# Enhanced In-Situ Bioremediation Work Plan Buell Automatics, BCP Site #C828114 Rochester, NY

Prepared for:
New York State Department of
Environmental Conservation
Division of Environmental
Remediation
6274 East Avon-Lima Road
Avon, NY 14414-9519

Prepared by:
Stantec Consulting Services Inc.
61 Commercial Street, Suite 100
Rochester NY  14614-1009
Tel: (585) 475-1440
Fax: (585) 272-1814

On behalf of:
Buell Automatics
381 Buell Road
Rochester, NY 14624

December 2014

**New York State Department of Environmental Conservation**
**Division of Environmental Remediation, Region 8**
6274 East Avon-Lima Road, Avon, New York 14414-9519
**Phone:** (585) 226-5353 • **Fax:** (585) 226-8139
**Website:** www.dec.ny.gov

Joe Martens
Commissioner

January 6, 2015

Mr. Gary Lawton
President
Buell Automatics, Inc.
381 Buell Road
Rochester, NY 14624

Dear Mr. Lawton:

**Re: Buell Automatics Site #C828114**
**Brownfield Cleanup Program (BCP)**
**Enhanced In-Situ Bioremediation Work Plan; December 2014**
**Town of Gates, Monroe County**

The New York State Department of Environmental Conservation (NYSDEC) has completed its review of the document entitled "*Enhanced In-Situ Bioremediation Work Plan*" dated December 2014 (the Work Plan) and prepared by Stantec Consulting Services Inc. for the Buell Automatics Site in the Town of Gates, Monroe County. Based on the information and representations given in the Work Plan, NYSDEC has determined that the Work Plan substantially addresses the requirements of the Brownfield Cleanup Agreement. The Work Plan is hereby approved.

Please distribute copies of the approved Work Plan as follows:
- Frank Sowers (NYSDEC) – 2 hardcopies;
- Gates Public Library – 1 hardcopy; and
- John Frazer (MCHD) – 1 electronic copy.

NYSDEC understands that field activities are scheduled to start on January 12, 2015. Please notify me as soon as possible if there are any changes to the schedule and please keep me informed as work progresses.

Please contact me at (585) 226-5357 if you have any questions.

Sincerely,

Frank Sowers

Frank Sowers, P.E.
Environmental Engineer 2

ec:

B. Putzig
J. Frazer
M. Storonsky
J. Mahoney
M. Sergott
P. Lytle
J. Picciotti

(This page left blank intentionally for double-sided copying)

## CERTIFICATION

I, Peter Nielsen, certify that I am currently a NYS registered professional engineer and that this Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

PETER NIELSEN
No. 061499-1

12/16/14

Signature
**Peter Nielsen**

Date

(This page left blank intentionally for double-sided copying)

# Executive Summary

On behalf of Buell Automatics, Stantec Consulting Services Inc. (Stantec) has prepared this Enhanced In-Situ Bioremediation (EISB) Work Plan (Work Plan) to treat residual groundwater impacts at the Buell Automatics Site (Buell). This work is proposed to be performed in substantial accordance with the overall Remedial Work Plan approved by the New York State Department of Environmental Conservation (the Department) on March 30, 2010 for the Brownfield Cleanup Program (BCP) Buell Automatics Site #C828114, located at 381 Buell Road, City of Rochester, Monroe County, New York (Site). Remedial investigation activities conducted at the Site indicate that there are two source areas of subsurface chlorinated volatile organic compound (VOC) contamination at the Site: the Former Loading Dock Area (FLDA) and the Former Trench Drain Area (FTDA). EISB will be used to address the identified chlorinated VOC impacts.

The major driving force for biodegradation involves the transfer of energy in the form of electrons. Consequently, successful applications require both an electron donor and an electron acceptor. During EISB, the chlorinated VOC acts as an electron acceptor, therefore requiring an electron donor for the reaction to proceed. Bench-scale treatability testing completed by Stantec for the Site in 2009 determined that a mixture of organic acids, prepared by the fermentation of a complex polysaccharide and simple sugar, was capable of providing complete degradation of the chlorinated VOCs of concern at the Site. Stantec is proposing to use such a mixture to prepare the required organic mixture for field implementation of the EISB technology in the FLDA and FTDA at the Site.

Contamination identified in the FLDA, which spans the paved outdoor area between the western end of the southern portion of the Buell building and the western boundary of the Site, was addressed beginning in September 2014 by excavation and offsite disposal of impacted soil. Guar gum (the Variflo® QD Guar Gum product marketed by CETCO Drilling Products Group) and sucrose were placed in the bottom of the completed FLDA excavation to provide electron donor in this area.

The FTDA includes an area inside the southwest portion of the Buell manufacturing building and the adjacent area located outside the south wall, with a groundwater plume extending to the southwest. Electron donor delivery within the FTDA and its downgradient plume will be accomplished by directed injection of a fermented solution of the Variflo® QD product and sucrose into existing FTDA monitoring wells and 20 new injection wells to be installed as part of the proposed remedial activities.

Upon completing the electron donor injection, a post-injection monitoring program will be initiated to evaluate the effectiveness of the treatment, using existing monitoring wells within both treatment areas, on a monthly basis for the first three months after electron donor application and on a quarterly basis for a period of two years thereafter. Regular progress reports will be prepared and submitted by Stantec.

(This page left blank intentionally for double-sided copying)

# Table of Contents

## FIGURES

## TABLES

## APPENDICES

# 1.0 INTRODUCTION

On behalf of Buell Automatics, Stantec Consulting Services Inc. (Stantec) has prepared this Enhanced In-Situ Bioremediation (EISB) Work Plan (Work Plan) to treat residual groundwater impacts at the Buell Automatics Site (Buell). This work is proposed to be performed in substantial accordance with the overall Remedial Work Plan approved by the New York State Department of Environmental Conservation (the Department) on March 30, 2010 for the Brownfield Cleanup Program (BCP) Buell Automatics Site #C828114, located at 381 Buell Road, City of Rochester, Monroe County, New York (Site). The location of the Site is shown on the attached Site Location Map (Figure 1).

The planned EISB program will address residual contamination by chlorinated volatile organic compounds (VOCs), specifically tetrachloroethene (PCE), trichloroethene (TCE), the daughter products cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC), and 1,1,1-trichloroethane (TCA), which has been identified by groundwater monitoring performed at the site. A summary of previous groundwater monitoring results is presented in attached Table 1. The EISB program will involve application and injection of a carbohydrate substrate in the proposed treatment areas west and southwest of the building to promote the activity of indigenous bacteria which use the contaminant compounds in metabolism and thereby cause the compounds to break down. Groundwater sampling and analyses will be performed to establish baseline site conditions prior to implementation of the EISB program and monitor performance of the EISB process following the injection of the EISB treatment mixture.

# 2.0 SUMMARY OF REMEDIAL INVESTIGATION FINDINGS

## 2.1 SITE GEOLOGY AND HYDROGEOLOGY

The underlying subsurface geology of the Site is characterized by proglacial lake sediments and glacial till underlain by Paleozoic sedimentary rocks of the Lockport Dolomite Formation.

The thickness of individual overburden units varies across the Site. Granular fill material is the uppermost overburden unit. Fill thickness measured at RI test borings ranged from 0.0 to 3.0 ft. and averaged 1.6 ft. across the Site. Typical fill material is asphalt road base, and consists of dry to moist, gray coarse to fine sand and gravel, with some silt.

Site fill is underlain by a sequence of lacustrine sediments. The uppermost unit consists of brown silty fine sand interbedded with denser varved silt and clayey silt seams. The uppermost unit ranges in thickness from 0.4 to 19.2 ft. and averaging 6.4 ft. across the Site. Several remedial investigation test borings indicated that the upper unit is underlain by a few to several feet of lacustrine silty clay or clayey silt beds. Thin lacustrine sand intervals were on occasion found within the upper few feet of the silty clay or clayey silt beds, and were often found to underlie the silty clay or clayey silt beds.

The lacustrine units are underlain by dense gray glacial till. Where it was encountered, the depth to the top of the till ranged from 11 to 29 feet below ground surface (bgs). Bedrock was encountered in one (the deepest) site boring at a depth of 37.3 ft. bgs.

The surficial geology provides for a low permeability hydrogeologic setting characterized by a shallow water table. Unconfined water table conditions exist within the shallow lacustrine silty fine sand unit, and generally speaking, the water table at the Site was found to be within 5 feet of ground surface. Groundwater elevation monitoring results indicate that the direction of groundwater flow in the surficial deposits is generally to the south-southwest.

## 2.2 NATURE AND EXTENT OF CONTAMINATION

The RI indicates that there are three source areas of subsurface contamination at the Site: the Former Trench Drain Area (FTDA), the Former Loading Dock Area (FLDA) and the Petroleum Impacts Area. EISB will be used to address the impacts from TCE and TCA and related chlorinated VOCs in the FTDA and FLDA. The FTDA includes an area inside the southwest portion of Buell's manufacturing building and the adjacent area located outside the south wall of the building, and the FLDA is located outside the west end of the facility (Figure 1).

In both the FTDA and the FLDA, TCE and other chlorinated VOCs were documented to be present in soil at concentrations above the Department's soil cleanup objectives (SCOs) for protection of groundwater (POGW). In one soil sample interval in the FLDA (test boring B-23, sample depth of 1 to 2 ft. bgs), TCE was detected at a concentration that exceeded the Department's SCOs for protection of public health at sites restricted to industrial uses, but otherwise detected VOCs were below SCOs for industrial use sites. Groundwater in the FTDA and FLDA and down-gradient groundwater in adjacent areas to the southwest have been impacted by chlorinated VOCs. Chlorinated VOCs were also detected off-Site in soil vapor beneath the aScribe Laser Building. The eastern end of the aScribe Laser Building is located at the western edge of an area where groundwater contamination has been detected west of the FLDA.

Table 1 and Figures 2, 3, 4, and 5 summarize the exceedances of NYSDEC's TOGS 1.1.1 groundwater quality standards observed in groundwater monitoring events from 2006 to 2014. Groundwater monitoring events from 2011 to 2014 have shown that VOC concentrations have generally decreased in wells down gradient from the FLDA and FTDA. The principal exception is monitoring well MW-8, where concentrations of chlorinated VOCs decreased from 2006 to July 2012 but began to increase in November 2012 and by July 2013 had increased by three orders of magnitude for TCE and two orders of magnitude for cis-1,2-DCE. A decrease in the levels of both contaminants was observed, however, in the most recent sampling event (November 2014.)

# 3.0 REMEDIATION TECHNOLOGY DESCRIPTION

Reductive dechlorination is an anaerobic biological process whereby naturally-occurring microorganisms degrade chlorinated compounds like PCE and TCE. The process serves as the major metabolic pathway used for natural attenuation of chlorinated solvents. Contaminant degradation is dependent on the presence of the appropriate microorganisms, nutrients, and energy sources. The biochemical transformation of contaminants is the result of enzymes produced by the microorganisms that act as catalysts for the degradation reactions. The overall contaminant reduction mechanisms are greatly influenced by the interrelationship between several microorganisms and a series of chemical reactions that occur within the subsurface environment.

The major driving force for biodegradation involves the transfer of energy in the form of electrons. Consequently, successful applications require both an electron donor and an electron acceptor. During reductive dechlorination, the chlorinated hydrocarbon acts as an electron acceptor, therefore requiring an electron donor for the reaction to proceed.

Hydrocarbon compounds such as organic acids are used as an electron donor. These compounds undergo degradation via a variety of cleavage, hydrolysis, oxidation/reduction, dehydrogenation, and/or substitution reactions which lead to the production of hydrogen and electrons. The resulting energy is then used to replace chlorine with hydrogen through reductive reactions such as hydrogenolysis or dihaloelimination. The following reaction shows the reduction of TCE to cis-1,2-DCE.

$$C_2HCl_3 + H^+ + 2e \rightarrow C_2H_2Cl_2 + Cl^-$$

In anaerobic environments, complete degradation of chlorinated VOC contaminants typically occurs as a result of the interactions between several specialized microorganisms. These reactions are biologically driven and will proceed only if the indigenous bacteria in the aquifer are capable of producing the desired biochemical reactions. Bacteria such as *dehalospirillum multivorans*, *dehalobacter restrictus, defulfitobecterium, clostricium bifermentans, desulfuromonas, dehalococcoides ethenogenes* and others are responsible for the degradation of chlorinated solvents in subsurface environments. *Dehalococcoides* bacteria are responsible for the complete dechlorination of cis-1,2-DCE, and in its absence, the overall reductive dechlorination process stalls with the production of this compound. Optimal geochemical conditions for the EISB process include dissolved oxygen (DO) levels of less than 2 milligrams per liter (mg/L) and a negative oxidation/reduction potential (ORP), measured in millivolts (mV).

Selection of the proper electron donor is dependent on the physical properties of the contaminants, the geology of the subsurface, and the estimated clean-up timeframes. The complexity and solubility of the proposed carbon source needs to be accounted for when evaluating contact limitation and availability issues. Many studies and projects have been completed using carbon sources ranging from simple sugars to more complex food oils and polysaccharides like guar gum. Less complex electron donors such as sucrose, acetate and lactate are advantageous because of their high solubility and low molecular weight. These compounds readily dissolve in the groundwater and are quickly accessible as a food source for indigenous microorganisms, thus minimizing acclimation periods. The use of these less complex compounds can quickly convert the subsurface into a reductive state where dechlorination processes can readily occur. This provides the jump-start to the biodegradation process that is often lacking with slow-release, higher molecular weight compounds. However, they are shorter lived than more complex compounds.

# 4.0 BENCH-SCALE TREATABILITY TESTING

Stantec's Treatability Testing Services Group conducted a bench-scale treatability test in 2008 to evaluate the use of various electron donors in mixed systems of native Site soil and groundwater to evaluate the effectiveness of electron donor additions for increasing biodegradation rates of chlorinated compounds. A copy of Stantec's March 13, 2009 report (Treatability Testing Report, Oxidative and Reductive Treatment Technologies for Chlorinated Compounds in Soil and Groundwater) is presented in Appendix A.

The bench-scale testing was conducted using soil and ground water samples collected from the FTDA. The presence of TCE, along with daughter products cis-1,2-DCE and VC, in groundwater samples collected during the RI indicates a population of *dehalococcoides* bacteria exists at the Site. This was confirmed by the results of groundwater analyses performed by SiREM Laboratories, Inc. (SiREM), using the method of polymerase chain reaction (PCR) to detect specific target sequences of DNA unique to the 16s rRNA gene of *dehaloccoides* bacteria, on the groundwater sample collected from MW-2, located in the FTDA.

Three different electron donor solutions were evaluated during the EISB treatability testing performed by Stantec. These included sodium acetate, sodium lactate, and a mixture of organic acids. The organic acid mixture was prepared by fermentation of a solution of guar gum and sucrose. During the 127-day testing timeframe, sodium lactate and sodium acetate failed to successfully provide complete destruction of the contaminants of concern at the Site. The organic acid mixture, however, provided complete destruction of the chlorinated alkene compounds of concern, and during the process produced the least amount of vinyl chloride of the three substrates tested. The organic acid mixture also produced an 86% reduction in 1,1,1-TCA levels. Based on the results of the bench-scale treatability testing, the EISB process can successfully stimulate indigenous bacteria populations to degrade the chlorinated VOCs of concern at the Site, without the need for bioaugmentation (injection of additional bacteria using commercially-available bacteria inoculums).

# 5.0 DESIGN ASSUMPTIONS

The results of the treatability testing conducted by Stantec indicate the application of a remediation program employing EISB appears to be a viable technology option for addressing chlorinated solvent impacts of the groundwater and saturated soils at the Site. The following assumptions have been used to support the basis of design for the source area treatment using EISB:

- TCE is the primary contaminant identified, along with its daughter products cis-1,2-DCE and VC, in the groundwater. 1,1,1-TCA and its daughter products have also been detected during subsurface investigations and monitoring;
- Two residual source areas of soil and groundwater chlorinated VOC impacts, requiring treatment, have been identified at the site. These areas include the FLDA and FTDA;
- The soil in the source areas consists of a fine to medium silty sand extending to approximately 20 feet bgs underlain by silty clay and glacial till;
- The EISB process will be applied to address the saturated interval within the silty sand soils;
- The groundwater flow is to the south-southwest in the proposed treatment area;
- The depth to groundwater ranges between approximately 1 to 5 feet bgs in the treatment areas, with the exception of MW-16, where depth to water is generally less than 1 ft. bgs;
- EISB operations will be conducted using a mixture of organic acids as the electron donor solution. The electron donor solution will be prepared through fermentation of a complex polysaccharide and simple sugar in order to provide both a short-term electron source to jump start the EISB process and a long-term source for a sustained treatment timeframe;

## 5.1 ELECTRON DONOR

The bench-scale treatability testing was conducted using fermentation of a guar gum (galactomannan polysaccharide) and sucrose mixture to produce the organic acid solution which was shown to promote the highest degree of contaminant reduction of the substrates tested and which provided both simple and complex electron donors. In the interim since the bench scale testing was performed and the Remedial Work Plan (RWP) for the Buell site was submitted to NYSDEC, intense demand for guar gum from the natural gas industry for use in hydraulic fracturing has severely limited the availability and greatly increased the cost of the Revert ™ guar gum product that had been specified in the RWP as the material to be used in the EISB program. This condition was brought to the attention of NYSDEC in Stantec’s email correspondence dated September 24, 2014. An alternative guar gum product (Variflo® QD) was identified, and the technical product sheet and Material Safety Data Sheet (MSDS) for the alternative product, copies of which are presented in Appendix B, were submitted for NYSDEC's review and approval.

When a carbohydrate is used as an electron donor for biostimulation of indigenous bacteria, the solution will undergo a series of reactions within the subsurface following injection, whereby the initial carbohydrate is oxidized to alcohols, then aldehydes, and finally organic or fatty acids. The proposed remedy will dissolve Variflo® QD and sucrose and allow initial fermentation reactions to occur prior to producing a mixture of end products as the substrate is further oxidized. The end products will depend on the type of microorganisms present during solution preparation, but will likely include a mixture of acids (propionic, formic, acetic, lactic, butyric, etc.), alcohols (ethanol, butanol, isopropanol), and gases (hydrogen, carbon dioxide, and methane).

# 6.0 REMEDIAL ACTIVITY WORK SCOPE

In order to provide a comprehensive, efficient, and cost-effective application of the EISB technology at the Site, remediation activities will be conducted in a phased approach. The work tasks to be completed include the following:

- Project preparation and permitting;
- Excavation of contaminated soil in the FLDA and application of electron donor in the completed excavation prior to backfilling in accordance with the Work Plan for Remedial Excavation, Former Loading Dock Area approved by the Department on July 24, 2013;
- EISB baseline (pre-injection) groundwater sampling event;
- Evaluation of EISB baseline event results to determine whether adjustments to the injection program design are needed;
- Installation of injection wells;
- Injection of electron donor solution in the FTDA and its downgradient plume; and
- Post-treatment monitoring.

The work will be performed in accordance with a Health and Safety Plan (HASP) and Community Air Monitoring Plan (CAMP) included herein as Appendices C and D. Each phase of the proposed EISB program is discussed in greater detail below.

## 6.1 PROJECT PREPARATION AND PERMITTING

During this phase of operations the following work will be completed:

- Detailed design of the electron donor application systems;
- Procurement of equipment and materials;
- Scheduling and coordination activities; and
- Acquisition of all required permits.

The full-scale EISB remediation activities to be conducted in the FTDA will involve the injection of an electron donor solution into the subsurface to enhance in-situ biodegradation. Injection of treatment solutions into the groundwater for remedial purposes is permitted by rule under 40 CFR §144 since it involves a beneficial use, Class V, underground injection control (UIC) well for aquifer remediation (classified as a category 5X26 well in EPA 570/9-87-006). However, there are inventory reporting requirements as described in 40 CFR §144.83.

New York is a direct implementation state so USEPA is in charge of the Class V UIC program in New York. The inventory reporting requirements to USEPA can therefore be satisfied by submitting a completed Office of Management and Budget No. 2040-0042 form to the UIC Program Director in USEPA Region 2. This form may be submitted before or after installation of the Class V UIC wells. If it is submitted after well installation, there may be a requirement to wait 90 days prior to performing any injection activities, although the UIC Program Director can authorize an earlier injection. NYSDEC will be copied on all project-related correspondence with the USEPA.

The State of New York does not have primacy over the UIC program, but the Department and/or local regulatory agencies may also require notification or additional permitting requirements prior to injection of solutions into the ground. All permitting requirements will be determined and accounted for prior to initiating injection activities.

## 6.2 FLDA ELECTRON DONOR APPLICATION

Implementation of remedial excavation activities to address chlorinated VOC contamination identified in the FLDA, which spans the paved outdoor area between the western end of the southern portion of the Buell building and the western boundary of the Site, began on September 29, 2014. Following in-place abandonment of existing wells MW-10 and MW-16, an 1,650 square-foot excavation of varying depths was completed in the FLDA during the period from September 29th through October 9th.

Approximately 723 tons of contaminated soil was removed, placed in stockpiles, tested and disposed of off-site. The Variflo® QD guar gum product (175 pounds) and sucrose (30 pounds) were applied in the bottom and along the sidewalls of the completed excavation as part of the remedial measure to promote EISB activity. The direct application of the electron donor material in the completed excavation should preclude the need for any additional injection of organic acid solution in the FLDA during the initial injection. Additional injection of organic acid solution in the FLDA may be necessary in the future.

Replacements for FLDA monitoring wells MW-10 and MW-16 were installed on October 29th.

## 6.3 EISB BASELINE GROUNDWATER MONITORING EVENT

Prior to initiating electron donor injection operations, baseline geochemical conditions were determined by collecting groundwater samples from existing monitoring wells within the identified EISB treatment areas. Sampling was performed from November 12th through 14th, 2014. The monitoring event included measurement of water levels in all site wells and collection of samples from the following wells:

- monitoring wells MW-2, MW-6, MW-7, MW-8 and MW-11, all located downgradient of the FTDA;
- FLDA replacement monitoring wells MW-10R and MW-16R; and
- monitoring wells MW-9, MW-14 and MW-15, located downgradient of the FLDA.

Sampling of FTDA well RW-2 had also been planned; however, groundwater was not present during the sampling event in either of the two wells (RW-1 and RW-2) located inside the FTDA, and both wells were dry when re-checked on December 3rd.

Wells were purged and samples were collected using low-flow/low-stress sampling procedures in accordance with the Interim Site Management Plan for the Buell site.

The following time-dependent field parameters were monitored with field instrumentation during the purging and sampling of all wells sampled: pH, ORP, temperature, DO, and conductivity. Ferrous iron was also measured in the field at MW-2, MW-6, MW-8, MW-11, and MW-16R.

Samples were submitted to Paradigm Environmental Services of Rochester, New York (Paradigm) for laboratory analysis of VOC contaminants and aquifer geochemistry parameters. Analyses were performed for the following parameters on all samples collected:

- VOCs (by USEPA SW846 Method 8260B);
- Total Organic Carbon, (TOC, EPA 415.1);
- $Na^+$ (EPA 6010);
- $Fe^{2+}$ (EPA 6010/7000);
- $Mn^{2+}$ (EPA 6010/7000); and
- As (EPA 6010/7000).

The following additional analyses were performed by Paradigm (or its subcontracted ELAP partners) on the samples from MW-2, MW-6, MW-8, MW-11, and MW-16R:

- $Cl^-$ (EPA 300);
- $NO^{3-}$ (EPA 300);
- $SO_4^{2-}$ (EPA 300);
- Alkalinity (SM 2320 B);
- Methane, ethane and ethene (EPA 8015 B).

Samples from MW-2 and MW-8 in the FTDA were sent to SiREM Laboratories, Inc. (SiREM) in Guelph, Ontario Canada for DNA analysis by PCR for qualitative and quantitative screening for the presence of the *Dehalococcoides* bacteria responsible for the reduction of cis-1,2-DCE to ethene.

Samples from MW-2 and MW-8 were sent to the University of Oklahoma for carbon stable isotope analysis (CSIA) of the ratio of $^{12}$Carbon to $^{13}$Carbon in TCE. TCE molecules with $^{12}C$ are preferentially degraded by microbes, and therefore an enrichment of $^{13}C$ is indicative of biodegradation activity.

Copies of laboratory analysis reports and summaries of water level and field parameter measurement data were provided to the Department under separate cover (in Progress Report #48). The following summaries of the results of the monitoring event and relevant previous data are attached to this Work Plan:

- A summary of field parameter measurements and laboratory analysis results is presented in Table 1, which also summarizes data from previous monitoring events from 2006 through 2014.

- A partial site plan showing the locations of the wells sampled and summarizing exceedances of NYSDEC's groundwater quality standards for VOCs detected in samples from wells in the proposed EISB treatment areas is presented in Figure 2.

- Graphs showing contaminant concentration trends at wells MW-2, -8, and -11 are presented in Figures 3, 4 and 5, respectively.

- Groundwater elevation contour plans for the last four groundwater monitoring events performed at the site (February 2013 through November 2014) are presented in Figures 6A through 6D.

## 6.4 EVALUATION OF EISB BASELINE MONITORING RESULTS

The water level measurement data presented on Figures 6A through 6D indicate that the direction of groundwater flow from both the FLDA and FTDA source areas is to the south, southwest, or west. These data indicate that the application of the electron donor in the completed FLDA excavation should serve to address the contaminant plume downgradient of the FLDA, and that injection of electron donor in the areas from RW-1 south to MW-8 and west from MW-8 towards MW-11 should serve to address the contaminant plume within and downgradient of the FTDA.

Field and Laboratory Parameters

Anaerobic (low DO) and reducing (negative ORP) conditions favorable to in-situ bioremediation of chlorinated VOCs have been noted relatively consistently over time at FTDA well MW-2 and FLDA well MW-16/16R. Low DO and negative ORP were also observed in FLDA well MW-10R during the November 2014 event. At locations downgradient of both the FTDA and FLDA, anaerobic or reducing conditions have been observed only intermittently, and were for the most part not evident during the November 2014 event.

The pH of groundwater measured during the EISB baseline sampling event ranged from 6.45 to 7.91. This range of pH indicates a favorable environment for bacteria populations necessary for reductive dechlorination, which thrive under neutral pH conditions. Anaerobic biodegradation can lower pH, thus limiting the sustainability of the bacteria populations in the groundwater and stalling the remediation process. The alkalinity of groundwater indicates how well the aquifer can buffer changes in pH. Analysis of samples from treatment area wells indicates that the aquifer is sufficiently alkaline to buffer pH changes resulting from the degradation process.

Ethane and ethene detected in samples from MW-8 and MW-16R, and to a lesser extent in the sample from MW-11, are indications that the breakdown of chlorinated ethanes and ethenes has occurred.

PCR analysis identified the presence of *dehalococcoides* bacteria at MW-2 and expression in the *dehalococcoides* population at MW-2 of the vcrA gene for the vinyl chloride reductase enzyme necessary for reduction of vinyl chloride to ethene. A significant *dehalococcoides* population was not detected in the sample from MW-8.

The CSIA results are reported as $\delta^{13}C$ (Carbon$^{13}$ delta) in parts per thousand (per mil, ‰):

$$\delta^{13}C = \left( \frac{\left(\frac{^{13}C}{^{12}C}\right)_{sample}}{\left(\frac{^{13}C}{^{12}C}\right)_{standard}} - 1 \right) \times 1000\ ‰$$

The standard is an established reference material, which in the case of the analyses performed by the University of Oklahoma laboratory was the Vienna Pee Dee Belemnite (VPDB).

The $\delta^{13}C$ in TCE can be used to assess bioremediation activity independently of the concentration of contaminant present. The more positive the $\delta^{13}C$ value, the more biodegradation of the target compound has occurred. The CSIA results from the EISB baseline event indicate that more biodegradation of TCE has occurred at MW-2 ($\delta^{13}C$ = -10.0‰) than at MW-8 ($\delta^{13}C$ = -31.1‰).

The relative concentrations of the individual chlorinated compounds detected in samples from MW-2 and MW-8 are consistent with the DNA and CSIA results and the DO and ORP measurements for these two wells. Time-series plots of concentrations of the individual VOCs detected in samples from MW-2, MW-8 and MW-11 are presented in Figures 3, 4 and 5. As the plots show, at MW-8, where conditions appear to have been less amenable to reductive dechlorination, TCE is present at higher concentrations than the concentrations of its daughter products. Daughter products have predominated at MW-2 and MW-11.

In summary, the analytical results from the EISB baseline event confirm that the planned introduction of an electron donor is likely to produce geochemical conditions which will enhance in-situ biodegradation processes in the FTDA and FLDA contaminant plume areas.

## 6.5 FTDA INJECTION PROGRAM

The Remedial Work Plan proposed employing a groundwater recirculation system for subsurface injection of carbon substrate and/or electron donor. This system was to use a network of EISB program injection and extraction wells, mixing and holding tanks, associated pumps and piping, and the testing necessary to achieve design concentrations of electron donor and other parameters in the subsurface. A recirculation loop would be established by installing down-gradient wells (south of MW-6) to collect groundwater and then injecting up-gradient in the source area after adding the electron donor solution. However, for the following reasons, a recirculation approach is no longer considered a practicable or viable option for the site:

1. In order for the natural bacteria to breakdown the chlorinated solvents in the groundwater, anaerobic reducing conditions are desired. A recirculation system would induce groundwater mixing which would oxygenate the groundwater, delaying onset of or disrupting enhancement of existing anaerobic reducing conditions required for EISB to proceed to completion.

2. Recirculation is typically applied for higher permeability, sandy soils where greater groundwater recovery rates and uniform distribution of injected fluids can occur. We now consider recirculation to be less well suited to the site geology (a lower permeability silty sand unit with interbedded seams and layers of silty clay and lenses of glacial till) than a closely-spaced grid of injection wells.

3. The existing chlorinated VOC groundwater plume extends off-site to the south, but the vast majority of the residual source material remains on site (north of MW-8). A recirculation loop, pumping from south of MW-6, could draw more contamination out of the source area and off-site.

4. A recirculation loop would require installation of larger-diameter groundwater recovery wells and pumps in the parking lot used by the patrons of the Best Western property, directly adjacent to the building. Hoses and piping will be required to convey the recovered groundwater back up to the source area north of MW-8. A recirculation system would therefore be more disruptive to normal operations on the Best Western property than a direct-injection program.

5. The injection well network and injection program can be designed to adequately distribute the hydrocarbon substrate throughout the depth and breadth of the plume and more effectively promote the required anaerobic, reducing conditions required.

Therefore, instead of employing a groundwater recirculation system, direct injection of the organic acid solution will be used to apply the remedy to the site. This approach is similar to the direct injection approach successfully employed by us at other BCP sites with chlorinated solvent impacts in NYSDEC Region 8.

### 6.5.1 Pre-Existing Wells to be used for Injection

To address the impacted area beneath the building, two existing remediation wells (RW-1 and RW-2) will be used. Existing monitoring wells, MW-2, MW-6, MW-8 and MW-11 will be used to inject the organic acid mixture into the downgradient plume area.

### 6.5.2 Injection Well Installation

Twenty injection wells will be installed within the plume downgradient of MW-2 and upgradient of MW-11. Proposed locations are shown on Figure 7. The injection wells will be installed at an approximate 20-foot spacing using auger drilling methods. Each well will be constructed of 2-inch Schedule 40 PVC pipe with a 15-foot interval of 0.020-inch slotted well screen from 4 feet bgs to 19 feet bgs. The annular space will be filled with filter sand to approximately 6 inches above the screen interval and then sealed to ground surface with a bentonite/grout mixture. Soil cuttings will be containerized, sampled for waste characterization and managed accordingly for appropriate offsite disposal.

### 6.5.3 Electron Donor Solution Preparation

A solution of organic acids prepared by the fermentation of sucrose and the Variflo® QD guar gum product will be utilized during EISB operations to provide the simultaneous benefits of both simple and complex electron donor solutions. The organic acid solution planned contains approximately 2.5% organics by weight. An initial 1,200-gallon stock organic acid solution will be prepared in an above-ground mixing tank to allow the initial fermentation reactions to occur prior to injection.

The stock organic acid solution will be prepared by dissolving 150 pounds of Variflo® QD guar gum and 50 pounds of sucrose in 1,190 gallons of water to be provided from the facility's potable water supply. The solution will be allowed to undergo fermentation for a period of 1 to 2 weeks, until the pH of the solution is measured to be between 3 and 5. Sufficient sodium carbonate (soda ash) will then be added to raise the stock solution pH to between 7 and 8, prior to initiating preparation of injection batches.

If necessary (depending on the timing of the activities), the stock solution tank (or tanks) will be placed indoors or otherwise set up and equipped to avoid the potential for freezing. Space constraints inside the Buell facility will not allow for staging the stock solution in a single tank, and therefore for indoor staging four 300-gallon plastic totes will be used. The totes will be staged in the scrap metal chip room located at the northwest corner of the southern section of the building. Alternatively, for outdoor staging during cold weather a single tank equipped with a heating system may be used. The capacity of a single tank staged outdoors, whether during cold months or not, would be approximately 1,500 gallons.

Some off-gas comprised mainly of carbon dioxide will be generated by the fermentation process. The off-gas does not represent a health risk, but pressure build-up in a sealed tank could represent a safety risk. Localized nuisance odors associated with the fermented end product will also be an issue in the immediate vicinity of the tank or totes. Therefore, if placed indoors, the totes will be vented using pipe and/or hose to convey vapors outside. If placed outdoors, the lid of the tank will be kept loose to allow the escape of any vapors and prevent pressure build up and the tank will be stored at a location removed from the vicinity of air intakes and windows and doors that may be frequently opened. In either case (either indoor or outdoor storage), twice weekly checks of the tanks/totes will be performed to confirm that off-gas vent, odor or pressure issues have not arisen. Results of each check will be recorded in a field log book.

### 6.5.4 Injection Program Operations

Bench-scale treatability testing conducted by Stantec identified a mixture of organic acids prepared by the fermentation of a guar gum/sucrose solution as a successful electron donor for stimulating the reductive dechlorination process to treat chlorinated compound impacts at the Site. The testing applied the organic acid mixture at a concentration of 5,000 mg/L to test samples prepared using Site soil and groundwater. The goal of the full-scale injection program will be to achieve a groundwater electron donor concentration of approximately 5,000 mg/L. The following assumptions have been incorporated into the design of the FTDA electron donor injection program.

- 26 injection locations (6 existing and 20 new wells);
- 10-foot radius of influence (ROI) for each injection location;
- 15-foot saturated screen interval for each well;
- 27% soil porosity;
- 0.5 pore volume exchange;
- Injection electron donor solution concentration = 10,000 mg/L; and
- Electron donor stock solution specific gravity = 1.04 g/ml.

The calculations performed, using the above listed assumptions, to determine the injection system design parameters are provided in Appendix E. The basis for the assumptions is provided below.

As part of the remedial investigation completed in 2007, two soil samples were collected from test borings at MW-8 and MW-2 (Deep) and submitted for grain size analysis. The samples were collected from locations within the proposed treatment area and at depths of 10 to 14 ft bgs and 12 to 16 ft bgs, respectively. This analysis indicated that the lithology of the aquifer from 10 to 16 ft bgs consists of predominately sand (approximately 50 to 65%) and silt (approximately 35 to 45%). The typical porosity of sand ranges from 25 to 50% (Freeze and Cherry, 1979). A mixture of grain sizes results in a lower porosity, as the smaller particles (in this case, silt) fill in around the larger particles (Fetter, 2001). Due to the mixture of sand and silt that makes up the aquifer in the treatment area a value on the lower end of the range of porosities for sand, was selected as representative for the aquifer.

The targeting of a 10-foot radius of influence (ROI) around each injection well is a conservative estimate based on Stantec's experience performing EISB and other remediation programs involving subsurface fluid injection over many years at several sites with similar soil characteristics. It has been observed, for silty sand soils, that the most universal distribution of electron donor solution occurs within this ROI. The goal of the full-scale injection program will be to achieve groundwater electron donor concentrations of approximately 5,000 mg/L, as applied during the bench-scale treatability testing conducted by Stantec. To reduce proposed injection volumes and application timeframes to manageable levels, a 0.5 pore volume exchange will be targeted with an electron donor solution that is twice the concentration of the end goal for the process. These estimates, coupled with the proposed 20-foot injection well spacing, result in a design that should adequately deliver substrate to the proposed FTDA treatment zone.

The electron donor solution will be prepared and injected in a batch process using water obtained from the facility's potable water supply. The water will be pumped into a 1,500-gallon poly tank equipped with a submersible pump and sufficient stock organic acid solution (~14.4 gallons) added to provide an approximate stock solution concentration of 10,000 mg/L in the injection initial injection batch. If necessary (if necessitated by slow uptake of the injection solution at the initial locations), subsequent batch concentrations will be increased in response to field conditions.

A submersible pump in the tank will be connected to a valved distribution manifold equipped with in-line flowmeters to regulate injection flow. The injection plumbing will be configured to utilize a 1-inch hose with Camlock fittings to connect the injection hose to the individual injection wells. The system will be capable of injecting into multiple wells simultaneously. A process schematic of the planned injection system is provided in Figure 9.

Based on the targeted design parameters, approximately 4,760 gallons of 10,000 mg/L organic acid solution will need to be injected into each injection well location to achieve the desired 0.5 pore volume exchange. Therefore, the total volume of electron donor solution to be injected within the identified FTDA treatment area is calculated to be approximately 123,708 gallons. The volume estimate will be less if the injection solution concentration is increased to address field conditions. The total mass of organic acid mixture to be introduced to the subsurface for EISB purposes during injection activities will be approximately 10,322 pounds (approximately 397 pounds per well).

Electron donor injection activities will be conducted at a controlled rate. System injection pressures and flow rates will be monitored at the system distribution manifold (PI-100 and FQI-100 in Figure 9). In order to minimize the potential for short circuiting of injected fluids to the surface at the individual well locations, monitoring will be conducted to ensure that a well back-pressure less than 15 pounds per square inch (psi) is maintained. All monitoring data collected during injection activities will be recorded on the daily field log sheets.

## 6.6 POST-INJECTION MONITORING

Upon completing the electron donor injection, a post-injection monitoring program will be initiated to evaluate the effectiveness of the treatment. Monitoring wells will be purged and sampled in accordance with Section 5.1.1 of the document entitled *Quality Assurance Project Plan, Remedy Implementation, Buell Automatics Site, BCP Site #C828114, 381 Buell Road, Rochester, New York* dated February 10, 2011, as updated and approved by NYSDEC. The following parameters will be monitored at existing monitoring wells within the proposed treatment areas on a monthly basis for the first three months after the injection operations are completed and on a quarterly basis for a period of two years:

- pH (field measurement)
- ORP (field measurement)
- Conductivity (field measurement)
- Temperature (field measurement)
- DO (field measurement)
- VOCs (EPA 8260B)
- TOC (EPA 415.1)
- $Fe^{2+}$ (EPA 6010/7000)
- $Mn^{2+}$ (EPA 6010/7000)
- As (EPA 6010/7000)

The wells to be sampled include:

- MW-2;
- RW-2;
- MW-6;
- MW-7;
- MW-8;
- MW-11;
- MW-14;

- MW-15; and
- MW-16R.

In addition to the parameters described above, during the sampling events to be performed 3 months, 6 months, and 1 year after electron donor injection operations are completed, samples of groundwater will be collected from 2 selected wells (wells to be determined at the time of each event) for CSIA of $\delta^{13}C$ in TCE and analysis of *dehalococcoides* and the VC reductase gene.

After the two years of quarterly sampling, groundwater samples will be collected semi-annually unless an alternate sampling frequency is specified in a NYSDEC-approved Site Management Plan (SMP) or Interim SMP. The semi-annual groundwater sampling events will occur during periods of typical seasonal high and seasonal low groundwater elevations.

All samples collected as part of the EISB remediation activities will be screened on-site or sent for off-site laboratory analyses. Analytes, methods, sample container, preservative, and holding times are listed in Table 2 below.

**Table 2 - Analytical Method Summary**

| Analyte(s) | Method | Sample Container | Preservative | Holding Time |
|---|---|---|---|---|
| Temperature | Field | None | None | - |
| Conductivity | Field | None | None | - |
| pH | Field | None | None | - |
| DO | Field | None | None | - |
| ORP | Field | None | None | - |
| VOCs | EPA 8260B | 3 - 40 mL glass vials | HCl, keep cool[1] | 14 days |
| TOC | EPA 415.1 | 1-250 mL amber bottle | Keep cool[1], $H_2SO_4$ | 28 days |
| Mn, Fe, As | EPA 6010/7000 | 1- 1L HDPE bottle | $HNO_3$ to pH < 2 (lab) | 6 months |
| *Dehalococcoides* and VC reductase | PCR | 1 – 1L HDPE bottle | Keep cool[1] | 14 days |
| CSIA | IRMS | 3 – 40 mL glass vials | HCl, keep cool[1] | - |

Notes:

[1] Keep cool at 4° C

## 6.7 DATA MANAGEMENT

Analyses for most EISB process parameters will be performed by an ELAP laboratory. Parameters measured in the field rather than off-site will include pH, ORP, conductivity, DO, and temperature. The results for these parameters will be recorded on field log sheets. Analyses for *dehalococcoides* and VC reductase will be performed by SiREM Laboratories, Inc. CSIA for $\delta^{13}C$ of TCE will be performed by the University of Oklahoma. Original analytical reports will be included as appendices to submitted EISB progress reports. All data will be submitted as an electronic data deliverable (EDD) in a format acceptable to NYSDEC within 90 days of receipt by Stantec.

## 6.8 EVALUATION AND REPORTING OF RESULTS

Stantec will prepare a post-injection summary detailing the methodologies, activities, and results obtained during implementation of the EISB technology at the Buell Site. The initial report will cover electron donor injection activities. Subsequent reports will address the post-treatment groundwater sampling results. The post-injection report will be a Construction Completion Report (CCR) prepared in accordance with DER-10. Groundwater data collected subsequent to completion of the CCR will be included in the monthly progress reports or as otherwise specified in a NYSDEC-approved SMP or Interim SMP.

# 7.0 CONTINGENCY RECOGNITION AND RESPONSE

## 7.1 MULTIPLE INJECTION EVENTS OR ADDITIONAL REMEDIAL MEASURES

Initially one donor injection event is proposed for the EISB remediation program. The results of the post-injection groundwater monitoring will be evaluated to determine if, where, or when injection activities may need to be repeated. Additional injection events would be completed, if necessary, based on an evaluation of the monitoring results and discussion with the Department.

## 7.2 METALS RELEASE

When anaerobic reducing conditions are created in the subsurface, the potential for metals to reduce and dissolve into groundwater arises. The primary metals that dissolve under reducing conditions are iron and manganese. Bench-scale testing showed that these two constituents could exceed secondary drinking water standards established for purposes of color and taste in water. However, the concentrations did not exceed typical risk-based values applied to human consumption, and it should be noted that Site groundwater is not currently used and that future use will be prohibited.

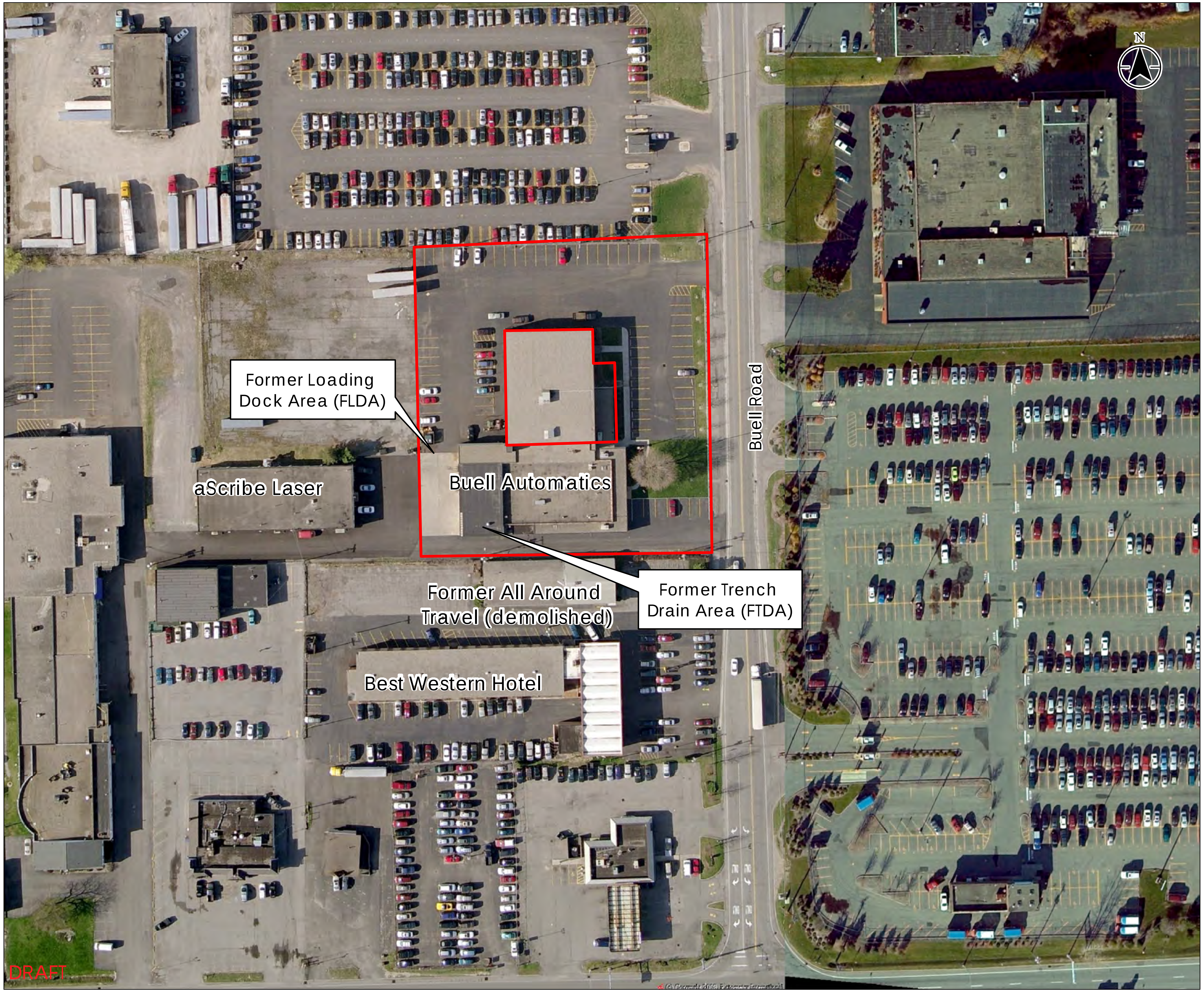
During bench-scale testing, increases in dissolved-phase arsenic concentrations were observed for the microcosm samples amended with organic acids during the testing timeframe. However, the potential for increases in arsenic levels during the full-scale EISB application will require monitoring.

As reducing conditions are established in the EISB treatment area, concentrations of iron, manganese and arsenic are anticipated to temporarily increase since these metals are known to dissolve under reducing conditions. Typically, dissolved metal concentrations are proportional to TOC concentrations and while initial increases may be observed following electron donor addition, the metal concentrations begin to decline as TOC degradation occurs. The potential need for pH adjustment will be evaluated following VOC treatment.

# 8.0 SCHEDULE

The EISB baseline sampling event was performed in November 2014. It is proposed that injection wells be installed in December or early January 2015, followed by the injection program. Three monthly groundwater sampling events will follow completion of the injection event, followed by quarterly sampling for the balance of two years. The CCR will be submitted to the Department within one month of receipt of the laboratory results from the third of the first three monthly post-injection groundwater monitoring events (after completion of the first quarter of post-injection monitoring). The timing of a second injection event, if needed, will be discussed with the Department.

# Figures



## Legend

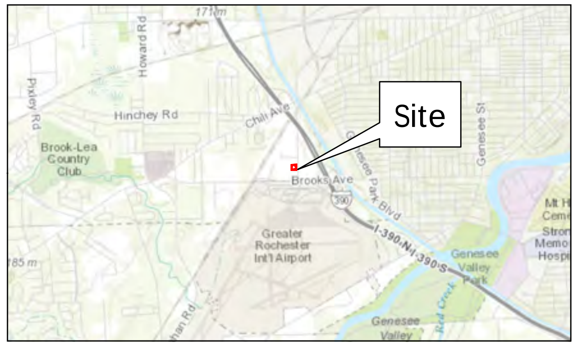
🟥 Buell BCA Boundaries

0 80 160 Feet

1:1,200 (At Original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 StatePlane New York West FIPS 3103 Feet



Project Location:
Buell Road
Rochester, NY

Prepared by AG on 2014-09-29
Technical Review by MPS on 2014-12-10
Independent Review by mmm on 2014-xx-xx

190500033

Client/Project
Buell Automatics
Brownfield Cleanup Program
EISB Work Plan

Figure No.
1

Title

# Site Location Map

U:\16059\GIS\EISB WP\Figure 1 - Site Location.mxd Revised: 2014-12-12 By: aglose

| Sample Location | | | MW-16 | | | | | | | | | | | MW-16R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | 1-May-06 | 15-Sep-06 | 5-Aug-11 | 2-Nov-11 | 9-Mar-12 | 3-May-12 | 26-Jul-12 | 16-Nov-12 | 21-Feb-13 | 8-Jul-13 | 20-Mar-14 | 14-Nov-14 |
| VOCs | Units | TOGS | Values | | | | | | | | | | | |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 8200$^{B}$ | 15000$^{B}$ | | | 737$^{B}$ | 610$^{B}$ | 133$^{B}$ | 83.1$^{B}$ | 50$^{B}$ | | | 1670 J$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 120000 D$^{B}$ | 150000$^{B}$ | 22900$^{B}$ | 22700$^{B}$ | 12400$^{B}$ | 13900$^{B}$ | 3240$^{B}$ | 3210$^{B}$ | 2900$^{B}$ | 2590$^{B}$ | 1060$^{B}$ | 5070$^{B}$ |
| Vinyl chloride | µg/L | 2$^{B}$ | 640 J$^{B}$ | | 11800$^{B}$ | 6100$^{B}$ | 2430$^{B}$ | 3620$^{B}$ | 230$^{B}$ | 2130$^{B}$ | 1400$^{B}$ | 2140$^{B}$ | 1340$^{B}$ | |
| Trichloroethane, 1,1,1- | µg/L | 5**$^{B}$ | 4000$^{B}$ | 5800$^{B}$ | 1610$^{B}$ | 1540$^{B}$ | 2310$^{B}$ | 2220$^{B}$ | 95.7 J$^{B}$ | 280$^{B}$ | 710$^{B}$ | 421$^{B}$ | 733$^{B}$ | 101$^{B}$ |
| Dichloroethane, 1,1- | µg/L | 5**$^{B}$ | 2800 J$^{B}$ | 3600$^{B}$ | 1800$^{B}$ | 1670$^{B}$ | 1080$^{B}$ | 1310$^{B}$ | 112$^{B}$ | 410$^{B}$ | 350$^{B}$ | 473$^{B}$ | 268$^{B}$ | 181$^{B}$ |
| Dichloroethene, 1,1- | µg/L | 5**$^{B}$ | 780 J$^{B}$ | 1600$^{B}$ | 233$^{B}$ | | 203$^{B}$ | 158 J$^{B}$ | 52.3 J$^{B}$ | 57.2$^{B}$ | 39$^{B}$ | | | |
| Benzene | µg/L | 1$^{B}$ | | | | | | | | | | | | 704$^{B}$ |
| Xylene, m & p- | µg/L | 5**$^{B}$ | | | | | | | | | | 108 J B$^{B}$ | | |
| Acetone | µg/L | 50$^{A}$ | | | | | | 944 J$^{A}$ | 777$^{A}$ | 163 J$^{A}$ | | 653 J$^{A}$ | | |
| Methylene Chloride | µg/L | 5**$^{B}$ | | | | | | | | 77.7 J$^{B}$ | | | | |

| Sample Location | | | MW-10 | MW-10R |
|---|---|---|---|---|
| Sample Date | | | 1-May-06 | 13-Nov-14 |
| VOCs | Units | TOGS | Values | |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 160 J$^{B}$ | 792 J$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 3000$^{B}$ | 3880$^{B}$ |
| Vinyl chloride | µg/L | 2$^{B}$ | 910$^{B}$ | 260$^{B}$ |
| Dichloroethane, 1,1- | µg/L | 5**$^{B}$ | 330$^{B}$ | 137$^{B}$ |

| Sample Location | | | RW-1 |
|---|---|---|---|
| Sample Date | | | 2-May-06 |
| Sample Type | Units | TOGS | Value |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 400$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 4600 D$^{B}$ |
| Dichloroethylene, trans-1,2- | µg/L | 5**$^{B}$ | 27 J$^{B}$ |
| Vinyl chloride | µg/L | 2$^{B}$ | 1200$^{B}$ |
| Dichloroethane, 1,1- | µg/L | 5**$^{B}$ | 250$^{B}$ |

| Sample Location | | | RW-2 |
|---|---|---|---|
| Sample Date | | | 2-May-06 |
| VOCs | Units | TOGS | Value |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 13000$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 27000$^{B}$ |
| Trichloroethane, 1,1,1- | µg/L | 5**$^{B}$ | 230 J$^{B}$ |
| Dichloroethane, 1,1- | µg/L | 5**$^{B}$ | 160 J$^{B}$ |

Stantec

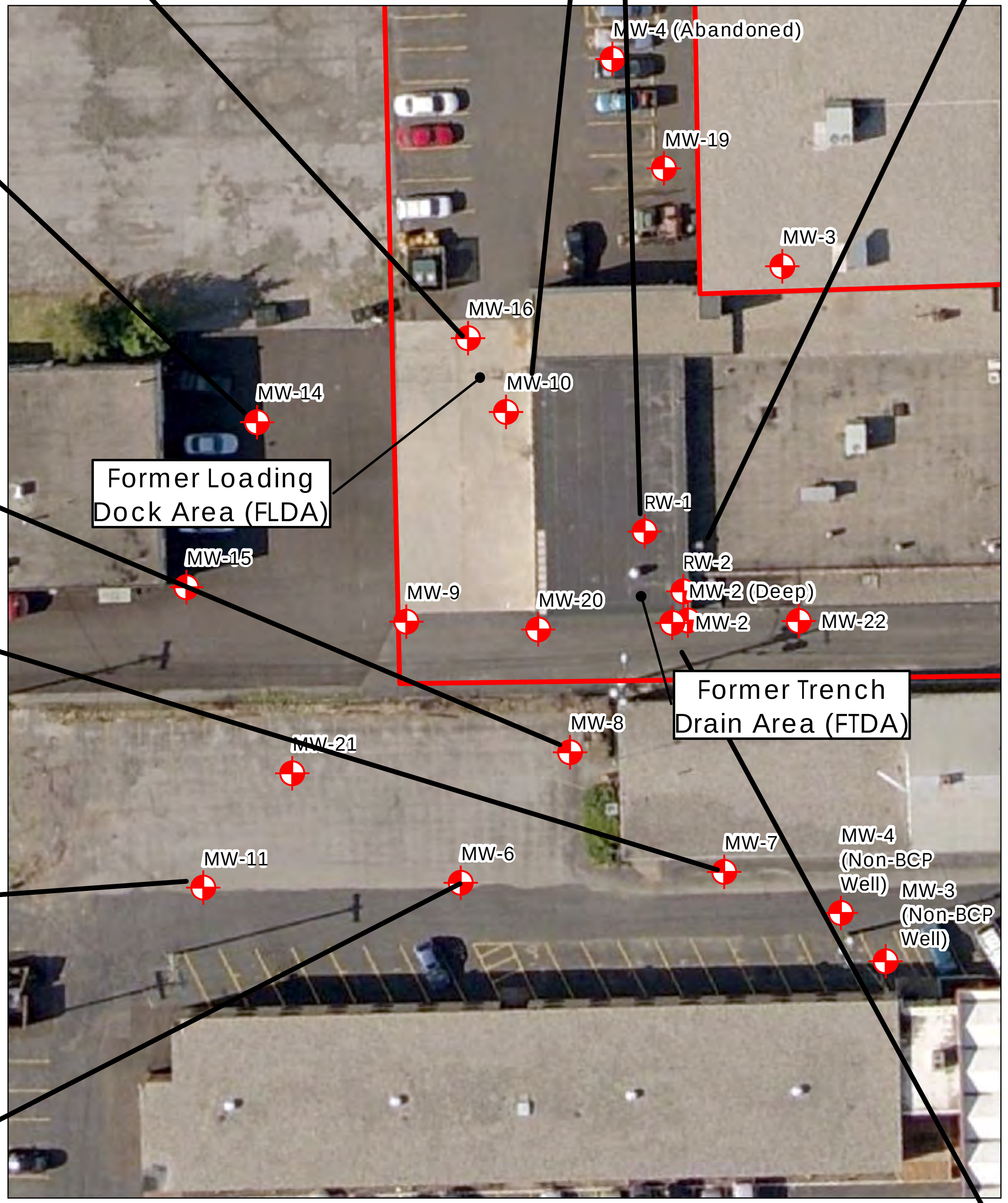
## Legend

Monitoring Wells

- ⌖ Monitoring Wells
- ▭ Buell BCA Boundaries

N

| Sample Location | | | MW-14 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | 2-Aug-11 | 3-Nov-11 | 9-Mar-12 | 3-May-12 | 26-Jul-12 | 16-Nov-12 | 22-Feb-13 | 8-Jul-13 | 20-Mar-14 | 12-Nov-14 |
| VOCs | Units | TOGS | Values | | | | | | | | | |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 14.7$^{B}$ | 7.18$^{B}$ | | | 5.56$^{B}$ | 5.17$^{B}$ | | 6.67$^{B}$ | | 5.62$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 172$^{B}$ | 112$^{B}$ | 41.8$^{B}$ | 40.1$^{B}$ | 54.9$^{B}$ | 53.4$^{B}$ | 32$^{B}$ | 52.4$^{B}$ | 23.2$^{B}$ | 51.4$^{B}$ |
| Vinyl chloride | µg/L | 2$^{B}$ | 15.7$^{B}$ | 6.15$^{B}$ | | | | | | | | |
| Dichloroethane, 1,1- | µg/L | 5**$^{B}$ | 30.0$^{B}$ | 21.9$^{B}$ | 11.1$^{B}$ | 11.3$^{B}$ | 14.1$^{B}$ | 16.1$^{B}$ | 9.1$^{B}$ | 13.6$^{B}$ | 5.71$^{B}$ | 14.6$^{B}$ |



| Notes: | |
|---|---|
| TOGS | NYSDEC TOGS 1.1.1 (Reissued June 1998 with errata in January 1999 and addenda in April 2000 and June 2004) |
| A | TOGS 1.1.1- Table 1- Ambient Water Quality Standards and Guidance Values, Division of Water, Technical and Operational Guidance Series (TOGS 1.1.1); Guidance |
| B | TOGS 1.1.1- Table 1- Ambient Water Quality Standards and Guidance Values, Division of Water, Technical and Operational Guidance Series (TOGS 1.1.1); Standards |
| 6.5$^{A}$ | Concentration exceeds the indicated standard. |
| | Concentration did not exceed standards. |
| D | Indicates reanalysis of sample with additional dilution to address exceedance of instrument calibration range. |
| J | The reported result is an estimated value. |

| Sample Location | | | MW-8 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | 1-May-06 | 3-Aug-11 | 2-Nov-11 | 8-Mar-12 | 2-May-12 | 25-Jul-12 | 16-Nov-12 | 22-Feb-13 | 9-Jul-13 | 20-Mar-14 | 13-Nov-14 |
| VOCs | Units | TOGS | Values | | | | | | | | | | |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 1700$^{B}$ | 449$^{B}$ | 442$^{B}$ | 315$^{B}$ | 150$^{B}$ | 84.0$^{B}$ | 361$^{B}$ | 1100$^{B}$ | 15000$^{B}$ | 18400$^{B}$ | 3970$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 3300$^{B}$ | 241$^{B}$ | 215$^{B}$ | 163$^{B}$ | 91.8$^{B}$ | 86.8$^{B}$ | 192$^{B}$ | 240$^{B}$ | 1990$^{B}$ | 2380$^{B}$ | 611$^{B}$ |
| Vinyl chloride | µg/L | 2$^{B}$ | 150 J$^{B}$ | 22.0$^{B}$ | 18.6$^{B}$ | 12.5$^{B}$ | 4.84$^{B}$ | 5.81$^{B}$ | 12.6$^{B}$ | | | | 24.2$^{B}$ |
| Trichloroethane, 1,1,1- | µg/L | 5**$^{B}$ | | | | | | | | | | | 20.2$^{B}$ |
| Dichloroethane, 1,1- | µg/L | 5**$^{B}$ | 14 J$^{B}$ | | | | | | | | | | |
| Acetone | µg/L | 50$^{A}$ | | | | | | | | 53 J$^{A}$ | 3600 J$^{A}$ | | |

| Sample Location | | | MW-7 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | 1-May-06 | 4-Aug-11 | 2-Nov-11 | 9-Mar-12 | 3-May-12 | 25-Jul-12 | 15-Nov-12 | 22-Feb-13 | 9-Jul-13 | 20-Mar-14 | 12-Nov-14 |
| VOCs | Units | TOGS | Values | | | | | | | | | | |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 10$^{B}$ | 11.8$^{B}$ | 6.84$^{B}$ | 6.35$^{B}$ | 6.45$^{B}$ | 7.43$^{B}$ | | | 6.89$^{B}$ | | 7.73$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 20$^{B}$ | 6.22$^{B}$ | | 5.80$^{B}$ | | 5.39$^{B}$ | 5.67$^{B}$ | | 5.50$^{B}$ | | 6.57$^{B}$ |

| Sample Location | | | MW-11 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | 1-May-06 | 4-Aug-11 | 3-Nov-11 | 8-Mar-12 | 2-May-12 | 25-Jul-12 | 15-Nov-12 | 22-Feb-13 | 9-Jul-13 | 20-Mar-14 | 13-Nov-14 |
| VOCs | Units | TOGS | Values | | | | | | | | | | |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 110$^{B}$ | 33.6$^{B}$ | 10.3$^{B}$ | 14.1$^{B}$ | 8.9$^{B}$ | 10.8$^{B}$ | 14.4$^{B}$ | 27$^{B}$ | 21.5$^{B}$ | 22.0$^{B}$ | 11.3$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 740$^{B}$ | 372$^{B}$ | 78.3$^{B}$ | 131$^{B}$ | 135$^{B}$ | 147$^{B}$ | 140$^{B}$ | 380$^{B}$ | 439$^{B}$ | 546$^{B}$ | 148$^{B}$ |
| Vinyl chloride | µg/L | 2$^{B}$ | 45$^{B}$ | 23.5$^{B}$ | 5.29$^{B}$ | 14.2$^{B}$ | 13.9$^{B}$ | 10.8$^{B}$ | 13.0$^{B}$ | 19 J$^{B}$ | 24.4$^{B}$ | 22.0$^{B}$ | 6.99$^{B}$ |
| Trichloroethane, 1,1,1- | µg/L | 5**$^{B}$ | 21 J$^{B}$ | | | | | | | | | | |
| Dichloroethane, 1,1- | µg/L | 5**$^{B}$ | 87$^{B}$ | 58.2$^{B}$ | 9.64$^{B}$ | 26.4$^{B}$ | 22$^{B}$ | 17.6$^{B}$ | 13.0$^{B}$ | 36$^{B}$ | 27.3$^{B}$ | 36.2$^{B}$ | 10.2$^{B}$ |
| Dichloroethene, 1,1- | µg/L | 5**$^{B}$ | 6 J$^{B}$ | | | | | | | | | | |
| Trichloroethane, 1,1,2- | µg/L | 1$^{B}$ | 2 J$^{B}$ | | | | | | | | | | |

| Sample Location | | | MW-6 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | 1-May-06 | 3-Aug-11 | 2-Nov-11 | 8-Mar-12 | 2-May-12 | 25-Jul-12 | 15-Nov-12 | 9-Jul-13 | 20-Mar-14 | 13-Nov-14 |
| VOCs | Units | TOGS | Values | | | | | | | | | |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 2400$^{B}$ | | | | | | | | | |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 720$^{B}$ | | | | | | | | | |
| Vinyl chloride | µg/L | 2$^{B}$ | 50$^{B}$ | | | | | | | | | |
| Trichloroethane, 1,1,1- | µg/L | 5**$^{B}$ | 25 J$^{B}$ | | | | | | | | | |

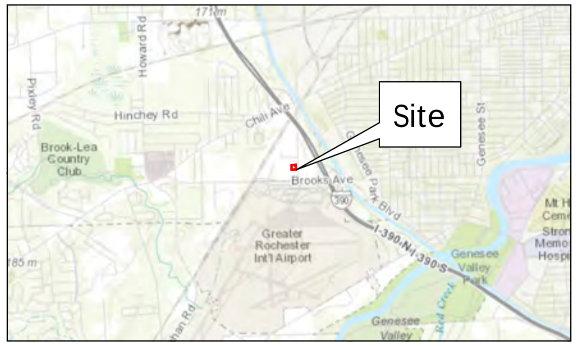
| Sample Location | | | MW-2 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | 1-May-06 | 4-Aug-11 | 3-Nov-11 | 9-Mar-12 | 3-May-12 | 26-Jul-12 | 16-Nov-12 | 22-Feb-13 | 8-Jul-13 | 20-Mar-14 | 13-Nov-14 |
| VOCs | Units | TOGS | Values | | | | | | | | | | |
| Trichloroethylene (TCE) | µg/L | 5**$^{B}$ | 240$^{B}$ | 5.52$^{B}$ | | 5.86$^{B}$ | | | | 18$^{B}$ | 12.2$^{B}$ | 13.8$^{B}$ | 11.6$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | 5**$^{B}$ | 3800$^{B}$ | 148$^{B}$ | 66.2$^{B}$ | 30.0$^{B}$ | 43.8$^{B}$ | 13.7$^{B}$ | 18.4$^{B}$ | 30$^{B}$ | 24.3$^{B}$ | 25.7$^{B}$ | 22.8$^{B}$ |
| Dichloroethylene, trans-1,2- | µg/L | 5**$^{B}$ | 26 J$^{B}$ | 6.66$^{B}$ | 5.36$^{B}$ | | 5.98$^{B}$ | | 5.54$^{B}$ | | 6.64$^{B}$ | | |
| Vinyl chloride | µg/L | 2$^{B}$ | 560$^{B}$ | 146$^{B}$ | 35.5$^{B}$ | 7.33$^{B}$ | 11.9$^{B}$ | 4.00$^{B}$ | 2.66$^{B}$ | 4.1$^{B}$ | 9.03$^{B}$ | 5.60$^{B}$ | 2.74$^{B}$ |

