentatively identified compounds (TICs), and other selected analyses as requested by the relevant vendor (ISCO and/or soil excavation). Additional soil samples may be provided directly to the vendor for their own use. As indicated in Table 4-1 soil samples for VOC analysis will be collected to minimize headspace.

4.3 Monitoring Point/Well Ground-Water Sampling

Ground-water samples will be collected from each newly installed monitoring point/well a minimum of two weeks after development. Monitoring points/wells will be sampled via the micropurge sampling method. The United States Environmental Protection Agency (USEPA) has encouraged the use of this method because of its reproducibility, accuracy, and cost-effectiveness (additional details are available in the April 1996 USEPA reference document).

A micropurging pump capable of a flow rate of approximately 0.1 to 0.5 liters per minute (i.e., peristaltic/bladder pump) will be used to minimize turbulence in the well bore and hydraulic stress on the formation. The pump will be positioned in the middle of the saturated portion of the screened interval of the well. Water quality indicator parameters (temperature, pH, specific conductivity, oxidation-reduction potential [ORP], and dissolved oxygen [DO]) will be monitored during purging with a continuous “flow-through” cell device (YSI-600XL or equivalent). Readings will be taken every three to five minutes until the following stabilization rates are achieved: pH \pm 0.1 standard units, specific conductivity \pm 3%, ORP \pm 10 mV, and DO \pm 10%. After the water quality parameters have stabilized, ground-water samples will be collected directly from the pump effluent line using dedicated tubing and pump bladders at each well. Ground-water samples will be collected in a manner that minimizes turbulence in the samples.

4.4 Ground-Water Sample Analyses

Ground-water samples will be collected in appropriate laboratory bottleware (see Table 4-1), properly labeled, logged on a chain-of-custody form, and maintained at 4°C until laboratory receipt via courier or overnight delivery. Ground-water samples will be analyzed for VOCs via EPA Method 8260 plus heptane and TICs, and other selected analyses (see below). A summary of relevant sampling protocol have been provided in Table 4-1. All analyses will include Category B laboratory deliverables.

4.5 Supplemental Ground-Water Analyses

In addition to the analyses discussed in Section 4.4, one monitoring location in each of the three pilot testing areas will be sampled for the following electron acceptor and other natural bioattenuation parameters during baseline and post-treatment ground-water sampling events (see Table 4-1): redox, pH, and O₂ (via field instrumentation), Fe⁺² (via field chemical analysis kit), total and dissolved iron (EPA Method 7380), nitrate/nitrite (EPA Method 353.2), phosphate (EPA Method 365.1), sulfate (EPA Method 375.4) alkalinity (EPA Method 310.1), methane/ethane/ethene (Misc. GC Methods), hydrogen sulfide to determine H₂ (from pH and sulfide via EPA Method 376.1), total organic carbon (TOC) via EPA Method 415.1, and total heterotrophic bacteria and toluene-xylene (TX)-degrading bacteria microbial counts (via Standard Plate Count Methods).

Redox, pH, and O₂ will continue to be monitored via field instrumentation during subsequent pilot testing ground-water sampling events. The supplemental ground-water analyses will be used to evaluate the effectiveness of the enhanced bioremediation technologies.

4.6 Purge Water Disposal

Purge water from monitoring point/well development and ground-water sampling conducted in conjunction with CMS pilot testing will be temporarily containerized in 55-gallon drums. Drums will be stored at an approved on-site staging location pending proper off-site disposal at a later date.

SECTION 5.0

PRIMARY TECHNOLOGY TESTING/EVALUATION

This section provides additional information on the equipment, vendors, testing activities and procedures, and field monitoring that will be used in conjunction with each of the remedial technologies proposed for pilot testing at the former Norton/Nashua Site.

5.1 Enhanced Bioremediation - Oxygen Delivery (C-Sparge/Perzone & iSOC)

Dissolved oxygen appears to be the key limiting factor for biodegradation at the Former Norton/Nashua Site. Decreases in toluene concentrations at regularly sampled wells in the Building Subslab AOC are likely a result of physical mixing (and oxygenation) of ground water near each sampling location. It is anticipated that addition of dissolved oxygen at selected wells will produce a similar effect on the overall aquifer in the Building Subslab AOC.

5.1.1 Equipment and Pilot Test Set-Up

Two oxygen delivery technologies are proposed for CMS pilot testing: 1) the C-Sparge/Perzone delivery system developed by Kerfoot, which uses a proprietary well (C-Sparger) to deliver microbubbles of ozone with a “coating” of hydrogen peroxide (H_2O_2) into the ground water; and 2) the in-situ submerged oxygen curtain (iSOC) distributed by inVentures, which uses microporous fibers to introduce microbubbles of oxygen into ground water within the well borehole. Pilot testing will be performed on these oxygen delivery technologies to determine: 1) their overall effectiveness at increasing dissolved oxygen levels (including ROI) 2) their overall effectiveness at reducing dissolved toluene concentrations (including ROI for possible use in system design); and based on #2, 3) potential short-term remedial performance goals and target concentrations if either of these technologies is selected for implementation.

As mentioned in Section 3.1.2, the C-Sparge/Perozone system requires the installation of a proprietary “sparge” well that creates the ozone microbubbles. The ozone is generated at a wall-mounted, electric-powered control panel, which also feeds H₂O₂ into the modified well annulus. The H₂O₂ reportedly acts to release organic material (including toluene) bound to saturated soils, while the ozone accelerates the chemical (abiotic) degradation and biodegradation of the desorbed organic material. Supplemental nutrients are generally not required because this technology relies more on direct oxidation (versus stimulation of biodegradation); however, any remnant dissolved oxygen will promote biodegradation at the margins of the direct treatment area. A one month pilot test will also generally require one 55-drum of dilute H₂O₂ (consumption rate of approximately 5 milliliters per minute).

Based on information provided by the vendor, because C-Sparge/Perozone system is an active technology (i.e., the ozone is being sparging into the aquifer) the ROI is usually established within one month or less. In contrast, the iSOC oxygen delivery technology utilizes a downhole well device to produce oxygen microbubbles in the ground-water flowing through the well borehole. Because the ground-water velocity beneath the building at the Former Norton/Nashua Facility is suspected to be relatively low, additional time may be required to establish the ROI for the iSOC technology.

The proposed iSOC pilot testing equipment footprint is more compact than the C-Sparge/Perozone system and is limited to a compressed oxygen cylinder. No power source is required; oxygen is introduced via pressure from the gas cylinder (regulated to approximately 50 pounds per square inch). Each iSOC device uses approximately one cubic foot of oxygen per day, so a standard (K-size) oxygen cylinder (capacity 250 cubic feet) will supply two iSOC devices for approximately four months. The vendor indicated that a nitrate deficiency will often act as a limiting factor during the use of this technology, so monitoring for dissolved nitrate (and supplementation, if needed) is recommended.

5.1.2 Pilot Test Protocol

Baseline sampling for oxygen delivery technology pilot testing will be conducted approximately 60 to 90 days after EFR and ISCO pilot testing activities (see Sections 5.2 & 5.4, respectively) to allow site conditions to equilibrate. Baseline sampling will include bioattenuation supplemental analyses parameters (see Section 4.5).

Deployment of oxygen delivery test units will occur immediately after oxygen delivery technology baseline sampling. Ground-water monitoring events will be conducted on a monthly basis (approximately every 30 days). Ground-water monitoring samples will be submitted for standard laboratory turn-around times (two to three weeks).

Based on vendor information, one month of ground-water sampling will be sufficient to evaluate to effectiveness of the C-Sparge/Perozone technology; however, an additional monthly event will be completed to evaluate potential post-treatment rebound. At least two monthly monitoring events will be required for evaluation of the iSOC technology. Following two rounds of ground-water sampling, the need for extended testing of either oxygen delivery technology will be reviewed for approval by the NYSDEC.

Interim monitoring is not required, but ORP, pH, and dissolved oxygen concentrations will be monitored via field instrumentation when personnel are present in association with other on-site activities. Additional technical information and vendor-supplied case studies on these technologies is provided in Appendix A.

5.2 In-Situ Chemical Oxidation (ISCO)

In-situ chemical oxidation (ISCO) technology utilizes injection points to introduce chemicals to the subsurface to oxidize (mineralize) target compounds. Excess reagents and catalysts are monitored and neutralized naturally or through the introduction of buffer solutions. The first stage of ISCO evaluation will be a bench-scale test.

5.2.1 ISCO Bench-Scale Test

Bench scale testing will be conducted by submitting soil and ground-water samples to an ISCO vendor. Based on previous experience at other sites, In-Situ Oxidative Technologies, Inc. (ISOTEC) of West Windsor, New Jersey has been identified as a potential ISCO vendor. ISOTEC has indicated that they will require approximately 10 pounds of soil and 5 liters of ground water (unpreserved) for bench testing purposes. Soil samples will be collected from the borings proposed in the Former Tank Farm SWMU (see Section 3.1.1, and ground-water samples will be collected from monitoring well MW-14. (Note: if insufficient soil is recovered from the proposed borings, additional geoprobe borings will be installed in the immediate vicinity to obtain the requested sample volume.)

The chem-ox pilot test (and subsequent contingent treatment) will likely employ Fenton's reagent chemistry, which utilizes dissolved iron as the catalyst, and hydrogen peroxide as the source of the hydroxyl radical. Hydrogen peroxide is added to the subsurface in a solution ranging from five to fifteen percent; however, the concentration of the catalysts and the hydrogen peroxide can be adjusted to control the intensity (but not the rate) of the reaction. In general, the reaction (oxidation of hydrocarbons) occurs rapidly (instantaneously) due to the fact the hydroxyl radical is not stable (short-lived) in the subsurface. For this reason, multiple applications of catalysts and hydrogen peroxide may be necessary.

ISOTEC will also be requested to evaluate permanganate as a possible ISCO reagent. Permanganate is usually more appropriate when target concentrations are lower, but permanganate has the advantage of reacting more slowly. This quality is desirable in a "curtain" application where the ISCO reagent is injected in a continuous row of points to provide longer-term treatment to ground water flowing through the curtain area. This application may potentially be appropriate for use on the north side of the Former Tank Farm SWMU (see Figure 2-1) to treat low levels of toluene in ground water following contingent soil excavation activities.

ISOTEC will provide a feasibility report on their internal bench testing that will include: 1) recommended chemicals, concentrations, and total injection volumes for the proposed site-specific applications; and 2) recommended density of injection points for pilot testing based on estimated ROIs. The principal objectives of a pilot-scale ISCO test will be to: 1) confirm bench testing results; 2) collect empirical data to establish field reagent injection concentrations and injection volumes; 3) determine potential short-term remedial performance goals and target concentrations if ISCO technology is selected for implementation; and 4) collect requisite vapor monitoring data to evaluate the feasibility of applying this technology as a contingent alternative treatment technology in the Building Subslab AOC.

5.2.2 ISCO Pilot Test Baseline Sampling

Prior to pilot testing, baseline ground-water data will be collected from adjacent monitoring points. In addition to VOCs and the supplemental analyses discussed in Section 4.5, selected ground-water samples in the ISCO testing area will also be analyzed for chemical oxygen demand (COD) via EPA Method 410.4. In addition to VOCs, selected soil samples collected in the ISCO pilot testing area will also be analyzed for COD via EPA Method 410.1, total iron via EPA Method 200.7, and TOC via Lloyd Kahn Method.

5.2.3 ISCO Pilot Test - First Day of Testing

Prior to the start of ISCO injections, each monitoring point/well will be fitted with a pressure gauge and vapor sample collection port, and the following data will be recorded at each monitoring point via field meter or field chemical kit:

- liquid levels
- dissolved oxygen, peroxide and carbon dioxide concentrations
- pH, temperature, specific conductivity and turbidity
- head space concentration readings (PID, LEL, O₂, CO₂)

A geoprobe drilling rig will be used to install temporary ISCO injection points to a total depth of 8 to 15 feet. The depth of the injection screen (approximately four feet in length) will be adjusted from shallow (7 to 11 feet deep) to deep (12 to 16 feet) at alternating borings to provide coverage across the entire target injection interval of 7 to 16 feet.

The initial ISCO injection will use relatively low concentrations of hydrogen peroxide (3%-5%) in water. The mobile injection trailer used by ISOTEC allows preparation of 500-gallon batches of reagent. The reagent concentration for each batch will be increased in a step-wise manner to determine the highest reagent concentration that can safely and effectively be injected at the site.

The following data will be collected on an hourly basis from the field monitoring points during first day of injections:

- liquid levels
- dissolved oxygen, peroxide and carbon dioxide concentrations
- pH, temperature, specific conductivity and turbidity
- head space concentration readings (PID, LEL, O₂, CO₂)

If steady-state conditions (i.e., baseline conditions) are recorded at the monitoring points, the hydrogen peroxide concentration in each subsequent reagent batch will be increased (to a maximum of 15%). However, if the ground-water temperature increases, or there are negative visual indicators (steam and/or excessive bubbling), and/or evidence of vapor migration, the concentration of the injection solution may be capped or reduced (or the injection rate may be reduced) until field parameters stabilize.

At the completion of the first day of ISCO injections, a Summa canister will be used to collect a vapor sample for laboratory analysis from the monitoring point with the highest PID reading. The vapor sample will be submitted for the following analyses: hydrogen, oxygen, and carbon dioxide via ASTM Method 1946-90, VOCs via TO-15 plus TICs, methane via EPA Modified Method TO-18, and TOC via EPA Method TO-25.

5.2.4 ISCO Pilot Test - Additional Testing Days

Subsequent ISCO pilot testing (a maximum of 2 additional field days) will begin injection at the optimal pressure, flow rate, and reagent concentrations established during the first day of testing to maximize the volume of reagent injected. Field parameters will continue to be monitored hourly; however, if field parameters remain stable after three monitoring rounds, the monitoring frequency will be reduced to every other hour. If there are any indications that longer-term injections are resulting in adverse effects (i.e., temperature increase, unfavorable visual indicators, and/or vapor migration), the concentration of the injection solution (or the injection rate) will be reduced for the remainder of the test, or testing will be terminated.

During the last stage of ISOC testing (restoration), subsurface conditions (i.e., pH and dissolved oxygen concentration) are returned to their pre-treatment condition through natural processes (or the addition of buffer solutions, if needed). Field monitoring will continue until target parameters return to background levels.

5.2.5 ISCO Post-Test Sampling

To allow for possible “rebound” effects, ground-water and soil samples will not be collected for laboratory analysis until four to six weeks after ISCO injection activities are completed. Ground-water samples will be collected from existing monitoring points. Geoprobe borings will be installed immediately adjacent to the baseline soil borings, and soil samples collected from the previously identified impacted intervals.

Soil and ground-water samples will be analyzed for VOCs via EPA Method 8260 plus TICs. Chem-ox pilot testing results will be used to further evaluate the effectiveness of this technology, and determine the: 1) injection point density; 2) quantity and concentrations of required reagents/catalysts; 3) number of treatment rounds; and 4) cost of treatment for the potential implementation of full-phase ISCO remediation at the former Norton/Nashua Site.

5.3 Soil Excavation

This technology was rated feasible for the Former Tank Farm SWMU (assuming that a secondary technology is implemented to address residual aqueous-phase mass after excavation is completed), but bench scale treatability testing and/or additional information must be obtained from potential disposal facilities to determine the most cost-effective implementation of this technology. CMS “pilot testing” activities related to this technology are limited to the collection of additional soil characterization samples to: 1) verify that the soil can be treated at an off-site disposal facility in compliance with NYSDEC correspondence regarding “Contained-In Determination” dated July 24, 2007 (see Appendix B); and 2) satisfy supplemental testing requirements for potential off-site disposal facilities (i.e., analysis for corrosivity, moisture content, pH, etc.).

Soil samples will be collected from geoprobe borings in the Former Tank Farm SWMU, and submitted for laboratory and potential off-site disposal facility analysis. Based on these data, the potential off-site facilities will be asked to provide: 1) detailed information regarding disposal requirements; and 2) a soil disposal cost proposal.

5.4 Enhanced Fluid Recovery (EFR)

This technology utilizes a high vacuum (via vacuum truck or other methods) to extract ground water and FPP from monitoring points. EFR events can enhance FPP recovery through removal of “stranded” FPP pockets via the development of preferred fluid pathways. Residual mass is also recovered from the vadose zone via vapor extraction.

One EFR event was conducted adjacent to the former tank farm in March 2007 after FPP was detected at monitoring well MW-14 at an apparent product thickness 0.10 foot (see Figure 1-2). This technology appears to have been effective; FPP has not been observed in well MW-14 during subsequent monitoring events.

Although this technology is generally not intended to directly address dissolved-phase constituents, assuming that another technology is implemented, EFR may be feasible in the Building Subslab AOC (or the southern portion of the Former Tank Farm SWMU) for limited “hot spot” remediation. Fluid and vapor removal may also stimulate intrinsic remediation by circulating and oxygenating stagnant water.

VOC ground-water data obtained from the newly-installed monitoring points in the Building Subslab AOC (east) test area (see Section 3.1.3 & Figure 3-1) will serve as EFR pilot testing baseline data. Ground-water samples will also be collected for VOC analysis from monitoring point MP-11 during the same sampling event.

5.4.1 EFR Pilot Test

Prior to initiation of the EFR pilot test, each monitoring point/well will be fitted with a pressure gauge and vapor sample collection port, and the following data will be recorded at each monitoring point via field meter:

- liquid levels
- dissolved oxygen concentration
- head space concentration readings (PID)

Following the collection of pre-test data, the vacuum truck “stinger” (drop tube) will be inserted into well MP-11 to remove fluids. Air flow, vacuum, and total fluids recovered will be recorded from truck-mounted gauges every 15 minutes. Fluid removal will continue until well MP-11 goes dry or for a maximum of 30 minutes.

After fluid removal is completed, the vacuum truck hose will be connected to the riser of well MP-11, so vacuum is applied to the entire well. Air flow, vacuum, and total fluids recovered will be recorded from truck-mounted gauges every 15 minutes, and influent PID readings will be obtained at the truck every 30 minutes. Surrounding monitoring points will be gauged approximately every 30 minutes for induced vacuum and liquid levels.

Whole well vacuum extraction at well MP-11 will continue until: 1) monitoring readings are stable for three consecutive rounds; 2) 500 gallons of fluids have been recovered; or 3) a maximum of four hours. Prior to termination of vacuum extraction at well MP-11, PID readings will be collected from surrounding monitoring points. Immediately following the termination of vacuum extraction at well MP-11, dissolved oxygen readings will be collected from surrounding monitoring points, and liquid level measurements will be collected at the surrounding monitoring points every 15 minutes until water level rebound to static levels, or for a maximum of one hour.

Based on field results, a follow-up whole well vacuum extraction test may be performed at well MP-11. The first stage of this test will include fluid removal via stinger at MP-11 and all surrounding monitoring points prior to initiation of whole well vacuum extraction. The removal of additional fluids from the shallow vadose zone may allow an increase in the vacuum ROI generated at the extraction well. Test monitoring would be performed as outlined above.

Ground-water samples will be collected for VOC analysis from the EFR pilot test monitoring points/wells following testing. Fluids removed during EFR pilot testing activities will be transported via vacuum truck to an off-site facility for proper disposal.

5.4.2 Contingent Soil Vapor Extraction/In-Situ Air Sparging (SVE/IAS)

For a number of technical reasons, SVE/IAS received low ratings for potential implementation at the former Norton/Nashua Facility (see the December 2007 Preliminary CMS Report). However, if the pilot testing activities proposed in this Workplan indicate that enhanced bioremediation and ISCO are not viable remedial technologies; potential use of SVE/IAS will be reevaluated. The reevaluation will include an analysis of potential SVE extraction well ROIs, based, in part, upon EFR pilot test results. If SVE/IAS remains a viable technology for the former Norton/Nashua Facility, preparation and submittal of a workplan addendum outlining SVE/IAS testing protocol will be discussed with the NYSDEC.

SECTION 6.0

SUB-SLAB VAPOR MONITORING POINT (VMP) INSTALLATION

Per direction of the NYSDOH, sub-slab vapor and indoor air sampling are required in the office area of the on-site facility (Building #52, see Figure 1-2). Preliminary access has been received from the current owner of the facility to allow the installation and sampling of one sub-slab vapor monitoring point (VMP) and concurrent indoor air sampling.

6.1 Pre-Installation Survey and Selection of VMP Location

A pre-installation survey will be conducted at the former Norton/Nashua Facility to: 1) review the layout and construction of the facility; 2) select the proposed VMP location; 3) interview the property owner, review the proposed VMP location, and confirm permission to proceed with VMP installation; 4) inventory commercial/industrial products present in the immediate sampling area (and throughout the facility); and 5) perform other preliminary activities associated with sub-slab vapor and indoor air sampling (see Section 7.0).

The VMP will be installed in the immediate vicinity of the offices. The concrete slab in this area will be inspected for water leaks, cracks, floor drains, sump holes, and other penetrations, and field screened with a PID. The proposed VMP location, preferably away from walls and penetrations, and closest to the area of the dissolved toluene plume, will be reviewed with the property owner and NYSDEC/NYSDOH for approval.

6.2 VMP Installation

Prior to VMP installation, the floor of the slab/barrier will be inspected. Any facility inventory/equipment in the vicinity of the proposed VMP will be temporarily relocated.

The VMP assembly, patterned after Figure 2.3 in the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006, will consist of a 1/4-inch outer diameter (OD) threaded pipe. The pipe will be open at the bottom end and equipped with a 1/4-inch inner diameter (ID) threaded to compression fitting (or nipple) at the top end (see Figure 6-1). A recessed plug will be used to seal the compression fitting (or nipple). All VMP materials will be made of brass or stainless steel.

An oversize diameter “outer” hole approximately one-inch in diameter will be installed with a hammer drill (or similar) to a depth of one to two inches in the concrete slab. A smaller diameter “inner” hole (approximately three-eighths to one-half inch in diameter) will be installed with a hammer drill (or similar) through the remainder of the slab, and extended approximately one to two inches below the slab.

The VMP assembly will be placed in the smaller diameter hole. The bottom of the VMP assembly will extend approximately one inch below the base of the slab, but the top of VMP assembly will not extend above the top of the slab (see Figure 6-1). Porous, inert backfill (glass beads or similar) will be placed around the bottom one-inch of the VMP assembly.

The VMP assembly will be sealed in place with quick-drying expanding portland or hydraulic cement taking care to fill the annular space between the VMP assembly and the “outer” hole wall without blocking the upper fitting (see Figure 6-1). The cement will be allowed to cure for a minimum of 24 hours before any sampling is performed.

SECTION 7.0

SUB-SLAB VAPOR AND INDOOR/OUTDOOR AIR SAMPLING

Sub-slab vapor and ambient indoor/outdoor air samples will be collected at the former Norton/Nashua Facility. Sub-slab vapor and ambient air sampling protocol is based upon the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006.

Unless otherwise directed by NYSDEC/NYSDOH, sub-slab vapor/ambient air samples will be collected during the next heating season (general time frame approximately November 15, 2008 to March 31, 2009). Results will be forwarded to NYSDEC & NYSDOH for review and discussion to determine if additional sampling will be required. A sub-slab vapor/ambient air sampling summary matrix is presented as Table 7-1.

7.1 Pre-Sampling Inspection

A pre-sampling inspection will be conducted at least 24 hours prior to the scheduled sampling time. During the pre-sampling inspection, an Indoor Air Quality Questionnaire and Building Characteristics Inventory form, as outlined in the October 2006 NYSDOH guidance document, will be completed.

The pre-sampling inspection will also include: 1) a brief interview of the property owner; 2) preparation of a general floor plan for the facility; 3) PID field screening of the proposed sampling area; and 4) an inventory of commercial/industrial products, inventory materials, and other potentially contributing substances (see below) present in the proposed sampling areas. The goal of the inventory is to identify products (or other substances stored or present in the facility) that could potentially interfere with the testing and/or contribute site-specific compounds of concern (COCs) to the vapor samples.

