CORRECTIVE MEASURES STUDY

RCRA CORRECTIVE ACTION

RACER TRUST
FLINT WEST #12990
FLINT, MICHIGAN
EPA ID# MIK204011722

Æ PROJECT # 11-4317-102

OCTOBER 31, 2014

Applied EcoSystems, Inc.
Environmental Management, Consulting & Field Services

G-4300 South Saginaw Street, Burton, Michigan 48529
☎(810) 715-2525 FAX (810) 715-2526
www.appliedecosystems.com

CORRECTIVE MEASURES STUDY

RCRA CORRECTIVE ACTION

RACER TRUST
FLINT WEST #12990
FLINT, MICHIGAN
EPA ID# MIK204011722

Æ PROJECT # 11-4317-102

OCTOBER 31, 2014

Æ

Michael D. Smith
Technical Operations Manager

Sandra Clark
President

TABLE OF CONTENTS

FIGURES:

APPENDICES:

TABLES:

EXECUTIVE SUMMARY

This Resource Conservation Recovery Act (RCRA) Corrective Measures Study (CMS) has been prepared on behalf of the Revitalizing Auto Communities Environmental Response (RACER) Trust for the property identified as "Flint West Industrial Land," RACER Site #12990, located in Flint, Michigan (Site) (Figure 1). This CMS Report has been developed in accordance with United States Environmental Protection Agency (USEPA) guidance (USEPA 2005) and Part 201 of the Michigan Natural Resources and Environmental Protection Act (Act 451, 1994, as amended). The purpose of this CMS is to develop and evaluate corrective measure alternatives based on the findings of the RCRA Facility Investigation (RFI) and to propose the corrective measure(s) to be taken.

The Site consists of approximately five acres of land located west of Stevens Street and north of Glenwood Avenue in Flint, Genesee County, Michigan. The Site is developed with a Consumers Energy electrical substation in the central portion. Almost the entire Site consists of concrete pavement, remaining after the demolition of a former manufacturing building. The concrete pavement is supported by a concrete retaining wall that runs east-west and immediately south of the northern property line. A small area on the north portion of the property is unpaved and part of a former railroad. The majority of the Site is secured with a locked chain-link fence.

A railroad grade runs along the northern property boundary, beyond which is located the Chevy-in-the-Hole property. Former industrial land is located to the east, across Stevens Street and to the west. Current and former commercial uses are located to the southwest and south. A General Motors tool and die facility is located to the southeast.

Subsurface materials consist of glacial tills in the upper approximately 20 feet to 30 feet below grade with shallow groundwater perched on a clay layer. (Note that site topography varies approximately 8 feet to 10 feet due to the retaining wall.) The saturated thickness above the clay ranges from about 10 feet to 15 feet, and groundwater flow in this unit is generally to the north/northwest toward the Flint River. Bedrock was encountered at approximately 20 feet below a clay layer on the north portion of the Site.

The primary constituent of concern is trichloroethene and it appears to be present from historic releases. No significant trichloroethene source mass was found in unsaturated soils. The highest remaining concentrations of trichloroethene are in the saturated unit and underlying clay in the north portion of the Site and the immediately adjacent abandoned railroad property.

Figure 2 and Table 1 identify the applicable locations and corrective measures evaluated. These corrective measures were screened against RCRA's threshold criteria (protection of human health and the environment, attainment of media cleanup objectives, and controlling the sources or demonstrating plume stability, USEPA 2005). After screening against the threshold criteria, various corrective measures were combined to form corrective measures alternatives. The corrective measures alternatives developed as a result of the screening process were then measured against the RCRA evaluation criteria (Table 2); long-term reliability and effectiveness, reduction of toxicity, mobility and volume of waste, short-term effectiveness, implementation, community acceptance, state acceptance, and cost (USEPA 2005).

After assessing the corrective measures alternatives per the process described above, the proposed final corrective measures alternative for the Site is:

- Land Use Restrictions: Limit future use for the entire Site to non-residential, requiring site-wide contaminated soil management and evaluation of future non-residential structures to include either mitigation or assessment of potential vapor intrusion. Note that there are no identified non-residential vapor intrusion concerns for buildings constructed in accordance with the Michigan Department of Environmental Quality's (MDEQ's) default assumptions for vapor intrusion; however, as a conservative measure the land use restrictions include provisions to consider future vapor intrusion concerns in accordance with requirements effective at that time.