0 40 80 Feet

1:600 (At Original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 StatePlane New York West FIPS 3103 Feet



Project Location:
Buell Road
Rochester, NY

Prepared by AG on 2014-12-10
Technical Review by MPS on 2014-12-10
Independent Review by mmm on 2014-xx-xx

190500033

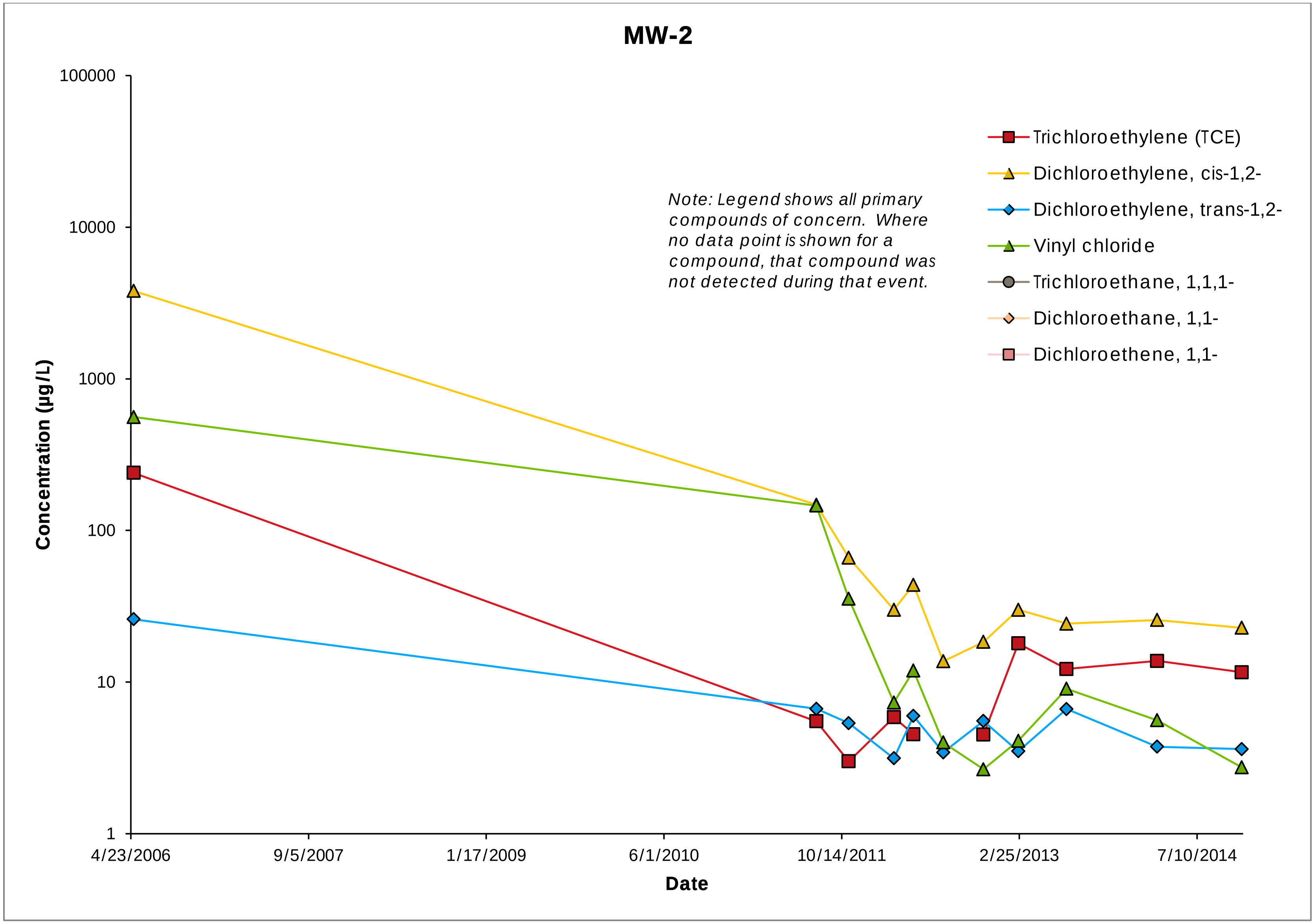
Client/Project
Buell Automatics
Brownfield Cleanup Program
EISB Work Plan

Figure No.
2

Title

# Exceedances of Groundwater Quality Standards at Selected Monitoring Wells, 2006 to 2014

U:\16059\GIS\EISB WP\Figure 2 - VOCs Exceedances in GW - All.mxd Revised: 2014-12-12 By: aglose



*Note: Legend shows all primary compounds of concern. Where no data point is shown for a compound, that compound was not detected during that event.*

**Figure 3. Selected contaminant concentrations in groundwater at MW-2 over time.**

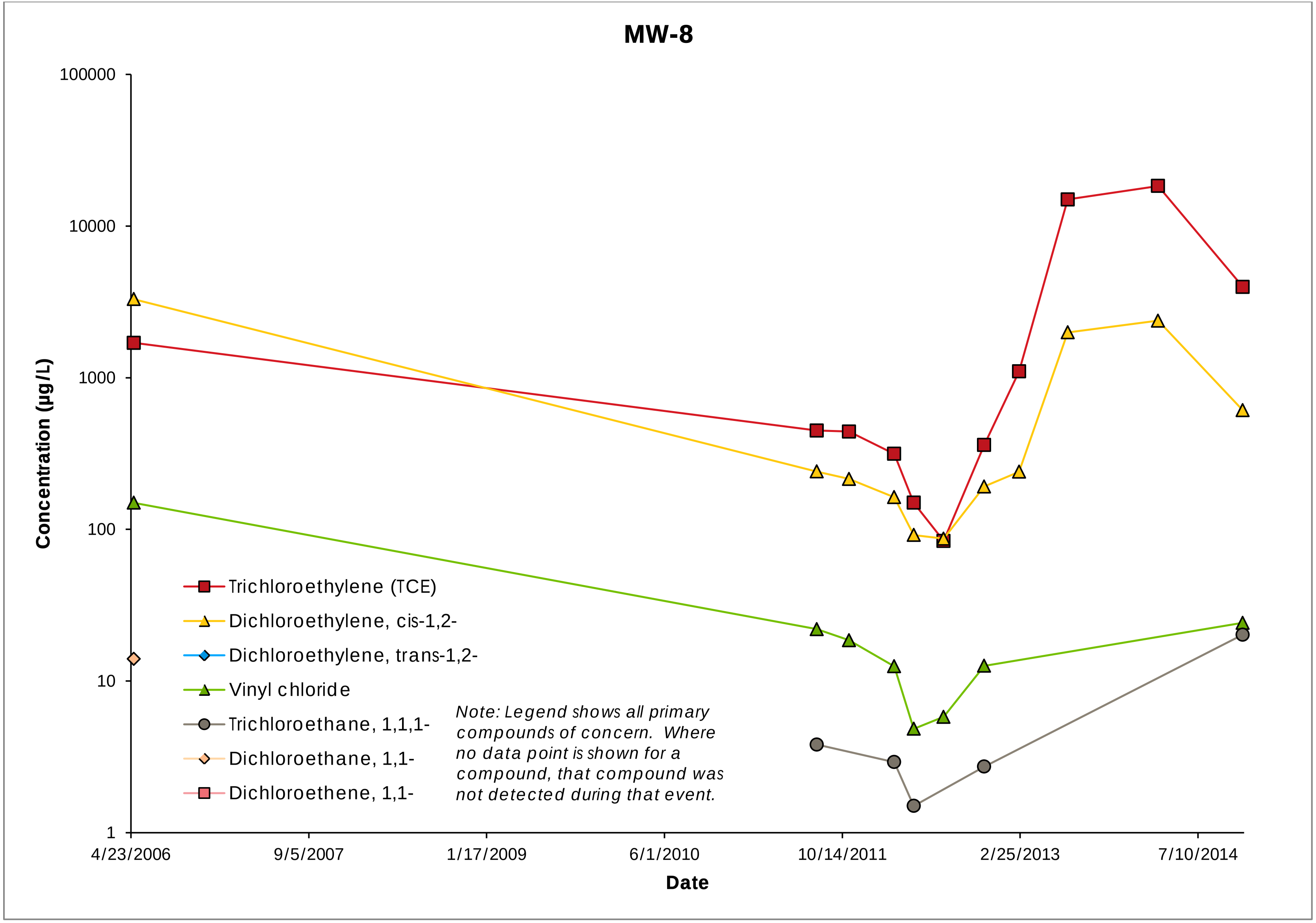
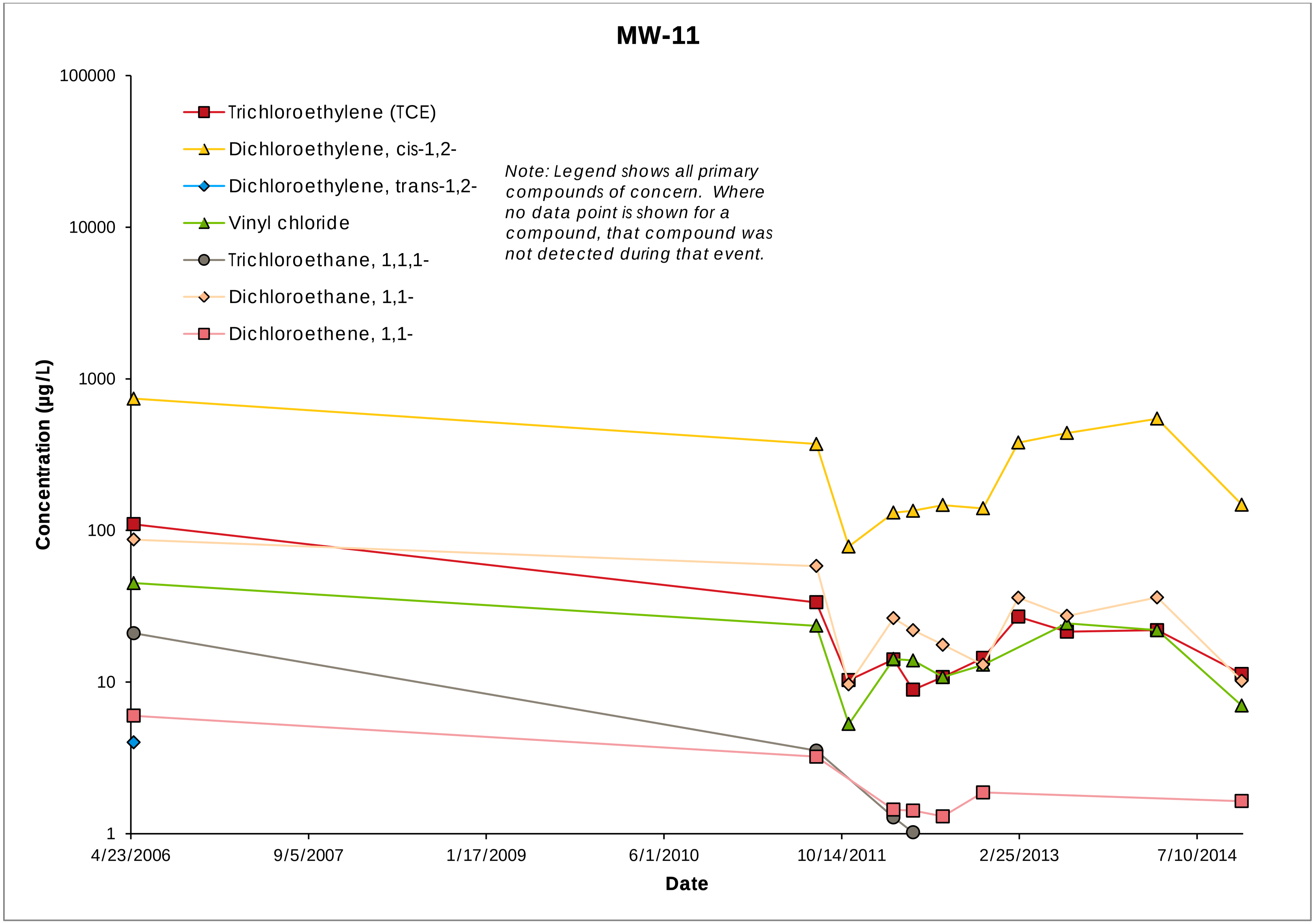
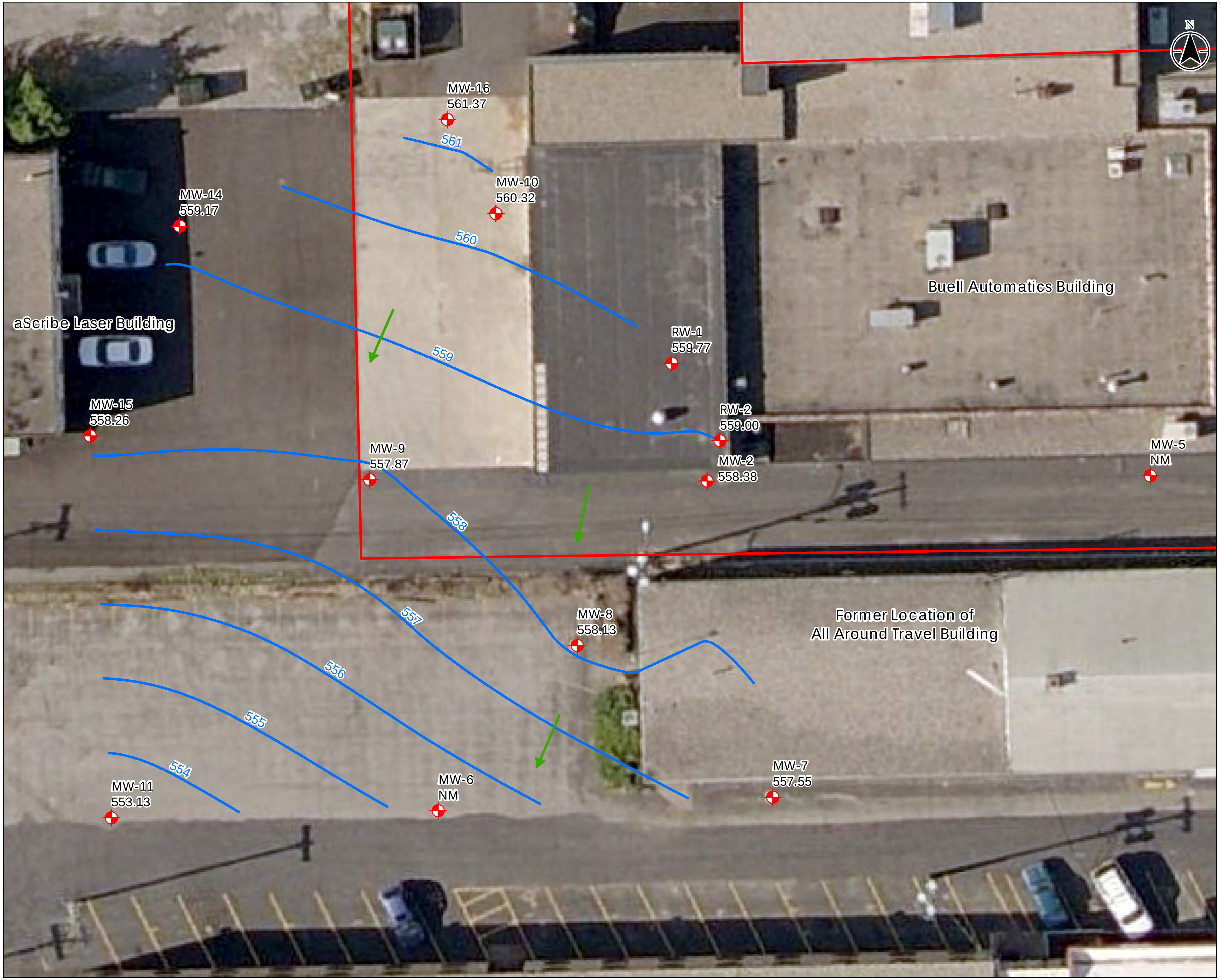


Figure 4. Selected contaminant concentrations in groundwater at MW-8 over time.



*Note: Legend shows all primary compounds of concern. Where no data point is shown for a compound, that compound was not detected during that event.*

**Figure 5. Selected contaminant concentrations in groundwater at MW-11 over time.**



Stantec

## Legend

Monitoring Wells

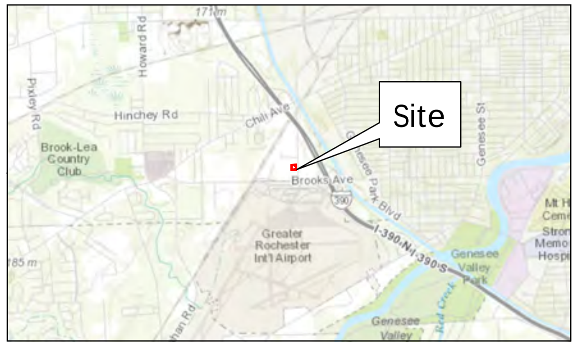
- ⊕ Monitoring Wells
- 🟥 Buell BCA Boundaries
- RW-1 559.77 ⊕ Monitoring Well Location Groundwater Elevation Measured on 2/21/2013
- 559 Groundwater Elevation Contour Line (1 ft. contour interval)
- → Inferred Direction of Shallow Groundwater flow

Notes

1. Coordinate System: NAD 1983 StatePlane New York West FIPS 3103 Feet
2. All elevations in feet
3. NM = not measured

0 10 20 Feet

1:240 (At Original document size of 11x17)



Project Location:
Buell Road
Rochester, NY

Prepared by AG on 2014-10-04
Technical Review by MPS on 2014-12-10
Independent Review by mmm on 2014-xx-xx

190500033

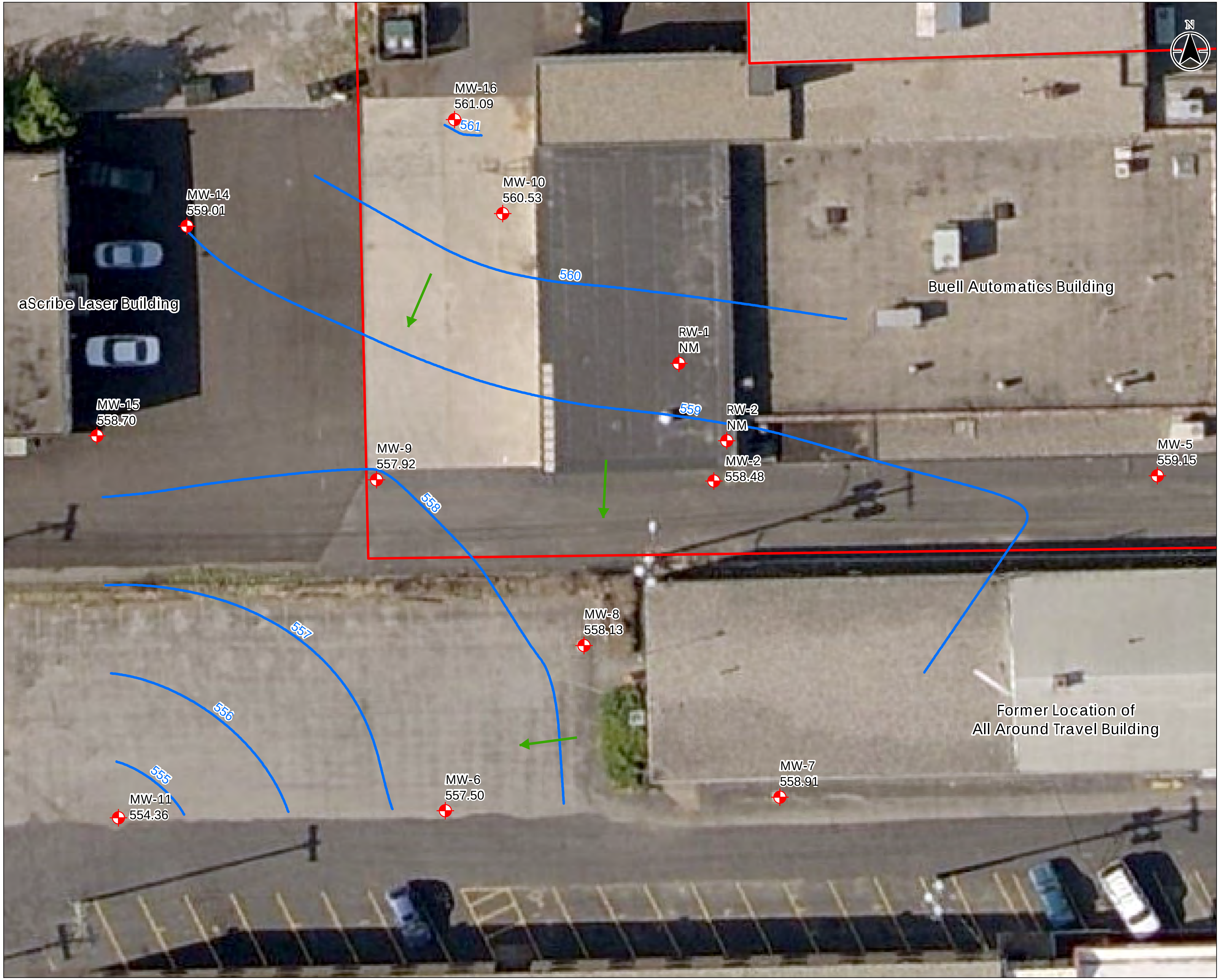
Client/Project
Buell Automatics
Brownfield Cleanup Program
EISB Work Plan

Figure No.
6a

Title

# Groundwater Elevation Contour Plan, February 2013

U:\16059\GIS\EISB WP\Figure 6a - GW Contours - 2013-2-21.mxd Revised: 2014-12-12 By: aglose



Stantec

## Legend

Monitoring Wells

⊕ Monitoring Wells

▭ Buell BCA Boundaries

RW-1 559.77 ⊕ Monitoring Well Location Groundwater Elevation Measured on 7/8/2013

559 Groundwater Elevation Contour Line (1 ft. contour interval)

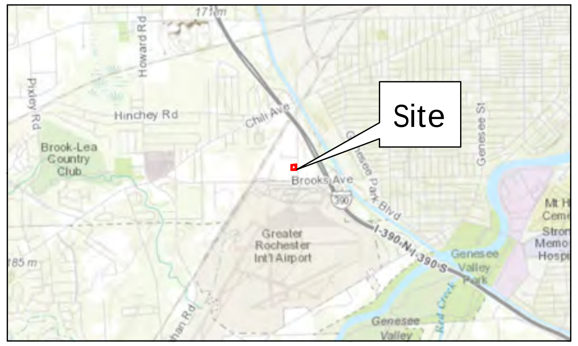
→ Inferred Direction of Shallow Groundwater flow

Notes

1. Coordinate System: NAD 1983 StatePlane New York West FIPS 3103 Feet
2. All elevations in feet
3. NM = not measured

0 10 20 Feet

1:240 (At Original document size of 11x17)



Project Location:
Buell Road
Rochester, NY

Prepared by AG on 2014-10-04
Technical Review by MPS on 2014-12-10
Independent Review by mmm on 2014-xx-xx

190500033

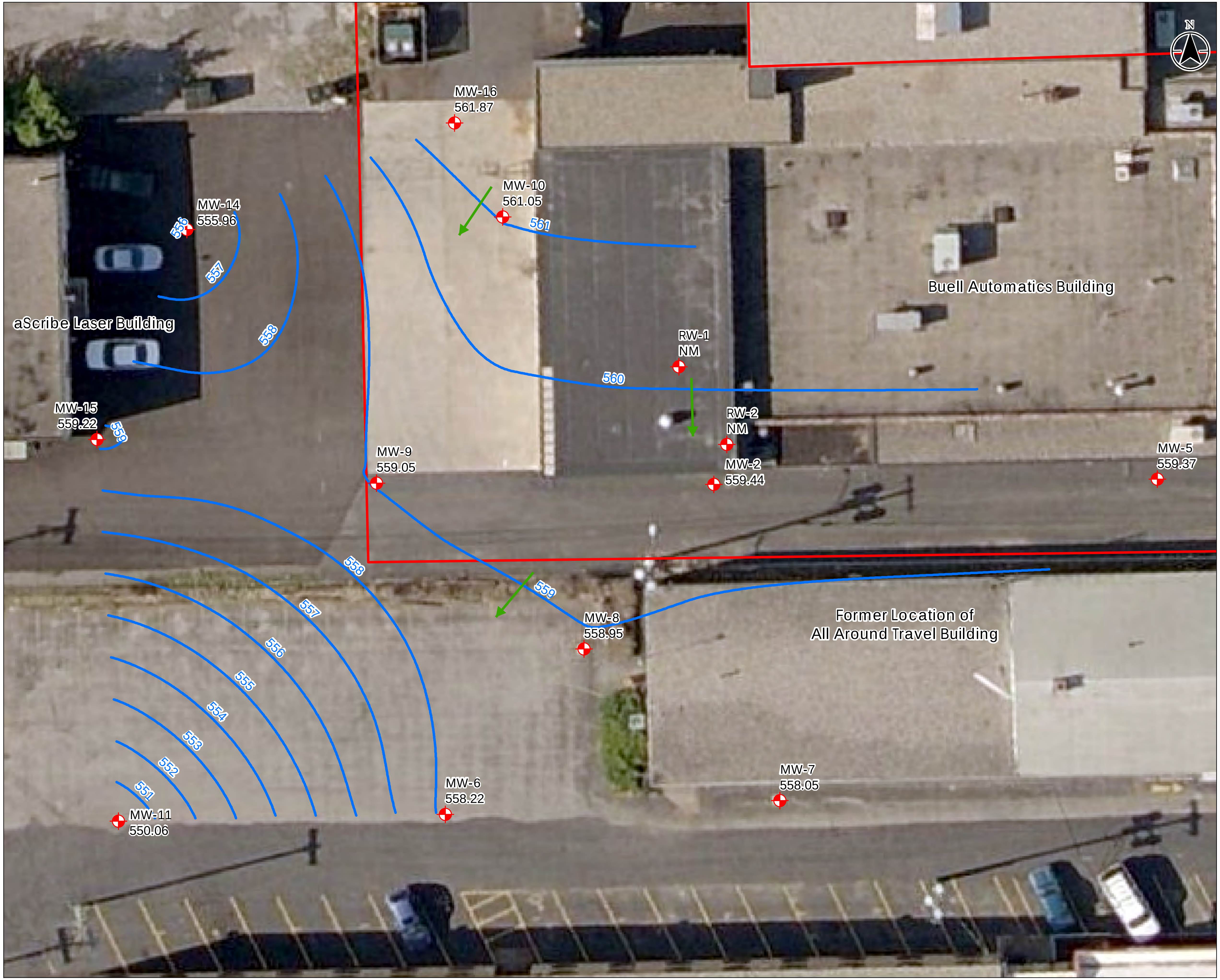
Client/Project
Buell Automatics
Brownfield Cleanup Program
EISB Work Plan

Figure No.
6b

Title

# Groundwater Elevation Contour Plan, July 2013

U:\16059\GIS\EISB WP\Figure 6b - GW Contours - 2013-7-8.mxd Revised: 2014-12-12 By: aglose



Stantec

Legend

Monitoring Wells

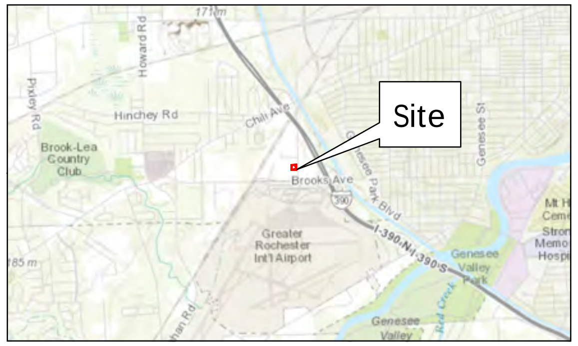
- Monitoring Wells
- 🟥 Buell BCA Boundaries
- RW-1 559.77 Monitoring Well Location Groundwater Elevation Measured on 3/20/2013
- 559 Groundwater Elevation Contour Line (1 ft. contour interval)
- Inferred Direction of Shallow Groundwater flow

Notes

1. Coordinate System: NAD 1983 StatePlane New York West FIPS 3103 Feet
2. All elevations in feet
3. NM = not measured

0 10 20 Feet

1:240 (At Original document size of 11x17)



Project Location:
Buell Road
Rochester, NY

Prepared by AG on 2014-10-05
Technical Review by MPS on 2014-12-10
Independent Review by mmm on 2014-xx-xx

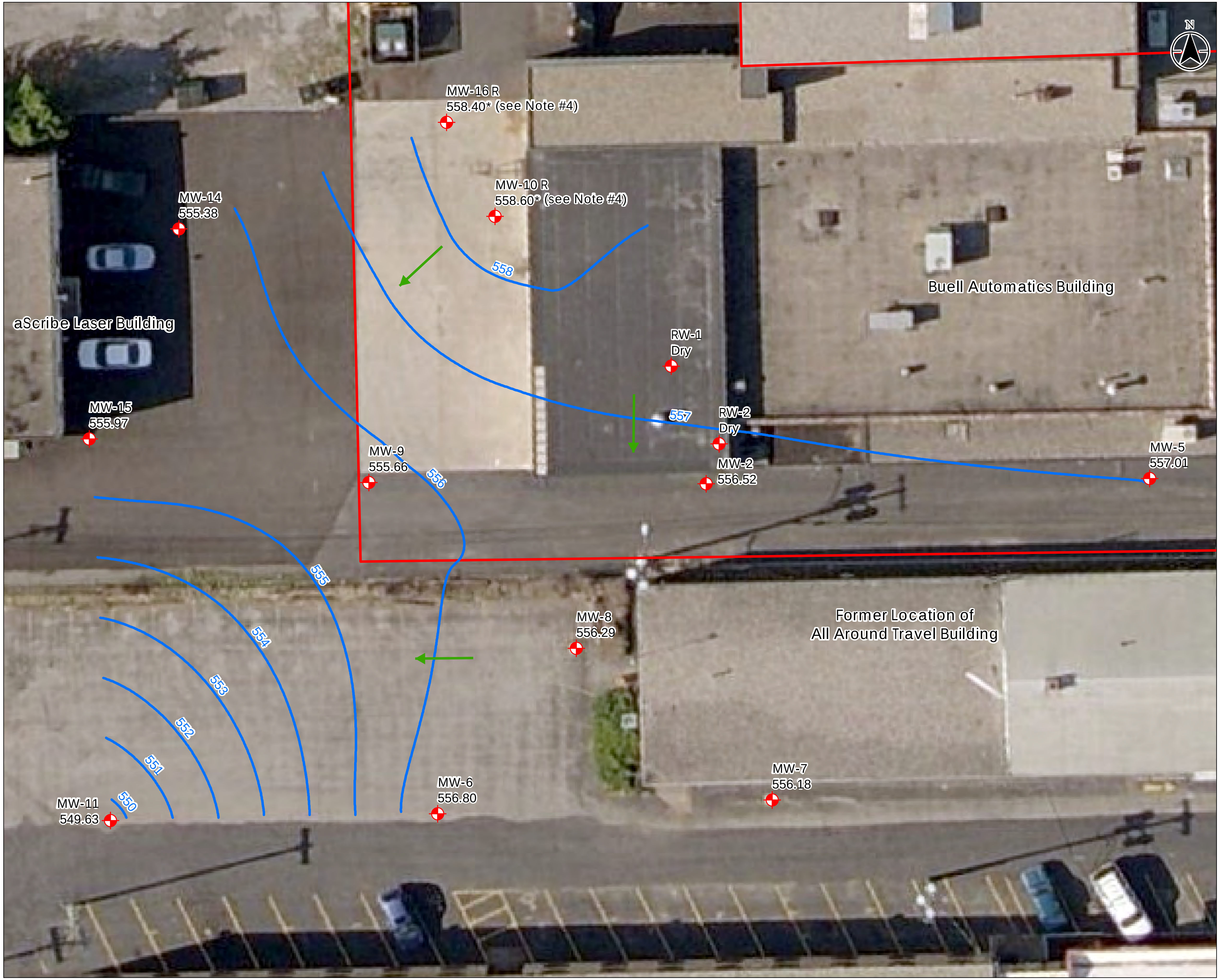
190500033

Client/Project
Buell Automatics
Brownfield Cleanup Program
EISB Work Plan

Figure No.
6c

Title
Groundwater Elevation Contour Plan, March 2014

U:\16059\GIS\EISB WP\Figure 6c - GW Contours - 2014-3-20.mxd Revised: 2014-12-12 By: aglose



Stantec

## Legend

Monitoring Wells

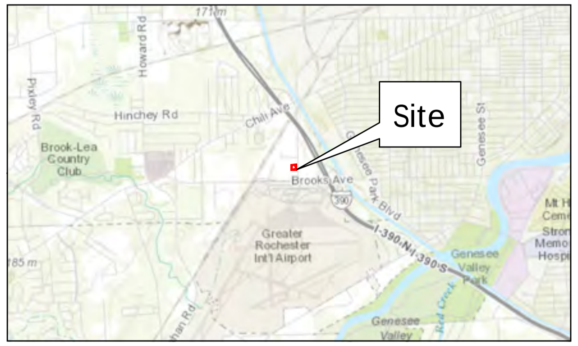
- ⊕ Monitoring Wells
- 🟥 Buell BCA Boundaries
- RW-1 559.77 ⊕ Monitoring Well Location Groundwater Elevation Measured on 11/12/2013
- 559 Groundwater Elevation Contour Line (1 ft. contour interval)
- → Inferred Direction of Shallow Groundwater flow

Notes

1. Coordinate System: NAD 1983 StatePlane New York West FIPS 3103 Feet
2. All elevations in feet
3. NM = not measured
4. MW-10 and MW-16 were replaced with MW-10R and MW-16R in November 2014. These wells have not yet been surveyed, and groundwater elevations reported here for MW-10R and MW-16R are approximate.

0 10 20 Feet

1:240 (At Original document size of 11x17)



| Project Location: | |
|---|---|
| Buell Road | Prepared by AG on 2014-10-05 |
| Rochester, NY | Technical Review by MPS on 2014-12-10 |
| | Independent Review by mmm on 2014-xx-xx |
| | 190500033 |

Client/Project
Buell Automatics
Brownfield Cleanup Program
EISB Work Plan

Figure No.
6d

Title

# Groundwater Elevation Contour Plan, November 2014

U:\190500817\05_report_deliv\dwgs_desgn\figures_general\GIS\mxd\RI\Figure 6d - GW Contours - 2014-11-12.mxd Revised: 2014-12-12 By: aglose

Stantec

## Legend

⊕ EISB Proposed Injection Wells

Pre-Existing Wells as Injection Wells

Type

⊕ Monitoring Well

⊕ Pre-Existing Monitoring Well

⊕ SS Remediation Well

Buell Investigation Points

Type

⊕ Monitoring Well

⃠ Abandoned Monitoring Well

⊕ Pre-Existing Monitoring Well

⊕ SS Remediation Well

▭ FLDA Excavation Boundaries

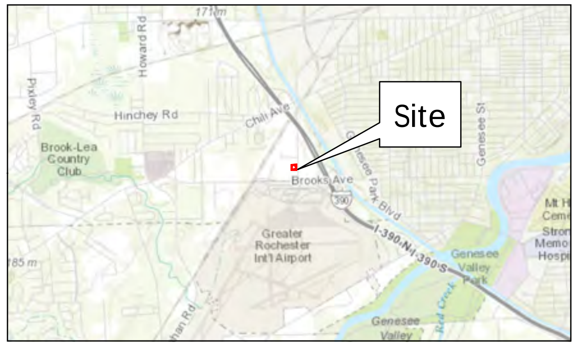
🟥 Buell BCA Boundaries

0 20 40 Feet

1:300 (At Original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 StatePlane New York West FIPS 3103 Feet



Project Location:
Buell Road
Rochester, NY

Prepared by AG on 2014-12-4
Technical Review by MPS on 2014-12-10
Independent Review by mmm on 2014-xx-xx

190500033

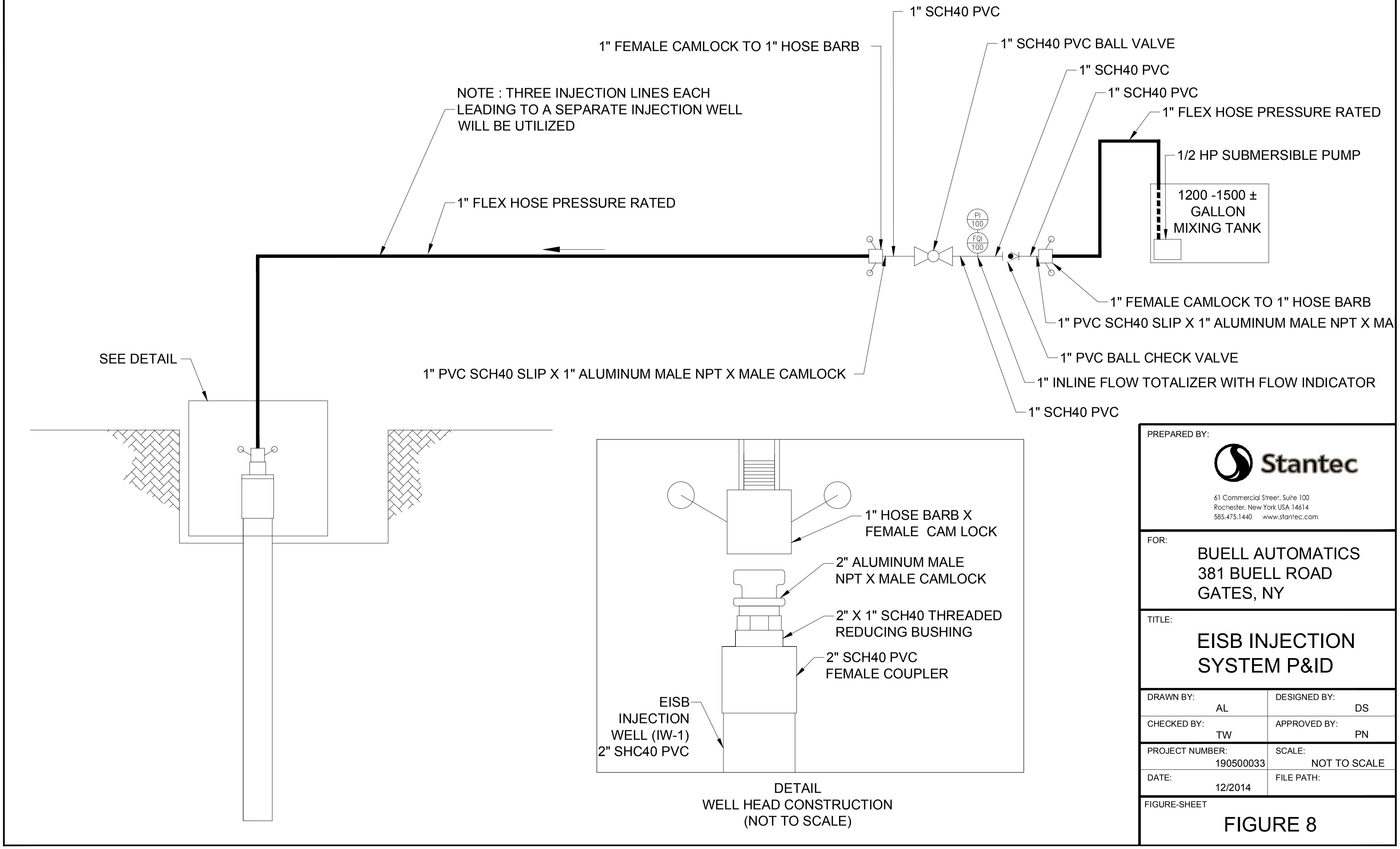
Client/Project
Buell Automatics
Brownfield Cleanup Program
EISB Work Plan

Figure No.
7

Title

## Proposed Injection Well Layout

U:\16059\GIS\EISB WP\Figure 7 - EISB Proposed Well Layout and Excavation Areas_rev1.mxd Revised: 2014-12-12 By: aglose



DETAIL
WELL HEAD CONSTRUCTION
(NOT TO SCALE)

PREPARED BY:

Stantec
61 Commercial Street, Suite 100
Rochester, New York USA 14614
585.475.1440 www.stantec.com

FOR:

BUELL AUTOMATICS
381 BUELL ROAD
GATES, NY

TITLE:

# EISB INJECTION SYSTEM P&ID

| | |
|---|---|
| DRAWN BY: AL | DESIGNED BY: DS |
| CHECKED BY: TW | APPROVED BY: PN |
| PROJECT NUMBER: 190500033 | SCALE: NOT TO SCALE |
| DATE: 12/2014 | FILE PATH: |

FIGURE-SHEET

FIGURE 8

FILEPATH:U:\16059\GIS\EISB WP\Figure 8_PID Injection System.dwg|aless|Dec 11, 2014 at 7:57|Layout: EBRD

# Tables

# Table 1
## Summary of Groundwater Sample Analysis Results, 2006-2014
## Buell Automatics Site
## 381 Buell Road, Gates, New York
## Brownfield Clean-up Program Site # C828114

| Sample Location | | | MW-2 | | | | | | | | | | | RW-1 | RW-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Date** | | | **1-May-06** | **4-Aug-11** | **3-Nov-11** | **9-Mar-12** | **3-May-12** | **26-Jul-12** | **16-Nov-12** | **22-Feb-13** | **8-Jul-13** | **20-Mar-14** | **13-Nov-14** | **2-May-06** | **2-May-06** |
| **Sample ID** | | | **BU-MW2-GW** | **MW-2** | **MW-2** | **MW-2** | **MW-2** | **BU-MW-2** | **MW-2** | **BU-MW-2-02222013** | **MW-2** | **BU-MW2-W-R1** | **BU-MW2-W-111314** | **RW-1** | **RW-2** |
| **Sampling Company** | | | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** |
| **Sample Type** | **Units** | **TOGS** | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | |
| Dissolved Oxygen | mg/L | n/v | - | 0 | 0.7 | 2.35 | 0.27 | 0.27 | 0.86 | 0.85 | 0.12 | 0.01 | 0.92 | - | - |
| ORP | eV | n/v | - | -171 | -113 | -62 | -72 | -81.7 | -52.1 | -12.6 | -220.4 | -14 | -12.7 | - | - |
| pH | S.U. | n/v | 6.92 | 7.09 | 7.19 | 7.15 | 7.22 | 7.12 | 7.21 | 7.23 | 7.14 | 7 | 7.13 | 6.49 | 6.97 |
| Ferrous Iron | mg/L | n/v | - | 0.07 | - | - | - | - | - | - | - | - | 0.63 | - | - |
| **Laboratory** | | | **CASR** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **CASR** | **CASR** |
| **Laboratory Work Order** | | | **R2631499** | **11-3254A** | **P11-4774** | **12:1051** | **12:1907** | **12:3152** | **12:4815** | **130677** | **132537** | **141040** | **145009** | **R2631499** | **R2631499** |
| **Laboratory Sample ID** | | | **UNKNOWN** | **10645** | **16038** | **12:1051-04** | **12:1907-03** | **12:3152-01** | **12:4815-04** | **130677-02** | **132537-04** | **141040-01** | **145009-02** | **UNKNOWN** | **UNKNOWN** |
| **TCL Volatile Organic Compounds Detected in Site Groundwater** | | | | | | | | | | | | | | | |
| Tetrachloroethylene (PCE) | µg/L | $5_{**}^{B}$ | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***200 U*** | ***2000 U*** |
| Trichloroethylene (TCE) | µg/L | $5_{**}^{B}$ | **240$^{B}$** | **5.52$^{B}$** | 3.00 | **5.86$^{B}$** | 4.53 | 1.05 JB | 4.50 | **18$^{B}$** | **12.2$^{B}$** | **13.8$^{B}$** | **11.6$^{B}$** | **400$^{B}$** | **13000$^{B}$** |
| Dichloroethylene, cis-1,2- | µg/L | $5_{**}^{B}$ | **3800$^{B}$** | **148$^{B}$** | **66.2$^{B}$** | **30.0$^{B}$** | **43.8$^{B}$** | **13.7$^{B}$** | **18.4$^{B}$** | **30$^{B}$** | **24.3$^{B}$** | **25.7$^{B}$** | **22.8$^{B}$** | **4600 D$^{B}$** | **27000$^{B}$** |
| Dichloroethylene, trans-1,2- | µg/L | $5_{**}^{B}$ | **26 J$^{B}$** | **6.66$^{B}$** | **5.36$^{B}$** | 3.14 | **5.98$^{B}$** | 3.44 | **5.54$^{B}$** | 3.5 | **6.64$^{B}$** | 3.75 | 3.61 | **27 J$^{B}$** | ***2000 U*** |
| Vinyl chloride | µg/L | $2^{B}$ | **560$^{B}$** | **146$^{B}$** | **35.5$^{B}$** | **7.33$^{B}$** | **11.9$^{B}$** | **4.00$^{B}$** | **2.66$^{B}$** | **4.1$^{B}$** | **9.03$^{B}$** | **5.60$^{B}$** | **2.74$^{B}$** | **1200$^{B}$** | ***2000 U*** |
| Trichloroethane, 1,1,1- | µg/L | $5_{**}^{B}$ | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***200 U*** | **230 J$^{B}$** |
| Dichloroethane, 1,1- | µg/L | $5_{**}^{B}$ | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | **250$^{B}$** | **160 J$^{B}$** |
| Dichloroethene, 1,1- | µg/L | $5_{**}^{B}$ | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 1.11 J | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***200 U*** | ***2000 U*** |
| Chloroethane | µg/L | $5_{**}^{B}$ | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***200 U*** | ***2000 U*** |
| Trichloroethane, 1,1,2- | µg/L | $1^{B}$ | ***200 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***200 U*** | ***2000 U*** |
| Dichloroethane, 1,2- | µg/L | $0.6^{B}$ | ***200 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***200 U*** | ***2000 U*** |
| Benzene | µg/L | $1^{B}$ | ***200 U*** | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | ***200 U*** | ***2000 U*** |
| Xylene, m & p- | µg/L | $5_{**}^{B}$ | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***200 U*** | ***2000 U*** |
| Acetone | µg/L | $50^{A}$ | ***200 U*** | 10.0 U | 10.0 U | 10.0 U | 7.05 J | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | ***200 U*** | ***2000 U*** |
| Methylene Chloride | µg/L | $5_{**}^{B}$ | ***200 U*** | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | ***200 U*** | ***2000 U*** |
| **Volatile Gases** | | | | | | | | | | | | | | | |
| Methane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | <1 | - | - |
| Ethane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | <1 | - | - |
| Ethene | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | <1 | - | - |
| **Inorganics** | | | | | | | | | | | | | | | |
| Arsenic | mg/L | $25^{B}$ | - | - | - | - | - | - | - | - | - | - | 0.0772 | - | - |
| Iron | mg/L | $300^{B}$ | - | - | - | - | - | - | - | - | - | - | 6.25 | - | - |
| Manganese | mg/L | $500^{B}$ | - | - | - | - | - | - | - | - | - | - | 0.893 | - | - |
| Sodium | mg/L | $20000^{B}$ | - | - | - | - | - | - | - | - | - | - | 58.3 | - | - |
| **General Chemistry Parameters** | | | | | | | | | | | | | | | |
| Alkalinity, Total (As $CaCO_3$) | mg/L | n/v | - | 305 | - | - | - | - | - | - | - | - | 340 | - | - |
| Chloride | mg/L | $250^{B}$ | - | 90.5 | - | - | - | - | - | - | - | - | 152 | - | - |
| Nitrate (as N) | mg/L | n/v | - | 0.02 U | - | - | - | - | - | - | - | - | 0.16 | - | - |
| Sulfate | mg/L | $250^{B}$ | - | 57.9 | - | - | - | - | - | - | - | - | 94.7 | - | - |
| Total Organic Carbon | mg/L | n/v | - | 7.7 | - | - | - | - | - | - | - | - | 5.4 | - | - |
| **Laboratory** | | | | | | | | | | | **SIREM** | | |
| **Laboratory Work Order** | | | | | | | | | | | | | **S-3420** | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | **DHC-11006** | | |
| **Gene-Trac Dehalococcoides Assay** | | | | | | | | | | | | | | | |
| Percent Dhc | % | n/v | - | - | - | - | - | - | - | - | - | - | 0.008-0.02 | - | - |
| Dhc 16S rRNA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | 100000 | - | - |
| Percent vcrA | % | n/v | - | - | - | - | - | - | - | - | - | - | 0.02-0.07 | - | - |
| vcrA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | 300000 | - | - |
| **Laboratory** | | | | | | | | | | | | | **OU** | | |
| **Laboratory Work Order** | | | | | | | | | | | | | **872** | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | **MW-2** | | |
| **Carbon Stable Isotope Analysis (CSIA)** | | | | | | | | | | | | | | | |
| Trichloroethene $\delta^{13}C$ | ‰, VPDB | n/v | - | - | - | - | - | - | - | - | - | - | -10.0 | - | - |

# Table 1
## Summary of Groundwater Sample Analysis Results, 2006-2014
## Buell Automatics Site
## 381 Buell Road, Gates, New York
## Brownfield Clean-up Program Site # C828114

| Sample Location | | | MW-3 | MW-5 | MW-6 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Date** | | | 1-May-06 | 4-Aug-11 | 1-May-06 | 3-Aug-11 | 2-Nov-11 | 8-Mar-12 | 2-May-12 | 25-Jul-12 | 15-Nov-12 | 9-Jul-13 | 20-Mar-14 | 13-Nov-14 |
| **Sample ID** | | | BU-MW3-GW | MW-5 | BU-MW6-GW | MW-6 | MW-6 | MW-6 | MW-6 | BU-MW-6 | MW-6 | MW-6 | BU-MW6-W-R1 | BU-MW6-W-111314 |
| **Sampling Company** | | | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC |
| **Sample Type** | **Units** | **TOGS** | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | |
| Dissolved Oxygen | mg/L | n/v | - | 0 | - | 2.35 | 1 | 2.25 | 0.38 | 0.37 | 0.6 | 0.26 | 0.58 | 0.71 |
| ORP | eV | n/v | - | -133 | - | 51 | 104 | 147 | 87.9 | 82.3 | -57.9 | -134.8 | 138.4 | 121.7 |
| pH | S.U. | n/v | 6.97 | 6.99 | 7.19 | 7.15 | 7.14 | 7.07 | 7.33 | 7.2 | 7.21 | 7.19 | 7.25 | 7.06 |
| Ferrous Iron | mg/L | n/v | - | 0.56 | - | 0.1 | - | - | - | - | - | - | - | 0 |
| **Laboratory** | | | CASR | PARAROCH | CASR | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH |
| **Laboratory Work Order** | | | R2631499 | 11-3254A | R2631499 | 11-3216A | P11-4734 | 12:1025 | 12:1882 | 12:3126 | 12:4794 | 132537 | 141040 | 145009 |
| **Laboratory Sample ID** | | | UNKNOWN | 10644 | UNKNOWN | 10548 | 15928 | 12:1025-04 | 12:1882-02 | 12:3126-01 | 12:4794-02 | 132537-06 | 141040-03 | 145009-04 |
| **TCL Volatile Organic Compounds Detected in Site Groundwater** | | | | | | | | | | | | | | |
| Tetrachloroethylene (PCE) | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethylene (TCE) | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | **$2400^{B}$** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 1.50 J | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethylene, cis-1,2- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | **$720^{B}$** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethylene, trans-1,2- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Vinyl chloride | µg/L | $2^{B}$ | ***10 U*** | 2.00 U | **$50^{B}$** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethane, 1,1,1- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | **25 $J^{B}$** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethane, 1,1- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethene, 1,1- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Chloroethane | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethane, 1,1,2- | µg/L | $1^{B}$ | ***10 U*** | ***2.00 U*** | ***200 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** |
| Dichloroethane, 1,2- | µg/L | $0.6^{B}$ | ***10 U*** | ***2.00 U*** | ***200 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** |
| Benzene | µg/L | $1^{B}$ | ***10 U*** | 0.700 U | ***200 U*** | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U |
| Xylene, m & p- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | ***200 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 1.10 J B | 2.00 U | 2.00 U |
| Acetone | µg/L | $50^{A}$ | 10 U | 10.0 U | ***200 U*** | 10.0 U | 10.0 U | 10.0 U | 7.55 J | 10.0 U | 9.48 J | 10.0 U | 10.0 U | 10.0 U |
| Methylene Chloride | µg/L | $5_{**}^{B}$ | ***10 U*** | 5.00 U | ***200 U*** | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| **Volatile Gases** | | | | | | | | | | | | | | |
| Methane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | 0.67 J |
| Ethane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | <1 |
| Ethene | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | <1 |
| **Inorganics** | | | | | | | | | | | | | | |
| Arsenic | mg/L | $25^{B}$ | - | - | - | - | - | - | - | - | - | - | - | 0.01U |
| Iron | mg/L | $300^{B}$ | - | - | - | - | - | - | - | - | - | - | - | 0.0781 J |
| Manganese | mg/L | $500^{B}$ | - | - | - | - | - | - | - | - | - | - | - | 1.92 |
| Sodium | mg/L | $20000^{B}$ | - | - | - | - | - | - | - | - | - | - | - | 51.5 |
| **General Chemistry Parameters** | | | | | | | | | | | | | | |
| Alkalinity, Total (As $CaCO_3$) | mg/L | n/v | - | 285 | - | 220 | - | - | - | - | - | - | - | 210 |
| Chloride | mg/L | $250^{B}$ | - | **$627^{B}$** | - | 215 | - | - | - | - | - | - | - | 148 |
| Nitrate (as N) | mg/L | n/v | - | 0.02 | - | 1.61 | - | - | - | - | - | - | - | 0.6 |
| Sulfate | mg/L | $250^{B}$ | - | 204 | - | 69.3 | - | - | - | - | - | - | - | 39.4 |
| Total Organic Carbon | mg/L | n/v | - | 5.5 | - | 3.2 | - | - | - | - | - | - | - | 2.5 |
| **Laboratory** | | | | | | | | | | | | | | |
| **Laboratory Work Order** | | | | | | | | | | | | | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | | |
| **Gene-Trac Dehalococcoides Assay** | | | | | | | | | | | | | | |
| Percent Dhc | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - |
| Dhc 16S rRNA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - |
| Percent vcrA | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - |
| vcrA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - |
| **Laboratory** | | | | | | | | | | | | | | |
| **Laboratory Work Order** | | | | | | | | | | | | | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | | |
| **Carbon Stable Isotope Analysis (CSIA)** | | | | | | | | | | | | | | |
| Trichloroethene $\delta^{13}C$ | ‰, VPDB | n/v | - | - | - | - | - | - | - | - | - | - | - | - |

## Table 1
## Summary of Groundwater Sample Analysis Results, 2006-2014
## Buell Automatics Site
## 381 Buell Road, Gates, New York
## Brownfield Clean-up Program Site # C828114

| **Sample Location** | | | **MW-7** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Date** | | | **1-May-06** | **4-Aug-11** | **2-Nov-11** | **9-Mar-12** | **3-May-12** | **25-Jul-12** | **15-Nov-12** | **22-Feb-13** | **9-Jul-13** | **20-Mar-14** | **12-Nov-14** |
| **Sample ID** | | | **BU-MW7-GW** | **MW-7** | **MW-7** | **MW-7** | **MW-7** | **BU-MW-7** | **MW-7** | **BU-MW-7-02222013** | **MW-7** | **BU-MW7-W-R1** | **BU-MW7-W-111214** |
| **Sampling Company** | | | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** |
| **Sample Type** | **Units** | **TOGS** | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | |
| Dissolved Oxygen | mg/L | n/v | - | 0 | 1.0 | 2.91 | 0.94 | 0.27 | 0.24 | 0.82 | 0.17 | 3.13 | 0.30 |
| ORP | eV | n/v | - | -80 | 70 | 49 | 64.4 | 38.9 | -77.8 | 105.6 | -142.1 | 153.6 | 129.5 |
| pH | S.U. | n/v | 6.95 | 7.13 | 7.13 | 6.79 | 7.18 | 7.11 | 7.13 | 7.17 | 7.15 | 7.1 | 6.91 |
| Ferrous Iron | mg/L | n/v | - | 0.1 | - | - | - | - | - | - | - | - | - |
| **Laboratory** | | | **CASR** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** |
| **Laboratory Work Order** | | | **R2631499** | **11-3254A** | **P11-4734** | **12:1051** | **12:1907** | **12:3126** | **12:4794** | **130677** | **132537** | **141040** | **144993** |
| **Laboratory Sample ID** | | | **UNKNOWN** | **10647** | **15927** | **12:1051-01** | **12:1907-04** | **12:3126-02** | **12:4794-01** | **130677-05** | **132537-08** | **141040-02** | **144993-01** |
| **TCL Volatile Organic Compounds Detected in Site Groundwater** | | | | | | | | | | | | | |
| Tetrachloroethylene (PCE) | µg/L | $5_{**}^{B}$ | 2 J | 4.34 | 2.04 | 1.67 J | 2.09 | 2.01 | 2.00 U | 2.00 U | 1.07 J | 2.00 U | 1.24J |
| Trichloroethylene (TCE) | µg/L | $5_{**}^{B}$ | **$10^{B}$** | **$11.8^{B}$** | **$6.84^{B}$** | **$6.35^{B}$** | **$6.45^{B}$** | **$7.43^{B}$** | 4.96 | 3.0 | **$6.89^{B}$** | 4.26 | **$7.73^{B}$** |
| Dichloroethylene, cis-1,2- | µg/L | $5_{**}^{B}$ | **$20^{B}$** | **$6.22^{B}$** | 4.17 | **$5.80^{B}$** | 4.46 | **$5.39^{B}$** | **$5.67^{B}$** | 3.3 | **$5.50^{B}$** | 4.50 | **$6.57^{B}$** |
| Dichloroethylene, trans-1,2- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Vinyl chloride | µg/L | $2^{B}$ | 2 J | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethane, 1,1,1- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethane, 1,1- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethene, 1,1- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Chloroethane | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethane, 1,1,2- | µg/L | $1^{B}$ | ***10 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** |
| Dichloroethane, 1,2- | µg/L | $0.6^{B}$ | ***10 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** |
| Benzene | µg/L | $1^{B}$ | ***10 U*** | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U |
| Xylene, m & p- | µg/L | $5_{**}^{B}$ | ***10 U*** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Acetone | µg/L | $50^{A}$ | 10 U | 10.0 U | 10.0 U | 10.0 U | 9.88 J | 10.0 U | 6.33 J | 10.0 U | 10.0 U | 10.0 U | 10.0 U |
| Methylene Chloride | µg/L | $5_{**}^{B}$ | ***10 U*** | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| **Volatile Gases** | | | | | | | | | | | | | |
| Methane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - |
| Ethane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - |
| Ethene | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - |
| **Inorganics** | | | | | | | | | | | | | |
| Arsenic | mg/L | $25^{B}$ | - | - | - | - | - | - | - | - | - | - | 0.01U |
| Iron | mg/L | $300^{B}$ | - | - | - | - | - | - | - | - | - | - | 0.319 |
| Manganese | mg/L | $500^{B}$ | - | - | - | - | - | - | - | - | - | - | 1.54 |
| Sodium | mg/L | $20000^{B}$ | - | - | - | - | - | - | - | - | - | - | 115 |
| **General Chemistry Parameters** | | | | | | | | | | | | | |
| Alkalinity, Total (As $CaCO_3$) | mg/L | n/v | - | 215 | - | - | - | - | - | - | - | - | - |
| Chloride | mg/L | $250^{B}$ | - | 161 | - | - | - | - | - | - | - | - | - |
| Nitrate (as N) | mg/L | n/v | - | 0.02 U | - | - | - | - | - | - | - | - | - |
| Sulfate | mg/L | $250^{B}$ | - | **$890^{B}$** | - | - | - | - | - | - | - | - | - |
| Total Organic Carbon | mg/L | n/v | - | 7.3 | - | - | - | - | - | - | - | - | - |
| **Laboratory** | | | | | | | | | | | | | |
| **Laboratory Work Order** | | | | | | | | | | | | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | |
| **Gene-Trac Dehalococcoides Assay** | | | | | | | | | | | | | |
| Percent Dhc | % | n/v | - | - | - | - | - | - | - | - | - | - | - |
| Dhc 16S rRNA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - |
| Percent vcrA | % | n/v | - | - | - | - | - | - | - | - | - | - | - |
| vcrA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - |
| **Laboratory** | | | | | | | | | | | | | |
| **Laboratory Work Order** | | | | | | | | | | | | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | |
| **Carbon Stable Isotope Analysis (CSIA)** | | | | | | | | | | | | | |
| Trichloroethene $\delta^{13}C$ | ‰, VPDB | n/v | - | - | - | - | - | - | - | - | - | - | - |