Because toluene is the primary site-specific COC identified in ground water at the former Norton/Nashua Facility, the inventory (and any required mitigation) will focus on potential toluene sources. If present, and with the property owner's permission, potential toluene sources will be mitigated by moving these items to an alternate location, tightening container seals, etc. Any ventilation activities associated with mitigation will be completed at least 24 hours prior to sampling.

Following the pre-sampling inspection, the proposed sampling appointment time will be confirmed with the property owner. Employees will be given a handout asking them to refrain from the following activities during the 24 hours prior to testing (adopted from NYSDOH, 2006):

- opening any windows or vents
- operating ventilation fans unless special arrangements are made
- using auxiliary heating equipment (e.g., kerosene heaters)
- smoking in the facility
- painting in the facility
- using cosmetics, including hair spray, nail polish, nail polish remover, etc.
- using perfume/cologne
- cleaning, waxing, or polishing furniture or floors with petroleum or oil-based products
- using air fresheners or odor eliminators
- engaging in any other activities that use materials containing VOCs
- applying pesticides
- allowing containers of gasoline or oil to remain within the facility
- operating or storing automobiles in an attached garage (Note: the facility is an active warehouse. Operation of propane fueled forklifts and other equipment will continue in the warehouse areas during the vapor/air sampling event.)

7.2 Sub-Slab VMP Sampling

On the day of VMP sampling, a final site inspection and PID field screening survey will be performed to document conditions at the time of sampling. The integrity of the VMP will also be inspected. The plug will be removed from the VMP and approximately 1 foot of dedicated ¼-inch ID Teflon tubing will be connected to the compression fitting (or nipple).

Immediately prior to, and immediately after, VMP sampling, tracer gas monitoring will be conducted per the 2006 NYSDOH guidance document to confirm the integrity of the VMP (and associated fittings). Tracer gas monitoring protocol is provided in Appendix C.

A low-flow peristaltic pump (i.e., flow rate 0.2 liters per minute or less) will be connected to the other end of the Teflon tubing and used to extract the tracer gas monitoring sample. Collection of the tracer gas monitoring sample will also serve to purge more than three implant volumes (approximately 0.12 liters) from the VMP. After tracer gas monitoring is complete, the pump will be deactivated, and the Teflon tubing from the VMP will be attached to a 6L Summa canister equipped with a particulate filter and an 8-hour regulator preset by the laboratory.

The pre-sample vacuum of the Summa canister will be recorded at the laboratory following cleaning for shipping to the field, and again, immediately prior to sampling. The two readings should be within 1.5 inches of mercury (inHg) of each other, and the pre-sampling vacuum must be greater than 25 inHg.

The canister valve will then be opened to begin sub-slab vapor collection. The VMP sub-slab sample will be recovered approximately 8 hours later. The Summa canister valve will be closed when vacuum reaches approximately 2 inHg (to allow the laboratory to check for leaks), and the vacuum reading recorded. This reading must be within 1.5 inHg of the reading recorded in the laboratory prior to analysis.

Immediately after VMP sampling is complete, tracer gas monitoring will be conducted as described above (see Appendix C), and the VMP will be plugged. VMP sub-slab samples will be submitted for laboratory analysis of VOCs via EPA Method TO-15 plus TICs (see Table 7-1). The target reporting limit for the sub-slab air sample is 5.0 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). If the laboratory pressurizes the Summa canister for analysis, it must apply the appropriate dilution factor and provide NYSDEC with the information used in the calculations.

7.3 Indoor/Outdoor Air Sampling

In conjunction with VMP sampling, a concurrent ambient indoor air sample and a field duplicate (see Section 10.0) will be collected by co-locating two Summa canisters with equal initial vacuums in the facility offices. A concurrent ambient outdoor air sample will also be collected outside the office area.

Ambient indoor air samples will be collected as follows. A certified-clean 6L Summa canister, equipped with a particulate filter and an 8-hour regulator preset by the laboratory, will be placed in the center of the sampling area approximately three to five feet off the floor (where physically possible) to collect a representative “breathing air” sample. The Summa canister will not be attached to any tubing.

The pre-sample vacuum of the Summa canister will be recorded at the laboratory following cleaning for shipping to the field, and again, immediately prior to sampling. The two readings should be within 1.5 inHg of each other, and the pre-sampling vacuum must be greater than 25 inches of mercury. Temperature and barometric pressure will be recorded along with current weather conditions.

The Summa canister valve will be opened to begin indoor ambient air collection. A similar procedure will be followed for collection of the outdoor ambient air sample.

Employees will be asked to stay out of the active sampling area as much as possible for the duration of testing, restrict their movements in the active sampling area, and avoid opening and/or closing doors and windows. Ambient air samples will be recovered approximately 8 hours later.

Indoor (and outdoor) ambient air sampling activities will be terminated and each canister valve will be closed when vacuum reaches approximately 2 inHg (to allow the laboratory to check for leaks). The vacuum reading for each canister will be recorded. These readings must be within 1.5 inHg of the readings recorded in the laboratory prior to analysis of each canister.

Ambient indoor/outdoor air samples will be submitted for laboratory analysis of VOCs via EPA Method TO-15 plus TICs (see Table 7-1). The target reporting limit for the ambient indoor/outdoor air samples is 0.25 µg/m³.

7.4 Contingent Sub-Slab Vapor/Indoor Air Sampling

Following initial receipt (prior to validation), sub-slab vapor and ambient indoor/outdoor air sampling data will be reviewed and discussed with project representatives from the NYSDEC and the NYSDOH. This preliminary data assessment will determine whether additional VMP and ambient indoor air sampling locations (or the collection of additional samples from the existing VMP during the same heating season) are needed to complete the evaluation of this potential exposure pathway.

SECTION 8.0

SEWER SWMUs CORRECTIVE MEASURES TESTING

Proposed Sewer SWMUs Corrective Measures were limited to addressing the presence of PAHs in the Storm Sewer SWMU. Any PAHs present in the Sanitary Sewer SWMU are ultimately treated by the local publicly owned treatment works (POTW). The December 2007 RFI Report concluded that the source of the PAHs currently present in the storm sewer sediments is most likely: 1) historical site activities; and/or 2) run-off from asphalt covered areas, e.g., parking lots and/or the roof of the main building (a large section of the roof was recently resealed/repaired).

8.1 Storm Sewer SWMU Corrective Measures Testing

Removing accumulated sediment from the storm sewer manholes may allow identification of the source of the PAH-impacted sediment. If the PAH-impacted sediments are associated with historical site activities, there will be no subsequent accumulation of contaminated sediment, and the removal event will eliminate the potential migration of sediments from the Norton/Nashua Site via the storm sewer system. If PAH-impacted sediments return after removal of the current sewer sediments, the source is more likely ongoing surface run-off to the storm sewer system, and thus, unrelated to activities associated with NYSDEC Order on Consent Index No. CO: 4-20001205-3375. In the latter case, further Corrective Measures will not be proposed.

The proposed Corrective Measure testing activity for the Storm Sewer SWMU is sediment removal via vacuum truck extraction. All visible sediment and standing water will be removed from each of the accessible on-site storm sewer manholes. Accumulated vacuum truck waste materials will be sent off site for proper disposal.

8.2 Storm Sewer SWMU Monitoring

Following the sediment removal event, and at least two significant (greater than 0.5 inches) rainfall events or equivalent snow melts, a sewer inspection and sampling event will be performed. Sewer sampling will be performed according to the sampling procedures documented in Section 5.4 of the December 2007 RFI report.

Sewer sediment sampling will proceed upstream to avoid agitation of bottom sediments at succeeding sediment sample locations (see Figure 1-2 for storm sewer manhole locations). If sewer sediment is present, sediment samples will be collected from five storm sewer manholes (MH-2, MH-3, MH-5, MH-6, MH-13 & MH-14). If no sediment is present at sewer manholes MH-2 and/or MH-3, alternate locations upstream along the same sewer line will be assessed for possible substitution (see Table 8-1).

Sewer sediment samples will be analyzed for semi-volatile organic compounds (SVOCs) via EPA Method 8270 plus TICs. All analyses will include Category B laboratory deliverables (see Table 8-2).

Regardless of whether or not sewer sediment is present, sewer water samples will be collected from the same manholes listed above according to the sampling procedures documented in Section 5.5 of the December 2007 RFI report. If a specific sewer manhole is dry, no samples will be collected, but alternate sampling locations upstream along the same sewer line will be assessed for possible substitution (see Table 8-1).

All sewer water samples will be analyzed for SVOCs via EPA Method 8270 plus TICs (see Table 8-2). All sewer sample analyses will include Category B laboratory deliverables. Sewer sampling results will be used to determine the need, if any, for additional Corrective Measures for the Storm Sewer SWMU.

SECTION 9.0

DECONTAMINATION PROCEDURES

All non-disposable sampling and data procurement equipment will be decontaminated using the following procedures:

- 1) manual scrub withalconox and potable water using a brush;
- 2) thorough rinse with potable water;
- 3) triple rinse with distilled water (ASTM Type II); and
- 4) air dry.

Any liquids generated during the decontamination process will be treated in the same manner as purge and development water as discussed in Section 4.6.

SECTION 10.0

QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

The objective of the sampling Quality Assurance/Quality Control (QA/QC) program is to ensure the reliability and integrity of all data generated as part of the pilot testing and sampling program. Unless otherwise noted in this Workplan, QA/QC for all proposed pilot testing and sampling activities will be conducted in accordance with the procedures outlined in: 1) the May 2005 Supplemental RFI Workplan QAPP; 2) the July 2003 RFI Workplan; and 3) for instances where specific QA/QC procedures were not presented in the former two documents, the April 1994 QAPP, IRM, and General RFA/RFI Sampling Investigation Work Plan prepared by Rust Environment & Infrastructure (Rust).

The QA/QC program will involve the collection of trip blanks, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, and field duplicate samples. QA/QC sample collection is summarized in Table 10-1. Data validation will be performed in accordance with NYSDEC and USEPA procedures by a third party reviewer retained by Saint-Gobain for that purpose (see Section 11.0).

Trip Blanks

One trip blank sample will be analyzed for each ground-water sampling cooler utilized for the transport of samples for VOC analyses. Trip blanks will be analyzed for VOC target parameters and TICs. The trip blanks will be prepared and supplied by the laboratory, and transported and handled in the same manner as other ground-water sampling bottleware. The trip blank will be received in the field within one day of laboratory preparation and cannot be held at the field site for more than two days.

MS/MSD Samples

One set of MS/MSD samples will be collected for every twenty samples from each applicable medium (ground water and soil/sediment) and analyzed for the complete set of VOC/SVOC target parameters. Care will be taken to ensure that each MS/MSD pair can be considered a homogeneous sample split in two (however, there will be no mechanical mixing of soil samples that will be analyzed for VOCs). The MS/MSD samples will be identified as such and given a sample designation that is consistent with other analytical samples.

Field Duplicate Sampling

One field duplicate sample will be collected for every twenty samples collected from each medium (ground water, soil/sediment, and vapor) and analyzed for the complete set of VOC/SVOC target analytes. Care will be taken to ensure that each field duplicate can be considered a homogeneous sample split (however, there will be no mechanical mixing of soil samples that will be analyzed for VOCs).

Each field duplicate will be given a sample designation that is consistent with other analytical samples collected from the same medium to prevent the analyzing laboratory from identifying the field duplicate samples. Identification of the field duplicate samples will be provided to the NYSDEC.

Equipment Blanks

One equipment blank sample will be collected from each medium sampled (ground water, soil/sediment, and vapor) during each mobilization (except for the ISCO vapor sample; see Section 5.2.3). The equipment blank samples will be analyzed for the complete list of VOC/SVOC target analytes (except “vendor” sample analyses, see Section 11.0).

The ground-water equipment blank sample will be obtained by pouring demonstrated analyte-free water through or over the sampling device so that the rinsate flows directly into the laboratory cleaned sample containers. The sediment equipment blank sample will be obtained by pouring demonstrated analyte-free water through or over the previously decontaminated sampling device so that the rinsate flows directly into the laboratory cleaned sample containers. The vapor equipment blank sample will be obtained by analyzing a prepared gas sample (laboratory certified “clean air”) provided in a laboratory supplied Summa canister.

SECTION 11.0

LABORATORY ANALYSIS

All soil and ground-water samples will be submitted to Adirondack Environmental Services, Inc., of Albany, New York, and all vapor samples will be submitted to Accutest Laboratories of Dayton, New Jersey, for analysis via standard turn around times. Both laboratories are certified by the NYSDOH – Environmental Laboratory Approval Program (NYSDOH-ELAP). All samples will be analyzed following NYSDEC, ASP (June 2000) CLP procedures with complete NYSDEC CLP/Category B laboratory deliverables including TICs.

In addition to the above samples, supplemental soil and/or ground-water samples may be collected for vendor characterization and bench testing purposes (“vendor” sample). These samples may be sent to alternative laboratory facilities identified by the vendor (including internal vendor laboratories). Although complete laboratory analytical reports and QA/QC information will be requested from each vendor and forwarded to the NYSDEC, these samples may not be subjected to the same laboratory QA/QC methods and standards specified above. Therefore, utilization of the resulting data will be limited to the internal vendor purposes.

Data validation will be performed by a third party reviewer retained by Saint-Gobain for that purpose in accordance with the NYSDEC ASP (June 2000), the USEPA Region II document CLP Organics Data Review and Preliminary Review (SOP No. HW-6, Revision No. 8, January 1992), and USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994). Data validation will include a comparison of QC checks to prescribed acceptance criteria for the following major elements: equipment blanks, trip blanks, field duplicate samples, MS/MSD samples, laboratory qualifiers, holding times, detection limits, and accuracy. Each element will be examined by the third party reviewer to ensure project data quality objectives are met.

As outlined in Section 10.0, one equipment blank sample will be collected for each medium (ground water, soil/sediment, and vapor) during each mobilization and analyzed for all VOC/SVOC target parameters. A sample or sample delivery group may be qualified if the equipment blank contains detectable concentrations of target analytes; however, the data may be used qualitatively to assess the quality of the decontamination procedure or ambient site conditions. A similar procedure will be followed for the utilization of trip/travel blanks.

The laboratory report may qualify the sample concentration with a “B”, which indicates that a target analyte has been detected in the laboratory method blank. Data which have been qualified with a “B” will be utilized quantitatively only if the following criteria apply: 1) historical data suggests this specific compound was utilized at the facility; 2) the compound has been detected in previous analytical sampling; or 3) the laboratory case narrative states the presence of this compound is not the result of laboratory contamination. Consistent detection of compounds in the method blank suggests a laboratory contamination problem, and more importantly, problems with the internal laboratory QA/QC procedures.

The laboratory will often estimate analyte concentrations when samples are below, or greatly exceed, quantification limits. A concentration below the laboratory method detection limit, qualified with a “J”, will be used for quantitative interpretation as it represents the “best” estimate of a specific analyte concentration. Under NYSDEC ASP methods, the laboratory should not report concentrations that exceed the highest concentration within the calibration range. The analysis should be rerun using an appropriate dilution factor.

Analytical data packages received from the contract laboratory will be compared with the list of analyses requested on the chain-of-custody record and the project Workplan to ensure all analyses were performed as requested. If an analytical sample exceeds the method-specific holding time (see Tables 4-1, 7-1 & 8-2), the sample will be rejected for quantitative interpretation, and the data will be utilized only in a qualitative manner.

Practical quantitation limits for each analyte should meet the Contract Required Quantitation Limit (CRQL) as per NYSDEC ASP, revised June 2000. All data will be reviewed by the NYSDEC for precision, accuracy, representativeness, completeness, and comparability (PARCC). Surrogate recoveries, GC/MS calibrations, system performance checks, and other internal laboratory QA/QC results will be reviewed to assure that the laboratory analysis met all applicable performance criteria.

In addition to the above, the laboratory deliverables package for volatiles via Method TO-15 will include the following:

- 1) Chain of custody forms;
- 2) Instrument run logs with time and date information;
- 3) A case narrative describing any QC problems encountered by the lab, in addition to a written statement with regard to sample holding times from collection analysis (30 days for Summa canisters);
- 4) CLP Form I for each sample analyzed plus total/extracted ion chromatographs;
- 5) CLP Form II, system monitoring compounds (surrogate recoveries);
- 6) CLP Form III, MS/MSD recoveries and RPDs;
- 7) CLP Form IV, system, field and trip blanks where applicable;
- 8) CLP Form V, GC/MS instrument performance check for bromofluorobenzene;
- 9) CLP Form VI, GC/MS initial calibration form;
- 10) CLP Form VII, GC/MS continuing calibration;
- 11) CLP Form VIII, internal standard area and retention time summaries; and
- 12) CLP Form IV, system, field and trip blanks where applicable.

SECTION 12.0

SCHEDULE & REPORTING

This CMS Workplan has been revised to address the NYSDEC comment letter received on December 12, 2008 (see Appendix D). Per the general requirements of NYSDEC CO: 4-20001205-3375, CMS Workplan revisions are to be submitted within 45 days of receipt of comments from the NYSDEC (or within 30 days of a meeting with the NYSDEC to discuss the CMS Workplan, if determined to be necessary). Field work will be scheduled (and initiated depending upon contractor availability) within 30 days of receipt of final CMS Workplan approval from the NYSDEC.

The first phase of work will consist of the Geoprobe boring and monitoring well installations proposed in Section 3.0. Indoor and outdoor borings will be installed during the same mobilization if possible, but the facility is an active warehouse, and additional advance notice may be required for access to all indoor locations. Associated Geoprobe soil and ground-water samples (see Section 4.0) will be submitted for standard laboratory turn-around times (two to three weeks).

If preliminary laboratory data (prior to validation) indicate dissolved toluene concentrations are not suitable for pilot testing (too low) at specific monitoring locations, alternate Geoprobe soil boring or monitoring well locations will be finalized and submitted to the NYSDEC for approval within 30 days. Within 30 days of receipt of NYSDEC approval, installation of any supplemental Geoprobe boring or monitoring well locations will be initiated.

Baseline ground-water sampling (see Section 4.0) will be begin at least 14 days, but no more than 30 days, after well development activities are completed at the Site. Immediately following baseline sampling, EFR testing (Section 5.4) will be conducted. Vacuum removal of sewer sediments (see below) will occur during the same EFR mobilization.

The ISCO evaluation (Section 5.2) will be conducted concurrently with EFR pilot testing. Field work for the ISCO evaluation will require approximately one week to complete.

A ground-water monitoring event will be conducted approximately 4 to 6 weeks after ISCO field testing to monitor potential post-treatment rebound. Ground-water monitoring samples will be submitted for standard laboratory turn-around times (two to three weeks).

Baseline sampling for testing of oxygen delivery technology (Section 5.1) will be conducted approximately 60 to 90 days after the ISCO monitoring event to allow site conditions to equilibrate. In the interim, pilot testing equipment will be procured. (Note: a rental unit will be used for proposed C-Sparge/Perzone pilot testing.)

Deployment of oxygen delivery test units will occur immediately after baseline sampling. Ground-water monitoring events will be conducted on a monthly basis (approximately every 30 days). Ground-water monitoring samples will be submitted for standard laboratory turn-around times (two to three weeks).

Based on vendor information, one month of ground-water sampling will be sufficient to evaluate to effectiveness of the C-Sparge/Perzone technology; however, an additional monthly event will be completed to evaluate potential post-treatment rebound. At least two monthly monitoring events will be required for evaluation of the iSOC technology. Following two rounds of ground-water sampling, the need for extended testing of either oxygen delivery technology will be reviewed for approval by the NYSDEC.

The schedule for installation and sampling of the subslab VMP (see Section 6.0 & 7.0) will be determined by the NYSDEC & NYSDOH. Field mobilizations for vapor and ambient air sampling will be scheduled to coincide with other field work.

Storm sewer sediment and water sampling is proposed on a contingency basis dependent upon observed Site conditions (see Section 8.0). The contingent sewer sampling will be performed concurrently with other pilot testing mobilizations following the initial removal of sewer sediments. Sewer sediment and water samples will be submitted for standard laboratory turn-around times (two to three weeks).

Progress reports summarizing the status of all activities associated with implementation of the approved CMS Workplan will be submitted to the NYSDEC on a monthly basis. Copies of all final soil, sediment, ground-water, and vapor sampling laboratory data packages and the third party data validation review will be submitted to the NYSDEC in CD format.

Following receipt of the analytical data from all phases of the pilot testing, Saint-Gobain will prepare data summary tables and figures. A meeting with the NYSDEC will be scheduled within 60 days of the receipt of the analytical data from all phases of the pilot testing to discuss results.

Per NYSDEC Order on Consent Index No. CO: 4-20001205-3375, the Commissioner will subsequently notify Saint-Gobain in writing of: 1) the submittal schedule for a CMS that evaluates the alternative remedies, if required; or 2) if the NYSDEC and Saint-Gobain agree on the implementation of a pragmatic and presumptive remedy(ies), Saint-Gobain will be directed to submit a focused CMS report that includes a conceptual design for the remedy(ies) within 60 days (see Section 12.0).

Within 45 days of receipt of comments from the NYSDEC (or within 30 days of a meeting with the NYSDEC to discuss the draft Report, if determined to be necessary), a finalized CMS or focused CMS Report will be submitted for approval. An updated project schedule is provided as Table 12-1.

SECTION 13.0

REFERENCES

Forensic Environmental Services, Inc. (FES), 2001. RCRA Facility Assessment (Enhanced RFA) Workplan, September 2001.

FES, 2002. RCRA Facility Assessment (Enhanced RFA) Sampling Results, May 2002 (Revised June 2002).

FES, 2003. Final RCRA Investigation (RFI) Workplan, July 2003.

FES, 2005. Supplemental RCRA Facility Investigation (RFI) Workplan and Quality Assurance Project Plan (QAPP), May 2005.

FES, 2006. Addendum to the Supplemental RCRA Investigation (RFI) Workplan, January 2006.

FES, 2007. Final RCRA Investigation (RFI) Report, December 2007. (Revised March 2008).

New York State Department of Health, 2005. Indoor Air Sampling and Analysis Guidance, February 1, 2005.

New York State Department of Health, 2006. Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York. October 2006.

Rust Environment & Infrastructure (Rust), 1994. Quality Assurance Project Plan (QAPP), IRM and General RFA/RFI Sampling Investigation, April 1994.

USEPA Region II, 1992. Contract Laboratory Program (CLP) Organics Data Review and Preliminary Review. Publication No. SOP No. HW-6, Revision No. 8, January 1992.

USEPA, 1994. Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review, February 1994.

USEPA, 1996a. Ground Water Issue Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures. USEPA Publication No. EPA/540/S-95/504, April 1996.

USEPA Region I, 1996b. Low Stress (Low-Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells, July 30, 1996.