- Groundwater Use Restrictions: Prohibit the use of groundwater for consumption, irrigation, or any other purpose with the exception of evaluating groundwater, remediation of subsurface contamination, or short-term dewatering for construction purposes. The goals of the proposed corrective measure include removing contaminant mass to further attenuation of groundwater concentrations. Note that RACER has requested the City of Flint pass an ordinance to restrict groundwater use on the Site and in the surrounding area. A groundwater ordinance will protect human health from the contaminants at the Site and in the surrounding area covered by such an ordinance by preventing use of groundwater.

- Monitored Stability: Implement a Site-wide groundwater monitoring program that provides data to verify Chlorinated volatile organic compound (CVOC) concentrations at the Site are stable or decreasing. Groundwater monitoring data will be evaluated as it is collected and appropriate recommendations made, but it is proposed that if after five years of continued groundwater monitoring the data indicates concentrations on-Site and at the northern (downgradient) property line are stable or decreasing, then groundwater monitoring could be discontinued.

- In-Situ Bioremediation: Conduct a single injection event of Regensis Hydrogen Release Compound (HRC) to address soil contaminated with CVOCs that is contributing to CVOC groundwater impacts. Supporting literature for HRC indicates that elevated concentrations of degradation compounds, mainly vinyl chloride, are possible in the short term (6-18 months); however, previous case studies indicate long-term decreasing concentrations of degradation compounds associated with HRC injection.

1.0 INTRODUCTION

This Resource Conservation Recovery Act (RCRA) Corrective Measures Study (CMS) has been prepared on behalf of the Revitalizing Auto Communities Environmental Response (RACER) Trust for the "Flint West Industrial Land," (MIK204011722) RACER Site #12990, located in Flint, Michigan (Site). RACER was established and assumed the rights, title, and interest of Motors Liquidation Company in and to the Site pursuant to an Environmental Response Trust Consent Decree and Settlement Agreement ("Settlement Agreement") entered by the U.S. Bankruptcy Court for the Southern District of New York on March 29, 2011, in the case of *In re Motors Liquidation Company*, etc. et al, Debtors, Case No. 09-50026 (REG), among the Debtors, the United States of America, certain states including the State of Michigan, the Saint Regis Mohawk Tribe, and EPLET, LLC, (not individually but solely in its representative capacity as Administrative Trustee of the Trust).

This CMS has been developed in accordance with United States Environmental Protection Agency (USEPA) guidance (USEPA 2005) and Part 201 of the Michigan Natural Resources and Environmental Protection Act (Act 451, 1994, as amended). The purpose of this CMS is to develop and evaluate corrective measures alternatives and to recommend corrective measures alternatives for the Site that meet the corrective action objectives, RCRA evaluation criteria, and the overall Site strategy. The location of the Site is shown on Figure 1. A Site layout is included on Figure 2.

1.1 Corrective Action Background

Applied *Eco*Systems, Inc. (*Æ*) of Burton, Michigan has completed several phases of investigation and groundwater monitoring at and in the vicinity of the Site and has obtained groundwater monitoring data for the adjacent Chevy-in-the-Hole site. The combined data from these various investigations is considered the RCRA Facility Investigation (RFI). The RFI targeted areas of interest (AOIs) identified at the Site based on historical land use and previous investigation results. A Draft CA 725 Report was submitted to USEPA on July 1, 2013, and a draft CA 750 was submitted to the USEPA on March 1, 2014. The results of the RFI were summarized in various Data Reports completed in 2012, 2013, and 2014. Soil and groundwater data included in the Data Reports are summarized and attached. Figures 3 and 4 summarize cleanup criteria exceedances identified in the most recent sampling of the Site (June and July 2014).

Æ has also reviewed past reports associated with soil and groundwater sampling conducted on the downgradient Chevy-in-the-Hole site. The most recent groundwater data, collected in April 2014, is summarized on a map prepared by AKT Peerless and included in Appendix 7.

Æ has prepared this CMS on behalf of RACER to present the identification and evaluation of corrective measures alternatives and describe the proposed corrective measures alternative for the Site for USEPA's consideration. This CMS references information that can be found in the various documents submitted to USEPA during the RCRA Corrective Action process as cited herein.