# Table 1
## Summary of Groundwater Sample Analysis Results, 2006-2014
## Buell Automatics Site
## 381 Buell Road, Gates, New York
## Brownfield Clean-up Program Site # C828114

| Sample Location | | | MW-8 | | | | | | | | | | | MW-9 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Date** | | | **1-May-06** | **3-Aug-11** | **2-Nov-11** | **8-Mar-12** | **2-May-12** | **25-Jul-12** | **16-Nov-12** | **22-Feb-13** | **9-Jul-13** | **20-Mar-14** | **13-Nov-14** | **1-May-06** | **12-Nov-14** |
| **Sample ID** | | | **BU-MW8-GW** | **MW-8** | **MW-8** | **MW-8** | **MW-8** | **BU-MW-8** | **MW-8** | **BU-MW-8-02222013** | **MW-8** | **BU-MW8-W-R1** | **BU-MW8-W-111314** | **BU-MW9-GW** | **BU-MW9-W-111214** |
| **Sampling Company** | | | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** |
| **Sample Type** | **Units** | **TOGS** | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | |
| Dissolved Oxygen | mg/L | n/v | - | 4.76 | 1.67 | 1.84 | 0.99 | 0.94 | 0.56 | 1 | 0.49 | 3.65 | 2.29 | - | 1.97 |
| ORP | eV | n/v | - | 76 | 202 | 149 | 128.9 | 76.2 | -51.7 | 84.7 | -67.2 | 106.6 | 99.9 | - | 102.2 |
| pH | S.U. | n/v | 7.58 | 7.47 | 7.55 | 7.3 | 7.38 | 7.4 | 7.39 | 7.42 | 7.44 | 7.56 | 7.3 | 6.79 | 7.91 |
| Ferrous Iron | mg/L | n/v | - | 0.05 | - | - | - | - | - | - | - | - | 0.08 | - | - |
| **Laboratory** | | | **CASR** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **CASR** | **PARAROCH** |
| **Laboratory Work Order** | | | **R2631499** | **11-3216A** | **P11-4734** | **12:1025** | **12:1882** | **12:3126** | **12:4815** | **130677** | **132537** | **141040** | **145009** | **R2631499** | **144993** |
| **Laboratory Sample ID** | | | **UNKNOWN** | **10549** | **15929** | **12:1025-03** | **12:1882-04** | **12:3126-03** | **12:4815-01** | **130677-03** | **132537-07** | **141040-08** | **145009-03** | **UNKNOWN** | **144993-04** |
| **TCL Volatile Organic Compounds Detected in Site Groundwater** | | | | | | | | | | | | | | | |
| Tetrachloroethylene (PCE) | µg/L | $5_{**}^{B}$ | ***200 U*** | 5.00 U | 5.00 U | 4.00 U | 2.00 U | 2.00 U | 4.00 U | ***20 U*** | ***1000 U*** | ***1000 U*** | ***40 U*** | ***20 U*** | 2.00 U |
| Trichloroethylene (TCE) | µg/L | $5_{**}^{B}$ | **1700$^{B}$** | **449$^{B}$** | **442$^{B}$** | **315$^{B}$** | **150$^{B}$** | **84.0$^{B}$** | **361$^{B}$** | **1100$^{B}$** | **15000$^{B}$** | **18400$^{B}$** | **3970$^{B}$** | **21$^{B}$** | 2.00 U |
| Dichloroethylene, cis-1,2- | µg/L | $5_{**}^{B}$ | **3300$^{B}$** | **241$^{B}$** | **215$^{B}$** | **163$^{B}$** | **91.8$^{B}$** | **86.8$^{B}$** | **192$^{B}$** | **240$^{B}$** | **1990$^{B}$** | **2380$^{B}$** | **611$^{B}$** | **250$^{B}$** | 2.00 U |
| Dichloroethylene, trans-1,2- | µg/L | $5_{**}^{B}$ | ***200 U*** | 5.00 U | 5.00 U | 4.00 U | 2.00 U | 2.00 U | 4.00 U | ***20 U*** | ***1000 U*** | ***1000 U*** | ***40 U*** | ***20 U*** | 1.9 J |
| Vinyl chloride | µg/L | $2^{B}$ | **150 J$^{B}$** | **22.0$^{B}$** | **18.6$^{B}$** | **12.5$^{B}$** | **4.84$^{B}$** | **5.81$^{B}$** | **12.6$^{B}$** | ***20 U*** | ***1000 U*** | ***1000 U*** | **24.2$^{B}$** | **53$^{B}$** | 2.00 U |
| Trichloroethane, 1,1,1- | µg/L | $5_{**}^{B}$ | ***200 U*** | 3.81 J | 5.00 U | 2.92 J | 1.5 J | 2.00 U | 2.73 J | ***20 U*** | ***1000 U*** | ***1000 U*** | **20.2$^{B}$** | **9 J$^{B}$** | 2.00 U |
| Dichloroethane, 1,1- | µg/L | $5_{**}^{B}$ | **14 J$^{B}$** | 5.00 U | 5.00 U | 4.00 U | 2.00 U | 2.00 U | 4.00 U | ***20 U*** | ***1000 U*** | ***1000 U*** | ***40 U*** | **170$^{B}$** | 2.00 U |
| Dichloroethene, 1,1- | µg/L | $5_{**}^{B}$ | ***200 U*** | 5.00 U | 5.00 U | 4.00 U | 2.00 U | 2.00 U | 4.00 U | ***20 U*** | ***1000 U*** | ***1000 U*** | ***40 U*** | ***20 U*** | 2.00 U |
| Chloroethane | µg/L | $5_{**}^{B}$ | ***200 U*** | 5.00 U | 5.00 U | 4.00 U | 2.00 U | 2.00 U | 4.00 U | ***20 U*** | ***1000 U*** | ***1000 U*** | ***40 U*** | **5.4 J$^{B}$** | 2.00 U |
| Trichloroethane, 1,1,2- | µg/L | $1^{B}$ | ***200 U*** | ***5.00 U*** | ***5.00 U*** | ***4.00 U*** | ***2.00 U*** | ***2.00 U*** | ***4.00 U*** | ***20 U*** | ***1000 U*** | ***1000 U*** | ***40 U*** | ***20 U*** | ***2.00 U*** |
| Dichloroethane, 1,2- | µg/L | $0.6^{B}$ | ***200 U*** | ***5.00 U*** | ***5.00 U*** | ***4.00 U*** | ***2.00 U*** | ***2.00 U*** | ***4.00 U*** | ***20 U*** | ***1000 U*** | ***1000 U*** | ***40 U*** | ***20 U*** | ***2.00 U*** |
| Benzene | µg/L | $1^{B}$ | ***200 U*** | ***1.75 U*** | ***1.75 U*** | ***1.40 U*** | 0.700 U | 0.700 U | ***1.40 U*** | ***7 U*** | ***350 U*** | ***350 U*** | ***14 U*** | ***20 U*** | 0.700 U |
| Xylene, m & p- | µg/L | $5_{**}^{B}$ | ***200 U*** | 5.00 U | 5.00 U | 4.00 U | 2.00 U | 2.00 U | 4.00 U | ***20 U*** | ***1000 U*** | ***1000 U*** | ***40 U*** | ***20 U*** | 2.00 U |
| Acetone | µg/L | $50^{A}$ | ***200 U*** | 25.0 U | 25.0 U | 20.0 U | 8.58 J | 10.0 U | 20.0 U | **53 J$^{A}$** | **3600 J$^{A}$** | ***5000 U*** | ***200 U*** | 8.9 J | 10.0 U |
| Methylene Chloride | µg/L | $5_{**}^{B}$ | ***200 U*** | ***12.5 U*** | ***12.5 U*** | ***10.0 U*** | 5.00 U | 5.00 U | ***10.0 U*** | ***50 U*** | ***2500 U*** | ***2500 U*** | ***100 U*** | ***20 U*** | 5.00 U |
| **Volatile Gases** | | | | | | | | | | | | | | | |
| Methane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | 190 | - | - |
| Ethane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | 5.8 | - | - |
| Ethene | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | 1.6 | - | - |
| **Inorganics** | | | | | | | | | | | | | | | |
| Arsenic | mg/L | $25^{B}$ | - | - | - | - | - | - | - | - | - | - | 0.01 U | - | 0.01U |
| Iron | mg/L | $300^{B}$ | - | - | - | - | - | - | - | - | - | - | 1.42 | - | 8.39 |
| Manganese | mg/L | $500^{B}$ | - | - | - | - | - | - | - | - | - | - | 0.912 | - | 0.27 |
| Sodium | mg/L | $20000^{B}$ | - | - | - | - | - | - | - | - | - | - | 912 | - | 78.1 |
| **General Chemistry Parameters** | | | | | | | | | | | | | | | |
| Alkalinity, Total (As CaCO$_3$) | mg/L | n/v | - | 155 | - | - | - | - | - | - | - | - | 220 | - | - |
| Chloride | mg/L | $250^{B}$ | - | 221 | - | - | - | - | - | - | - | - | 1480 | - | - |
| Nitrate (as N) | mg/L | n/v | - | 0.57 | - | - | - | - | - | - | - | - | 0.03 | - | - |
| Sulfate | mg/L | $250^{B}$ | - | 40.3 | - | - | - | - | - | - | - | - | 89.1 | - | - |
| Total Organic Carbon | mg/L | n/v | - | 3.1 | - | - | - | - | - | - | - | - | 2.2 | - | - |
| **Laboratory** | | | | | | | | | | | **SIREM** | | |
| **Laboratory Work Order** | | | | | | | | | | | | | **S-3420** | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | **DHC-11005** | | |
| **Gene-Trac Dehalococcoides Assay** | | | | | | | | | | | | | | | |
| Percent Dhc | % | n/v | - | - | - | - | - | - | - | - | - | - | NA | - | - |
| Dhc 16S rRNA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | 3000 U | - | - |
| Percent vcrA | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |
| vcrA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Laboratory** | | | | | | | | | | | | | **OU** | | |
| **Laboratory Work Order** | | | | | | | | | | | | | **872** | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | **MW-8** | | |
| **Carbon Stable Isotope Analysis (CSIA)** | | | | | | | | | | | | | | | |
| Trichloroethene δ$^{13}$C | ‰, VPDB | n/v | - | - | - | - | - | - | - | - | - | - | -31.3 | - | - |

\\US1275-F02\shared_projects\16059\docs\EISB Work Plan\Revised December 2014 draft and response to DEC comments\Tables\Revised Table 1.xlsx

# Table 1
## Summary of Groundwater Sample Analysis Results, 2006-2014
## Buell Automatics Site
## 381 Buell Road, Gates, New York
## Brownfield Clean-up Program Site # C828114

| Sample Location | | | MW-10 | MW-10R | MW-11 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Date** | | | 1-May-06 | 13-Nov-14 | 1-May-06 | 4-Aug-11 | 3-Nov-11 | 8-Mar-12 | 2-May-12 | 25-Jul-12 | 15-Nov-12 | 22-Feb-13 | 9-Jul-13 | 20-Mar-14 | 13-Nov-14 |
| **Sample ID** | | | BU-MW10-GW | BU-MW10R-W-111214 | BU-MW11-GW | MW-11 | MW-11 | MW-11 | MW-11 | BU-MW-11 | MW-11 | BU-MW-11-02222013 | MW-11 | BU-MW11-W-R1 | BU-MW11-W-111314 |
| **Sampling Company** | | | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC |
| **Sample Type** | **Units** | **TOGS** | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | |
| Dissolved Oxygen | mg/L | n/v | - | 0.44 | - | 0 | 1.4 | 0.81 | 0.3 | 0.29 | 0.29 | 7.19 | 2.19 | 5.55 | 6.78 |
| ORP | eV | n/v | - | -135.2 | - | -30 | 30 | 51 | -27.2 | 128.5 | -31.9 | 121.9 | -52.7 | 167.4 | 143.3 |
| pH | S.U. | n/v | 6.55 | 6.45 | 6.84 | 7.1 | 7.13 | 6.95 | 7.23 | 7.04 | 7.13 | 7.24 | 7.15 | 7.11 | 7.38 |
| Ferrous Iron | mg/L | n/v | - | - | - | 0.05 | - | - | - | - | - | - | - | - | 0 |
| **Laboratory** | | | CASR | PARAROCH | CASR | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH |
| **Laboratory Work Order** | | | R2631499 | 145009 | R2631499 | 11-3254A | P11-4774 | 12:1025 | 12:1882 | 12:3126 | 12:4794 | 130677 | 132537 | 141040 | 145009 |
| **Laboratory Sample ID** | | | UNKNOWN | 145009-01 | UNKNOWN | 10646 | 16037 | 12:1025-02 | 12:1882-03 | 12:3126-04 | 12:4794-03 | 130677-04 | 132537-05 | 141040-04 | 145009-05 |
| **TCL Volatile Organic Compounds Detected in Site Groundwater** | | | | | | | | | | | | | | | |
| Tetrachloroethylene (PCE) | µg/L | 5$_{**}^{B}$ | ***200 U*** | ***200 U*** | ***40 U*** | 4.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***20 U*** | ***10.0 U*** | ***20.0 U*** | 2.00 U |
| Trichloroethylene (TCE) | µg/L | 5$_{**}^{B}$ | **160 J$^{B}$** | **792 J$^{B}$** | **110$^{B}$** | **33.6$^{B}$** | **10.3$^{B}$** | **14.1$^{B}$** | **8.9$^{B}$** | **10.8$^{B}$** | **14.4$^{B}$** | **27$^{B}$** | **21.5$^{B}$** | **22.0$^{B}$** | **11.3$^{B}$** |
| Dichloroethylene, cis-1,2- | µg/L | 5$_{**}^{B}$ | **3000$^{B}$** | **3880$^{B}$** | **740$^{B}$** | **372$^{B}$** | **78.3$^{B}$** | **131$^{B}$** | **135$^{B}$** | **147$^{B}$** | **140$^{B}$** | **380$^{B}$** | **439$^{B}$** | **546$^{B}$** | **148$^{B}$** |
| Dichloroethylene, trans-1,2- | µg/L | 5$_{**}^{B}$ | ***200 U*** | ***200 U*** | 4 J | 4.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***20 U*** | ***10.0 U*** | ***20.0 U*** | 2.00 U |
| Vinyl chloride | µg/L | 2$^{B}$ | **910$^{B}$** | **260$^{B}$** | **45$^{B}$** | **23.5$^{B}$** | **5.29$^{B}$** | **14.2$^{B}$** | **13.9$^{B}$** | **10.8$^{B}$** | **13.0$^{B}$** | **19 J$^{B}$** | **24.4$^{B}$** | **22.0$^{B}$** | **6.99$^{B}$** |
| Trichloroethane, 1,1,1- | µg/L | 5$_{**}^{B}$ | ***200 U*** | ***200 U*** | **21 J$^{B}$** | 3.53 J | 2.00 U | 1.28 J | 1.02 J | 2.00 U | 2.00 U | ***20 U*** | ***10.0 U*** | ***20.0 U*** | 2.00 U |
| Dichloroethane, 1,1- | µg/L | 5$_{**}^{B}$ | **330$^{B}$** | **137$^{B}$** | **87$^{B}$** | **58.2$^{B}$** | **9.64$^{B}$** | **26.4$^{B}$** | **22$^{B}$** | **17.6$^{B}$** | **13.0$^{B}$** | **36$^{B}$** | **27.3$^{B}$** | **36.2$^{B}$** | **10.2$^{B}$** |
| Dichloroethene, 1,1- | µg/L | 5$_{**}^{B}$ | ***200 U*** | ***200 U*** | **6 J$^{B}$** | 3.22 J | 2.00 U | 1.44 J | 1.42 J | 1.30 J | 1.87 J | ***20 U*** | ***10.0 U*** | ***20.0 U*** | 1.64 J |
| Chloroethane | µg/L | 5$_{**}^{B}$ | ***200 U*** | ***200 U*** | ***40 U*** | 4.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***20 U*** | ***10.0 U*** | ***20.0 U*** | 2.00 U |
| Trichloroethane, 1,1,2- | µg/L | 1$^{B}$ | ***200 U*** | ***200 U*** | **2 J$^{B}$** | ***4.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***20 U*** | ***10.0 U*** | ***20.0 U*** | ***2.00 U*** |
| Dichloroethane, 1,2- | µg/L | 0.6$^{B}$ | ***200 U*** | ***200 U*** | ***40 U*** | ***4.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***20 U*** | ***10.0 U*** | ***20.0 U*** | ***2.00 U*** |
| Benzene | µg/L | 1$^{B}$ | ***200 U*** | ***200 U*** | ***40 U*** | ***1.40 U*** | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | ***7 U*** | ***3.50 U*** | ***7.00 U*** | 0.700 U |
| Xylene, m & p- | µg/L | 5$_{**}^{B}$ | ***200 U*** | ***200 U*** | ***40 U*** | 4.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | ***20 U*** | ***10.0 U*** | ***20.0 U*** | 2.00 U |
| Acetone | µg/L | 50$^{A}$ | ***200 U*** | ***200 U*** | 40 U | 20.0 U | 10.0 U | 10.0 U | 9.84 J | 5.45 J | 10.1 | ***100 U*** | 39.7 J | ***100 U*** | 10.0 U |
| Methylene Chloride | µg/L | 5$_{**}^{B}$ | ***200 U*** | ***200 U*** | ***40 U*** | ***10.0 U*** | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | ***50 U*** | ***25.0 U*** | ***50.0 U*** | 5.00 U |
| **Volatile Gases** | | | | | | | | | | | | | | | |
| Methane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | 0.92 J |
| Ethane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | 0.69 J |
| Ethene | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | 0.51 J |
| **Inorganics** | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 25$^{B}$ | - | 0.0324 | - | - | - | - | - | - | - | - | - | - | 0.01U |
| Iron | mg/L | 300$^{B}$ | - | 40.1 | - | - | - | - | - | - | - | - | - | - | 1.09 |
| Manganese | mg/L | 500$^{B}$ | - | 1.76 | - | - | - | - | - | - | - | - | - | - | 34.7 |
| Sodium | mg/L | 20000$^{B}$ | - | 567 | - | - | - | - | - | - | - | - | - | - | 134 |
| **General Chemistry Parameters** | | | | | | | | | | | | | | | |
| Alkalinity, Total (As $CaCO_3$) | mg/L | n/v | - | - | - | 295 | - | - | - | - | - | - | - | - | 230 |
| Chloride | mg/L | 250$^{B}$ | - | - | - | 194 | - | - | - | - | - | - | - | - | 341 |
| Nitrate (as N) | mg/L | n/v | - | - | - | 0.09 | - | - | - | - | - | - | - | - | 0.2 |
| Sulfate | mg/L | 250$^{B}$ | - | - | - | 114 | - | - | - | - | - | - | - | - | 108 |
| Total Organic Carbon | mg/L | n/v | - | 86.2 | - | 4.7 | - | - | - | - | - | - | - | - | 4.2 |
| **Laboratory** | | | | | | | | | | | | | | | |
| **Laboratory Work Order** | | | | | | | | | | | | | | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | | | |
| **Gene-Trac Dehalococcoides Assay** | | | | | | | | | | | | | | | |
| Percent Dhc | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dhc 16S rRNA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Percent vcrA | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |
| vcrA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Laboratory** | | | | | | | | | | | | | | | |
| **Laboratory Work Order** | | | | | | | | | | | | | | | |
| **Laboratory Sample ID** | | | | | | | | | | | | | | | |
| **Carbon Stable Isotope Analysis (CSIA)** | | | | | | | | | | | | | | | |
| Trichloroethene $\delta^{13}C$ | ‰, VPDB | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |

# Table 1
## Summary of Groundwater Sample Analysis Results, 2006-2014
## Buell Automatics Site
## 381 Buell Road, Gates, New York
## Brownfield Clean-up Program Site # C828114

| Sample Location |  |  | MW-14 |  |  |  |  |  |  |  |  |  | MW-15 |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Date** |  |  | **2-Aug-11** | **3-Nov-11** | **9-Mar-12** | **3-May-12** | **26-Jul-12** | **16-Nov-12** | **22-Feb-13** | **8-Jul-13** | **20-Mar-14** | **12-Nov-14** | **2-Aug-11** | **26-Jul-12** | **8-Jul-13** | **21-Mar-14** | **12-Nov-14** |
| **Sample ID** |  |  | **MW-14** | **MW-14** | **MW-714** | **MW-14** | **BU-MW-14** | **MW-14** | **BU-MW-14-02222013** | **MW-14** | **BU-MW14-W-R1** | **BU-MW14-W-111214** | **MW-15** | **BU-MW-15** | **MW-15** | **BU-MW15-W-R1** | **BU-MW15-W-111214** |
| **Sampling Company** |  |  | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** |
| **Sample Type** | **Units** | **TOGS** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Field Parameters** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dissolved Oxygen | mg/L | n/v | 0 | 2.1 | 2.55 | 1.19 | 0.28 | 1.95 | 2.25 | 0.26 | 5.06 | 0.55 | 0 | 0.24 | 1.44 | 7.06 | 0.99 |
| ORP | eV | n/v | -48 | 149 | 59 | 106.7 | 99.5 | -6.8 | 167.5 | -165.7 | 88.7 | 136.3 | 68 | 75.1 | -113.5 | 190.1 | 140.4 |
| pH | S.U. | n/v | 7.12 | 7.13 | 7.25 | 7.22 | 7.02 | 7.13 | 6.94 | 6.95 | 6.84 | 6.9 | 7.26 | 7.28 | 7.22 | 7.12 | 6.89 |
| Ferrous Iron | mg/L | n/v | 0.1 | - | - | - | - | - | - | - | - | - | 0.05 | - | - | - | - |
| **Laboratory** |  |  | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** |
| **Laboratory Work Order** |  |  | **11-3190A** | **P11-4774** | **12:1051** | **12:1907** | **12:3152** | **12:4815** | **130677** | **132537** | **141040** | **144993** | **11-3190A** | **12:3152** | **132537** | **141040** | **144993** |
| **Laboratory Sample ID** |  |  | **10468** | **16036** | **12:1051-03** | **12:1907-02** | **12:3152-02** | **12:4815-02** | **130677-01** | **132537-02** | **141040-07** | **144993-02** | **10467** | **12:3152-03** | **132537-03** | **141040-05** | **144993-03** |
| **TCL Volatile Organic Compounds Detected in Site Groundwater** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Tetrachloroethylene (PCE) | µg/L | $5_{**}^{B}$ | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethylene (TCE) | µg/L | $5_{**}^{B}$ | **$14.7^{B}$** | **$7.18^{B}$** | 3.11 | 3.29 | **$5.56^{B}$** | **$5.17^{B}$** | 2.8 | **$6.67^{B}$** | 2.62 | **$5.62^{B}$** | 1.29 J | 1.49 J | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethylene, cis-1,2- | µg/L | $5_{**}^{B}$ | **$172^{B}$** | **$112^{B}$** | **$41.8^{B}$** | **$40.1^{B}$** | **$54.9^{B}$** | **$53.4^{B}$** | **$32^{B}$** | **$52.4^{B}$** | **$23.2^{B}$** | **$51.4^{B}$** | 3.65 | 4.21 | 4.26 | 1.31 J | **$13.3^{B}$** |
| Dichloroethylene, trans-1,2- | µg/L | $5_{**}^{B}$ | 1.65 J | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 1.05 J | 2.00 U | 1.05 J | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Vinyl chloride | µg/L | $2^{B}$ | **$15.7^{B}$** | **$6.15^{B}$** | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 1.34 J | 2.00 U | 3.04 | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethane, 1,1,1- | µg/L | $5_{**}^{B}$ | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethane, 1,1- | µg/L | $5_{**}^{B}$ | **$30.0^{B}$** | **$21.9^{B}$** | **$11.1^{B}$** | **$11.3^{B}$** | **$14.1^{B}$** | **$16.1^{B}$** | **$9.1^{B}$** | **$13.6^{B}$** | **$5.71^{B}$** | **$14.6^{B}$** | 1.07 J | 1.07 J | 2.00 U | 2.00 U | 1.17 J |
| Dichloroethene, 1,1- | µg/L | $5_{**}^{B}$ | 2.60 | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Chloroethane | µg/L | $5_{**}^{B}$ | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethane, 1,1,2- | µg/L | $1^{B}$ | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** |
| Dichloroethane, 1,2- | µg/L | $0.6^{B}$ | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** |
| Benzene | µg/L | $1^{B}$ | 0.351 J | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U |
| Xylene, m & p- | µg/L | $5_{**}^{B}$ | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 1.04 J B | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Acetone | µg/L | $50^{A}$ | 10.0 U | 10.0 U | 10.0 U | 8.96 J | 10.0 U | 10.0 U | 10.0 U | 6.86 J | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U | 10.0 U |
| Methylene Chloride | µg/L | $5_{**}^{B}$ | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| **Volatile Gases** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Methane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ethane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ethene | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Inorganics** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Arsenic | mg/L | $25^{B}$ | - | - | - | - | - | - | - | - | - | 0.01U | - | - | - | - | 0.01U |
| Iron | mg/L | $300^{B}$ | - | - | - | - | - | - | - | - | - | 0.417 | - | - | - | - | 0.185 |
| Manganese | mg/L | $500^{B}$ | - | - | - | - | - | - | - | - | - | 6.56 | - | - | - | - | 2.13 |
| Sodium | mg/L | $20000^{B}$ | - | - | - | - | - | - | - | - | - | 683 | - | - | - | - | 602 |
| **General Chemistry Parameters** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Alkalinity, Total (As $CaCO_3$) | mg/L | n/v | 275 | - | - | - | - | - | - | - | - | - | 260 | - | - | - | - |
| Chloride | mg/L | $250^{B}$ | 130 | - | - | - | - | - | - | - | - | - | **$273^{B}$** | - | - | - | - |
| Nitrate (as N) | mg/L | n/v | 0.02 U | - | - | - | - | - | - | - | - | - | 0.36 | - | - | - | - |
| Sulfate | mg/L | $250^{B}$ | **$307^{B}$** | - | - | - | - | - | - | - | - | - | 169 | - | - | - | - |
| Total Organic Carbon | mg/L | n/v | 6.8 | - | - | - | - | - | - | - | - | - | 3.3 | - | - | - | - |
| **Laboratory** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Laboratory Work Order** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Laboratory Sample ID** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Gene-Trac Dehalococcoides Assay** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Percent Dhc | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dhc 16S rRNA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Percent vcrA | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| vcrA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Laboratory** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Laboratory Work Order** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Laboratory Sample ID** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Carbon Stable Isotope Analysis (CSIA)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Trichloroethene $\delta^{13}C$ | ‰, VPDB | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## Table 1
## Summary of Groundwater Sample Analysis Results, 2006-2014
## Buell Automatics Site
## 381 Buell Road, Gates, New York
## Brownfield Clean-up Program Site # C828114

| Sample Location |  |  | MW-16 |  |  |  |  |  |  |  |  |  |  |  |  | MW-16R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date |  |  | 1-May-06 | 1-May-06 | 1-May-06 | 15-Sep-06 | 5-Aug-11 | 2-Nov-11 | 9-Mar-12 | 3-May-12 | 26-Jul-12 | 16-Nov-12 | 21-Feb-13 | 8-Jul-13 | 20-Mar-14 | 14-Nov-14 |
| Sample ID |  |  | BU-DUP-GW | BU-MW16-GW | BU-MW16-GW | BU-MW16-GW | MW-16 | MW-16 | MW-16 | MW-16 | BU-MW-16 | MW-16 | BU-MW-16 022113 | MW-16 | BU-MW16-W-R1 | BU-MW16R-W-111414 |
| Sampling Company |  |  | STANTEC | DEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC | STANTEC |
| Sample Type | Units | TOGS | Field Duplicate |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Field Parameters** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dissolved Oxygen | mg/L | n/v | - | - | - | - | 3.08 | 1 | 5.69 | 0.09 | 4.61 | 0.31 | 1.95 | 0.06 | 0.18 | 0.23 |
| ORP | eV | n/v | - | - | - | - | -159 | -97 | -16 | 10.5 | -59.6 | -122.2 | -78.4 | -224.7 | -84 | -92.2 |
| pH | S.U. | n/v | 6.59 | - | 6.59 | 6.85 | 6.82 | 6.64 | 6.83 | 7.12 | 7.37 | 6.94 | 6.96 | 7.08 | 6.95 | 6.53 |
| Ferrous Iron | mg/L | n/v | - | - | - | - | 0.12 | - | - | - | - | - | - | - | - | 1.74 |
| **Laboratory** |  |  | CASR | DECNY | CASR | CASR | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH | PARAROCH |
| **Laboratory Work Order** |  |  | R2631499 | DEC | R2631499 | R2633662 | 11-3269A | P11-4734 | 12:1051 | 12:1907 | 12:3152 | 12:4815 | 130663 | 132537 | 141040 | 145009 |
| **Laboratory Sample ID** |  |  | UNKNOWN | UNKNOWN | UNKNOWN | UNKNOWN | 10739 | 15930 | 12:1051-02 | 12:1907-01 | 12:3152-04 | 12:4815-03 | 130663-01 | 132537-01 | 141040-06 | 145009-01 |
| **TCL Volatile Organic Compounds Detected in Site Groundwater** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Tetrachloroethylene (PCE) | µg/L | $5_{**}^{B}$ | 200 U | 5 U | 4000 U | 1000 U | 200 U | 500 U | 200 U | 200 U | 100 U | 40.0 U | 50 U | 200 U | 200 U | 200 U |
| Trichloroethylene (TCE) | µg/L | $5_{**}^{B}$ | 170 J$^{B}$ | 7800 D$^{B}$ | 8200$^{B}$ | 15000$^{B}$ | 200 U | 500 U | 737$^{B}$ | 610$^{B}$ | 133$^{B}$ | 83.1$^{B}$ | 50$^{B}$ | 200 U | 200 U | 1670 J$^{B}$ |
| Dichloroethylene, cis-1,2- | µg/L | $5_{**}^{B}$ | 2800$^{B}$ | 160000 D$^{B}$ | 120000 D$^{B}$ | 150000$^{B}$ | 22900$^{B}$ | 22700$^{B}$ | 12400$^{B}$ | 13900$^{B}$ | 3240$^{B}$ | 3210$^{B}$ | 2900$^{B}$ | 2590$^{B}$ | 1060$^{B}$ | 5070$^{B}$ |
| Dichloroethylene, trans-1,2- | µg/L | $5_{**}^{B}$ | 31 J$^{B}$ | 900 E$^{B}$ | 4000 U | 1000 U | 200 U | 500 U | 200 U | 200 U | 100 U | 40.0 U | 50 U | 200 U | 200 U | 200 U |
| Vinyl chloride | µg/L | $2^{B}$ | 890$^{B}$ | 520 E$^{B}$ | 640 J$^{B}$ | 1000 U | 11800$^{B}$ | 6100$^{B}$ | 2430$^{B}$ | 3620$^{B}$ | 230$^{B}$ | 2130$^{B}$ | 1400$^{B}$ | 2140$^{B}$ | 1340$^{B}$ | 200 U |
| Trichloroethane, 1,1,1- | µg/L | $5_{**}^{B}$ | 200 U | 3900 D$^{B}$ | 4000$^{B}$ | 5800$^{B}$ | 1610$^{B}$ | 1540$^{B}$ | 2310$^{B}$ | 2220$^{B}$ | 95.7 J$^{B}$ | 280$^{B}$ | 710$^{B}$ | 421$^{B}$ | 733$^{B}$ | 101$^{B}$ |
| Dichloroethane, 1,1- | µg/L | $5_{**}^{B}$ | 340$^{B}$ | 3300 D$^{B}$ | 2800 J$^{B}$ | 3600$^{B}$ | 1800$^{B}$ | 1670$^{B}$ | 1080$^{B}$ | 1310$^{B}$ | 112$^{B}$ | 410$^{B}$ | 350$^{B}$ | 473$^{B}$ | 268$^{B}$ | 181$^{B}$ |
| Dichloroethene, 1,1- | µg/L | $5_{**}^{B}$ | 200 U | 670 E$^{B}$ | 780 J$^{B}$ | 1600$^{B}$ | 233$^{B}$ | 500 U | 203$^{B}$ | 158 J$^{B}$ | 52.3 J$^{B}$ | 57.2$^{B}$ | 39$^{B}$ | 200 U | 200 U | 200 U |
| Chloroethane | µg/L | $5_{**}^{B}$ | 200 U | 5 U | 4000 U | 2000 U | 200 U | 500 U | 200 U | 200 U | 100 U | 40.0 U | 50 U | 200 U | 200 U | 200 U |
| Trichloroethane, 1,1,2- | µg/L | $1^{B}$ | 200 U | 65$^{B}$ | 4000 U | 1000 U | 200 U | 500 U | 200 U | 200 U | 100 U | 40.0 U | 50 U | 200 U | 200 U | 200 U |
| Dichloroethane, 1,2- | µg/L | $0.6^{B}$ | 200 U | 4.5 J$^{B}$ | 4000 U | 1000 U | 200 U | 500 U | 200 U | 200 U | 100 U | 40.0 U | 50 U | 200 U | 200 U | 200 U |
| Benzene | µg/L | $1^{B}$ | 200 U | 5.6$^{B}$ | 4000 U | 1000 U | 70.0 U | 175 U | 70.0 U | 70.0 U | 35.0 U | 14.0 U | 18 U | 70.0 U | 70.0 U | 704$^{B}$ |
| Xylene, m & p- | µg/L | $5_{**}^{B}$ | 200 U | 15 U | 4000 U | 1000 U | 200 U | 500 U | 200 U | 200 U | 100 U | 40.0 U | 50 U | 108 J B$^{B}$ | 200 U | 200 U |
| Acetone | µg/L | $50^{A}$ | 200 U | 25 U | 4000 U | 10000 U | 1000 U | 2500 U | 1000 U | 944 J$^{A}$ | 777$^{A}$ | 163 J$^{A}$ | 250 U | 653 J$^{A}$ | 1000 U | 1000 U |
| Methylene Chloride | µg/L | $5_{**}^{B}$ | 200 U | 5 U | 4000 U | 1000 U | 500 U | 1250 U | 500 U | 500 U | 250 U | 77.7 J$^{B}$ | 130 U | 500 U | 500 U | 200 U |
| **Volatile Gases** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Methane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | 18 |
| Ethane | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | 11 |
| Ethene | µg/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - | 14 |
| **Inorganics** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Arsenic | mg/L | $25^{B}$ | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.0312 |
| Iron | mg/L | $300^{B}$ | - | - | - | - | - | - | - | - | - | - | - | - | - | 47 |
| Manganese | mg/L | $500^{B}$ | - | - | - | - | - | - | - | - | - | - | - | - | - | 3.25 |
| Sodium | mg/L | $20000^{B}$ | - | - | - | - | - | - | - | - | - | - | - | - | - | 1500 |
| **General Chemistry Parameters** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Alkalinity, Total (As $CaCO_3$) | mg/L | n/v | - | - | - | - | 340 | - | - | - | - | - | - | - | - | 380 |
| Chloride | mg/L | $250^{B}$ | - | - | - | - | 1370$^{B}$ | - | - | - | - | - | - | - | - | 854 |
| Nitrate (as N) | mg/L | n/v | - | - | - | - | 0.02 U | - | - | - | - | - | - | - | - | 0.04 |
| Sulfate | mg/L | $250^{B}$ | - | - | - | - | 39.5 | - | - | - | - | - | - | - | - | 3490 |
| Total Organic Carbon | mg/L | n/v | - | - | - | - | 25.5 | - | - | - | - | - | - | - | - | 164 |
| **Laboratory** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Laboratory Work Order** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Laboratory Sample ID** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Gene-Trac Dehalococcoides Assay** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Percent Dhc | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |  |
| Dhc 16S rRNA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |  |
| Percent vcrA | % | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |  |
| vcrA Gene Copies | #/L | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |  |
| **Laboratory** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Laboratory Work Order** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Laboratory Sample ID** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Carbon Stable Isotope Analysis (CSIA)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Trichloroethene $\delta^{13}C$ | ‰, VPDB | n/v | - | - | - | - | - | - | - | - | - | - | - | - | - |  |

## Table 1
## Summary of Groundwater Sample Analysis Results, 2006-2014
## Buell Automatics Site
## 381 Buell Road, Gates, New York
## Brownfield Clean-up Program Site # C828114

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sample Location** | | | **MW-17** | | | | | | |
| **Sample Date** | | | **1-May-06** | **1-May-06** | **15-Sep-06** | **3-Aug-11** | **3-Nov-11** | **8-Mar-12** | **2-May-12** |
| **Sample ID** | | | **BU-MW17-GW** | **BU-MW17-GW** | **BU-MW17-GW** | **MW-17** | **MW-17** | **MW-17** | **MW-17** |
| **Sampling Company** | | | **DEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** | **STANTEC** |
| **Sample Type** | **Units** | **TOGS** | | | | | | | |
| **Field Parameters** | | | | | | | | | |
| Dissolved Oxygen | mg/L | n/v | - | - | - | 0 | 0.7 | 2.36 | 8.35 |
| ORP | eV | n/v | - | - | - | -30 | -29 | 138 | 163.4 |
| pH | S.U. | n/v | - | 7.2 | 7.23 | 7.16 | 7.2 | 6.72 | 7.41 |
| Ferrous Iron | mg/L | n/v | - | - | - | 0 | - | - | - |
| **Laboratory** | | | **DECNY** | **CASR** | **CASR** | **PARAROCH** | **PARAROCH** | **PARAROCH** | **PARAROCH** |
| **Laboratory Work Order** | | | **DEC** | **R2631499** | **R2633662** | **11-3216A** | **P11-4774** | **12:1025** | **12:1882** |
| **Laboratory Sample ID** | | | **UNKNOWN** | **UNKNOWN** | **UNKNOWN** | **10550** | **16039** | **12:1025-01** | **12:1882-01** |
| **TCL Volatile Organic Compounds Detected in Site Groundwater** | | | | | | | | | |
| Tetrachloroethylene (PCE) | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethylene (TCE) | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethylene, cis-1,2- | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethylene, trans-1,2- | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Vinyl chloride | µg/L | $2^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethane, 1,1,1- | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethane, 1,1- | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Dichloroethene, 1,1- | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Chloroethane | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 2 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Trichloroethane, 1,1,2- | µg/L | $1^{B}$ | 1 U | ***10 U*** | 1 U | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** |
| Dichloroethane, 1,2- | µg/L | $0.6^{B}$ | ***1 U*** | ***10 U*** | ***1 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** | ***2.00 U*** |
| Benzene | µg/L | $1^{B}$ | 1 U | ***10 U*** | 1 U | 0.700 U | 0.700 U | 0.700 U | 0.700 U |
| Xylene, m & p- | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Acetone | µg/L | $50^{A}$ | 1 U | 10 U | 10 U | 5.70 J | 10.0 U | 10.0 U | 7.02 J |
| Methylene Chloride | µg/L | $5_{**}^{B}$ | 1 U | ***10 U*** | 1 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| **Volatile Gases** | | | | | | | | | |
| Methane | µg/L | n/v | - | - | - | - | - | - | - |
| Ethane | µg/L | n/v | - | - | - | - | - | - | - |
| Ethene | µg/L | n/v | - | - | - | - | - | - | - |
| **Inorganics** | | | | | | | | | |
| Arsenic | mg/L | $25^{B}$ | - | - | - | - | - | - | - |
| Iron | mg/L | $300^{B}$ | - | - | - | - | - | - | - |
| Manganese | mg/L | $500^{B}$ | - | - | - | - | - | - | - |
| Sodium | mg/L | $20000^{B}$ | - | - | - | - | - | - | - |
| **General Chemistry Parameters** | | | | | | | | | |
| Alkalinity, Total (As $CaCO_3$) | mg/L | n/v | - | - | - | 285 | - | - | - |
| Chloride | mg/L | $250^{B}$ | - | - | - | 147 | - | - | - |
| Nitrate (as N) | mg/L | n/v | - | - | - | 0.02 U | - | - | - |
| Sulfate | mg/L | $250^{B}$ | - | - | - | 84.9 | - | - | - |
| Total Organic Carbon | mg/L | n/v | - | - | - | 5.1 | - | - | - |
| **Laboratory** | | | | | | | | | |
| **Laboratory Work Order** | | | | | | | | | |
| **Laboratory Sample ID** | | | | | | | | | |
| **Gene-Trac Dehalococcoides Assay** | | | | | | | | | |
| Percent Dhc | % | n/v | - | - | - | - | - | - | - |
| Dhc 16S rRNA Gene Copies | #/L | n/v | - | - | - | - | - | - | - |
| Percent vcrA | % | n/v | - | - | - | - | - | - | - |
| vcrA Gene Copies | #/L | n/v | - | - | - | - | - | - | - |
| **Laboratory** | | | | | | | | | |
| **Laboratory Work Order** | | | | | | | | | |
| **Laboratory Sample ID** | | | | | | | | | |
| **Carbon Stable Isotope Analysis (CSIA)** | | | | | | | | | |
| Trichloroethene $\delta^{13}C$ | ‰, VPDB | n/v | - | - | - | - | - | - | - |

**Table 1**
**Summary of Groundwater Sample Analysis Results, 2006-2014**
**Buell Automatics Site**
**381 Buell Road, Gates, New York**
**Brownfield Clean-up Program Site # C828114**

## Notes:

| | |
|---|---|
| TOGS | NYSDEC TOGS 1.1.1 (Reissued June 1998 with errata in January 1999 and addenda in April 2000 and June 2004) |
| $^A$ | TOGS 1.1.1 - Table 1 - Ambient Water Quality Standards and Guidance Values, Division of Water, Technical and Operational Guidance Series (TOGS 1.1.1); Guidance |
| $^B$ | TOGS 1.1.1 - Table 1 - Ambient Water Quality Standards and Guidance Values, Division of Water, Technical and Operational Guidance Series (TOGS 1.1.1); Standards |
| **6.5$^A$** | Concentration exceeds the indicated standard. |
| 15.2 | Concentration was detected but did not exceed applicable standards. |
| ***0.50 U*** | Laboratory reportable detection limit exceeded standard. |
| 0.03 U | The analyte was not detected above the laboratory reportable detection limit. |
| n/v | No standard/guideline value. |
| - | Parameter not analyzed / not available. |
| $^{**}$ | The principal organic contaminant standard for groundwater of 5 ug/L (described elsewhere in the TOGS table) applies to this substance. |
| $^p$ | Applies to the sum of cis- and trans-1,3-dichloropropene. |
| B | Indicates analyte was found in associated blank, as well as in the sample. |
| D | Indicates reanalysis of sample with additional dilution to address exceedance of instrument calibration range. |
| E | Result exceeded calibration range. |
| J | The reported result is an estimated value. |
| δ13C, ‰, VPDB | Carbon 13 delta, parts per thousand, relative to Vienna Pee Dee Belemnite |
| vcrA | Vinyl chloride reductase |
| Dhc | Dehalococcoides |

# Appendix A

## Treatability Testing Report, Oxidative and Reductive Treatment Technologies for Chlorinated Compounds in Soil and Groundwater

# TREATABILITY TESTING REPORT
# OXIDATIVE AND REDUCTIVE TREATMENT TECHNOLOGIES FOR CHLORINATED COMPOUNDS IN SOIL AND GROUNDWATER

**Prepared for**:

Buell Automatics, Inc. Site
381 Buell Road
Rochester, New York

**Submitted to:**

Stantec Consulting Services, Inc.
2250 Brighton Henrietta Townline Road
Rochester, New York 14623

**Submitted by:**

Stantec Consulting Corporation
Treatability Testing Services Group
4035 King Road
Suite D
Sylvania, Ohio 43560

March 13, 2009

# EXECUTIVE SUMMARY

Soil and groundwater at the Buell Automatics, Inc. Site (Site) in Rochester, New York (Site) have become impacted with trichloroethene (TCE) and 1,1,1-trichloroethane (1,1,1-TCA). Subsurface conditions have resulted in the further production of the daughter products cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), 1,1-dichloroethene (1,1-DCE) and vinyl chloride (VC). A bench-scale, treatability study was conducted by Stantec Consulting's (Stantec) Treatability Testing Services Group in Sylvania, Ohio to determine the efficacy of applying biological reductive treatment using enhanced reductive dechlorination (ERD) and/or the in-situ oxidation (ISCO) technologies using potassium permanganate and Fenton's oxidation to address the contaminants of concern at the Site.

The major driving force for biodegradation involves the transfer of energy in the form of electrons. During ERD, the halogenated hydrocarbon acts as an electron acceptor, therefore requiring an additional carbon source to act as an electron donor for the reaction to proceed. Three different electron donors were tested as part of the treatability study. The evaluated donor solutions consisted of sodium lactate, sodium acetate, and an organic acid solution prepared by fermentation of sucrose and galactoamannan polymer.

Treatability testing results for reductive dechlorination indicated the application of a remediation program employing ERD has been demonstrated to be a viable technology option for addressing chlorinated solvent impacts of the groundwater and saturated soils at the Site. During testing, the best contaminant reduction and process performance was observed using a mixture of organic acids as a supplemental electron donor for the ERD process, when compared to sodium lactate and sodium acetate. The addition of the organic acid mixture created the required reduced conditions within the microcosm test samples, and degraded TCE, cis-1,2-DCE, trans-1,2-DCE, and VC to levels below analytical detection limits. Testing was also performed to evaluate degradation of 1,1,1-TCA, and the organic acid mixture produce an 86% reduction in microcosm sample levels for this compound within 56 days of testing. Laboratory testing conducted by SiREM Laboratories, Inc. (SiREM) in Guelph, Ontario, Canada identified moderate population levels of *dehalococcoides* bacteria (required for cis-1,2-DCE degradation) at the Site. The SiREM results, coupled with the ERD treatability testing, indicated a viable population of *dehalococcoides* bacteria is present within the proposed treatment area in the vicinity of MW-2.

The results of the treatability testing further showed that Fenton's oxidation will not be effective for this site. The buffer capacity of the soil exceeds five percent calcium carbonate, making it both technically and economically difficult to lower the pH to optimal ranges for Fenton's oxidation. Permanganate oxidation could be effective for this site for treatment of TCE and other chlorinated alkene compounds. The natural oxidant demand (NOD) for the soil was moderate at a rate of six pounds of permanganate per cubic yard of saturated soil system. However, the treatment performs poorly for 1,1,1-TCA and other chlorinated alkanes.

It is recommended that the results of the bench-scale treatability study be extrapolated to a field implementation of the ERD process at the Site, using an organic acid mixture as the electron donor to supplement the biological process. It is anticipated that the donor solution would be delivered to the subsurface using temporary injection wells installed using a hydraulic probing unit. Following electron donor injection, existing monitoring wells would be used as sampling locations to evaluate remedial performance by monitoring the parameters of concern for the ERD process – pH, ORP, VOCs, dissolved metals, and *dehalococcoides* populations.

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS (Continued)

## TABLES

## FIGURES

## APPENDICIES

# 1.0 INTRODUCTION

Stantec Consulting (Stantec) was contracted to conduct a bench-scale treatability study to determine the efficacy of applying oxidative and/or reductive remediation technologies to address subsurface chlorinated compound impacts at the Buell Automatics, Inc. Site in Rochester, New York (Site). The following report summarizes the results and activities of treatability testing conducted by Stantec's Treatability Testing Services Group located in Sylvania, Ohio. Data obtained from the bench-scale, treatability testing will be used to help select a treatment alternative for future field application.

## 1.1 SITE DESCRIPTION

The subsurface of the Site has been impacted with the volatile organic compounds (VOCs) tetrachloroethene (PCE) trichloroethene (TCE), 1,1,1-trichloroethane (TCA), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethylene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), and vinyl chloride (VC). Based on observations of soil and groundwater samples collected from the Site and submitted for testing, the subsurface saturated zone to be addressed during remediation activities is comprised of fine silty sand.

## 1.2 TREATMENT TECHNOLOGY DESCRIPTION

Chlorinated solvents are recalcitrant compounds that are difficult to remove from soils and groundwater using conventional treatment technologies. In recent years, reductive and oxidative technologies have been used to remediate these contaminants in situations that were once thought to be untreatable. Oxidative technologies include treatments such as chemical oxidation by Fenton's reagent, permanganate or ozone. Reductive treatments typically involve enhanced biological reductive treatment or treatment of groundwater using dissolving metal reactions. This report summarizes the results of testing performed to evaluate both reductive and oxidative treatment technologies as applied under site-specific conditions and how those conditions enhance or interfere with the effectiveness of the technologies.

### 1.2.1 REDUCTIVE TREATMENT TECHNOLOGIES

Reductive dechlorination is a natural process in which native bacteria in soils and groundwater degrade contaminants in the environment. In this process, the chlorinated solvent serves as an electron acceptor (or weak oxidizing agent) that is reduced by electrochemical reactions with other chemicals in the groundwater that serve as electron donors. Typical electron donors include natural organic carbon, dissolved hydrocarbon gases and dissolved hydrogen. For reductive dechlorination to occur, the supply of electron donors must meet or exceed the concentration of chlorinated solvents in the groundwater when evaluated in terms of an electron balance. The available electron donors must also be capable of driving the desired biochemical reactions without interferences from other electron acceptors.

Sites containing low concentrations of chlorinated solvents are often good candidates for natural reductive dechlorination because natural electron donors and electron acceptors are often balanced. However, at higher concentrations, natural reductive processes often become limited due to an inadequate supply of electron donors. Enhanced reductive dechlorination may be used to artificially stimulate degradation and increase the kinetics of contaminant destruction under rate-limited site conditions.

Process enhancement may be accomplished by adding a supplemental electron donor into the groundwater to balance the electrochemistry. The artificial electron donor should be carbon-based so that it also provides the substrate necessary to fuel biological growth. This carbon source may consist of carbohydrates, organic acids, alcohols, alkanes, aromatics, glycerides, or other hydrocarbons that possess some degree of aqueous solubility. Carbohydrates or lactate are most often added to the subsurface to increase the availability of electron donors to enhance reductive dechlorination, but other carbon-based electron donors may also be used. Supplemental addition of electron donors has the ability to increase reaction kinetics for reductive dechlorination by one to two orders of magnitude. This is significant because the destructive half-life for a compound like PCE may be reduced from greater than 1,000 days to a half-life in the range of 50 to 100 days.

Iron and manganese removal is a treatment that can be coupled with the enhanced reductive dechlorination technology. When electron donors are added to the groundwater to stimulate reductive dechlorination, the resulting reductive conditions can cause an increase in dissolved iron and manganese in the groundwater. After the enhanced reductive dechlorination has taken place and chlorinated compounds have reached cleanup standards, any iron and/or manganese releases can be controlled by adjusting the pH of the groundwater to prevent dissolution and to precipitate dissolved metals in place. This can be accomplished by the injection of soluble bases like sodium carbonates or hydroxides. The treatment is repeated until the pH within the plume has been raised to a level of approximately 9.3. At this pH, manganese and iron are readily oxidized to the +4 and +3 respectively, valence states where they become insoluble.

### 1.2.1.1 Electron Acceptor Competition

The major driving force for biodegradation involves the transfer of energy in the form of electrons. During reductive dechlorination, the halogenated hydrocarbon acts as an electron acceptor, therefore requiring an additional carbon source for the reaction to proceed. Hydrogen and electrons are produced as this carbon source undergoes a variety of cleavage, hydrolysis, dehydrogenation, and/or substitution reactions. The resulting energy is then used to replace the halogen (chlorine in the case of TCE) with hydrogen through reductive reactions such as hydrogenolysis or dihaloelimination. The following reaction shows the reduction of TCE to cis-1,2-DCE:

$$C_2HCl_3 + H^+ + 2e \rightarrow C_2H_2Cl_2 + Cl^-$$

In anaerobic environments, complete degradation of organic contaminants typically occurs from the interactions between several specialized microorganisms. Metabolite intermediates produced by one organism are often required by others within the group. As a result, several inorganic electron acceptors, including nitrates, sulfates, carbonates, ferric iron, and manganese oxide, may also be consumed during the overall biological process.

The addition of supplemental electron donors to the subsurface can result in competition with other electron acceptors for the new supply of electrons. Oxygen will scavenge electron donors faster than most other electron acceptors, and is a significant interference to reductive dechlorination. Similarly, denitrification occurs readily in the presence of dissolved carbon, so nitrates typically out-compete the chlorinated solvents for electrons. Denitrification and nitrate reduction may occur by the following reactions:

Denitrification: $2NO_3 + 12H^+ + 10e \rightarrow N_2 + 6H_2O$

Nitrate Reduction: $NO_3 + 10H^+ + 8e \rightarrow NH_4 + 3H_2O$

Ferric iron ($Fe^{+3}$) and manganese ($Mn^{+4}$) also compete for electrons from supplemental carbon sources, but the limited solubility of these metals makes them less of an interference when compared to nitrates or oxygen. Iron and manganese reduction occur by the following reactions:

Iron Reduction: $Fe^{+3} + 1e \rightarrow Fe^{+2}$
Manganese Reduction: $Mn^{+4} + 2e \rightarrow Mn^{+2}$

Reductive dechlorination will occur simultaneously with iron and manganese reduction. Therefore, the presence of these dissolved metals in groundwater is typically viewed as an indicator of favorable reductive conditions, rather than a competitive threat. However, the increased concentrations of dissolved iron and manganese associated with reductive treatment may require secondary post-treatment to geochemically sequester the metals back into a non-soluble state. This may be accomplished naturally by metal sulfide precipitates or by the addition of a dissolved carbonate or hydroxide salts.

Sulfates may compete with chlorinated solvents as an electron acceptor. An example of this reaction with acetate is shown below:

Sulfate Reduction: $SO_4^{-2} + CH_3COO^- + H^+ \rightarrow H_2S + 2HCO_3^-$

The issue of whether sulfate will inhibit reductive dechlorination appears to be related to overall Site geochemistry issues rather than sulfate itself. Hoelen and Reinhard[1] demonstrated that dehalogenation of chlorinated ethenes can occur in moderately high sulfate concentrations in the range of 100 to 250 milligrams per liter (mg/l). Some patented biological treatment processes for dehalogenation actually require the addition of sulfates as part of the process.[2] Thus, the presence of elevated sulfate concentrations does not necessarily mean that enhanced reductive treatment processes will be inhibited. In fact, the kinetics of reductive dechlorination have been observed to substantially increase under sulfate reducing conditions. The normally slower degradation rates of daughter products from TCE such as 1,2-DCE can approach the degradation rate of TCE under sulfate reducing or methanogenic conditions. Methanogenic reduction occurs in electron-acceptor starved systems where carbon dioxide serves as the electron donor via the following reaction:

Methane Fermentation: $CO_2 + 8H^+ + 8e \rightarrow CH_4 + 2H_2O$

Since the chlorinated contaminants serve as electron acceptors, subsurface conditions need to be optimized during enhanced reductive dechlorination applications to ensure

---

[1] T.P. Hoelen and M. Reinhard, *Complete biological dehalogenation of chlorinated ethylenes in sulfate containing groundwater*, BIOREMEDIATION, Vol. 15, pp. 395-403, 2004.

[2] Beeman, U.S. Pat. 5,277,815; Saunders, U.S. Pat. 5,833,855; Suthersan, U.S. Pat. 6,322,700

that competition reactions with the naturally-occurring electron acceptors are minimized. The potential free energy that can be generated by a microorganism determines the preference for an individual electron acceptor. As subsurface conditions become more reduced, the preference for contaminant reduction increases. Consequently, more chlorinated compounds will be reduced under methanogenic conditions than denitrification.

### 1.2.1.2 Biological Factors

Reductive dechlorination in this report is discussed primarily in terms of the electrochemical reactions that surround the reductive dechlorination process. These reactions are biologically driven and will proceed only if the indigenous bacteria in the soil are capable of producing the desired biochemical reactions. Bacteria such as *dehalospirillum multivorans*, *dehalobacter restrictus, defulfitobecterium, clostricium bifermentans, desulfuromonas, dehalococcoides ethenogenes* and others are responsible for the degradation of chlorinated solvents in subsurface environments. While these bacteria and their associated biodegradation mechanisms are important, they were not explored in this treatability study, with the exception of *dehalococcoides*.

*Dehalococcoides* bacteria are responsible for the complete dechlorination of cis-1,2-DCE, and in its absence, the overall reductive dechlorination process stalls with the production of this compound. Therefore, baseline population data for *dehalococcoides* were obtained as part of the bench-scale test. The testing involved the collection of groundwater from the planned treatment plume area for analysis by method of polymerase chain reaction (PCR) to detect if specific target sequences of DNA unique to the 16s rRNA gene of *dehaloccoides* bacteria.

Vinyl chloride has been detected in multiple wells during regular groundwater monitoring events conducted at the Site. The presence of VC indicates that a *dehalococcoides* population likely exists at the Site, but it does not confirm a site-wide spatial population. Bench-scale testing is often used to determine if low populations of *dehalococcoides* (i.e. false negatives by PCR analysis due to low cell count) can be stimulated under reducing conditions. The focus of this portion of the treatability study was on *in-situ* chemical enhancements to increase the kinetics of reductive dechlorination by indigenous bacteria rather than bacteria identification.

### 1.2.1.3 Electron Donor Selection

Selection of the proper electron donor is dependent on the physical properties of the contaminants, the geology of the subsurface, and the estimated clean-up time frames. The complexity and solubility of the proposed carbon source needs to be accounted for when evaluating contact limitation and availability issues. Several documented studies have been conducted using carbon sources ranging from simple sugars to more complex food oils.

Less complex electron donors such as sucrose, alcohols, lactate, and acetate can be advantageous due to their higher solubilities and lower molecular weights. These compounds readily dissolve in the groundwater and are quickly accessible for the indigenous microorganisms. The lower molecular weight compounds are more easily metabolized, thereby minimizing acclimation periods.

The same physical properties can prove disadvantageous for long-term remedial applications, however. Since the compounds are readily accessible to the microorganisms, they are more quickly metabolized. Frequent, repeat injections can be required for replacement of the carbon source. These injections increase overall capital and operational costs. In addition, frequent injections have been documented to cause fouling within the subsurface surrounding the injection point, thereby restricting delivery of the required substrate to the microorganisms.

To increase the long-term availability of a carbon source for the desired biological processes, more complex hydrocarbons may be introduced to the subsurface. The lower solubilities of these compounds provide a slow release of electron donors to the microorganisms. The increased molecular weights also mean that once dissolved into the groundwater, metabolic transformation of the carbon source and subsequent donation of hydrogen and electrons has a longer time frame.

The use of more complex compounds as electron donors significantly reduces the number of injections required, often requiring only a single injection. The rates of dissolution for these compounds needs to be accurately identified to ensure that sufficient amounts are provided to microorganisms to sustain optimal rates of reductive dechlorination. One disadvantage of the more complex, less soluble electron donors is that an increased acclimation period is observed before increased microbial activity is initiated.

This treatability study evaluated the use of “complex” and “less complex” electron donors under site-specific geochemical conditions to better define their performance. Data from the treatability study may be used to prepare a conceptual basis of design for electron donor injections applicable to the Site.

### 1.2.2 OXIDATIVE TREATMENT TECHNOLOGIES

*In-situ* chemical oxidation has become a well-recognized technology for remediation of contaminated soils and ground water. While the technology has proven to be effective for a wide variety of chlorinated and recalcitrant compounds, many applications exist where *in-situ* chemical oxidation may be ineffective or uneconomical. Oxidizing chemicals may be consumed in a variety of secondary oxidation and degradation reactions as a result of the site soil geochemistry. Bench-scale testing is therefore recommended in order to determine if a specific site geochemistry is suitable for full-scale, *in-situ* chemical oxidation operations. Oxidative technologies commonly used for chlorinated solvents include Fenton’s oxidation and permanganate oxidation. These technologies are discussed in detail below.

#### 1.2.2.1 Fenton's Oxidation

Hydrogen peroxide is a strong oxidizing agent often used in remedial applications for the destruction of organic compounds. With an oxidation potential of 1.8 volts, it has the ability to immediately oxidize some organic compounds upon contact. During the reaction, the peroxide is turned into oxygen and water. However, stable organic compounds (such as halogenated organics or polynuclear aromatic compounds) are not readily oxidized by hydrogen peroxide alone. Instead, these compounds must be oxidized by reacting the hydrogen peroxide with certain transition metals (such as iron or copper) at low pH values to produce hydroxyl radicals ($OH^{\bullet}$). The most recognized form of this reaction is the Fenton's Reaction where reduced-state iron is used to produce hydroxyl radicals through the following reaction:

$$Fe^{+2} + H_2O_2 \rightarrow Fe^{+3} + OH^{-} + OH^{\bullet}$$

This reaction is very pH dependant. Ground water must generally be maintained between a pH value of 3 and 5 for optimum kinetics. Although some Fenton-like reactions can occur at neutral pH, the kinetics typically are too slow to be effective before the peroxide decomposes. The addition of an acid is therefore usually required in order to achieve the proper valence and solubility for the iron during the Fenton's reactions. The availability of ferrous iron can be a limiting factor for the reaction unless the iron is converted back to its reduced state. However, hydrogen peroxide and its related radicals serve as reducing agents under low pH conditions to reduce $Fe^{+3}$ back to $Fe^{+2}$ through the following reaction:

$$Fe^{+3} + H_2O_2 \rightarrow 2H^{+} + O_2 + Fe^{+2}$$

Soil with elevated carbonates interferes with the Fenton's reaction by making it difficult to lower to pH to its ideal pH range of 3 to 5. The carbonates not only act as a buffer to make it difficult to lower pH, but the carbonates and bicarbonates also react with the hydroxyl radical and consume it in unproductive reactions. Soils with carbonate buffer demands in excess of three percent are generally unsuitable for Fenton's oxidation.

#### 1.2.2.2 Permanganate Oxidation

In-situ chemical oxidation is a well-recognized technology for remediation of a wide range of organic constituents. Chemical oxidation using the permanganate ($MnO_4^{-}$) anion has been demonstrate to work very well for the treatment of chlorinated alkenes like PCE, TCE, and cis-1,2-DCE because the permanganate ions has a unique capability of attacking the carbon-carbon double bond in these compounds. The permanganate ion is strongly attracted to the negative charge associated with electrons in the carbon-carbon double bonds. It borrows electron density from the pi-bond in these compounds which disturbs the carbon-carbon double bond to form a bridged oxygen compound known as the hypomanganate diester. This intermediate product is unstable and further reacts by a number of mechanisms including hydroxylation, hydrolysis or cleavage.

Under normal subsurface pH and temperature conditions, the primary oxidation reaction for alkenes involves spontaneous cleavage of the carbon-carbon bond. Once this double bond is broken, the highly unstable carbonyl groups are immediately converted to carbon dioxide through either hydrolysis or further oxidation by the permanganate ion. The reaction for PCE with potassium permanganate ($KMnO_4$) is shown below.

$$4\ KMnO_{4\ (aq)} + 3\ C_2Cl_{4\ (aq)} + 4\ H_2O_{\ (l)} \rightarrow 6\ CO_{2\ (aq)} + 4\ MnO_{2\ (s)} + 4\ K^+_{(aq)} + 8\ H^+_{(aq)} + 12\ Cl^-_{(aq)}$$

Approximately 1.3 grams of $KMnO_4$ are required to oxidize one gram of PCE, but the concentrations of permanganate ion in the water must typically be above 100 mg/l to drive the reaction forward. The entire reaction usually proceeds to completion within two to six hours when there is adequate contact between the contaminant and the oxidant. However, the rate of oxidation for contaminants in a saturated soil system proceeds slower due to the slow desorption rate of contaminants from the soil matrix. By products of the reaction include the insoluble mineral pyrusolite ($MnO_2$), chloride ($Cl^-$), hydronium ($H^+$) and potassium ($K^+$) ions, and carbon dioxide ($CO_2$). The $CO_2$ is rapidly absorbed by water and mostly converted into bicarbonate ($HCO_3$) alkalinity. At neutral pH, approximately 70 percent of the $CO_2$ produced by the reaction will be converted into bicarbonate alkalinity and the remainder will exist as dissolved $CO_2$ in groundwater.

Because permanganate is a strong oxidizing anion, it reacts not only with contaminants like PCE in the groundwater, but it also reacts with other dissolved and hydrous constituents in the soil and groundwater like humic and fulvic acids, iron-containing minerals, and reduced-state organics and inorganics. These natural reactions consume a significant amount of the oxidant and the reactions often proceed at very fast rates. Therefore, the design for a chemical oxidation system must allow for the injection of enough oxidant to first react with the natural oxidant demand (NOD) while leaving enough residual oxidant to treat constituents of concern in the groundwater passing through the reactive zone.

The NOD for sandy soil is typically in the range of 0.1 to 1 gram of $MnO_4^-$ per kilogram of soil. The ISCO process is only effective when sufficient $MnO_4^-$ is added to the saturated zone to react with the NOD while still leaving residual $MnO_4^-$ to react with compounds of concern. The effectiveness and cost for chemical oxidation is therefore highly dependant upon the soil NOD.

## 2.0 TREATABILITY TEST OBJECTIVES

The objective of this treatability study was to define the feasibility of the ISCO and ERD technologies for remediation of chlorinated solvents under site-specific geochemical conditions. In particular, effective treatability testing for ISCO and reductive biological treatment must determine the following:

- Ability to address both chlorinated alkene and alkane impacts;
- Need for native microbes to be supplemented;
- An effective electron donor;
- Magnitude of manganese, iron and arsenic release;
- Longevity of injected electron donor solutions;
- Reductive dechlorination reaction kinetics for destruction of chlorinated solvents
- Natural oxidant demand of Site soils; and
- Potential degree of effectiveness of oxidizing chemical application.

The testing protocol for the treatability study was designed to achieve these objectives in order to provide a comprehensive evaluation of the ISCO and ERD technologies and design parameters for a potential full-scale field application.

# 3.0 EXPERIMENTAL DESIGN AND PROCEDURES

Representative samples of Site soil were collected on September 22, 2008 using a Geoprobe unit. The Geoprobe sample cores were collected from the saturated soils between the interval of 5 and 12.8 feet below ground surface (bgs) at designated borings B1 and B2 within the plume area. The ends of the soil cores were capped and taped for transport. Five gallons of groundwater were collected from monitoring well MW-2 by Stantec personnel on Septenber 23, 2008 to be used during bench-scale testing. The soil and groundwater sample containers were labeled, placed on ice, and shipped by over-night courier to Stantec's Treatability Testing Services Group in Sylvania, Ohio for bench-scale testing.

Upon arrival at Stantec's Sylvania Office, initial screening of the groundwater samples was conducted for pH, ORP, and target VOCs. A composite sample was prepared of the subsurface soil interval sampled from borings B1 and B2. A one-liter groundwater sample collected from MW-2 was sent to SiREM Laboratories, Inc. (SiREM) in Guelph, Ontario Canada for qualitative and quantitative screening of the *dehalococcoides* bacteria responsible for the reduction of cis-1,2-DCE, since the overall biological process can become rate inhibited (cis-1,2-DCE stall) in their absence.

The initial bench-scale testing protocol was developed to provide a comprehensive evaluation of the ERD technology with regards to the remediation of chlorinated alkene impacts (TCE and daughter products) within the subsurface. The testing work scope was later expanded to include evaluation of ERD for addressing chlorinated alkane impacts (1,1,1-TCA and daughter products) and ISCO using both Fenton's and potassium permanganate oxidation. The procedures followed during testing activities are discussed in the following sections.

## 3.1 CHEMICAL OXIDATION TESTING

Laboratory bench-scale testing was conducted to evaluate the efficacy of utilizing the ISCO options of Fenton's oxidation and $KMnO_4$ to address contaminant impacts at the Site. Specifically, the soil buffer capacity and soil oxidant demand was determined. The testing was conducted with the Site soil collected from soil borings B1 and B2 and groundwater collected from monitoring well MW-2.

### 3.1.1 Soil Buffer Capacity

Testing for Fenton's oxidation is conducted by first analyzing the geochemistry of the soil and groundwater. The Fenton's reaction is pH dependant, with optimal conditions achieved at a pH range between 3.5 and 5.0. The subsurface injection of dilute acid solutions is typically required for field applications of the remediation technology. Consequently, the determination of soil buffering capacity is required to accurately estimate the amount of acid required for treatment and whether the application is economically feasible.

Testing for the buffer capacity of the soil is completed by placing 10 grams of soil into a 125-milliliter plastic container with 40 milliliters of site groundwater as a wetting solution, followed by 15 milliliters of a 0.21 Molar sulfuric acid ($H_2SO_4$) solution. The sample container is then placed into a tumbler at a rotational speed of 12 to 18 revolutions per minute to provide complete contact between the chemical and the soils.

After 24 hours of contact time, a 25-milliliter sample of the reaction solution is collected from the jar for titration with a 0.5 Molar solution of sodium hydroxide (NaOH), using a bromophenol blue indicator to determine the buffer capacity of the soil. If the indicator turns blue prior to the NaOH titration, the pH of the sample is greater than 4.6. This indicates a soil buffer capacity, in terms of calcium carbonate, above 30,000 mg/kg. Generally, Fenton's oxidation is not feasible for soils having a calcium carbonate buffer capacity in excess of 30,000 mg/kg due to the treatment costs associated with the acidification step of the process.

### 3.1.2 Soil Oxidant Demand

The capability of natural minerals and organics in soil to react with oxidizing chemicals is known as the NOD. Before oxidizing chemicals can effectively begin to treat the contaminants of concern, the oxidant demand of the soil must first be met. This can often lead to much higher dosages than required to oxidize contaminants alone. The testing procedure for soil oxidant demand is performed using $KMnO_4$ as the oxidant. This oxidant was selected because it aggressively oxidizes TCE, a primary constituent of interest at the Site, and because it closely simulates the chemical oxidation reactions observed with the standard chromic acid reactions used in ASTM procedures for testing of chemical oxidant demand.

Testing for oxidant demand testing on the soil is accomplished by placing 10 grams of soil into a 125-milliliter plastic container with 40 milliliters of site groundwater as a wetting solution. Fifteen milliliters of a 0.063 Molar solution of $KMnO_4$ oxidant is added to create a dosage concentration of approximately 15,000 mg/kg of oxidant. The sample container is placed into a tumbler at a rotational speed of 12 to 18 revolutions per minute to provide complete contact between the chemical and soils. After 24 hours of contact time, a 25-milliliter sample of the reaction solution is collected from the jar for titration with a solution of Caro's acid to determine the oxidant demand of the soil/groundwater matrix.

## 3.2 ENHANCED REDUCTIVE DECLORINATION TESTING

Treatability testing was conducted to determine the ability of the ERD technology to address chlorinated solvent impacts of the subsurface at the Site. Three different electron donor solutions were evaluated during testing. These included sodium acetate, sodium lactate, and a mixture of organic acids. Initial testing was designed to evaluate chlorinated alkene degradation (TCE and daughter products) using all three electron donor solutions.