TABLES

Table 2-1
Selected Corrective Measure Alternative(s)
Former Norton/Nashua Facility
Watervliet, New York

	Area of Concern (AOC)/Solid Waste Management Unit (SWMU)	Compound(s) of Concern (COCs)		Selected Corrective Measure Alternative(s)
		Soil	Ground Water	
Building Subslab AOC	Former "Beartex" Sump Pit SWMU/ Building #61 Doorway Spill AOC	toluene, PAHs*	toluene, phenols	enhanced bioremediation (and contingent EFR) or ISCO (and contingent EFR) followed by MNA
	Building #58 AOC	toluene, heptane, VOC TICs, PAHs*	toluene	
	Former Text Pit AOC	toluene, heptane, phenols, PAHs*	toluene, phenols	
	Former Solvent Line AOC	toluene, heptane, xylenes, VOC TICs, phenols, PAHs*	toluene, VOC TICs, phenols	
	Former Tank Farm SWMU - FPP	-	FPP	passive FPP recovery, EFR
	Former Tank Farm SWMU	toluene, heptane, VOC TICs, phenols	toluene, heptane, VOC TICs	soil excavation and/or enhanced bioremediation, ISCO, MNA
	Storm Sewer SWMU	PAHs	PAHs	sediment removal, sewer sediment/water monitoring
	Off-Site AOC	<i>none</i>	toluene	MNA

* Soil PAHs will not be further investigated or addressed as COCs at the Site. See the December 2007 RFI Report.

boldface COC = concentration exceeds NYSDEC restricted industrial use soil clean-up objective (SCO) or ground-water standard

EFR = enhanced fluid recovery (vacuum truck or similar), ISCO = in-situ chemical oxidation, MNA = monitored natural attenuation;

FPP = free-phase product; PAH = polyaromatic hydrocarbon; TIC = tentatively identified compound

Table 4-1
Sample Summary Matrix - Soil & Ground-Water Samples
CMS Pilot Testing
Former Norton/Nashua Facility
Watervliet, NY

Matrix	Sample Locations	Parameter	Analytical Parameter	Container and Preservative	Analysis Holding Time
Soil	Selected Geoprobe locations (see text)	TCL Volatiles plus heptane	EPA 8260	4 oz. glass w/septum (no headspace)	14 days
Supplemental Soil	Selected Geoprobe locations (see text)	chemical oxygen demand	EPA 410.1	100 gm glass, Cool to 4°C	28 days
		total organic carbon (TOC)	Lloyd Kahn	20 gm glass, Cool to 4°C	28 days
		total iron	EPA 200.7	100 gm glass, Cool to 4°C	6 mos.
Water	Selected Monitoring Points/Wells (see text)	TCL Volatiles plus heptane	EPA 8260	3 x 40 ml glass vials w/teflon lined enclosure (no headspace)	14 days
Supplemental Water	Selected Monitoring Points/Wells (see text)	alkalinity	EPA 310.1	200 ml plastic	14 days
		chemical oxygen demand	EPA 410.4	100 ml plastic, H ₂ SO ₄ to pH <2	28 days
		hydrogen sulfide	EPA 376.1	500 ml plastic, NaOH/zinc acetate	7 days
		total/dissolved (field filter) iron	EPA 200.7	250 ml plastic, HNO ₃ to pH <2	6 mos.
		methane/ethane/ethene	Misc. GC	1 x 40 ml glass vial	14 days
		nitrate/nitrite	EPA 300.0	100 ml plastic, H ₂ SO ₄ to pH <2	28 days
		phosphate	EPA 365.1	100 ml plastic, H ₂ SO ₄ to pH <2	28 days
		sulfate	EPA 300.0	100 ml plastic	28 days
		TOC	EPA 415.1	125 ml amber glass, Cool to 4°C H ₃ PO ₄ to pH < 2	28 days
		microbial counts	Standard Plate Count Methods	3 x 40 ml sterile glass	24 hours

Table 7-1
Sample Summary Matrix - Sub-Slab Vapor/Ambient Air Sampling
CMS Pilot Testing
Former Norton/Nashua Facility
Watervliet, NY

Matrix/ Sample Type	Sample Locations	No. of Samples*	Parameter	Analytical Method	Sample Container (no preservative)	Analysis Holding Time
Sub-Slab Vapor	1 sample - VMP location	1	TCL Volatiles plus TICs	EPA TO-15	6 Liter Summa Canister equipped w/8-hour sample regulator	14 days
Ambient Indoor Air	2 samples - facility office area (see text; Section 7.3)	2*	TCL Volatiles plus TICs	EPA TO-15	6 Liter Summa Canister equipped w/8-hour sample regulator	14 days
Ambient Outdoor Air	1 sample - outdoor location (see text; Section 7.3)	1	TCL Volatiles plus TICs	EPA TO-15	6 Liter Summa Canister equipped w/8-hour sample regulator	14 days
Contingent ISCO field testing	1 sample - monitoring point (see text; Section 5.2.3)	1	TCL Volatiles plus TICs	EPA TO-15	6 Liter Summa Canister equipped w/ 4-hour sample regulator	14 days
			methane	EPA TO-18		
			TOC	EPA TO-25		
			CO ₂ , H ₂ , O ₂	ASTM 1946-90		

* does not include additional QA/QC sample - see Table 10-1

TOC = total organic carbon

Table 8-1
Storm Sewer Manhole Sampling Locations
CMS Pilot Testing
Former Norton/Nashua Facility
Watervliet, NY

Matrix	Sewer Sample Manhole Location	Matrix	Sewer Sample Manhole Location
Sediment	MH-2	Water	MH-2
	MH-3		MH-3
	MH-5		MH-5
	MH-6		MH-6
	MH-13		MH-13
	MH-14		MH-14
Contingent Sampling Locations*	MH-1*	Contingent Sampling Locations*	MH-1*
	MH-2.5*		MH-2.5*
	MH-3.5*		MH-3.5*
	MH-4*		MH-4*
	MH-10*		MH-10*
	MH-12*		MH-12*
	MH-15*		MH-15*

Sewer sediment and water samples analyzed for TCL semi-volatiles & tentatively identified compounds (TICs) via EPA Method 8270.

Table 8-2
Sample Summary Matrix - Storm Sewer Samples
CMS Pilot Testing
Former Norton/Nashua Facility
Watervliet, NY

Matrix	Sample Locations	Parameter	Analytical Parameter	Container and Preservative	Analysis Holding Time
Sediment (Contingent)	MH-2, MH-3, MH-5, MH-6, MH-13 & MH-14	TCL Semi-Volatiles	EPA 8270	8 oz. glass Cool to 4°C	14 days extraction - analysis within 40 days of extraction
Water (Contingent)	MH-2, MH-3, MH-5, MH-6, MH-13 & MH-14	TCL Semi-Volatiles	EPA 8270	2 x 1Liter amber glass w/teflon lined enclosure Na ₂ S ₂ O ₃ , Cool to 4°C	7 days extraction - analysis within 40 days of extraction

Table 10-1
QA/QC Sample Summary Matrix
CMS Pilot Testing
Former Norton/Nashua Facility
Watervliet, NY

Matrix	Sample Type	Frequency	Analytical Parameters
Water	Equipment Blank	one sample per each mobilization	TCL Volatiles plus heptane and TICs TCL Semi-Volatiles and TICs
	MS/MSD Samples	one sample per every 20 samples	TCL Volatiles plus heptane and TICs TCL Semi-Volatiles and TICs
	Field Duplicate Sample	one sample per every 20 samples	TCL Volatiles plus heptane and TICs TCL Semi-Volatiles and TICs
	Trip Blank	one sample per cooler	TCL Volatiles plus heptane and TICs
Soil/Sediment	Equipment Blank	one sample per each mobilization	TCL Volatiles plus heptane and TICs TCL Semi-Volatiles and TICs
	MS/MSD Samples	one sample per every 20 samples	TCL Volatiles plus heptane and TICs TCL Semi-Volatiles and TICs
	Field Duplicate Sample	one sample per every 20 samples	TCL Volatiles plus heptane and TICs
Vapor/Ambient Air	Equipment Blank	one sample per each mobilization*	Volatiles plus TICs methane
	Ambient Air	one sample each sampling day*	Volatiles plus TICs methane
	Field Duplicate Sample	one sample each sampling day*	Volatiles plus TICs methane

* indoor/outdoor ambient air and one field duplicate will be collected in association with VMP sampling activities (see text; Section 7.3);
 QA/QC samples will not be collected in association with ISCO pilot testing activities (see text; Section 5.2.3)

Water and sediments - Volatile analysis via EPA Method 8260; semi-volatile analysis via EPA Method 8270

Vapor - Volatile analysis via EPA Method TO-15


**Table 12-1
Tentative CMS Pilot Testing Schedule
Former Norton/Nashua Tape Facility
Watervliet, New York**

	Test Month												
	1	2	3	4	5	6	7	8	9	10	11	12	
Interim Ground-Water Monitoring Activities	■			■			■			■			
CMS Workplan Approved by NYSDEC	■												
Install Geoprobe Borings and Monitoring Wells/Points	■												
Laboratory Analysis/ISCO Bench Testing		■											
Install Supplemental Borings and Monitoring Wells/Points			■										
Baseline Ground-Water Sampling				■									
EFR Pilot Testing				■									
ISCO Field Testing				■									
Storm Sewer Sediment Removal				■									
Storm Sewer Sediment/Water Sampling					TBD								
Post-ISCO Ground-Water Sampling					■		■						
Baseline Bioremediation Ground-Water Sampling							■						
Bioremediation Ground-Water Sampling								■	■	■			
VMP/Ambient Air Testing					TBD								
Pilot Testing Data Discussion Meeting												■	

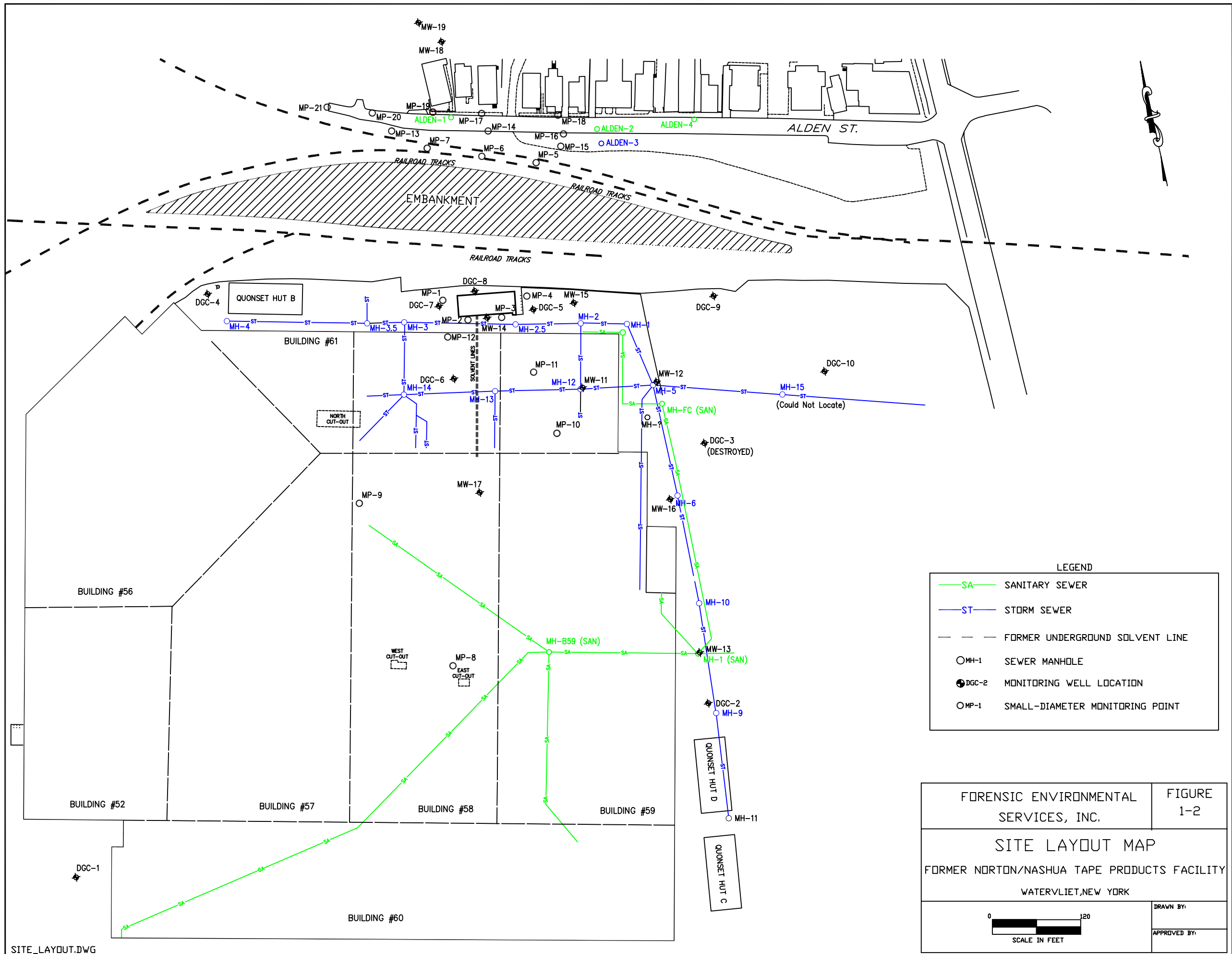
FIGURES

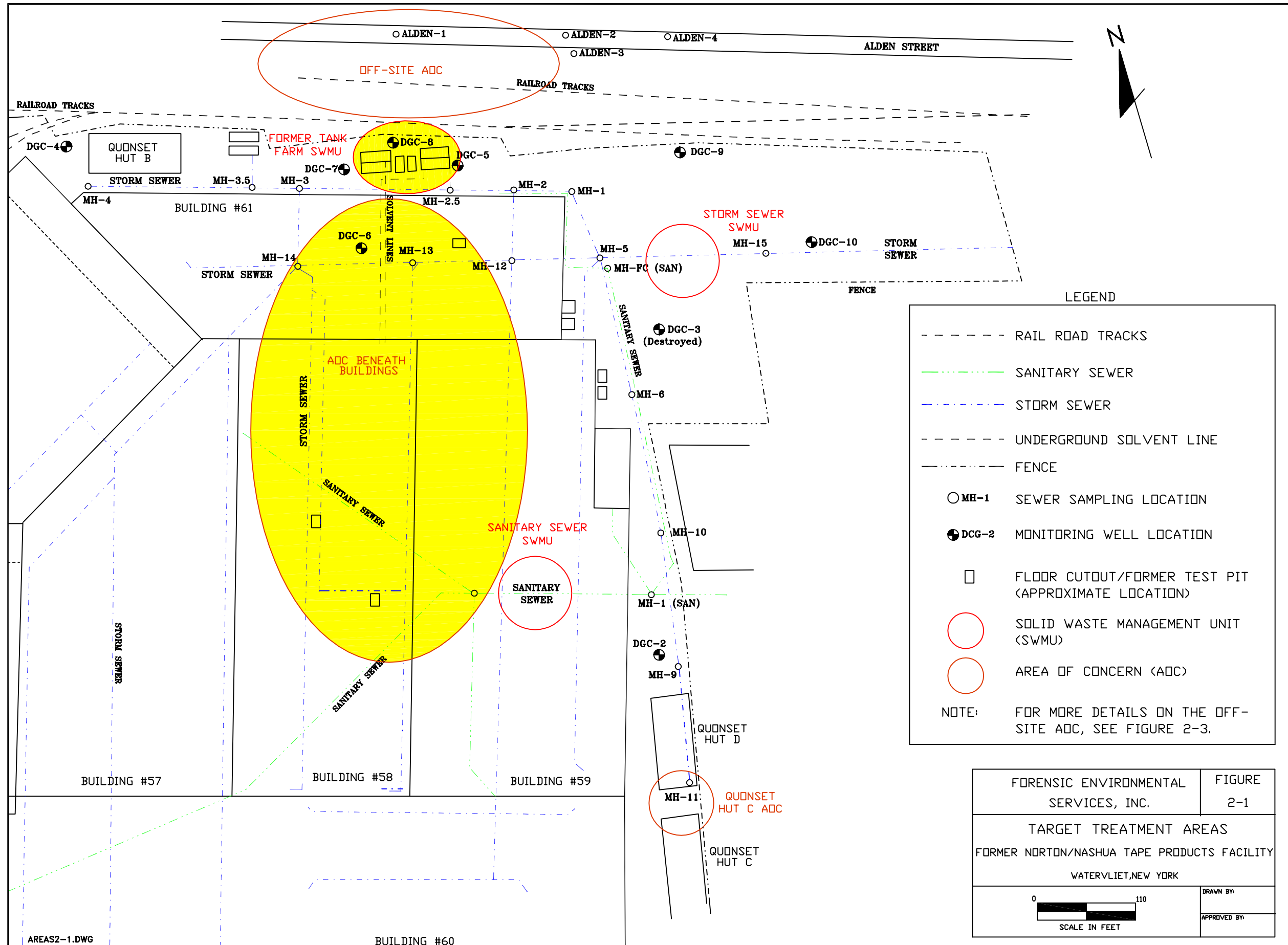
N



FORENSIC ENVIRONMENTAL SERVICES, INC.	FIGURE 1-1
SITE LOCATION MAP FORMER NORTON/NASHUA TAPE PRODUCTS FACILITY WATERVLIET, NEW YORK	
 SCALE IN FEET	DRAWN BY: APPROVED BY:

DERIVED FROM THE TROY SOUTH QUADRANGLE
COMPILED BY THE U.S. GEOLOGICAL SURVEY.






LEGEND

- RAIL ROAD TRACKS
- SANITARY SEWER
- STORM SEWER
- UNDERGROUND SOLVENT LINE
- FENCE
- MH-1 SEWER SAMPLING LOCATION
- ⊕ DGC-2 MONITORING WELL LOCATION
- FLOOR CUTOUT/FORMER TEST PIT (APPROXIMATE LOCATION)
- SOLID WASTE MANAGEMENT UNIT (SWMU)
- AREA OF CONCERN (ADC)

NOTE: FOR MORE DETAILS ON THE OFF-SITE ADC, SEE FIGURE 2-3.

FORENSIC ENVIRONMENTAL SERVICES, INC.	FIGURE 2-1
TARGET TREATMENT AREAS FORMER NORTON/NASHUA TAPE PRODUCTS FACILITY WATERVLIET, NEW YORK	
0  110 SCALE IN FEET	DRAWN BY: APPROVED BY:

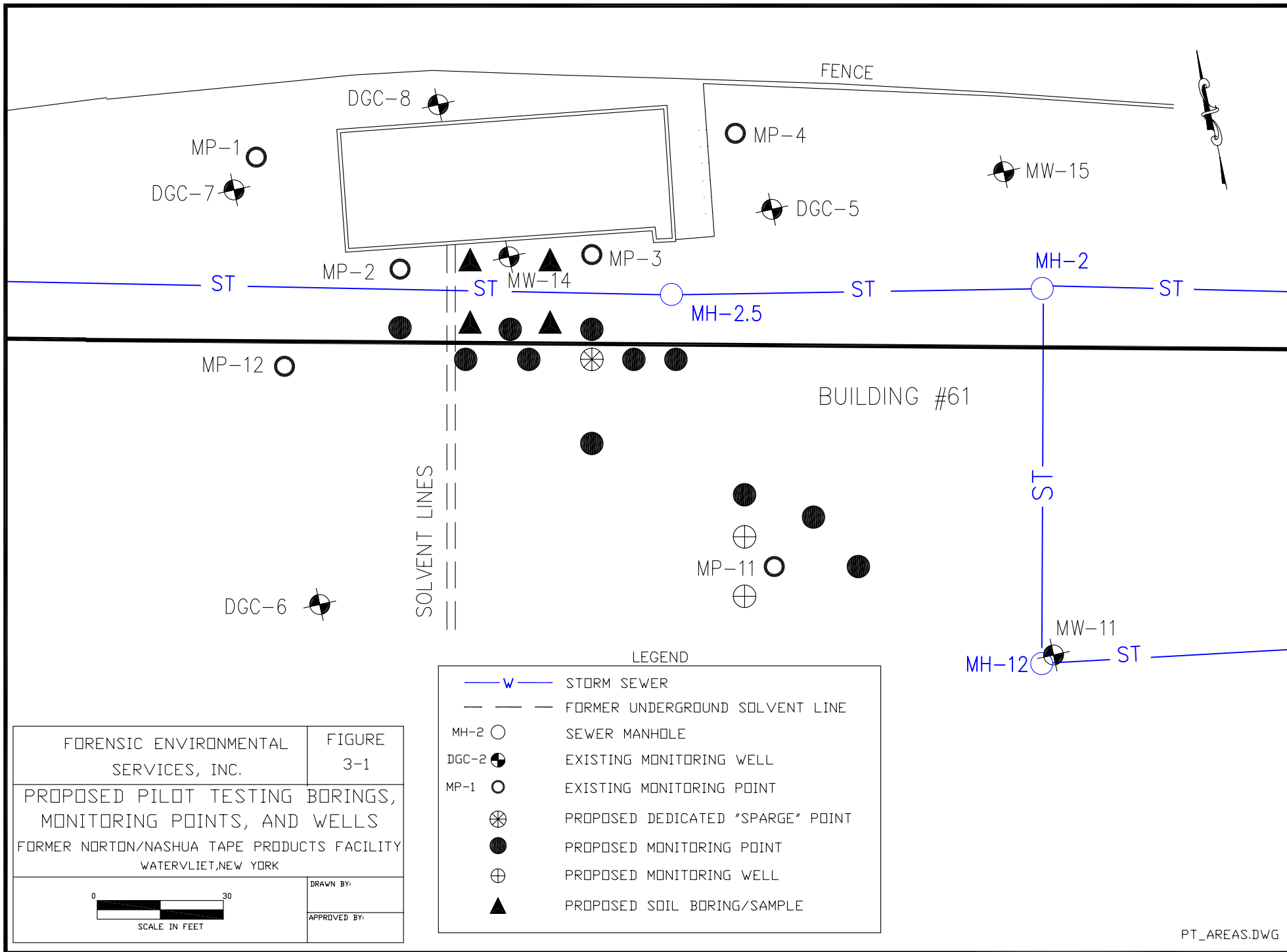
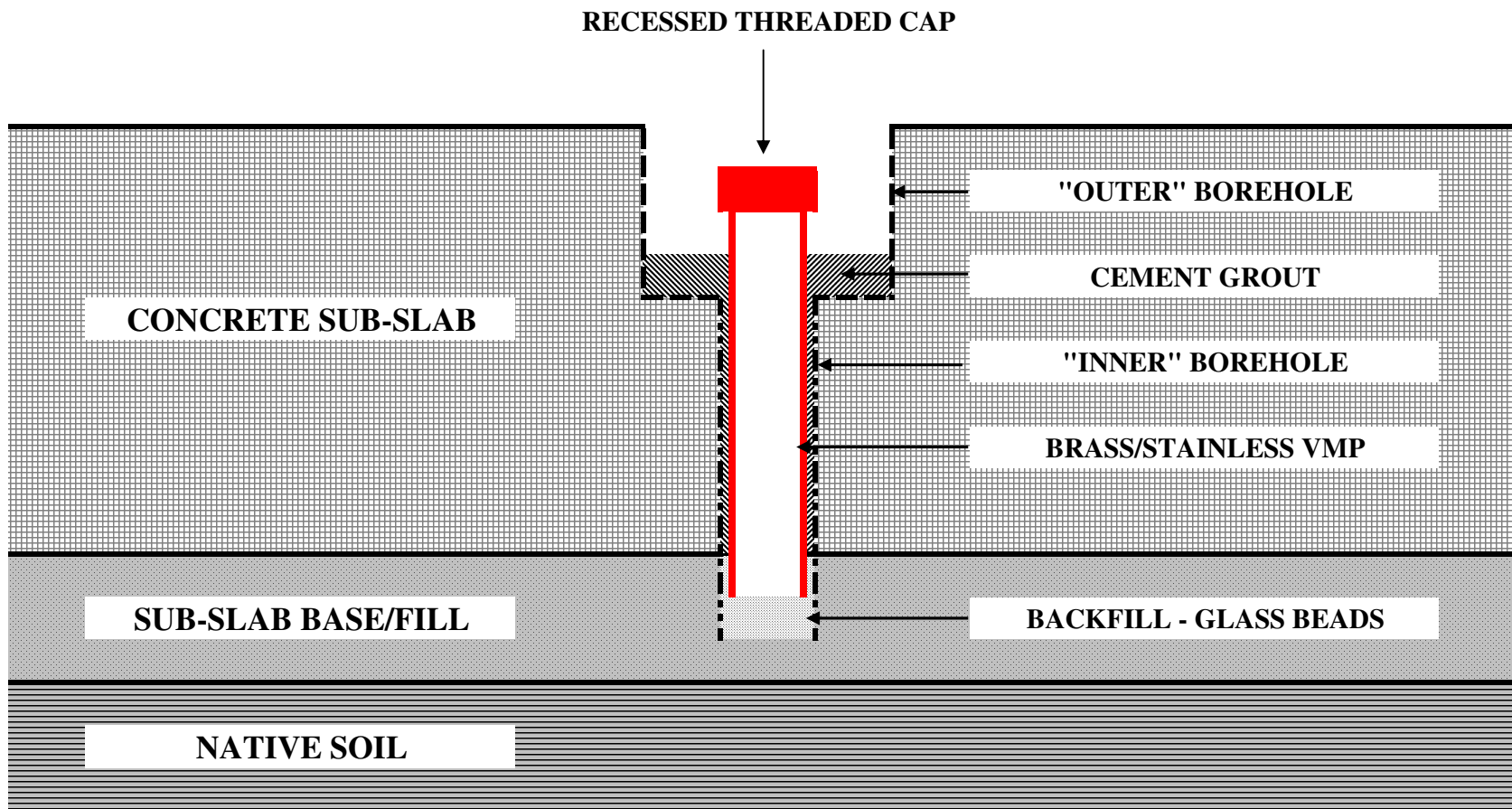


Figure 6-1
Schematic Drawing of Vapor Monitoring Point
Former Norton/Nashua Tape Facility
Watervliet, New York



APPENDIX A

**REMEDIAL TECHNOLOGY INFORMATION
PROVIDED BY VENDORS**

Frequently Asked Questions

What is the C-Sparger® System?