1.2 Corrective Action Objectives

The corrective action objective for the Site is to protect human health and the environment by achieving industrial/commercial closure (i.e. non-residential closure per MDEQ standards) in accordance with the Settlement Agreement.

2. SITE BACKGROUND

2.1 Site Location

The Site consists of approximately five acres of land located west of Stevens Street and north of Glenwood Avenue in Flint, Genesee County, Michigan. The Site is developed with a Consumers Energy electrical substation in the central portion. Almost the entire Site consists of concrete pavement, remaining after the demolition of a former manufacturing building. The majority of the Site is secured with a locked chain-link fence. The June 10, 2011 Work Plan provides a detailed description of the Site's history and operations.

2.2 Geology and Hydrogeology

2.2.1 Site Stratigraphy

The sedimentary environment present at the Site includes a sequence of glacial sediments consisting predominantly of sand in the upper approximately 20 feet, underlain by gray clay and silty clay with shale bedrock encountered in two locations beneath the clay unit. Details regarding the site geologic and hydrogeologic conditions are provided in cross sections attached in Appendix 1.

2.2.1.1 Overburden

In general, the unconsolidated overburden stratigraphy consists primarily of silty sand, including fill sand, in the upper 20 feet, underlain by gray clay and silty clay.

2.2.1.2 Bedrock

In order to limit the potential for vertical migration, soil borings advanced on the Site did not penetrate the clay layer, except for two locations on the north portion of the Site, where dual-tube Geoprobe borings were conducted. Shale was encountered at approximately 20 feet below grade in these locations.

2.2.2 Site Hydrogeologic Setting

The Site is located in the valley of the Flint River, approximately 600 feet south of the river channel, which is currently lined with concrete with hydrostatic groundwater relief valves to allow groundwater to vent to the river. Shallow groundwater is present in the upper approximately 20 feet, is in a unit primarily characterized as silty sand, and is underlain by clay and silty clay with a maximum observed thickness of approximately five feet on top of shale.

2.2.2.1 Perched Zones

A continuous clay layer was encountered Site-wide, creating a perched sand saturated unit.

2.2.2.2 Bedrock Aquifer

According to the MDEQ's 1987 Bedrock Map of Michigan (Appendix 5), the bedrock in the area of the Site is classified as The Saginaw Formation. The Saginaw Formation consists largely of sandstone interbedded with shale. Groundwater flow within bedrock is largely dependent on the presence of bedrock fractures, and the groundwater elevation within a bedrock well will depend on screen depth, fracture distribution and the proximity to municipal pumping wells. Specific capacity testing of bedrock wells suggests the bulk K of the bedrock ranges from 80 ft/day in highly fractured wells to 0.6 ft/day in wells where minimal fracturing is encountered.

2.2.3 Surface Water Hydrology

The Flint River is located in a concrete channel approximately 600 feet north of and downgradient from the Site. Due to the concrete channel, it is unlikely that significant quantities of groundwater vent to this stretch of the river; however groundwater is occasionally discharged through a series of hydrostatic valves along the walls of the channel.

There are no storm sewer utilities on the Site with the likely potential to convey contaminated groundwater to a surface water body.

2.3 Well Search

A search of drinking water wells within one-half mile of the Site, using the MDEQ's water well record database managed by Michigan State University, identified only two wells. Both wells are located nearly one-half mile north of the Site on the other side of the Flint River and are listed as owned by the City of Flint. The wells are set in unspecified bedrock at 96 feet and 100 feet below grade and are located approximately 0.32 and 0.45 miles from the Site. Neither well record indicates pumping equipment; thus it appears that the wells are not in use. Consultation with the Genesee County Health Department did not identify additional wells within one-half mile of the site. In addition, a windshield survey was completed on August 10 and 11, 2014, and did not identify unregistered wells. No well heads were found in the areas where the identified wells were mapped by the MDEQ.

A map showing the identified well locations and copies of the well records are attached in Appendix 4.

The well log for the well located closer to the Site (ID #25077613002), indicates 18 feet of yellow clay underlain by gray clay from 18 feet to 30 feet below grade. The gray clay is underlain by what is described as "hardpan." The depths to gray clay and bedrock are similar to that encountered at Flint West.