Since 1,1,1-TCA has been detected within the subsurface of areas of the Site, the testing work scope was expanded to evaluate chlorinated alkane degradation. A portion of the groundwater submitted for testing was spiked with 1,1,1-TCA and based on preliminary results observed during alkene testing, the electron donors of sodium lactate and a mixture of organic acids evaluated for degrading the additional compound of concern. The testing protocol used for ERD testing is provided in the following sections.

### 3.2.1 Preparation of Microcosm Samples

Five test groups were prepared to determine the natural degradation rates for the chlorinated contaminants, evaluate the enhancement of electron donor addition, and identify potential process limitations. The first sample group was an active control and served as a baseline for a system with no additives. The second sample set served as a sterile control group, with the samples spiked with mercuric nitrate to halt biological activity. The third and fourth sample groups were supplemented with sodium lactate and sodium acetate, respectively, to serve as electron donors. The final group used a supplemental solution of organic acids prepared by biodegrading a soluble mixture of sucrose and a galactomannan polysaccharide to serve as short-term and long-term carbon substrates and electron donors.

To create an oxygen free environment, the preparations and procedures for the tests were conducted under a nitrogen blanket. This environment was created by using an $I^2R$ Glove Bag Inflatable Glove Chamber. This chamber is essentially a large, transparent plastic bag with a fitting to inject nitrogen gas from a compressed cylinder and an open sleeve to place the materials in. The chamber includes a device to seal the open sleeve once the materials are in the bag. The device includes a base with a grove fitting and a spine that is pressed into the base to create a seal. Once the sleeve was sealed, the bag was purged with nitrogen until it was approximately 90 percent expanded to create a nitrogen blanket over the test materials. This procedure was followed for the electron donor amended samples, kill group samples and control samples. All transfers and additions of reagents to create the testing microcosms were performed under a nitrogen blanket. The groundwater samples were not sparged with nitrogen since the sparging would remove both contaminants and other gases from the groundwater. The sample water for the microcosms was determined to contain low concentrations of VOCs upon arrival at the laboratory.

All microcosms and control samples were prepared in 40-milliliter vials with screw caps and Teflon septa. The dosage concentration evaluated for each of the selected electron donors was approximately 5,000 mg/l. Multiple microcosm samples were created for each test group. Analysis in this manner eliminated problems associated with removing or replacing water from a single microcosm test. Five microcosm sets containing 12 microcosm samples per set were prepared for the bench-scale testing. Four test samples were also prepared to evaluate the potential release of iron, manganese, and arsenic from the site soils as a result of the reduced geochemical conditions induced by the ERD process during the testing timeframe. A 5,000 mg/l dosage of each of the three selected electron donors was evaluated along with a non-amended control sample to provide a baseline. The following sections detail preparation of the individual test sample groups.

#### 3.2.2.1 Active Control

The first sample group of microcosms was the active control group. It served as the baseline for evaluation of indigenous reductive dechlorination biological reactions, without the addition of a supplemental electron donor. The active control samples were comprised of 10 grams of soil placed in a 40-ml VOA and filled to zero headspace with Site groundwater. Twelve individual test samples were prepared and labeled as “AC” to designate the active control conditions. The samples were kept in a light-deficient environment at room temperature.

A batch sample was also prepared to serve as a baseline control in evaluating potential iron, manganese, and arsenic release by the addition of a supplemental electron. The sampling for analysis of these three metals was conducted at the beginning of the test and at the end of the test. The batch sample was prepared by placing 750 grams of soil in a 3.5-liter plastic container, and adding 3 liters of Site groundwater. The samples were prepared under a nitrogen blanket to create an anaerobic environment in the container. The sample was placed in a light-deficient environment at room temperature.

#### 3.2.1.2 Sterile Control

The second sample set was dosed with mercuric nitrate to create a sterile control group that lacked biological activity. The individual sterile control samples were prepared by placing 10 grams of soil in a 40-milliliter VOA with two milliliters of 0.0171 Normal mercuric nitrate solution, and filled to zero headspace with Site groundwater. Twelve individual test samples were prepared and labeled as “SC” to designate the sterile control conditions. The samples were kept in a light-deficient environment at room temperature.

#### 3.2.1.3 Sodium Lactate Donor Solution

The third sample set of microcosms were prepared using sodium lactate as the donor solution. To prepare the donor solution, 60% sodium lactate (weight/weight) solution was combined with 500 milliliters of Site groundwater to provide an electron donor concentration of approximately 5,000 mg/l. Twelve, individual microcosm samples were prepared by placing 10 grams of Site soil in a 40-milliliter vial and then filling to zero head space with the groundwater dosed with sodium lactate. The microcosm samples were prepared under a nitrogen blanket to create an anaerobic environment in the vials. The vials were labeled as “L” to designate sodium lactate as the donor.

A batch sample was also prepared to evaluate potential iron, manganese, and arsenic release and monitor utilization of available TOC provided by the supplemental electron donor, sodium lactate, during the ERD process. Sampling for analysis of the three metals of concern was conducted at the beginning and end of the 127-day testing timeframe. The sampling frequency for TOC was the same as the metals screening. The batch sample was prepared by placing 750 grams of soil in a 3.5-liter plastic container, and adding 3 liters of Site groundwater. The groundwater was dosed at a sodium lactate concentration of approximately 5,000 mg/l. The batch sample was prepared under a nitrogen blanket to create an anaerobic environment in the container. The sample was stored in a light-deficient environment at room temperature during the 127-day testing timeframe.

#### 3.2.1.4 Sodium Acetate Donor Solution

The fourth sample set of microcosms were prepared using sodium acetate as the donor solution. To prepare the donor solution, 2.5 grams of sodium acetate was dissolved in 500 milliliters of Site groundwater to provide an electron donor concentration of approximately 5,000 mg/l. Twelve, individual microcosm samples were prepared by placing 10 grams of Site soil in a 40-milliliter vial and then filling to zero head space with the groundwater dosed with sodium acetate solution. The microcosm samples were prepared under a nitrogen blanket to create an anaerobic environment in the vials. The vials were labeled as “A” to designate sodium acetate as the donor.

A batch sample was also prepared to evaluate potential iron, manganese, and arsenic release and monitor utilization of available TOC provided by the supplemental electron donor, sodium acetate, during the ERD process. Sampling for analysis of the three metals of concern was conducted at the beginning and end of the 127-day testing timeframe. The sampling frequency for TOC was the same as the metals screening. The batch sample was prepared by placing 750 grams of soil in a 3.5-liter plastic container, and adding 3 liters of Site groundwater. The groundwater was dosed at a sodium acetate concentration of approximately 5,000 mg/l. The batch sample was prepared under a nitrogen blanket to create an anaerobic environment in the containers. The sample was stored in a light-deficient environment at room temperature during the 127-day testing timeframe.

#### 3.2.1.5 Organic Acid Donor Solution

The fifth sample set of microcosms were prepared using a solution of organic acids prepared by fermentation of sucrose and galactomannan polysaccaride (guar gum). The organic acid solution contained approximately 2.5% organics by weight. The solution was combined with 500 milliliters of Site groundwater to provide an electron donor concentration of approximately 5,000 mg/l. Light soda ash was added until the pH stabilized between 7 and 8. Twelve, individual microcosm samples were prepared by placing 10 grams of Site soil in a 40-milliliter vial and then filling to zero head space with the groundwater dosed with the organic acid solution. The microcosm samples were prepared under a nitrogen blanket to create an anaerobic environment in the vials. The vials were labeled as “OA” to designate the organic acid mixture as electron donor. Samples were stored in a light-deficient environment at room temperature.

A batch sample was also prepared to evaluate potential iron, manganese, and arsenic release and monitor utilization of available TOC provided by the supplemental organic acid mixture during the ERD process. Sampling for analysis of the three metals of concern was conducted at the beginning and end of the 127-day testing timeframe. The sampling frequency for TOC was the same as the metals screening. The batch sample was prepared by placing 750 grams of soil in a 3.5-liter plastic container, and adding 3 liters of composite groundwater. The groundwater was dosed at an organic acid mixture concentration of approximately 5,000 mg/l. The batch sample was prepared under a nitrogen blanket to create an anaerobic environment in the containers. The sample was stored in a light-deficient environment at room temperature during the 127-day testing timeframe.

### 3.2.2 Analysis of Microcosm Samples

Microcosm samples were periodically tested as a function of time for pH, ORP, and VOCs. A gas chromatograph (GC) equipped with a flame ionization detector (FID) was used to perform VOC screening, utilizing the headspace analysis method. This method reports the results in terms of VOC equivalents because it measures VOCs from both the soil and groundwater (each having different densities). These VOC analyses were performed in-house by Stantec’s Treatability Testing Services Group to obtain real-time data.

In addition to the VOC analyses, water samples were periodically sent to Merit Laboritories, Inc. (Merit) in East Lansing, Michigan during the treatability study for analyses of the testing parameters of TOC, iron, manganese, and arsenic. The analysis results were used to measure the decay rate of soluble organic electron donors in solution and the evolution of dissolved metals as a function of time.

## 3.3 EQUIPMENT AND MATERIALS

The following equipment/instruments were used during implementation of treatability study:

- Fisher Scientific Model 900 water bath
- Shimadzu Model GC-9A gas chromatograph equipped with FID
- Ohaus GT480 laboratory balance
- Laboratory tumbler
- Magnetic stirrers and stir bars
- Burrettes
- Graduated cylinders
- Labconco laboratory fume hood
- 70-mm aluminum weigh boats
- Stainless steel spatula
- Gas-tight vapor syringes
- Glass thermometer
- Oakton pH meter
- Oakton ORP meter
- 500-milliliter glass jars with Teflon-lined lids
- 3.5-liter, plastic reaction containers with air-tight lids
- 40-milliliter, unpreserved glass vials with screw caps and Teflon septa
- $I^2$R Glove Bag Inflatable Glove Chamber Model X-27-17

The following solutions were used in the treatability study:

- Distilled water
- Organic acid solution prepared by biodegradation of sucrose and galactomannan polysaccharide
- Sodium lactate (60% weight: weight)
- Sodium acetate
- Sodium carbonate (100% light soda ash)
- Mercuric nitrate solution (0.0171 Normal)
- YSI 3682 Zobell ORP standard
- Oakton pH 4 and 7 buffer standards
- Sigma-Aldrich VOC standards
- Potassium permanganate
- Hydrogen peroxide
- Sulfuric acid
- Sodium hydroxide
- Caro’s acid
- Bromophenol blue indicator

## 3.4 SAMPLING AND ANALYSIS

The following parameters were analyzed using the corresponding methods;

- *Dehalococcoides* by PCR procedure (SiREM);
- pH (Oakton hand-held probe, in-house);
- ORP (Oakton hand-held probe, in-house);
- VOCs using a headspace screening method (in-house);
- TOC using USEPA Method 5310C (Merit);
- Dissolved arsenic using USEPA Method 200.8 (Merit);
- Dissolved manganese using USEPA Method 200.8 (Merit); and
- Dissolved iron using USEPA Method 200.8 (Merit).

### 3.4.1 VOC Headspace Screening Method

Screening of samples was performed in a mixed soil/water system to best represent saturated soil conditions. Ten milliliters of water was removed from each sample vial prior to equilibration of the sample using a water bath. Analysis was then performed through direct injection of a volume of the vapor headspace into the GC. The dissolved-phase VOC concentrations are calculated from known equilibrium constants relating the partitioning of the VOCs between the gas and aqueous phases.

$$K = \frac{C\ \text{liquid}}{C\ \text{gas}} = \frac{1}{Hc}$$

where:
K = Partition Coefficient
C = Concentration
Hc = Henry's Law Constant

The following steps are followed during the testing procedure:

1. Each sample is placed in a water bath and allowed to equilibrate at 70.0 ± 0.1 degrees Celsius for 45 minutes prior to analysis.

2. A clean 1,000-microliter gas-tight syringe is inserted into the 40-milliliter vial through the septa lid and a representative sample of the vapor headspace is collected for analysis through direct sample injected into the GC. Care is taken to ensure that no liquid is extracted, as this would adversely affect the GC performance. Following collection of the syringe sample, the vial is placed back into the water bath to await the results of the GC analysis.

3. Once sample analysis is completed the results are evaluated. If an error or improper integration is determined to have occurred, Steps 1 and 2 are repeated.

4. If the sample analysis is acceptable, the results are recorded in the analytical log book along with the analysis time, and injection volume.

5. Once the sample results are recorded, the 40-milliliter vial is removed from the water bath, and the groundwater and vial are disposed following proper protocol.

### 3.5 DATA MANAGEMENT

Analytical data were produced using the software associated with the laboratory instrumentation. The outputs included identifications of compounds, concentrations, retention times, and comparison to standards. Outputs were in graphic form (i.e. chromatographs) and printed tabular form. Most outputs were calculated by the instrumentation. However, manual verification was performed to assure that retention time drift or other error did not occur in these automatic calculations. These changes were accounted for during the data reduction. In the data review process, the data were compared to other data in the data set and associated data sets to evaluate the validity of the results. Data discrepancies are discussed during reporting of the results.

# 4.0 RESULTS AND DISCUSSION

The results of the bench-scale testing for ERD are summarized in the sections below.

## 4.1 ANALYSIS OF BASELINE DATA

The testing protocol was developed to provide a comprehensive evaluation of the ISCO and ERD technologies. Representative groundwater and soil samples from the Site were received on September 24, 2008. The pH and ORP levels of the groundwater collected from MW-2 were immediately tested upon arrival. The measured pH level was 7.15 and the corresponding ORP level was +120 millivolts (mV). The elevated ORP measurement suggests that the subsurface at the location of the groundwater sample is not suited for sustaining reductive dechlorination at its current conditions, and that reductive biological processes are likely limited by the availability of electron donors.

The groundwater sample was also analyzed in-house for dissolved-phase VOCs using the GC. The results of this baseline screening indicated that cis-1,2-DCE was the only contaminant of concern detected in the submitted sample, at a concentration of approximately 1,185 ug/l. In order to evaluate samples more representative of overall Site conditions, the initial groundwater samples were spiked with trans-1,2-DCE, cis-1,2-DCE, and TCE to provide the dissolved-phase concentrations listed in Table 1.

**TABLE 1: Spiked Groundwater VOC Concentrations**

| Analytical Parameter | Dissolved-phase Concentration (ug/l) |
|---|---|
| trans-1,2-DCE | 750 |
| cis-1,2-DCE | 6,500 |
| TCE | 1,700 |

The presence of the TCE daughter product of cis-1,2-DCE in the submitted groundwater sample indicated that natural degradation by indigenous bacteria is currently occurring at the Site. The presence of cis-1,2-DCE and vinyl chloride, as identified during historical Site groundwater monitoring events also suggest that a viable population of *dehalococcoides* may exist in the subsurface and the reductive dechlorination process may be rate limited by current site-specific, subsurface geochemical conditions.

### 4.1.1 *Dehalococcoides* Screening Results

A representative sample of the groundwater was submitted to SiREM for PRC analyses. SiREM extracted genomic DNA from the sample and evaluated its suitability for testing using universal bacterial primers. The sample was determined to contain DNA suitable for *dehalococcoides* testing. *Dehalococcoides* bacteria are generally assumed to contain one 16S ribosomal ribonucleic acid (rRNA) gene copy per organism; therefore, the number of copies detected can be used to estimate the bacteria population present within the sample.

The analysis results identified the presence of *dehalococcoides* in the MW-2 sample at a population enumeration of approximately 2 x$10^5$ gene copies/liter. Values in this range are indicative of moderate *dehalococcoides* levels which may, or may not, be associated with observable dechlorination impacts. The positive identification is promising for the potential to stimulate the complete ERD process by enhancing indigenous microbes through the addition of a supplemental electron donor. The analytical laboratory report for the dehalococcoides analysis performed by SiREM is provided in Appendix A.

## 4.2 ANALYSIS OF MICROCOSM SAMPLES

The ERD testing for chlorinated alkene compound impacts involved preparation and monitoring of five sample subsets including an active control sample; sterile control sample; and samples amended with sodium lactate, sodium acetate, and a mixture of organic acids as electron donors. This phase of the treatability study was initiated with sample preparation on October 4, 2008, and completed on January 23, 2009 after a 121-day testing timeframe. Gas chromatograph analyses and sample monitoring were performed on a regular basis throughout the duration of testing. The GC analytical parameters consisted of TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and vinyl chloride as the primary alkene constituents of concern for the groundwater and soils.

After the initial microcosm sample preparation was completed and testing initiated, the evaluation of the ERD technology for addressing chlorinated alkane impacts at another area of the site was added to the work scope of the treatability study. A portion of the submitted groundwater sample was spiked with 1,1,1-TCA and additional microcosm samples prepared. Microcosm samples evaluating sodium lactate as the electron donor were prepared on October 17, 2008, while samples evaluating a mixture of organic acids as the electron donor were prepared on January 8, 2009. The testing duration for these additional samples was 128 days for the sodium lactate and 56 days for the organic acid mixture.

The test samples were designed to represent a soil/water system enhanced with a supplemental carbon source and electron donor. Since the testing evaluated treatment of contaminants in a soil/water system rather than a soil or water system, the GC analytical results are reported in terms of VOC equivalents (GC peak areas) rather than concentration units. The peak area is proportional to the total mass of VOCs in both the soil and water. The results of the alkene microcosm sample screening for reductive dechlorination parameters are summarized in Table 2. Figures 1 through 5 graphically depict VOC degradation over time for each test sample type. Figure 6 provides the results of pH monitoring for the test samples versus time, while the corresponding ORP levels are depicted graphically over time in Figure 7. The results of the alkane microcosm sample screening for reductive dechlorination parameters are summarized in Table 3. Figures 8 and 9 graphically depict VOC degradation over time for the sodium lactate and organic acid mixture samples, respectively. The results of pH monitoring for the additional test samples versus time are shown in Figure 10, while the corresponding ORP levels are depicted graphically over time in Figure 11.

### 4.2.1 Active Control Sample

The initial GC analysis identified TCE, trans-1,2-DCE, and cis-1,2-DCE as the only contaminants of concern present in the microcosm sample. The mass of TCE and cis-1,2-DCE was reduced over the 121-day testing timeframe by 37 and 47 percent, respectively. The levels of trans-1,2-DCE were reduced by approximately 48 percent over the same timeframe. The decreases observed in the active control sample represent all losses occurring as a result of abiotic losses (volatilization, diffusion, adsorption, etc.) as well as natural biological losses without electron donor amendment. The results of VOC screening for the active control samples are shown graphically versus time in Figure 1.

### 4.2.2 Sterile Control Sample

The initial GC analysis identified TCE, cis-1,2-DCE, and trans-1,2-DCE as the only contaminants of concern present in the microcosm sample. The mass of TCE and cis-1,2-DCE was reduced over the 121-day testing timeframe by 45 and 18 percent, respectively. The levels of trans-1,2-DCE were reduced by approximately 42 percent over the same timeframe. The decreases observed in the sterile control sample represent all losses occurring as a result of abiotic losses (volatilization, diffusion, adsorption, etc.). The results of VOC screening for the sterile control samples are shown graphically versus time in Figure 2.

### 4.2.3 Sodium Lactate Sample – Alkene Degradation

The ORP for the alkene test samples supplemented with 5,000 mg/l of sodium lactate decreased to -137 mV within the first 16 days and continued to decrease to levels below -200 mV during testing. The corresponding pH levels decreased from 7.5 to 7.0 before increasing to level out at 7.1. Over the course of the 121-day testing timeframe, complete destruction was only achieved for TCE (10 days) of the initial contaminants of concern. The mass of cis-1,2-DCE and trans-1,2-DCE in the system decreased by 49 and 56 percent, respectively. The production of VC was first observed on Day 10 days of testing, peaked on Day 42 after a 31 percent increase, then decreased below analytical detection limits on Day 86. The results indicate the potential for *dehalococoides* stimulation and subsequent cis-1,2-DCE degradation using sodium lactate as an electron donor. The results of VOC screening for the sodium lactate amended, alkene samples are shown graphically versus time in Figure 3.

### 4.2.4 Sodium Acetate Sample – Alkene Degradation

The ORP for the alkene test samples supplemented with 5,000 mg/l of sodium acetate decreased steadily during the testing timeframe, eventually levelling out around -100 mV. The corresponding pH levels decreased slowly from 7.5 to 7.1 during the first 75 days of testing before increasing to level out around 7.2. Over the course of the duration of testing, complete destruction was only achieved for TCE (58 days). The mass of cis-1,2-DCE and trans-1,2-DCE in the system decreased by 45 and 12 percent, respectively. Vinyl chloride was first detected on Day 10 at a level of 5,771 VOC equivalents, increased to 7,051 equivalents on Day 36, and decreased to 3,600 VOC equivalents on Day 121. The results of VOC screening for the sodium acetate amended, alkene samples are shown graphically versus time in Figure 4.

### 4.2.5 Organic Acid Mixture Sample – Alkene Degradation

The system ORP for the alkene samples supplemented with 5,000 mg/l dosage of fermented organic acids dropped to -175 mV within the first 16 days of testing before increasing to level out around -100 mV at the end of testing. The corresponding pH levels decreased to steadily to 6.5 in the first 58 days and stabilized at this level for the duration of testing. During the 121-day testing period, complete destruction was achieved for all the initial contaminants of concern; TCE (16 days), cis-1,2-DCE (75 days), and trans-1,2-DCE (86 days). Levels of 1,1-DCE were detected intermittently during testing and VC was only detected on Day 10 at 4,674 VOC equivalents. The results of VOC screening for the organic acid amended, alkene samples are shown graphically versus time in Figure 5.

### 4.2.6 Sodium Lactate Sample – Alkane Degradation

The ORP for the alkane test samples supplemented with 5,000 mg/l of sodium lactate decreased steadily during the testing timeframe to a low of -236 mV on Day 80 before rebounding to approximately -210 mV. The corresponding pH levels decreased slowly from 7.6 to 7.1 during the first 52 days of testing before increasing to 7.3 on Day 128. Over the course of the duration of testing, complete destruction was only achieved for TCE (28 days). The mass of cis-1,2-DCE, trans-1,2-DCE, and VC increased during the initial portion of testing, peaking on Day 28 to correspond with the degradation of TCE. During the remainder of 128-day testing timeframe, the levels of cis-1,2-DCE, trans-1,2-DCE, and VC decreased from peak values by 61%, 59%, and 23%, respectively. Degradation of 1,1,1-TCA levels in the microcosm samples provided a steady decrease of 64% over the 128-day testing timeframe. The reduction of 1,1,1-TCA produced the daughter product of 1,1-DCE. The results of VOC screening for the sodium lactate amended, alkane samples are shown graphically versus time in Figure 8.

### 4.2.7 Organic Acid Mixture Sample – Alkane Degradation

The system ORP for the alkane test samples supplemented with 5,000 mg/l dosage of fermented organic acids dropped to -59 mV within the first 15 days of testing before eventually levelling out around -70 mV at the end of testing. The corresponding pH levels decreased from 7.2 to 6.9 in the first 6 days, before rebounding to stabilize at approximately 7.0 for the remainder of testing. During the 56-day testing period, complete destruction was achieved for both TCE and trans-1,2-DCE within the first 36 days. Levels of cis-1,2-DCE increased by 44% in the first 15 days before decreasing by 74% over the final 21 days of testing. Vinyl chloride was not detected in any of the microcosm samples during testing. The mass of 1,1,1-TCA decreased by 86% over the course of the 56-day testing timeframe. Levels of 1,1-DCE were first detected on Day 15 at 1,193 VOC equivalents and increased during the remaining evaluation period. The results of VOC screening for the organic acid amended alkane samples are shown graphically versus time in Figure 9.

### 4.2.8 ERD Testing Summary

The bench-scale testing showed that the addition of a supplement carbon-based electron donor to the saturated soils at the Site can successfully reduce the ORP of the saturated soil system to less than -100 mV where rapid reductive dechlorination kinetics can occur using native bacteria in the soil and groundwater. Complete destruction for all VOCs of concern was only achieved within the alkene test microcosm samples supplemented with the organic acid mixture. Estimated first-order degradation rate constants are presented below in Table 4. Corresponding half-lives based on the results observed during testing are provided in Table 5 below.

**TABLE 4: First-Order Contaminant Degradation Rates**

| Contaminant Parameter | Rate Constant (days$^{-1}$) | | |
|---|---|---|---|
| | Sodium Lactate | Sodium Acetate | Organic Acid Mix |
| Vinyl Chloride | >1.15x10$^{-1}$ | 7.91x10$^{-3}$ | >7.56x10$^{-1}$ |
| trans-1,2-DCE | 1.19x10$^{-2}$ | 6.75x10$^{-3}$ | >6.75x10$^{-2}$ |
| cis-1,2-DCE | 1.12x10$^{-2}$ | 9.45x10$^{-3}$ | >1.15x10$^{-1}$ |
| 1,1,1-TCA | 7.92x10$^{-3}$ | NA | 3.49x10$^{-2}$ |
| TCE | >4.82x10$^{-2}$ | >8.70x10$^{-2}$ | >3.11x10$^{-1}$ |

**TABLE 5: Contaminant Degradation Half-lives**

| Contaminant Parameter | Half-Life (days) | | |
|---|---|---|---|
| | Sodium Lactate | Sodium Acetate | Organic Acid Mix |
| Vinyl Chloride | < 6.0 | 87.6 | < 0.9 |
| trans-1,2-DCE | 58.3 | 103 | < 10.3 |
| cis-1,2-DCE | 62.6 | 73.4 | < 6.0 |
| 1,1,1-TCA | 87.5 | NA | 19.9 |
| TCE | < 14.4 | < 10.0 | < 2.2 |

The rates detailed in Tables 4 and 5 were calculated using peak contaminant levels as a starting point, coinciding with the sampling event where the parent product for the individual compound had been degraded below analytical detection limits and therefore was no longer generating daughter compounds. Degradation rates observed in the field during a full-scale application would likely be slower (typically one order of magnitude) than those observed in the laboratory due to contact limitations associated with delivery of the electron donor solution within the soil.

## 4.3 METALS REDUCTION

Under reducing conditions, minerals in the soil can be reduced to release iron, manganese or arsenic into the groundwater. The initial concentrations of these three metals in the active control microcosm sample were 0.002 mg/l for arsenic, 0.45 mg/l for iron, and 0.938 for manganese. Final analysis for these three parameters within the electron donor amended microcosm samples was conducted on Day 127 of the treatability study. The results are presented in Table 6 below.

TABLE 6: Potential Metals Release Monitoring Results

| Analysis Parameter | Dissolved-Phase Concentration (mg/l) | | | | |
|---|---|---|---|---|---|
| | Active Control | | Sodium Lactate | Sodium Acetate | Organic Acids |
| | Day 2 | Day 127 | Day 127 | Day 127 | Day 127 |
| Arsenic | 0.002 | 0.001 | 0.066 | 0.013 | 0.027 |
| Iron | 0.45 | 0.03 | 146 | 3.08 | 0.04 |
| Manganese | 0.938 | < 0.005 | 9.27 | 3.08 | 0.131 |

The reduced conditions generated by the ERD process resulted in Federal primary drinking water standards for arsenic (> 0.01 mg/l) being exceeded in all three electron donor amended samples. The potential for treatment to exceed Federal secondary drinking water standards (aesthetic standards) for iron (> 0.3 mg/l) and manganese (> 0.05 mg/l) may be an issue, based on the results of all three electron donor test samples. This can be addressed through pH adjustment following VOC treatment.

## 4.4 CONSUMPTION OF TOC

Each of the original electron donor microcosm batch samples were dosed with approximately 5,000 mg/l of electron donor to stimulate reductive dechlorination which is roughly equivalent to 2,000 mg/l TOC. Samples were collected at the beginning and end of the treatability testing. Through Day 127, minimal reduction was observed in TOC levels originating from sodium lactate and sodium acetate (< 2 percent). The organic acid mixture microcosm sample showed a reduction in TOC of approximately 70 percent over the same timeframe. This corresponds to an organic acid mixture half life of 73 days.

## 4.5 SOIL BUFFER CAPACITY

The soil buffer capacity testing was conducted in triplicate. All three samples were acidified with a 0.21 Molar $H_2SO_4$ solution and placed in the tumbler on October 23, 2008. After 24 hours of mixing, the samples were removed from the tumbler on October 24, 2008 and prepared for titration with the NaOH solution. When the bromophenol blue indicator was added, each of the three test samples turned blue. Subsequent monitoring indicated an average sample pH of approximately 5.2. Therefore, the soil buffer capacity for the Site was determined to be greater than 30,000 mg/kg in the vicinity of soil borings B1 and B2.

## 4.6 SOIL OXIDANT DEMAND

The soil oxidant demand testing was conducted in triplicate. All three samples were dosed with $KMnO_4$ solution at a concentration of approximately 15,000 mg/kg and placed in the tumbler on October 23, 2008. After 24 hours of mixing, the samples were removed from the tumbler on October 24, 2008 and prepared for titration with the Caro's acid solution to determine the permanganate oxidant demand of the soil groundwater matrix. The soil oxidant demand for the Site was determined to be approximately 2,072 mg/kg in the vicinity of soil borings B1 and B2.

# 5.0 COMPARISON TO TEST OBJECTIVES

The bench-scale testing included microcosm tests and soil flushing tests. The objectives of the testing were to determine the following:

- Ability to address both chlorinated alkene and alkane impacts;
- Need for native microbes to be supplemented;
- An effective electron donor;
- Magnitude of manganese, iron and arsenic release;
- Longevity of injected electron donor solutions;
- Reductive dechlorination reaction kinetics for destruction of chlorinated solvents
- Natural oxidant demand of Site soils; and
- Potential degree of effectiveness of oxidizing chemical application.

A brief comparison of these test objectives to the bench-scale test results is provided below.

## 5.1 EVALUATION OF NATIVE MICROBES

The presence of PCE and TCE, along with the daughter products of cis-1,2-DCE and VC, in groundwater samples collected as part of historical monitoring activities indicates a population of *dehalococcoides* bacteria exists at the Site. This was confirmed by the results of the PRC analyses conducted by SiREM on the groundwater sample collected from MW-2. The generation of daughter compounds and complete destruction of all alkene VOCs of concern observed during the treatability testing for organic acid mixture electron donor shows the ERD process can successfully stimulate indigenous bacteria populations to degrade contaminants. Based on the results of testing, it is not believed that bioaugmentation with commercially-available bacteria inoculums is required for the Site.

## 5.2 MOST EFFECTIVE ELECTRON DONOR

Sodium lactate and sodium acetate failed to successfully provide complete destruction of the contaminants of concern at the Site during the treatability testing. The organic acid mixture provided complete destruction of the alkene compounds of concern, produced the least amount of vinyl chloride, and an 86% reduction in 1,1,1-TCA levels. Therefore, based on contaminant reduction, electron donor longevity, cost, and ease of implementation, it is believed that the organic acid mixture represents the most effective electron donor for field implementation at the Site.

## 5.3 MANGANESE, IRON, AND ARSENIC RELEASE

The results showed that iron, manganese and arsenic concentrations increased in the groundwater as a result of the reducing conditions. The sodium lactate microcosm showed the highest metals release, while the organic acid mixture sample had the lowest. The concentrations of iron and manganese exceeded secondary drinking water standards (300 ug/l and 50 ug/l, respectively) following the addition of sodium lactate and sodium acetate. The organic acid supplemented sample exceeded the levels for manganese but was below the limits for iron. Arsenic concentrations exceeded the drinking water standard of 10 ug/l for all three electron donor types. The results indicate that a final pH adjustment step may be required following application of the ERD technology at the Site.

## 5.4 ELECTRON DONOR LONGEVITY

Electron donor longevity was evaluated as part of the testing. Minimal reduction (< 2%) was observed for the TOC originating from sodium lactate and sodium acetate was consumed during the 127 days of testing. The reduced consumption by site-specific bacteria likely played a role in the degradation performance for these two electron donors. The organic acid mixture, microcosm sample showed a reduction in TOC of 19% over the same timeframe. Actual degradation rates are anticipated to be faster during field application. The organic acid mixture microcosm sample showed a reduction in TOC of approximately 70 percent over the same timeframe. This corresponds to an organic acid mixture half life of 73 days.

## 5.5 REDUCTIVE DECHLORINATION REACTION KINETICS

Monitoring was conducted during the treatability study to determine the levels for the VOCs of concern in the individual microcosm samples with respect to time. Only the organic acid mixture samples showed complete reduction of the alkene contaminants of concern during testing. Overall reaction kinetics were fastest for the organic acid mixture samples with half-lives ranging from < 1 day (VC) to approximately 20 days (1,1,1-TCA). Degradation rates observed in the field during a full-scale application would likely be slower (typically one order of magnitude) than those observed in the laboratory due to contact limitations associated with delivery of the electron donor solution within the soil.

## 5.6 NATURAL OXIDANT DEMAND OF SITE SOILS

The NOD was calculated to be approximately 2 grams of $KMnO_4$ per kilogram of soil. The results are reasonable given the silty sand soil type and moderate with respect to ISCO applications. This would equate to a chemical demand of greater than 6 pounds per cubic yard of soil to overcome the site-specific geochemistry conditions prior to addressing the contaminant impacts.

## 5.7 POTENTIAL DEGREE OF EFFECTIVENESS FOR OXIDIZING CHEMICAL

The NOD results indicate that the implementation of an ISCO program utilizing $KMnO_4$ may be feasible for areas of the Site. However, the oxidant is specific to alkene treatment and therefore would not address 1,1,1-TCA or other alkane impacts. The elevated soil buffering capacity would likely make Fenton's oxidation an infeasible application, as large volumes of acid would be required to adjust groundwater pH levels to the optimal range for the process.

## 6.0 CONCLUSIONS

The results of the treatability testing shows that Fenton's oxidation will not be effective for this site. The buffer capacity of the soil exceeds five percent calcium carbonate, making it both technically difficult and economically difficult to lower the pH to optimal ranges for Fenton's oxidation. Permanganate oxidation could be effective for this site for treatment of TCE and other chlorinated alkene compounds. The NOD of the soil is moderate, at a rate of six pounds of permanganate per cubic yard of saturated soil system. However, the treatment performs poorly for 1,1,1-TCA and other chlorinated alkanes.

Treatability testing results for reductive dechlorination indicate the application of a remediation program employing ERD appears to be a viable technology option for addressing chlorinated solvent impacts of the groundwater and saturated soils at the Site. During testing, the best contaminant reduction and process performance was observed using a mixture of organic acids as a supplemental electron donor for the ERD process, when compared to sodium lactate and sodium acetate.

The addition of the organic acid mixture created the required reduced conditions within the microcosm test samples, and degraded TCE, cis-1,2-DCE, trans-1,2-DCE, and VC levels below analytical detection limits. Testing was also performed to evaluate degradation of 1,1,1-TCA, and the organic acid mixture produce an 86% reduction in microcosm sample levels for this compound. Laboratory testing conducted by SiREM identified moderate population levels of *dehalococcoides* bacteria at the Buell Automatics Site. The SiREM results, coupled with the ERD bench-scale testing, indicate that a viable population of *dehalococcoides* bacteria is present within the proposed treatment area in the vicinity of MW-2.

It is recommended that the results of the bench-scale treatability study be extrapolated to a field implementation of the ERD process at the Site, using an organic acid mixture as the electron donor to supplement the biological process. It is anticipated that the donor solution would be delivered to the subsurface using temporary injection wells installed using a hydraulic probing unit. Following electron donor injection, existing monitoring wells would be used as sampling locations to evaluate remedial performance by monitoring the parameters of concern for the ERD process – pH, ORP, VOCs, dissolved metals, and *dehalococcoides* populations.

## 7.0 LIMITATIONS

The conclusions and recommendations contained in this report are based upon professional opinions with regard to the subject matter. These opinions have been arrived at in accordance with currently accepted hydrogeologic and engineering standards and practices applicable to this location, and are subject to the following limitations:

1. The data and findings presented in this report are valid as of the dates when the investigations were performed.

2. The data reported and the findings, observations, and conclusions expressed in the report are limited by the Scope of Work. The Scope of Work was defined by the request of the client, the time and budgetary constraints imposed by the client, and availability of access to the Site.

3. Because of the limitations stated above, the findings, observations, and conclusions expressed by Stantec in this report are not, and should not be, considered an opinion concerning the compliance of any past or present owner or operator of the Site with any federal, state, or local law or regulation.

4. No warranty or guarantee, whether expressed or implied, is made with respect to the data or the reported findings, observations, and conclusions, which are based solely upon Site conditions in existence at the time of the investigations.

Stantec reports present professional opinions and findings of a scientific and technical nature. While attempts were made to relate the data and findings to applicable environmental laws and regulations, the report shall not be constructed to offer legal opinion or representations as to the requirements of, nor the compliance with, environmental laws, rules, regulations, or policies of federal, state, or local governmental agencies. Any use of this report constitutes acceptance of the limits of Stantec's liability. Stantec's liability extends only to its client and not to any other parties who may obtain the report. Appropriate legal counsel should review issues raised by the report.

# TABLES

OXIDATIVE AND REDUCTIVE TREATABILITY TESTING REPORT
Buell Automatics, Inc. Site – Rochester, New York
March 13, 2009

## TABLE 2
## ALKENE MICROCOSM TREATABILITY TESTING SCREENING RESULTS
## BUELL AUTOMATICS SITE - ROCHESTER, NEW YORK

| | | | | | GC Analytical Screening Results (VOC Equivalents) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sample Identification** | **Testing Timeframe (Days)** | **Testing Date** | **pH** | **ORP (mv)** | **Vinyl Chloride** | **1,1-DCE** | **trans-1,2-DCE** | **cis-1,2-DCE** | **TCE** |
| Active Control | 0 | 10/04/08 | 7.01 | 105 | BDL | BDL | 3,431 | 33,883 | 8,233 |
| | 10 | 10/14/08 | 6.64 | 152 | BDL | BDL | 3,425 | 33,017 | 8,243 |
| | 16 | 10/20/08 | 7.02 | 124 | BDL | BDL | 3,375 | 31,528 | 8,282 |
| | 36 | 10/30/08 | 6.92 | 122 | BDL | BDL | 3,129 | 29,690 | 8,105 |
| | 42 | 11/05/08 | 7.09 | 123 | BDL | BDL | 2,639 | 29,990 | 7,684 |
| | 51 | 11/14/08 | 7.16 | 120 | BDL | BDL | 3,090 | 29,196 | 7,743 |
| | 58 | 11/21/08 | 7.05 | 116 | BDL | BDL | 2,281 | 27,255 | 6,146 |
| | 75 | 12/08/08 | 7.06 | 117 | BDL | BDL | 2,867 | 26,357 | 6,157 |
| | 86 | 12/19/08 | 7.12 | 111 | BDL | BDL | 2,701 | 25,517 | 5,681 |
| | 103 | 01/05/09 | 7.12 | 109 | BDL | BDL | 2,647 | 19,051 | 5,563 |
| | 112 | 01/14/09 | 7.15 | 111 | BDL | BDL | 2,553 | 18,257 | 5,265 |
| | 121 | 01/23/09 | 7.27 | 107 | BDL | BDL | 1,795 | 17,842 | 5,211 |
| Sterile Control | 0 | 10/04/08 | 6.85 | 340 | BDL | BDL | 4,260 | 30,798 | 9,735 |
| | 10 | 10/14/08 | 6.70 | 247 | BDL | BDL | 4,188 | 30,552 | 9,427 |
| | 16 | 10/20/08 | 6.94 | 191 | BDL | BDL | 4,696 | 30,779 | 9,490 |
| | 36 | 10/30/08 | 6.75 | 173 | BDL | BDL | 3,391 | 29,691 | 7,892 |
| | 42 | 11/05/08 | 6.94 | 154 | BDL | BDL | 3,169 | 29,438 | 7,614 |
| | 51 | 11/14/08 | 7.16 | 124 | BDL | BDL | 3,133 | 28,834 | 7,770 |
| | 58 | 11/21/08 | 7.12 | 118 | BDL | BDL | 3,663 | 28,440 | 7,480 |
| | 75 | 12/08/08 | 7.19 | 135 | BDL | BDL | 3,150 | 28,142 | 6,430 |
| | 86 | 12/19/08 | 7.15 | 137 | BDL | BDL | 3,315 | 27,949 | 6,210 |
| | 103 | 01/05/09 | 6.99 | 141 | BDL | BDL | 2,648 | 27,373 | 6,098 |
| | 112 | 01/14/09 | 7.03 | 136 | BDL | BDL | 2,238 | 25,599 | 5,879 |
| | 121 | 01/23/09 | 7.01 | 121 | BDL | BDL | 2,469 | 25,265 | 5,311 |
| Sodium Lactate | 0 | 10/04/08 | 7.50 | 255 | BDL | BDL | 4,877 | 27,020 | 6,248 |
| | 10 | 10/14/08 | 7.29 | 203 | 6,107 | BDL | 4,335 | 45,505 | BDL |
| | 16 | 10/20/08 | 7.36 | -137 | 6,476 | BDL | 3,598 | 37,733 | BDL |
| | 36 | 10/30/08 | 7.23 | -140 | 7,495 | BDL | 4,171 | 37,121 | BDL |
| | 42 | 11/05/08 | 7.27 | -153 | 7,994 | BDL | 4,208 | 31,316 | BDL |
| | 51 | 11/14/08 | 7.32 | -195 | 7,383 | BDL | 3,716 | 29,139 | BDL |
| | 58 | 11/21/08 | 7.33 | -203 | 6,578 | BDL | 2,587 | 27,028 | BDL |
| | 75 | 12/08/08 | 7.04 | -174 | 6,435 | BDL | 2,970 | 24,245 | BDL |
| | 86 | 12/19/08 | 7.08 | -218 | BDL | BDL | 2,996 | 23,454 | BDL |
| | 103 | 01/05/09 | 7.11 | -224 | BDL | BDL | 1,869 | 18,295 | BDL |
| | 112 | 01/14/09 | 7.13 | -218 | BDL | BDL | 1,809 | 14,983 | BDL |
| | 121 | 01/23/09 | 7.09 | -189 | BDL | BDL | 1,151 | 13,141 | BDL |
| Sodium Acetate | 0 | 10/04/08 | 7.55 | 250 | BDL | BDL | 3,499 | 32,879 | 7,766 |
| | 10 | 10/14/08 | 7.35 | 195 | 5,771 | BDL | 4,635 | 41,238 | 7,137 |
| | 16 | 10/20/08 | 7.33 | -4 | 4,098 | BDL | 3,160 | 48,726 | 7,062 |
| | 36 | 10/30/08 | 7.28 | -45 | 7,051 | BDL | 5,459 | 44,913 | 7,375 |
| | 42 | 11/05/08 | 7.34 | -42 | 6,736 | BDL | 2,836 | 38,536 | 6,448 |
| | 51 | 11/14/08 | 7.35 | -43 | 3,674 | BDL | 3,065 | 37,962 | 3,456 |
| | 58 | 11/21/08 | 7.26 | -43 | 3,510 | BDL | 3,339 | 38,978 | BDL |
| | 75 | 12/08/08 | 7.05 | -41 | 3,809 | BDL | 2,608 | 35,447 | BDL |
| | 86 | 12/19/08 | 7.11 | -95 | 4,072 | BDL | 3,148 | 27,992 | BDL |
| | 103 | 01/05/09 | 7.21 | -97 | 3,353 | BDL | 2,979 | 23,812 | BDL |
| | 112 | 01/14/09 | 7.19 | -99 | 3,163 | BDL | 2,757 | 23,509 | BDL |
| | 121 | 01/23/09 | 7.24 | -101 | 3,600 | BDL | 3,076 | 18,069 | BDL |
| Organic Acid Mixture | 0 | 10/04/08 | 6.82 | 286 | BDL | BDL | 2,885 | 25,071 | 7,287 |
| | 10 | 10/14/08 | 6.72 | -131 | 4,674 | BDL | 3,189 | 35,282 | 1,176 |
| | 16 | 10/20/08 | 6.76 | -175 | BDL | 908 | 4,106 | 42,897 | BDL |
| | 36 | 10/30/08 | 6.61 | -152 | BDL | 876 | 4,603 | 41,215 | BDL |
| | 42 | 11/05/08 | 6.60 | -109 | BDL | 897 | 4,079 | 28,143 | BDL |
| | 51 | 11/14/08 | 6.57 | -116 | BDL | BDL | 2,737 | 9,936 | BDL |
| | 58 | 11/21/08 | 6.48 | -99 | BDL | BDL | 1,985 | 4,321 | BDL |
| | 75 | 12/08/08 | 6.55 | -98 | BDL | BDL | 1,146 | BDL | BDL |
| | 86 | 12/19/08 | 6.56 | -99 | BDL | 812 | 792 | BDL | BDL |
| | 103 | 01/05/09 | 6.47 | -92 | BDL | BDL | BDL | BDL | BDL |
| | 112 | 01/14/09 | 6.53 | -97 | BDL | BDL | BDL | BDL | BDL |
| | 121 | 01/23/09 | 6.52 | -103 | BDL | BDL | BDL | BDL | BDL |

BDL - Below Detection Limits (50)

# TABLE 3
# CHLORINATED ALKANE MICROCOSM TREATABILITY TESTING SCREENING RESULTS
# BUELL AUTOMATICS SITE - ROCHESTER, NEW YORK

| | | | | | GC Analytical Screening Results (VOC Equivalents) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Identification** | **Testing Timeframe (Days)** | **Testing Date** | **pH** | **ORP (mv)** | **Vinyl Chloride** | **1,1-DCE** | **trans-1,2-DCE** | **1,1-DCA** | **cis-1,2-DCE** | **1,1,1-TCA** | **TCE** |
| Sodium Lactate | 0 | 10/17/08 | 7.55 | 191 | BDL | BDL | 4,321 | BDL | 43,200 | 45,060 | 15,705 |
| | 6 | 10/23/08 | 7.22 | 149 | 3,774 | BDL | 4,027 | BDL | 42,478 | 42,932 | 14,238 |
| | 13 | 10/30/08 | 7.16 | -198 | 8,299 | 948 | 5,631 | BDL | 51,353 | 39,389 | 10,703 |
| | 19 | 11/05/08 | 7.32 | -176 | 7,792 | 1,007 | 5,105 | BDL | 62,361 | 37,250 | 5,582 |
| | 28 | 11/14/08 | 7.26 | -170 | 11,311 | 1,562 | 8,753 | BDL | 108,901 | 30,913 | BDL |
| | 35 | 11/21/08 | 7.31 | -191 | 6,512 | 1,768 | 5,169 | BDL | 87,311 | 28,417 | BDL |
| | 52 | 12/08/08 | 7.10 | -212 | 5,442 | 1,156 | 4,907 | BDL | 63,765 | 27,864 | BDL |
| | 63 | 12/19/08 | 7.10 | -227 | 8,804 | 1,030 | 4,093 | BDL | 63,698 | 27,363 | BDL |
| | 80 | 01/05/09 | 7.15 | -236 | 8,962 | 1,163 | 3,846 | BDL | 54,174 | 25,229 | BDL |
| | 89 | 01/14/09 | 7.15 | -219 | 8,926 | 1,224 | 4,281 | BDL | 51,655 | 25,052 | BDL |
| | 128 | 02/13/09 | 7.29 | -209 | 8,732 | 1,561 | 3,570 | BDL | 42,187 | 16,353 | BDL |
| Organic Acid | 0 | 01/08/09 | 7.23 | 135 | BDL | BDL | 1,338 | BDL | 9,654 | 169,290 | 587 |
| | 6 | 01/14/09 | 6.88 | 2 | BDL | BDL | 5,260 | BDL | 12,355 | 163,678 | 555 |
| | 15 | 01/23/09 | 6.98 | -59 | BDL | 1,193 | 4,408 | BDL | 13,884 | 153,878 | 535 |
| | 25 | 02/02/09 | 6.96 | -71 | BDL | 1,876 | 2,108 | BDL | 13,277 | 146,419 | 528 |
| | 36 | 02/13/09 | 7.04 | -77 | BDL | 2,511 | BDL | BDL | 12,261 | 108,754 | BDL |
| | 50 | 02/27/09 | 7.04 | -73 | BDL | 2,003 | BDL | BDL | 7,010 | 64,566 | BDL |
| | 56 | 03/05/09 | 7.06 | -67 | BDL | 2,247 | BDL | BDL | 3,611 | 23,966 | BDL |

BDL - Below Detection Limits (50)

# FIGURES

OXIDATIVE AND REDUCTIVE TREATABILITY TESTING REPORT
Buell Automatics, Inc. Site – Rochester, New York
March 13, 2009

## FIGURE 1: VOCs versus Time - Active Control

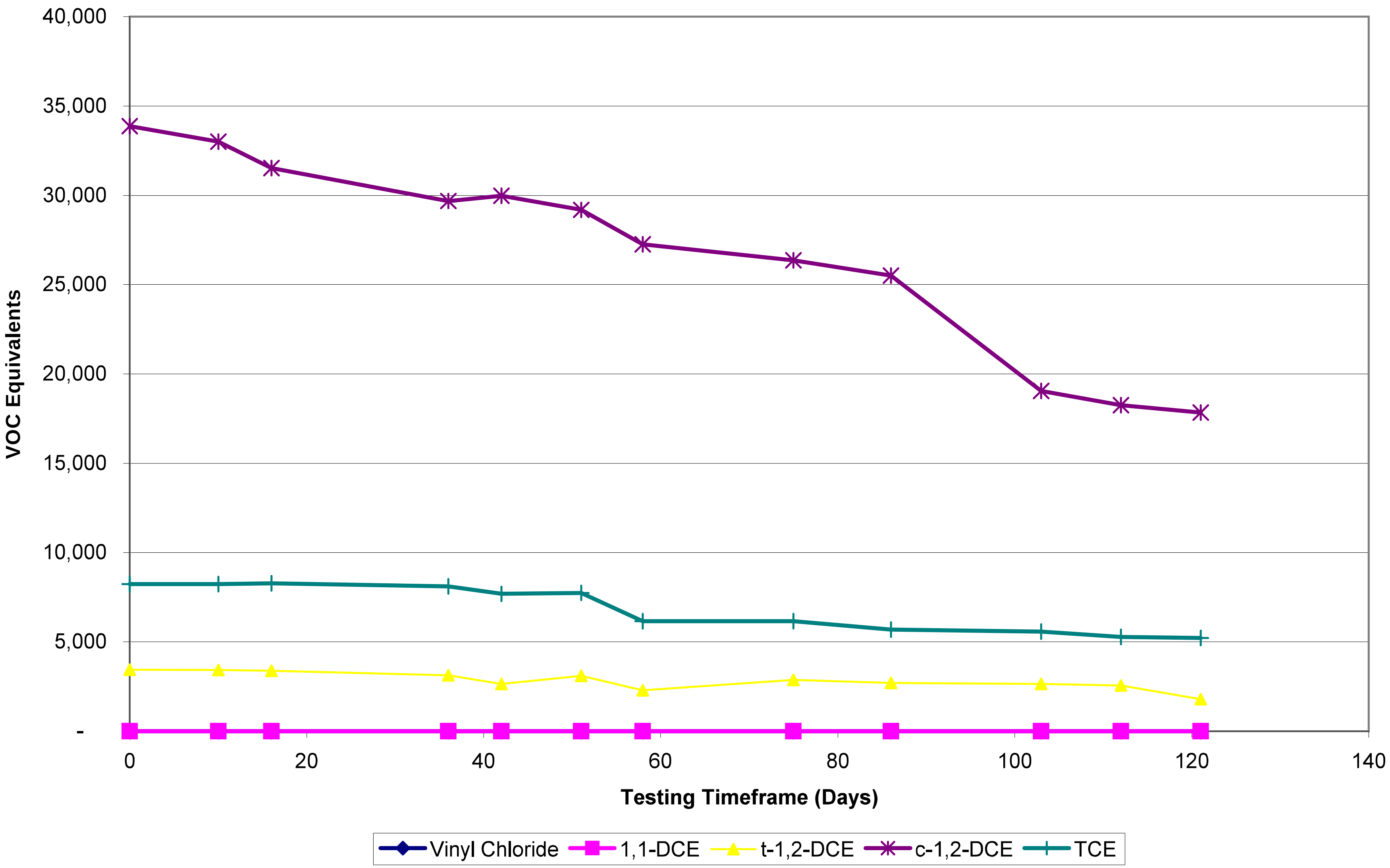


FIGURE 2:  VOCs versus Time - Sterile Control

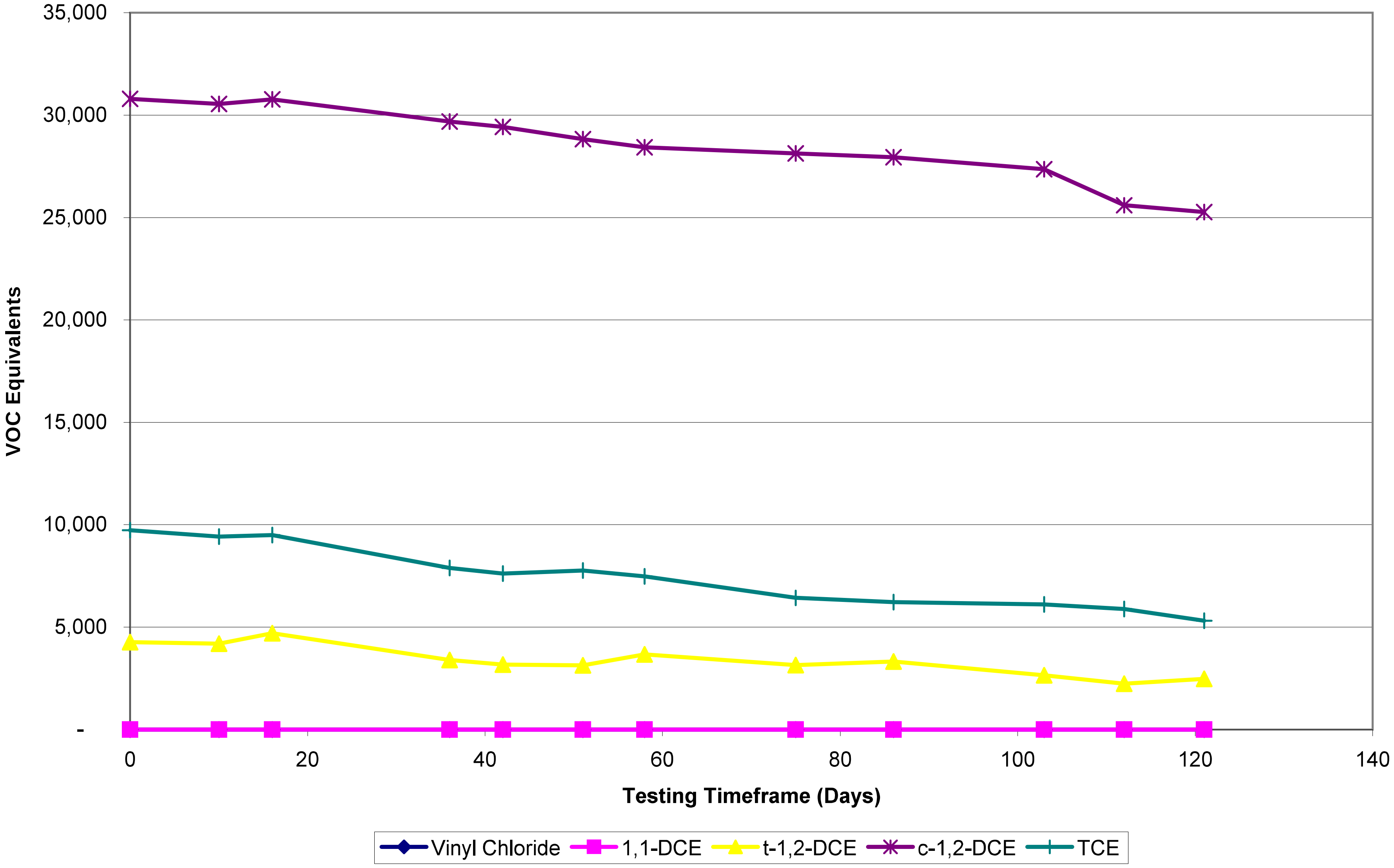
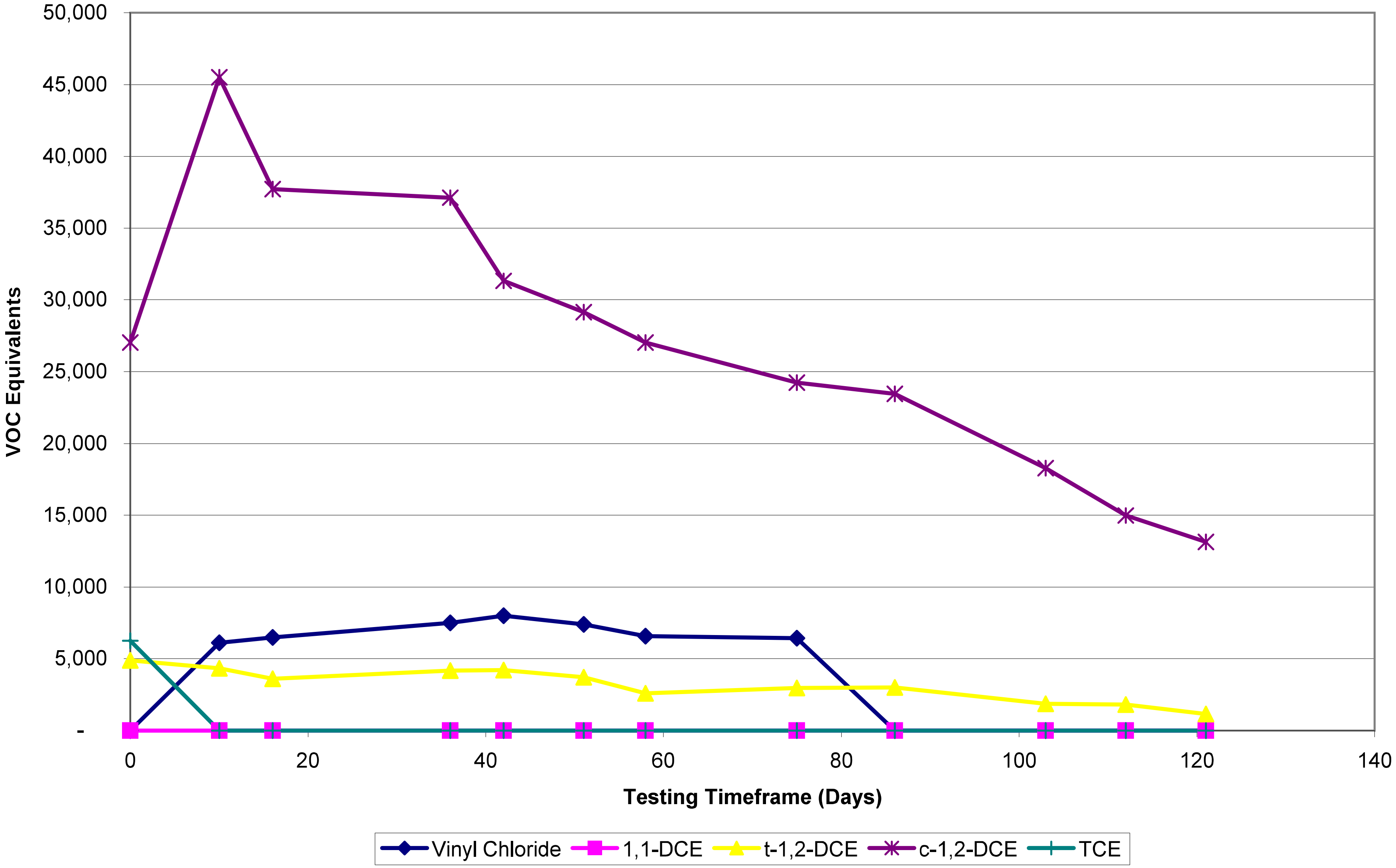


FIGURE 3:  VOCs versus Time - Alkene Sodium Lactate



## FIGURE 4: VOCs versus Time - Alkene Sodium Acetate

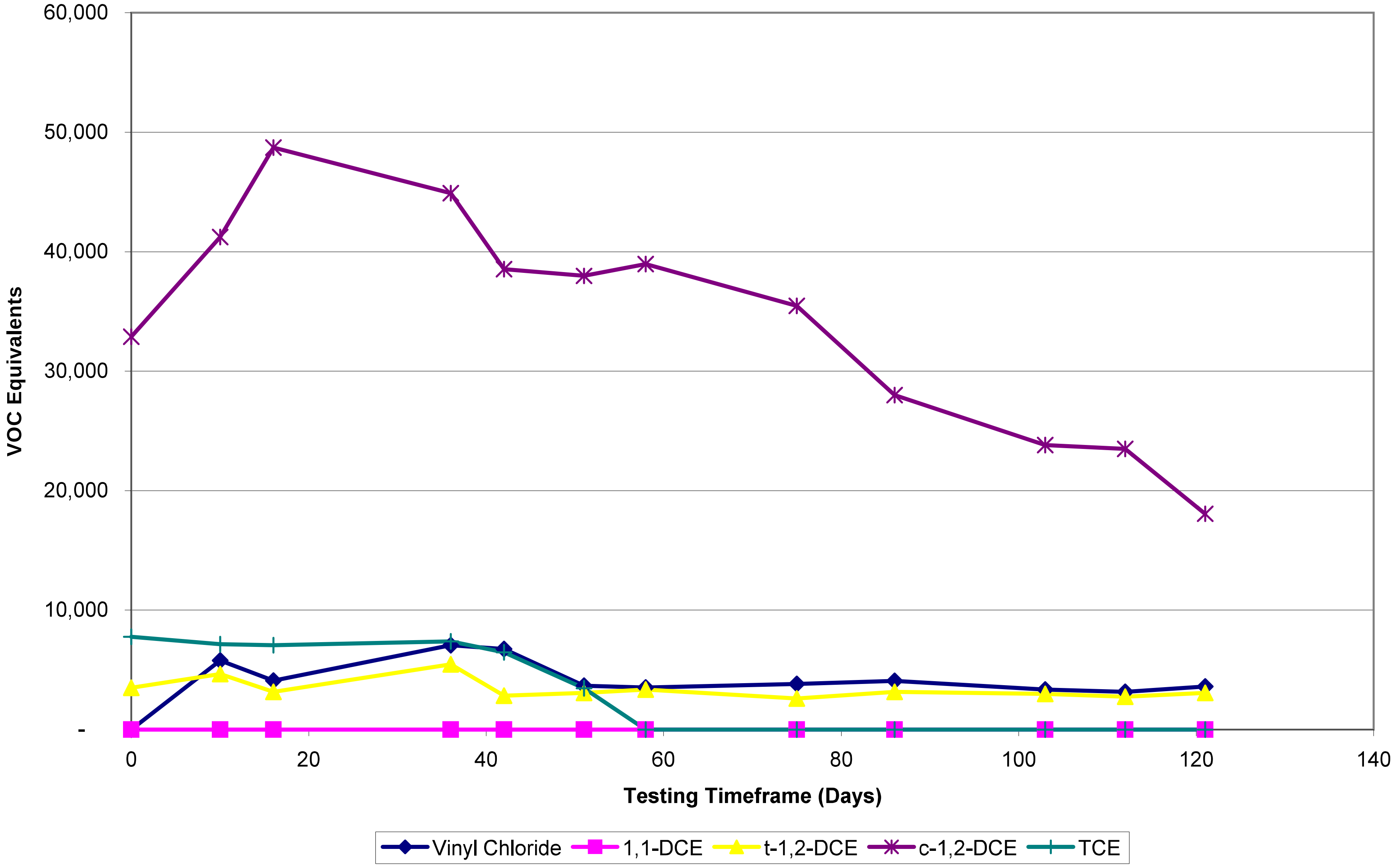
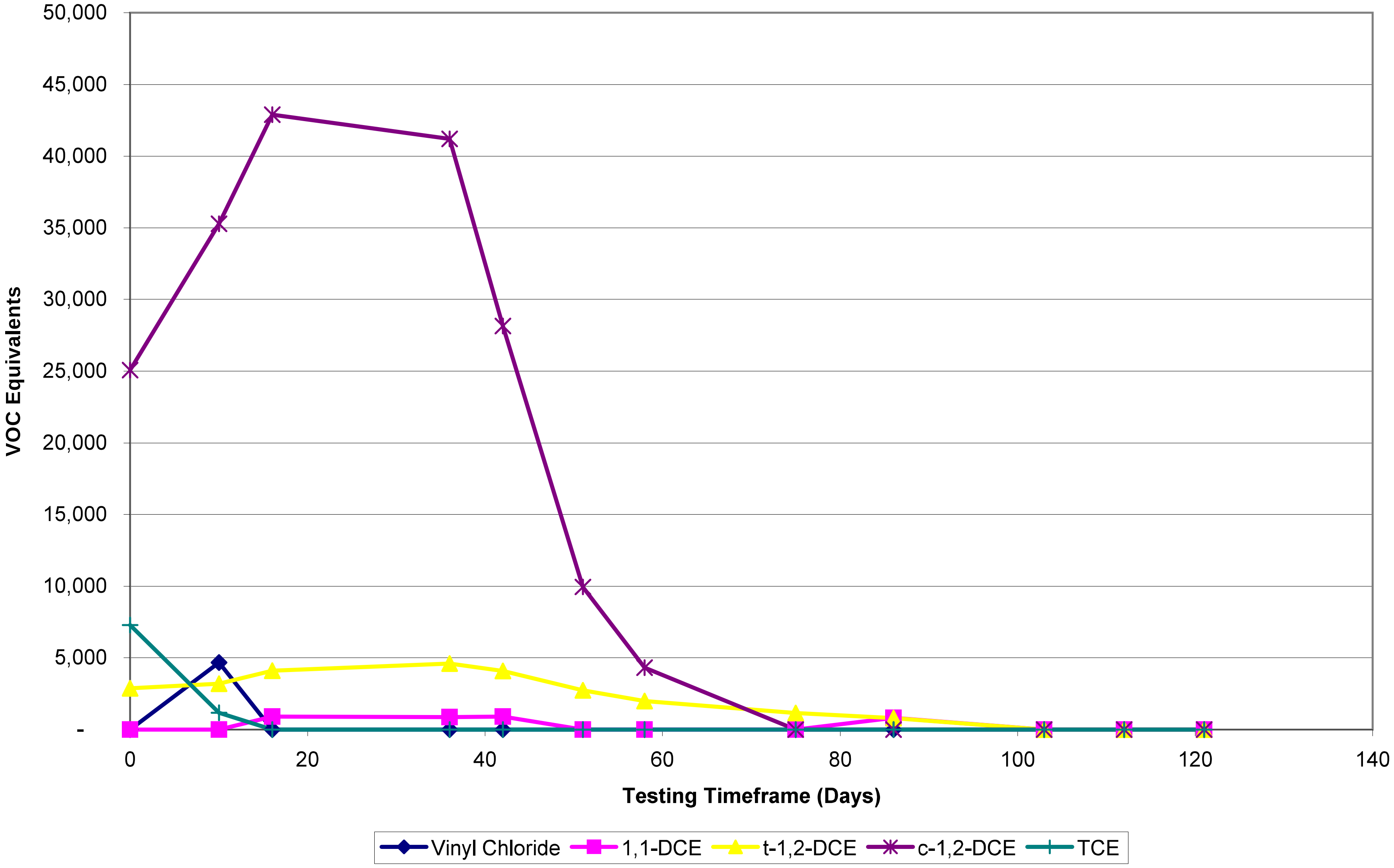