The C-Sparger® is a patented innovative oxidation remediation technology, including process and equipment.

How does the C-Sparger® Work?

The C-Sparger® releases microbubbles of encapsulated ozone that are injected directly into the groundwater. The microbubbles are randomly dispersed through the water and the saturated soil formation. The process combines stripping and treatment, targeting both soil and groundwater compartments. The encapsulated ozone reacts with contaminants (hydrocarbon and chlorinated solvents), producing harmless by-products.

What are the advantages of using the C-Sparger® System?

Site clean-up time may be at least 3 to 4 times faster and cost 50% to 75% less than other pump and treat methods.

Does the injection of ozone constitute injection of hazardous waste?

The injection of low-level ozone into the groundwater does not constitute an injection of hazardous material because of the following:

- The injection occurs beneath the groundwater surface and is adjusted to zero concentration in the vadose zone (area above groundwater).
- The injection concentration is low (80 to 350 ppmv).
- The injection quantity is low (less than 1 lb/day or 400 gm/day with use of the wall-mount unit).
- There is no respiratory risk to a person on the surface. Both DOD and EPA monitoring of groundwater injection has confirmed no ozone in gas recovery wells (vacuum extraction wells) placed above the water table during proper operations.

What are the breakdown products?

The following are the first-order laboratory-isolated breakdown products:

- Aliphatics (alkanes): acetate, butyrate, formate, propionate
- BTEX: carboxylic acids
- Oxygenates:
- MTBE: TBA (tertiary butyl alcohol), TBF (tertiary butyl formate), formate, oxygen, hydrogen peroxide
- ETBE: TBA (tertiary butyl alcohol), TBF (tertiary butyl formate), acetate, oxygen, hydrogen peroxide
- TBA: formaldehyde, acetate, carbon dioxide, water

Do the breakdown products present a problem?

Monitoring for breakdown products of ozone reactions has shown virtually no evidence of the expected compounds. Chemical oxidation of the byproducts and bacterial populations enhanced by an abundance of oxygen and carbon sources appear responsible for this phenomenon.

On what kind of site is ozone oxidation applicable?

- Drycleaners PCE, TCE, DCE, vinyl chloride
- MTBE -gasoline MTBE, ETBE, TAME, BTEX, TPH, naphthalene
- Diesel/fuel oil C6-C30 alkanes (aliphatics) and aromatics
- Circuit board solvents TCE; 1,1,1-TCA; DCA
- MGP PAH's, BTEX

What is the soil permeability range for satisfactory system operation?

100 to 10^{-6} cm/sec (1000 to .01 ft/day)

What are Spargepoints®?

Spargepoints® are an essential part of the C-Sparger® system. They are a microporous screen used to introduce the micro-fine air/ozone bubbles into the saturated zone.

What is the maximum operating pressure for the Spargepoints®?

The Spargepoints® installed in soil can withstand any applied pressure. However, soil fracturing pressure (>50 psi in soil pores) can result in channeling, and is undesirable unless fracturing is planned as part of the operational design.

What is the radius of influence that can be achieved with a Spargepoint®?

Saturated Depth above

Spargepoints®	ROI	Multiplier
5 ft	12ft	2.5
10 ft	20 ft	2.0
20 ft	30 ft	1.5
50 ft	65 ft	1.3

What ozone loading should be used?

Within the radius of influence of a Spargepoint®, the ozone demand should match the gram requirement for the contaminants present. References published by the ACS and the AEHS may be used for common contaminants.

Do the Spargepoints® plug?

Plugging of the Spargepoints® has been a rare occurrence if check valves are placed on the system and at the wellhead, and if the Spargepoints® are filled with distilled water when not in active use. Ozone flow through the points prevents bacterial fouling.

Why use microporous Spargepoints® instead of well screens?

The small size of microbubbles, as opposed to the large bubble produced by use of a well screen, yields greater surface area to volume ratio, therefore greater treatment capacity. The small size of the bubble allows easy movement through the similarly-sized soil pores, with no fracturing of the soil occurring. Gas transfer of oxygen is four times more efficient using microporous Spargpoints® versus 10 slot well screen.

What is the power requirement for the systems?

Wall-mount unit: 120vac, 20amp. Uses 400 to 600 kwh per month
Pallet or trailer: 220vac, 60amp. Uses 1600 kwh per month

The above usage reflects the standard system. Additional accessories require additional power.

Why did K-V Associates, Inc. change its name to Kerfoot Technologies, Inc.?

To better represent who we are and what we do. Kerfoot Technologies is an Industry Leader in the development of environmental tools that speed up, simplify, and reduce the cost of groundwater characterization and remediation around the world.

For greater detail or answers to other questions, contact Kerfoot Technologies.

[About Kerfoot Technologies](#) | [Our Technology](#) | [Kerfoot Technology Products](#) | [Contact Us](#) | [C-SPARGER®](#)

Kerfoot Technologies, Inc. • P: 508-539-3002 • F: 508-539-3566 • Toll Free: 877-582-3784

PEROZONE™: Giving Bubble Power A Big Boost

At Kerfoot Technologies, our microbubbles pack an even bigger wallop now that we're coating them with peroxide.

Our most recent innovation: the Perozone™ Ozone Oxidation Microbubble System, working in tandem with the powerful C-Sparger® pulse coated microbubbles through the soil and groundwater, dramatically reducing the time, cost, and potential long-term liability of old-fashioned, cleanup methods.

Best of all, after the initial reaction, both ozone and Perozone™ decompose into beneficial oxygen.

For 25 years, our mission at Kerfoot Technologies is to create powerful and ingenious environmental tools that make our planet a healthier place.



Benefits

- Low capital equipment costs
- Minimal site disturbance during installation
- Low on-site profile
- Low operating costs
- In-situ destruction of targeted components
- Rapid decrease of contaminant mass and concentration in soil and water - impressive results may be seen in weeks
- No vapor control necessary - contaminants are destroyed rather than transferred from one phase to another
- Clean reaction - no hazardous byproduct formation
- Microporous Laminar Spargepoints® create microbubbles of hydroperoxide-coated encapsulated air/ozone
- Microbubble size and means of introduction into the interstitial spaces of the formation ensures maximum contact with contaminant
- Microbubbles act to extract VOCs from groundwater and soil pores which reduces soil oxidative demand common to liquid oxidants

Features

- Hydroxyl radical formation boosts the oxidative capacity of the C-Sparger®
- Extends contaminant treatability to PAHs, PCBs, pesticides
- Runs on standard household current (120 VAC, 20 amp)
- Uses very dilute solution of hydrogen peroxide pulsed into the formation

[▲BACK TO TOP](#)

Available in wall-mount, modular, and trailer units.

For greater detail or answers to other questions contact Kerfoot Technologies

Technical Papers

C-Sparge™ Ozone Microsparging for Rapid Removal of MTBE and Benzene

By William B. Kerfoot, Ph.D., LSP and Angus McGrath, Ph.D.

A system called C-Sparging™ which uses ozone/air injected periodically in conjunction with a pulsing pump has been demonstrated to reduce MTBE from over 1000 ppb to less than 100 ppb in less than 40 days. The rate of decay was found to be a ten-fold reduction in monitoring wells located 3 to 7 meters from the injection point. Monitoring was performed weekly during and after treatment.

What is C-Sparging™

The KVA process of C-Sparging™, in situ air stripping with micro-encapsulated ozone, combines three-unit operations offering a one-two-three punch to knockout MTBE. Firstly, fine bubbles with a high surface-to-volume ratio are injected into the saturated zone to extract dissolved MTBE from contaminated groundwater. Secondly, ozone contained within the bubble and thin film around the bubble reacts extremely rapidly to decompose the MTBE into simple products, alcohols, acetate and formate. Thirdly, the residual oxygen from the reaction encourages bioremediation which consumes the breakdown products and converts them to carbon dioxide (CO₂) and water (H₂O).

Ozone Microsparging is a Patented Technology for In Situ Treatment of Volatile Organic Compounds (VOCs) in Groundwater

The reaction detoxifies groundwater containing MTBE and BTEX compounds, specifically benzene, rapidly to groundwater standards without producing harmful byproducts. The reaction is produced with very low ozone concentrations-molar ratios-compared to VOC concentrations in groundwater. The technology combines the unit operations of air stripping and oxidative decomposition in a single process which can be catalytically accelerated. In the C-Sparge™ process, air and ozone are injected directly into groundwater through specially-designed spargers to create "microbubbles" that have very high surface area-to-volume ratio. The Henry's Constant which regulates the partitioning of MTBE from aqueous to gaseous state is about one-tenth that of benzene derivatives. However, the surface-to-volume ratio increase of over 30-fold compensates to promote rapid in situ stripping of MTBE. As the "microbubbles" rise within a saturated column of groundwater, they extract or "strip" the VOCs from aqueous to gas partitioning. Upon entering the microbubbles, MTBE and BTEX compounds react with ozone in the gaseous state or in the aqueous "thin layer" surrounding the bubble to decompose. MTBE is rapidly degraded with time. The rate of decay is similar to that previously reported by Karpel vel Leitner, et. al. (1994). In both bench-scale testing and field testing, ozone microbubbles appeared effective in reducing MTBE concentrations to beyond 90% of original levels (Kerfoot, 2000). The rate of removal has been sensitive to ozone concentration, pressure, and iron silicate content.

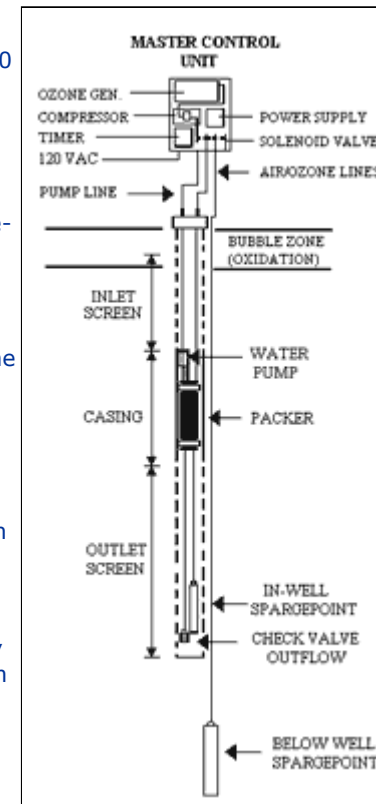


Figure 1. Master Control Unit

Site Specific System Set-up

A single C-Sparger[®] master unit with 6 Spargepoints[®] was installed upgradient of plume region. The unit can be installed with a dual-screened recirculation spargewell which has a lower Spargepoint[®] or with isolated Spargepoints[®]. The depth to groundwater was 2 to 3 meters. The general construction of a C-Sparger[®] consists of a 100 mm casing leading to a 1.5 meter screen with 0.5 meter above the water table, a blank casing which was bentonite-sealed in the annular space to prevent short-circuiting, and a lower 1.5 meter screen (10 slot). Alongside this was a 1.5 cm diameter tubing leading from the wellhead region to a 50 mm microporous Spargepoint[®] 46 cm long with a compression fitting situated below the lower double screen.

The predominant soil type was gravelly sands. Water table level occurred at 2 to 3 meters. The predominant contaminated region extended vertically from 1 to 3 meters deep. The Spargepoints[®] were installed at a depth of 10 meters.

PILOT TEST SUMMARY OF GROUNDWATER FIELD DATA										
Well ID	Date	Time	pH	Temp (°C)	Conductivity (mS/cm)	Dissolved Oxygen (mg/l)	ORP (mv)	Ferrous Iron (mg/l)	Ozone (mg/l)	Magnehelic Reading (in. of water)
MW-13	2/24/00	10:07	NM	12.9	9.10	NM	NM	1.9	NM	NM ⁽¹⁾
	4/12/00	13:46	7.24	13.6	11.00	3.000	NM	3.4	0.08 ⁽²⁾	NM ⁽¹⁾
	4/17/00	15:45	7.40	15.5	7.57	1.000	525	1.0	0.00	3.0
	4/20/00	12:40	7.10	14.6	8.57	1.750	350	0.0	0.00	4.0
	4/24/00	10:20	7.40	14.3	7.85	0.750	135 ⁽³⁾	0.0	0.00	3.0
	5/1/00	15:10	7.20	15.7	8.21	1.000	-25*	0.0	0.00	3.0
	5/9/00	9:15	7.10	14.9	8.66	1.000	-25*	0.0	0.27	N/A**
	5/22/00	16:05	7.40	16.7	8.83	1.250	N/A*	0.0	0.22	N/A**
	MW-21	2/23/00	11:31	6.90	12.9	4.80	NM	NM	1.2	NM
4/12/00		14:46	7.51	14.7	9.80	0.800	213	4.0	0.00	NM ⁽¹⁾
4/17/00		16:30	7.10	15.9	8.61	0.500	265	0.0	0.00	10.0
4/20/00		11:15	7.20	15.0	8.68	1.000	680	0.0	0.00	10.0
4/24/00		9:20	7.20	15.6	8.76	1.500	95 ⁽³⁾	0.0	0.00	8.0
5/1/00		14:20	7.20	15.8	8.85	1.500	35	0.0	0.00	10.0
5/9/00		10:15	7.00	15.6	8.74	2.000	N/A*	0.0	0.17	N/A**
5/22/00		14:50	7.20	17.7	8.52	3.000	N/A*	0.0	0.16	N/A**

Notes:
 System turned on after data collected on 4/12/00.
 * Instrument believed to be malfunctioning.
 ** System no longer running, turned off 5/8/00.
⁽¹⁾ Data collected before pilot start-up.
⁽²⁾ Sample turbidity high, results may not be reliable.
⁽³⁾ Began using new ORP meter.

Figure 2. Pilot test. Summary of groundwater field data.

Procedure Documents Quick Results

Initial results of the treatment were monitoring by three indicators:

- VOC removal by groundwater sampling from monitoring wells and certified laboratory analysis.
- Dissolved oxygen (D.O.) field

determinations on groundwater grab samples from monitoring wells.

- Oxidation-reduction potential (ORP) field determinations on groundwater grab samples.

Groundwater sampling showed an immediate rise in concentration of MTBE and benzene due to mixing followed by a progressive drop in concentration. The agitation of the groundwater and capillary pores by the fine bubbles often strips adsorbed fractions. The mixed concentrations are often a better measure of total mass for treatment than solely the aqueous fraction. The concentrations of MTBE from monitoring wells placed at 3 meters' and 4 meters' distance from the Spargepoint[®] rose to 1300 and 550 ppb before converging to less than 100 ppb for a removal efficiency of 99.9% and 99.8% respectively after 5 ± weeks of operation. Benzene rose to a high of 4300 ppb before dropping to below 700 ppb for 99.8% removal efficiency over 5 ± weeks.

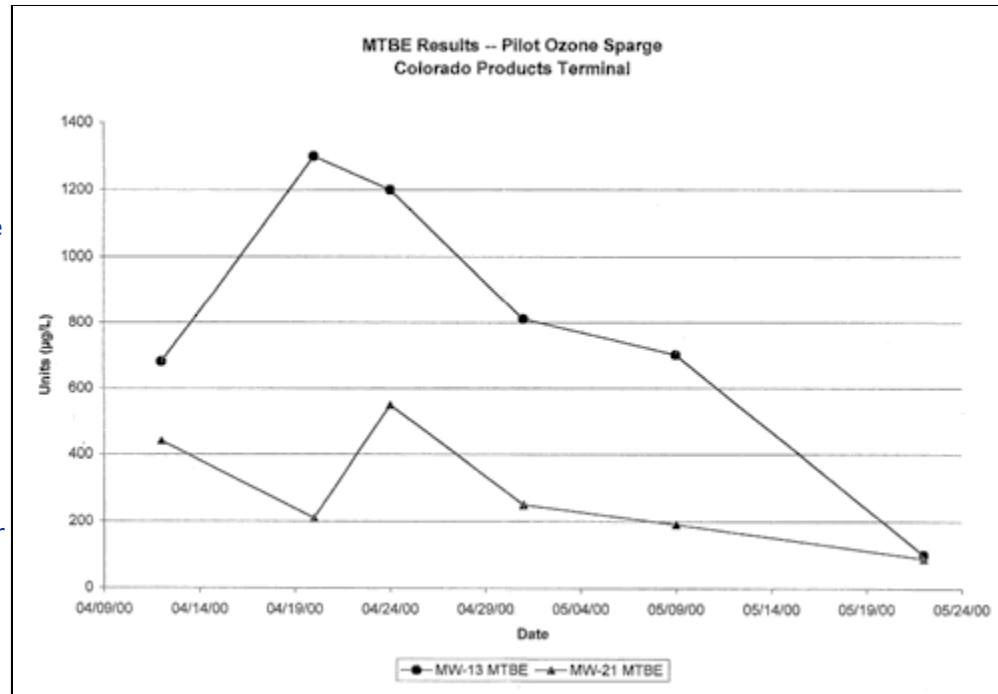
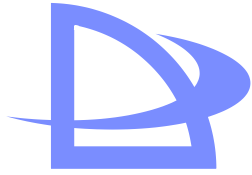


Figure 3. MTBE results. Pilot ozone sparge Colorado Products Terminal.

William B. Kerfoot, Ph.D., is President and an LSP with K-V Associates, Inc., Mashpee, Massachusetts.

Angus McGrath is a principal Geochemist with SECOR International, Inc., Oakland, California.



What is iSOC[®]?

What is iSOC[®]?

iSOC[®] is an oxygen delivery technology called in-situ Submerged Oxygen Curtain (iSOC[®]) that when suspended in existing monitoring wells infuses high levels of oxygen into groundwater. The proprietary structured polymer used in iSOC[®] contains hydrophobic microporous hollow fiber. These fibers provide approximately 7,000 square meters of interface area per cubic meter of fiber for the mass transfer of oxygen into groundwater.

iSOC[®] is owned and manufactured by inVentures Technology incorporated (iT_i) in Fredericton, New Brunswick and Oakville, Ontario, Canada.

How does iSOC[®] work?

Oxygen is infused into the water in such a way that large quantities of dissolved oxygen (DO) are created (without sparging), and with a very low decay rate at atmospheric pressure. Once equilibrium is achieved, this process "idles" (no additional oxygen added), until there is a demand for oxygen—either through biomass utilization, or through DO migration and groundwater movement through the well. iSOC[®] then continues to maintain equilibrium, generating more dissolved oxygen as required.

The use of dissolved oxygen in hydrocarbon-contaminated groundwater to enhance natural attenuation of MTBE and BTEX has been growing as a remediation technology since the mid-1990s. Most conventional technologies, however, waste most of their oxygen because the bubbles rise to the top of the groundwater table and escape before they have a chance to dissolve or to be utilized by naturally occurring hydrocarbon degraders. The result is an inadequate biodegradation response in aquifers with high ferrous iron, moderate BOD, and/or high concentrations of hydrocarbon constituents.

What is Gas inFusion Technology?

The patented Gas inFusion technology is a unique method of infusing gas into liquids. The underlying scientific principle for the iSOC[®] is the equilibrium that exists between the dissolved concentration of a gas in a liquid and the partial pressure of the gas above the liquid. Henry's Law states: the weight of any gas that will dissolve in a given volume of liquid, at constant temperature, is directly proportional to the pressure that the gas exerts above the liquid.

Where has iSOC[®] been approved?

iSOC[®] has been approved for remediation use in most states. iSOC[®] is now operating on hundreds of sites in North America, Europe and Asia.

iSOC[®] Construction

- Stainless Steel unit -1.62" Diameter, 13" long (41 x 330 mm) with a drain fitting.
- Stainless Steel barb fitting connects to 0.25" or 6 mm OD polyurethane tubing.
- Lifting /security eye for connecting to a suspension line.
- Gas inFusion module using microporous hollow fiber & PVC shell.
- High tolerance to most pure gas & contaminant environments.

iSOC[®] Remediation Approach

- **Creation of oxygen barrier** at leading edge of contaminant plume—avoids boundary litigation; protects off-site receptors.
- **Source treatment**—reduces contamination levels with supersaturated oxygen at heart of the plume.
- **Rapid, localized remediation** of low-level contamination in existing monitoring wells—cost effective, passive enhancement of natural bioremediation.
- **Accelerates site closure** through natural attenuation as a primary remediation strategy or as a polisher

iSOC[®] Remediation Enhancement

- Supersaturates monitoring well with low decay DO—typically 40-200 PPM depending on depth.
- Natural convection current fills well with uniform DO curtain.
- DO floods downstream groundwater and/or fractured bedrock.
- Enhanced bioremediation removes organics.
- Placement of injection wells depends on site-specific conditions.
- Installed in a few hours; easily moved to optimize performance.

iSOC[®] Oxygen Distribution

- Mass transport laws govern oxygen distribution.
- Supplies oxygen according to demand.
- Down-gradient DO depends on groundwater velocity & O₂ demand.
- Case studies show the typical radius of influence to be 10-30 feet.
- One iSOC[®] unit will use 1 cu ft (28 l) of oxygen per day.

iSOC[®] Advantages

- Infuses 4 to 10 times more DO than any competitive technology.
- Delivers 40-200 PPM DO depending on groundwater characteristics & iSOC[®] depth.
- Uses existing 2-inch monitoring wells for installation.
- Infusion results in half to two-thirds less time than competitive technologies.
- Connects to standard oxygen cylinder.
- No power, off-gases, pumps, hazardous by-products, or permits.
- Small, simple, efficient, predictable, easy to use, & very low maintenance.

What are remediation consultants saying about iSOC®?

In the past few months, several leading environmental firms have achieved significant reductions in MTBE, BTEX, and TBA, and have commented:

- "In less than 3 months since iSOC® installation, MTBE & TBA have decreased by an order of magnitude, DO has increased in monitoring wells 30' away, and ferrous iron and BOD have dropped."
- "Since installation of iSOC®, MTBE has been reduced from 3500 to under 200 PPM in fractured bedrock in about 4 weeks."
- "We established an effective barrier of DO in ~3 months with reductions of 84% MTBE, 31% TBA, 73% benzene down gradient of O₂ barrier."

Who do I contact for iSOC® sales and Information?