2.4 Land Use

Currently, the Site is nearly completely fenced and covered in paved former parking areas and the concrete slabs of the former building floors. A stormwater sump with an out-of-use sump pump is located under a steel plate on the northeast portion of the Site. A Consumers Energy substation operates on the property and serves the industrial facility to the southeast. The Site is currently zoned as heavy industrial, and is likely to be redeveloped for industrial use or used for recreational land, which is consistent with the City of Flint's plans for the adjacent "Chevy-in-the-Hole" property.

An abandoned railroad property is located between the Site and the adjacent Chevy-in-the-Hole property to the north. The railroad property appears to be an orphan parcel. There are no local records that provide ownership records or property descriptions. Past efforts to obtain information from Grand Trunk (current or former owner of other former rail line parcels abutting the orphan parcel) were not successful. The Chevy-in-the-Hole property is located to the east and north and is being used for composting lawn waste while trees are being planted. A commercial building operating as a marijuana dispensary is located to the west. Properties to the south are developed with vacant, deteriorated, commercial buildings. A General Motors tool and die facility is located to the southeast.

2.5 Summary of the RCRA Facility Investigation

The results of the RFI were summarized in various Data Reports in 2011 through 2014. The Site was evaluated based on current and future non-residential use except residential exposure scenarios were also considered for the groundwater pathway due to the relatively small size of the Site that results in a short distance for groundwater impacts to potentially reach and migrate beyond the property boundary. Conditions at the Site were evaluated based on potentially exposed industrial and construction workers. The Site and off-site properties were evaluated based on a residential exposure scenario and groundwater to surface water interface (GSI) protection.

AOIs on the Site were investigated, and impact above residential criteria was primarily found on the north-central portion of the Site, extending onto the adjacent railroad parcel. The full extent of soil impacts is not known; however, investigations conducted on the Chevy-in-the-Hole property support the conclusion that groundwater impacts are delineated and are not a threat to the Flint River. The goals of the RFI have largely been met. The key findings of the RFI are summarized as follows:

- Various metals were detected in soils and groundwater above the MDEQ's criteria for drinking water and GSI protection. No other criteria were exceeded. The metals concentrations are spatially variable and not indicative of a plume and may be naturally-occurring.
- Chlorinated volatile organic compounds (CVOCs), primarily trichloroethene, have been detected in soil and groundwater, primarily on the north central portion of the Site, with increasing concentrations in soil present on the orphan rail parcel to the north. The CVOC soil contamination is at the highest concentrations in the clay and silty clay underlying the perched silty sand saturated unit. The CVOC contamination in soil does not exceed the relevant residential ambient air inhalation protection or direct contact criteria in either saturated or unsaturated soil. The CVOC exceedances in groundwater are above only the drinking water and GSI protection criteria. Leachate testing of impacted soils in the clay and silty clay indicate the potential for impacted soils to leach contaminants to groundwater above applicable generic residential criteria. While CVOC contamination was identified in the clay overlying bedrock, the contaminants appear to have accumulated in this soil unit and are not believed to threaten deeper groundwater units.
- No non-aqueous phase liquids (NAPL) were encountered, and soil contaminant concentrations are not indicative of the likely presence of NAPL.
- Assuming placement of a deed restriction that prevents installation and use of drinking water wells on the Site, there are no non-residential exposure concerns.
- It appears that probable releases on the RACER property contribute to CVOC contamination and may commingle with releases on the abandoned railroad property where releases may have occurred due to storage and handling. Based on the lithology of the area of impact, it is likely that a surface release would migrate vertically through the silty sand and then migrate on top of, across, and into the underlying clay layer.

2.6 Conceptual Site Model

The Site consists of approximately five acres of land located west of Stevens Street and north of Glenwood Avenue in Flint, Genesee County, Michigan. The Site is developed with a Consumers Energy electrical substation in the central portion. Almost the entire Site consists of concrete pavement, remaining after the demolition of a former manufacturing building. The concrete pavement is supported by a concrete retaining wall that runs east-west and immediately south of the northern property line. A small area on the north portion of the property is unpaved and part of a former railroad. The majority of the Site is secured with a locked chain-link fence.

A railroad grade runs along the northern property boundary, beyond which is located the Chevy-in-the-Hole property. Former industrial land is located to the east, across Stevens Street and to the west. Current and former commercial uses are located to the southwest and south. A General Motors tool and die facility is located to the southeast.