FIGURE 5:  VOCs versus Time - Alkene Organic Acid Mixture



## FIGURE 6: Alkene Microcosm pH Levels versus Time

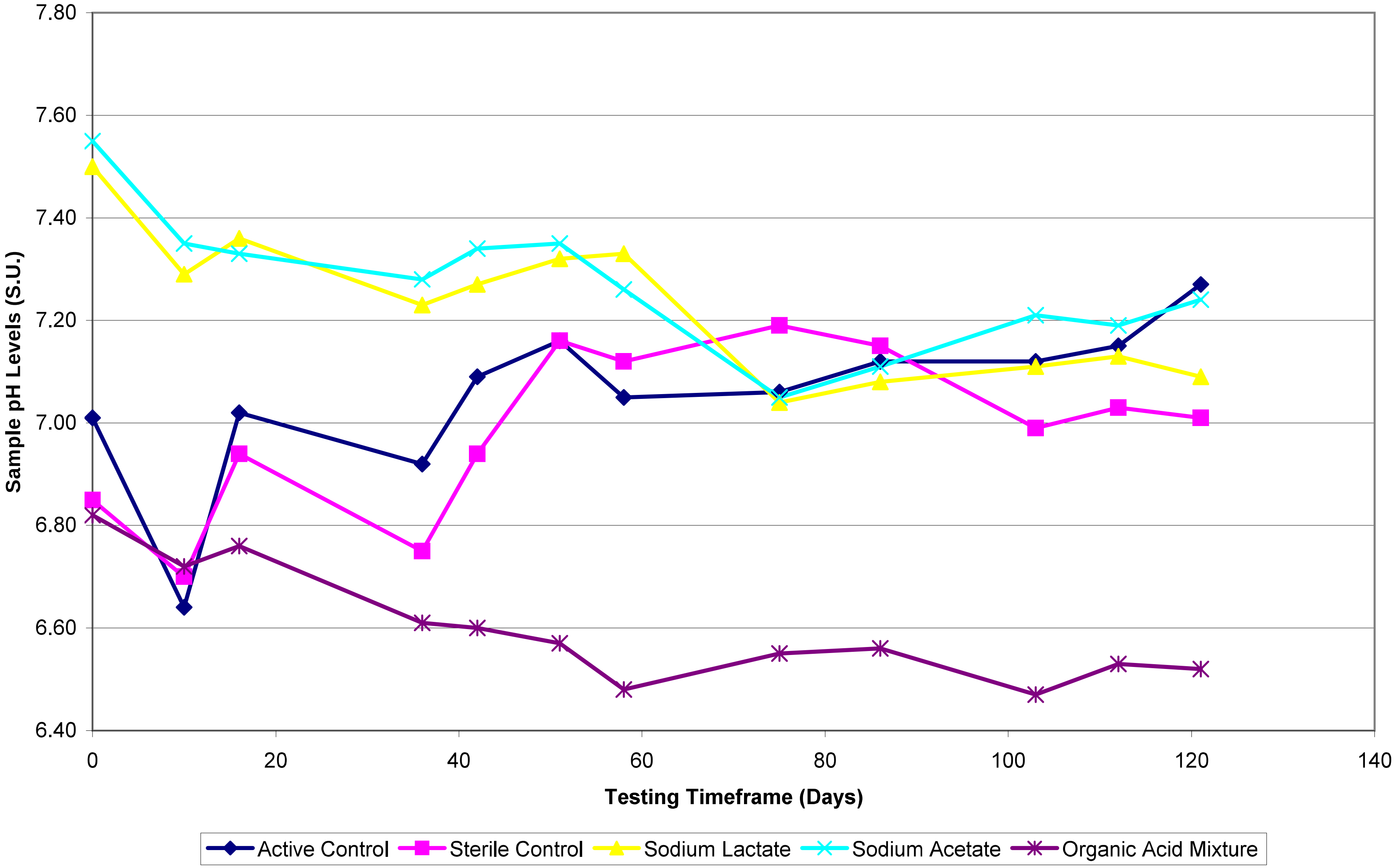
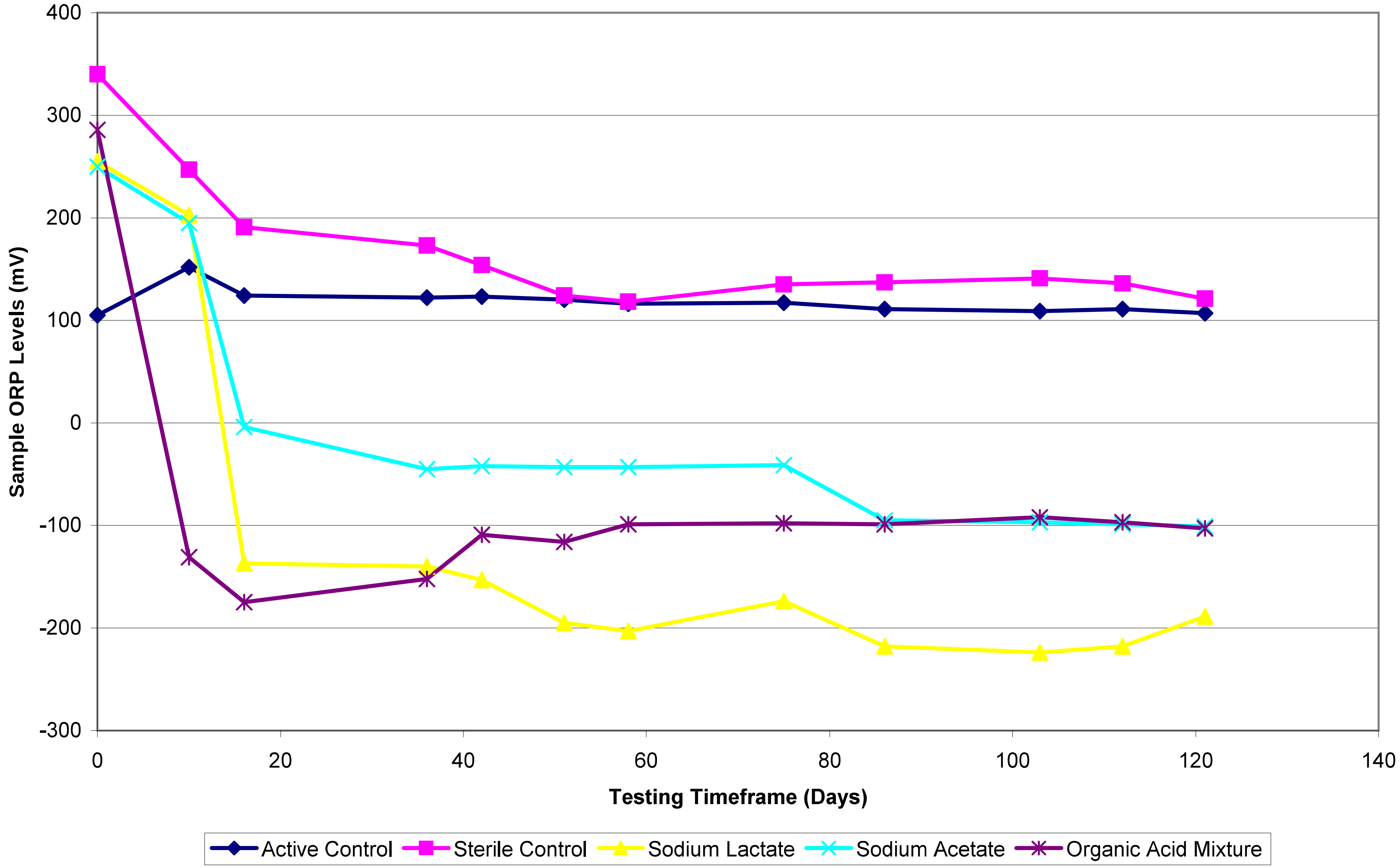


FIGURE 7: Alkene Microcosm ORP Levels versus Time



# FIGURE 8: VOCs versus Time - Alkane Sodium Lactate

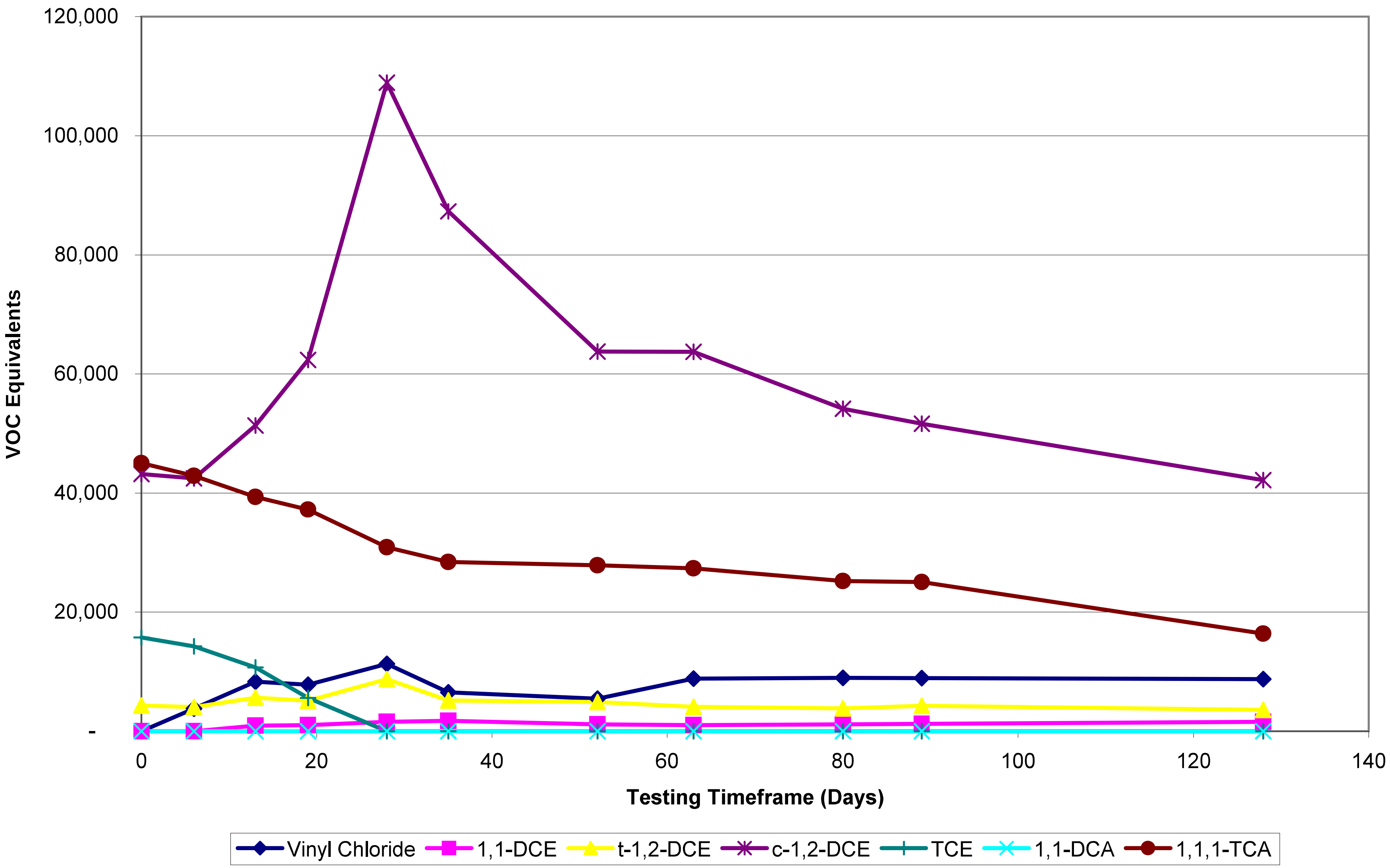
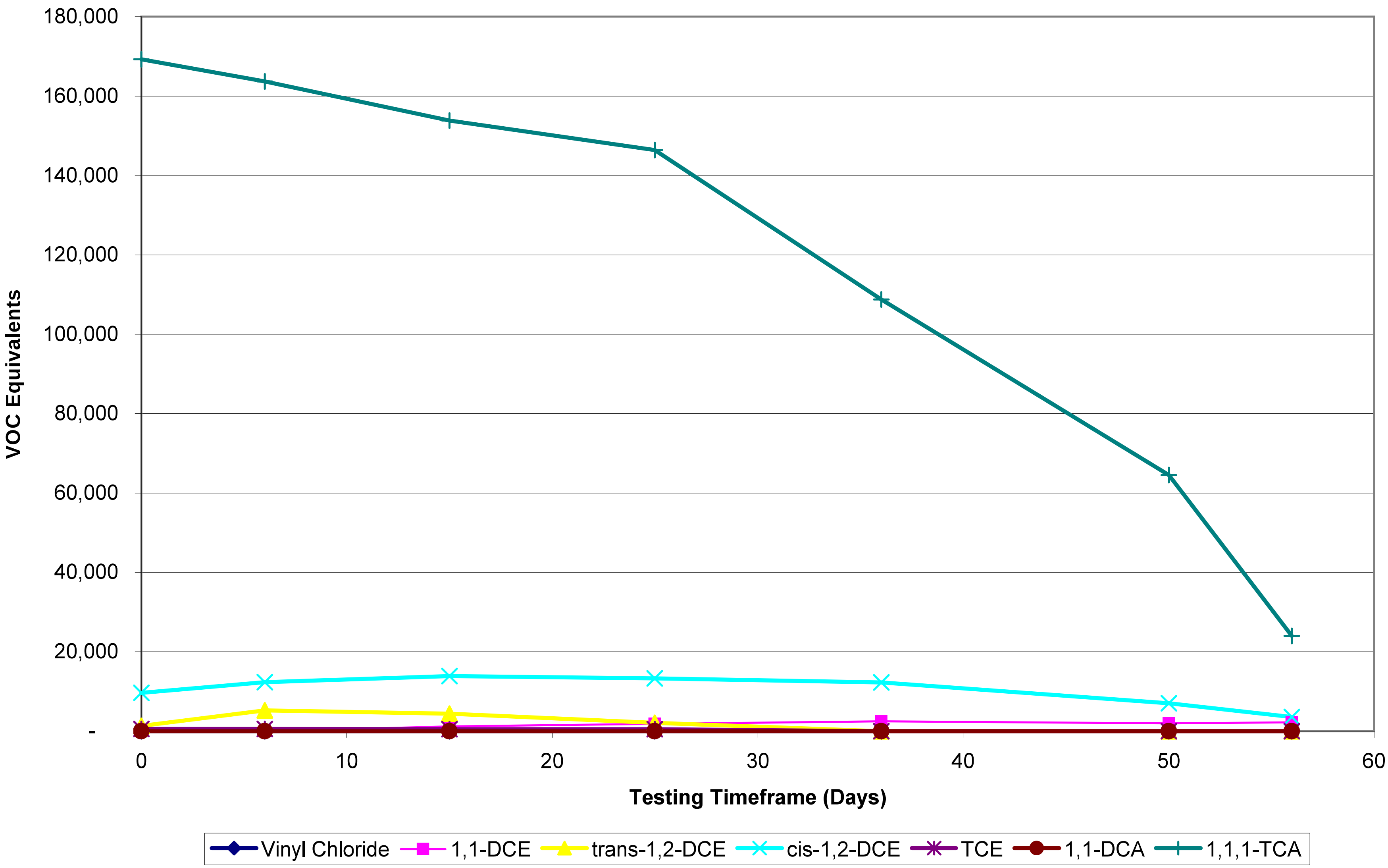


FIGURE 9: VOCs versus Time - Alkane Organic Acid



## FIGURE 10: Alkane Microcosm pH Levels versus Time

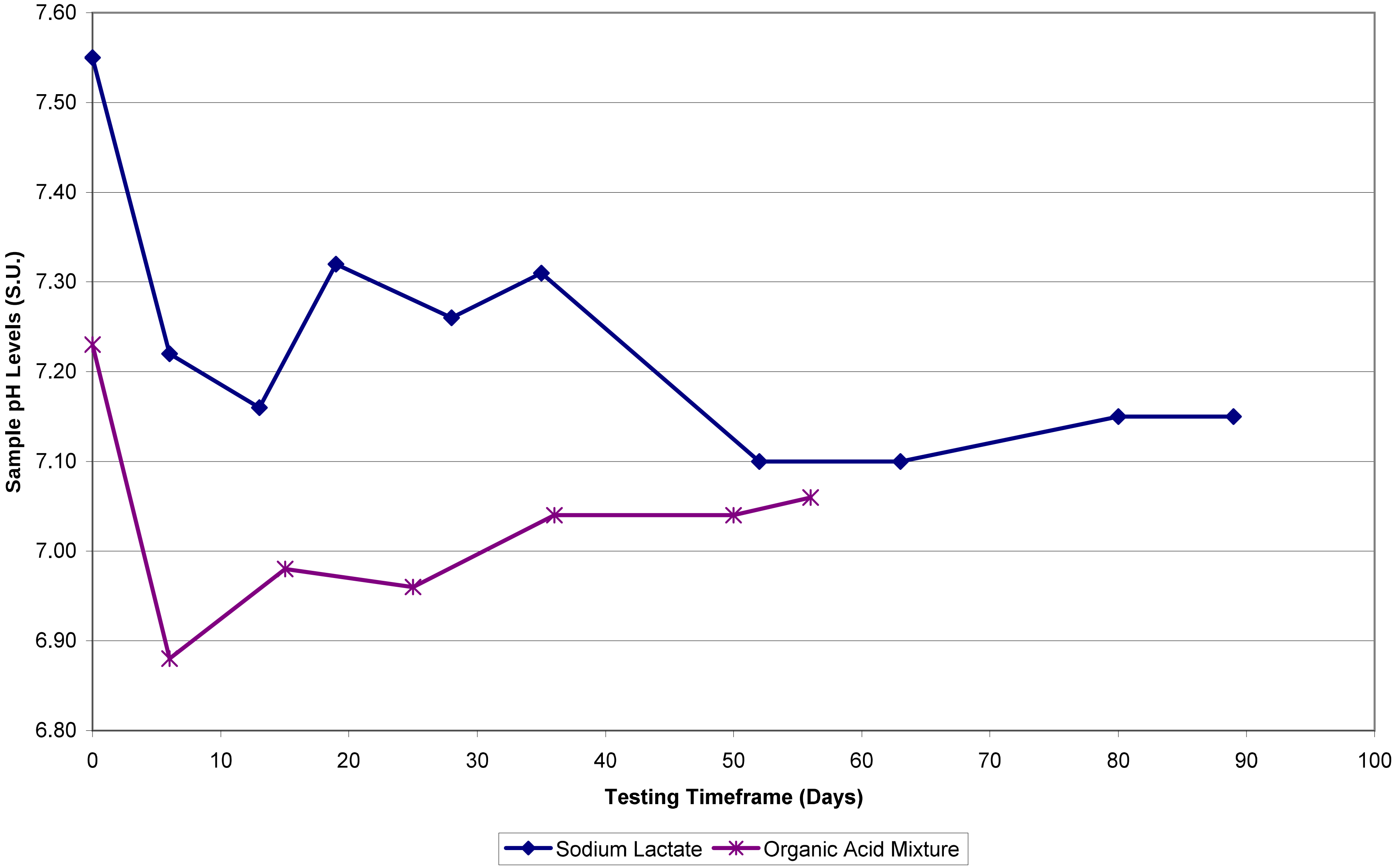
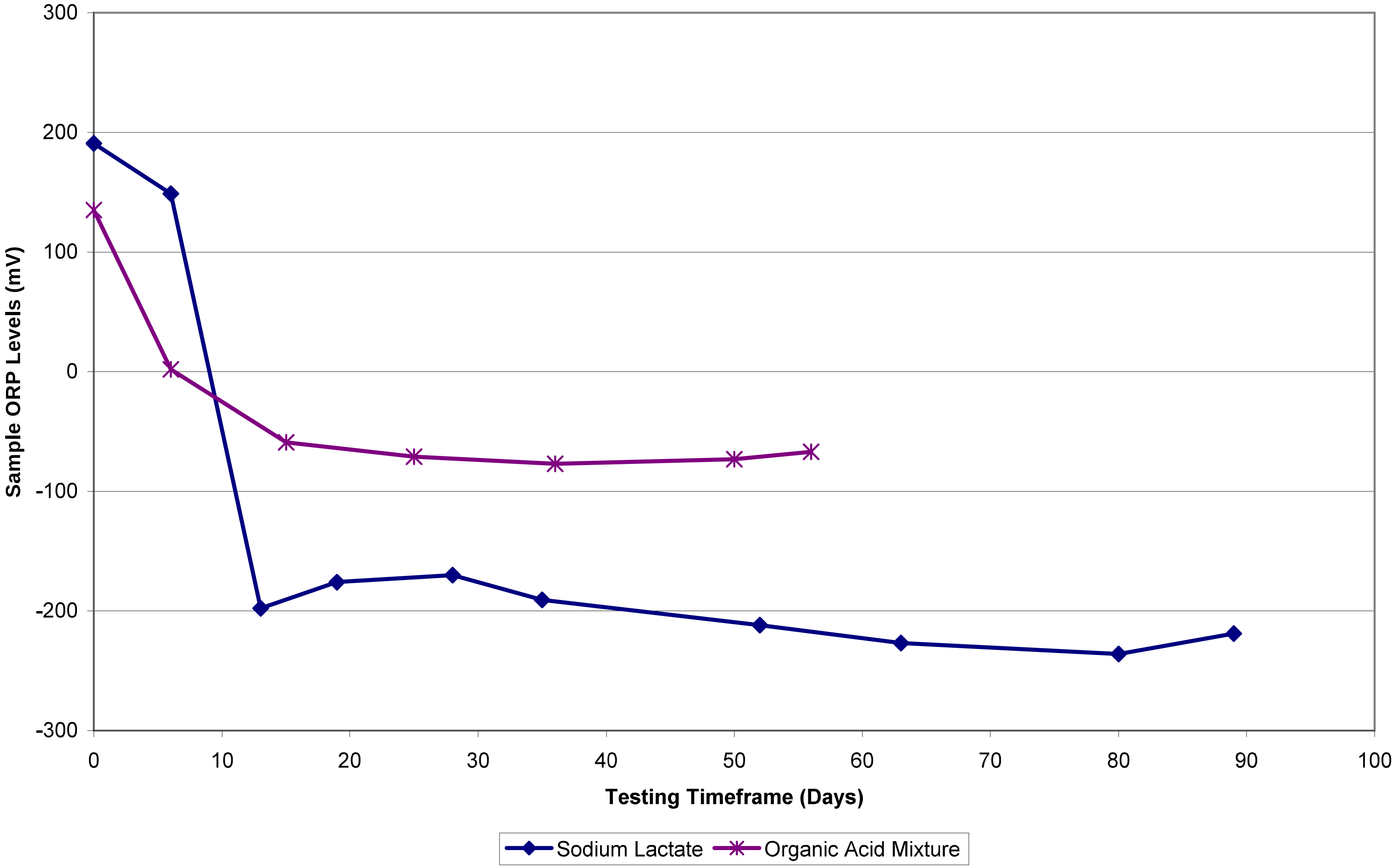


**FIGURE 11: Alkane Microcosm ORP Levels versus Time**



# APPENDIX A

LABORATORY ANALYTICAL REPORT SHEETS – SiREM LABORATORIES, INC.

OXIDATIVE AND REDUCTIVE TREATABILITY TESTING REPORT
Buell Automatics, Inc. Site – Rochester, New York
March 13, 2009

SiREM
Site Recovery & Management

www.siremlab.com

130 Research Lane, Suite 2
Guelph, Ontario N1G 5G3
Phone (519) 822-2265
Fax (519) 822-3151

# Certificate of Analysis: Quantitative Gene-Trac *Dehalococcoides* Assay

**Customer:** David Schroder, Stantec
**Project:** Buell Automatics
**Customer Reference:** 24OT.00001.02.0001

**SiREM Reference:** S-1421
**Report Issued:** 21-Oct-08
**Data Files:** DHC-UP-0506
QPCR-0396

## Table 1: Test Results

| Customer Sample ID | SiREM Sample ID | Sample Collection Date | Sample Matrix | Percent Dhc [A] | *Dehalococcoides* Enumeration [B] |
|---|---|---|---|---|---|
| BST-MW2 | DHC-4388 | 6-Oct-08 | Groundwater | 0.0005-0.002% | 2 x $10^5$/liter |

**Notes:**

[A] Percent *Dehalococcoides* (Dhc) in microbial population. This value is calculated by dividing the number of Dhc 16S ribosomal ribonucleic acid (rRNA) gene copies by the total number of bacteria as estimated by the mass of DNA extracted from the sample. Range represents normal variation in Dhc enumeration.

[B] Based on quantification of Dhc 16S rRNA gene copies. Dhc are generally reported to contain one 16S rRNA gene copy per cell; therefore, this number is often interpreted to represent the number of Dhc cells present in the sample.

**Analyst:** J. Wilkinson
**Jennifer Wilkinson**
**Biotechnology Technologist**

**Approved:** Ximena Druar
**Ximena Druar, B.Sc.**
**Molecular Biology Coordinator**

# Certificate of Analysis: Gene-Trac-VC, Vinyl Chloride Reductase (*vcrA*) Assay

**Customer:** David Schroder, Stantec
**Project:** Buell Automatics
**Customer Reference:** 24OT.00001.02.0001

**SiREM Reference:** S-1421
**Report Issued:** 21-Oct-08
**Data Files:** VC-QPCR-0157
VC-QPCR check-gel-0181

## Table 1: Test Results

| Customer Sample ID | SiREM Sample ID | Sample Collection Date | Sample Matrix | Percent *vcrA* [A] | Vinyl Chloride Reductase (*vcrA*) Gene Copies |
|---|---|---|---|---|---|
| BST-MW2 | VCR-0988 | 6-Oct-08 | Groundwater | 0.0006-0.002% | 2 x $10^5$/liter |

**Notes:**

[A] Percent *vcrA* in microbial population. This value is calculated by dividing the number of vinyl chloride reductase A (*vcrA)* gene copies quantified by the total number of bacteria estimated to be in the sample based on the mass of DNA extracted from the sample. Range represents normal variation in enumeration of *vcrA*.

**Analyst:** J. Wilkinson
**Jennifer Wilkinson**
**Biotechnology Technologist**

**Approved:** Ximena Druar
**Ximena Druar, B.Sc.**
**Molecular Biology Coordinator**

## Table 2: Detailed Test Parameters, Gene-Trac Test Reference S-1421

| | |
|---|---|
| **Customer Sample ID** | BST-MW2 |
| **SiREM Test ID** | DHC-4388/VCR-0988 |
| **Date Received** | 7-Oct-08 |
| **Sample Temperature** | 3.8 °C |
| **Volume Used for DNA Extraction** | 25 mL |
| **DNA Extraction Date** | 10-Oct-08 |
| **DNA Concentration in Sample (extractable)** | 69440 ng/L |
| **Extracted DNA Quality Test (universal PCR primers)** | ND |
| **Dhc qPCR Analysis Date** | 15-Oct-08 |
| **vcrA qPCR Analysis Date** | 17-Oct-08 |
| **qPCR Controls (see Table 3 & 4)** | Passed |
| **Comments** | - - |

**Notes:**

Refer to Table 3 & 4 for detailed results of controls.
NR = not required
ND = not detected
°C = degrees Celsius

PCR = polymerase chain reaction
qPCR = quantitative PCR
Dhc = *Dehalococcoides*

ng/L = nanograms per liter
mL = milliliters
DNA = Deoxyribonucleic acid

Table 3: Gene-Trac-DHC Experimental Control Results, Gene-Trac Test Reference S-1421

| Laboratory Control | Analysis Date | Control Description | Spiked Dhc 16S rRNA Gene Copies per Liter | Recovered Dhc 16S rRNA Gene Copies per Liter | Comments |
|---|---|---|---|---|---|
| **Positive Control Low Concentration** | 15-Oct-08 | qPCR with KB1 genomic DNA (CSLD-0040) | 1.7 x $10^{6}$ | 1.4 x $10^{6}$ | Normal[1] |
| **Positive Control High Concentration** | 15-Oct-08 | qPCR with KB1 genomic DNA (CSHD-0040) | 1.7 x $10^{8}$ | 1.2 x $10^{8}$ | Normal[1] |
| **DNA Extraction Blank** | 15-Oct-08 | DNA extraction sterile water (DB-0842) | 0 | ND | Normal |
| **Negative Control** | 15-Oct-08 | Tris Reagent Blank | 0 | ND | Normal |

**Notes:**

[1] Within defined limits of +/- 50%

Dhc = *Dehalococcoides*

DNA = Deoxyribonucleic acid

NA = not applicable

ND = not detected

qPCR = quantitative PCR

16S rRNA = 16S ribosomal ribonucleic acid

## Table 4: Gene-Trac-VC Experimental Control Results, Gene-Trac Test Reference S-1421

| Laboratory Control | Analysis Date | Control Description | Spiked *vcrA* reductase Gene Copies per Liter | Recovered *vcrA* reductase Gene Copies per Liter | Comments |
|---|---|---|---|---|---|
| **Positive Control Low Concentration** | 17-Oct-08 | qPCR with KB1 genomic DNA (CSLV-0024) | $1.7 \times 10^{6}$ | $1.9 \times 10^{6}$ | Normal[1] |
| **Positive Control High Concentration** | 17-Oct-08 | qPCR with KB1 genomic DNA (CSHV-0024) | $1.8 \times 10^{8}$ | $1.8 \times 10^{8}$ | Normal[1] |
| **DNA Extraction Blank** | 17-Oct-08 | DNA extraction sterile water (DB-0842) | 0 | ND | Normal |
| **Negative Control** | 17-Oct-08 | Tris Reagent Blank | 0 | ND | Normal |

**Notes:**

NA = not applicable

ND = not detected

[1] Within defined limits of +/- 50%

qPCR = quantitative PCR

Dhc = *Dehalococcoides*

DNA = Deoxyribonucleic acid

16S rRNA = 16S ribosomal ribonucleic acid

*vcrA* = vinyl chloride reductase

SiREM
Site Recovery & Management

# Chain-of-Custody Form

130 Research Lane, Suite 2 · Guelph, Ontario, Canada N1G 5G3 · Phone (519) 822-2265 or toll free 1-866-251-1747 Fax (519)822-3151
www.siremlab.com

No. 0001

Lab # S-1421

Page 1 of 1

Project Name: Buell Automatics
Project #: 240T.00001.02.0001
Project Manager: David Schroder
Company: Stantec
Address: 4035 King Road Suite D
Sylvania, Ohio 43560
Phone #: (419) 843-1518
Fax #: (419) 843-1571
Samplers Signature: David Schrod
Sampler's Printed Name: David Schroder

**Analysis**

| Client Sample ID | Lab ID | Sampling Date | Sampling Time | Matrix | # of Containers | Gene Trac Methods 1 and 2 | | | | | | | | | | | Other Information |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Preservative | | | | | | 0 | | | | | | | | | | | |
| BST-MW2 | | 10/6/08 | 0930 | GW | 1 | X | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

**Preservative Key**
0. None
1. HCL
2. Other ____
3. Other ____
4. Other ____
5. Other ____
6. Other ____

**Sample Receipt**
Cooler Condition: Good
Cooler Temperature: 3.8 °C
Custody Seals: Yes ☐ No ☒

**Invoice Information**
P.O #: 240T.00001.02.0001
Bill To: Stantec Attn: Kim Weston
2321 Club Meridian Dr. Ste E
Okemos, MI 48864

**For Lab Use Only**

| | Relinquished By: | Received By: | Relinquished By: | Received By: | Relinquished By: | Received By: |
|---|---|---|---|---|---|---|
| Signature | David Schrod | [illegible] | | | | |
| Printed Name | David Schroder | [illegible] | | | | |
| Firm | Stantec | SiREM | | | | |
| Date/Time | 10/6/08 / 16:00 | [illegible] | | | | |

Distribution: White - Return to Originator; Yellow - Lab Copy; Pink - Retained by Client

In the absence of an executed agreement, submission of samples to SiREM implies consent for performance of analyses specified on this Chain-of-Custody form and agreement with the terms and conditions of the SiREM Laboratory Services Agreement. The entity submitting samples shall be responsible for payment in full for said analyses.

# Interpretation of Quantitative Gene-Trac *Dehalococcoides* Test Results

## 1) Background:

*Dehalococcoides* group organisms (*Dhc*) are the only known microorganisms capable of complete dechlorination of chloroethenes (i.e., tetrachloroethene, trichloroethene, *cis*-dichloroethene, vinyl chloride to non-toxic ethene. The detection of the *Dhc* 16S ribosomal ribonucleic acid (rRNA) gene has been correlated with the complete biological dechlorination of chlorinated ethenes to ethene at contaminated sites (Hendrickson et. al., 2002, *Applied and Environmental Microbiology*, 68: 485-495). The Quantitative Gene-Trac *Dehalococcoides* test is a quantitative polymerase chain reaction (PCR) test used to determine the concentration of the *Dhc* 16S rRNA gene in soil and groundwater samples.

## 2) Interpretation of Test Results:

The Quantitative Gene-Trac test reports two types of results, *"Dehalococcoides* 16S rRNA Gene Copies" is a raw value whereas **"**% *Dehalococcoides* in Microbial Population*"* is the raw value expressed as percentage of total microbial population. A detailed explanation of the two types of results is provided below.

### a) *Dehalococcoides* 16S rRNA Gene Copies

This value is the direct number of *Dhc* 16S rRNA gene copies detected in the sample. Results may be reported either per liter (for groundwater) or per gram (for soil). This number is generally interpreted as equivalent to the number of viable *Dhc* present in the sample when certain reasonable assumptions are made, including that the DNA quantified belongs to viable *Dhc* (i.e., not from dead *Dhc*) and that each *Dhc* cell contains only one 16S rRNA gene. Guidelines for relating this value to observable dechlorination impacts for groundwater samples are provided below.

- **Values of $10^3$ gene copies per liter or lower,** indicate the sample contains low concentrations of *Dhc* organisms which may indicate that site conditions are sub-optimal for high rates of dechlorination. Increases in *Dhc* concentrations at the site may be possible if conditions are modified (e.g., electron donor addition).

- **Values of $10^4$-$10^6$ gene copies per liter,** indicates the sample contains moderate concentrations of *Dhc* which may, or may not, be associated with observable dechlorination impacts (i.e., ethene).

- **Values at or above $10^7$ gene copies per liter,** indicate the samples contains high concentrations of *Dhc* which is often associated with high rates of dechlorination and the production of ethene. Test results exceeding $10^9$ gene copies/liter are rarely observed.

### b) % *Dehalococcoides* in Microbial Population (% *Dhc*)

This value presents the percentage of *Dhc* (% *Dhc*) relative to other microorganisms in the sample based on the formulas below. % *Dhc* is a measure of the predominance of *Dhc and,* in general, the higher this percentage the better.

$$\%\ Dhc = \frac{Number\ Dhc}{Number\ Dhc + Number\ other\ Bacteria}$$

*Where:*

$$Number\ other\ Bacteria = \frac{Total\ DNA\ in\ sample\ (ng) - DNA\ attributed\ to\ Dhc\ (ng)}{4.0\ x\ 10^{-6}\ ng\ DNA\ per\ bacterial\ cell}$$

The number of non-*Dhc* bacteria is estimated by assuming each non-*Dhc* bacterium contains 4.0 x $10^{-6}$ nanograms (ng) of DNA (Paul and Clark. 1996. *Soil Microbiology and Biochemistry*). Because the total mass of DNA in a sample is determined (by fluorometry) the total number of bacteria present can be estimated. For perspective, the % *Dhc* can range from very low fractions of percentages, in samples that have low numbers of *Dhc* and high numbers of other bacteria (incompletely colonized by *Dhc*), to greater than 50% in *Dhc* enriched cultures such as KB-1™ (fully colonized by *Dhc*).

In addition to determining the predominance of *Dhc*, this value is also used for interpretation of *Dhc* counts from different sampling locations or the same location over time, because it is normalized to total bacteria. In particular, the % *Dhc* value can be used to correct *Dhc* counts where samples are biased low due to non-representative sampling of biomass (bacteria). Example 1 below illustrates a scenario where the % *Dhc* value improves the interpretation of data where one sampling event was biased.

#### *Example 1, use of % Dhc Value to interpret raw data*

Example 1 presents results from monitoring well MW-1 sampled in April, May and June. Based on the raw *Dhc* counts alone (*Dehalococcoides* 16S rRNA Gene Copies) it might be assumed that the number of *Dhc* decreased 10-fold between April and May; however, based on the percentage of *Dhc* it is clear that the proportion of *Dhc* actually increased from April to May and that the low count is probably a case of sampling variability (biased low). The higher raw count and the higher percentage of *Dhc* in June confirms the trend of increasing *Dhc* concentrations over time.

| Sample | ***Dehalococcoides*** **16S rRNA Gene Copies** | **% *Dhc*** | **Interpretation Based on % *Dhc*** |
|---|---|---|---|
| MW-1–April | 1.0 x $10^5$/Liter | 0.1% | *Dhc* is a low proportion of total microbial population |
| MW-1–May | 1.0 x $10^4$/Liter | 1% | *Dhc* predominance increased 10-fold from April, low count from low biomass sampled, non-biased sample would be [(1.0/0.1) x 1.0 x$10^5$] = $10^6$ /Liter |
| MW-1 June | 1.0 x $10^7$/Liter | 10% | *Dhc* predominance moderate and has increased 100-fold from April |

## 3) <u>Explanation of Notes</u>

**Quantitation limit:** The quantitation limit of Gene-Trac test is 2,150 *Dhc* 16S rRNA gene copies per liter. Note, the specific quantitation limit for each test varies depending on the volume of sample used in the DNA extraction process. For example, if only a ½ liter of water was used the quantitation limit would increase two-fold to 4300 gene copies per liter. The specific quantitation limit is provided only where *Dhc* is not detected.

**Value is an estimated quantity between the quantitation limit and detection limit:** This is applicable in situations where *Dhc* DNA is detected above the detection limit, but below the quantitation limit, of the standard curve. In such cases an estimated value is provided which is based on extrapolation of the standard curve.

**Sample inhibited testing:** Each Quantitative Gene-Trac test includes a quantification of the amount of DNA extracted from the sample and a second test to determine if the extracted DNA is suitable for *Dhc* testing (PCR with a universal Bacteria primer). If a sample is determined to contain DNA and PCR with universal primers is negative, it suggests that the extracted DNA inhibited the PCR. Inhibition may be caused by compounds present in the original groundwater sample (e.g., humic acids). Where inhibition occurs there is an increased likelihood of false negatives since *Dhc* DNA, if present, may not be detected.

**DNA not extracted from the sample:** If DNA is not detected in the sample then “DNA not extracted from the sample” is reported. This is commonly due to samples that contain little or no biomass (bacteria). In some cases sampling may not capture bacteria (e.g., when attached bacteria are not dislodged from the aquifer matrix).

## 4) <u>Converting Standard Gene-Trac to *Dhc* 16S rRNA Gene Copies/Liter</u>

Quantitative Gene-Trac provides quantitative results in *Dhc* 16S rRNA Gene Copies/Liter, whereas standard Gene-Trac provides semi-quantitative results using a plus scale. Based on parallel analysis of standard versus Quantitative Gene-Trac estimates of the number of *Dhc* gene copies for each + score in the standard test were determined. Note, the conversion factors do not apply in all cases and are meant to be used as a rule of thumb for relating standard Gene-Trac results to Quantitative-Gene-Trac.

**Estimated 16S rRNA Gene Copies/Liter for Standard Gene-Trac Intensity Scores**

| Standard Gene-Trac Intensity Score | Approximate Range of 16S rRNA Gene Copies/Liter |
|---|---|
| + | $10^3$-$10^5$ |
| ++ | $10^4$-$10^6$ |
| +++ | $10^5$-$10^7$ |
| ++++ | $10^6$-$10^8$ |

# Appendix B

## Material Safety Data Sheets (MSDSs) for EISB Program Materials

# MATERIAL SAFETY DATA SHEET

**Sodium Carbonate, Anhydrous**

**MSDS Ref. No.:** 497-19-8
**Date Approved:** 12/19/2008
**Revision No.:** 7

---

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200; the Canada's Workplace Hazardous Materials Information System (WHMIS) and, the EC Directive, 2001/58/EC.

---

# 1. PRODUCT AND COMPANY IDENTIFICATION

| | |
|---|---|
| **PRODUCT NAME:** | Sodium Carbonate, Anhydrous |
| **ALTERNATE PRODUCT NAME(S):** | Soda Ash, Sodium Carbonate Anhydrous |
| **GENERAL USE:** | Glass manufacture, detergent manufacture, sodium chemicals and carbonate chemicals manufacture, pulp and paper, brine treatment, water hardness removal, pH adjustment in water or waste water, flue gas desulfurization, coal treatment, ion exchange resin regeneration.<br>This chemical is certified to ANSI/NSF Standard 60, Drinking Water Chemicals-Health Effects (as packaged in the original, unopened container). The maximum dosage level for this chemical is 150 mg/L |

## MANUFACTURER

FMC Wyoming Corporation
Alkali Chemicals Division
1735 Market Street
Philadelphia, PA 19103
(215) 299-6000 (General Information)
msdsinfo@fmc.com (Email - General Information)

## EMERGENCY TELEPHONE NUMBERS

(307) 872-2452 (Plant - Green River, WY)

(303) 595-9048 (Medical - Call Collect)

For leak, fire, spill, or accident emergencies, call:
(800) 424-9300 (CHEMTREC - U.S.A. & Canada)

---

# 2. HAZARDS IDENTIFICATION

## EMERGENCY OVERVIEW:

- White, odorless, granular solid.
- Product is non-combustible.
- Reacts with acids to release carbon dioxide gas and heat.
- Irritating to the eyes and continuous contact may irritate the skin.
- Not expected to be toxic to the environment, nor to aquatic organisms.

**POTENTIAL HEALTH EFFECTS:** Direct contact with the product causes irritation of the eyes and continuous contact may cause skin irritation (red, dry, cracked skin). Excessive levels of airborne dust may irritate the mucous membranes and upper respiratory tract.

# 3. COMPOSITION / INFORMATION ON INGREDIENTS

| Chemical Name | CAS# | Wt.% | EC No. | EC Class |
|---|---|---|---|---|
| Sodium carbonate | 497-19-8 | 99.8 | 207-838-8 | Xi; R36 |
| Water | 7732-18-5 | 0.2 | 231-791-2 | Not classified |

# 4. FIRST AID MEASURES

**EYES:** Immediately flush with water for at least 15 minutes, lifting the upper and lower eyelids intermittently. See a medical doctor or ophthalmologist as necessary.

**SKIN:** Wash with plenty of soap and water. Get medical attention if irritation occurs and persists.

**INGESTION:** Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

**INHALATION:** Remove to fresh air. If breathing difficulty or discomfort occurs and persists, obtain medical attention.

**NOTES TO MEDICAL DOCTOR:** While internal toxicity is low, irritant effects of high concentrations may produce corneal opacities, and vesicular skin reactions in humans with abraded skin only. Treatment is symptomatic and supportive.

# 5. FIRE FIGHTING MEASURES

**EXTINGUISHING MEDIA:** Water, water fog, carbon dioxide ($CO_2$), dry chemical

**FIRE / EXPLOSION HAZARDS:** Not applicable

**FIRE FIGHTING PROCEDURES:** Wear full protective clothing and self-contained breathing apparatus.

**FLAMMABLE LIMITS:** Not applicable

**HAZARDOUS COMBUSTION PRODUCTS:** Fumes of sodium oxide.

**SENSITIVITY TO IMPACT:** None

**SENSITIVITY TO STATIC DISCHARGE:** None

# 6. ACCIDENTAL RELEASE MEASURES

**COMMENTS:** PERSONAL PRECAUTIONS: Refer to Section 8 "Exposure Controls / Personal Protection".

CONTAINMENT: Prevent large quantities of this product from contacting vegetation or waterways; large spills could kill vegetation and fish.

CLEAN-UP: This product, if spilled, can be recovered and re-used if contamination does not present a problem. Vacuum or sweep up the material. If the spilled product is unusable due to contamination, consult state or federal environmental agencies for acceptable disposal procedures and locations. See Section 13 "Disposal Considerations".

NOTIFICATION REQUIREMENTS: Federal regulations do not require notification for spills of this product. State and local regulations may contain different requirements; consult local authorities.

# 7. HANDLING AND STORAGE

**HANDLING:** Use air conveying / mechanical systems for bulk transfer to storage. For manual handling o bulk transfer use mechanical ventilation to remove airborne dust from rail car, ship or truck. Use approved respiratory protection when ventilation systems are not available. Selection of respirators is based on the dust cloud generation. Keep material out of lakes, streams, ponds and sewer drains.

**STORAGE:** Store in a cool dry area, away from acids.

# 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**ENGINEERING CONTROLS:** Where possible, provide general mechanical and/or local exhaust ventilation to prevent release of airborne dust into the work environment.

## PERSONAL PROTECTIVE EQUIPMENT

**EYES AND FACE:** Appropriate eye and face protection equipment (ANSI Z87 approved) should be selected for the particular use intended for this material. Safety glasses with side shields are recommended.

**RESPIRATORY:** Whenever dust in the worker's breathing zone cannot be controlled with ventilation or other engineering means, workers should wear respirators or dust masks approved by NIOSH/MSHA, EU CEN or comparable certification organization to protect them against airborne dust.

**PROTECTIVE CLOTHING:** Dry product is generally non-irritating to intact skin. However, this product can be irritating where skin has been damaged and can create skin irritation after long exposures when moisture is present. Under such conditions, gloves and long-sleeved clothing are recommended to minimize skin contact.

### COMMENTS:

ADDITIONAL EXPOSURE GUIDELINES:

Federal guidelines treat the ingredient(s) in this product as a nuisance dust, as no product-specific guidelines have been issued for exposure. As with all nuisance dusts, worker breathing zone concentrations should be measured by validated sampling and analytical methods. The following limits (OSHA and MSHA) apply to this material:

Particulates Not Otherwise Regulated:
OSHA (PEL / TWA): 15 mg/m³ (total dust); 5 mg/m³ (resp fraction)
MSHA (PEL / TWA): 10 mg/m³ (total dust)

The information noted above provides general guidance for handling this product. Specific work environments and material handling practices will dictate the selection and use of personal protection equipment (PPE).

---

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| **ODOR:** | Odorless |
| **APPEARANCE:** | White, granular solid. |
| **AUTOIGNITION TEMPERATURE:** | Not applicable |
| **BOILING POINT:** | Decomposes |
| **COEFFICIENT OF OIL / WATER:** | Not applicable |
| **DENSITY / WEIGHT PER VOLUME:** | (g/ml) Dense Grades = 0.86 - 1.12; Light Grades = 0.70 - 0.90 |
| **EVAPORATION RATE:** | Not applicable (Butyl Acetate = 1) |
| **FLASH POINT:** | Non-combustible |
| **MELTING POINT:** | 851 °C (1,564 °F) |
| **ODOR THRESHOLD:** | Not applicable |
| **OXIDIZING PROPERTIES:** | Not applicable |

| | |
|---|---|
| **PERCENT VOLATILE:** | Not applicable |
| **pH:** | 11.4 (1% solution) |
| **SOLUBILITY IN WATER:** | 33.2 % maximum |
| **SPECIFIC GRAVITY:** | 2.509 (water = 1) |
| **VAPOR DENSITY:** | Not Applicable |
| **VAPOR PRESSURE:** | Not applicable |

# 10. STABILITY AND REACTIVITY

| | |
|---|---|
| **CONDITIONS TO AVOID:** | Contact with acids except under controlled conditions. |
| **STABILITY:** | Stable |
| **POLYMERIZATION:** | Will not occur |
| **INCOMPATIBLE MATERIALS:** | Reacts with acids with release of large volumes of carbon dioxide gas and heat. |
| **HAZARDOUS DECOMPOSITION PRODUCTS:** | Heated to decomposition, it emits fumes of sodium oxide. |

**COMMENTS:** Materials to Avoid : Aluminum powder, acids, fluorine, molten lithium

# 11. TOXICOLOGICAL INFORMATION

**EYE EFFECTS:** Severe irritant (rabbit) [Toxicology 23:281 (1982)]

**SKIN EFFECTS:** Non-irritating to intact skin. Minor irritation may occur on abraded skin. [Toxicol. Appl. Pharmacol. 31:481 (1975)]

**DERMAL $LD_{50}$:** No data available for the product.

**ORAL $LD_{50}$:** 4,090 mg/kg (rat) [RTECS 1986]

**INHALATION $LC_{50}$:** 2.3 mg/l (2 h) (rat) [Environ, Res. 31:138 (1983)]

**SENSITIZATION:** 0.25% sodium carbonate: Non-sensitizing (human) [Toxicol. Appl. Pharmacol. 31:481 (1975)]

**TARGET ORGANS:** Eyes

**ACUTE EFFECTS FROM OVEREXPOSURE:** May cause severe irritation of the eyes, including corneal opacities. Dusts and mists may be irritating to the skin, mucous membranes and upper respiratory tract. No significant acute toxicological effects expected.

**CHRONIC EFFECTS FROM OVEREXPOSURE:** No data available for the product.

### CARCINOGENICITY:

| | |
|---|---|
| **NTP:** | Not listed |
| **IARC:** | Not listed |
| **OSHA:** | Not listed |
| **OTHER:** | (ACGIH) Not listed |

# 12. ECOLOGICAL INFORMATION

**ECOTOXICOLOGICAL INFORMATION:** 96-hour $LC_{50}$ = 265 - 565 mg/L (daphnia magnia) (low toxicity)
96-hour $LC_{50}$ = 300 - 320 mg/L (bluegill sunfish) (low toxicity)

**CHEMICAL FATE INFORMATION:** Biodegradability does not apply to inorganic substances. No significant toxicity to aquatic organisms is expected.

# 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** When this product is discarded or disposed of, as purchased, it is neither a characteristic nor a listed hazardous waste according to US Federal RCRA regulations (40 CFR 261). As a non-hazardous waste the material may be disposed of in a landfill in accordance with government regulations; check local or state regulations for applicable requirements prior to disposal. Any processing, usage, alteration, chemical additions to, or contamination of, the product may alter the disposal requirements. Under Federal regulations, it is the generator's responsibility to determine if a waste is a hazardous waste.

# 14. TRANSPORT INFORMATION

## U.S. DEPARTMENT OF TRANSPORTATION (DOT)

| | |
|---|---|
| **PROPER SHIPPING NAME:** | Not regulated |
| **PRIMARY HAZARD CLASS / DIVISION:** | Not applicable |

| | |
|---|---|
| **UN/NA NUMBER:** | None |
| **LABEL(S):** | Not applicable |
| **PLACARD(S):** | Not applicable |
| **MARKING(S):** | Not applicable |
| **ADDITIONAL INFORMATION:** | Hazardous Substance/RQ: Not applicable<br>49 STCC Number: Not applicable |

### INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

**ADDITIONAL INFORMATION:** Not regulated

### ADR - EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD

**ADDITIONAL INFORMATION:** Not regulated

### INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

**ADDITIONAL INFORMATION:** Not regulated

### OTHER INFORMATION:

CANADIAN TRANSPORT (TDG):
This material is not regulated when transported by road in Canada.

---

# 15. REGULATORY INFORMATION

## UNITED STATES

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):**
Not listed

**SECTION 311 HAZARD CATEGORIES (40 CFR 370):**
Immediate (Acute) Health Hazard

### SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):

The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.: None

### SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):

Not listed

## CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

### CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):

Not listed

## TSCA (TOXIC SUBSTANCE CONTROL ACT)

### TSCA INVENTORY STATUS (40 CFR 710):

Listed

## RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

### RCRA IDENTIFICATION OF HAZARDOUS WASTE (40 CFR 261):

Waste Number: Refer to Section 13 "Disposal Considerations" for RCRA status.

# CANADA

## WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

| | |
|---|---|
| Hazard Classification / Division: | D2B<br>E |
| Ingredient Disclosure List: | Listed |
| Domestic Substance List: | Listed |

# E NUMBERS:

E 500

# EU EINECS NUMBERS:

011-005-00-2

# INTERNATIONAL LISTINGS

Australia (AICS): Listed
China: Listed

Japan (ENCS): (1)-164
Korea: KE-31380
Philippines (PICCS): Listed

## HAZARD AND RISK PHRASE DESCRIPTIONS:

| | | |
|---|---|---|
| EC Symbols: | Xi | (Irritant) |
| EC Risk Phrases: | R36 | (Irritating to eyes.) |

## COMMENTS:

CLEAN WATER ACT (CWA) - SECTION 307 / 311
Not listed as a hazardous pollutant (40 CFR 116), nor as a toxic pollutant (40 CFR 401.15)

CLEAN AIR ACT (CAA) - SECTION 112
Not regulated under the chemical accident prevention provisions (40 CFR 68)

---

# 16. OTHER INFORMATION

**HMIS**

| | |
|---|---|
| Health | 2 |
| Flammability | 0 |
| Physical Hazard | 0 |
| Personal Protection (PPE) | B |

Protection = B (Safety glasses and gloves)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:
4 = Severe
3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

**NFPA**

| | |
|---|---|
| Health | 2 |
| Flammability | 0 |
| Reactivity | 0 |
| Special | None |

No special requirements

NFPA (National Fire Protection Association)

Degree of Hazard Code:
4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

**REVISION SUMMARY:**
This MSDS replaces Revision #7, dated February 02, 2007.
Changes in information are as follows:
Section 1 (Product and Company Identification)
Section 15 (Regulatory Information)
Section 16 (Other Information)

FMC - Trademark of FMC Corporation

FMC Corporation believes that the information and recommendations contained herein (including data and statements) are accurate as of the date hereof. NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, WARRANTY OF MERCHANTABILITY, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION PROVIDED HEREIN. The information provided herein relates only to the specific product designated and may not be applicable where such product is used in combination with any other materials or in any process. It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Further, since the conditions and methods of use are beyond the control of FMC Corporation, FMC Corporation expressly disclaims any and all liability as to any results obtained or arising from any use of the product or reliance on such information.

# MATERIAL SAFETY DATA SHEET

## 1. Product and Company Identification

| | |
|---|---|
| **Material name** | VARIFLO® QD |
| **Version #** | 02 |
| **Revision date** | 19-December-2008 |
| **Chemical description** | Powder |
| **CAS #** | Mixture |
| **Synonym(s)** | XANTHAN GUM |
| **Manufacturer** | CETCO<br>Drilling Products Group<br>2870 Forbs Avenue<br>Hoffman Estates, IL 60192 US<br>safetydata@amcol.com<br>http://www.cetco.com/<br>General Information (800) 527-9948<br>CHEMTREC® (800) 424-9300 |

## 2. Hazards Identification

| | |
|---|---|
| **Emergency overview** | Material can be slippery when wet. Product may form explosive dust/air mixtures if high concentration of product dust is suspended in air. |
| **OSHA regulatory status** | While this material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200), this MSDS contains valuable information critical to the safe handling and proper use of the product. This MSDS should be retained and available for employees and other users of this product. |
| **Potential health effects** | |
| **Routes of exposure** | Ingestion. Inhalation. Eye contact |
| **Eyes** | Dust or powder may irritate eye tissue. |
| **Skin** | Substance may cause slight skin irritation. No components in this product are known to be absorbed through the skin. |
| **Inhalation** | Inhalation of dusts may cause respiratory irritation. |
| **Ingestion** | No hazard in normal industrial use. Ingestion of this product may cause blockage of the mouth, pharynx, trachea, esophagus, and the gastrointestinal system, which may cause choking, suffocation, or other life threatening medical conditions. |

## 3. Composition / Information on Ingredients

The manufacturer lists no ingredients as hazardous according to OSHA 29 CFR 1910.1200.

## 4. First Aid Measures

| | |
|---|---|
| **First aid procedures** | |
| **Eye contact** | Immediately flush eyes with plenty of water for at least 20 minutes. Get medical attention if irritation develops or persists. |
| **Skin contact** | Wash affected area with mild soap and water. Get medical attention if irritation develops or persists. |
| **Inhalation** | If exposed to excessive levels of dusts or fumes, remove to fresh air and get medical attention if cough or other symptoms develop. |
| **Ingestion** | If material is ingested, immediately contact a physician or poison control center. |
| **Notes to physician** | Provide general supportive measures and treat symptomatically. |
| **General advice** | If you feel unwell, seek medical advice (show the label where possible). |

## 5. Fire Fighting Measures

| | |
|---|---|
| **Flammable properties** | Dusts at sufficient concentrations can form explosive mixtures with air. |

**Extinguishing media**

| | |
|---|---|
| **Suitable extinguishing media** | Dry chemical, CO2, water spray or regular foam. |

**Protection of firefighters**

| | |
|---|---|
| **Protective equipment and precautions for firefighters** | Material can be slippery when wet. Move containers from fire area if you can do it without risk. |

## 6. Accidental Release Measures

| | |
|---|---|
| **Personal precautions** | Material can be slippery when wet. Ensure adequate ventilation. Avoid inhalation of dust from the spilled material. Wear a dust mask if dust is generated above exposure limits. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. |
| **Environmental precautions** | Do not flush into surface water or sanitary sewer system. Prevent further leakage or spillage if safe to do so. |
| **Methods for containment** | Stop leak if you can do so without risk. |
| **Methods for cleaning up** | Sweep up or gather material and place in appropriate container for disposal. Avoid the generation of dusts during clean-up. After removal flush contaminated area thoroughly with water. |

## 7. Handling and Storage

| | |
|---|---|
| **Handling** | Material can be slippery when wet. Keep formation of airborne dusts to a minimum. Take measures to prevent the build up of electrostatic charge. Provide appropriate exhaust ventilation at places where dust is formed. Refer to NFPA Pamphlet No. 654, "Prevention of Fire and Dust Explosions in the Chemical, Dye, Pharmaceutical, and Plastics Industries." |
| **Storage** | Keep containers tightly closed in a dry, cool and well-ventilated place. Guard against dust accumulation of this material. Keep out of the reach of children. |

## 8. Exposure Controls / Personal Protection

**Occupational exposure limits**

**ACGIH**

| Constituents | Type | Value | Form |
|---|---|---|---|
| INERT OR NUISANCE DUST (SEQ250) | TWA | 3 mg/m3 | Respirable particles. |
| | | 10 mg/m3 | Inhalable particles. |

**U.S. - OSHA**

| Constituents | Type | Value | Form |
|---|---|---|---|
| INERT OR NUISANCE DUST (SEQ250) | PEL | 5 mg/m3 | Respirable fraction. |
| | | 15 mg/m3 | Total dust. |
| | TWA | 5 mg/m3 | Respirable fraction. |
| | | 15 mg/m3 | Total dust. |
| | | 50 mppcf | Total dust. |
| | | 15 mppcf | Respirable fraction. |

| | |
|---|---|
| **Engineering controls** | Ensure adequate ventilation, especially in confined areas. If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. If engineering measures are not sufficient to maintain concentrations of dust particulates below the OEL, suitable respiratory protection must be worn. |

**Personal protective equipment**

| | |
|---|---|
| **Eye / face protection** | Wear safety glasses with side shields. |
| **Skin protection** | Normal work clothing (long sleeved shirts and long pants) is recommended. |
| **Respiratory protection** | Use a particulate filter respirator for particulate concentrations exceeding the Occupational Exposure Limit. |
| **General hygeine considerations** | Use good industrial hygiene practices in handling this material. Wash hands before breaks and immediately after handling the product. |

## 9. Physical & Chemical Properties

| | |
|---|---|
| **Appearance** | Powder. |
| **Color** | Off-white. |

| | |
|---|---|
| **Odor** | Bean-like |
| **Odor threshold** | Not available. |
| **Physical state** | Solid. |
| **Form** | Not available. |
| **pH** | 5 - 8 |
| **Melting point** | Not available. |
| **Freezing point** | Not available. |
| **Boiling point** | Not available. |
| **Flash point** | Not available. |
| **Evaporation rate** | Not available. |
| **Flammability** | Not available. |
| **Flammability limits in air, upper, % by volume** | Not available. |
| **Flammability limits in air, lower, % by volume** | Not available. |
| **Vapor pressure** | Not available. |
| **Vapor density** | Not available. |
| **Specific gravity** | Not available. |
| **Relative density** | Not available. |
| **Solubility (water)** | Soluble |
| **Partition coefficient (n-octanol/water)** | Not available. |
| **Auto-ignition temperature** | Not available. |
| **Decomposition temperature** | Not available. |
| **VOC** | 0 % estimated |
| **Percent volatile** | 0 % estimated |

## 10. Chemical Stability & Reactivity Information

| | |
|---|---|
| **Chemical stability** | Stable at normal conditions. |
| **Conditions to avoid** | Heat, flames and sparks. Exposure to moisture. |
| **Incompatible materials** | Strong oxidizing agents. |
| **Hazardous decomposition products** | Upon decomposition, this product emits carbon monoxide, carbon dioxide and/or low molecular weight hydrocarbons. |
| **Possibility of hazardous reactions** | Will not occur. |

## 11. Toxicological Information

**Toxicological data**

| **Product** | **Test Results** |
|---|---|
| VARIFLO® QD (Mixture) | Acute Oral LD50 Hamster: 6000 mg/kg estimated |
| | Acute Oral LD50 Mouse: 8100 mg/kg |
| | Acute Oral LD50 Rabbit: 7000 mg/kg estimated |
| | Acute Oral LD50 Rabbit: 7 g/kg |
| | Acute Oral LD50 Rat: 6770 mg/kg |

* Estimates for product may be based on additional component data not shown.

| | |
|---|---|
| **Acute effects** | Acute LD50: 6770 mg/kg, Rat, Oral<br>Acute LD50: 8100 mg/kg, Mouse, Oral<br>Acute LD50: 7 g/kg, Rabbit, Oral |
| **Local effects** | Harmful by inhalation and if swallowed. |
| **Carcinogenicity** | Not listed by ACGIH, IARC, NIOSH, NTP OR OSHA. |
| **Mutagenicity** | No data available for this product. |
| **Teratogenicity** | No data available for this product. |

| | |
|---|---|
| **Further information** | This product has no known adverse effect on human health. |

## 12. Ecological Information

**Ecotoxicological data**

| **Product** | **Test Results** |
|---|---|
| VARIFLO® QD (Mixture) | EC50 Daphnia: 50 48.00 Hours<br>LC50 Fish: 218 mg/l 96.00 Hours estimated |

* Estimates for product may be based on additional component data not shown.

| | |
|---|---|
| **Ecotoxicity** | No data available for this product. |
| **Environmental effects** | No data available for this product. |
| **Persistence and degradability** | Not available. |

## 13. Disposal Considerations

| | |
|---|---|
| **Disposal instructions** | Dispose in accordance with all applicable regulations. Do not allow this material to drain into sewers/water supplies. |

## 14. Transport Information

**DOT**

Not regulated as dangerous goods.

**IATA**

Not regulated as dangerous goods.

**IMDG**

Not regulated as dangerous goods.

## 15. Regulatory Information

| | |
|---|---|
| **US federal regulations** | OSHA Process Safety Standard: This material is not known to be hazardous by the OSHA Highly Hazardous Process Safety Standard, 29 CFR 1910.119. |

**CERCLA (Superfund) reportable quantity**

None

**Superfund Amendments and Reauthorization Act of 1986 (SARA)**

| | |
|---|---|
| **Hazard categories** | Immediate Hazard - Yes<br>Delayed Hazard - No<br>Fire Hazard - Yes<br>Pressure Hazard - No<br>Reactivity Hazard - No |
| **Section 302 extremely hazardous substance** | No |
| **Section 311 hazardous chemical** | Yes |
| **Food and Drug Administration (FDA)** | Total food additive<br>Direct food additive |

**Inventory status**

| **Country(s) or region** | **Inventory name** | **On inventory (yes/no)*** |
|---|---|---|
| Australia | Australian Inventory of Chemical Substances (AICS) | Yes |
| Canada | Domestic Substances List (DSL) | Yes |
| Canada | Non-Domestic Substances List (NDSL) | No |
| China | Inventory of Existing Chemical Substances in China (IECSC) | Yes |
| Europe | European Inventory of New and Existing Chemicals (EINECS) | Yes |
| Europe | European List of Notified Chemical Substances (ELINCS) | No |
| Japan | Inventory of Existing and New Chemical Substances (ENCS) | Yes |
| Korea | Existing Chemicals List (ECL) | Yes |
| New Zealand | New Zealand Inventory | Yes |

| Country(s) or region | Inventory name | On inventory (yes/no)* |
|---|---|---|
| Philippines | Philippine Inventory of Chemicals and Chemical Substances (PICCS) | Yes |
| United States & Puerto Rico | Toxic Substances Control Act (TSCA) Inventory | Yes |

A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

## 16. Other Information

**Further information**

This safety datasheet only contains information relating to safety and does not replace any product information or product specification.