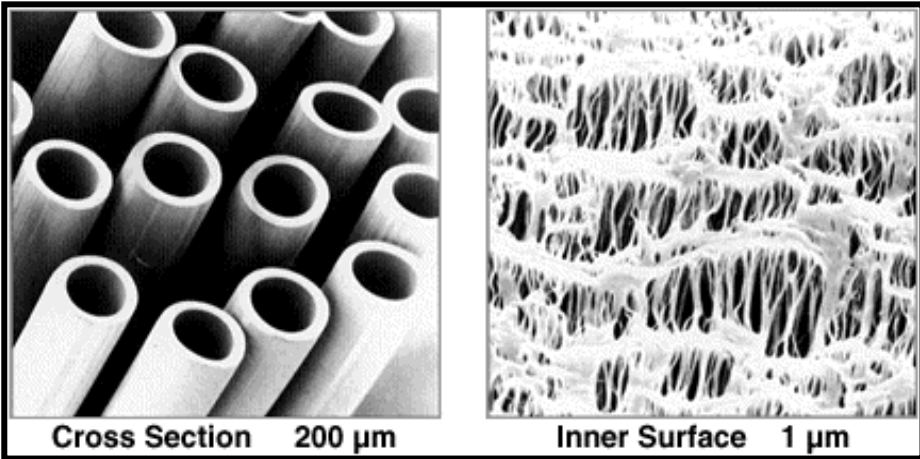
Click onto www.isocinfo.com to locate the iSOC® Representative nearest you.

www.isocinfo.com



iSOC[®] Technology

Microporous Hollow Fiber



How Does It Work?

- 700 Hollow fibers filled with holes
- Provides large surface area for mass transfer (7000 sq ft per cu ft)
- Mass transfer occurs when gas pressure is less than GW
- GW in well is saturated with high DO (without bio-sparging)
- High DO levels migrate to surrounding biomass
- Microbial population increases
- Microbes degrade targeted compounds

Mass Transfer Device



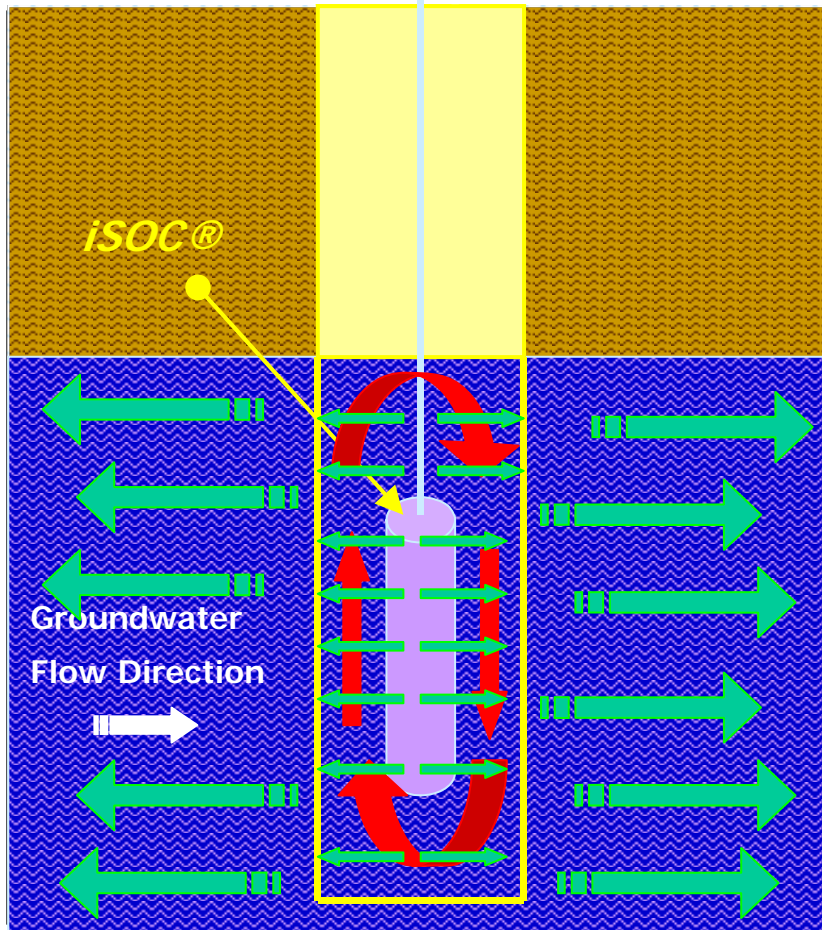
iSOC[®]





iSOC[®] Treatment Process

Regulated O₂ supplied to *iSOC*[®]



- Install up gradient of source, in the plume or cut-off curtain
- Screen injection well in target zone
- Natural convection current distributes DO in the well
- DO disperses around well and into groundwater
- GW velocity, oxygen demand of aquifer and molecular dispersion affect ROI
- Supersaturates well with Dissolved Oxygen (DO) 40 to 200 PPM depending on depth of *iSOC*[®] in the well (GW)
- High DO stimulates microbes to remove target compounds



iSOC[®] Dissolved Gas Concentrations (ppm)

(Atmospheric Pressure Determines DO Levels)

Gas Type	Water Column Depth (ft)				
	5'	10'	15'	20'	50'
Oxygen	42	55	62	69	111
Methane	22	30	33	37	59
Propane	66	88	99	110	175
Hydrogen	2	2	3	3	5
Ethane	57	75	85	95	150

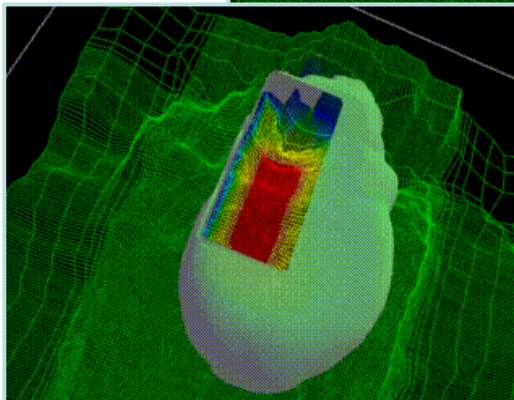
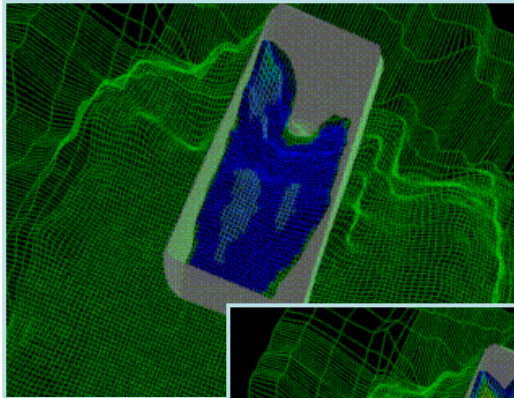


Injection Well Concentration Gradient

- iSOC[®] technology: 40 – 60 ppm
- Regenesis ORC sock: 3 ppm
- Waterloo Emitter: 10 – 13 ppm
- Air Sparging: 8 – 11 ppm



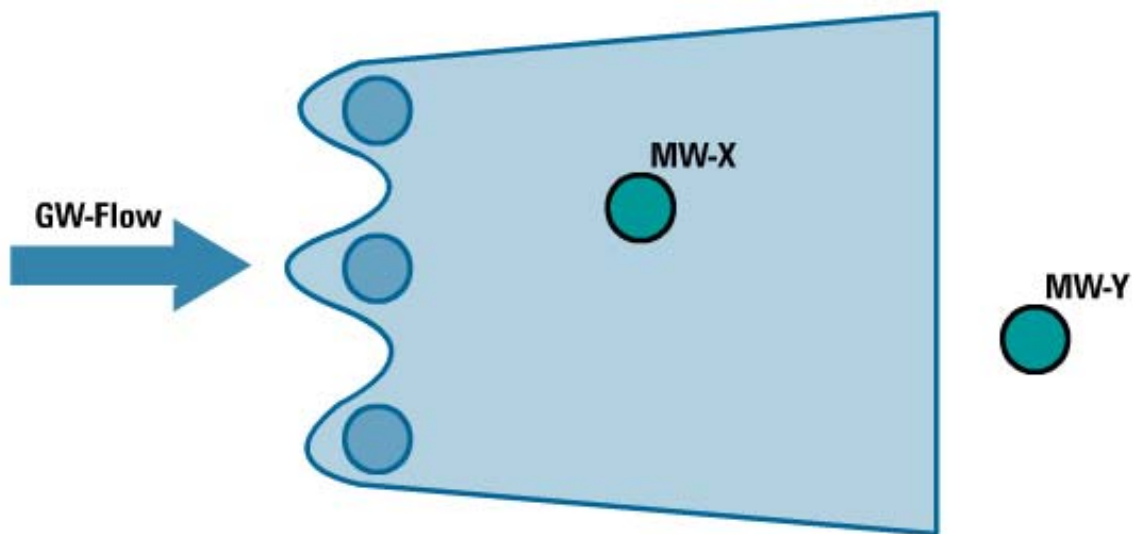
iSOC[®] Remediation Strategies



- Create O₂ curtain at leading edge of plume
- Plume treatment barriers (fences)
- Target Hot Spots
- Polish off low level contaminates
- Stop off site migration

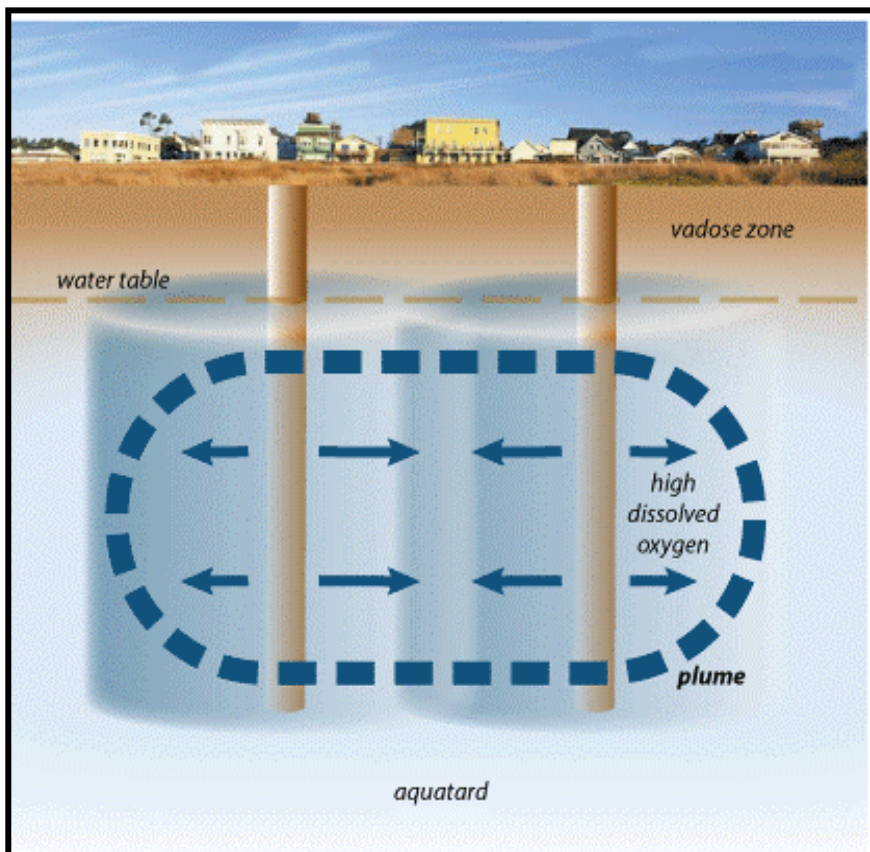


iSOC[®] Treatment Zone

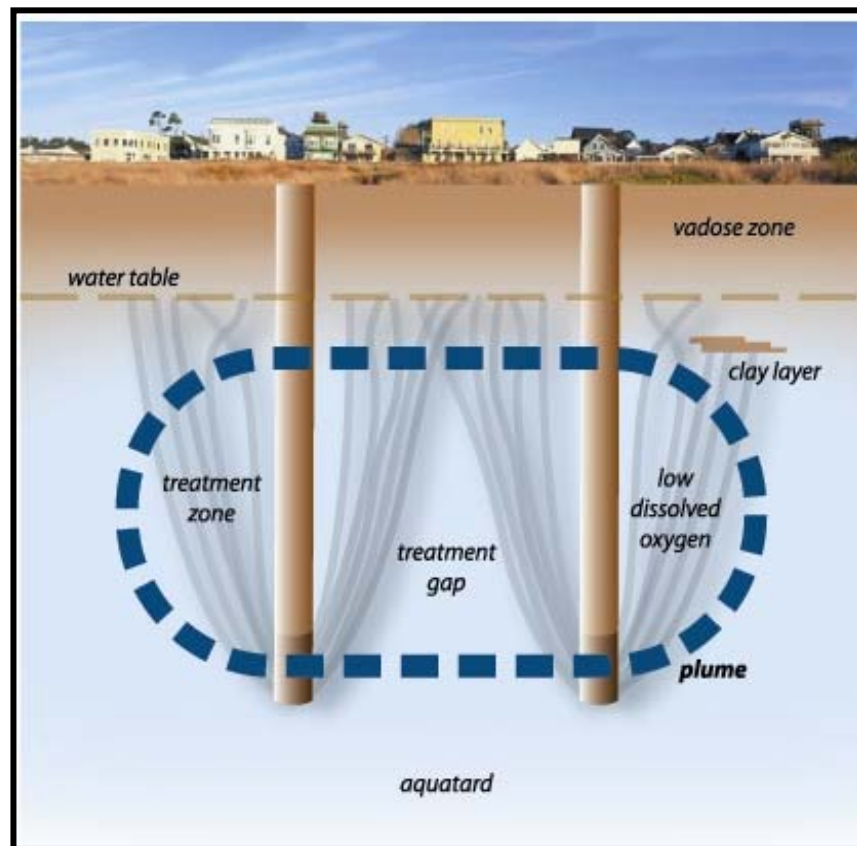




iSOC[®] Gas Infusion



Air Sparging





*GROUND WATER BIOREMEDIATION OF A
RAILROAD XYLENE SPILL USING iSOC[®]
TECHNOLOGY*

CASE STUDY: GEORGIA



Gannett Fleming

Steven D. Buser

Fredric L. Pirkle

Presented by Jim Begley
MT Environmental Restoration



Site Description

- Most of the site has low permeability, heterogeneous layers of interbedded sands, silts and silty clay.
- Depth to bedrock approx. 7-15 feet; most ground water contamination in a narrow zone 1 - 2 feet above bedrock.
- South plume is approximately 500 feet long, 80 feet wide, traveling south at 78 ft/year.

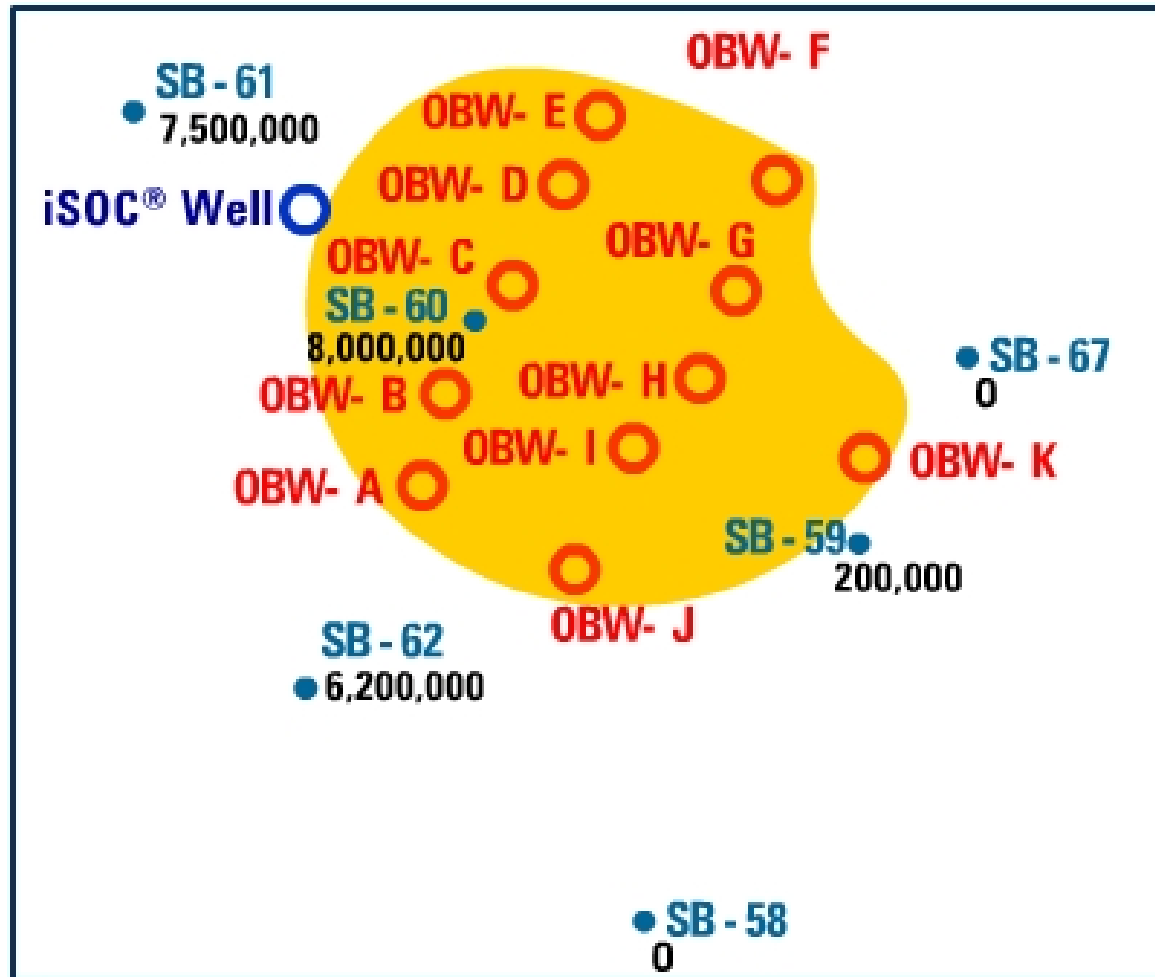


Pilot Test Description

- Pilot test consisted of 1 iSOC[®] injection well and 11 down-gradient monitoring wells.
- Two rows of monitor wells
 - 5 wells/line (wells 5' apart)
 - lines at 10,20' down gradient of iSOC[®] well
 - single monitor well 30' downgr. from iSOC[®] well.
- BTEX, heterotrophic bacteria plate counts sampled in monitor wells.
- Water quality sampled in April, May and September 2004.



Pilot Test Layout



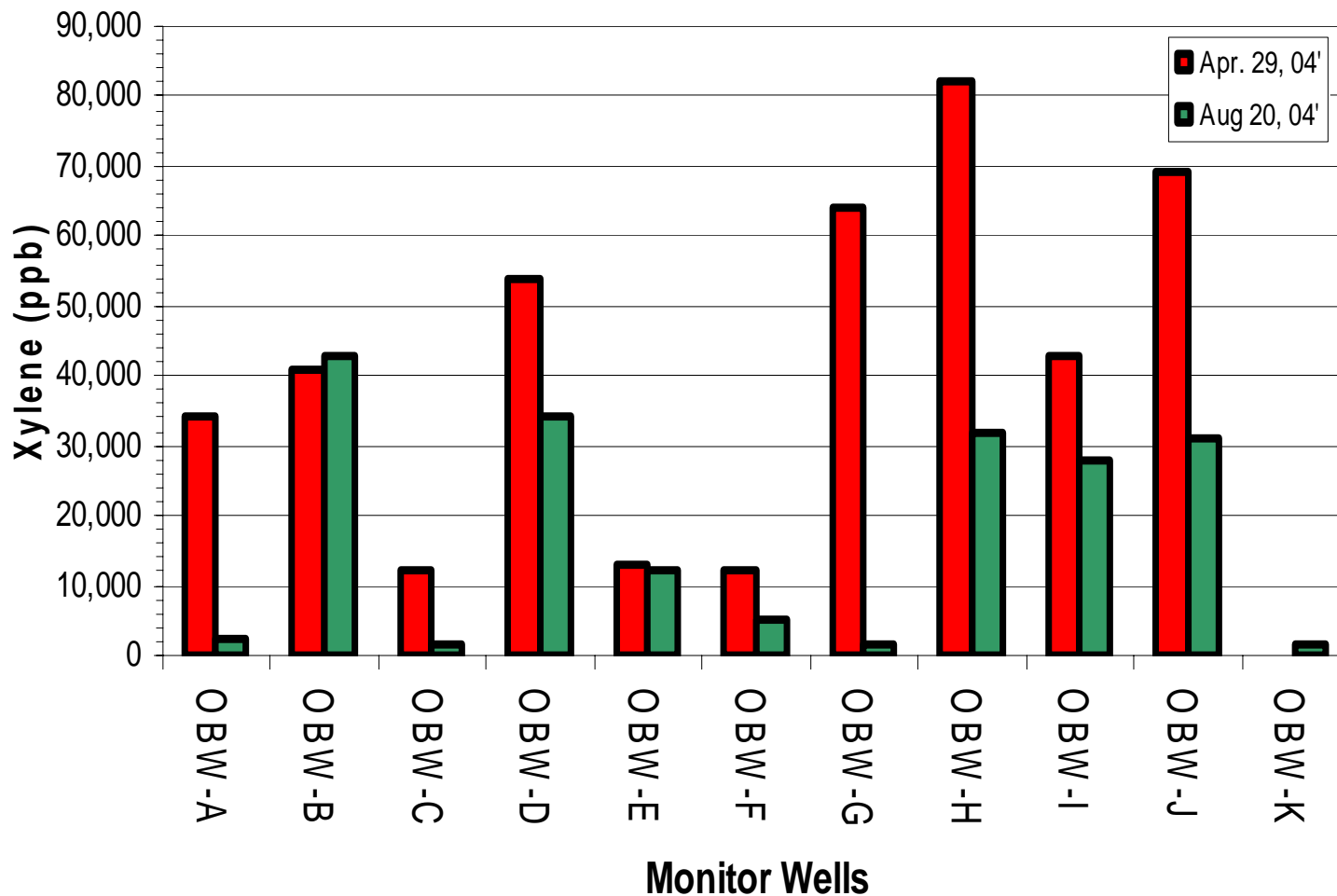


Bioremediation Results

- iSOC[®] area of influence created in all 11 monitor wells down gradient of injection well within one month of pilot startup.
- All 11 wells showed large increases in bacteria; most wells had decreases in background xylene concentrations.
- Four months after pilot startup, xylene reduced in 9 of 11 wells.
- Within 20' of injection well, xylene reduced an average of 57% in 9 of 10 wells.
- Within 20' of injection well, largest reduction 93%, smallest reduction 7.7%.
- In monitor well OBW-H (well with highest xylene concentration 82,000ppb), reduction of 61% in four months.