Subsurface materials consist of glacial tills in the upper approximately 20 feet to 30 feet below grade with shallow groundwater perched on a clay layer. (Note that site topography varies approximately 8 feet to 10 feet due to the retaining wall.) The saturated thickness above the clay ranges from about 10 feet to 15 feet, and groundwater flow in this unit is generally to the north/northwest toward the Flint River. Bedrock was encountered at approximately 20 feet below a clay layer on the north portion of the Site.

The primary constituent of concern is trichloroethene and it appears to be present from historic releases. No significant trichloroethene source mass was found in unsaturated soils. The highest remaining concentrations of trichloroethene are in the saturated unit and underlying clay in the north portion of the Site and the immediately adjacent abandoned railroad property.

3. Summary of Corrective Measures Alternatives

Soil and groundwater at the Site have documented CVOC impacts above the drinking water and GSI protection criteria. In addition, some CVOC contamination was identified in soil in excess of the residential indoor air and outdoor air infinite source inhalation criteria. Aside from drinking water and GSI criteria, no contamination in soil or groundwater was found above the non-residential criteria.

3.1 Identification of Corrective Measures Alternatives

Corrective measures for the applicable contaminant exceedances at the Site are detailed in the sections below and summarized on Table 1. The corrective measures have been screened against RCRA's threshold criteria (USEPA 2005) which are:

- Protection of human health and the environment;
- Attainment of media clean up objectives;
- Controlling the sources or demonstrating plume stability;
- Community/Regulatory acceptance; and
- Overall sustainability (waste minimization, etc.)

After screening against the threshold criteria, the various corrective measures have been combined to form corrective measures alternatives for further evaluation; these alternatives are presented on Table 1.

3.2 Site-Wide Management Controls

3.2.1 Land Use Restriction

To prevent a change in land use and to address other potential exposures, a Restrictive Covenant would be recorded on the deeds and would cover the following:

- Site-wide Land Use Restriction: Land use at the entire Site would be limited to non-residential uses and if Owner elects to remove any slabs, pavement, or other impervious surface on the Property, Owner shall be responsible for any and all obligations under environmental laws arising from any such removal, alteration, or disturbance, whether or not caused by, arising from or related to, an environmental condition.
- Site-wide Contaminated Soil Management: All Site soils, media and/or debris will be managed in accordance with the applicable requirements of RCRA and all other relevant state and federal laws and this provision regarding contaminated soil management also applies in the event that the Owner elects to remove any slabs, pavement, or other impervious surface on the Property.

- Site-wide Vapor Intrusion: Prior to any future building construction, vapor intrusion will have to be mitigated or assessed to determine if mitigation is necessary. The assessment will be conducted in accordance with applicable regulations at that time.

Note that similar land use restrictions are included in the overall corrective action approach for the downgradient Chevy-in-the-Hole property. (See *Proposed RCRA Prospective Purchaser Agreement: Order on Consent and Covenant Not to Sue, Sep 5, 2012* between the USEPA and the City of Flint).

3.2.2 Groundwater Use Restriction

The Restrictive Covenant would also include Site-wide groundwater use restrictions for all groundwater. The restrictions will include prohibiting the construction and use of wells or other devices on the Site to extract groundwater for consumption, irrigation, or any other purpose, except as provided below:

- Wells and other devices constructed as part of a response activity for the purpose of evaluating groundwater quality or to remediate subsurface contamination associated with a release of hazardous substances into the environment are permitted provided the construction of the wells or devices complies with all applicable local, state, and federal laws and regulations and does not cause or result in a new release, exacerbation of existing contamination, or any other violation of local, state, or federal laws or regulations.

- Short-term dewatering for construction purposes is permitted provided the dewatering, including management and disposal of the groundwater, is conducted in accordance with all applicable local, state, and federal laws and regulations and does not cause or result in a new release, exacerbation of existing contamination, or any other violation of local, state, and federal environmental laws and regulations.

Note that similar groundwater use restrictions are included in the overall corrective action approach for the downgradient Chevy-in-the-Hole property. (See *Proposed RCRA Prospective Purchaser Agreement: Order on Consent and Covenant Not to Sue, Sep 5, 2012* between the USEPA and the City of Flint).

3.3 Soil

3.3.1 Cap

The Site data indicates that there are no areas of contamination requiring a cap. No concentrations of contaminants above the MDEQ's December 30, 3013 ambient air inhalation, direct contact, or particulate soil inhalation criteria have been identified on the Site. A cap would not address contaminated source soils leaching CVOCs to shallow groundwater as the highest detected levels of CVOCs are already in the groundwater or the underlying clay. No further consideration is given to a cap.