**HMIS ratings**

**NFPA ratings**

Health: 1
Flammability: 1
Instability: 0

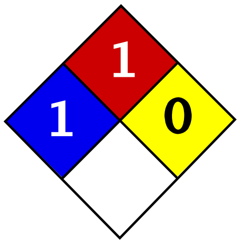
**Disclaimer**

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability, for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use.

Third party materials: Insofar as materials not manufactured or supplied by this manufacturer are used in conjunction with, or instead of this product, it is the responsibility of the customer to obtain, from the manufacturer or supplier, all technical data and other properties relating to these and other materials and to obtain all necessary information relating to them. No liability can be accepted in respect of the use of this product in conjunction with materials from another supplier.

**Issue date**

19-December-2008



| | |
|---|---|
| Health | 1 |
| Fire | 1 |
| Reactivity | 0 |
| Personal Protection | X |

# Material Safety Data Sheet
## Sucrose MSDS

## Section 1: Chemical Product and Company Identification

**Product Name:** Sucrose

**Catalog Codes:** SLS4048, SLS3253, SLS1036

**CAS#:** 57-50-1

**RTECS:** WN6500000

**TSCA:** TSCA 8(b) inventory: Sucrose

**CI#:** Not available.

**Synonym:**
beta-D-Fructofuranosyl-alpha-D-glucopyranoside

**Chemical Name:** Sucrose

**Chemical Formula:** $C_{12}H_{22}O_{11}$

**Contact Information:**

**Sciencelab.com, Inc.**
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

**CHEMTREC (24HR Emergency Telephone), call:**
1-800-424-9300

**International CHEMTREC, call:** 1-703-527-3887

**For non-emergency assistance, call:** 1-281-441-4400

## Section 2: Composition and Information on Ingredients

**Composition:**

| Name | CAS # | % by Weight |
|---|---|---|
| Sucrose | 57-50-1 | 100 |

**Toxicological Data on Ingredients:** Not applicable.

## Section 3: Hazards Identification

**Potential Acute Health Effects:** Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

**Potential Chronic Health Effects:**
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
Repeated or prolonged exposure is not known to aggravate medical condition.

## Section 4: First Aid Measures

**Eye Contact:**

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.

**Skin Contact:**
Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

**Serious Skin Contact:** Not available.

**Inhalation:**
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

**Serious Inhalation:** Not available.

**Ingestion:**
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

**Serious Ingestion:** Not available.

## Section 5: Fire and Explosion Data

**Flammability of the Product:** May be combustible at high temperature.

**Auto-Ignition Temperature:** Not available.

**Flash Points:** CLOSED CUP: Higher than 93.3°C (200°F).

**Flammable Limits:** Not available.

**Products of Combustion:** These products are carbon oxides (CO, CO2).

**Fire Hazards in Presence of Various Substances:** Slightly flammable to flammable in presence of heat.

**Explosion Hazards in Presence of Various Substances:**
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

**Fire Fighting Media and Instructions:**
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

**Special Remarks on Fire Hazards:** Not available.

**Special Remarks on Explosion Hazards:** Not available.

## Section 6: Accidental Release Measures

**Small Spill:**
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

**Large Spill:**
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

## Section 7: Handling and Storage

**Precautions:**
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable protective clothing. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids.

**Storage:** Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 23°C (73.4°F).

## Section 8: Exposure Controls/Personal Protection

**Engineering Controls:**
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

**Personal Protection:**
Safety glasses. Lab coat. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

**Personal Protection in Case of a Large Spill:**
Splash goggles. Full suit. Vapor and dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

**Exposure Limits:**
TWA: 15 (mg/m3) from OSHA (PEL) [United States] Inhalation Total.
TWA: 10 (mg/m3) from ACGIH (TLV) [United States] [1999] Inhalation Total.
TWA: 10 (mg/m3) from NIOSH Inhalation Total.
TWA: 5 (mg/m3) from NIOSH Inhalation Respirable.
TWA: 5 (mg/m3) from OSHA (PEL) [United States] Inhalation Respirable.3
Consult local authorities for acceptable exposure limits.

## Section 9: Physical and Chemical Properties

**Physical state and appearance:** Solid. (Crystalline granules solid.)

**Odor:** Characteristic Carmel to Odorless.

**Taste:** Sweet.

**Molecular Weight:** 342.3 g/mole

**Color:** White.

**pH (1% soln/water):** Not available.

**Boiling Point:** Not available.

**Melting Point:** 186°C (366.8°F)

**Critical Temperature:** Not available.

**Specific Gravity:** 1.587 (Water = 1)

**Vapor Pressure:** Not applicable.

**Vapor Density:** Not available.

**Volatility:** Not available.

**Odor Threshold:** Not available.

**Water/Oil Dist. Coeff.:** The product is more soluble in water; log(oil/water) = -3.7

**Ionicity (in Water):** Not available.

**Dispersion Properties:** See solubility in water, methanol.

**Solubility:**
Easily soluble in cold water.
Partially soluble in methanol.
Insoluble in diethyl ether.

## Section 10: Stability and Reactivity Data

**Stability:** The product is stable.

**Instability Temperature:** Not available.

**Conditions of Instability:** Excess heat, incompatible materials

**Incompatibility with various substances:** Reactive with oxidizing agents, acids.

**Corrosivity:** Not available.

**Special Remarks on Reactivity:** Reactive with sulfuric acid, nitric acid, and oxidizers.

**Special Remarks on Corrosivity:** Not available.

**Polymerization:** Will not occur.

## Section 11: Toxicological Information

**Routes of Entry:** Inhalation. Ingestion.

**Toxicity to Animals:** Acute oral toxicity (LD50): 29700 mg/kg [Rat].

**Chronic Effects on Humans:**
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast.

**Other Toxic Effects on Humans:** Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

**Special Remarks on Toxicity to Animals:** Not available.

**Special Remarks on Chronic Effects on Humans:**
No adverse reproductive affects have been found in humans. However at extremely high oral doses of 683,000 mg/kg given to rats during pregnancy showed some effects on newborn (growth, developmental anomalies of central nervous system).
Passes through the placental barrier in human.

**Special Remarks on other Toxic Effects on Humans:**
Acute Potential Health Effects:
Skin: May cause skin irritation. Low hazard for usual industrial handling.
Eyes: Dust may cause mechanical irritation.
Inhalation: Excessive inhalation may cause minor respiratory irritation.
Ingestion: Ingestion of large amounts may cause gastrointestinal (digestive) tract irritation. Expected to be a low

ingestion hazard.
Chronic Potential Health Effects: no information.

## Section 12: Ecological Information

**Ecotoxicity:** Not available.

**BOD5 and COD:** Not available.

**Products of Biodegradation:**
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

**Toxicity of the Products of Biodegradation:** The product itself and its products of degradation are not toxic.

**Special Remarks on the Products of Biodegradation:** Not available.

## Section 13: Disposal Considerations

**Waste Disposal:**
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

## Section 14: Transport Information

**DOT Classification:** Not a DOT controlled material (United States).

**Identification:** Not applicable.

**Special Provisions for Transport:** Not applicable.

## Section 15: Other Regulatory Information

**Federal and State Regulations:**
Rhode Island RTK hazardous substances: Sucrose
Pennsylvania RTK: Sucrose
Minnesota: Sucrose
Massachusetts RTK: Sucrose
Tennessee: Sucrose
TSCA 8(b) inventory: Sucrose

**Other Regulations:** EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

**Other Classifications:**

**WHMIS (Canada):** Not controlled under WHMIS (Canada).

**DSCL (EEC):**
This product is not classified according
to the EU regulations.
S24/25- Avoid contact with skin and eyes.

**HMIS (U.S.A.):**

**Health Hazard:** 1

**Fire Hazard:** 1

**Reactivity:** 0

**Personal Protection:** X

**National Fire Protection Association (U.S.A.):**

**Health:** 1

**Flammability:** 1

**Reactivity:** 0

**Specific hazard:**

**Protective Equipment:**
Gloves.
Lab coat.
Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent.
Safety glasses.

## Section 16: Other Information

**References:** Not available.

**Other Special Considerations:** Not available.

**Created:** 10/10/2005 08:28 PM

**Last Updated:** 11/06/2008 12:00 PM

# VARIFLO® QD

## QUICK DISPERSING GUAR GUM

## DESCRIPTION

VARIFLO QD is a coarse granular, high-viscosity blend of guar gum formulated for easy and quick dispersion in drilling applications. Coarser granules prevent lumps or encapsulation.

## CHARACTERISTICS

- Biodegradable
- Easy to mix in brackish water
- High viscosity formula
- No lumping while mixing
- Quick dispersing

## MIXING AND APPLICATIONS

Add VARIFLO QD slowly through a jet type mixer. If product is fed too quickly, lumping or balling will occur. Hydrate slowly first 3-10 minutes; follow with rapid hydration for 15-60 minutes. VARIFLO QD should not be poured unmixed into a pit or mixing tank.

| Formation Material | Ideal MFV (seconds) | Lbs of VariFlo QD per 100 gallons of water(1) |
|---|---|---|
| Fine Sand | 40 | 3.5 |
| Medium Sand | 50 | 4.5 |
| Coarse Sand | 60 | 5.5 |
| Gravel | 70-80 | 7-7.5 |

(1) assuming water temperature of 60°F.

| Formation Material | Ideal MFV (seconds) | Kg of VariFlo QD per 380 liters of water(1) |
|---|---|---|
| Fine Sand | 40 | 1.5 |
| Medium Sand | 50 | 2.0 |
| Coarse Sand | 60 | 2.5 |
| Gravel | 70-80 | 3.5 |

(1) assuming water temperature of 15.5°C

## FLUID BREAKDOWN

Chlorine concentrations of 1,000 ppm are recommended to effectively breakdown VARIFLO QD. Approximately 20 gallons (115 liters) of sodium hypochlorite (bleach) or 13 lbs (6 kg) of calcium hypochlorite per 1,000 gallons (3.8 m$^3$)drilling fluid is required.

## PACKAGING

25 lb (11.3 kg) pail, 36 per pallet. All pallets are plastic-wrapped.

**North America:** 847.851.1800 | 800.527.9948 | www.CETCO.com

UPDATED: OCTOBER 2013

CETCO®
OUR STANDARDS. YOUR PEACE OF MIND.
A Minerals Technologies Company

# Appendix C

## Health and Safety Plan (HASP)

# HEALTH AND SAFETY PLAN FOR
# BUELL AUTOMATICS SITE
# INDEX #B8-0576-00-04A
# 381 BUELL ROAD
# ROCHESTER, NEW YORK

December 2014

Stantec

Prepared for:
NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
6274 EAST AVON-LIMA ROAD
AVON, NEW YORK 14414

Prepared on behalf of:
BUELL AUTOMATICS, INC.
381 BUELL ROAD
ROCHESTER, NEW YORK

Prepared by:
STANTEC CONSULTING SERVICES INC.
61 COMMERCIAL ST. SUITE 100
ROCHESTER, NEW YORK 14614

## Table of Contents

**TABLES**

**FIGURES**

**APPENDICES**

**HEALTH AND SAFETY PLAN FOR**
**BUELL AUTOMATICS SITE**
**INDEX #B8-0576-00-04A**
**381 BUELL ROAD**
**ROCHESTER, NEW YORK**

# 1.0 INTRODUCTION

The following Health and Safety Plan (HASP) describes personal safety protection standards and procedures to be followed by Stantec staff during planned activities at the Buell Automatics site located in the Town of Gates, Monroe County, New York (Figure 1). This work will include well gauging, groundwater sampling and off-site indoor air sampling.

This HASP establishes mandatory safety procedures and personal protection standards pursuant to the Occupational Safety and Health Administration (OSHA) regulations 29 Code of Federal Regulations (CFR) 1910.120. The HASP applies to all Stantec personnel conducting any site work, as defined in 29 CFR 1910.120(a). All personnel involved in the mentioned activities must familiarize themselves with this HASP, comply with its requirements and have completed the required health and safety training and medical surveillance program participation pursuant to 29 CFR 1910.120 prior to beginning any work on site.

**THIS HASP IS FOR THE EXPRESSED USE OF STANTEC EMPLOYEES. ALL OTHER CONTRACTORS TO BE WORKING IN THE EXCLUSION AREAS ARE REQUIRED BY LAW TO DEVELOP THEIR OWN HASP, AS WELL TO MEET ALL PERTINENT ASPECTS OF OSHA REGULATIONS. STANTEC RESERVES THE RIGHT TO STOP ANY SITE WORK WHICH IS DEEMED TO POSE A HEALTH AND SAFETY THREAT TO ITS STAFF.**

## 1.1 BACKGROUND

This project is being performed as part of a Brownfield Cleanup Agreement (BCA). The objectives of the proposed project include remedial action at the Buell Automatics site.

### 1.1.1 Site Background

The Site property comprises approximately 1.67 acres and is improved by a manufacturing building with a footprint of approximately 13,000 square feet.

The original manufacturing building at the Site was constructed on the southern portion of the Site in 1957. Additions to the original structure were completed in 1981 and 1983. A second parcel was acquired by Buell in 2000, and a 11,000 square foot building addition for manufacturing was completed on the northern portion. The 2000 building addition and its 11,000 square foot footprint are excluded from the area encompassed by the BCA.

Buildings occupy roughly 29% of the real property which encompasses the Site, while the majority of the remaining surface area is covered by asphalt parking lots, and access roads.

Buell operates a manufacturing facility at the Site. The Buell operation uses automatic screw machines to produce machined parts for automotive components and other applications.

The Site has been used for light industrial manufacturing since the 1950's. Prior to the 1950s, the Site was reportedly used for agriculture.

An RI was performed in 2007 which indicates that there are three source areas of subsurface contamination at the Site: the Former Trench Drain Area, the Former Loading Dock Area and the Petroleum Impacts Area. The three areas are located in the southwest quadrant of the Site.

In two of the source areas, impacts are predominantly from trichloroethene (TCE) and related chlorinated volatile organic compounds (collectively VOCs). The two areas where TCE contamination is present are the Former Trench Drain Area, which includes an area inside the southwest portion of Buell's manufacturing building and the adjacent area located outside the south wall of the building, and the Former Loading Dock Area, which is located outside the west end of the facility.

The Petroleum Impacts Area, where impacts are from petroleum solvent compounds and cutting oil, is largely confined to the area beneath the footprint of the facility building to the north of the Former Trench Drain Area and east of the Former Loading Dock Area.

In both the Former Trench Drain Area (FTDA) and the Former Loading Dock Area (FLDA), TCE and other chlorinated VOCs are present in soil at concentrations above the NYSDEC’s soil cleanup objectives (SCOs) for protection of groundwater (POGW). In one soil sample interval in the Former Loading Dock area (test boring B-23, sample depth of 1 to 2 ft. bgs), TCE was detected at a concentration that exceeded the Department's SCOs for protection of public health at sites restricted to industrial uses, but otherwise VOCs detected were below SCOs for industrial use sites. Groundwater in the FTDA and FLDA and downgradient groundwater in adjacent areas to the southwest have been impacted by chlorinated VOCs. Chlorinated VOCs were also detected off-Site in soil vapor beneath the Five Star Tool Building. The eastern end of the Five Star Tool Building is located at the western edge of an area where groundwater contamination has been detected west of the Former Loading Dock Area.

While odors and other indications of petroleum impacts were observed in soil samples, in fact the concentrations of petroleum compounds in the soils do not exceed the Department’s SCOs. Related groundwater impacts by petroleum compounds were not observed downgradient of the Petroleum Impacts Area.

Excavation of the FLDA and application of electron donor in the completed excavation prior to backfilling was completed in 2014. An Enhanced In-Situ Bioremediation program is proposed to address groundwater contamination at the site. This program will involve the installation of injection wells, a subsequent injection of electron donor solution in the FTDA and its downgradient plume, and post-treatmentgroundwater monitoring.

## 1.2 SITE-SPECIFIC CHEMICALS OF CONCERN

The primary compounds of concern that are present, or are potentially present, in the soil and groundwater at the Buell Automatics Site are listed in Table 1. Material Safety Data Sheets (MSDSs) for these compounds are presented in Appendix A. The air monitoring action levels will be based on one-half of the current Threshold Limit Valve (TLV) or Permissible Exposure Limit (PEL) for vinyl chloride with a margin of safety built into the action levels to account for the non-specificity of the field monitoring instruments. Exposure limits for less hazardous compounds will be satisfied by meeting the more stringent exposure limits for vinyl chloride. Table 1 summarizes health and safety data for the compounds of primary concern.

## Table 1
## Health and Safety Data for Contaminants of Concern

| Compound | PEL/ TWA | Physical Description | Odor Threshold | Route of Exposure | Symptoms | Target Organs |
|---|---|---|---|---|---|---|
| 1,1-Dichloroethane (1,1-DCA) | 100 ppm | Colorless, oily liquid with a chloroform-like odor. | 255 ppm | inhalation, ingestion, skin and/or eye contact | irritation skin; central nervous system depression; liver, kidney, lung damage | Skin, liver, kidneys, lungs, central nervous system |
| cis- and trans-1,2-Dichloroethene (cis-1,2-DCE and trans-1,2-DCE) | 200 ppm | Colorless liquid (usually a mixture of the cis & trans isomers) with a slightly acrid, chloroform-like odor. | 19.1 ppm | inhalation, ingestion, skin and/or eye contact | Irritation eyes, respiratory system; central nervous system depression | Eyes, respiratory system, central nervous system |
| Stoddard Solvent | 500 ppm | Colorless liquid with a kerosene-like odor. | 1-30 ppm | inhalation, ingestion, skin and/or eye contact | irritation eyes, nose, throat; dizziness; dermatitis; chemical pneumonitis (aspiration liquid); in animals: kidney damage | Eyes, skin, respiratory system, central nervous system, kidneys |
| Tetrachloroethene (PCE) | 100 ppm | Colorless liquid with a mild, chloroform-like odor. | 6.17 ppm | inhalation, skin absorption, ingestion, skin and/or eye contact | irritation eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogen] | Eyes, skin, respiratory system, liver, kidneys, central nervous system |
| 1,1,1-trichloroethane (1,1,1-TCA) | 350 ppm | Colorless liquid with a mild, chloroform-like odor. | 22.4 ppm | inhalation, ingestion, skin and/or eye contact | irritation eyes, skin; headache, lassitude (weakness, exhaustion), central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmias; liver damage | Eyes, skin, central nervous system, cardiovascular system, liver |
| Trichloroethylene | 100 ppm | Colorless liquid with a | 1.36 ppm | inhalation, skin absorption, | Irritation eyes, skin; headache, visual disturbance, lassitude (weakness, | Eyes, skin, respiratory system, heart, liver, |

| Compound | PEL/ TWA | Physical Description | Odor Threshold | Route of Exposure | Symptoms | Target Organs |
|---|---|---|---|---|---|---|
| (TCE) | | chloroform-like odor. | | ingestion, skin and/or eye contact | exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen] | kidneys, central nervous system |
| Vinyl chloride | 1 ppm | Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations. | 0.253 ppm | inhalation, skin, and/or eye contact (liquid) | Lassitude (weakness, exhaustion); abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; liquid: frostbite; [potential occupational carcinogen] | Liver, central nervous system, blood, respiratory system, lymphatic system |
| Miscellaneous petroleum based solvents, lubricating oils, and rust preventatives | See Appendix A - MSDSs | | | | | |

Notes:

PEL - permissible exposure limits

TWA - time weighted average, 8-hour workday

$mg/m^3$ - milligrams per cubic meter.

ppm - parts per million, in air

# 2.0 STANTEC PERSONNEL ORGANIZATION

The following Stantec personnel will be involved in health and safety operations at the Buell Automatics Site:

## 2.1 PROJECT MANAGER

Mr. Michael Storonsky, Senior Associate, is the Project Manager. Mr. Storonsky is responsible for ensuring that all Stantec procedures and methods are carried out, and that all Stantec personnel abide by the provisions of this Health and Safety Plan.

## 2.2 SITE SAFETY OFFICER/FIELD TEAM LEAD

Ben Haravitch and AnneMarie Glose will serve as the field team leader and Site Safety Officer during this project. Mr. Haravitch and Ms. Glose will report directly to the Project Manager and will be responsible for the implementation of this HASP as well as daily calibration of Stantec's safety monitoring instruments. Mr. Haravitch and Ms. Glose will keep a log book of all calibration data and instrument readings for the Site.

## 2.3 HEALTH AND SAFETY COORDINATOR

Tom Wells will be the Health and Safety Coordinator. Mr. Wells will be responsible for overall coordination of Health and Safety issues on the project.

## 2.4 DAILY MEETINGS

All Stantec personnel and contractors working within the exclusion zone will be required to read this document and sign off on the daily safety meeting form presented in Appendix B.

# 3.0 MEDICAL SURVEILLANCE REQUIREMENTS

## 3.1 INTRODUCTION

Hazardous waste site workers can often experience high levels of physical and chemical stress. Their daily tasks may expose them to toxic chemicals, physical hazards, biologic hazards, or radiation. They may develop heat stress while wearing protective equipment or working under temperature extremes, or face life-threatening emergencies such as explosions and fires. Therefore, a medical program is essential to: assess and monitor worker's health and fitness both prior to employment and during the course of the work; provide emergency and other treatment as needed; and keep accurate records for future reference. In addition, OSHA requires a medical evaluation for employees that may be required to work on hazardous waste sites and/or wear a respirator (29 CFR Part 1910.120 and 1910.134), and certain OSHA standards include specific medical surveillance requirements (e.g., 29 CFR Part 1926.62, Part 1910.95 and Parts 1910.1001 through 1910.1045).

## 3.2 MEDICAL EXAMINATIONS

All Stantec personnel working in areas of the site where site-related contaminants may be present shall have been examined by a licensed physician as prescribed in 29 CFR Part 1910.120, and determined to be medically fit to perform their duties for work conditions which require respirators. Employees will be provided with medical examinations as outlined below:

- Pre-job physical examination
- Annually thereafter if contract duration exceeds 1 year;
- Termination of employment;
- Upon reassignment in accordance with CFR 29 Part 1910.120(e)(3)(i)(C);
- If the employee develops signs or symptoms of illness related to workplace exposures;
- If the physician determines examinations need to be conducted more often than once a year; and
- When an employee develops a lost time injury or illness during the Contract period.

Examinations will be performed by, or under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine, and will be provided without cost to the employee, without loss of pay and at a reasonable time and place. Medical surveillance protocols and examination and test results shall be reviewed by the Occupational Physician.

# 4.0 ON-SITE HAZARDS

## 4.1 CHEMICAL HAZARDS

The primary potential chemical hazards on-site are expected to be exposure to the VOCs detailed in Table 1. Material safety data sheets for the anticipated chemicals are presented in Appendix A.

The soil and groundwater contaminants are volatiles, therefore, any activity at the site which causes physical disturbance of the soil or groundwater can potentially allow the release of contaminants into the air. For volatiles, this can include release of organic vapors into the air. Such an occurrence may be recognized by noticeable chemical odors. Field personnel should be aware of the odor threshold for these chemicals and their relation to the action levels and Permissible Exposure Limits.

Symptoms of overexposure to primary compounds of concern are detailed in Table 1. To prevent exposure to these chemicals, dermal contact will be minimized by using disposable surgical gloves (such as nitrile gloves) with work gloves (as appropriate) when handling soil, groundwater equipment or samples. Real time, breathing zone levels of total VOCs will be monitored using a portable photoionization detector (PID). If ambient levels exceed action levels, all site activities will be performed using level C personal protection until ambient concentrations dissipate. Where levels exceed 50 ppm, work will cease and the project manager will be notified immediately. Intrusive work may also be halted where required by action levels detailed in the Community Air Monitoring Plan (CAMP).

In addition, depending on seasonal conditions, disturbance of the site soils may cause the particulate contaminants to become airborne as dust. Therefore, particulates will be monitored during drilling and excavation activities as discussed in Section 6.1 and dust-suppression methods used where appropriate as discussed in Section 6.2, or in the CAMP.

Finally, aeration of the groundwater may cause volatilization of chemicals into the air, particularly VOCs. Table 2 summarizes first aid instructions for exposure pathways for the compounds of concern.

**Table 2**
**Exposure Pathways and First Aid Response for Contaminants of Concern**

| Substance | Exposure Pathways | First-Aid Instructions |
|---|---|---|
| VOCs and petroleum products listed in Table 1 | Eye | irrigate immediately |
| | Dermal | soap wash promptly |
| | Inhalation | respiratory support |
| | Ingestion | medical attention immediately |

## 4.2 PHYSICAL HAZARDS

Hazards typically encountered at construction sites with drilling or excavation activities will be a concern at this site. These hazards include slippery ground surfaces, holes, and operation of heavy machinery and equipment. Field team members will wear the basic safety apparel such as steel-toed shoes, hard hat and safety glasses during all appropriate activities.

Under no circumstances will Stantec personnel approach the borehole during active drilling operation. All field personnel working around the rig will be shown the location and operation of kill switches, which are to be tested daily. Under no circumstance will Stantec personnel enter excavations or other confined spaces to collect soil samples or for any other reason.

Multi-purpose fire extinguishers, functional and within annual inspection period, will be staged and readily accessible for use.

The use of electrical equipment in any established exclusion zones will be limited to areas verified as containing non-explosive atmospheres (<10% LEL) prior to operation, unless the equipment has been previously demonstrated or designed to be FM or UL rated as intrinsically safe. Care will be taken to avoid an ignition source while working in the presence of vapors.

The contractor shall make all necessary contacts with utilities and/or underground utility locator hotlines prior to drilling, and shall meet OSHA requirements for distances between the drilling rig and overhead utilities. No drilling work will be carried out where the drill rig chassis has not been stabilized and the rig is not to be moved between locations with its boom in a vertical position.

During the groundwater remediation activities planned at the site, a solution of organic acids prepared by the fermentation of sucrose and guar gum product will be prepared in an above-ground mixing tank prior to injection. The fermentation process is anticipated to generate some off-gas, which will be comprised mainly of carbon dioxide. The off-gas does not represent a health risk, but pressure build up in a sealed tank could represent a safety risk. Localized nuisance odors in the vicinity of the stock solution tank, associated with the fermented end product, represent a potential issue. Therefore, the tank will be vented using pipe and/or hose to convey vapors outside if placed indoors. If placed outdoors, the lid of the tank will be kept loose to allow the escape of any vapors and prevent pressure build up. MSDSs for sucrose and guar gum are included in Appendix A.

### 4.2.1 Noise

The use of heavy machinery/equipment and operation may result in noise exposures, which require hearing protection. Exposure to noise can result in temporary hearing losses, interference with speech communication, interference with complicated tasks or permanent hearing loss due to repeated exposure to noise.

During the investigative activities, all Stantec field team members will use hearing protection when sound levels are in excess of 90 dB TWA.

### 4.2.2 Heat Stress Exposure

Heat is a potential threat to the health and safety of site personnel. The Site Safety Officer under the direction of the Project Manager will determine the schedule of work and rest. These schedules will be employed as necessary so that personnel do not suffer adverse effects from heat. Table 3 summarizes exposure symptoms and first aid instructions for heat stress. Non-caffeinated, thirst replenishment liquids will be available on-site

Cold stress is also a potential threat to the health and safety of site personnel. Symptoms of cold stress include, shivering, blanching of the extremities, numbness or burning sensations, blue, purple or gray discoloration of hands and feet, frostbite, hypothermia, and loss of consciousness. Cold stress can be prevented by acclimatizing one’s self to the cold, increasing fluid intake, avoiding caffeine and alcohol, maintaining proper salt and electrolyte intake, eating a well-balanced diet, wearing proper clothing, building heated enclosures to work in, and taking regular breaks to warm up. If any of the above symptoms are encountered the person should be removed from the cold area. Depending on the severity of the cold stress, 911 should be contacted and first aid administered. No fluids should be given to an unconscious person.

**Table 3**
**Exposure Symptoms and First Aid for Heat Exposure**

| Hazard | Exposure Symptoms | First-Aid Instructions |
|---|---|---|
| Heat Stress | Fatigue, sweating, irritability | rest; take fluids |
| | Dizziness, disorientation, perspiration ceases, loss of consciousness | remove from hot area, activate 911, administer first aid, no fluids to be administered to unconscious victim. |

### 4.2.3 Roadway Hazards

Field activities are planned to take place near active roadways and driveways. Where such work zones are established, personnel shall assure that protective measures including signage, cones, and shielding through use of vehicles parked at workmen perimeter, are in place. All contractors shall be responsible for meeting signage requirements of DOT. Fluorescent safety vests shall be worn by all personnel during activities in or adjacent to roadways and driveways.

### 4.2.4 Electrical Work

Site work involving electrical installation or energized equipment must be performed by a qualified electrician. All electrical work will be performed in accordance with the OSHA electrical safety requirements found in 29 CFR 1926.400 through 1926.449. Workers are not permitted to work near electrical power circuits unless the worker is protected against electric shock by de-energizing and grounding the circuit or by guarding or barricading the circuit and providing proper personal protective equipment. All electrical installations must comply with NEC regulations. All electrical wiring and equipment used must be listed by a nationally recognized testing laboratory.

All electrical circuits and equipment must be grounded in accordance with the NEC regulations. The path to ground from circuits, equipment, and enclosures will be permanent and continuous. Ground fault circuit interrupters (GFCIs) are required on all 120-volt, single phase, 15- and 20-amp outlets in work areas that are not part of the permanent wiring of the building or structure. A GFCI is required when using an extension cord. GFCIs must be tested regularly with a GFCI tester.

Heavy-duty extension cords will be used; flat-type extension cords are not allowed. All extension cords must be the three-wire type, and designed for hard/extra hard usage. Electrical wire or cords passing through work areas must be protected from water and damage. Worn, frayed, or damaged cords and cables will not be used. Walkways and work spaces will be kept clear of cords and cables to prevent a tripping hazard. Extension cords and cables may not be secured with staples, hung from nails, or otherwise temporarily secured. Cords or cables passing through holes in covers, outlet boxes, etc., will be protected by bushings or fittings.

All lamps used in temporary lighting will be protected from accidental contact and breakage. Metal shell and paper-lined lamp holders are not permitted. Fixtures, lamp holders, lamps, receptacles, etc. are not permitted to have live parts. Workers must not have wet hands while plugging/unplugging energized equipment. Plugs and receptacles will be kept out of water (unless they are approved for submersion).

### 4.2.5 Lock-Out/Tag-Out

Before a worker sets up, services, or repairs a system where unexpected energizing (or release of stored energy) could occur and cause injury or electrocution, the circuits energizing the parts must be locked-out and tagged. Only authorized personnel will perform lock-out/tag-out procedures. All workers affected by the lock-out/tag-out will be notified prior to, and upon completion of, the lock-out/tag-out procedure.

Lock-out/tag-out devices must be capable of withstanding the environment to which they are exposed. Locks will be attached in such a way as to prevent other personnel from operating the equipment, circuit, or control, or from removing the lock unless they resort to excessive force. Tags will identify the worker who attached the device, and contain information, which warns against the hazardous condition that will result from the system's unauthorized start-up. Tags must be legible and understood by all affected workers and incidental personnel. The procedures for attaching and removing lock-out/tag-out devices include the steps outlined in the following table.

If maintenance work is required, the electrical supply to the equipment must be disconnected. Turning off the MAIN breaker using the disconnect switch will disconnect all power to the system. Once the disconnect switch has been turned off, the switch will be locked-out using the steps outlined below.

| STEP | LOCK-OUT/TAG-OUT PROCEDURES |
|---|---|
| 1 | Disconnect the circuits and/or equipment to be worked on from all electrical energy sources. |
| 2 | Ensure that the system is completely isolated so that it cannot be operated at that shut-off point or at any other location. |
| 3 | Release stored electrical energy. |
| 4 | Block or relieve stored non-electrical energy. |

| | |
|---|---|
| 5 | Place a lock on each shut-off or disconnect point necessary to isolate all potential energy sources. Place the lock in such a manner that it will maintain the shut-off/disconnect in the off position. |
| 6 | Place a tag on each shut-off or disconnect point. The tag must contain a statement prohibiting the unauthorized re-start or re-connect of the energy source and the removal of the tag, and the identity of the individual performing the tag and lock-out. |
| 7 | Workers who will be working on the system must place their own lock and tag on each lock-out point. |
| 8 | A qualified person must verify the system cannot be re-started or re-connected, and de-energization of the system has been accomplished. |
| **Once the service or repairs have been made on the system:** | |
| 1 | A qualified person will conduct an inspection of the work area, to verify that all tools, jumpers, shorts, grounds, etc., have been removed so that the system can then be safely re-energized. |
| 2 | All workers stand clear of the system. |
| 3 | Each lock and tag will be removed by the worker who attached it. If the worker has left the site, then the lock and tag may be removed by a qualified person under the following circumstances: |
| | a. The qualified person ensures the worker who placed the lock and tag has left the site; and |
| | b. The qualified person ensures the worker is aware the lock and tag has been removed before the worker resumes work on-site. |

### 4.2.6 Ladders

One-third of worker deaths in construction result from falls. Many falls occur because ladders are not placed or used safely. Ladder use will comply with OSHA 1926.1053 through 1926.1060, including the following safety requirements.

| STEP | PROPER LADDER USE PROCEDURE |
|---|---|
| 1 | Choose the right ladder for the task--the proper type and size, with a sufficient rating for the task. |
| 2 | Check the condition of the ladder before climbing.<br>Do not use a ladder with broken, loose, or cracked rails or rungs.<br>Do not use a ladder with oil, grease, or dirt on its rungs.<br>The ladder should have safety feet. |
| 3 | Place the ladder on firm footing, with a four-to-one pitch. |

| | |
|---|---|
| 4 | Support the ladder by:<br>Tying it off;<br>Using ladder outrigger stabilizers; or<br>Have another worker hold the ladder at the bottom.<br>If another worker holds the ladder, they must:<br>Wear a hard hat;<br>Hold the ladder with both hands;<br>Brace the ladder with their feet; and<br>Not look up. |
| 5 | Keep the areas around the top and bottom of the ladder clear. |
| 6 | Extend the top of the ladder at least 36 inches (3 feet) above the landing. |
| 7 | Climb the ladder carefully - facing it - and use both hands.<br>Use a tool belt and hand-line to carry material to the top or bottom of the ladder.<br>Wear shoes in good repair with clean soles. |
| 8 | Inspect the ladder every day, prior to use, for the following problems:<br>Rail or rung damage<br>Broken feet<br>Rope or pulley damage<br>Rung lock defects or damage<br>Excessive dirt, oil, or grease<br>If the ladder fails inspection, it must be removed from service and tagged with a "Do Not Use" sign. |

Ladders with non-conductive side rails must be used when working near electrical conductors, equipment, or other sources. Ladders will not be used horizontally for platforms, runways, or scaffolds.

### 4.2.7 Hand and Power Tools

All hand and power tools will be maintained in a safe condition and in good repair. Hand and power tools will be used in accordance with 29 CFR 1926, Subpart I (1926.300 through 1926.307). Neither Stantec or its subcontractors will issue unsafe tools, and workers are not permitted to bring unsafe tools on-site. All tools will be used, inspected, and maintained in accordance with the manufacturer's instructions. Throwing tools or dropping tools to lower levels is prohibited. Hand and power tools will be inspected, tested, and determined to be in safe operating condition prior to each use. Periodic safety inspections of all tools will be conducted to assure that the tools are in good condition, all guards are in place, and the tools are being properly maintained. Any tool that fails an inspection will be immediately removed from service and tagged with a "Do Not Use" sign.

Workers using hand and power tools, who are exposed to falling, flying, abrasive, or splashing hazards will be required to wear personal protective equipment (PPE). Eye protection must always be worn when working on-site. Additional eye and face protection, such as safety goggles or face shields, may also be required when working with specific hand and power tools. Workers, when on-site, will wear hard hats. Additional hearing protection may be required when working with certain power tools. Workers using tools, which may subject their hands to an injury, such as cuts, abrasions, punctures, or burns, will wear protective gloves. Loose or frayed clothing, dangling jewelry, or loose long hair will not be worn when working with power tools.

Electric power-operated tools will be double insulated or grounded, and equipped with an on/off switch. Guards must be provided to protect the operator and other nearby workers from hazards such as in-going nip points, rotating parts, flying chips, and sparks. All reciprocating, rotating and moving parts of tools will be guarded if contact is possible. Removing machine guards is prohibited.

Abrasive wheels will only be used on equipment provided with safety guards. Safety guards must be strong enough to withstand the effect of a bursting wheel. Abrasive wheels will not be operated in excess of their rated speed. Work or tool rests will not be adjusted while the wheel is in motion. All abrasive wheels will be closely inspected and ring tested before each use, and any cracked or damaged wheels will be removed immediately and destroyed.

Circular saws must be equipped with guards that completely enclose the cutting edges and have anti-kickback devices. All planer and joiner blades must be fully guarded. The use of cracked, bent, or otherwise defective parts is prohibited. Chain saws must have an automatic chain brake or kickback device. The worker operating the chain saw will hold it with both hands during cutting operations. A chain saw must never be used to cut above the operator's shoulder height. Chain saws will not be re-fueled while running or hot. Power saws will not be left unattended.

Only qualified workers will operate pneumatic tools, powder-actuated tools, and abrasive blasting tools.

### 4.2.8 Manual Lifting

Back injuries are among the leading occupational injuries reported by industrial workers. Back injuries such as pulls and disc impairments can be reduced by using proper manual lifting techniques. Leg muscles are stronger than back muscles, so workers should lift with their legs and not with their back. Proper manual lifting techniques include the following steps:

| STEP | PROPER MANUAL LIFTING PROCEDURE |
|---|---|
| 1 | Plan the lift before lifting the load. Take into consideration the weight, size, and shape of the load. |
| 2 | Preview the intended path of travel and the destination to ensure there are no tripping hazards along the path. |
| 3 | Wear heavy-duty work gloves to protect hands and fingers from rough edges, sharp corners, and metal straps. Also, keep hands away from potential pinch points between the load and other objects. |
| 4 | Get the load close to your ankles, and spread your feet apart. Keep your back straight and do not bend your back too far; instead bend at your knees. |
| 5 | Feel the weight; test it. |
| 6 | Lift the load smoothly, and let your legs do the lifting. If you must pivot, do not swing just the load; instead, move your feet and body with the load. |

If the load is too heavy, then do not lift it alone. Lifting is always easier when performed with another person. Assistance should always be used when it is available.

### 4.2.9 Weather-Related Hazards

Weather-related hazards include the potential for heat or cold stress, electrical storms, treacherous weather-related working conditions, or limited visibility. These hazards correlate with the season in which site activities occur. Outside work will be suspended during electrical storms. In the event of other adverse weather conditions, the Site Safety Officer will determine if work can continue without endangering the health and safety of site personnel.

# 5.0 SITE WORK ZONES

The following work zones will be physically delineated by Stantec during the investigation activities.

## 5.1 CONTROL ZONES

Control boundaries will be established within the areas of site activities. Examples of boundary zones include the exclusion and decontamination zone. All boundaries will be dynamic, and will be determined by the planned activities for the day. The Field Team Leader will record the names of any visitors to the site.

## 5.2 EXCLUSION ZONE

The controlled portion of the site will be delineated to identify the exclusion zone, wherein a higher level of personal protective equipment may be required for entry during intrusive activities. The limits of the exclusion zone will be designated at each work location appropriately. A decontamination zone will be located immediately outside the entrance to the exclusion zone. All personnel leaving the exclusion zone will be required to adhere to proper decontamination procedures.

A "super exclusion" zone will be established around the borehole which will not be entered by Stantec personnel at any time during any active drilling, slambar, cathead, silica sand dumping, or other related activities. The drilling contractor will be directed to stop such activity when Stantec site team members have a need to enter this zone.

## 5.3 DECONTAMINATION ZONE

The decontamination zone will be located immediately outside the entrance to the exclusion zone on its apparent upwind side, if feasible, and will be delineated with caution tape and traffic cones. This zone will contain the necessary decontamination materials for personnel decontamination. Decontamination procedures are outlined in Section 8.0 of this plan.

# 6.0 SITE MONITORING/ACTION LEVELS

## 6.1 SITE MONITORING

Field activities associated with the drilling and sampling may create potentially hazardous conditions due to the migration of contaminants into the breathing zone. These substances may be in the form of mists, vapors, dusts, or fumes that can enter the body through ingestion, inhalation, absorption, and direct dermal contact. Monitoring for VOCs will be performed to ensure appropriate personal protective measures are employed during site activities.

A separate Community Air Monitoring Plan (CAMP) has also been developed to protect the surrounding neighborhood.

Although the concentrations of anticipated contaminants in soil/groundwater should not present an explosive hazard, explosive environments or conditions may be encountered unexpectedly during the course of this project. Monitoring for explosivity in the atmosphere will be routinely conducted during site activities as a precautionary measure to ensure site personnel are not subjected to any dangerous conditions.

The following describes the conditions that will be monitored for during the investigation activities. All calibrations, etc., done on instruments, as well as background and site readings will be logged.

Organic Vapor Concentrations - Organic vapors will be monitored continuously in the breathing zone in the work area with a portable photoionization detector (PID), such as a miniRAE Model 2000 with a 10.2 eV lamp. The instrument will be calibrated daily or as per the manufacturer's recommendations. PID readings will be used as the criteria for upgrading or downgrading protective equipment and for implementing additional precautions or procedures.

Split spoons or other soil sampling devices will be monitored using the PID at the time they are opened, with appropriate PPE to be used where soils exhibit measurable volatile organic compound levels.

Explosivity - Explosivity will be monitored continuously during active drilling and excavation operations. Measurements obtained from this monitoring instrument will also be used as criteria for implementation of work stoppage or site evacuation. A combination combustible gas/oxygen (CGO2) instrument, calibrated per manufacturer's recommendations, will be used.

Particulates - Should subsurface conditions be observed to be dry, Stantec will perform particulate monitoring with a MIE PDM-3 Miniram aerosol monitor, within the work area to monitor personal exposures to particulates and to compare work area readings with downwind and upwind readings. The first readings of the day will be obtained prior to the commencement of work to obtain a daily background reading, and the instrument will be zeroed daily and calibrated to manufacturer's specifications. Readings will be recorded every 30 minutes thereafter. If the work area particulate levels exceed the background levels by more than 0.15 mg/m3, the Contractor will be instructed to implement dust suppression measures.

## 6.2 ACTION LEVELS

During the course of any activity, as long as PID readings in the breathing zone are less than 5 ppm above background, Level D protection will be considered adequate. Level C protection will be required when VOC concentrations in ambient air in the work zone exceed 5 ppm total VOCs above background but remain below 50 ppm total VOCs.

If concentrations in the work zone exceed 50 ppm for a period of 5 minutes or longer, work will immediately be terminated by the Site Safety Officer. Options to allow continued work would then be discussed amongst all parties. Supplied-air respiratory protection is generally required for work to resume under these conditions. If Level B protection is not used, work may resume in Level C once monitoring concentrations have decreased below 50 ppm and conditions outlined in the CAMP are met.

If the monitoring of fugitive particulate levels within the work area exceeds 0.15 mg/m3 above background, then the Contractor will be directed to implement fugitive dust control measures which may include use of engineering controls, such as water spray at the borehole during drilling.

# 7.0 PERSONAL PROTECTIVE EQUIPMENT

Based on an evaluation of the hazards at the site, personal protective equipment (PPE) will be required for all personnel and visitors entering the drilling exclusion zone(s). It is anticipated that all Stantec oversight work will be performed in Level D. All contractors will be responsible for selection and implementation of PPE for their personnel.

## 7.1 PROTECTIVE CLOTHING/RESPIRATORY PROTECTION:

Protective equipment for each level of protection is as follows:

If PID readings are above 50 ppm, requiring an upgrade to Level B, site work will be halted pending review of conditions and options by Stantec and other parties.

When PID readings range between 5 and 50 ppm, upgrade to Level C:

Level C

- Full face, air purifying respirator with organic/HEPA cartridge;
- Disposable chemical resistant one-piece suit (Tyvek or Saranex, as appropriate);
- Inner and outer chemical resistant gloves;
- Hard hat;
- Steel-toed boots; and
- Disposable booties.

When PID readings range between background and 5 ppm use Level D:

Level D

- Safety glasses;

- Steel-toed boots;
- Protective cotton, latex or leather gloves depending on site duties;
- Hard hat; and
- Tyvek coverall (optional).

# 8.0 DECONTAMINATION

## 8.1 PERSONNEL DECONTAMINATION

For complete decontamination, all personnel will observe the following procedures upon leaving the exclusion zone:

1. Remove outer boots and outer gloves and place in disposal drum.
2. If using a respirator, remove respirator, dispose of cartridges if necessary, and set aside for later cleaning.
3. Remove disposable chemical resistant suits and dispose of in drum.
4. Remove and dispose of inner gloves.

Decontamination solutions shall be supplied at the decontamination zone. The wash solution will consist of water and detergent such as Alconox or trisodium phosphate (TSP), and the rinse solution will consist of clean water.

Contaminated wash solutions shall be collected in drums for disposal. All other disposable health and safety equipment will be decontaminated and disposed of as non-hazardous waste.

## 8.2 EQUIPMENT DECONTAMINATION

If equipment is used during field activities, it will be properly washed or steam-cleaned prior to exiting the decontamination zone. Pre- or post-use rinsing using solvents will be done wearing appropriate PPE.

Monitoring instruments will be either wrapped in polysheeting or carried by personnel not involved in handling contaminated materials, to reduce the need for decontamination. All instruments will be wet-wiped prior to removal from the work zone.

# 9.0 EMERGENCY PROCEDURES

The Site Safety Officer will coordinate emergency procedures and will be responsible for initiating emergency response activities. Emergency communications at the site will be conducted verbally or by means of an air or vehicle horn. All personnel will be informed of the location of the cellular telephone and horn. Three blasts on the air or vehicle horn will be used to signal distress.

## 9.1 LIST OF EMERGENCY CONTACTS

Ambulance: 911

Hospital: Strong Memorial Hospital: (585) 275-2100

Fire Department: 911

Police: 911

Poison Control Center: (585) 222-1222

RG&E Utility Emergency: 911 or (800) 743-1702

## 9.2 DIRECTIONS TO HOSPITAL

A map and directions to the hospital is included in the back of the document (Figure 2). The route shall be reviewed at the initial site safety meeting on site.

## 9.3 ACCIDENT INVESTIGATION AND REPORTING

All accidents requiring first aid, which occur incidental to activities onsite, will be investigated. The investigation format will be as follows:

- Interviews with witnesses,
- Pictures, if applicable, and
- Necessary actions to alleviate the problem.

In the event that an accident or some other incident such as an explosion or exposure to toxic chemicals occurs during the course of the project, the Project Health and Safety Officer will be telephoned as soon as possible and receive a written notification within 24 hours. The report will include the following items:

- Name of injured;
- Name and title of person(s) reporting;
- Date and time of accident/incident;
- Location of accident/incident, building number, facility name;
- Brief summary of accident/incident giving pertinent details including type of operation ongoing at the time of the accident/incident;
- Cause of accident/incident;
- Casualties (fatalities, disabling injuries), hospitalizations;
- Details of any existing chemical hazard or contamination;
- Estimated property damage, if applicable;
- Nature of damage; effect on contract schedule;
- Action taken to insure safety and security; and
- Other damage or injuries sustained (public or private).

Where reportable injuries, hospitalizations or fatalities occur amongst Stantec personnel, the necessary document required by OSHA will be submitted within timeframes allowed by law.

The accident report form is illustrated in Table 4.

**TABLE 4**

## ACCIDENT REPORT

Project__Buell Automatics Site__ Date of Occurrence________________________

Location __381 Buell Rd, Gates, NY______________________________

_____________________________________________________________________

Type of Occurrence: (check all that Apply)

☐Disabling Injury
☐Property Damage
☐Chemical Exposure
☐Explosion
☐Other (explain)__________________________________________________

☐Other Injury
☐Equip. Failure
☐Fire
☐Vehicle Accident

_____________________________________________________________________

Witnesses to Accident/Injury:

_____________________ ________________
_____________________ ________________
_____________________ ________________

Injuries:

Name of Injured _________________________________________________

What was being done at the time of the accident/injury?

______________________________________________________________
______________________________________________________________

What corrective actions will be taken to prevent recurrence? _________________________

______________________________________________________________
______________________________________________________________

## SIGNATURES

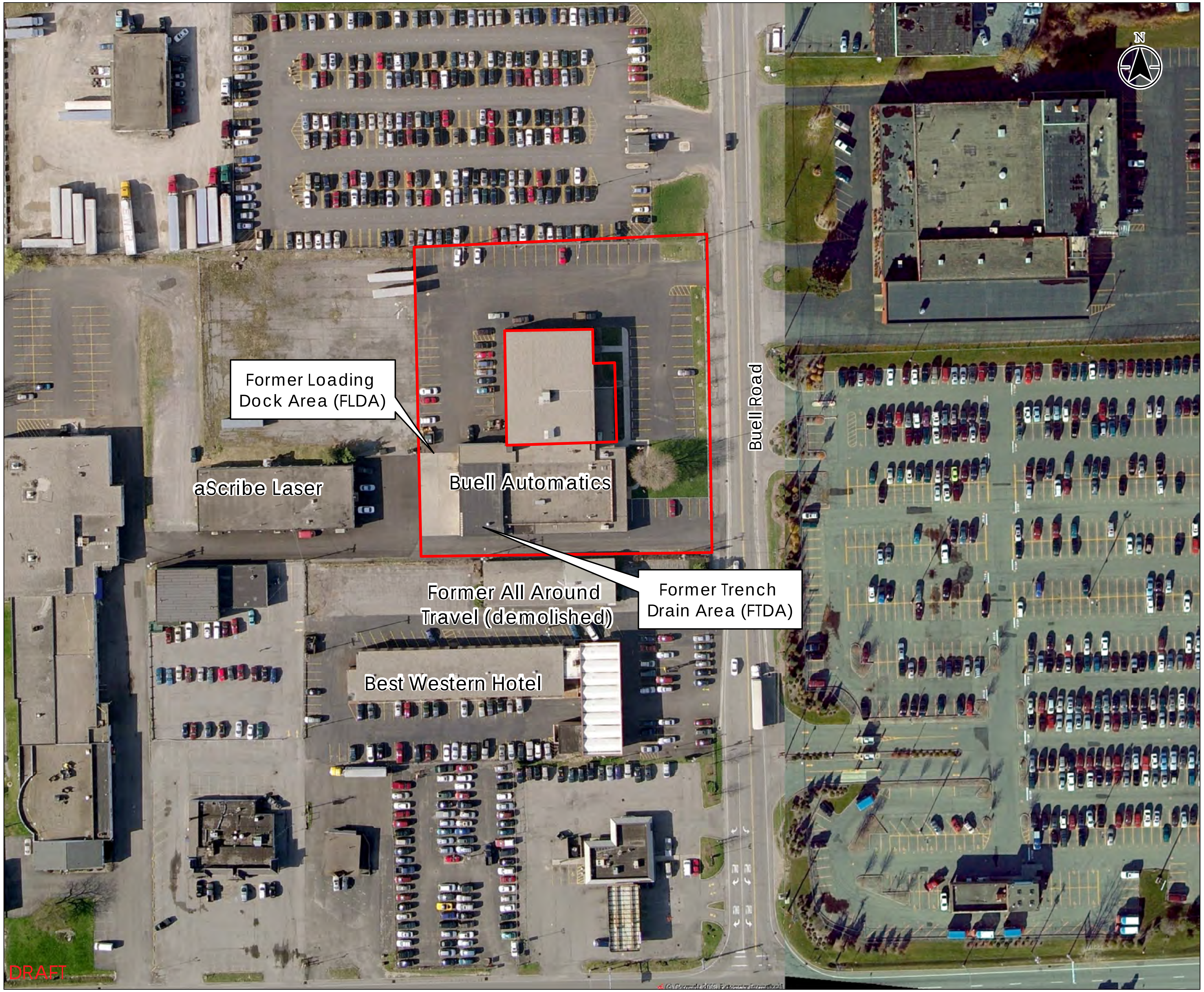
Health and Safety Officer _________________ Date ________________________
Project Manager _______________________ Date ________________________
Reviewer ____________________________ Date ________________________

Comments by reviewer __________________________________________________

_____________________________________________________________________
_____________________________________________________________________

HEALTH AND SAFETY PLAN FOR
BUELL AUTOMATICS SITE
INDEX #B8-0576-00-04A
381 BUELL ROAD
ROCHESTER, NEW YORK

# FIGURES



Stantec

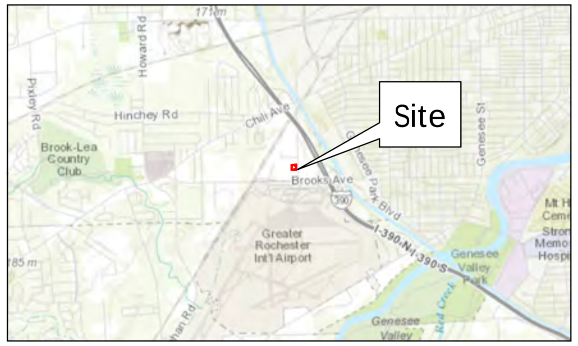
## Legend

🟥 Buell Project Boundaries

0 80 160
Feet
1:1,200 (At Original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 StatePlane New York West FIPS 3103 Feet



| | |
|---|---|
| Project Location: | Prepared by AG on 2014-09-29 |
| Buell Road | Technical Review by mmm on 2014-xx-xx |
| Rochester, NY | Independent Review by mmm on 2014-xx-xx |
| | 190500033 |

Client/Project
Buell Automatics
Brownfield Cleanup Program
EISB Work Plan

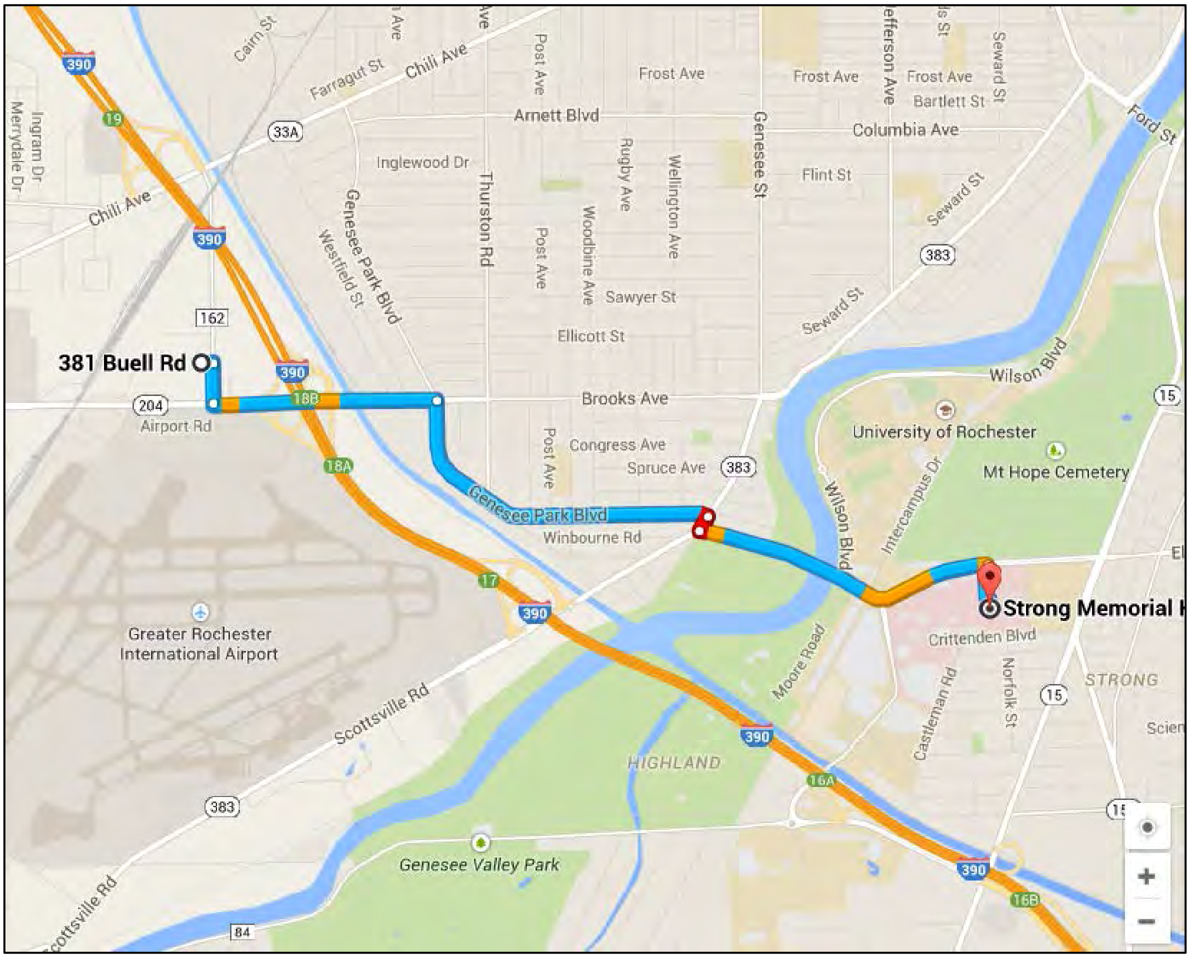
Figure No.
1

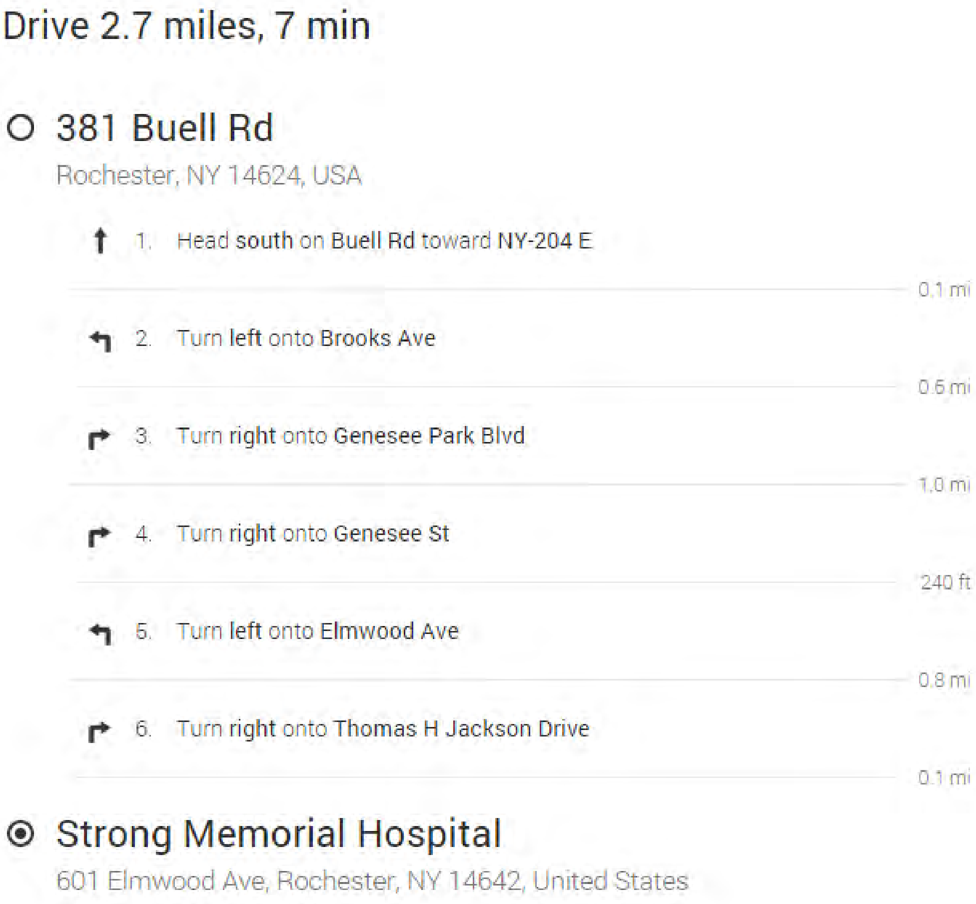
DRAFT

Title

## Site Location Map

U:\16059\GIS\EISB WP\Figure 1 - Site Location.mxd Revised: 2014-09-29 By: aglose





Drive 2.7 miles, 7 min

○ 381 Buell Rd

Rochester, NY 14624, USA

1. Head south on Buell Rd toward NY-204 E — 0.1 mi
2. Turn left onto Brooks Ave — 0.6 mi
3. Turn right onto Genesee Park Blvd — 1.0 mi
4. Turn right onto Genesee St — 240 ft
5. Turn left onto Elmwood Ave — 0.8 mi
6. Turn right onto Thomas H Jackson Drive — 0.1 mi

◉ Strong Memorial Hospital

601 Elmwood Ave, Rochester, NY 14642, United States

Figure 2 Map and Directions from Site to Hospital

# APPENDIX A
# MATERIAL SAFETY DATA SHEETS

Centers for Disease Control and Prevention
Your Online Source for Credible Health Information

September 2005

NIOSH Publication Number 2005-149

## Search the Pocket Guide

SEARCH

Enter search terms separated by spaces.

# 1,1-Dichloroethane

**Synonyms & Trade Names** Asymmetrical dichloroethane; Ethylidene chloride; 1,1-Ethylidene dichloride

**CAS No.** 75-34-3

**RTECS No.** KI0175000

**DOT ID & Guide** 2362 130

**Formula** $CHCl_2CH_3$

**Conversion** 1 ppm = 4.05 mg/m$^3$

**IDLH** 3000 ppm
See: 75343

### Exposure Limits

**NIOSH REL** : TWA 100 ppm (400 mg/m$^3$) See Appendix C (Chloroethanes)
**OSHA PEL** : TWA 100 ppm (400 mg/m$^3$)

**Measurement Methods**
**NIOSH** 1003 ;
**OSHA** 7
See: NMAM or OSHA Methods

**Physical Description** Colorless, oily liquid with a chloroform-like odor.

**MW:** 99.0

**BP:** 135°F

**FRZ:** -143°F

**Sol:** 0.6%

**VP:** 182 mmHg

**IP:** 11.06 eV

**Sp.Gr:** 1.18

**Fl.P:** 2°F

**UEL:** 11.4%

**LEL:** 5.4%

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

**Incompatibilities & Reactivities** Strong oxidizers, strong caustics

**Exposure Routes** inhalation, ingestion, skin and/or eye contact

**Symptoms** irritation skin; central nervous system depression; liver, kidney, lung damage

**Target Organs** Skin, liver, kidneys, lungs, central nervous system

**Personal Protection/Sanitation** (See protection codes)
**Skin:** Prevent skin contact
**Eyes:** Prevent eye contact

**First Aid** (See procedures)
**Eye:** Irrigate immediately
**Skin:** Soap flush promptly

| | |
|---|---|
| **Wash skin:** When contaminated<br>**Remove:** When wet (flammable)<br>**Change:** No recommendation | **Breathing:** Respiratory support<br>**Swallow:** Medical attention immediately |

**Respirator Recommendations**

**NIOSH/OSHA**

**Up to 1000 ppm**:
(APF = 10) Any supplied-air respirator

**Up to 2500 ppm**:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode

**Up to 3000 ppm**:
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

**Emergency or planned entry into unknown concentrations or IDLH conditions:**

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

**Escape:**
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

See also: INTRODUCTION See ICSC CARD: 0249

Page last reviewed: February 3, 2009
Page last updated: February 3, 2009
Content source: National Institute for Occupational Safety and Health (NIOSH) Education and Information Division

Centers for Disease Control and Prevention 1600 Clifton Rd. Atlanta, GA 30333, USA
800-CDC-INFO (800-232-4636) TTY: (888) 232-6348, 24 Hours/Every Day - cdcinfo@cdc.gov

CDC Home | CDC Search | CDC Health Topics A-Z

. Search NIOSH | NIOSH Home | NIOSH Topics | Site Index | Databases and Information Resources | NIOSH Products | Contact Us

**NIOSH Publication No. 2005-149:** **September 2005**

# NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

## 1,2-Dichloroethylene

### ClCH=ClCl

**CAS**

540-59-0

**RTECS**

KV9360000

**DOT ID & Guide**

1150 130P

**Synonyms & Trade Names**

Acetylene dichloride, cis-Acetylene dichloride, trans-Acetylene dichloride, sym-Dichloroethylene

**Exposure Limits**

**NIOSH REL**: TWA 200 ppm (790 mg/$m^3$)

**OSHA PEL**: TWA 200 ppm (790 mg/$m^3$)

**IDLH**

1000 ppm See: 540590

**Conversion**

1 ppm = 3.97 mg/$m^3$

**Physical Description**

Colorless liquid (usually a mixture of the cis & trans isomers) with a slightly acrid, chloroform-like odor.

| | | | |
|---|---|---|---|
| MW: 97.0 | BP: 118-140°F | FRZ: -57 to -115°F | Sol: 0.4% |
| VP: 180-265 mmHg | IP: 9.65 eV | | Sp.Gr(77°F): 1.27 |
| Fl.P: 36-39°F | UEL: 12.8% | LEL: 5.6% | |

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

**Incompatibilities & Reactivities**

Strong oxidizers, strong alkalis, potassium hydroxide, copper [Note: Usually contains inhibitors to prevent polymerization.]

**Measurement Methods**

NIOSH 1003; OSHA 7
See: NMAM or OSHA Methods

**Personal Protection & Sanitation**

(See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

**First Aid**

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

**Respirator Recommendations**

NIOSH/OSHA
**Up to 2000 ppm**:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode[£]
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)[£]
(APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
**Emergency or planned entry into unknown concentrations or IDLH conditions**:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
**Escape**:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

**Exposure Routes**

inhalation, ingestion, skin and/or eye contact

**Symptoms**

Irritation eyes, respiratory system; central nervous system depression

**Target Organs**

Eyes, respiratory system, central nervous system

See also: INTRODUCTION See ICSC CARD: 0436

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

CDC Centers for Disease Control and Prevention
Your Online Source for Credible Health Information

**September 2005**

**NIOSH Publication Number 2005-149**

## Search the Pocket Guide

SEARCH

Enter search terms separated by spaces.