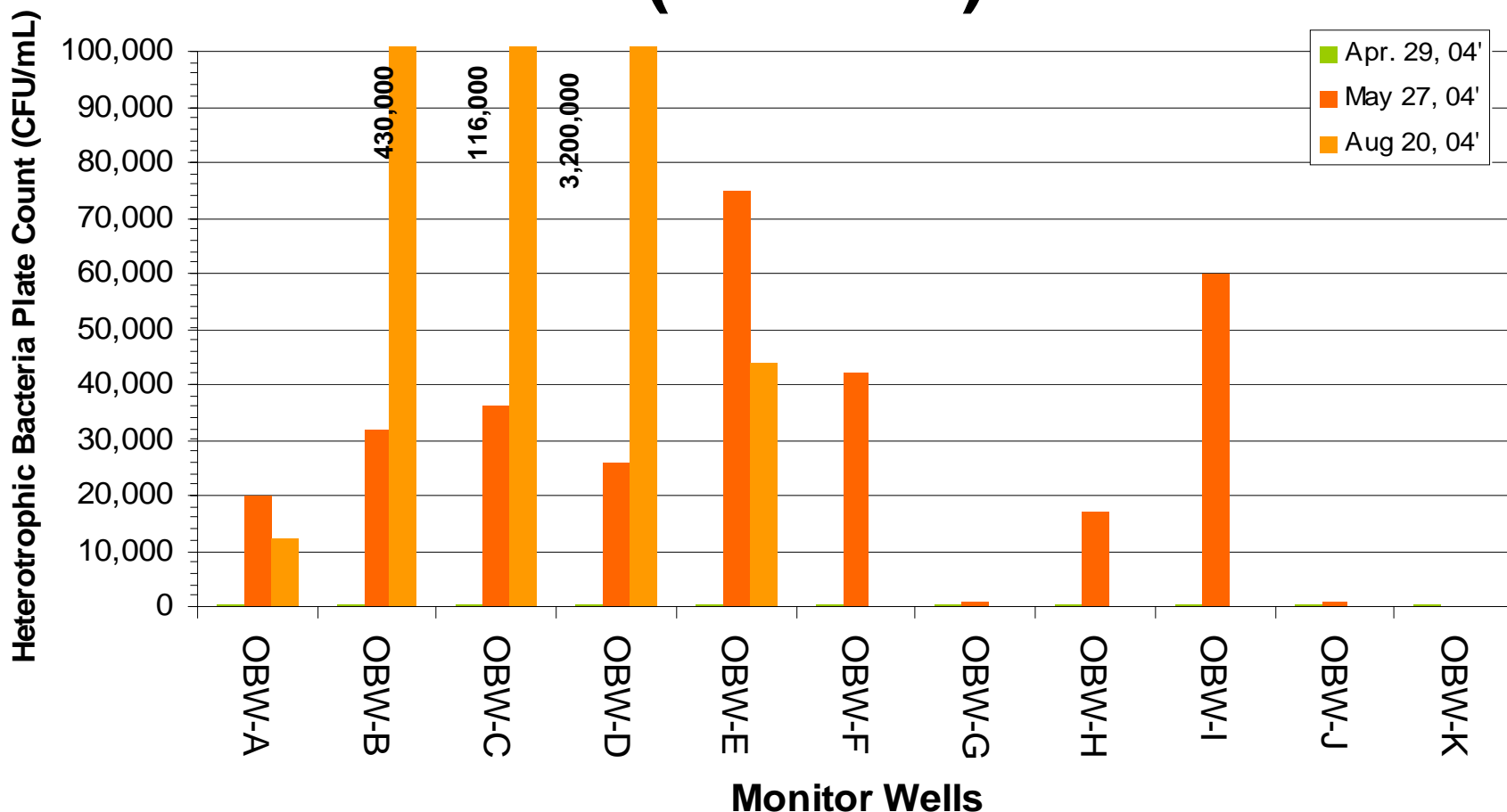


Xylene Plot





Heterotrophic Bacteria Plate Count (CFU/mL)

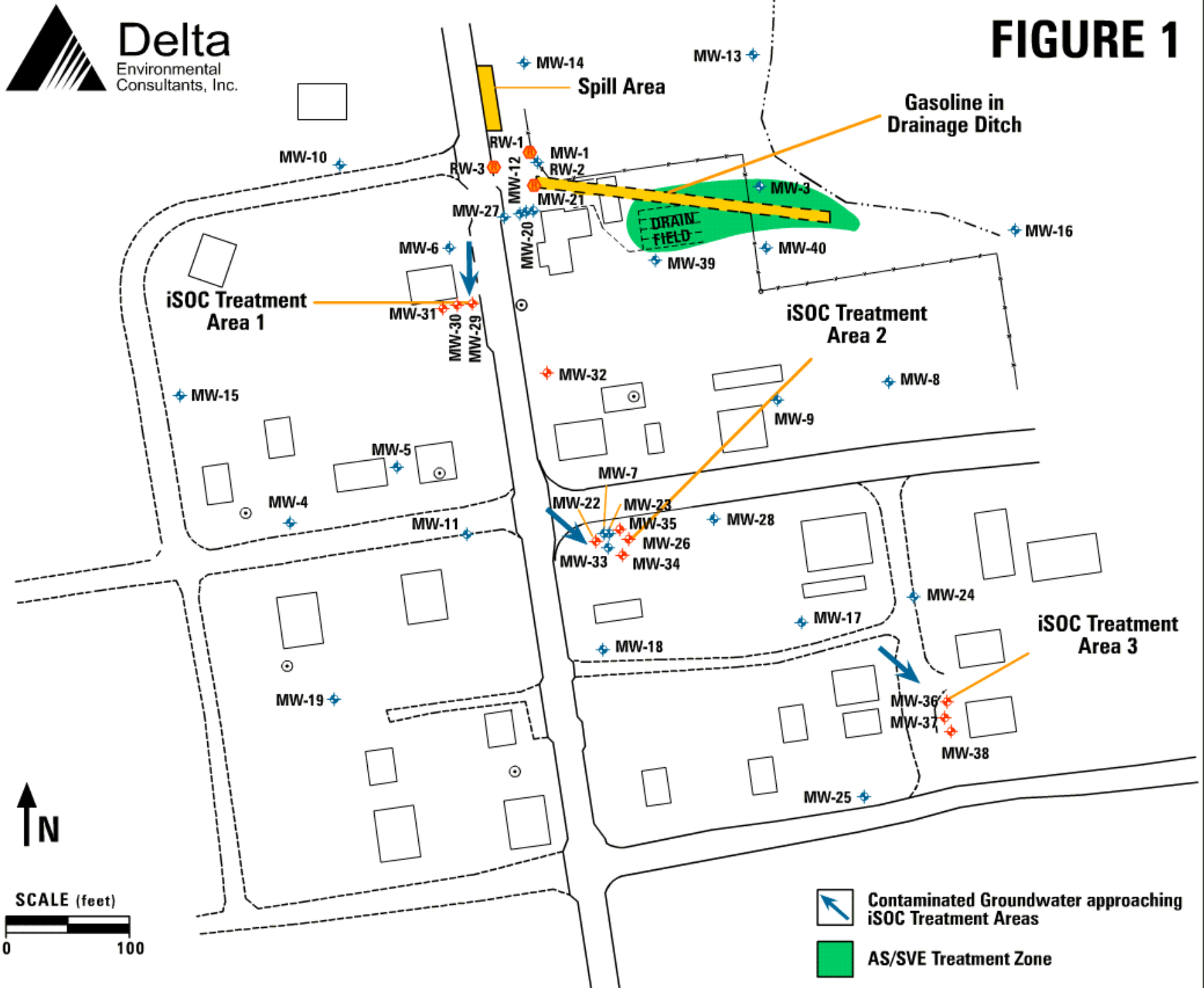


April 29, 04' – All monitor well concentrations are >300 CFU/mL




USE OF iSOC[®] TECHNOLOGY AT PETROLEUM TANKER SPILL

Lowell, Iowa



SCALE (feet)
0 100

 Contaminated Groundwater approaching iSOC Treatment Areas
 AS/SVE Treatment Zone



Site Geology

- Top 2 – 17 feet is silty clay, creating a confined aquifer
- Well – sorted medium to fine sand at depths of 5 – 20 feet
- Poorly sorted fine to coarse sand at depths of 12 – 25 feet
- Bedrock is weathered shale



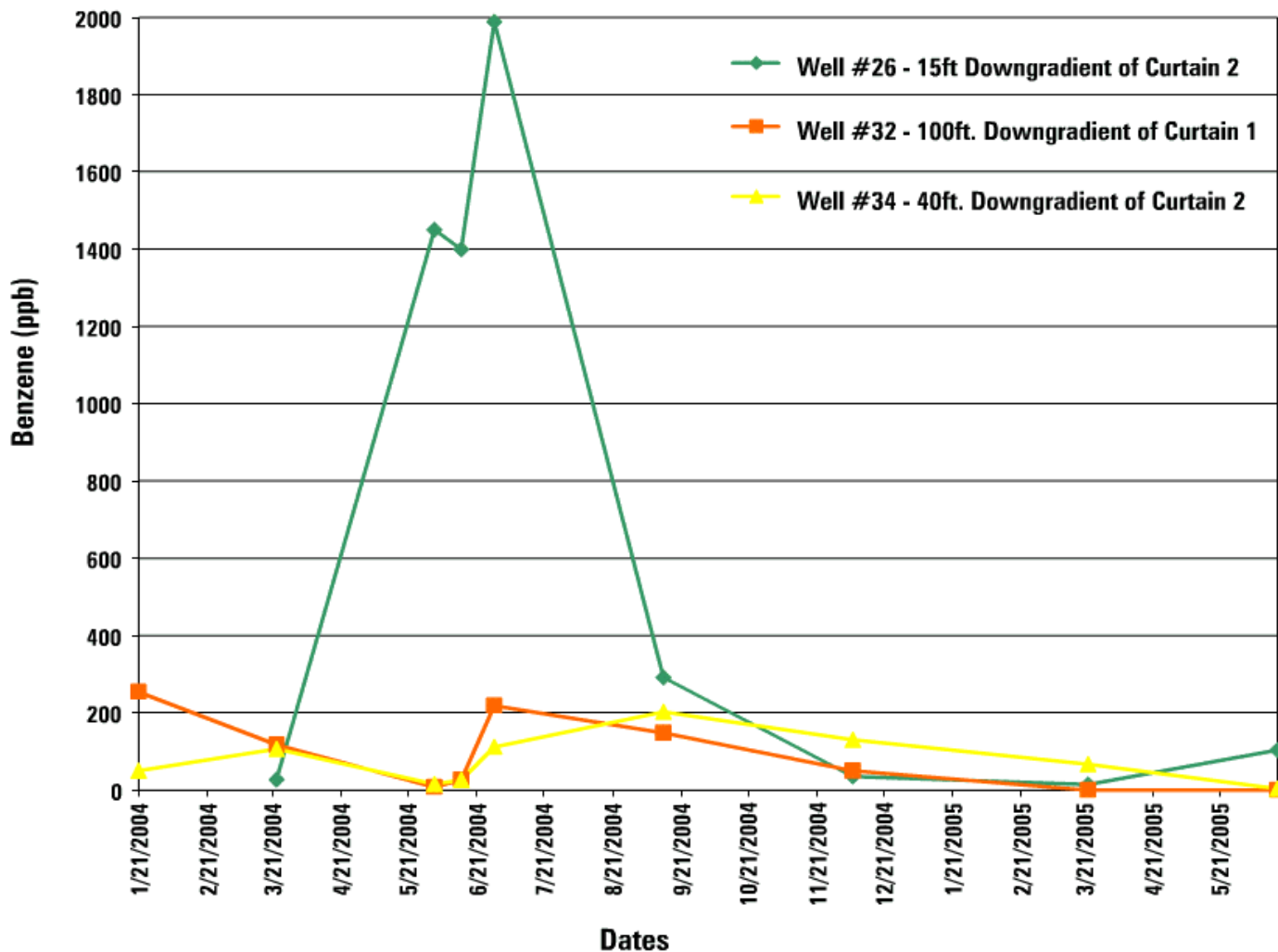
iSOC[®] System

- 3 iSOC[®] curtains (3 iSOC[®]s per curtain) along contaminant plume
 - **curtain 1 > 100 feet from source**
 - **curtain 2 > 300 feet from source**
 - **curtain 3 > 600 feet from source**
- 10 feet distance between iSOC[®] wells
- Screen length 10 feet
- Average water column thickness in wells 5.5 – 7.0 feet
- Average DO > 40ppm in iSOC[®] injection wells



Benzene Concentrations

MW 26, MW 32 & MW 34 (Curtains 1 & 2)





Conclusions

- Benzene is the major contaminant in groundwater throughout the 800 foot long plume
- The iSOC[®] oxygen curtains have significantly reduced petroleum contamination throughout the plume
- The iSOC[®] oxygen curtains continue to operate as the surface spill location continues to generate contamination



ISOTEC

In Situ Oxidative Technologies, Inc.



...innovative chemical treatment solutions for soil and groundwater remediation

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Frequently Asked Questions

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[ISOTEC Modified Fenton's Process Chemistry Laboratory Bench-Scale Study Installation of the Pilot System Treatment Application Treatment Costs Contaminant Treatment Reporting Health and Safety/ Regulatory Concerns](#)

ISOTECSM Modified Fenton's Process Chemistry

Is the modified Fenton's process patented or otherwise unique; what is the difference between ISOTECSM and other vendors that provide similar services.

ISOTECSM modified Fenton's Process is a patented remediation technology covered by U.S. Patents 6,319,328; 4,591,443 and 5,741,427. Additional patents are currently pending. Although based upon the fundamental principles of Fenton's chemistry, our technology vastly differs from conventional Fenton-based chemical oxidation technologies. Some of the major differences are outlined as below.

Circum-neutral pH Conditions: Conventional Fenton-based processes function only under acidic conditions because of the inability of iron catalyst to remain dissolved in the natural subsurface pH range of 6-7. ISOTECSM modified Fenton's process utilizes specially developed catalysts composed of active components that chelate the iron and keep it in dissolved form as an organometallic complex that functions effectively in the circum-neutral pH range (i.e. pH @ 7.0) for contaminant destruction.

Mobility Characteristics: One of the biggest challenges of in-situ oxidation is to ensure that the injected reagents travel to the location of contamination without being subjected to losses caused by precipitation or surface fixation. Iron, which is the key component required to promote Fenton's reaction, will precipitate within inches from the point of injection when introduced as solution of any of its typical salts. For example, a ferrous sulfate catalyst tends to precipitate to its oxidized form (Ferric), thereby, making hydroxyl radical generation magnitudes slower. Typically, 95% to 97% of a ferrous sulfate catalyst gets sorbed to the soil allowing only the remaining 3% to 5% of the catalyst to be utilized for hydroxyl radical generation. Acidified iron solution will remain in solution longer than regular iron solution; however, the low pH is quickly buffered by the native soil to its natural circum-

Experience:

- Zero accidents safety record in over 13 years of in-situ chemical oxidation (ISCO) field application.
- More than 300 field-scale (pilot and full-scale) ISCO projects completed to date.
- More than 350 bench-scale studies completed to date.
- Exclusive patent holder on the use of chelated iron catalysts for both Modified Fenton's Reagent as well as Activated Persulfate.



neutral pH resulting in iron precipitation. Furthermore, acidification of the entire contaminated aquifer is not only impractical but may also result in permanently increasing the corrosivity of groundwater. ISOTECSM's catalysts have superior mobility compared to conventional Fenton's catalysts and as discussed in (1), they function under natural subsurface conditions. The chelating components prevent precipitation or fixation of iron to native soil, thereby promoting its availability for hydroxyl radical generation from peroxide.

Control Agents: ISOTECSM also developed stabilizers and mobility control agents that control the formation and dispersion of hydroxyl radicals. ISOTECSM's stabilizers significantly enhance the longevity of peroxide when introduced into the subsurface.

Research: ISOTECSM developed its reagents through years of research - both in-house as well as through affiliated academic institutions. The injection technology has been fine-tuned through years of laboratory and field experimentation. ISOTECSM's reagents are especially designed for in-situ application. ISOTECSM performs a field pilot program based on the results of laboratory testing conducted on site-specific samples. Laboratory bench tests are conducted in an effort to determine the stoichiometric molar ratio of ISOTECSM reagents best suited to achieve maximum contaminant destruction at the subject site.

Detail experience with the production of interim daughter products and their toxicity.

ISOTECSM has not experienced the production of any toxic interim daughter products at sites utilizing their modified Fenton's process. The ISOTECSM modified Fenton's process is a chemical oxidation technology that destroys organic compounds in the subsurface. Upon injection of the reagents, hydroxyl radicals are generated. The modified Fenton's process is non-specific; meaning that when a free radical is formed, it will oxidize any oxidizable organic compound it comes in contact with, producing carbon dioxide and water, and chloride ions if chlorinated compounds are being treated. After a short period of time, the catalyst is oxidized to simple ferrous/ferric ions, which adsorb to the soil matrix.

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Discuss the effects of in-situ pretreatment pH and temperature on your process, including reaction kinetics.

Lab studies and corresponding field treatment programs can be performed at sites with varying subsurface conditions such as acidic pH levels to alkaline levels. ISOTECSM's patented catalysts allow for the generation of hydroxyl radicals and chemical oxidation to occur throughout the pH range of 2-10. ISOTECSM's 4000 series modified Fenton's catalysts are designed to function under natural subsurface conditions (i.e. pH of 7). Therefore, no acidification of the subsurface is required. Temperature increases of up to 10 degrees Celsius may be noted during treatment programs for a short time period (<24 hours).

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Laboratory Bench-Scale Study

"Although oxidation of organic compounds can occur at neutral to slightly acidic conditions, the optimum pH for oxidation of organic compound is between 2 and 4...There is no mention in the lab study of how this acidification was accomplished...Does the chelated-iron catalyst used by ISOTECSM modified Fenton's process provides the free Ferrous iron?"

The chelated iron catalyst used by ISOTECSM provides required iron concentration needed to catalyze the hydroxyl radical formation from hydrogen peroxide. While the optimal pH needed may be in the acidic range in conventional Fenton's chemistry, it has to be noted that the ISOTECSM process is a modified Fenton-based process that has been designed to function at natural subsurface conditions (i.e. pH @ 7). The chemical constituents ISOTECSM uses to attain the targeted process conditions are proprietary. No pH modification of the aquifer is conducted.

Provide a detailed breakdown of the number of samples to be analyzed. How many different concentrations of reagent will be evaluated in the determination of the optimum dosage?

In order to evaluate site conditions, ground water and/or soil samples, which exhibit elevated levels of contamination, are collected and shipped to ISOTECSM's research laboratory. The optimum reagent combination obtained from previous central composite optimization experiments performed on the contaminants of concern is used as the basis for each laboratory study. Specific concentrations and volumes of the reagents to be injected in the field are determined based on a series of experiments, which test several catalyst and oxidizer amendments.

Why is a 1:1 slurry of ground water and soil analyzed in the treatability study instead of a ratio more representative of in-situ conditions?

ISOTECSM has been utilizing the 1:1 slurry within ground water/soil lab study samples as a general representation of in-situ site conditions. The ratio is typically dependant on site soil conditions (i.e. moisture content, porosity, etc.) within the saturated zone. ISOTECSM can perform the ground water/soil lab study at any ratio, and will work with the client to provide the best available information.

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"Should the lab study indicate that the ISOTECSM process could not successfully treat...". Please identify factors and conditions that you understand or suspect present at the site that would be revealed during the lab study, which may render ISOTECSM's process ineffective for field-testing.

ISOTECSM processes including modified Fenton's, activated persulfate or permanganate may not be effective on samples containing high concentrations of heavier end (i.e. Carbon-10 or greater) aliphatics, polychlorinated alkanes and certain polyaromatic compounds. These contaminants

are strongly adsorbed to the soil and are not easily available for treatment by the aqueous generated hydroxyl radicals. In addition, samples from wells that contain free product will require free product to be removed prior to initiating one of ISOTEC's processes. Contaminants such as TCE, PCE and BTEX can be treated due to the presence of carbon-carbon double bonds within the target contaminants that are vulnerable for attack by free radicals during the reaction. Factors such as native pH and total organic carbon (TOC) content of the site soils are also critical. Samples containing unusually high or low pH may not provide conditions conducive for effective reaction propagation and contaminant oxidation. Such sites will require pH treatment prior to initiating ISOTECSM reagent injection. Most sites with the native subsurface pH in the range of 2.5 to 8.5 are suitable for ISOTECSM treatment. Sites with total organic carbon (TOC) content of soils >75,000-ppm result in high oxidant wastage due to competition provided by TOC. This limit is higher for sites where a significant portion of TOC can be attributed to contamination that is already present within the subsurface.

"While field tests with the modified Fenton's technology have been shown to be successful, due to heterogeneity and uncertainties in the subsurface, the in-situ reaction is never as complete as bench and batch scale studies would suggest..."

It is true that ISOTECSM laboratory study is performed as a controlled batch process that differs from the heterogeneity associated with a subsurface. While the main objective of our laboratory bench test is to determine the contaminant destruction efficacy using one of ISOTEC's processes, concerns associated with field application are usually addressed during the pilot study. In fact, the principal objective of the pilot study is to evaluate the injection mechanism, radial effects, and site-specific chemical formulation. Information obtained from laboratory study provides a basis to initiate the pilot program.

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Installation of the Pilot System

Describe how the bench-scale test results will be used to develop full scale-up recommendations.

A specific stoichiometry will be determined through a bench-scale lab study, with preliminary treatment quantities calculated. Application is typically tested in the field during a pilot program to determine the efficiency and radial extent of treatment, which varies depending on the site's subsurface characteristics. Based upon a successful lab study and pilot program, design and implementation of full-scale remediation is proposed (if required).

"The addition of acid to water generates heat. Also, the dissociation of hydrogen peroxide is exothermic. PVC is not capable of withstanding the heat of reaction.

Practical experience has shown that PVC wells will melt, collapsing and becoming unusable..."

PVC does not decompose until the temperature reaches a high of 148-149°C (or 298-300°F). Under normal treatment conditions, ISOTECSM modified Fenton's reaction temperatures rarely exceed a high of 10°C over background groundwater temperatures, which is significantly lower than the temperatures of concern. Furthermore, ISOTECSM has used PVC injection points at numerous sites in the past and has found evidence of PVC melting only at sites with free product or high organic loading such as a peat layer, which can cause an aggressive reaction upon contact with hydrogen peroxide. Stainless steel wells are recommended in those instances. An additional point to note is that the ISOTECSM process does not involve adding concentrated acid to the subsurface aquifer and therefore, will not generate such high reaction temperatures.

"Injecting the H₂O₂ under hydrostatic pressure may only succeed in treating the area immediately around the injection point...H₂O₂ should be applied under moderate pressure."

It is true that hydrostatic pressure may not be adequate to attain the desired radial effect if permeability is low. ISOTECSM designs its injection points for low to moderate pressure application where it is considered necessary. As mentioned before, a pilot study is performed to determine the conditions that are most suited for full-scale remediation of the site.

Provide information on full-scale processes you have implemented in residential areas or other areas that are populated (shopping centers, roadways, etc.)

The ISOTECSM process has and is currently being implemented within numerous residential areas. Full-scale programs have been completed from a small project within a residential dwelling basement where a former AGST spill occurred (See [Lake Front Residence, New Jersey](#) case study), to larger ongoing treatments within a warehouse (case study not completed) where total site VO's (TCE/PCE) levels have been reduced from 151 ppm to 3 ppm after 2 treatment applications. Several ISOTECSM case studies have been enclosed in the [case studies](#) section of this web site.

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Treatment Application

Discuss temperatures and pressures encountered with the proposed process during the treatment and how they will be controlled. Will standard PVC injection wells be utilized or will special well casing be required?

As stated above, an ISOTECSM reagent combination utilized at a site is first tested during a bench-scale lab study. The ISOTECSM process utilizes low concentration reagents under a gravity or slight pressure injection with constant off-gas releases through a site-specific injection apparatus. Reagents utilized are stabilized and at a low concentration,

with injection in a controlled manner to reduce the possibility of any hazard occurring. Pressure and temperature measurements are not typically collected due to ISOTECSM's non-aggressive reactions. Temperature rises of up to 10 degrees Celsius are noted for a short period (<24 hours), and slight applied pressure is used only within less permeable aquifers. Standard PVC injection points are sufficient with the ISOTECSM process. Treatment program activities are limited to the specific areas within the known contaminant plume, with injection of treatment chemicals controlled at the surface during the application. A site engineered injection apparatus is used to control flow of treatment chemicals into the subsurface via the chosen injection pathway.

In the injection of reagent into the contaminated subsurface, what percentage of pore volume is necessary for making adequate contact with contaminants of concern? Is there a concern with the displacement/forced migration of contaminants associated with adding significant volume of liquid to the subsurface? If so, how is this displacement/forced migration controlled?