3.3.2 Targeted Excavation

Targeted excavation and off-site disposal at a licensed disposal facility was evaluated for the soils impacted above the Generic Residential and Non-Residential Drinking Water Protection and GSI Protection Cleanup Criteria. Excavation would be targeted for the north-central portion of the property (approximately 2,400 square feet and 20 feet deep), in an area on the Site adjacent to a concrete wall that supports the concrete slab on the Flint West Site, which is approximately eight feet higher in elevation.

Approximately six downgradient monitoring wells would be sampled and analyzed for VOCs approximately two weeks following the excavation to evaluate the short-term impact of the corrective action. A second short-term monitoring event would be conducted four to six weeks after the corrective action. Note that Site-wide groundwater monitoring is also proposed as a separate item.

Soil excavation would also include the following complications:

- The need for sheet-pile to be used along the concrete wall (a distance of approximately 80 lineal feet and 20 feet deep) to prevent collapse of the concrete wall and around the remainder of the excavation to prevent continual collapse of the excavation walls (another 120 lineal feet);
- Dewatering of the excavation;
- Possible infiltration of groundwater and sand into the excavation area, undermining the concrete structures on the Site; and

3.3.3 Soil Vapor Extraction

The area of the highest impact is on the northern portion of the Site, in clay and silty clay, below an approximately 15-foot thick saturated unit. Soil vapor extraction is generally not effective in such low-permeability soils and was not considered further.

3.3.4 Multi-Phase Extraction

The area of the highest impact is on the northern portion of the Site, in clay and silty clay, below an approximately 15-foot thick saturated unit. Multi-phase extraction would involve depression of the water table, carbon filtering of the extracted groundwater, and vacuum extraction of subsurface air to enhance volatilization of CVOCs. Multi-phase extraction would require installation of extraction wells, construction and maintenance of a treatment system for extracted groundwater, and construction and maintenance of a soil vapor extraction system. This would require periodic air and water discharge monitoring.

Approximately six downgradient monitoring wells would be sampled and analyzed for VOCs approximately two weeks following the start-up of the MFE system to evaluate the short-term impact of the corrective action. A second short-term monitoring event would be conducted four to six weeks after the start of corrective action. Note that Site-wide groundwater monitoring is also proposed as a separate item.

3.3.5 In-Situ Bioremediation

In situ bioremediation has been identified as part of a potential corrective measures alternative for soil and groundwater. In situ bioremediation would consist of injection of a chemical through direct push drilling targeting the area where concentrations of CVOCs in soil exceed the MDEQ's GSI protection criteria. Figure 5 shows the proposed location for implementation of in situ bioremediation as a corrective measure.

The In situ bioremediation treatment would include injection of Regensis Hydrogen Release Compound (HRC) into the silty clay underlying the saturated sand unit and the saturated sand unit on the north portion of the Flint West Site in an area north of the concrete pavement, measuring approximately 80 feet long and extending approximately 20 feet to the north.

The In situ bioremediation chemicals would be applied as follows:

Applied By:	Direct push and grout pump
Application Rate:	10 pounds per foot
Application interval (vertical):	5 feet. Approximately 15-20' below grade
Application Interval (horizontal):	5-foot spacing
Application area:	Approximately 80 by 20 feet
Number of Application Points:	85
Pounds of HRC	4,250

Copies of Regensis HRC case studies involving successful treatment of CVOC contamination in silty/clayey soils are attached in Appendix 6.

Approximately six downgradient monitoring wells would be sampled and analyzed for VOCs approximately two weeks following the injection to evaluate the short-term impact of the corrective action. A second short-term monitoring event would be conducted four to six weeks after the corrective action. Note that Site-wide groundwater monitoring is also proposed as a separate item.

3.4 Groundwater

3.4.1 Monitored Stability

Monitored stability has been identified as a potential Site-wide corrective measure to meet the corrective action objective. This corrective measure includes post-active remediation groundwater monitoring to collect the necessary data for evaluating trends and verifying the stability of the CVOC concentrations at the Site. Sampling will be conducted semi-annually for three years and annually for two additional years.