# Stoddard solvent

**Synonyms & Trade Names** Dry cleaning safety solvent, Mineral spirits, Petroleum solvent, Spotting naphtha [Note: A refined petroleum solvent with a flash point of 102-110°F, boiling point of 309-396°F, and containing >65% $C_{10}$ or higher hydrocarbons.]

| | | |
|---|---|---|
| **CAS No.** 8052-41-3 | **RTECS No.** WJ8925000 | **DOT ID & Guide** 1268 128 (petroleum distillate, n.o.s.) |
| | **Conversion** | **IDLH** 20,000 mg/$m^3$ See: 8052413 |

| | |
|---|---|
| Exposure Limits<br>**NIOSH REL** : TWA 350 mg/$m^3$ C 1800 mg/$m^3$ [15-minute]<br>**OSHA PEL** †: TWA 500 ppm (2900 mg/$m^3$) | **Measurement Methods**<br>**NIOSH** 1550<br>See: NMAM or OSHA Methods |

**Physical Description** Colorless liquid with a kerosene-like odor.

| | | | | | |
|---|---|---|---|---|---|
| **MW:** varies | **BP:** 309-396°F | **FRZ:** ? | **Sol:** Insoluble | **VP:** ? | **IP:** ? |
| **Sp.Gr:** 0.78 | **Fl.P:** 102-110°F | **UEL:** ? | **LEL:** ? | | |

Class II Combustible Liquid: Fl.P. at or above 100°F and below 140°F.

**Incompatibilities & Reactivities** Strong oxidizers

**Exposure Routes** inhalation, ingestion, skin and/or eye contact

**Symptoms** irritation eyes, nose, throat; dizziness; dermatitis; chemical pneumonitis (aspiration liquid); in animals: kidney damage

**Target Organs** Eyes, skin, respiratory system, central nervous system, kidneys

| | |
|---|---|
| **Personal Protection/Sanitation** (See protection codes) | **First Aid** (See |

| | |
|---|---|
| **Skin:** Prevent skin contact<br>**Eyes:** Prevent eye contact<br>**Wash skin:** When contaminated<br>**Remove:** When wet or contaminated<br>**Change:** No recommendation | procedures)<br>**Eye:** Irrigate immediately<br>**Skin:** Soap wash promptly<br>**Breathing:** Respiratory support<br>**Swallow:** Medical attention immediately |

**Respirator Recommendations**

**NIOSH**

**Up to 3500 mg/m**$^3$:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*

**Up to 8750 mg/m**$^3$:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*

**Up to 17500 mg/m**$^3$:
(APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

**Up to 20000 mg/m**$^3$:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

**Emergency or planned entry into unknown concentrations or IDLH conditions:**

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

**Escape:**
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

See also: INTRODUCTION See ICSC CARD: 0361 See MEDICAL TESTS: 0212

Page last reviewed: February 3, 2009
Page last updated: February 3, 2009
Content source: National Institute for Occupational Safety and Health (NIOSH) Education and Information Division

Centers for Disease Control and Prevention 1600 Clifton Rd. Atlanta, GA 30333, USA
800-CDC-INFO (800-232-4636) TTY: (888) 232-6348, 24 Hours/Every Day - cdcinfo@cdc.gov

CDC Centers for Disease Control and Prevention
Your Online Source for Credible Health Information

September 2005

NIOSH Publication Number 2005-149

## Search the Pocket Guide

SEARCH

Enter search terms separated by spaces.

# Tetrachloroethylene

**Synonyms & Trade Names** Perchlorethylene, Perchloroethylene, Perk, Tetrachlorethylene

| | | |
|---|---|---|
| **CAS No.** 127-18-4 | **RTECS No.** KX3850000 | **DOT ID & Guide** 1897 160 |
| **Formula** $Cl_2C=CCl_2$ | **Conversion** 1 ppm = 6.78 mg/m$^3$ | **IDLH** Ca [150 ppm]<br>See: 127184 |

**Exposure Limits**

**NIOSH REL** : Ca Minimize workplace exposure concentrations. See Appendix A

**OSHA PEL** †: TWA 100 ppm
C 200 ppm (for 5 minutes in any 3-hour period), with a maximum peak of 300 ppm

**Measurement Methods**
**NIOSH** 1003 ;
**OSHA** 1001
See: NMAM or OSHA Methods

**Physical Description** Colorless liquid with a mild, chloroform-like odor.

| | | | | | |
|---|---|---|---|---|---|
| **MW:** 165.8 | **BP:** 250°F | **FRZ:** -2°F | **Sol:** 0.02% | **VP:** 14 mmHg | **IP:** 9.32 eV |
| **Sp.Gr:** 1.62 | **Fl.P:** NA | **UEL:** NA | **LEL:** NA | | |

Noncombustible Liquid, but decomposes in a fire to hydrogen chloride and phosgene.

**Incompatibilities & Reactivities** Strong oxidizers; chemically-active metals such as lithium, beryllium & barium; caustic soda; sodium hydroxide; potash

**Exposure Routes** inhalation, skin absorption, ingestion, skin and/or eye contact

**Symptoms** irritation eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogen]

**Target Organs** Eyes, skin, respiratory system, liver, kidneys, central nervous system

**Cancer Site** [in animals: liver tumors]

| **Personal Protection/Sanitation** (See protection codes) | **First Aid** (See procedures) |
|---|---|
| **Skin:** Prevent skin contact<br>**Eyes:** Prevent eye contact<br>**Wash skin:** When contaminated<br>**Remove:** When wet or contaminated<br>**Change:** No recommendation<br>**Provide:** Eyewash, Quick drench | **Eye:** Irrigate immediately<br>**Skin:** Soap wash promptly<br>**Breathing:** Respiratory support<br>**Swallow:** Medical attention immediately |

**Respirator Recommendations**

### NIOSH

**At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:**

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

**Escape:**

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

See also: INTRODUCTION See ICSC CARD: 0076 See MEDICAL TESTS: 0179

Page last reviewed: February 3, 2009
Page last updated: February 3, 2009
Content source: National Institute for Occupational Safety and Health (NIOSH) Education and Information Division

Centers for Disease Control and Prevention 1600 Clifton Rd. Atlanta, GA 30333, USA
800-CDC-INFO (800-232-4636) TTY: (888) 232-6348, 24 Hours/Every Day - cdcinfo@cdc.gov

Centers for Disease Control and Prevention
Your Online Source for Credible Health Information

September 2005

NIOSH Publication Number 2005-149

## Search the Pocket Guide

SEARCH

Enter search terms separated by spaces.

# Methyl chloroform

**Synonyms & Trade Names** Chlorothene; 1,1,1-Trichloroethane; 1,1,1-Trichloroethane (stabilized)

| | | |
|---|---|---|
| **CAS No.** 71-55-6 | **RTECS No.** KJ2975000 | **DOT ID & Guide** 2831 160 |
| **Formula** $CH_3CCl_3$ | **Conversion** 1 ppm = 5.46 $mg/m^3$ | **IDLH** 700 ppm<br>See: 71556 |

**Exposure Limits**
**NIOSH REL** : C 350 ppm (1900 $mg/m^3$) [15-minute] See Appendix C (Chloroethanes)
**OSHA PEL** †: TWA 350 ppm (1900 $mg/m^3$)

**Measurement Methods**
**NIOSH** 1003
See: NMAM or OSHA Methods

**Physical Description** Colorless liquid with a mild, chloroform-like odor.

| | | | | | |
|---|---|---|---|---|---|
| **MW:** 133.4 | **BP:** 165°F | **FRZ:** -23°F | **Sol:** 0.4% | **VP:** 100 mmHg | **IP:** 11.00 eV |
| **Sp.Gr:** 1.34 | **Fl.P:** ? | **UEL:** 12.5% | **LEL:** 7.5% | | |

Combustible Liquid, but burns with difficulty.

**Incompatibilities & Reactivities** Strong caustics; strong oxidizers; chemically-active metals such as zinc, aluminum, magnesium powders, sodium & potassium; water [Note: Reacts slowly with water to form hydrochloric acid.]

**Exposure Routes** inhalation, ingestion, skin and/or eye contact

**Symptoms** irritation eyes, skin; headache, lassitude (weakness, exhaustion), central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmias; liver damage

**Target Organs** Eyes, skin, central nervous system, cardiovascular system, liver

**Personal Protection/Sanitation** (See protection codes)
**Skin:** Prevent skin contact

**First Aid** (See procedures)
**Eye:** Irrigate immediately

| | |
|---|---|
| **Eyes:** Prevent eye contact<br>**Wash skin:** When contaminated<br>**Remove:** When wet or contaminated<br>**Change:** No recommendation | **Skin:** Soap wash promptly<br>**Breathing:** Respiratory support<br>**Swallow:** Medical attention immediately |

Respirator Recommendations

**NIOSH/OSHA**

**Up to 700 ppm**:
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

**Emergency or planned entry into unknown concentrations or IDLH conditions:**

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

**Escape:**
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

See also: INTRODUCTION See ICSC CARD: 0079 See MEDICAL TESTS: 0141

Page last reviewed: February 3, 2009
Page last updated: February 3, 2009
Content source: National Institute for Occupational Safety and Health (NIOSH) Education and Information Division

Centers for Disease Control and Prevention 1600 Clifton Rd. Atlanta, GA 30333, USA
800-CDC-INFO (800-232-4636) TTY: (888) 232-6348, 24 Hours/Every Day - cdcinfo@cdc.gov

CDC Home | CDC Search | CDC Health Topics A-Z

National Institute for Occupational Safety and Health

. Search NIOSH | NIOSH Home | NIOSH Topics | Site Index | Databases and Information Resources | NIOSH Products | Contact Us

**NIOSH Publication No. 2005-149:** **September 2005**

# NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

## Trichloroethylene

**CAS**

79-01-6

**RTECS**

KX4550000

## $ClCH=CCl_2$

**Synonyms & Trade Names**

Ethylene trichloride, TCE, Trichloroethene, Trilene

**DOT ID & Guide**

1710 160

## Exposure Limits

**NIOSH REL**: Ca See Appendix A See Appendix C

**OSHA PEL†**: TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 2 hours)

**IDLH**

Ca [1000 ppm] See: 79016

**Conversion**

1 ppm = 5.37 $mg/m^3$

**Physical Description**

Colorless liquid (unless dyed blue) with a chloroform-like odor.

| | | | |
|---|---|---|---|
| MW: 131.4 | BP: 189°F | FRZ: -99°F | Sol(77°F): 0.1% |
| VP: 58 mmHg | IP: 9.45 eV | | Sp.Gr: 1.46 |
| Fl.P: ? | UEL(77°F): 10.5% | LEL(77°F): 8% | |

Combustible Liquid, but burns with difficulty.

**Incompatibilities & Reactivities**

Strong caustics & alkalis; chemically-active metals (such as barium, lithium, sodium, magnesium, titanium & beryllium)

**Measurement Methods**

NIOSH 1022, 3800; OSHA 1001

See: NMAM or OSHA Methods

**Personal Protection & Sanitation**

(See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation
Provide: Eyewash, Quick drench

**First Aid**

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

**Respirator Recommendations**

NIOSH
**At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration**:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
**Escape**:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

**Exposure Routes**

inhalation, skin absorption, ingestion, skin and/or eye contact

**Symptoms**

Irritation eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen]

**Target Organs**

Eyes, skin, respiratory system, heart, liver, kidneys, central nervous system

**Cancer Site**

[in animals: liver & kidney cancer]
See also: INTRODUCTION See ICSC CARD: 0081 See MEDICAL TESTS: 0236

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

**NIOSH Publication No. 2005-149:** **September 2005**

# NIOSH Pocket Guide to Chemical Hazards

## Vinyl chloride

**CAS**

75-01-4

**RTECS**

KU9625000

### $CH_2=CHCl$

**Synonyms & Trade Names**

Chloroethene, Chloroethylene, Ethylene monochloride, Monochloroethene, Monochloroethylene, VC, Vinyl chloride monomer (VCM)

**DOT ID & Guide**

1086 116P (inhibited)

**Exposure Limits**

**NIOSH REL**: Ca See Appendix A

**OSHA PEL**: [1910.1017] TWA 1 ppm C 5 ppm [15-minute]

**IDLH**

Ca [N.D.] See: IDLH INDEX

**Conversion**

1 ppm = 2.56 mg/m$^3$

**Physical Description**

Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations. [Note: Shipped as a liquefied compressed gas.]

| | | | |
|---|---|---|---|
| MW: 62.5 | BP: 7°F | FRZ: -256°F | Sol(77°F): 0.1% |
| VP: 3.3 atm | IP: 9.99 eV | RGasD: 2.21 | |
| Fl.P: NA (Gas) | UEL: 33.0% | LEL: 3.6% | |
| Flammable Gas | | | |

**Incompatibilities & Reactivities**

Copper, oxidizers, aluminum, peroxides, iron, steel [Note: Polymerizes in air, sunlight, or heat unless stabilized by inhibitors such as phenol. Attacks iron & steel in presence of moisture.]

**Measurement Methods**

NIOSH 1007; OSHA 4, 75
See: NMAM or OSHA Methods

**Personal Protection & Sanitation**

(See protection)
Skin: Frostbite
Eyes: Frostbite
Wash skin: No recommendation
Remove: When wet (flammable)
Change: No recommendation
Provide: Frostbite wash

**First Aid**

(See procedures)
Eye: Frostbite
Skin: Frostbite
Breathing: Respiratory support

**Respirator Recommendations**

(See Appendix E) NIOSH
**At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration**:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
**Escape**:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

**Exposure Routes**

inhalation, skin, and/or eye contact (liquid)

**Symptoms**

Lassitude (weakness, exhaustion); abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; liquid: frostbite; [potential occupational carcinogen]

**Target Organs**

Liver, central nervous system, blood, respiratory system, lymphatic system

**Cancer Site**

[liver cancer]
See also: INTRODUCTION See ICSC CARD: 0082 See MEDICAL TESTS: 0241

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

**TEXO DATA**

TEXO CORPORATION
2828 Highland Avenue
Cincinnati, OH 45212

Call:(513) 731-3400
Fax: (513) 731-8113
Toll Free: (800) 998-8396

80gAL - 8gALS
~~40gal - 4gals~~

10%

# TEXO KLEEN 1704

CLEANER

## Liquid multi-metal cleaner/degreaser/rust preventative designed for industry.

Page 1 of 5 Original: 12/21/90 Revision: 2/18/99

FOR REFERENCE ONLY

**FEATURES:**

- *Multi-metal safe*
- *Rust inhibitive*
- *Near neutral pH*
- *Low foaming*
- *Spray or immersion application*
- *Oil splitting*
- *No rinse required*
- *Pleasant citrus odor*
- NON SILICATED

## TYPICAL PROPERTIES

| | |
|---|---|
| Appearance: | Clear liquid |
| Odor: | Mild surfactant |
| Color: | Straw |
| Specific Gravity: | 1.063 gr/ml |
| Weight per Gallon: | 8.87 lbs./gal. |
| pH (conc.): | 10.0 |
| pH (4%): | 9.4 |
| Flash Point: | >200°F (93.3°C) by Setaflash |
| Cloud Point (4%): | 32°C |
| Nonvolatile Material: | 18.5% |
| Heat Stability: | Separates but recombines with mixing * |
| Freeze/Thaw Stability: | Separates but recombines with mixing * |
| Foam: | Low foam; controlled |
| Total Alkalinity as $Na_2O$: | 1.67% |
| Phosphates as P: | 0.45% |
| Silicates: | None |
| Phenols: | None |
| Cresols: | None |
| Chromates: | None |
| Nitrites: | None |

* Please see Special Handling Procedures for further explanation.

## DIRECTIONS FOR USE

TEXO KLEEN 1704 can be used at a concentration of 1-10% by volume in spray washers, agitated tanks, power washers and immersion tanks. Parts will be cleaned and rust inhibited in one step. No rinse is required. TEXO KLEEN 1704 imparts indoor rust protection only. TEXO KLEEN 1704 is low foaming at temperatures above 100°F (37.8°C). Ambient temperature applications should be restricted to low agitation equipment, such as dip tanks. Actual cleaning temperature will depend upon cleaning time available and degree of soil. TEXO KLEEN 1704 can also be used as a hand wipe for metal surfaces prior to painting. Use 10-20% by volume, and wipe or blow dry after cleaning. The residue left by TEXO KLEEN 1704 is light to imperceptible and can be painted over by most coatings.

## CAUTION

CAUTION. May irritate eyes and skin of anyone sensitive to mild detergents. Harmful if swallowed. Do not get in eyes. Do not take internally.

Open drums slowly to vent. In case of skin or eye contact, flush with plenty of water. If irritation occurs, get medical aid. If swallowed, give large amounts of water. Do not induce vomiting. Get medical aid. Never give anything by mouth to an unconscious person. Remove contaminated shoes and clothing and wash before reuse. Personnel handling this product should be acquainted with its characteristics. Keep out of the reach of children. 83-07A

Consult MSDS for complete safety information.

ATTENTION: When empty, the container may still be hazardous. Because containers, even after they have been emptied, still retain product residues (vapor, liquid or solid), all labelled hazard precautions must be observed. If "emptied" product containers of 110 gallons (416 liters) or greater volume are to be shipped, DOT requires the containers be triple rinsed (or equivalent) to remove any residue and DOT placards be removed or covered with plain placards before they can be shipped as empty containers.

# TEXO CORPORATION

## MATERIAL SAFETY DATA SHEET

The information on this form is furnished solely for the purpose of compliance with OSHA Hazard Communication Standard 29CFR 1910.1200. Information pertains to product as received in container. The information provided should be evaluated by the user in terms of local operating conditions.

RODUCT: TEXO KLEEN 1704

Date of This Revision: 2/17/99

Health 1 Fire 0 Reactivity 0 PPE X
HMIS Rating: 0=Least 1=Slight 2=Moderate 3=High 4=Extreme

## SECTION I

Manufacturer's Name/Address

TEXO CORPORATION
2801 Highland Ave.
Cinti., OH 45212

| | Telephone No. |
|---|---|
| General Information | (513) 731-3400 |
| Health Emergency | (513) 244-1216 |
| Transportation Emergency-Chemtrec | (800) 424-9300 |

## SECTION II - HAZARDOUS INGREDIENTS

| INGREDIENT | CAS NO. | TLV (ACGIH) |
|---|---|---|
| Dipropylene Glycol Methyl Ether | 34590-94-8 | 100 ppm |
| Borax | 1303-96-4 | 5 mg/m³ |
| Triethanolamine | 102-71-6 | 5 mg/m³ |

## SECTION III - PHYSICAL DATA

| | | | |
|---|---|---|---|
| Boiling Point (°F) | ~212 | Specific Gravity ($H_2O$=1) | 1.06 |
| Vapor Pressure (mm Hg.) | N/AV | Percent Volatile | 70-80 |
| Vapor Density (Air=1) | N/AV | Evaporation Rate(____=1) | N/AV |
| Solubility in Water: | Complete | pH @ 100 % | 10.0 |
| Appearance & Odor: | Off white liquid, mild odor | | |

## SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT (Method used) (>200°F)

Flammable Limits
N/AP :Lel N/AP:Uel

EXTINGUISHING MEDIA: Water, foam, $CO_2$, dry chemical, for fires in area. Use water spray to cool container exposed to fire; do not get water inside containers.

SPECIAL FIREFIGHTING PROCEDURE: Wear self-contained breathing apparatus and impervious gear.

UNUSUAL FIRE & EXPLOSION HAZARDS:N/AP

## SECTION V - HEALTH HAZARD DATA

ROUTE OF EXPOSURE: X Skin Contact X Inhalation __Ingestion
THRESHOLD LIMIT VALUE: See Section II

EFFECTS OF OVEREXPOSURE: May irritate eyes and skin. Inhalation may irritate respiratory tract. For Dipropylene glycol methyl ether: SKIN ABSORPTION - The LD50 for skin absorption in rabbits is >20 ml/kg. Prolonged skin contact with very large amounts may cause drowsiness. INGESTION - Single does oral toxicity is low. The oral LD50 for rats is 5.4 ml/kg. Amounts ingested incidental to industrial handling are not likely to cause injury; however ingestion of larger amounts may cause injury. INHALATION - Signs and symptoms of excessive exposure may be anesthetic or narcotic effects. SYSTEMIC & OTHER EFFECTS - Repeated excessive exposures may cause liver or possibly kidney effects. Signs and symptoms of excessive exposure may be anesthetic or narcotic effects. Results of in vitro ("test tube") mutagenicity tests have been negative.

CARCINOGENICITY: ( )NTP ( )IARC ( )OSHA ( ) ACGIH (X)NONE

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Exposure to borax may aggravate kidney and liver diseases and nerve disorders.

N/AP = not applicable N/AV = not available

## SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE:

DO NOT ADD NITRITES DUE TO THE POSSIBLE FORMATION OF NITROSAMINES (POTENTIAL CARCINOGENS).

Do not store at temperatures above 90°F, because the product may separate. TEXO KLEEN 1704 can be reconstituted by cooling to 75°F and agitating for a minimum of 15 minutes. Do not store at temperatures below 40°F, because the product may separate. TEXO KLEEN 1704 can be reconstituted by warming to 75°F and agitating for a minimum of 15 minutes. The shelf life of this material is 12 months. Stock rotation is recommended.

Optimum storage temperature range 50-80°F. If in doubt of storage conditions, mix product before use. Indoor storage only.

STORE IN A COOL DRY AREA AWAY FROM EXCESS HEAT, OPEN FLAME, OR SPARKS. DO NOT CUT OR WELD ON OR AROUND DRUMS FULL OR EMPTY.

CAUTION. May irritate eyes and skin of anyone sensitive to mild detergents. Harmful if swallowed. Do not get in eyes. Do not take internally.

Open drums slowly to vent. In case of skin or eye contact, flush with plenty of water. If irritation occurs, get medical aid. If swallowed, give large amounts of water. Do not induce vomiting. Get medical aid. Never give anything by mouth to an unconscious person. Remove contaminated shoes and clothing and wash before reuse. Personnel handling this product should be acquainted with its characteristics. Keep out of the reach of children.

83-07A

ATTENTION: When empty, the container may still be hazardous. Because containers, even after they have been emptied, still retain product residues (vapor, liquid or solid), all labelled hazard precautions must be observed. If "emptied" product containers of 110 gallons or greater volume are to be shipped, DOT requires the containers be triple rinsed (or equivalent) to remove any residue and DOT placards be removed or covered with plain placards before they can be shipped as empty containers.

# TEXO DATA

TEXO CORPORATION
2828 Highland Avenue
Cincinnati, Ohio 45212

Call: (513) 731-3400
Fax: (513) 731-8113
Toll Free: (800) 998-8396

409 GALS
STRIGHT
AT 100%

## PROTEXO 1125

(RUST BAN)

STEEL
RUST
PROTECT

### Water Based - High Performance - Rust Preventative
### Unique in Market

Page 1 of 2 Original: 2/25/98 Revision: 3/18/99

## GENERAL DESCRIPTION

- Long-Term Indoor Rust Protection (1-2 years)
- For High Humidity Environments
- 500 + hours in Humidity Cabinet
- Replace Solvent-Cut-Back Rust Preventatives
- Only 0.06 pounds per gallon VOC
- New Technology, a significant improvement over other water-based systems

PROTEXO 1125 is a complex polymer-based rust inhibitor. PROTEXO 1125 develops a water resistant coating on steel. PROTEXO 1125 dries to a non-tacky coating within one hour after application. PROTEXO 1125 is water based, has no flash point and produces no irritating or dangerous solvent fumes as is common with many other rust inhibiting compounds.

PROTEXO 1125 provides effective, long-term indoor rust protection under highly humid conditions. In addition to the ease of spray or immersion application, PROTEXO 1125 offers a neutral pH and very low VOC content.

## TYPICAL PROPERTIES

| | |
|---|---|
| Appearance: | Emulsion |
| Odor: | Mild |
| pH: | 8.0 |
| Density: | 8.21 lbs./gal. |
| Humidity Resistance: | Excellent |
| Freezability: | Protect from freezing |
| Flammability: | None |

FOR REFERENCE ONLY

# TEXO CORPORATION

## MATERIAL SAFETY DATA SHEET

The information on this form is furnished solely for the purpose of compliance with OSHA Hazard Communication Standard 29CFR 1910.1200. Information pertains to product as received in container. The information provided should be evaluated by the user in terms of local operating conditions.

PRODUCT: PROTEXO 1125

Date of This Revision: 4/5/99

HMIS Rating: Health 0 Fire 0 Reactivity 0 PPE X

0=Least 1=Slight 2=Moderate 3=High 4=Extreme

## SECTION I

| Manufacturer's Name/Address | | Telephone No. |
|---|---|---|
| TEXO CORPORATION<br>2801 Highland Ave.<br>Cinti., OH 45212 | General Information | (513) 731-3400 |
| | Health Emergency | (513) 244-1216 |
| | Transportation Emergency-Chemtrec | (800) 424-9300 |

## SECTION II - HAZARDOUS INGREDIENTS

| INGREDIENT | CAS NO. | TLV (ACGIH) |
|---|---|---|
| Mineral Oil | Mixture | 5 mg/m³ as oil mist |

## SECTION III - PHYSICAL DATA

| | | | |
|---|---|---|---|
| Boiling Point (°F) | 212 | Specific Gravity ($H_2O$=1) | 0.986 g/ml |
| Vapor Pressure (mm Hg.) | N/AV | Percent Volatile | 85% |
| Vapor Density (Air=1) | N/AV | Evaporation Rate(_____=1). | As water |
| Solubility in Water: | Nil | pH @ 100 % | 8.0 |
| Appearance & Odor: | Emulsion, mild odor | | |

## SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT (Method used) None

Flammable Limits
N/AV :Lel N/AV :Uel

EXTINGUISHING MEDIA: Foam, sand or earth, $CO_2$, dry chemical, for fires in area. Use water spray to cool container exposed to fire; do not get water inside containers.

SPECIAL FIREFIGHTING PROCEDURE: Wear self-contained breathing apparatus and impervious gear.

UNUSUAL FIRE & EXPLOSION HAZARDS: N/AP

## SECTION V - HEALTH HAZARD DATA

ROUTE OF EXPOSURE: X Skin Contact __Inhalation __Ingestion

THRESHOLD LIMIT VALUE: See Section II

EFFECTS OF OVEREXPOSURE: May irritate skin. Irritates eyes and upper respiratory tract.

EMERGENCY & FIRST AID PROCEDURES: Flush skin with water for 15 minutes. If irritation persists, get medical aid. Flush eyes with water for 15 minutes. Get medical aid. For inhalation, remove to fresh air. If swallowed, give large amounts of water. Get medical aid.

CARCINOGENICITY: ( )NTP ( )IARC ( )OSHA ( ) ACGIH (X)NONE

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Unknown

N/AP = not applicable N/AV = not available

## SECTION VI - REACTIVITY DATA

STABILITY - Unstable:
Stable: X

Conditions to Avoid
N/AP

INCOMPATIBILITY (Materials to Avoid): Strong oxidizing agents, strong mineral acids. Contact with nitrites could form suspected cancer-causing nitrosamines.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition may produce CO, $CO_2$ and reactive volatile hydrocarbons.

## SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Remove sources of ignition. Ventilate. Dike to prevent spread. Return to container. Cover spill area with inert, non-combustible absorbent material and remove to disposal container.

WASTE DISPOSAL METHOD: Incineration is suggested. Obey all regulations. Do not allow material to enter waterways.

## SECTION VIII - EMPLOYEE PROTECTION INFORMATION

RESPIRATORY PROTECTION:NIOSH organic vapor respirator if TLV exceeded.

VENTILATION - Local Exhaust: Suggested
Mechanical: N/AP
Other: N/AP

Ventilation, natural or mechanical, is suggested to dilute any material in the air and help keep the potential exposure levels below the maximum exposure limits.

PROTECTIVE GLOVES: Rubber
EYE PROTECTION: Chemical goggles
OTHER PROTECTION: Rubber apron and boots

## SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE:

O NOT ADD NITRITES DUE TO THE POSIBLE FORMATION OF NITROSAMINES (POTENTIAL CARCINOGENS).

CAUTION. May irritate eyes and skin of anyone sensitive to mild detergents. Harmful if swallowed. Do not get in eyes. Do not take internally.

Open drums slowly to vent. In case of skin or eye contact, flush with plenty of water. If irritation occurs, get medical aid. If swallowed, give large amounts of water. Do not induce vomiting. Get medical aid. Never give anything by mouth to an unconscious person. Remove contaminated shoes and clothing and wash before reuse. Personnel handling this product should be acquainted with its characteristics. Keep out of the reach of children.

83-07A

ATTENTION: When empty, the container may still be hazardous. Because containers, even after they have been emptied, still retain product residues (vapor, liquid or solid), all labelled hazard precautions must be observed. If "emptied" product containers of 110 gallons or greater volume are to be shipped, DOT requires the containers be triple rinsed (or equivalent) to remove any residue and DOT placards be removed or covered with plain placards before they can be shipped as empty containers.

## X. REGULATORY INFORMATION

### STATUS ON SUBSTANCE LISTS:

The concentrations shown are maximum or ceiling levels (weight %) to be used for alculations for regulations.

### FEDERAL EPA

| Statute | Components Present | RQ | % Present |
|---|---|---|---|
| CERCLA - 40 CFR 302.4<br>Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Reportable Quantities (RQs) | None | N/AP | N/AP |

| | Components Present | % Present |
|---|---|---|
| SARA Title III 40 CFR 372 (for SARA 313) Superfund Amendments and Reauthorization Act of 1986 | None | N/AP |

| | Component Present | RQ | TPQ |
|---|---|---|---|
| SARA Title III, 40 CFR 355 (SARA 302, 304) Superfund Amendments and Reauthorization Act of 1986 Threshold Planning Quantities (TPQs) and Reportable Quantities (RQs) | None | N/AP | N/AP |

| | Component Present |
|---|---|
| Section 311, 40 CFR Part 116.4<br>Clean Water Act | None |

### STATE RIGHT-TO-KNOW

| State | Rule | Presence of: |
|---|---|---|
| CALIFORNIA | PROPOSITION 65 | None |
| ASSACHUSETTS | MSL - Right-To-Know | None |
| PENNSYLVANIA | Right-to-Know, Hazard Substance List | None |
| | "Contains Pennsylvania Right-to-Know Trade Secret Ingredients" | |
| NEW JERSEY | Right-to-Know, Hazard Substance List | None |

We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of the use of the product are not within the control of TEXO CORPORATION, it is the user's obligation to determine the conditions of safe use of the product.

Signed David L. Kaplan

RUST-BAN 392

**EXXON COMPANY, U.S.A.**
A DIVISION OF EXXON CORPORATION

DATE ISSUED 7/10/86

# MATERIAL SAFETY DATA SHEET

EXXON COMPANY, U.S.A. P.O. BOX 2180 HOUSTON, TX 77252-2180

## A. IDENTIFICATION AND EMERGENCY INFORMATION

| | |
|---|---|
| **PRODUCT NAME**<br>RUST-BAN 392 | **PRODUCT CODE**<br>280392 - 04114 |
| **CHEMICAL NAME**<br>Petroleum Rust Preventive | **CAS NUMBER**<br>Complex Mixture<br>CAS Number not applicable |

**PRODUCT APPEARANCE AND ODOR**
Clear liquid, amber color
Mild mineral spirits odor

**EMERGENCY TELEPHONE NUMBER**
(713) 656-3424

## B. COMPONENTS AND HAZARD INFORMATION

| COMPONENTS | CAS NO. OF COMPONENTS | APPROXIMATE CONCENTRATION |
|---|---|---|
| Hydrotreated heavy naphtha, petroleum | 64742-48-9 | Greater than 92% |
| Proprietary additives | Mixture | Approximately 7% |

See Section E for Health and Hazard Information

**HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS)**

| Health | Flammability | Reactivity | BASIS |
|---|---|---|---|
| 1 | 2 | 0 | Recommended by Exxon |

| EXPOSURE LIMIT FOR TOTAL PRODUCT | BASIS |
|---|---|
| 100 ppm (570 mg/m3) for an 8-hour workday | Recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) |

## C. PRIMARY ROUTES OF ENTRY AND EMERGENCY AND FIRST AID PROCEDURES

**EYE CONTACT**
If splashed into the eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists, call a physician.

**SKIN CONTACT**
In case of skin contact, remove any contaminated clothing and wash skin thoroughly with soap and water.

**INHALATION**
If overcome by vapor, remove from exposure and call a physician immediately. If breathing is irregular or has stopped, start resuscitation, administer oxygen, if available.

**INGESTION**
If ingested, DO NOT induce vomiting; call a physician immediately.

# Material Safety Data Sheet

# Noco Clean All 140 Solvent

## Material Identification and Use

MANUFACTURER'S NAME.............. Noco Energy Corp.
MANUFACTURER'S ADDRESS........... 700 Grand Island Blvd., Tonawanda, N. Y. 1415
EMERGENCY PHONE NUMBER........... 1-716-874-6200
SUPPLIER IDENTIFIER.............. Noco Clean All 140 Solvent
SUPPLIER'S ADDRESS............... P.O. Box 86, Tonawanda, New York 14151
SUPPLIER EMERGENCY PHONE NUMBER. 1-716-874-6200
PRODUCT IDENTIFIER............... Noco Clean All 140 Solvent
PRODUCT USE...................... Low odor cleaning solvent.

## Hazardous Ingredients of Materials

| Chemical Identity | Concentration | CAS#/NA#/UN# | LD(50) | LC(50) |
|---|---|---|---|---|

## Physical Data For Product

PHYSICAL STATE................... Liquid.
ODOR AND APPEARANCE.............. Clear water white, mild petroleum odor.
ODOR THRESHOLD................... Not determined.
SPECIFIC GRAVITY................. 0.799
VAPOR PRESSURE................... Less than 1 mm Hg @ 25°C
VAPOR DENSITY (air=1)............ Greater than 5.
EVAPORATION RATE................. (Butyll Acetate = 1) Less than 0.1
BOILING POINT.................... 360-465°F (182-241°C)
FREEZING POINT................... N/A
pH............................... Neutral.
COEFFICIENT OF WATER/OIL DISTRIBUTION.................. Negligible.

## Fire and Explosion Hazard of Product

CONDITIONS OF FLAMMABILITY...... Addition of water may cause frothing. Do not cut, drill or weld empty containers.
MEANS OF EXTINCTION............. Foam, water spray, dry chemical, carbon dioxid and vaporizing liquid type extinguishing agents may all be suitable for extinguishing fires involving this type of product.
FLASHPOINT AND METHOD OF DETERMINATION.................. 160°F (71°C) ASTM D 56 Tag Closed cup.
UPPER EXPLOSION LIMIT(% BY VOL). 7%
LOWER EXPLOSION LIMIT(% BY VOL). 0.6%
AUTO-IGNITION TEMPERATURE....... 420°F (216°C)
FLAMMABILITY CLASSIFICATION..... 2

## Material Safety Data Sheet

## Noco Clean All 140 Solvent

HAZARDOUS COMBUSTION PRODUCTS... Open flames, sparks.
EXPLOSION DATA.................. Not determined.
SENSITIVITY TO STATIC DISCHARGE. N/A

### Reactivity Data

CHEMICAL STABILITY.............. Stable.
INCOMPATIBLE MATERIALS.......... Strong oxidants such as liquid chlorine, concentrated oxygen.
CONDITIONS OF REACTIVITY........ Excessive heat.
HAZARDOUS DECOMPOSITION PRODUCTS Fumes, smoke , carbon monoxide and other decomposition products.

### Toxicological Properties of Product

ROUTES OF ENTRY
SKIN CONTACT.................. Repeated skin contact with this product tends to remove skin oils possibly leading to irritation and dermatitis.
EYE........................... Slightly irritating to eyes.
INHALATION.................... May cause headaches and dizziness, are anesthetic, and may have other central nervou system effects including death.
INGESTION..................... Amounts which are aspirated into the lungs during ingestion or or vomiting may cause mild to severe pulmonary injury and possibly death.
CARCINOGENICITY, REPRODUCTIVE EFFECTS....................... Not carcinogenic.

### Preventive Measures

PERSONAL PROTECTIVE EQUIPMENT... VENTILATION: Use only with ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air. Respiratory Protection: Use supplied air respiratory protection in confined or enclosed spaces. Protective Gloves: Use chemcial resistant gloves. Eye Protection: Use splash proof goggles or face shield when eye contact can occur.
SPECIFIC ENGINEERING CONTROLS... N/A
LEAK AND SPILL PROCEDURES....... Shut off and eliminate all sources of ignitio
WASTE DISPOSAL.................. Recover free product. Assure conformity with applicable governmental regulations.

## Material Safety Data Sheet

## Noco Clean All 140 Solvent

| | |
|---|---|
| HANDLING PROCEDURES AND EQUIPMENT...................... | Wash thoroughly after handling. |
| STORAGE REQUIREMENTS........... | Cool, dry. |
| SPECIAL SHIPPING INFORMATION.... | No special instructions. |

## First Aid Measures

| | |
|---|---|
| SPECIFIC FIRST AID PROCEDURES... | EYE: flush with clear water for at least 15 minutes or until irritation subsides. SKIN: Remove any contaminated clothing and wash ski thoroughly with soap and water. INHALATION: remove from exposure and call a physician immediately. INGESTION: Do not induce vomiting. |

## Special Percautions

| | |
|---|---|
| HAZARD CLASS............. | N/A |
| DOT SHIPPING NAME........ | Petroleum Solvent |
| REPORTABLE QUANTITY (RQ). | Check with local authority. |
| UN NUMBER................ | 1255 |
| NA #..................... | 1255 |
| PACKAGING SIZE........... | N/A |

## Preparation Date of Material Safety Data Sheet

| | |
|---|---|
| PREPARED BY...................... | NOCO - SK |
| PHONE NUMBER OF PREPARER........ | 1-800-544-1846 |
| DATE PREPARED................... | 9/6/91 |

FOR REFERENCE ONLY

# Material Safety Data Sheet

## NOCO CLEAN ALL 142 SOLVENT

### Material Identification and Use

MANUFACTURER'S NAME..............................................
MANUFACTURERS ADDRESS.......................................... NOCO ENERGY CORP.
EMERGENCY NUMBER.................................................. PO BOX 86, TONAWANDA, NY 14151
SUPPLIER'S ADDRESS................................................ 1-800-424-9300 (CHEMTREC)
SUPPLIER EMERGENCY PHONE NUMBER .............. 700 GRAND ISLAND BLVD., TONAWANDA, NY 14151
PRODUCT NAME.......................................................... 1-800-600-628
PRODUCT CODE.......................................................... CLEAN ALL 142 SOLVENT
CHEMICAL NAME AND SYNONYM.............................. NOC5410
PRODUCT USE.............................................................. SOLVENT NAPPA
.................................................................................... Used for industrial and automotive cleaning applications.

### Ingredients

| Components | % | CAS Number | Hazard Data |
|---|---|---|---|
| Medium Aliphatic Solvent | 100 | 64742-88-7 | OSHA PEL/TWA 100 PPM<br>ACGIH/TWA 100PPM |

WHMIS CLASSIFICATION.................................................. B3

### Physical Data

PHYSICAL STATE..........................................................
ODOUR AND APPEARANCE............................................. Liquid
SPECIFIC GRAVITY........................................................ Hydrocarbon odor, clear color
VAPOUR PRESSURE (MM HG @ 20 C)........................ (Water = 1) 0.79@ 60°F
VAPOUR DENSITY (air=1)................................................ Less than 5 mm/hg @ 100°F
EVAPORATION RATE....................................................... 6.2
BOILING POINT.............................................................. N Butyl Acetate = 1: 0.03
FREEZING POINT............................................................ 350°F – 415° F
pH.................................................................................. N/A
SOLUBILITY IN H2O (water)............................................ N/A
.................................................................................... Negligible

### Fire and Explosion Hazards

CONDITIONS OF FLAMMABILITY......................................
EXTINGUISHING MEDIA.................................................. Can be made to burn.
FLASHPOINT & METHOD OF DETERMINATION......... Foam, water fog, dry chemical, carbon dioxide
FLAMMABLE LIMITS IN AIR % B.V.-UPPER.................. 145°F Minimum TTC (61°C Minimum)
FLAMMABLE LIMITS IN AIR % B.V.-LOWER.................. 7%
NFPA - HAZARD CLASS.................................................. 1%
HAZARDOUS COMBUSTION PRODUCT......................... Health: 2 Flammability: 3 Reactivity: 0
UNUSUAL FIRE AND EXPLOSION HAZARD................... Open flames, sparks, intense heat
Container exposed to intense heat from fires should be cooled with water To prevent vapor pressure build up which could result in container rupture. Container areas exposed to direct flame contact should be cooled with large quantities of water as needed to prevent weakening of container structure.
SPECIAL FIRE FIGHTING PROCEDURES.......................... Wear self contained breathing apparatus when fire fighting in a confined space. Cool fire exposed containers with water spray.

/3/98

# Material Safety Data Sheet

## NOCO CLEAN ALL 142 SOLVENT

### Reactivity Data

| | |
|---|---|
| CHEMICAL STABILITY | Stable |
| INCOMPATIBLE MATERIALS | Avoid contact with strong oxidizers, heat and open flames |
| HAZARDOUS DECOMPOSITION | Carbon monoxide and unidentified organic compounds may be formed during combustion. |
| HAZARDOUS POLYMERIZATION | Material is not known to polymerize. |

### Health Hazard Information

| | |
|---|---|
| ROUTES OF ENTRY | |
| Skin Contact | Slightly irritating to skin. Prolonged or repeated contact can result in de-fatting and drying of skin. |
| Eye | Practically non-irritating to the eyes. |
| Inhalation | Vapors may cause irritation to nose, throat and respiratory tract. High concentrations may result in CNS depression. |
| Ingestion | May result in vomiting. Breathing of vomitus into lungs must be avoided, small quantities may result in aspiration pneumontis. |
| CARCINOGENICITY | Not carcinogenic.<br>ACGIH - No |

### Emergency And First Aid Procedures

| | |
|---|---|
| | In case of contact, flush eyes with large amounts of water for at least 15 minutes. Get medical attention. |
| SKIN | Wash skin thoroughly with soap and water or waterless hand cleaner. If irritation occurs, get medical attention. |
| INHALATION | If breathing is difficult, remove victim to fresh air, Give artificial respiration if not breathing. |
| INGESTION | Do not ingest. If ingested, DO NOT INDUCE VOMITING! Get medical attention. |

### Preventive Measures

| | |
|---|---|
| VENTILATION REQUIREMENTS | Use explosion proof ventilation as required to control vapor concentration |
| RESPIRATORY PROTECTION | Not required under normal OSHA TLV. Use NIOSH approved respirators to prevent over exposure. |
| EYE PROTECTION | Safety glasses with side shields or goggles |
| PROTECTIVE GLOVES | Nitrile gloves provide best protection to hands and arms. |
| PERSONAL HYGIENE | Wear effective plant clothing. Contaminated clothing should be removed and washed in soap and water. Cleanse skin thoroughly before meals with soap and water. Shower and eyewash facilities should be accessible. |
| NOTE | No data |

# Material Safety Data Sheet

## NOCO CLEAN ALL 142 SOLVENT

### Environmental Procedures

| | |
|---|---|
| SPILLS OR RELEASES | If material is spilled or released to the atmosphere, steps should be taken to prevent discharges to streams or sewer systems. Spills or releases should be reported, if required to the appropriate Local, State and Federal regulatory agencies. |
| DISPOSAL | Clean up action should be carefully planned and executed. Shipment, storage and/or disposal of waste materials are regulated and action to handle or dispose spilled or released materials must meet all State, Local and Federal rules. |
| STORAGE | Protect against physical damage. Separate from oxidizing materials. Store in cool well ventilated area of non-combustible construction, away from possible sources of ignition. |

### Regulatory Information

| | |
|---|---|
| DEPARTMENT OF TRANSPORATION | DOT Shipping Name: None<br>Hazard Class: Flammable Liquid - 3<br>ID Number: UN 1268 |
| TSCA | This product is listed on the TSCA inventory. |
| CERCLA | This product is classified as an oil under Section 311. Spills into or leading to surface water that cause sheen must be reported to The National Response Center at 1-800-424-8802. |
| RCRA | If this product becomes a waste it could not be a hazardous waste by RCRA-40 CFR 261. Place in an appropriate disposal facility in compliance with local authorities. |
| SARA TITLE III - SECTION 302 | Not applicable |
| SECTION 311/312 | H-1, H-2, P-3 |
| SECTION 313 | Not applicable |

### Preparation Date of Material Safety Data Sheet

| | |
|---|---|
| PREPARED BY | NOCO - SK |
| PHONE NUMBER OF PREPARER | 1-315-393-4530 |
| DATE PREPARED | 12/03/98 |
| REVISED DATE | New |

**DISCLAIMER** Information presented herein has been compiled from information provided to us by our suppliers and other sources considered to be dependable and is accurate and reliable to the best of our knowledge and belief but is not guaranteed to be so. Nothing herein is to be construed as recommending any practice or the use of any product in violation of any patent or in violation of any law or regulation. It is the users' responsibility to determine the suitability of any material for a specific purpose and to adopt such safety precautions as may be necessary. We make no warranty as to the results to be obtained by using any material and since conditions of use are not under our control, we must necessarily disclaim all liability with respect to the use of material supplied by us.

# NOCO

# Product Data Sheet

---

## NOCO CLEAN-ALL 142 SOLVENT

**NOCO Clean-All 142 Solvent** is a high flash point, mild odor solvent. It is especially suited for industrial and automotive cleaning applications.

| FEATURES | BENEFITS |
|---|---|
| High Flash Point | Safer to Use |
| Mild Odor | Pleasant to Use |
| Not Harsh On Normal Skin | Operator Friendly |
| Produces Cleaner, Brighter Parts | Less Rejected Parts |
| Less Evaporation, Lasts Longer | Saves Money |
| Low Viscosity and Specific Gravity | Better Separation from Water |

## Typical Properties Characteristics

| | |
|---|---|
| Appearance | Clear |
| Specific Gravity @ 60°F | 0.768 – 0.820 |
| Flash Point, TCC°F | 142° min. |
| Aniline Point °F | 165° max. |
| Kauri-Butanol Value | 29 MIN. |
| Distillation Degree F: | |
| Initial Boiling Point | 350° min |
| Ending Point | 419° max |

Refer to Material Safety Data Sheet for additional information.

Note: This product information sheet lists only target properties. Specific requirements should be discussed with your sales representative.

Rev:090498

# NOCO

# Product Data Sheet

---

## NOCO CLEAN-ALL 142 SOLVENT

**NOCO Clean-All 142 Solvent** is a high flash point, mild odor solvent. It is especially suited for industrial and automotive cleaning applications.

| FEATURES | BENEFITS |
|---|---|
| High Flash Point | Safer to Use |
| Mild Odor | Pleasant to Use |
| Not Harsh On Normal Skin | Operator Friendly |
| Produces Cleaner, Brighter Parts | Less Rejected Parts |
| Less Evaporation, Lasts Longer | Saves Money |
| Low Viscosity and Specific Gravity | Better Separation from Water |

### Typical Properties Characteristics

| | |
|---|---|
| Appearance | Clear |
| Specific Gravity @ 60°F | 0.768 – 0.820 |
| Flash Point, TCC°F | 142° min. |
| Aniline Point °F | 165° max. |
| Kauri-Butanol Value | 29 MIN. |
| Distillation Degree F: | |
| Initial Boiling Point | 350° min |
| Ending Point | 419° max |

Refer to Material Safety Data Sheet for additional information.

Note: This product information sheet lists only target properties. Specific requirements should be discussed with your sales representative.

Rev:090498

# Material Safety Data Sheet

## NOCO CLEAN ALL 142 SOLVENT

### Material Identification and Use

| | |
|---|---|
| MANUFACTURER'S NAME | NOCO ENERGY CORP. |
| MANUFACTURERS ADDRESS | PO BOX 86, TONAWANDA, NY 14151 |
| EMERGENCY NUMBER | 1-800-424-9300 (CHEMTREC) |
| SUPPLIER'S ADDRESS | 700 GRAND ISLAND BLVD., TONAWANDA, NY 14151 |
| SUPPLIER EMERGENCY PHONE NUMBER | 1-800-600-628 |
| PRODUCT NAME | CLEAN ALL 142 SOLVENT |
| PRODUCT CODE | NOC5410 |
| CHEMICAL NAME AND SYNONYM | SOLVENT NAPPA |
| PRODUCT USE | Used for industrial and automotive cleaning applications. |

### Ingredients

| Components | % | CAS Number | Hazard Data |
|---|---|---|---|
| Medium Aliphatic Solvent | 100 | 64742-88-7 | OSHA PEL/TWA 100 PPM<br>ACGIH/TWA 100PPM |

WHMIS CLASSIFICATION.......................................... B3

### Physical Data

| | |
|---|---|
| PHYSICAL STATE | Liquid |
| ODOUR AND APPEARANCE | Hydrocarbon odor, clear color |
| [illegible]CIFIC GRAVITY | (Water = 1) 0.79@ 60°F |
| [illegible]OUR PRESSURE (MM HG @ 20 C) | Less than 5 mm/hg @ 100°F |
| VAPOUR DENSITY (air=1) | 5.2 |
| EVAPORATION RATE | N Butyl Acetate = 1: 0.03 |
| BOILING POINT | 350°F – 415° F |
| FREEZING POINT | N/A |
| pH | N/A |
| SOLUBILITY IN H2O (water) | Negligible |

### Fire and Explosion Hazards

| | |
|---|---|
| CONDITIONS OF FLAMMABILITY | Can be made to burn. |
| EXTINGUISHING MEDIA | Foam, water fog, dry chemical, carbon dioxide |
| FLASHPOINT & METHOD OF DETERMINATION | 145°F Minimum TTC (61°C Minimum) |
| FLAMMABLE LIMITS IN AIR % B.V.-UPPER | 7% |
| FLAMMABLE LIMITS IN AIR % B.V.-LOWER | 1% |
| NFPA - HAZARD CLASS | Health: 2 Flammability: 3 Reactivity: 0 |
| HAZARDOUS COMBUSTION PRODUCT | Open flames, sparks, intense heat |
| UNUSUAL FIRE AND EXPLOSION HAZARD | Container exposed to intense heat from fires should be cooled with water To prevent vapor pressure build up which could result in container rupture. Container areas exposed to direct flame contact should be cooled with large quantities of water as needed to prevent weakening of container structure. |
| SPECIAL FIRE FIGHTING PROCEDURES | Wear self contained breathing apparatus when fire fighting in a confined space. Cool fire exposed containers with water spray. |

12/3/98

# Material Safety Data Sheet

## NOCO CLEAN ALL 142 SOLVENT

### Reactivity Data

| | |
|---|---|
| CHEMICAL STABILITY | Stable |
| INCOMPATIBLE MATERIALS | Avoid contact with strong oxidizers, heat and open flames |
| HAZARDOUS DECOMPOSITION | Carbon monoxide and unidentified organic compounds may be formed during combustion. |
| HAZARDOUS POLYMERIZATION | Material is not known to polymerize. |

### Health Hazard Information

| | |
|---|---|
| ROUTES OF ENTRY | |
| Skin Contact | Slightly irritating to skin. Prolonged or repeated contact can result in de-fatting and drying of skin. |
| Eye | Practically non-irritating to the eyes. |
| Inhalation | Vapors may cause irritation to nose, throat and respiratory tract. High concentrations may result in CNS depression. |
| Ingestion | May result in vomiting. Breathing of vomitus into lungs must be avoided, small quantities may result in aspiration pneumontis. |
| CARCINOGENICITY | Not carcinogenic.<br>ACGIH - No |

### Emergency And First Aid Procedures

| | |
|---|---|
| | In case of contact, flush eyes with large amounts of water for at least 15 minutes. Get medical attention. |
| SKIN | Wash skin thoroughly with soap and water or waterless hand cleaner. If irritation occurs, get medical attention. |
| INHALATION | If breathing is difficult, remove victim to fresh air, Give artificial respiration if not breathing. |
| INGESTION | Do not ingest. If ingested, <u>DO NOT INDUCE VOMITING!</u> Get medical attention. |

### Preventive Measures

| | |
|---|---|
| VENTILATION REQUIREMENTS | Use explosion proof ventilation as required to control vapor concentration |
| RESPIRATORY PROTECTION | Not required under normal OSHA TLV. Use NIOSH approved respirators to prevent over exposure. |
| EYE PROTECTION | Safety glasses with side shields or goggles |
| PROTECTIVE GLOVES | Nitrile gloves provide best protection to hands and arms. |
| PERSONAL HYGIENE | Wear effective plant clothing. Contaminated clothing should be removed and washed in soap and water. Cleanse skin thoroughly before meals with soap and water. Shower and eyewash facilities should be accessible. |
| NOTE | No data |

# Material Safety Data Sheet

## NOCO CLEAN ALL 142 SOLVENT

### Environmental Procedures

| | |
|---|---|
| SPILLS OR RELEASES | If material is spilled or released to the atmosphere, steps should be taken to prevent discharges to streams or sewer systems. Spills or releases should be reported, if required to the appropriate Local, State and Federal regulatory agencies. |
| DISPOSAL | Clean up action should be carefully planned and executed. Shipment, storage and/or disposal of waste materials are regulated and action to handle or dispose spilled or released materials must meet all State, Local and Federal rules. |
| STORAGE | Protect against physical damage. Separate from oxidizing materials. Store in cool well ventilated area of non-combustible construction, away from possible sources of ignition. |

### Regulatory Information

| | | |
|---|---|---|
| DEPARTMENT OF TRANSPORATION | DOT Shipping Name:<br>Hazard Class:<br>ID Number: | None<br>Flammable Liquid - 3<br>UN 1268 |
| TSCA | This product is listed on the TSCA inventory. | |
| CERCLA | This product is classified as an oil under Section 311. Spills into or leading to surface water that cause sheen must be reported to The National Response Center at 1-800-424-8802. | |
| [illegible]RA | If this product becomes a waste it could not be a hazardous waste by RCRA-40 CFR 261. Place in an appropriate disposal facility in compliance with local authorities. | |
| SARA TITLE III - SECTION 302 | Not applicable | |
| SECTION 311/312 | H-1, H-2, P-3 | |
| SECTION 313 | Not applicable | |

### Preparation Date of Material Safety Data Sheet

| | |
|---|---|
| PREPARED BY | NOCO - SK |
| PHONE NUMBER OF PREPARER | 1-315-393-4530 |
| DATE PREPARED | 12/03/98 |
| REVISED DATE | New |
| DISCLAIMER | Information presented herein has been compiled from information provided to us by our suppliers and other sources considered to be dependable and is accurate and reliable to the best of our knowledge and belief but is not guaranteed to be so. Nothing herein is to be construed as recommending any practice or the use of any product in violation of any patent or in violation of any law or regulation. It is the users' responsibility to determine the suitability of any material for a specific purpose and to adopt such safety precautions as may be necessary. We make no warranty as to the results to be obtained by using any material and since conditions of use are not under our control, we must necessarily disclaim all liability with respect to the use of material supplied by us. |

# MATERIAL SAFETY DATA SHEET

## Material Safety Data Sheet

## Noco Clean All 140 Solvent

### Material Identification and Use

MANUFACTURER'S NAME.............. Noco Energy Corp.
MANUFACTURER'S ADDRESS........... 700 Grand Island Blvd., Tonawanda, N. Y. 141
EMERGENCY PHONE NUMBER........... 1-716-874-6200
SUPPLIER IDENTIFIER.............. Noco Clean All 140 Solvent
SUPPLIER'S ADDRESS............... P.O. Box 86, Tonawanda, New York 14151
SUPPLIER EMERGENCY PHONE NUMBER.  1-716-874-6200
PRODUCT IDENTIFIER............... Noco Clean All 140 Solvent
PRODUCT USE...................... Low odor cleaning solvent.

### Hazardous Ingredients of Materials

| hemical Identity | Concentration | CAS#/NA#/UN# | LD(50) | LC(50) |
|---|---|---|---|---|

### Physical Data For Product

PHYSICAL STATE................... Liquid.
ODOR AND APPEARANCE.............. Clear water white, mild petroleum odor.
ODOR THRESHOLD................... Not determined.
SPECIFIC GRAVITY................. 0.799
VAPOR PRESSURE................... Less than 1 mm Hg @ 25°C
VAPOR DENSITY (air=1)............ Greater than 5.
EVAPORATION RATE................. (Butyl Acetate = 1) Less than 0.1
BOILING POINT.................... 360-465°F (182-241°C)
FREEZING POINT................... N/A
pH............................... Neutral.
COEFFICIENT OF WATER/OIL DISTRIBUTION.................. Negligible.

### Fire and Explosion Hazard of Product

ITIONS OF FLA ... Addition of water may cause frothing. Do not cut, drill or weld empty containers.
ANS OF EXTINCTION............... Foam, water spray, dry chemical, carbon dioxi and vaporizing liquid type extinguishing agents may all be suitable for extinguishing fires involving this type of product.
T AND METHOD OF TION.................. 160°F (71°C) ASTM D 56 Tag Closed cup.
EXPLOSION LIMIT(% BY VOL). 7%
EXPLOSION LIMIT(% BY VOL). 0.6%

# MATERIAL SAFETY DATA SHEET

## Material Safety Data Sheet

## Noco Clean All 140 Solvent

| | |
|---|---|
| HAZARDOUS COMBUSTION PRODUCTS... | Open flames, sparks. |
| EXPLOSION DATA.................. | Not determined. |
| SENSITIVITY TO STATIC DISCHARGE. | N/A |

## Reactivity Data

| | |
|---|---|
| CHEMICAL STABILITY.............. | Stable. |
| INCOMPATIBLE MATERIALS.......... | Strong oxidants such as liquid chlorine, concentrated oxygen. |
| CONDITIONS OF REACTIVITY........ | Excessive heat. |
| HAZARDOUS DECOMPOSITION PRODUCTS | Fumes, smoke , carbon monoxide and other decomposition products. |

## Toxicological Properties of Product

| | |
|---|---|
| ROUTES OF ENTRY | |
| SKIN CONTACT.................. | Repeated skin contact with this product tends to remove skin oils possibly leading to irritation and dermatitis. |
| EYE......................... | Slightly irritating to eyes. |
| INHALATION.................. | May cause headaches and dizziness, are anesthetic, and may have other central nervou system effects including death. |
| INGESTION................... | Amounts which are aspirated into the lungs during ingestion or or vomiting may cause mild to severe pulmonary injury and possibly death. |
| CARCINOGENICITY, REPRODUCTIVE EFFECTS....................... | Not carcinogenic. |

## Preventive Measures

| | |
|---|---|
| PERSONAL PROTECTIVE EQUIPMENT... | VENTILATION: Use only with ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air. Respiratory Protection: Use supplied air respiratory protection in confined or enclosed spaces. Protective Gloves: Use chemcial resistant gloves. Eye Protection: Use splash proof goggles or face shield when eye contact can occur. |
| SPECIFIC ENGINEERING CONTROLS... | N/A |
| LEAK AND SPILL PROCEDURES....... | Shut off and eliminate all sources of |
| WASTE DISPOSAL.................. | Recover free product. |

# MATERIAL SAFETY DATA SHEET

## Material Safety Data Sheet

## Noco Clean All 140 Solvent

| | |
|---|---|
| HANDLING PROCEDURES AND EQUIPMENT........................ | Wash thoroughly after handling. |
| STORAGE REQUIREMENTS............ | Cool, dry. |
| SPECIAL SHIPPING INFORMATION... | No special instructions. |

## First Aid Measure

| | |
|---|---|
| SPECIFIC FIRST AID PROCEDURES | EYE: flush with clear water for at least [illegible] minutes or until irritation subsides. SKIN: Remove any contaminated clothing and wash skin thoroughly with soap and water. INHALATION: remove from exposure and call a physician immediately. INGESTION: Do not induce vomiting. |

## Special Percautions

| | |
|---|---|
| HAZARD CLASS.............. | N/A |
| DOT SHIPPING NAME........ | Petroleum Solvent |
| REPORTABLE QUANTITY (RQ). | Check with local authority. |
| UN NUMBER................ | 1255 |
| NA #...................... | 1255 |
| PACKAGING SIZE............ | N/A |

## [illegible] rial Safety Data Sheet

| | |
|---|---|
| PREPARED [illegible] | [illegible] |
| PHONE NUMBER OF [illegible] | 1-[illegible]-184[illegible] |
| DATE PREPARED..................... | 9/6/[illegible] |

CHEMICAL SALES CORPORATION
1382 Niagara Street
Buffalo, New York  14213
(716) 885-5100

02/12/88

BUELL AUTOMATICS
PO BOX 24969
ROCHESTER, NY  14624

Attention: PURCHASING DEPT
Your Ref: ---
Subject: Material Safety Data Sheet (MSDS):

NEU TRI
DOW
851005

Dear Sir/Madam:

As part of our on-going safety committment, enclosed is a Material Safety Data Sheet (MSDS) covering this transaction.

MSDSs contain product property, hazard, first aid, handling and personal protection recommendations. It is the law, and our objective that users of the material have access to, and an understanding of the MSDS information.

For further safety information or MSDSs, call the undersigned. Previous MSDS mailings should be compared with this current one. Please sign and return the postpaid reply card. This helps us determine how effective our MSDS mailing program is.

Very truly yours;

CHEMICAL SALES CORPORATION

Reply to: Stuart Thompson

Our invoice: 23838

# *MATERIAL SAFETY DATA SHEET*

Stirling Industries Division 1100 University Ave. Rochester, N.Y. 14607

## I. IDENTIFICATION AND EMERGENCY INFORMATION

****************************************************************************************

**PRODUCT NAME:** NOCOR 0, 1, 1A, 2, 2B, 3, 4, 11

INFORMATION FURNISHED BY: Stirling Industries Division REV 08/7/92

**EMERGENCY TELEPHONE NUMBER:** (800) 424-9300 Chemtrec (Inquiries 716-461-8310)

CHEMICAL NAME: Petroleum Lubricating Oil

CAS NUMBER : complex mixture CAS not applicable

D.O.T. HAZARD CLASS: NA

D.O.T. I.D. NUMBER: NA

LABELING: NA

MISCELLANEOUS: HMIS Code - Health -1; Fire - 1; Reactivity - 0

## II. PHYSICAL DATA

****************************************************************************************

BOILING POINT: IBP> 200 C

APPEARANCE: Clear liquid slight amber or yellow color ODOR: Bland petroleum type

SPECIFIC GRAVITY:(68 deg F) 0.8494-0.9506

VAPOR DENSITY (AIR=1): <5

EVAPORATION RATE: nil

VAPOR PRESSURE: less than 0.01 mmHg @ 20 C

SOLUBILITY IN WATER: Nil

VISCOSITY: 45-180 SUS @ 100F

POUR,CONGEALING OR MELTING POINT: -20 F

pH: essentially neutral

PERCENT VOLATILE BY VOL.:Nil from open container after 4 hrs @ 100 F

## III. INGREDIENTS

****************************************************************************************

| | | |
|---|---|---|
| Lubricating oil base stocks. | | 80-95% |
| Sulfurized animal fat | CAS# 68991-70-8 | 5-20% |

## IV. FIRE AND EXPLOSION HAZARD DATA

****************************************************************************************

**FLASH POINT (MINIMUM):**>265 F (COC)

**EXPLOSIVE LIMITS:** (APPROX. % BY VOLUME IN AIR) Unkown

**EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES:** Foam, water spray (fog), dry chemical, carbon dioxide and vaporizing liquid type extinguishing agents may all be suitable , depending on size or potential size of fire and circumstances related to the situation.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS: Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes and other decomposition products, in the case of incomplete combustion.

**"EMPTY" CONTAINER WARNING:** "Empty" containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS OR OTHER SOURCES OF IGNITION: THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. "Empty" drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All other containers should be disposed of in a environmentally safe manner in compliance with applicable government regulations.

## V. HEALTH HAZARD DATA

**VARIABILITY AMONG INDIVIDUALS:** Health studies have shown that many petroleum hydrocarbons and synthetic lubricants pose potential human health risks which may vary from person to person. As a precaution, exposure to liquids, vapors, mist or fumes should be minimized.
EFFECTS OF OVEREXPOSURE (Signs and Symptoms of exposure):Prolonged or repeated skin contact may cause skin irritation.
**NATURE OF HAZARD:**Prolonged or repeated skin contact with this product tends to remove skin oils possibly leading to irritation and dermatitis. Product contacting the eyes may cause irritation.
**TOXICITY INFORMATION:**Product has a low order of acute oral and dermal toxicity, but minute amounts aspirated into the lumgs druing ingestion or vomiting may cause mild to severe pulmonary injury and possibly death.
PRE-EXISTING MEDICAL CONDITION WHICH MAY BE AGGRAVATED BY EXPOSURE: None recognized

## REACTIVITY DATA

This product is stable and will not react violently with water. Hazardous polymerization will not occur. Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calcium hypochlorite. Oxides of carbon, sulfur, phosphorous, calcium and zinc will occur on thermal decomposition.

## VII. SPILL OR LEAK PROCEDURES

**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:** Recover free product. Add sand, earth or other suitable absorbent to spill area. Minimize skin contact. Keep product out of sewers and watercourses by diking or impounding. Advise authorities if product has entered or may enter sewers, watercourses, or extensive land areas. Assure conformity with applicable governmental regulations.