The first part of the question should be answered by the stoichiometric ratio determined in the bench-scale lab study, along with several other factors as discussed above. The ISOTECSM process injection rate and volume of discharge are extremely complex and interrelated to the reaction rates of hydroxyl radicals with the contaminants, the contaminant distribution coefficients in the subsurface systems, and the rate of hydrogen peroxide decomposition within the subsurface. The rate at which any flow can be injected into the subsurface is determined by the soil/aquifer characteristics. The treating flow will be discharged under hydrostatic or an applied pressure based on the engineering and construction of the injection system and receiving aquifer. The volume of discharge varies based on the specific stoichiometry determined in the lab study, level of contamination, volume of area to be treated, and subsurface soil and ground water characteristics.

The following should address the requested information on the actual destruction of contaminants versus possible displacement/forced migration. The ISOTECSM process is a contact treatment that actually changes the chemical composition of the compound in-situ and occurs instantaneously. When ISOTECSM chemicals are injected into the subsurface, a reaction transpires which immediately produces free radicals (via modified Fenton's reagent or activated persulfate). The free radicals are non-specific oxidants that react with most organic contaminants at diffusion controlled rates. As the free radical comes into contact with organic compounds, oxidation occurs. A complete oxidation of the organic compound results in the production of carbon dioxide and water. Therefore, no displacement/forced migration occurs, only the chemical oxidation of organic compounds within the area being treated. In addition, subsurface aquifers consist of large quantities of liquid totaling in the

millions of gallons. The addition of a few hundred/thousand gallons of ISOTECSM catalysts and oxidizers within a particular area would not cause any significant decrease in contaminant levels due to dilution.

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How are such parameters as pH and alkalinity manipulated as part of the full-scale treatment process in order to optimize performance of the injected reagents? Provide details.

Laboratory treatability studies and corresponding field treatment programs can be performed at sites with varying subsurface conditions such as low acidic pH levels to higher alkaline levels. ISOTECSM's patented catalysts allow for the generation of free radicals and chemical oxidation to occur through most of the pH scale (i.e. pH = 2-10). ISOTECSM's 4000 series catalysts are designed to function under natural subsurface conditions (i.e. pH of 7) and are suitable for majority of the sites using modified Fenton's or persulfate. Therefore, no manipulation is required.

Are ISOTECSM reagents prepared on site? What happens to these chemicals when injected into the subsurface?

ISOTECSM catalysts consist of a site-specific chelated iron complex. ISOTECSM typically uses H₂O₂ and sodium persulfate at a concentration of 5%-20% during injection activities. Permanganate is used at concentrations ranging from 1% to 10%. Typically, the H₂O₂ is shipped directly to the site and stored in DOT approved 55-gallon drums with an initial concentration of 50%. Sodium persulfate is shipped to the site in a dry form in 55 lb bags. Potassium permanganate is shipped in dry form in 100 kg pails while sodium permanganate is shipped in liquid form in DOT approved 55-gallon drums at an initial concentration of 40%.

Field dilution and addition of ISOTECSM's proprietary non-hazardous stabilizers and mobility control agents are performed as determined during our bench scale studies. All reagent components are premixed in a dry form and packaged prior to shipment to any site. The reagent additives will be mixed/ diluted on-site and added during dilution activities. The ISOTECSM series catalysts consist of a chelated iron complex. The iron complex is similar and at levels comparable to that of naturally occurring metals within the soil matrix. ISOTECSM catalysts include proprietary chelating agents, which keep the catalyst in dissolved form until adequate dispersion is completed and at levels to that of naturally occurring metals within the subsurface. The oxidizer slowly consumes the catalytic components before a gradual liberation of catalyst throughout the treatment area occurs. This process allows the catalyst to distribute evenly within subsurface before finally adsorbing to the soil particles. After a short period of time, the catalyst is oxidized to simple ferrous/ferric ions. For modified Fenton's, the hydrogen peroxide oxidizer is itself reduced to water and oxygen. For activated persulfate, the sodium persulfate oxidizer is reduced to sulfate. For permanganate, MnO₂ formation occurs, which precipitates as a dark brown to black solid that adsorbs to

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the soil matrix.

"Since the hydroxyl ions which are generated are not selective, some of them will be wasted on other carbon sources such as the peat layer beneath the site. Besides the PCE, there are other contaminants, such as waste oils (PAHs) and phthalates, which will react with the oxidants."

It is true that hydroxyl radicals generated during the reaction are non-specific and will react with any organic material including peat and free product. Our bench test will test low to high reagent concentrations to evaluate the reagent quantities needed for contaminant treatment for the site-specific soil and groundwater and will include volumes to offset scavenging losses. A pilot study is primarily conducted to obtain a better idea of the overall site-specific factors affecting the process efficacy. Typically, ISOTEC uses a conservative correction factor while estimating the reagent quantities in order to account for losses such as those caused by the scavenging materials (such as peat) in the native soil. The reaction with the free product results in its gradual depletion from the subsurface, which is beneficial for the site.

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"When injecting modified Fenton's reagent into DNAPL areas, a conversion from DNAPL into dissolved phase will occur. This raises an important question on how will this conversion take place. Do the reagents they will be adding to the groundwater will include surfactants to bring the DNAPL into solution."

ISOTEC modified Fenton's process does not utilize any surfactants as part of its reagents. The critical ingredients are hydrogen peroxide and chelated iron complex. The conversion of DNAPL into dissolved phase will occur because of DNAPL desorption from the soil matrix and subsequent transfer to groundwater phase when groundwater contacts desorbed DNAPLs. Desorption occurs because the hydroxyl radicals non-selectively attack the soil-based organic matter binding these contaminants to the soil. The extent of transfer will depend upon the solubility of contaminants and their associated distribution coefficient.

Fenton-reaction involves forced injection of air into the subsurface which may result in pressure buildup that may create hydraulic fracturing resulting in preferential pathways.

Air injection into the subsurface, forced or otherwise is not performed at majority of ISOTEC sites. At sites with extremely tight subsurface conditions (such as tight clayey soils), pneumatic fracturing of the subsurface using pressurized air/nitrogen injection may sometimes be performed to promote distribution of reagents but only after a thorough investigation of the feasibility and potential effects have been completed.

Safety is a priority with the ISOTECSM Process, which uses relatively non-aggressive reaction chemistry. Possible side effects such as surface breakout or lateral migration of treatment reagents and/or off-gases occur with aggressive reaction type oxidative processes utilizing high

concentration of reagents under a constant pressurized condition. ISOTEC does not utilize this approach. Reagents utilized by ISOTEC are stabilized and at a low concentration, with injection in a controlled manner to reduce the possibility of surface breakout or lateral migration. Furthermore, at sites with shallow depth of ground water, extreme caution is exercised while injecting reagents as the mounding effect created raises the ground water elevation to close proximity of the surface. This mounding effect will be monitored in the field by collection of continuous water levels shortly after injection of reagents. It should be noted that the mounding effect offers a potential benefit by treating contaminants present in the "smear" or vadose zone.

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Treatment Costs

What type of a model would you use for determining full-scale costs?

ISOTECSM estimates project costs based on numerous site factors. A specific stoichiometry is first determined through a bench-scale lab study, with preliminary treatment quantities calculated. Application is typically tested in the field during a pilot program to determine the efficiency and radial extent of treatment, which varies depending on the site's subsurface characteristics. Based upon a successful lab study and pilot program, design and implementation of full-scale remediation is proposed (if required). The following factors are considered in estimating the full-scale treatment costs: number of injection points required, amount and extent of delineated groundwater contaminant plume/ soil contamination, oxidant to be utilized, subsurface geology, and estimated volume of reagents required.

Discuss how your cost estimates for full-scale treatment will reflect treatment sufficient to meet remedial action objectives.

The ISOTECSM process is typically a three-step process from laboratory-scale to pilot-scale to full-scale. Each step requires input from the previous. Full-scale treatment typically requires several applications, with each subsequent application treating a smaller area within the former plume. Each treatment application is followed by specific site monitoring to obtain information related to the treatment process, subsurface characteristics and remedial goals.

Initial estimates will reflect the cost of applying the ISOTECSM process throughout the entire area of concern. ISOTECSM typically performs a pilot study prior to site wide remediation to determine actual radial effects of treatment. The radial treatment estimates contained within any proposal are based upon ISOTECSM fieldwork conducted in the past at facilities with similar geology. Actual radial treatment effects are site specific and can only be determined during actual remedial activities.

Actual injection point locations will be determined upon a review of subsurface utility maps.

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Contaminant Treatment

Where do I get information if my contaminants of concern have been treated by ISOTECSM in the past?

Please follow the link [contaminant treatability](#) to download the calculator that has information on contaminant treatment. If your contaminant of concern is not listed or you need additional information, please contact us.

Discuss your experience with the mobilization and control of DNAPLs resulting from your process.

The ISOTECSM chemical oxidation process is a contact remedial treatment and works through contaminant desorption from the soil phase followed by oxidation in the aqueous phase. When injecting ISOTECSM reagents into DNAPL areas, a conversion from DNAPL into dissolved phase will occur. Therefore, a thorough investigation must be completed at a site prior to remedial activities to determine the plume contaminant mass in the area to be treated. Once the plume mass has been calculated, a sufficient amount of reagents can be calculated to treat the contaminants in these areas.

ISOTECSM has noted on some projects an increase in VOC concentrations after a chemical oxidation application. This scenario indicates the presence of large amounts of residual contamination bound to the soil matrix in the vicinity of treatment area or monitoring points. Such increases are caused by the desorption process of organics from the site soils and initial reagent quantities calculated not being sufficient to oxidize all organic contamination which may have been present in the treatment area. This is overcome by additional injection points and/or treatment applications, plus an increase in reagent volume injected.

If an unknown quantity of DNAPL is present in the portion of the site area tested, it is difficult to calculate the exact number of injections and/or quantity of reagent required to complete a remedial cleanup using chemical oxidation. However, ISOTECSM will be better able to determine these amounts once the treatment program has commenced and initial data and trends can be evaluated.

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Reporting

When will final laboratory and pilot reports be available?

Laboratory treatability study report is typically available within five to six weeks from the date of sample submission to ISOTECSM. Pilot program reports are typically available within two weeks after receipt of post-treatment sampling results by ISOTECSM from the analytical laboratory.

Health and Safety/ Regulatory Concerns

What is your experience in dealing with Fenton's reagent in states where it is not widely accepted to attain state standards, including any precedents for injecting Fenton's reagents into potential drinking waters?

The ISOTECSM Process has been accepted by numerous state agencies as a remedial treatment alternative. Most state agencies now consider modified Fenton's reagent and permanganate as an acceptable technology with sodium persulfate gaining increasing acceptance. The state agencies may ask for a lead time of any where from one month to one year prior to commencement of the project to complete review of the proposed remedial action. To date, we have completed projects in Alabama, California, Colorado, Connecticut, Delaware, Florida, Georgia, Indiana, Iowa, Illinois, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Nebraska, New Jersey, New York, North Carolina, South Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Virginia, Washington, Wisconsin and West Virginia and internationally in Japan, Canada and Holland.

Please describe briefly your approach to health and safety in the field (designated personnel, monitoring, safety controls, etc.) to achieve the requirement of no reportable OSHA incidents during field activities.

The ISOTECSM process was created based on numerous years of both academic and private research in the chemical oxidation field. ISOTECSM personnel understand the potential dangers associated with the chemical reaction they are creating, and have completed extensive safety training. As with any activity, by applying safety measures, plus understanding how a process works, limits the potential for any misfortune. ISOTECSM personnel work hard every day to maintain our untarnished record of zero accidents in over 11 years of ISCO field implementation.

An ISOTECSM injection team typically consists of a field supervisor, along with 2-3 injection specialists. All members of the injection team have completed health and safety training consistent with the Occupational Safety and Health Act (Title 29 of the Code of Federal Regulations 1910.120). ISOTECSM supervisors have completed an additional 8 hours of OSHA supervisor training. ISOTECSM reagent combinations to be utilized at the site will be tested during a bench-scale lab study. The ISOTECSM process utilizes low concentration of reagents under a gravity or slight pressure injection with constant off-gas releases through a site-specific injection apparatus. Reagents utilized are stabilized, with injections performed in a controlled manner to reduce the possibility of any hazard occurring. Pressure and temperature measurements are not typically collected due to ISOTECSM's non-aggressive reactions. However, temperature rises of up to 10 degrees Celsius have been noted for a short period (<24

hours), and slight applied pressure is used only within less permeable aquifers.

What is the potential for surface breakout of reagents during injection activities?

Safety is a priority with the ISOTECSM process, which uses a relatively non-aggressive reaction chemistry. Possible side effects such as surface breakout or lateral migration of treatment reagents and/or off-gases occur with aggressive reaction type oxidative processes utilizing high concentration reagents under a constant pressurized condition. This type of reaction creates a significant temperature rise and an enormous amount of carbon dioxide and/or oxygen off-gas, which push vapors and contaminants within the subsurface. ISOTECSM does not utilize this approach. Reagents utilized by ISOTECSM are stabilized and at a low concentration, with injection in a controlled manner to reduce the possibility of surface breakout or lateral migration. Furthermore, at sites with shallow depth of ground water, extreme caution must be exercised while injecting reagents as the mounding effect created raises the ground water elevation to close proximity of the surface. Again, the stabilized ISOTECSM reagents utilized along with control of the injection process limits these concerns.

Will the use of Fenton's reagent increase the groundwater concentrations of arsenic, chromium, iron and/or manganese, and will any of the by-products of Fenton's reagent reactions create compounds not now present in the groundwater? If so, what are the expected concentrations of these compounds?

Conventional Fenton's reaction occurs at or within an acidic pH range, and therefore, would allow metals to leach into the aquifer. The ISOTECSM modified Fenton's process, with its neutral pH based reagents, should not create a condition to allow leaching of metals.

"Another concern I have is whether the injections can be done safely. The injections will be done indoors... The injections should be designed so that these wooden structures will not be damaged"

ISOTEC has worked at several sites where the injection activities were performed indoors. We have treated petroleum hydrocarbon contamination resulting from a heating oil spill in the basement of a house that was occupied during the treatment program (Enclosed Case Study 8).

Another project in northern New Jersey was a vacant warehouse contaminated with PCE and Cis-DCE. We have achieved substantial contaminant destruction and the case is currently being reviewed by NJDEP for closure. Currently, we are working on another project in an industrial warehouse (currently occupied) in New Jersey. We have successfully performed a pilot program at a former car dealership (vacant) in Boston. We have also performed injection activities inside an existing seasonal boutique store (former dry cleaners) in upstate New York.

The use of low reagent concentrations coupled with a

milder reaction limits any concerns associated with damage of wooden structures. No adverse impacts were reported at any of our previous sites. Vapor generation is not a major concern with our process mainly due to the low concentration of reagents that we use. Our catalysts are prepared for use at circum-neutral pH conditions and are not acidic in nature. All previous monitoring activities conducted for vapor generation during ISOTEC injections have yielded negative results. A site specific Health and Safety Plan (HASP) will be prepared prior to initiating field activities.

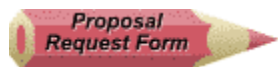
Why should you use the ISOTECSM Process?

When reviewing a site for the ISOTECSM process, we first utilize a common sense approach to evaluate and design a treatment program. In some cases, ISCO may not be the most practical remedial treatment alternative, as is the case with large layers of free product (>2") and associated large amount of reagents needed to treat such. For any site, ISOTECSM first presents their approach for remedial treatment utilizing a chemical oxidation process. The approach incorporates dividing the test area into small treatment zones, along with several treatment applications. ISOTECSM designs their treatment programs to not only meet the desired "Corrective Action Objectives" proposed, but to reduce the contaminants of concern to as close to a non-detectable level as possible.

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- Overview
- Modified Fenton's
- Activated Persulfate
- Permanganate



Technology Overview

Technology > Overview

We offer in situ soil and groundwater remediation via:

- [Modified Fenton's Reagent](#)
- [Activated Persulfate](#)
- [Sodium or Potassium Permanganate](#)

Please follow the links for additional information on each oxidant.

ISOTEC's patented *Modified Fenton's Reagent* technology uses chelated iron catalysts and stabilized hydrogen peroxide that are injected into the contaminated subsurface at neutral pH to produce free radicals that oxidize and reduce contaminants. The reaction byproducts include carbon dioxide, water and chloride ion if chlorinated contaminants are present.

ISOTEC's *Persulfate* technology uses sodium persulfate catalyzed by heat, hydrogen peroxide or our patented chelated iron complex to produce sulfate free radicals that attack contaminants.

OXIDANT COMPARISON

Technology Features	Modified/Conventional Fenton's Reagent	Permanganate	Persulfate	Ozone
Physical State As Injected	Liquid	Liquid	Liquid	Gas
Key Oxidant	OH [•]	MnO ₄ ⁻	SO ₄ ^{•-}	O ₃
Oxidation Potential	2.8V (highest)	1.7 V	2.5 V	2.07 V
Reaction Times	Fast	Slow	Moderate	Fast
By-Products	Ferric iron, O ₂ , H ₂ O	Dissolved Manganese, potential heavy metals	Sulfate	Oxygen
Contaminant Mass / NAPL Reduction	Yes	Limited	Moderate	Limited
Potential to Enhance Bioremediation	Yes using Modified Fenton's	No	No	Yes

Capital Costs	Low	Low	Low	High
Reagent Costs	Moderate	Moderate (for KMnO_4) to High (for NaMnO_4)	Moderate	Moderate
Subsurface Fouling	No (Modified Fenton's). Possible (with Conventional)	Yes due to MnO_2 formation	No	No
Metals Mobilization / Oxidation Potential	Possible under acidic conditions	Possible oxidation of Cr^{3+} to Cr^{6+}	Possible due to acid formation	Potential


Overview
Modified Fenton's
Activated Persulfate
Permanganate


Modified Fenton's Reagent

Technology > Modified Fenton's Reagent

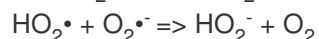
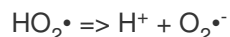
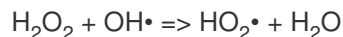
ISOTECSM's modified Fenton's process is based on the fundamental principles of Fenton's chemistry. H.J.H. Fenton first demonstrated the use of Fenton's chemistry in 1894 by oxidation of tartaric acid using a soluble iron-catalyzed decomposition of dilute hydrogen peroxide under acidic conditions. The modified Fenton's process was developed with the fundamental goal of enhancing *in situ* treatment of soil and groundwater contamination using Fenton's chemistry while mitigating the negatives associated with application of Fenton's reagent in its conventional form (such as acidic pH, limited catalyst mobility, etc). The process generates powerful free radicals when the catalyst reacts with hydrogen peroxide. The principal chemical reaction associated with the modified Fenton's process is provided below.



Where,

H_2O_2 = Hydrogen Peroxide, Fe^{2+} = Ferrous Ion, Fe^{3+} = Ferric Ion, $\text{OH}\cdot$ = Hydroxyl Radicals

In addition to the initiation reaction (1) described above that produces hydroxyl radical oxidants, the modified Fenton's process also produces superoxide radical and hydroperoxide anion reductants by additional chain propagation reactions described below. The perhydroxyl radical is known to be a weaker reductant compared to superoxide radical and hydroperoxide anions.



Where

$\text{O}_2\cdot^-$ = superoxide radical anion, HO_2^- = hydroperoxide anion, $\text{HO}_2\cdot$ = perhydroxyl radical

The co-existing oxidation-reduction reactions associated with a modified Fenton's process promote enhanced desorption and degradation of recalcitrant compounds. These include compounds such as carbon tetrachloride and chloroform, which were previously considered untreatable by Fenton's chemistry

WHY USE MODIFIED FENTON'S REAGENT?

ISOTEC's modified Fenton's Reagent is quickly emerging as the leading remedial technique of the 21st century. However, if you are familiar with how conventional Fenton's is most often applied, using strong acids and high reagent concentrations under pressure, then you are familiar with its shortcomings, often including incomplete treatment, explosive reactions, organic vapor generation and contaminant migration.

ISOTEC's modified Fenton's Reagent process was specifically

designed to overcome these problems. ISOTEC's patented catalysts allow reagents at background neutral pH conditions to be effectively distributed within the aquifer, destroying contaminants in saturated soil and groundwater without generating organic vapors or high temperatures.

COMPARISON OF OTHER PEROXIDE-BASED TECHNOLOGIES

Technology Features	Hydrogen Peroxide	Classic Fenton's Reagent	Modified Fenton's Reagent
Aquifer Acidification	No	Yes	No
Hydroxyl Radical Production	Limited	Yes, if pH < 3	Yes
Superoxide Radical Production	No	Limited	Yes
Controlled Reaction	No	No	Yes
Bioremediation Stimulation	Yes	Limited	Yes

The modified Fenton's Reagent process is an in-situ remedial treatment technology that destroys organic contamination through co-existing chemical oxidation and reduction. This process consists of injecting patented chelated iron catalysts and hydrogen peroxide into contaminated aquifers.

As compared to conventional Fenton's Reagent, which require acidic conditions (pH~3), ISOTEC's modified Fenton's Reagent process is effective at neutral (pH~7) conditions. This is an important consideration in full-scale application, since acidifying an aquifer is typically impractical. Additionally, the production of superoxide, which is the driving reaction for contaminant reduction and desorption, is inhibited at acidic conditions.

ISOTEC uses patented reagents designed for neutral subsurface conditions and efficient hydroxyl radical and superoxide generation. ISOTEC's oxidation and reduction method utilizes a site-specific delivery system designed to treat organic contaminants within an area of concern. ISOTEC oxidants and catalysts react with the organic contaminants within the subsurface producing innocuous by-products such as carbon dioxide and water (and chloride ions if chlorinated compounds are being treated).

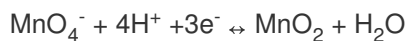
[Overview](#)[Modified Fenton's](#)[Activated Persulfate](#)[Permanganate](#)

Permanganate

Technology > Permanganate

ISOTECSM Permanganate-based reagents use either potassium permanganate (KMnO₄) or sodium permanganate (NaMnO₄). The reaction mechanism associated with both the permanganates is similar.

ISOTECSM's Permanganate-based reagents are designed for both solo use or in combination with other ISOTECSM reagents (e.g. modified Fenton's reagent, Persulfate reagent). The reaction mechanism associated with our Permanganate process is shown below.



Where

MnO₄⁻ = Permanganate (Sodium or Potassium), H⁺ = Hydrogen ion, e⁻ = Electrons, MnO₂ = Manganese Dioxide, H₂O = Water



FORMER GASOLINE SERVICE STATION

SITE LOCATION:	Western Florida
CONTAMINATION:	Benzene (3,736 µg/l); Ethylbenzene (5,769 µg/l); Toluene (10,700 µg/l); Xylenes (9,984 µg/l); Methyl-t-butyl ether MTBE (107 µg/l); and Naphthalene (1,372 µg/l).
GEOLOGY:	General shallow subsurface conditions at the site consist of fine sands and silty sands; water table at approximately 5-7 ft bgs.
AREA TREATED:	12,000 Sq. ft area at 4-15 ft bgs vertical depth interval.
EFFECTIVENESS:	Greater than 99% reduction of total VOCs and SVOCs site-wide following ISOTEC pilot and full-scale treatment programs. All concentrations reduced to below the most stringent FDEP groundwater quality standards.



The subject site is a former gasoline service station located in Western Florida. Past business activities at the site resulted in soil and groundwater contamination with gasoline related volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). Previous remedial activities included excavation of all underground storage tanks (USTs) and surrounding impacted soils at the site. Groundwater was encountered at 5-7 ft below ground surface (bgs). Contamination extended from the smear zone (i.e. 5-7 ft bgs) to about 15 ft bgs covering an area of more than 12,000 square ft. Permitting for the treatment program was governed by the Bureau of Petroleum Storage Systems within the Florida Department of Environmental Protection (FDEP) to remediate high levels of **Benzene, Ethylbenzene, Toluene, Total Xylenes, Methyl-t-butyl ether (MTBE) and Naphthalene** in site soil and groundwater.

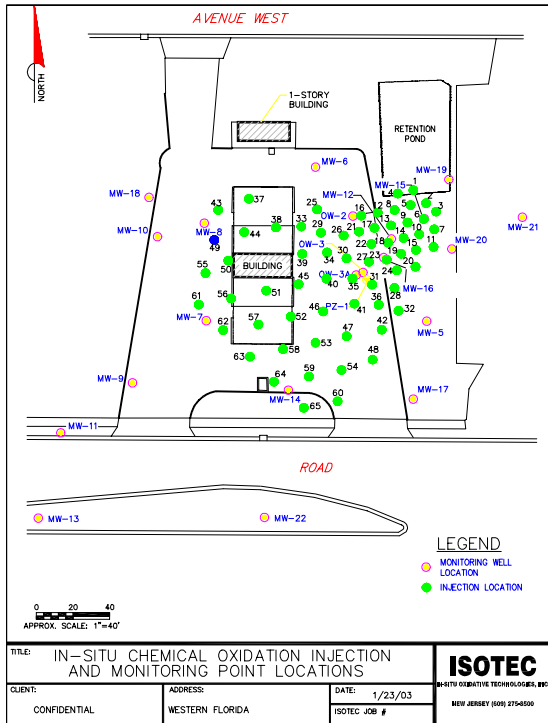
The objective of the treatment program was to treat the primary site contaminants of concern to below the most stringent primary standard groundwater cleanup target levels for the state of Florida. Specifically, the primary standard criteria for individual contaminants are: Benzene = 1 µg/l, Ethylbenzene = 30 µg/l, Toluene = 40 µg/l, Total Xylenes = 20 µg/l, MTBE = 20 µg/l and Naphthalene = 20 µg/l.

Geology/Hydrogeology:

General subsurface lithology at the site consists of fine to silty sands. Depth to groundwater is approximately 5-7 ft bgs with a groundwater flow in the southwest direction.

Laboratory Study:

An ISOTEC groundwater and soil-slurry **laboratory study** was initially completed noting over a 99% reduction in total volatile organic compounds (VOCs) in both the groundwater and soil samples.

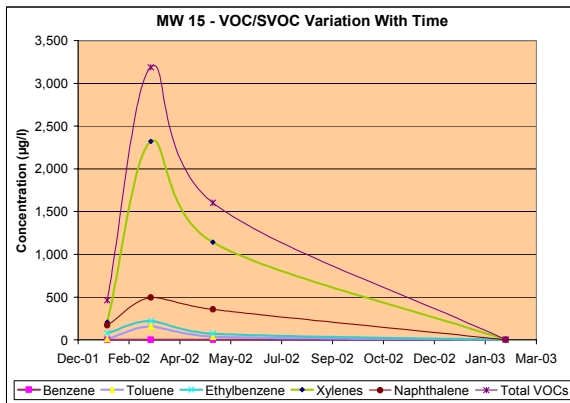
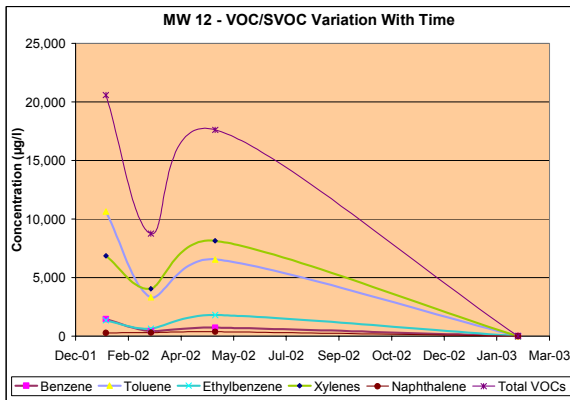


Pilot Program:

An initial **field pilot program**, consisting of two 4-5 day injection events in January and April of 2002 was completed at the site to determine treatment efficiency. Injections targeted the 4-15 ft aquifer depth interval using an open borehole direct push technique. A site map is attached.

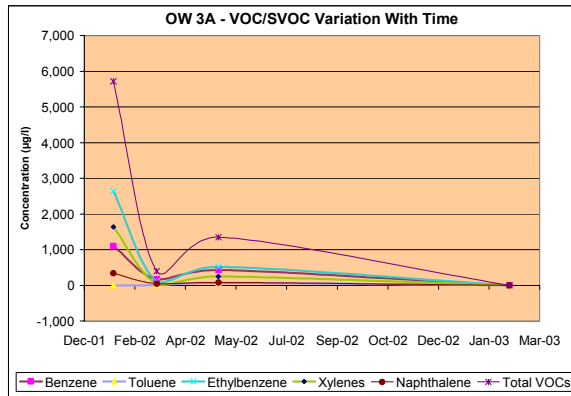
The first injection event consisted of injecting ISOTEC reagents into the subsurface via 39 direct push injection points using a 20-foot grid pattern except in the former UST excavation area where spacing was 7.5 ft. A total of 13,680 gallons of ISOTEC reagents were injected at an average flow rate of 7.6 gallons per minute (gpm) during the first event.

The second injection event consisted of injecting ISOTEC reagents into the subsurface via 40 direct push injection points using the same grid pattern as was used during the first injection event; however, the locations of the injection points were laterally offset to be centered between the previous locations. A total of 14,400 gallons of ISOTEC reagents were injected at an average flow rate of 10.1 gpm during the second event.



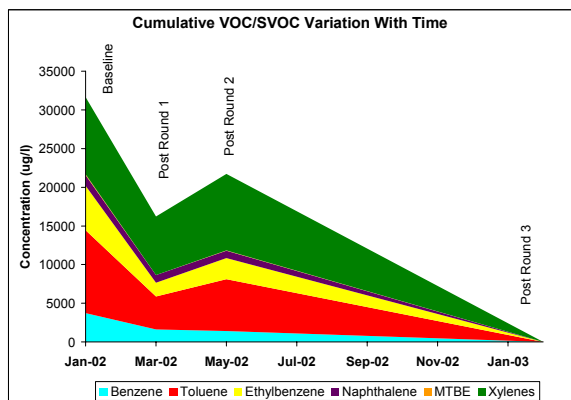
Pilot program results indicated that overall site-wide soil contamination of total VOCs and SVOCs was reduced from 76,443 µg/kg to 8,332µg/kg, an 89% decrease. The May 2002 sampling results (based on three soil sampling locations SB-1, SB-2 and SB-3) show that individual VOCs/SVOCs, except for naphthalenes, have been treated to non-detectable (ND) levels at two sampling locations SB-1 and SB-3 where as sampling location SB-2 indicated low concentrations of BTEX-MTBE. While naphthalenes have been treated to below ND levels at SB-3, significant concentrations were still detected at SB-1 and SB-2.

The cumulative VOC/SVOC groundwater concentrations were reduced from 32,191µg/l to 22,175µg/l, a 31% decrease following the pilot program. Most notable reductions were achieved in source area wells OW-3, OW-3A (77-82% decrease) and almost all the down-gradient wells (MW-8, MW-9, MW-10 and MW-14 except MW-7), which showed between 70%-100% decrease. Some increases in concentrations of COCs were noted, especially in the vicinity of the former UST area (MW-12 and MW-15). Together, these two wells accounted for nearly 90% of the residual contamination remaining in May 2002. Conservative mass calculations estimated a total 57 pound decrease (or 74% mass destruction) in soil and groundwater contaminant mass within the treated area.



Results of Treatment Program for all Wells Former Gasoline Service Station				
Well ID	Bsln 01/02	Rnd 1 (Pilot) 03/02	Rnd 2 (Pilot) 05/02	Rnd 3 (Full) 02/03
MW-7	141	167	317	1
MW-8	80	8.9	3.3	1.4
MW-9	45	ND	ND	NS
MW-10	32	ND	ND	NS
MW-11	13	NS	NS	2
MW-12	20,719	8,916	17,786	ND
MW-14	262	866	80	ND
MW-15	572	3,515	1,852	ND
MW-16	96	NS	NS	ND
OW-2	7	NS	NS	ND
OW-3	4,413	2,867	776	NS
OW-3A	5,810	429	1,361	ND
Total	32,191	16,769	22,175	4.4
% Reductio	-	48%	31%	99.9%

Notes: All results are in ug/l; NS = Not Sampled; ND = Analyzed for but not detected



Full-Scale Treatment Program:

Although significant contaminant destruction was achieved after the pilot program, VOCs and SVOCs still remained in select areas of the site and exceeded the applicable FDEP groundwater standards. Since a significant portion of the soil-based VOCs/SVOCs in the source area appeared to have been depleted and transferred to aqueous phase following the pilot program, a **full-scale treatment program** was recommended and approved by the FDEP to further reduce the groundwater contamination.

The full-scale treatment program was performed in January 2003 and consisted of one 7-day injection event. ISOTEC reagents were injected into the subsurface via 65 direct push injection points using a 20-foot grid pattern except in the former UST area of MW-12 where spacing was 5-ft. A total of 23,400 gallons of ISOTEC reagents were injected at an average flow rate of 6.15 gpm during the full-scale event. Unlike the pilot program, the full-scale program targeted the 4-15 ft aquifer interval using screened sections instead of open boreholes to distribute ISOTEC reagents. The locations of the injection points are shown on the attached map.

The cumulative VOC/SVOC groundwater concentrations were reduced from 32,191 µg/l (January 2002-baseline) to 4 µg/l (February 2003-post full-scale). Except for toluene, all VOCs/SVOCs site-wide were reduced to ND levels in every well sampled. Concentration of toluene was reduced to 4 µg/l (99.9% reduction), well below the FDEP standard. Most notable reductions were achieved in source area wells MW-12, MW-15 and OW-3A, which decreased from 17,786 µg/l to ND, 1,852 µg/l to ND and 1,361 µg/l to ND, respectively.

The full-scale treatment program has successfully treated site groundwater contamination and achieved its goal of bringing the entire site to be in compliance with applicable FDEP standards. Every compound was treated to either ND levels or below its most stringent FDEP criteria (e.g. 1 µg/l for benzene) at every sampling location. Site closure is expected in fall of 2003 after two additional quarters of monitoring.

For further information, please contact:

Prasad Kakarla, 51 Everett Dr, West Windsor, NJ
 Phone: (609) 275-8500 x111
 E-Mail: pkakarla@insituoxidation.com

APPENDIX B

**NYSDEC CORRESPONDENCE
DATED JULY 24, 2007**

New York State Department of Environmental Conservation
Division of Solid & Hazardous Materials
Bureau of Hazardous Waste and Radiation Management
625 Broadway, Albany, NY 12233-7258
Phone: (518) 402-8594 • **FAX:** (518) 402-8646
Website: www.dec.ny.gov



Alexander B. Grannis
Commissioner

July 24, 2007

Robert W. Zei, Ph.D., CPG
Sr. Project Manager
Forensic Environmental Services, Inc.
113 John Robert Thomas Drive
The Commons at Lincoln Center
Exton, Pennsylvania 19341



Re: Request for "Contained-In" Determination
Former Norton-Nashua Tape Products Site
2600 Seventh Avenue, Watervliet, NY
EPA ID No. NYD002083954
NYSDEC Index Number: CO 4-20001205-3375

Dear Mr Zei:

This office has reviewed the proposed "Contained-In" Request received on June 15, 2007. The "Contained-In" Determination will be performed once the soil and groundwater sampling data associated with the above site is submitted to this office. As per agreement:

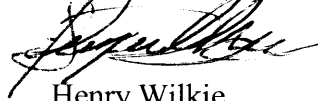
- The "Contained-In" determination would be used to assist in the evaluation of future treatment and/or discharge alternatives. There is no intention within this "Contained-In" determination to put forth a methodology for developing cleanup levels for contaminated environmental media. Cleanup levels will be determined at a later time as part of the corrective action process.
- Identify where the environmental media or debris will be disposed. If the material will be transported off-site for disposal or for thermal treatment provide the name and address of the facility that will receive it. For soil that will be placed on-site after receiving a "contained-in" determination first describe and identify on a scaled facility plot plan the placement location, and submit this information to the NYSDEC project manager for approval.

In order for the Department to process a "contained-in" determination, you must submit all QA/QC deliverables for which a determination is sought. There should be a QA/QC section describing sample information records (sample location, field sample I.D. link to specific segregated piles, sample analysis method, etc). We also need a brief narrative from the laboratory describing any problems with the calibration data or a statement saying there were no QC problems plus a statement on whether samples were analyzed within the proper holding

times. Once we have reviewed the analytical data results for each individual batch, we will send you a "Contained-In" determination letter, similar to the enclosed draft letter.

Should you have any questions regarding the content of this letter, please do not hesitate to contact me at (518) 402-8594 or email me at hjwilkie@gw.dec.state.ny.us.

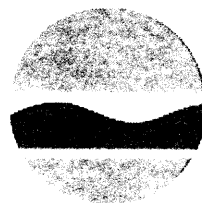
Sincerely,



Henry Wilkie
Environmental Engineer 1
Hazardous Waste Engineering Eastern Section

ecc: A. Barraza
L. Rosenman

New York State Department of Environmental Conservation
Division of Solid & Hazardous Materials
Bureau of Hazardous Waste and Radiation Management
625 Broadway, Albany, NY 12233-7258
Phone:(518) 402-8594 • **FAX:**(518) 402-8646
Website: www.dec.ny.gov



Alexander B. Grannis
Commissioner

Robert W. Zei, Ph.D., CPG
Sr. Project Manager
Forensic Environmental Services, Inc.
113 John Robert Thomas Drive

The Commons at Lincoln Center
Exton, Pennsylvania 19341

Re: Request for "Contained-In" Determination
Former Norton-Nashua Tape Products Site
2600 Seventh Avenue, Watervliet, NY
EPA ID No. NYD002083954
NYSDEC Index Number: CO 4-20001205-3375

Dear Mr Zei:

A review of the referenced data from Soil Pile ID# X has been completed. Contaminated soils which have concentrations of toluene meet the Department's "contained-in" criteria TAGM 3028. Therefore, Soil Pile ID# X does not have to be managed as hazardous waste when transported to XYZ Facility for thermal treatment.

Should you have any questions regarding the content of this letter, please do not hesitate to contact me at (518) 402-8594.

Sincerely,

Henry Wilkie
Environmental Engineer 1
Hazardous Waste Engineering Eastern Section

ecc: A. Barraza
L. Rosenman

APPENDIX C

**TRACER GAS
MONITORING PROTOCOL**

APPENDIX C

Tracer Gas Monitoring Protocol

Tracer gas monitoring will be performed per the 2006 NYSDOH guidance document immediately before and immediately after collection of environmental samples from the sub-slab VMP to confirm the integrity of the VMP (and associated fittings). Pre-sampling tracer gas monitoring will be performed as follows:

- Remove the VMP plug and connect the open end of approximately two to three feet of dedicated ¼-inch ID Teflon tubing to the VMP compression fitting (or nipple). Use the VMP plug to seal the open end of the tubing.
- Insert the plugged end of the Teflon tubing through the opening on the top of the tracer gas flux chamber. Seal the tubing penetration with beeswax.
- Place a piece of plastic sheeting measuring approximately 2 feet by 2 feet over the VMP and seal the sheeting to the slab/floor with duct tape. Puncture the plastic sheeting to expose the VMP compression fitting (or nipple). Seal the flux chamber to the surface with beeswax.
- Open the inlet valve and outlet valve on the flux chamber and connect a short length of Teflon tubing to each.
- Connect the helium source to the inlet valve tubing and open the valve on the helium source allowing helium to enter the flux chamber. Any excess vapor pressure will be relieved via the outlet valve (see above).
- Activate the helium detector and connect it to the outlet valve tubing. Continue to introduce helium into the flux chamber until helium is detected at the outlet valve. Close the helium source valve and flux chamber inlet valve.
- Record the % helium in the flux chamber. Close the outlet valve.
- Unplug the sample tubing and connect to a low-flow peristaltic pump. Collect a one-liter (L) Tedlar bag sample at a flow rate of less than 0.2 liters per minute (lpm).
- After the Tedlar bag is filled, deactivate the pump, and seal the Tedlar bag.
- Connect the sample tubing to a 6L Summa canister positioned adjacent to the flux chamber in preparation for later sampling.
- Screen the Tedlar bag sample for helium by connecting it to the helium detector.

- If no helium is detected in the Tedlar bag sample (or if the ratio of the helium in the Tedlar bag versus the flux chamber is less than 1:5), seal the Tedlar bag sample and set it aside for later volatile organic compound (VOC) screening with a photoionization detector (PID). Proceed with VMP sampling.
- If pre-sampling tracer gas monitoring indicates a 20% leak by volume or greater, check the integrity of the VMP and all fittings, correct if possible, and return to the first step of pre-sampling tracer gas monitoring. If the integrity of the fitting cannot be corrected in the field (i.e., the VMP needs to be resealed or is defective), terminate VMP sampling (and any concurrent indoor air sampling) until the problem is corrected.

Post-sampling tracer gas monitoring will be performed as follows:

- Terminate VMP sampling by recording the post-sample vacuum, closing the Summa canister sample valve, and disconnecting and plugging the sampling tubing.
- Screen the flux chamber by connecting the helium detector to the outlet valve tubing and opening the outlet valve. If helium is not detected, recharge the flux chamber until helium is detected at the outlet valve. Close the helium source valve and flux chamber inlet and outlet valves.
- Unplug the VMP sample tubing and connect to a low-flow peristaltic pump. Collect a 1-L Tedlar bag sample at a flow rate of less than 0.2 lpm.
- After the Tedlar bag is filled, deactivate the pump, and seal the VMP and Tedlar bag.
- Screen the Tedlar bag sample for helium by connecting it to the helium detector.
- If no helium is detected in the Tedlar bag sample (or if the ratio of the helium in the Tedlar bag versus the flux chamber is less than 1:5), tracer gas monitoring is complete. Seal the Tedlar bag sample and set it aside for later VOC screening.
- Remove the sample tubing and plug the VMP. Restore the floor to its previous condition to the extent practicable. Submit the Summa canister for laboratory analysis.
- If post-sampling tracer gas monitoring indicates a 20% leak by volume or greater, set aside the Summa canister (and any concurrent ambient indoor air samples) for optional lab submittal. Check the integrity of the VMP and all fittings, correct if possible, and begin collection of a replacement VMP sample starting with pre-sample tracer gas monitoring (or schedule a follow-up sampling date). If the integrity of the fittings cannot be corrected in the field (i.e., the VMP needs to be resealed or is defective), postpone additional sampling until the problem is corrected, and restore the sampling area as described above.

APPENDIX D

**NYSDEC CORRESPONDENCE
DATED DECEMBER 12, 2008**

**New York State Department of Environmental Conservation
Division of Solid and Hazardous Materials**

Bureau of Hazardous Waste and Radiation Management, 9th Floor

625 Broadway, Albany, New York 12233-7258

Phone: (518) 402-8594 • FAX: (518) 402-9024

Website: www.dec.ny.gov



Alexander B. Grannis
Commissioner

December 12, 2008

Mr. Robert Zei
Senior Project Manager
Forensic Environmental Services, Inc.
113 John Robert Thomas Drive
The Commons at Lincoln Center
Exton, PA 19341

Dear Mr. Zei:

**Re: Former Norton/Nashua Tape Products Facility, Watervliet, NY; NYSDEC
Order on Consent No. 4-20001205-3375, USEPA ID No. NYD066829599;
Corrective Measures Study Work Plan, May 2008**

The New York State Department of Environmental Conservation (the Department) has reviewed the referenced work plan submitted by Forensic Environmental Services, Inc. on behalf of Saint-Gobain Abrasives. The comments discussed below must be addressed in a revised work plan and submitted to the Department for approval.

4.1 Geoprobe Boring Soil Collection and Field Screening Methods

- On page 4-1, first paragraph, the work plan states that “additional soil characterization in the Building Subslab AOC is unnecessary ...”. In order to clarify this point, include additional information that explains why additional soil characterization is unnecessary. For example, was this conclusion included in an approved report?
- Soil samples to be analyzed for VOCs should not be composited.

4.6 Purge Water Disposal

- On November 20, 2008, the Department discussed with Forensics the possible options for disposal of purge water. Forensics indicated that the purge water would probably be collected and disposed off-site. The Department agrees and prefers that the purge water be disposed off-site.

7.0 Sub-slab Vapor and Indoor/Outdoor Air Sampling

- The following guidance documents referenced on page 7-1 are not appropriate, as the New York State Department of Health (NYSDOH) guidance applies and should be used: 1)

Massachusetts Department of Environmental Protection, Indoor Air Sampling & Evaluation Guide, April 2002; and 2) Colorado Department of Public Health and Environment, Indoor Air Guidance, September 2004.

- Table 7-1 states that “Contingent ISCO (see text)” vapor sampling will be completed. However, it is not clear where this is discussed in the text. Please clarify.

7.2 Sub-Slab VMP Sampling

- According to the NYSDOH guidance, one to three implant volumes should be purged prior to collecting the samples (i.e. the volume of the sample probe and tube).
- The canister valve should be closed when vacuum reaches approximately 2 inches of Hg (in order for the lab to check for leaks).
- A tracer gas such as helium should be used to verify that samples are not diluted by surface air.
- Four sets of vacuum readings should be obtained as follows:
 - (1) following canister cleaning for shipping to field;
 - (2) prior to sampling, with all connections and leak test checks completed;
 - (3) at end of sampling; and
 - (4) prior to analysis in lab.Readings (1) and (2) should be within 1.5 inches Hg, as should readings (3) and (4).
- If the lab pressurizes the canisters, it must apply the appropriate dilution factor and provide the Department with the information that was used for the calculations.
- The target reporting limit for the laboratory is 5 ug/m^3 for sub-slab samples.

7.3 Indoor/Outdoor Air Sampling

- Indoor and outdoor air samples should be collected over an 8-hour period, to correspond with a normal working day.
- On page 7-4, first paragraph, the fourth sentence should end with “...to begin indoor ambient air collection.”, rather than “...to begin sub-slab vapor collection”.
- Temperature and barometric pressure in both indoor and outdoor air samples should be recorded, along with current weather conditions.
- The target reporting limit for the laboratory is 0.25 ug/m^3 for indoor and outdoor air samples.

10.0 Quality Assurance/Quality Control Samples

- These should be field duplicate samples rather than blind replicate samples.

11.0 Laboratory Analysis

- It is the responsibility of Norton and their consultant to validate the data and submit the data validation report to the Department for review. The Department does not perform the actual validation of data on behalf of Norton.
- Please submit the laboratory data package on CD format.
- The deliverables package for volatiles by method TO-15 should include the following.
 - (1) Chain of custody forms;

- (2) Instrument run logs with time and date information;
- (3) A case narrative describing any QC problems encountered by the lab, in addition to a written statement with regard to sample holding times from collection to analysis (30 days for SUMMA canisters);
- (4) CLP Form I for each sample analyzed plus total/extracted ion chromatographs;
- (5) CLP Form II, system monitoring compound (surrogate recoveries);
- (6) CLP Form III, MS/MSD recoveries and RPDs;
- (7) CLP Form IV, system, field and trip blanks where applicable;
- (8) CLP Form V, GC/MS instrument performance check for bromofluorobenzene;
- (9) CLP Form VI, GC/MS initial calibration form;
- (10) CLP Form VII, GC/MS continuation calibration;
- (11) CLP Form VIII, internal standard area and retention time summaries; and
- (12) Starting and ending vacuum/pressure readings of each sample canister.

The revised work plan should be submitted to the Department by December 24, 2008 or sooner. If additional time is needed, please request an extension. If you have any questions concerning this letter, they may be addressed to me or Larry Rosenmann at (518) 402-8594.

Sincerely,



Alicia Barraza
Environmental Engineer
Hazardous Waste Engineering Eastern Section

cc: J. Reidy, USEPA Region 2
C. Bethony, NYSDOH

ecc: L. Rosenmann
D. Evans