## VIII. SPECIAL PROTECTION INFORMATION

VENTILATION:Use local exhaust to capture vapor, mist, or fumes, if necessary. Provide greater than 60 feet per minute hood face velocity for confined spaces. Provide ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air. Use explosion-proof equipment. No smoking or open lights.
RESPIRATORY PROTECTION: Normally not needed at ambient temperatures. Use supplied-air respiratory protection in confined or enclosed spaces, if needed.
PROTECTIVE GLOVES: Use chemical-resistant gloves, if needed, to avoid prolonged or repeated skin contact.
EYE PROTECTION: Use splash goggles or face shield when eye contact may occur.
OTHER PROTECTIVE EQUIPMENT: Use chemical-resistant gloves, if needed, to avoid contaminating regular clothing which could result in prolonged or repeated skin contact.

## IX. SPECIAL PRECAUTIONS

WORK PRACTICES/ENGINEERING CONTROLS: Keep containers closed when not in use. Do not handle or store near heat, sparks, flame or strong oxidants.
PERSONAL HYGIENE: Minimize breathing vapors, mist or fumes. Avoid prolonged or repeated contact with skin. Remove contaminated clothing. Cleanse skin thoroughly after contact, before breaks and meals and at end of work period . Product is readily removed from skin by waterless hand cleaners followed by washing thoroughly with soap and water.

## X. EMERGENCY AND FIRST AID PROCEDURES

****************************************************************************************

**EYE CONTACT**: If splashed into the eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists, call a physician.
**SKIN CONTACT**: In case of skin contact, remove any contaminated clothing and wash skin with soap and water.
**INHALATION**: Vapor pressure is very low. Vapor inhalation under ambient conditions is normally not a problem. If overcome by vapor from product. Immediately remove from exposure and call a physician. If breathing is irregular or has stopped, start resuscitation; administer oxygen,if available. If overexposed to oil mist, remove from further exposure until excessive oil mist condition subsides.
**INGESTION**: If ingested, call a physician immediately.

## XI. TRANSPORTATION INFORMATION

****************************************************************************************

Transportation Incident Information : For further information relative to spills resulting from transportation incidents, refer to latest Department of Transportation regulations.

The information presented herein has been compiled from sources considered to be dependable and is accurate to the best of seller's knowledge. However, since the conditions of handling and use are beyond our control, seller makes no warranty whatsoever, expressed, implied or of merchantability regarding the accuracy or completeness of such data or the results to be obtained from use thereof. Further, seller assumes no responsibiltiy for injury to buyer or to third persons or for damage to any property. Buyer assumes all such risks, including but not limited to compliance of user with all applicable Federal, State and local laws and regulations. Further, nothing contained herein is to be construed as a recommendation for use in violaton of any patent or applicable laws and regulatins.

J. T. BAKER MSDS
MSDS for TRICHLOROETHYLENE

716-885-5100

Chemical Sales Corp. 1382 Niagara St. Buffalo, NY

## 1 - Site Specific Information

No SITE SPECIFIC INFORMATION has been entered for this chemical

## 2 - PRODUCT IDENTIFICATION

PRODUCT NAME: TRICHLOROETHYLENE
COMMON SYNONYMS: TRICHLOROETHENE; ETHINYL TRICHLORIDE; ACETYLENE TRICHLORIDE; TCE
CHEMICAL FAMILY: CHLORINATED HYDROCARBONS
FORMULA: $C_2HCL_3$
FORMULA WT.: 131.40
CAS NO.: 79-01-6
NIOSH/RTECS NO.: KX4550000
PRODUCT USE: LABORATORY REAGENT
PRODUCT CODES: 9464, 9474, 9454, 9473, 9455, 9458, 5376

CHEMTREC # (800) 424-9300
NATIONAL RESPONSE CENTER # (800) 424-8802
[illegible] BAKER INC.
[illegible] RED SCHOOL LANE
PHILLIPSBURG, NJ 08865
24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151

EFFECTIVE: 05/01/89 ISSUED: 01/06/90
REVISION #05

### PRECAUTIONARY LABELING

BAKER SAF-T-DATA* SYSTEM

| | | | |
|---|---|---|---|
| HEALTH | - | 3 | SEVERE (CANCER CAUSING) |
| FLAMMABILITY | - | 1 | SLIGHT |
| REACTIVITY | - | 2 | MODERATE |
| CONTACT | - | 2 | MODERATE |

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES

### U.S. PRECAUTIONARY LABELING

WARNING

CAUSES IRRITATION. HARMFUL IF SWALLOWED OR INHALED. HEAT MAY CAUSE

# MATERIAL SAFETY DATA SHEET

Stirling Industries Division 1100 University Ave. Rochester, N.Y. 14607

## I. IDENTIFICATION AND EMERGENCY INFORMATION

PRODUCT NAME: NOCOR 60 REV 08/7/92

INFORMATION FURNISHED BY: Stirling Industries Division

EMERGENCY TELEPHONE NUMBER: (800) 424-9300 Chemtrec (Inquiries 716-461-8310)

CHEMICAL NAME: Petroleum Lubricating Oil

CAS NUMBER : complex mixture CAS not applicable

D.O.T. HAZARD CLASS: NA

D.O.T. I.D. NUMBER: NA

LABELING: NA

MISCELLANEOUS: HMIS Code - Health -1; Fire - 1; Reactivity - 0

## II. PHYSICAL DATA

BOILING POINT: IBP> 200 C

APPEARANCE: Clear liquid slight amber or yellow color ODOR: Bland petroleum type

SPECIFIC GRAVITY:(68 deg F) 0.950

VAPOR DENSITY (AIR=1): <5

EVAPORATION RATE: nil

VAPOR PRESSURE: less than 0.01 mmHg @ 20 C

SOLUBILITY IN WATER: Nil

VISCOSITY: 190 SUS @ 100F

pH: essentially neutral

PERCENT VOLATILE BY VOL.:Nil from open container after 4 hrs @ 100 F

## III. INGREDIENTS

| | | |
|---|---|---|
| Lubricating oil base stocks. | | >60% |
| Sulfurized animal fat | CAS# 68991-70-8 | <40% |

## IV. FIRE AND EXPLOSION HAZARD DATA

**FLASH POINT (MINIMUM):**>265 F (COC)

EXPLOSIVE LIMITS: (APPROX. % BY VOLUME IN AIR) Unkown

**EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES:** Foam, water spray (fog), dry chemical, carbon dioxide and vaporizing liquid type extinguishing agents may all be suitable , depending on size or potential size of fire and circumstances related to the situation.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS: Fumes, smoke, carbon monoxide, sulfur oxides aldehydes and other decomposition products, in the case of incomplete combustion.

**"EMPTY" CONTAINER WARNING:** "Empty" containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS OR OTHER SOURCES OF IGNITION: THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. "Empty" drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All other containers should be disposed of in a environmentally safe manner in compliance with applicable government regulations.

## V. HEALTH HAZARD DATA

******************************************************************************************

**VARIABILITY AMONG INDIVIDUALS:** Health studies have shown that many petroleum hydrocarbons and synthetic lubricants pose potential human health risks which may vary from person to person. As a precaution, exposure to liquids, vapors, mist or fumes should be minimized.

EFFECTS OF OVEREXPOSURE (Signs and Symptoms of exposure):Prolonged or repeated skin contact may cause skin irritation.

NATURE OF HAZARD:Prolonged or repeated skin contact with this product tends to remove skin oils possibly leading to irritation and dermatitis. Product contacting the eyes may cause irritation.

TOXICITY INFORMATION:Product has a low order of acute oral and dermal toxicity, but minute amounts aspirated into the lumgs druing ingestion or vomiting may cause mild to severe pulmonary injury and possibly death.

PRE-EXISTING MEDICAL CONDITION WHICH MAY BE AGGRAVATED BY EXPOSURE: None recognized

## REACTIVITY DATA

******************************************************************************************

This product is stable and will not react violently with water. Hazardous polymerization will not occur. Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calcium hypochlorite. Oxides of carbon, sulfur, phosphorous, calcium and zinc will occur on thermal decomposition.

## VII. SPILL OR LEAK PROCEDURES

******************************************************************************************

**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:** Recover free product. Add sand, earth or other suitable absorbent to spill area. Minimize skin contact. Keep product out of sewers and watercourses by diking or impounding. Advise authorities if product has entered or may enter sewers, watercourses, or extensive land areas. Assure conformity with applicable governmental regulations.

## VIII. SPECIAL PROTECTION INFORMATION

******************************************************************************************

VENTILATION:Use local exhaust to capture vapor, mist, or fumes, if necessary.
Provide greater than 60 feet per minute hood face velocity for confined spaces. Provide ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air. Use explosion-proof equipment. No smoking or open lights.

RESPIRATORY PROTECTION: Normally not needed at ambient temperatures. Use supplied-air respiratory protection in confined or enclosed spaces, if needed.

PROTECTIVE GLOVES: Use chemical-resistant gloves, if needed, to avoid prolonged or repeated skin contact.

EYE PROTECTION: Use splash goggles or face shield when eye contact may occur.

OTHER PROTECTIVE EQUIPMENT: Use chemical-resistant gloves, if needed, to avoid contaminating regular clothing which could result in prolonged or repeated skin contact.

## IX. SPECIAL PRECAUTIONS

******************************************************************************************

WORK PRACTICES/ENGINEERING CONTROLS: Keep containers closed when not in use. Do not handle or store near heat, sparks, flame or strong oxidants.

PERSONAL HYGIENE: Minimize breathing vapors, mist or fumes. Avoid prolonged or repeated contact with skin. Remove contaminated clothing. Cleanse skin thoroughly after contact, before breaks and meals and at end of work period . Product is readily removed from skin by waterless hand cleaners followed by washing thoroughly with soap and water.

## X. EMERGENCY AND FIRST AID PROCEDURES

*****************************************************************************************

**EYE CONTACT:** If splashed into the eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists, call a physician.
**SKIN CONTACT:** In case of skin contact, remove any contaminated clothing and wash skin with soap and water.
**INHALATION:** Vapor pressure is very low. Vapor inhalation under ambient conditions is normally not a problem. If overcome by vapor from product. Immediately remove from exposure and call a physician. If breathing is irregular or has stopped, start resuscitation; administer oxygen,if available. If overexposed to oil mist, remove from further exposure until excessive oil mist condition subsides.
**INGESTION:** If ingested, call a physician immediately.

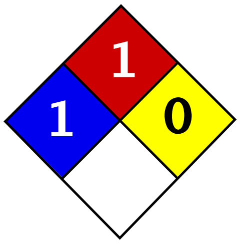
## XI. TRANSPORTATION INFORMATION

*****************************************************************************************

Transportation Incident Information : For further information relative to spills resulting from transportation incidents, refer to latest Department of Transportation regulations.

The information presented herein has been compiled from sources considered to be dependable and is accurate to the best of seller's knowledge. However, since the conditions of handling and use are beyond our control, seller makes no warranty whatsoever, expressed, implied or of merchantability regarding the accuracy or completeness of such data or the results to be obtained from use thereof. Further, seller assumes no responsibiltiy for injury to buyer or to third persons or for damage to any property. Buyer assumes all such risks, including but not limited to compliance of user with all applicable Federal, State and local laws and regulations. Further, nothing contained herein is to be construed as a recommendation for use in violaton of any patent or applicable laws and regulatins.

**ScienceLab.com**
Chemicals & Laboratory Equipment



| | |
|---|---|
| Health | 1 |
| Fire | 1 |
| Reactivity | 0 |
| Personal Protection | X |

# Material Safety Data Sheet

## Sucrose MSDS

## Section 1: Chemical Product and Company Identification

**Product Name:** Sucrose

**Catalog Codes:** SLS4048, SLS3253, SLS1036

**CAS#:** 57-50-1

**RTECS:** WN6500000

**TSCA:** TSCA 8(b) inventory: Sucrose

**CI#:** Not available.

**Synonym:**
beta-D-Fructofuranosyl-alpha-D-glucopyranoside

**Chemical Name:** Sucrose

**Chemical Formula:** $C_{12}H_{22}O_{11}$

**Contact Information:**

**Sciencelab.com, Inc.**
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

**CHEMTREC (24HR Emergency Telephone), call:**
1-800-424-9300

**International CHEMTREC, call:** 1-703-527-3887

**For non-emergency assistance, call:** 1-281-441-4400

## Section 2: Composition and Information on Ingredients

**Composition:**

| Name | CAS # | % by Weight |
|---|---|---|
| Sucrose | 57-50-1 | 100 |

**Toxicological Data on Ingredients:** Not applicable.

## Section 3: Hazards Identification

**Potential Acute Health Effects:** Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

**Potential Chronic Health Effects:**
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
Repeated or prolonged exposure is not known to aggravate medical condition.

## Section 4: First Aid Measures

**Eye Contact:**

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.

**Skin Contact:**
Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

**Serious Skin Contact:** Not available.

**Inhalation:**
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

**Serious Inhalation:** Not available.

**Ingestion:**
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

**Serious Ingestion:** Not available.

## Section 5: Fire and Explosion Data

**Flammability of the Product:** May be combustible at high temperature.

**Auto-Ignition Temperature:** Not available.

**Flash Points:** CLOSED CUP: Higher than 93.3°C (200°F).

**Flammable Limits:** Not available.

**Products of Combustion:** These products are carbon oxides (CO, CO2).

**Fire Hazards in Presence of Various Substances:** Slightly flammable to flammable in presence of heat.

**Explosion Hazards in Presence of Various Substances:**
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

**Fire Fighting Media and Instructions:**
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

**Special Remarks on Fire Hazards:** Not available.

**Special Remarks on Explosion Hazards:** Not available.

## Section 6: Accidental Release Measures

**Small Spill:**
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

**Large Spill:**
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

## Section 7: Handling and Storage

**Precautions:**
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable protective clothing. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids.

**Storage:** Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 23°C (73.4°F).

## Section 8: Exposure Controls/Personal Protection

**Engineering Controls:**
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

**Personal Protection:**
Safety glasses. Lab coat. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

**Personal Protection in Case of a Large Spill:**
Splash goggles. Full suit. Vapor and dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

**Exposure Limits:**
TWA: 15 (mg/m3) from OSHA (PEL) [United States] Inhalation Total.
TWA: 10 (mg/m3) from ACGIH (TLV) [United States] [1999] Inhalation Total.
TWA: 10 (mg/m3) from NIOSH Inhalation Total.
TWA: 5 (mg/m3) from NIOSH Inhalation Respirable.
TWA: 5 (mg/m3) from OSHA (PEL) [United States] Inhalation Respirable.3
Consult local authorities for acceptable exposure limits.

## Section 9: Physical and Chemical Properties

**Physical state and appearance:** Solid. (Crystalline granules solid.)

**Odor:** Characteristic Carmel to Odorless.

**Taste:** Sweet.

**Molecular Weight:** 342.3 g/mole

**Color:** White.

**pH (1% soln/water):** Not available.

**Boiling Point:** Not available.

**Melting Point:** 186°C (366.8°F)

**Critical Temperature:** Not available.

**Specific Gravity:** 1.587 (Water = 1)

**Vapor Pressure:** Not applicable.

**Vapor Density:** Not available.

**Volatility:** Not available.

**Odor Threshold:** Not available.

**Water/Oil Dist. Coeff.:** The product is more soluble in water; log(oil/water) = -3.7

**Ionicity (in Water):** Not available.

**Dispersion Properties:** See solubility in water, methanol.

**Solubility:**
Easily soluble in cold water.
Partially soluble in methanol.
Insoluble in diethyl ether.

## Section 10: Stability and Reactivity Data

**Stability:** The product is stable.

**Instability Temperature:** Not available.

**Conditions of Instability:** Excess heat, incompatible materials

**Incompatibility with various substances:** Reactive with oxidizing agents, acids.

**Corrosivity:** Not available.

**Special Remarks on Reactivity:** Reactive with sulfuric acid, nitric acid, and oxidizers.

**Special Remarks on Corrosivity:** Not available.

**Polymerization:** Will not occur.

## Section 11: Toxicological Information

**Routes of Entry:** Inhalation. Ingestion.

**Toxicity to Animals:** Acute oral toxicity (LD50): 29700 mg/kg [Rat].

**Chronic Effects on Humans:**
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast.

**Other Toxic Effects on Humans:** Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

**Special Remarks on Toxicity to Animals:** Not available.

**Special Remarks on Chronic Effects on Humans:**
No adverse reproductive affects have been found in humans. However at extremely high oral doses of 683,000 mg/kg given to rats during pregnancy showed some effects on newborn (growth, developmental anomalies of central nervous system).
Passes through the placental barrier in human.

**Special Remarks on other Toxic Effects on Humans:**
Acute Potential Health Effects:
Skin: May cause skin irritation. Low hazard for usual industrial handling.
Eyes: Dust may cause mechanical irritation.
Inhalation: Excessive inhalation may cause minor respiratory irritation.
Ingestion: Ingestion of large amounts may cause gastrointestinal (digestive) tract irritation. Expected to be a low

ingestion hazard.
Chronic Potential Health Effects: no information.

## Section 12: Ecological Information

**Ecotoxicity:** Not available.

**BOD5 and COD:** Not available.

**Products of Biodegradation:**
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

**Toxicity of the Products of Biodegradation:** The product itself and its products of degradation are not toxic.

**Special Remarks on the Products of Biodegradation:** Not available.

## Section 13: Disposal Considerations

**Waste Disposal:**
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

## Section 14: Transport Information

**DOT Classification:** Not a DOT controlled material (United States).

**Identification:** Not applicable.

**Special Provisions for Transport:** Not applicable.

## Section 15: Other Regulatory Information

**Federal and State Regulations:**
Rhode Island RTK hazardous substances: Sucrose
Pennsylvania RTK: Sucrose
Minnesota: Sucrose
Massachusetts RTK: Sucrose
Tennessee: Sucrose
TSCA 8(b) inventory: Sucrose

**Other Regulations:** EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

**Other Classifications:**

**WHMIS (Canada):** Not controlled under WHMIS (Canada).

**DSCL (EEC):**
This product is not classified according
to the EU regulations.
S24/25- Avoid contact with skin and eyes.

**HMIS (U.S.A.):**

**Health Hazard:** 1

**Fire Hazard:** 1

**Reactivity:** 0

**Personal Protection:** X

**National Fire Protection Association (U.S.A.):**

**Health:** 1

**Flammability:** 1

**Reactivity:** 0

**Specific hazard:**

**Protective Equipment:**
Gloves.
Lab coat.
Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent.
Safety glasses.

## Section 16: Other Information

**References:** Not available.

**Other Special Considerations:** Not available.

**Created:** 10/10/2005 08:28 PM

**Last Updated:** 11/06/2008 12:00 PM

# VARIFLO® QD

## QUICK DISPERSING GUAR GUM

## DESCRIPTION

VARIFLO QD is a coarse granular, high-viscosity blend of guar gum formulated for easy and quick dispersion in drilling applications. Coarser granules prevent lumps or encapsulation.

## CHARACTERISTICS

- Biodegradable
- Easy to mix in brackish water
- High viscosity formula
- No lumping while mixing
- Quick dispersing

## MIXING AND APPLICATIONS

Add VARIFLO QD slowly through a jet type mixer. If product is fed too quickly, lumping or balling will occur. Hydrate slowly first 3-10 minutes; follow with rapid hydration for 15-60 minutes. VARIFLO QD should not be poured unmixed into a pit or mixing tank.

| Formation Material | Ideal MFV (seconds) | Lbs of VariFlo QD per 100 gallons of water(1) |
|---|---|---|
| Fine Sand | 40 | 3.5 |
| Medium Sand | 50 | 4.5 |
| Coarse Sand | 60 | 5.5 |
| Gravel | 70-80 | 7-7.5 |

(1) assuming water temperature of 60°F.

| Formation Material | Ideal MFV (seconds) | Kg of VariFlo QD per 380 liters of water(1) |
|---|---|---|
| Fine Sand | 40 | 1.5 |
| Medium Sand | 50 | 2.0 |
| Coarse Sand | 60 | 2.5 |
| Gravel | 70-80 | 3.5 |

(1) assuming water temperature of 15.5°C

## FLUID BREAKDOWN

Chlorine concentrations of 1,000 ppm are recommended to effectively breakdown VARIFLO QD. Approximately 20 gallons (115 liters) of sodium hypochlorite (bleach) or 13 lbs (6 kg) of calcium hypochlorite per 1,000 gallons (3.8 $m^3$)drilling fluid is required.

## PACKAGING

25 lb (11.3 kg) pail, 36 per pallet. All pallets are plastic-wrapped.

**North America:** 847.851.1800 | 800.527.9948 | www.CETCO.com

UPDATED: OCTOBER 2013

OUR STANDARDS. YOUR PEACE OF MIND.

A Minerals Technologies Company

# MATERIAL SAFETY DATA SHEET

## 1. Product and Company Identification

| | |
|---|---|
| **Material name** | VARIFLO® QD |
| **Version #** | 02 |
| **Revision date** | 19-December-2008 |
| **Chemical description** | Powder |
| **CAS #** | Mixture |
| **Synonym(s)** | XANTHAN GUM |
| **Manufacturer** | CETCO<br>Drilling Products Group<br>2870 Forbs Avenue<br>Hoffman Estates, IL 60192 US<br>safetydata@amcol.com<br>http://www.cetco.com/<br>General Information (800) 527-9948<br>CHEMTREC® (800) 424-9300 |

## 2. Hazards Identification

| | |
|---|---|
| **Emergency overview** | Material can be slippery when wet. Product may form explosive dust/air mixtures if high concentration of product dust is suspended in air. |
| **OSHA regulatory status** | While this material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200), this MSDS contains valuable information critical to the safe handling and proper use of the product. This MSDS should be retained and available for employees and other users of this product. |
| **Potential health effects** | |
| **Routes of exposure** | Ingestion. Inhalation. Eye contact |
| **Eyes** | Dust or powder may irritate eye tissue. |
| **Skin** | Substance may cause slight skin irritation. No components in this product are known to be absorbed through the skin. |
| **Inhalation** | Inhalation of dusts may cause respiratory irritation. |
| **Ingestion** | No hazard in normal industrial use. Ingestion of this product may cause blockage of the mouth, pharynx, trachea, esophagus, and the gastrointestinal system, which may cause choking, suffocation, or other life threatening medical conditions. |

## 3. Composition / Information on Ingredients

The manufacturer lists no ingredients as hazardous according to OSHA 29 CFR 1910.1200.

## 4. First Aid Measures

| | |
|---|---|
| **First aid procedures** | |
| **Eye contact** | Immediately flush eyes with plenty of water for at least 20 minutes. Get medical attention if irritation develops or persists. |
| **Skin contact** | Wash affected area with mild soap and water. Get medical attention if irritation develops or persists. |
| **Inhalation** | If exposed to excessive levels of dusts or fumes, remove to fresh air and get medical attention if cough or other symptoms develop. |
| **Ingestion** | If material is ingested, immediately contact a physician or poison control center. |
| **Notes to physician** | Provide general supportive measures and treat symptomatically. |
| **General advice** | If you feel unwell, seek medical advice (show the label where possible). |

## 5. Fire Fighting Measures

| | |
|---|---|
| **Flammable properties** | Dusts at sufficient concentrations can form explosive mixtures with air. |

**Extinguishing media**

| | |
|---|---|
| **Suitable extinguishing media** | Dry chemical, CO2, water spray or regular foam. |

**Protection of firefighters**

| | |
|---|---|
| **Protective equipment and precautions for firefighters** | Material can be slippery when wet. Move containers from fire area if you can do it without risk. |

## 6. Accidental Release Measures

| | |
|---|---|
| **Personal precautions** | Material can be slippery when wet. Ensure adequate ventilation. Avoid inhalation of dust from the spilled material. Wear a dust mask if dust is generated above exposure limits. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. |
| **Environmental precautions** | Do not flush into surface water or sanitary sewer system. Prevent further leakage or spillage if safe to do so. |
| **Methods for containment** | Stop leak if you can do so without risk. |
| **Methods for cleaning up** | Sweep up or gather material and place in appropriate container for disposal. Avoid the generation of dusts during clean-up. After removal flush contaminated area thoroughly with water. |

## 7. Handling and Storage

| | |
|---|---|
| **Handling** | Material can be slippery when wet. Keep formation of airborne dusts to a minimum. Take measures to prevent the build up of electrostatic charge. Provide appropriate exhaust ventilation at places where dust is formed. Refer to NFPA Pamphlet No. 654, "Prevention of Fire and Dust Explosions in the Chemical, Dye, Pharmaceutical, and Plastics Industries." |
| **Storage** | Keep containers tightly closed in a dry, cool and well-ventilated place. Guard against dust accumulation of this material. Keep out of the reach of children. |

## 8. Exposure Controls / Personal Protection

**Occupational exposure limits**

**ACGIH**

| Constituents | Type | Value | Form |
|---|---|---|---|
| INERT OR NUISANCE DUST (SEQ250) | TWA | 3 mg/m3 | Respirable particles. |
| | | 10 mg/m3 | Inhalable particles. |

**U.S. - OSHA**

| Constituents | Type | Value | Form |
|---|---|---|---|
| INERT OR NUISANCE DUST (SEQ250) | PEL | 5 mg/m3 | Respirable fraction. |
| | | 15 mg/m3 | Total dust. |
| | TWA | 5 mg/m3 | Respirable fraction. |
| | | 15 mg/m3 | Total dust. |
| | | 50 mppcf | Total dust. |
| | | 15 mppcf | Respirable fraction. |

| | |
|---|---|
| **Engineering controls** | Ensure adequate ventilation, especially in confined areas. If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. If engineering measures are not sufficient to maintain concentrations of dust particulates below the OEL, suitable respiratory protection must be worn. |

**Personal protective equipment**

| | |
|---|---|
| **Eye / face protection** | Wear safety glasses with side shields. |
| **Skin protection** | Normal work clothing (long sleeved shirts and long pants) is recommended. |
| **Respiratory protection** | Use a particulate filter respirator for particulate concentrations exceeding the Occupational Exposure Limit. |
| **General hygeine considerations** | Use good industrial hygiene practices in handling this material. Wash hands before breaks and immediately after handling the product. |

## 9. Physical & Chemical Properties

| | |
|---|---|
| **Appearance** | Powder. |
| **Color** | Off-white. |

| | |
|---|---|
| **Odor** | Bean-like |
| **Odor threshold** | Not available. |
| **Physical state** | Solid. |
| **Form** | Not available. |
| **pH** | 5 - 8 |
| **Melting point** | Not available. |
| **Freezing point** | Not available. |
| **Boiling point** | Not available. |
| **Flash point** | Not available. |
| **Evaporation rate** | Not available. |
| **Flammability** | Not available. |
| **Flammability limits in air, upper, % by volume** | Not available. |
| **Flammability limits in air, lower, % by volume** | Not available. |
| **Vapor pressure** | Not available. |
| **Vapor density** | Not available. |
| **Specific gravity** | Not available. |
| **Relative density** | Not available. |
| **Solubility (water)** | Soluble |
| **Partition coefficient (n-octanol/water)** | Not available. |
| **Auto-ignition temperature** | Not available. |
| **Decomposition temperature** | Not available. |
| **VOC** | 0 % estimated |
| **Percent volatile** | 0 % estimated |

## 10. Chemical Stability & Reactivity Information

| | |
|---|---|
| **Chemical stability** | Stable at normal conditions. |
| **Conditions to avoid** | Heat, flames and sparks. Exposure to moisture. |
| **Incompatible materials** | Strong oxidizing agents. |
| **Hazardous decomposition products** | Upon decomposition, this product emits carbon monoxide, carbon dioxide and/or low molecular weight hydrocarbons. |
| **Possibility of hazardous reactions** | Will not occur. |

## 11. Toxicological Information

**Toxicological data**

| **Product** | **Test Results** |
|---|---|
| VARIFLO® QD (Mixture) | Acute Oral LD50 Hamster: 6000 mg/kg estimated |
| | Acute Oral LD50 Mouse: 8100 mg/kg |
| | Acute Oral LD50 Rabbit: 7000 mg/kg estimated |
| | Acute Oral LD50 Rabbit: 7 g/kg |
| | Acute Oral LD50 Rat: 6770 mg/kg |

* Estimates for product may be based on additional component data not shown.

| | |
|---|---|
| **Acute effects** | Acute LD50: 6770 mg/kg, Rat, Oral<br>Acute LD50: 8100 mg/kg, Mouse, Oral<br>Acute LD50: 7 g/kg, Rabbit, Oral |
| **Local effects** | Harmful by inhalation and if swallowed. |
| **Carcinogenicity** | Not listed by ACGIH, IARC, NIOSH, NTP OR OSHA. |
| **Mutagenicity** | No data available for this product. |
| **Teratogenicity** | No data available for this product. |

| | |
|---|---|
| **Further information** | This product has no known adverse effect on human health. |

## 12. Ecological Information

**Ecotoxicological data**

| Product | Test Results |
|---|---|
| VARIFLO® QD (Mixture) | EC50 Daphnia: 50 48.00 Hours<br>LC50 Fish: 218 mg/l 96.00 Hours estimated |

* Estimates for product may be based on additional component data not shown.

| | |
|---|---|
| **Ecotoxicity** | No data available for this product. |
| **Environmental effects** | No data available for this product. |
| **Persistence and degradability** | Not available. |

## 13. Disposal Considerations

| | |
|---|---|
| **Disposal instructions** | Dispose in accordance with all applicable regulations. Do not allow this material to drain into sewers/water supplies. |

## 14. Transport Information

**DOT**

Not regulated as dangerous goods.

**IATA**

Not regulated as dangerous goods.

**IMDG**

Not regulated as dangerous goods.

## 15. Regulatory Information

| | |
|---|---|
| **US federal regulations** | OSHA Process Safety Standard: This material is not known to be hazardous by the OSHA Highly Hazardous Process Safety Standard, 29 CFR 1910.119. |

**CERCLA (Superfund) reportable quantity**

None

**Superfund Amendments and Reauthorization Act of 1986 (SARA)**

| | |
|---|---|
| **Hazard categories** | Immediate Hazard - Yes<br>Delayed Hazard - No<br>Fire Hazard - Yes<br>Pressure Hazard - No<br>Reactivity Hazard - No |
| **Section 302 extremely hazardous substance** | No |
| **Section 311 hazardous chemical** | Yes |
| **Food and Drug Administration (FDA)** | Total food additive<br>Direct food additive |

**Inventory status**

| Country(s) or region | Inventory name | On inventory (yes/no)* |
|---|---|---|
| Australia | Australian Inventory of Chemical Substances (AICS) | Yes |
| Canada | Domestic Substances List (DSL) | Yes |
| Canada | Non-Domestic Substances List (NDSL) | No |
| China | Inventory of Existing Chemical Substances in China (IECSC) | Yes |
| Europe | European Inventory of New and Existing Chemicals (EINECS) | Yes |
| Europe | European List of Notified Chemical Substances (ELINCS) | No |
| Japan | Inventory of Existing and New Chemical Substances (ENCS) | Yes |
| Korea | Existing Chemicals List (ECL) | Yes |
| New Zealand | New Zealand Inventory | Yes |

| Country(s) or region | Inventory name | On inventory (yes/no)* |
|---|---|---|
| Philippines | Philippine Inventory of Chemicals and Chemical Substances (PICCS) | Yes |
| United States & Puerto Rico | Toxic Substances Control Act (TSCA) Inventory | Yes |

A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

## 16. Other Information

**Further information** This safety datasheet only contains information relating to safety and does not replace any produc information or product specification.

**HMIS ratings**

**NFPA ratings**

Health: 1
Flammability: 1
Instability: 0

**Disclaimer** The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability, for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use.

Third party materials:  Insofar as materials not manufactured or supplied by this manufacturer ar used in conjunction with, or instead of this product, it is the responsibility of the customer to obtain, from the manufacturer or supplier, all technical data and other properties relating to these and other materials and to obtain all necessary information relating to them. No liability can be accepted in respect of the use of this product in conjunction with materials from another supplier.

**Issue date** 19-December-2008

# MATERIAL SAFETY DATA SHEET

**Sodium Carbonate, Anhydrous**

**MSDS Ref. No.:** 497-19-8
**Date Approved:** 12/19/2008
**Revision No.:** 7

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200; the Canada's Workplace Hazardous Materials Information System (WHMIS) and, the EC Directive, 2001/58/EC.

# 1. PRODUCT AND COMPANY IDENTIFICATION

| | |
|---|---|
| **PRODUCT NAME:** | Sodium Carbonate, Anhydrous |
| **ALTERNATE PRODUCT NAME(S):** | Soda Ash, Sodium Carbonate Anhydrous |
| **GENERAL USE:** | Glass manufacture, detergent manufacture, sodium chemicals and carbonate chemicals manufacture, pulp and paper, brine treatment, water hardness removal, pH adjustment in water or waste water, flue gas desulfurization, coal treatment, ion exchange resin regeneration.<br>This chemical is certified to ANSI/NSF Standard 60, Drinking Water Chemicals-Health Effects (as packaged in the original, unopened container). The maximum dosage level for this chemical is 150 mg/L |

## MANUFACTURER

FMC Wyoming Corporation
Alkali Chemicals Division
1735 Market Street
Philadelphia, PA 19103
(215) 299-6000 (General Information)
msdsinfo@fmc.com (Email - General Information)

## EMERGENCY TELEPHONE NUMBERS

(307) 872-2452 (Plant - Green River, WY)

(303) 595-9048 (Medical - Call Collect)

For leak, fire, spill, or accident emergencies, call:
(800) 424-9300 (CHEMTREC - U.S.A. & Canada)

# 2. HAZARDS IDENTIFICATION

## EMERGENCY OVERVIEW:

- White, odorless, granular solid.
- Product is non-combustible.
- Reacts with acids to release carbon dioxide gas and heat.
- Irritating to the eyes and continuous contact may irritate the skin.
- Not expected to be toxic to the environment, nor to aquatic organisms.

**POTENTIAL HEALTH EFFECTS:** Direct contact with the product causes irritation of the eyes and continuous contact may cause skin irritation (red, dry, cracked skin). Excessive levels of airborne dust may irritate the mucous membranes and upper respiratory tract.

---

# 3. COMPOSITION / INFORMATION ON INGREDIENTS

| Chemical Name | CAS# | Wt.% | EC No. | EC Class |
|---|---|---|---|---|
| Sodium carbonate | 497-19-8 | 99.8 | 207-838-8 | Xi; R36 |
| Water | 7732-18-5 | 0.2 | 231-791-2 | Not classified |

---

# 4. FIRST AID MEASURES

**EYES:** Immediately flush with water for at least 15 minutes, lifting the upper and lower eyelids intermittently. See a medical doctor or ophthalmologist as necessary.

**SKIN:** Wash with plenty of soap and water. Get medical attention if irritation occurs and persists.

**INGESTION:** Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

**INHALATION:** Remove to fresh air. If breathing difficulty or discomfort occurs and persists, obtain medical attention.

**NOTES TO MEDICAL DOCTOR:** While internal toxicity is low, irritant effects of high concentrations may produce corneal opacities, and vesicular skin reactions in humans with abraded skin only. Treatment is symptomatic and supportive.

---

# 5. FIRE FIGHTING MEASURES

**EXTINGUISHING MEDIA:** Water, water fog, carbon dioxide ($CO_2$), dry chemical

**FIRE / EXPLOSION HAZARDS:** Not applicable

**FIRE FIGHTING PROCEDURES:** Wear full protective clothing and self-contained breathing apparatus.

**FLAMMABLE LIMITS:** Not applicable

**HAZARDOUS COMBUSTION PRODUCTS:** Fumes of sodium oxide.

**SENSITIVITY TO IMPACT:** None

**SENSITIVITY TO STATIC DISCHARGE:** None

## 6. ACCIDENTAL RELEASE MEASURES

**COMMENTS:** PERSONAL PRECAUTIONS: Refer to Section 8 "Exposure Controls / Personal Protection".

CONTAINMENT: Prevent large quantities of this product from contacting vegetation or waterways; large spills could kill vegetation and fish.

CLEAN-UP: This product, if spilled, can be recovered and re-used if contamination does not present a problem. Vacuum or sweep up the material. If the spilled product is unusable due to contamination, consult state or federal environmental agencies for acceptable disposal procedures and locations. See Section 13 "Disposal Considerations".

NOTIFICATION REQUIREMENTS: Federal regulations do not require notification for spills of this product. State and local regulations may contain different requirements; consult local authorities.

## 7. HANDLING AND STORAGE

**HANDLING:** Use air conveying / mechanical systems for bulk transfer to storage. For manual handling o bulk transfer use mechanical ventilation to remove airborne dust from rail car, ship or truck. Use approved respiratory protection when ventilation systems are not available. Selection of respirators is based on the dust cloud generation. Keep material out of lakes, streams, ponds and sewer drains.

**STORAGE:** Store in a cool dry area, away from acids.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**ENGINEERING CONTROLS:** Where possible, provide general mechanical and/or local exhaust ventilation to prevent release of airborne dust into the work environment.

### PERSONAL PROTECTIVE EQUIPMENT

**EYES AND FACE:** Appropriate eye and face protection equipment (ANSI Z87 approved) should be selected for the particular use intended for this material. Safety glasses with side shields are recommended.

**RESPIRATORY:** Whenever dust in the worker's breathing zone cannot be controlled with ventilation or other engineering means, workers should wear respirators or dust masks approved by NIOSH/MSHA, EU CEN or comparable certification organization to protect them against airborne dust.

**PROTECTIVE CLOTHING:** Dry product is generally non-irritating to intact skin. However, this product can be irritating where skin has been damaged and can create skin irritation after long exposures when moisture is present. Under such conditions, gloves and long-sleeved clothing are recommended to minimize skin contact.

### COMMENTS:

ADDITIONAL EXPOSURE GUIDELINES:

Federal guidelines treat the ingredient(s) in this product as a nuisance dust, as no product-specific guidelines have been issued for exposure. As with all nuisance dusts, worker breathing zone concentrations should be measured by validated sampling and analytical methods. The following limits (OSHA and MSHA) apply to this material:

Particulates Not Otherwise Regulated:
OSHA (PEL / TWA): 15 mg/m$^3$ (total dust); 5 mg/m$^3$ (resp fraction)
MSHA (PEL / TWA): 10 mg/m$^3$ (total dust)

The information noted above provides general guidance for handling this product. Specific work environments and material handling practices will dictate the selection and use of personal protection equipment (PPE).

---

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| **ODOR:** | Odorless |
| **APPEARANCE:** | White, granular solid. |
| **AUTOIGNITION TEMPERATURE:** | Not applicable |
| **BOILING POINT:** | Decomposes |
| **COEFFICIENT OF OIL / WATER:** | Not applicable |
| **DENSITY / WEIGHT PER VOLUME:** | (g/ml) Dense Grades = 0.86 - 1.12; Light Grades = 0.70 - 0.90 |
| **EVAPORATION RATE:** | Not applicable (Butyl Acetate = 1) |
| **FLASH POINT:** | Non-combustible |
| **MELTING POINT:** | 851 °C (1,564 °F) |
| **ODOR THRESHOLD:** | Not applicable |
| **OXIDIZING PROPERTIES:** | Not applicable |

| | |
|---|---|
| **PERCENT VOLATILE:** | Not applicable |
| **pH:** | 11.4 (1% solution) |
| **SOLUBILITY IN WATER:** | 33.2 % maximum |
| **SPECIFIC GRAVITY:** | 2.509 (water = 1) |
| **VAPOR DENSITY:** | Not Applicable |
| **VAPOR PRESSURE:** | Not applicable |

# 10. STABILITY AND REACTIVITY

| | |
|---|---|
| **CONDITIONS TO AVOID:** | Contact with acids except under controlled conditions. |
| **STABILITY:** | Stable |
| **POLYMERIZATION:** | Will not occur |
| **INCOMPATIBLE MATERIALS:** | Reacts with acids with release of large volumes of carbon dioxide gas and heat. |
| **HAZARDOUS DECOMPOSITION PRODUCTS:** | Heated to decomposition, it emits fumes of sodium oxide. |

**COMMENTS:** Materials to Avoid : Aluminum powder, acids, fluorine, molten lithium

# 11. TOXICOLOGICAL INFORMATION

**EYE EFFECTS:** Severe irritant (rabbit) [Toxicology 23:281 (1982)]

**SKIN EFFECTS:** Non-irritating to intact skin. Minor irritation may occur on abraded skin. [Toxicol. Appl. Pharmacol. 31:481 (1975)]

**DERMAL $LD_{50}$:** No data available for the product.

**ORAL $LD_{50}$:** 4,090 mg/kg (rat) [RTECS 1986]

**INHALATION $LC_{50}$:** 2.3 mg/l (2 h) (rat) [Environ, Res. 31:138 (1983)]

**SENSITIZATION:** 0.25% sodium carbonate: Non-sensitizing (human) [Toxicol. Appl. Pharmacol. 31:481 (1975)]

**TARGET ORGANS:** Eyes

**ACUTE EFFECTS FROM OVEREXPOSURE:** May cause severe irritation of the eyes, including corneal opacities. Dusts and mists may be irritating to the skin, mucous membranes and upper respiratory tract. No significant acute toxicological effects expected.

**CHRONIC EFFECTS FROM OVEREXPOSURE:** No data available for the product.

### CARCINOGENICITY:

| | |
|---|---|
| **NTP:** | Not listed |
| **IARC:** | Not listed |
| **OSHA:** | Not listed |
| **OTHER:** | (ACGIH) Not listed |

---

# 12. ECOLOGICAL INFORMATION

**ECOTOXICOLOGICAL INFORMATION:** 96-hour $LC_{50}$ = 265 - 565 mg/L (daphnia magnia) (low toxicity)
96-hour $LC_{50}$ = 300 - 320 mg/L (bluegill sunfish) (low toxicity)

**CHEMICAL FATE INFORMATION:** Biodegradability does not apply to inorganic substances. No significant toxicity to aquatic organisms is expected.

---

# 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** When this product is discarded or disposed of, as purchased, it is neither a characteristic nor a listed hazardous waste according to US Federal RCRA regulations (40 CFR 261). As a non-hazardous waste the material may be disposed of in a landfill in accordance with government regulations; check local or state regulations for applicable requirements prior to disposal. Any processing, usage, alteration, chemical additions to, or contamination of, the product may alter the disposal requirements. Under Federal regulations, it is the generator's responsibility to determine if a waste is a hazardous waste.

---

# 14. TRANSPORT INFORMATION

## U.S. DEPARTMENT OF TRANSPORTATION (DOT)

| | |
|---|---|
| **PROPER SHIPPING NAME:** | Not regulated |
| **PRIMARY HAZARD CLASS / DIVISION:** | Not applicable |

| | |
|---|---|
| **UN/NA NUMBER:** | None |
| **LABEL(S):** | Not applicable |
| **PLACARD(S):** | Not applicable |
| **MARKING(S):** | Not applicable |
| **ADDITIONAL INFORMATION:** | Hazardous Substance/RQ: Not applicable<br>49 STCC Number: Not applicable |

## INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

**ADDITIONAL INFORMATION:** Not regulated

## ADR - EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD

**ADDITIONAL INFORMATION:** Not regulated

## INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

**ADDITIONAL INFORMATION:** Not regulated

## OTHER INFORMATION:

CANADIAN TRANSPORT (TDG):
This material is not regulated when transported by road in Canada.

# 15. REGULATORY INFORMATION

## UNITED STATES

### SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

**SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):**
Not listed

**SECTION 311 HAZARD CATEGORIES (40 CFR 370):**
Immediate (Acute) Health Hazard

### SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):

The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.: None

### SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):

Not listed

## CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

### CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):

Not listed

## TSCA (TOXIC SUBSTANCE CONTROL ACT)

### TSCA INVENTORY STATUS (40 CFR 710):

Listed

## RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

### RCRA IDENTIFICATION OF HAZARDOUS WASTE (40 CFR 261):

Waste Number: Refer to Section 13 "Disposal Considerations" for RCRA status.

# CANADA

## WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

| | |
|---|---|
| Hazard Classification / Division: | D2B<br>E |
| Ingredient Disclosure List: | Listed |
| Domestic Substance List: | Listed |

# E NUMBERS:

E 500

# EU EINECS NUMBERS:

011-005-00-2

# INTERNATIONAL LISTINGS

Australia (AICS): Listed
China: Listed

Japan (ENCS): (1)-164
Korea: KE-31380
Philippines (PICCS): Listed

### HAZARD AND RISK PHRASE DESCRIPTIONS:

| | | |
|---|---|---|
| EC Symbols: | Xi | (Irritant) |
| EC Risk Phrases: | R36 | (Irritating to eyes.) |

### COMMENTS:

CLEAN WATER ACT (CWA) - SECTION 307 / 311
Not listed as a hazardous pollutant (40 CFR 116), nor as a toxic pollutant (40 CFR 401.15)

CLEAN AIR ACT (CAA) - SECTION 112
Not regulated under the chemical accident prevention provisions (40 CFR 68)

---

## 16. OTHER INFORMATION

**HMIS**

| | |
|---|---|
| Health | 2 |
| Flammability | 0 |
| Physical Hazard | 0 |
| Personal Protection (PPE) | B |

Protection = B (Safety glasses and gloves)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:
4 = Severe
3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

**NFPA**

| | |
|---|---|
| Health | 2 |
| Flammability | 0 |
| Reactivity | 0 |
| Special | None |

No special requirements

NFPA (National Fire Protection Association)

Degree of Hazard Code:
4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

**REVISION SUMMARY:**
This MSDS replaces Revision #7, dated February 02, 2007.
Changes in information are as follows:
Section 1 (Product and Company Identification)
Section 15 (Regulatory Information)
Section 16 (Other Information)

FMC - Trademark of FMC Corporation

FMC Corporation believes that the information and recommendations contained herein (including data and statements) are accurate as of the date hereof. NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, WARRANTY OF MERCHANTABILITY, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION PROVIDED HEREIN. The information provided herein relates only to the specific product designated and may not be applicable where such product is used in combination with any other materials or in any process. It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Further, since the conditions and methods of use are beyond the control of FMC Corporation, FMC Corporation expressly disclaims any and all liability as to any results obtained or arising from any use of the product or reliance on such information.

HEALTH AND SAFETY PLAN FOR
BUELL AUTOMATICS SITE
INDEX #B8-0576-00-04A
381 BUELL ROAD
ROCHESTER, NEW YORK

# APPENDIX B
# ON-SITE SAFETY MEETING FORMS

Stantec

# FIELD LEVEL RISK ASSESSMENT (FIT FOR DUTY), 1 DAY – RMS 2

Project: Buell Automatics
Project No: 190500033
Client: Buell Automatics
Location: 381 Buell Road, Rochester, NY
Start Date:

## Work Description

**Provide a general description of the work to be conducted.**

## Documentation and Procedure Review

1. Risk Management Strategy (RMS1) form and/or Site Specific Health and Safety Plan signed and reviewed? ☐ Yes ☐ **No***
2. Emergency Response Plan reviewed? ☐ Yes ☐ **No*** ☐ N/A
3. Tested two-way communications (cell phone, satellite phone) and security measures? ☐ Yes ☐ **No***
4. Attended Client Site Health and Safety meeting? ☐ Yes ☐ **No*** ☐ N/A
5. Conducted Stantec site safety meeting with all workforces? ☐ Yes ☐ **No*** ☐ N/A
6. Are there any new or unexpected hazards not identified in the RMS1/HASP? ☐ Yes ☐ No
   *If yes, include in the Job Safety Analysis (JSA).*
7. Working alone or remote work? ☐ Yes ☐ No
   *If yes, complete call in/out process – Safe Work form must be completed.*

## Notifications and Permits

8. Are work permits required for this site? ☐ Yes ☐ No
   *If yes, have they been completed and submitted as required?* ☐ Yes ☐ **No***
9. Are utility locates required for this site? ☐ Yes ☐ No
   *If yes, have they been completed and reviewed?* ☐ Yes ☐ **No***
10. Does the Client require any notification prior to starting the work? ☐ Yes ☐ No
    *If yes, has the notification been provided?* ☐ Yes ☐ **No***

### *Contact your Project Manager immediately.

## Personal Protective Equipment

**List specific PPE as needed. Verify type and inspect condition.**

☒ Head Protection Type: Hard hat
☒ Foot Protection Type: Steel toe
☒ Eye Protection Type: Safety glasses
☒ High Visibility Vest:
☐ Hearing Protection:
☐ Respiratory Protection:
☐ Fire Retardant Coveralls:
☐ Fall Protection:
☐ Gloves Type:
☐ Water Safety Gear:
☐
☐

## Tools and Equipment

**List specific equipment to be used. Verify type and inspect condition.**

☐
☐
☐
☐
☐
☐

# FIELD LEVEL RISK ASSESSMENT (FIT FOR DUTY), 1 DAY – RMS 2

## Daily Tailgate Discussions/Subcontractor Input

| | | |
|---|---|---|
| **Start** | Time: | Weather: |
| | | |
| **Mid-Day** | Time: | Weather: |
| | | |
| **Post-Day** | Time: | Weather: |
| | | |

**I know the hazards:**

By signing here, you are stating the following:

1. I have been involved in the Job Safety Analysis and understand the hazards and risk control actions associated with each task I am about to perform.
2. I understand the permit to work requirements applicable to the work I am about to perform (if it includes permitted activities).
3. I am aware that no jobs or work (that is not risk-assessed) is to be performed.
4. I am aware of my obligation to "**Stop Work**" (*See Stop Work Section).*

**I arrived and departed fit for duty:**

5. I am physically and mentally fit for duty.
6. I am not under the influence of any type of medication, drugs or alcohol that could affect my ability to work safely.
7. I am aware of my responsibility to bring any illness, injury (regardless of where or when it occurred) or fatigue issue I may have to the attention of the Crew Lead.
8. I signed out uninjured unless I have otherwise informed the Crew Lead.

**Insert fitness level under corresponding time column: Fit for Duty = F Alternate Plan = AP**
**Team Lead to contact Project Manager for any personnel identified as AP**

| Individual Name/Company Name/Signature | Time: | Time: | Time: |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**I will STOP** the job any time anyone is concerned or uncertain about safety.

**I will STOP** the job if anyone identifies a hazard or additional mitigation not recorded.

**I will** be alert to any changes in personnel or their fitness level (AP), conditions at the work site or hazards.

If it is necessary to **STOP THE JOB**, I will reassess the task, hazards and mitigations; and then proceed only when safe to do so.

**Conclusion of day: I certify that the planned work activities are completed for the day and all injuries and first aids have been reported via RMS3.**

**Signature of Crew Lead:** ______________________ **Date:** ______________

Stantec

# FIELD LEVEL RISK ASSESSMENT (FIT FOR DUTY), 1 DAY – RMS 2

**Job Safety Analysis (JSA)** **Must be completed for all field activities.**

| Basic Job Steps | Potential Hazards | Controls to Reduce or Eliminate Hazard | Person Responsible |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Review the hazard categories below and check the mitigation measures applicable to the identified scope of work.**

**Environmental Hazards**

1. Work area clean ☐
2. Material storage identified ☐
3. Dust/Mist/Fume ☐
4. Noise in area ☐
5. Extreme temperatures ☐
6. Spill potential ☐
7. Waste containers needed ☐
8. Waste properly disposed ☐
9. Waste plan identified ☐
10. Excavation permit required ☐
11. Other workers in area ☐
12. Weather conditions ☐
13. MSDS reviewed ☐

**Ergonomic Hazards**

14. Awkward body position ☐
15. Over extension ☐
16. Prolonged twisting/bending motion ☐
17. Working in a tight area ☐
18. Lift too heavy/awkward to lift ☐
19. Parts of body in line of fire ☐
20. Repetitive motion ☐
21. Hands not in line of sight ☐
22. Working above your head ☐

**Access/Egress Hazards**

23. Aerial life/Man basket (inspected & tagged) ☐
24. Scaffold (inspected & tagged) ☐
25. Ladders (tied off) ☐
26. Slips & trips ☐
27. Hoisting (tools, equipment) ☐
28. Evacuation (alarms, routes, ph. #) ☐
29. Confined space entry permit required ☐

**Overhead Hazards**

30. Barricades & signs in place ☐
31. Hole coverings identified ☐
32. Harness/lanyard inspected ☐
33. 100% Tie-off with harness ☐
34. Tie off points identified ☐
35. Falling items ☐
36. Foreign bodies in eyes ☐
37. Hoisting or moving loads overhead ☐

**Rigging & Hoisting Hazards**

38. Lift study required ☐
39. Proper tools used ☐
40. Tools inspected ☐
41. Equipment inspected ☐
42. Slings inspected ☐
43. Others working overhead/below ☐
44. Critical lift permit ☐

**Electrical Hazards**

45. GFI test ☐
46. Lighting levels too low ☐
47. Working on/near energized equipment ☐
48. Electrical cords condition ☐
49. Electrical tools condition ☐
50. Fire extinguisher ☐
51. Hot work or electrical permit required ☐

**Personal Limitations/Hazards**

52. Procedure not available for task ☐
53. Confusing instructions ☐
54. No training for task or tools to be used ☐
55. First time performing the task ☐
56. Micro break (stretching/flexing) ☐
57. Report **all injuries** to your supervisor ☐

**It is important that all relevant hazards have plans in place to reduce risk.**
**Be sure that all associated permits are closed off at the end of the job.**

**Remember: Stop and Think**

Reviewed by Name and Signature: ____________________________

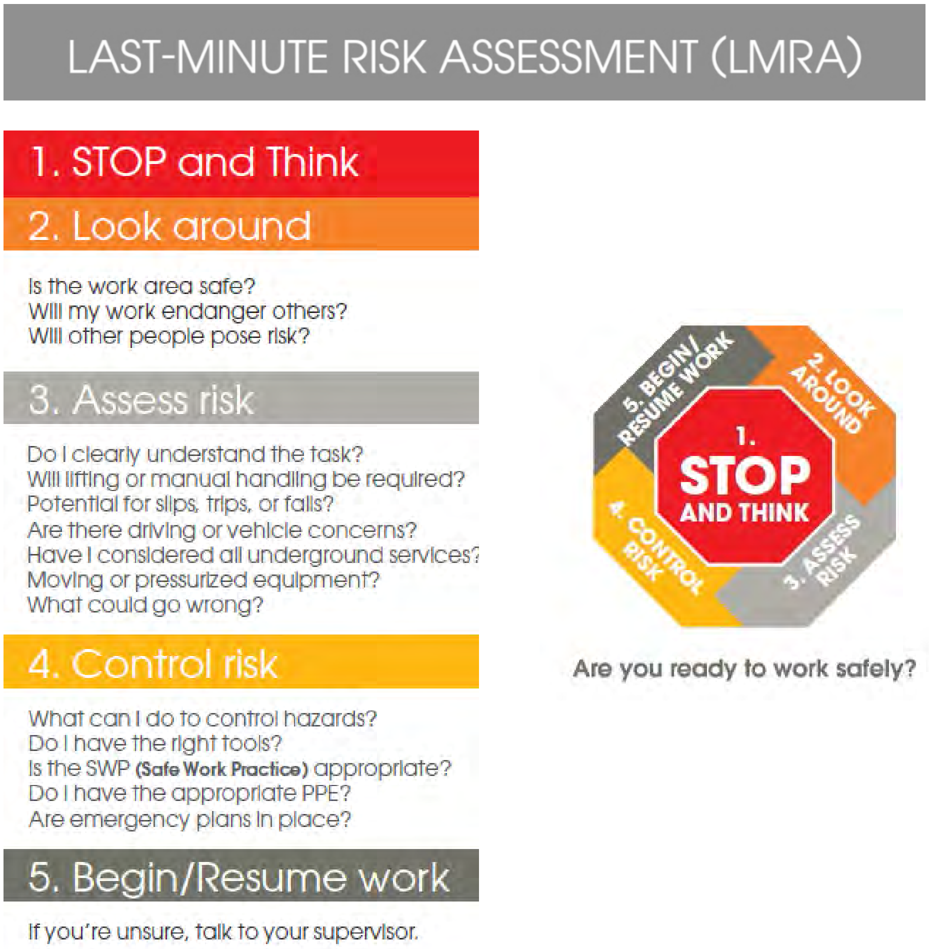
## Fit for Duty

Safety is influenced by many factors, but the most important is the health and well-being of Stantec's employees and partners. Physical and mental health are just as important as good tools, good practices, and good job planning.

This card is designed to help you do a quick self-assessment of your physical and mental health. Any concerns resulting from your assessment regarding your ability to carry out your job responsibilities safely and in good health need to be discussed with your supervisor before starting work.

- Am I feeling good today and ready to work at my typical level of physical activity and responsibility?
- Do I have any sprains/strains, areas of weakness or soreness?
- Am I managing multiple sources of stress?
- Am I well hydrated?
- Any physically-demanding activities recently (chores, sports, hobbies)?
- Am I well-rested with a good energy level? When did I eat last?
- Am I taking any medications that can make me drowsy or adversely affect my safe performance?
- Any cuts/scrapes are clean and bandaged?
- Did I remember to bring with me my health maintenance medications (blood pressure, diabetes, cholesterol, heart, etc.)?

**If your answers to any of the questions above indicate that you may not be ready to work, contact your supervisor immediately to discuss a plan of action**.



LAST-MINUTE RISK ASSESSMENT (LMRA)

1. STOP and Think

2. Look around

Is the work area safe?
Will my work endanger others?
Will other people pose risk?

3. Assess risk

Do I clearly understand the task?
Will lifting or manual handling be required?
Potential for slips, trips, or falls?
Are there driving or vehicle concerns?
Have I considered all underground services?
Moving or pressurized equipment?
What could go wrong?

4. Control risk

What can I do to control hazards?
Do I have the right tools?
Is the SWP **(Safe Work Practice)** appropriate?
Do I have the appropriate PPE?
Are emergency plans in place?

5. Begin/Resume work

If you're unsure, talk to your supervisor.

Are you ready to work safely?

# Appendix D

## Community Air Monitoring Plan

# Appendix 1A
# New York State Department of Health
# Generic Community Air Monitoring Plan

## Overview

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

## Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate DEC/NYSDOH staff.

> **Continuous monitoring** will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.
>
> **Periodic monitoring** for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or

overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

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

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

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

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

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

Particulate Monitoring, Response Levels, and Actions

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

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

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

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

December 2009

# Appendix 1B
# Fugitive Dust and Particulate Monitoring

A program for suppressing fugitive dust and particulate matter monitoring at hazardous waste sites is a responsibility on the remedial party performing the work. These procedures must be incorporated into appropriate intrusive work plans. The following fugitive dust suppression and particulate monitoring program should be employed at sites during construction and other intrusive activities which warrant its use:

1. Reasonable fugitive dust suppression techniques must be employed during all site activities which may generate fugitive dust.

2. Particulate monitoring must be employed during the handling of waste or contaminated soil or when activities on site may generate fugitive dust from exposed waste or contaminated soil. Remedial activities may also include the excavation, grading, or placement of clean fill. These control measures should not be considered necessary for these activities.

3. Particulate monitoring must be performed using real-time particulate monitors and shall monitor particulate matter less than ten microns (PM10) with the following minimum performance standards:

   (a) Objects to be measured: Dust, mists or aerosols;
   (b) Measurement Ranges: 0.001 to 400 mg/m3 (1 to 400,000 :ug/m3);
   (c) Precision (2-sigma) at constant temperature: +/- 10 :g/m3 for one second averaging; and +/- 1.5 g/m3 for sixty second averaging;
   (d) Accuracy: +/- 5% of reading +/- precision (Referred to gravimetric calibration with SAE fine test dust (mmd= 2 to 3 :m, g= 2.5, as aerosolized);
   (e) Resolution: 0.1% of reading or 1g/m3, whichever is larger;
   (f) Particle Size Range of Maximum Response: 0.1-10;
   (g) Total Number of Data Points in Memory: 10,000;
   (h) Logged Data: Each data point with average concentration, time/date and data point number
   (i) Run Summary: overall average, maximum concentrations, time/date of maximum, total number of logged points, start time/date, total elapsed time (run duration), STEL concentration and time/date occurrence, averaging (logging) period, calibration factor, and tag number;
   (j) Alarm Averaging Time (user selectable): real-time (1-60 seconds) or STEL (15 minutes), alarms required;
   (k) Operating Time: 48 hours (fully charged NiCd battery); continuously with charger;
   (l) Operating Temperature: -10 to 50$^{o}$ C (14 to 122$^{o}$ F);
   (m) Particulate levels will be monitored upwind and immediately downwind at the working site and integrated over a period not to exceed 15 minutes.

4. In order to ensure the validity of the fugitive dust measurements performed, there must be appropriate Quality Assurance/Quality Control (QA/QC). It is the responsibility of the remedial party to adequately supplement QA/QC Plans to include the following critical features: periodic instrument calibration, operator training, daily instrument performance (span) checks, and a record keeping plan.

5. The action level will be established at 150 ug/m3 (15 minutes average). While conservative,

this short-term interval will provide a real-time assessment of on-site air quality to assure both health and safety. If particulate levels are detected in excess of 150 ug/m3, the upwind background level must be confirmed immediately. If the working site particulate measurement is greater than 100 ug/m3 above the background level, additional dust suppression techniques must be implemented to reduce the generation of fugitive dust and corrective action taken to protect site personnel and reduce the potential for contaminant migration. Corrective measures may include increasing the level of personal protection for on-site personnel and implementing additional dust suppression techniques (see paragraph 7). Should the action level of 150 ug/m3 continue to be exceeded work must stop and DER must be notified as provided in the site design or remedial work plan. The notification shall include a description of the control measures implemented to prevent further exceedances.

6. It must be recognized that the generation of dust from waste or contaminated soil that migrates off-site, has the potential for transporting contaminants off-site. There may be situations when dust is being generated and leaving the site and the monitoring equipment does not measure PM10 at or above the action level. Since this situation has the potential to allow for the migration of contaminants off-site, it is unacceptable. While it is not practical to quantify total suspended particulates on a real-time basis, it is appropriate to rely on visual observation. If dust is observed leaving the working site, additional dust suppression techniques must be employed. Activities that have a high dusting potential--such as solidification and treatment involving materials like kiln dust and lime--will require the need for special measures to be considered.

7. The following techniques have been shown to be effective for the controlling of the generation and migration of dust during construction activities:

(a) Applying water on haul roads;
(b) Wetting equipment and excavation faces;
(c) Spraying water on buckets during excavation and dumping;
(d) Hauling materials in properly tarped or watertight containers;
(e) Restricting vehicle speeds to 10 mph;
(f) Covering excavated areas and material after excavation activity ceases; and
(g) Reducing the excavation size and/or number of excavations.

Experience has shown that the chance of exceeding the 150ug/m3 action level is remote when the above-mentioned techniques are used. When techniques involving water application are used, care must be taken not to use excess water, which can result in unacceptably wet conditions. Using atomizing sprays will prevent overly wet conditions, conserve water, and provide an effective means of suppressing the fugitive dust.

8. The evaluation of weather conditions is necessary for proper fugitive dust control. When extreme wind conditions make dust control ineffective, as a last resort remedial actions may need to be suspended. There may be situations that require fugitive dust suppression and particulate monitoring requirements with action levels more stringent than those provided above. Under some circumstances, the contaminant concentration and/or toxicity may require additional monitoring to protect site personnel and the public. Additional integrated sampling and chemical analysis of the dust may also be in order. This must be evaluated when a health and safety plan is developed and when appropriate suppression and monitoring requirements are established for protection of health and the environment.

# Appendix E

## EISB Injection Program Electron Donor Solution Calculations

# Appendix E

## ELECTRON DONOR SOLUTION CALCULATIONS, BUELL AUTOMATICS SITE EISB PROGRAM

Treatability testing completed by Stantec in January 2009 identified a mixture of organic acids prepared by the fermentation of a guar gum/sucrose solution as the most successful electron donor tested for stimulating the enhanced reductive dechlorination (ERD) process to treat chlorinated compound impacts. The testing applied the organic acid mixture at a concentration of 5,000 mg/L to test samples prepared using Site soil and groundwater. The goal of the full-scale injection program will be to achieve a groundwater electron donor concentration of approximately 5,000 mg/L. The following assumptions have been incorporated into the design of the FTDA electron donor injection program.

- 26 injection locations (6 existing and 20 new wells);
- 10-foot radius of influence (ROI) for each injection location;
- 15-foot saturated screen interval for each well;
- 27% soil porosity;
- 0.5 pore volume exchange;
- Injection electron donor solution concentration = 10,000 milligrams/liter;
- Electron donor stock solution specific gravity = 1.04 grams/milliliter;
- Variflo® QD guar gum concentration in stock solution = 0.125 pounds/gallon;
- Sucrose concentration in stock solution = 0.042 pounds/gallon;
- 1 cubic foot = 7.48052 gallons;
- 1 milligram/liter = 8.345x10$^{-6}$ pounds/gallon;
- 1 gram/milliliter = 8.345 pounds/gallon;
- 1 gallon = 3.7854 Liters

**Electron Donor Injection Calculations:**

Injection volume:

Total pore volume = π x (10 feet)$^2$ x 15 feet x 0.27 = 1,272 feet$^3$ = 9,515 gallons

Target injection volume per well = 9,515 gallons x 0.5 = 4,758 gallons

Total injection volume = 4,758 gallons x 26 wells = 123,708 gallons

Total number of 1,500-gallon batches = 123,708 gallons ÷ 1,500 gallons = 82.5 batches

Electron Donor Mass:

Electron donor mass per well = 10,000 milligrams stock solution /liter of injection material x 8.345x10$^{-6}$ x 4,758 gallons = 397 pounds stock solution per well

Total electron donor mass to be injected = 397 pounds x 26 wells = 10,322 pounds stock solution

*(Calculations continue on next page)*

# Appendix E, Continued

## ELECTRON DONOR SOLUTION CALCULATIONS, BUELL AUTOMATICS SITE EISB PROGRAM

**Electron Donor Stock Solution Calculations:**

Total stock solution volume = 1,200 gallons

Total Sucrose mass = 1,200 gallons x 0.042 pounds/gallon = 50 pounds

Total Variflo® QD guar gum mass = 1,200 gallons x 0.125 pounds/gallon = 150 pounds

Stock solution volume per 1,500-gallon batch =

(10,000 milligrams/liter x $8.345 \times 10^{-6}$ x 1,500 gallons) ÷ (1.04 grams/milliliter x 8.345) = 14.4 gallons