Data collected during the monitoring activities will be used to:

- Evaluate the stability of the groundwater impacts at the Site;
- Monitor the seasonal variability of groundwater elevation at the Site;
- Groundwater monitoring data will be evaluated as it is collected and appropriate recommendations made, but it is proposed that upon completion of the five year monitoring period, the data will be utilized to evaluate the stability of the groundwater impacts at the Site. If the evaluation shows that the impacts are stable, then monitoring would be discontinued.

3.4.1.1 Infiltration Barrier

The majority of the Site is paved with concrete. A narrow strip of unpaved former railroad property runs along the concrete surface on the north property boundary. This area receives storm water runoff from the upgradient paved surface. The highest levels of CVOC contamination in soils and groundwater exists on-site and off-site in this unpaved area. It does not appear that the current concrete surface of the Site provides significant benefit to preventing leaching of soil contaminants to groundwater or reducing groundwater contamination migration.

An infiltration barrier installed in the area of greatest impact will not significantly reduce soil contamination levels as the highest detected levels of CVOCs are already in the groundwater or the underlying clay.

3.4.1.2 *Restrictions*

If monitored stability was the (or part of the) selected corrective measures alternative, the Declaration of Restrictive Covenant (DRC) for the Site would include a provision to prohibit any activity that would interfere with the function of or obstruct access to any monitoring wells and devices located on the Site. In-Situ Bioremediation

It is expected that the in situ bioremediation injection would address the soil contamination that is the source of the CVOC groundwater contamination, eliminating the need for direct contamination to remediate the current groundwater contamination, which exists in a shallow silty sand saturated unit. (The soils in the saturated unit are expected to be of low carbon content and thus would have a limited capacity as a contamination source.)

3.4.2 Hydraulic Control and Passive Remediation Barriers

Hydraulic control (structures designed to divert, collect, treat, and discharge groundwater) and Passive Remediation Barriers (permeable barriers allowing contaminated groundwater to receive a chemical treatment, such as oxidation, while passing through the barrier) would necessitate operation and maintenance and/or monitoring until soil and groundwater concentrations fall below applicable criteria, and neither would provide a significant reduction in soil contamination levels. These remedies are not given further consideration.

3.4.3 Groundwater Pump and Treat

A groundwater pump and treat system would involve extracting contaminated groundwater from a trench or a network of wells, treating the groundwater through carbon filters, and discharging the treated groundwater. A groundwater pump and treat system would address groundwater contamination at the Site boundary in the short term but would do little to address source soil contamination. No further consideration is given to this remedial action.

3.5 LNAPL

No NAPL or soil contamination indicative of the potential for NAPL have been identified at the Site.

4. Evaluation of Corrective Measures Alternatives

Evaluation of the corrective measures alternatives that meet the screening criteria for soil, and groundwater are presented on Tables 2 and 3, respectively. These tables include a description of the corrective measures alternative, evaluation of the corrective measure against the RCRA evaluation criteria (described below), and pre- design testing required.

The RCRA corrective measures alternative evaluation criteria are summarized below. The results of the evaluation for each area are summarized on Table 2.

- Long-Term Reliability and Effectiveness: This criterion considers both the level of threat posed by hazardous constituents remaining in place and the adequacy of the remedial alternative and the risk associated with any treatment residuals compared to untreated waste.
- Reduction of Toxicity, Mobility, or Volumes of Waste: This criterion considers the ability of the remedial alternatives to reduce the toxicity, mobility, or volume of waste significantly and permanently.
- Short-term Effectiveness: This criterion evaluates the effects of the remedial alternatives on human health and the environment during their implementation period. It considers factors such as impacts from remedy construction, transportation, and air quality.

- Implementation: This criterion considers the technical and administrative feasibility of implementing the selected remedial alternative.
- Community Acceptance: This criterion evaluates the issues and concerns the local community may have regarding the alternatives. USEPA encourages community involvement in remedial alternatives and community acceptance will be considered in the remedial alternative selection.
- State Acceptance: This criterion evaluates the technical and administrative issues and concerns the state may have regarding the alternatives. USEPA encourages coordination with state agencies and state acceptance will be considered in the remedial alternative selection.
- Cost: This criterion considers the cost effectiveness of each alternative. Cost effectiveness is evaluated by comparing the costs proportional to the effectiveness achieved by the remedial alternative. The basis for the cost estimates are provided in Table 7.
- Sustainability: This criterion considers the sustainability of each alternative with regard to energy requirements; air emissions; water requirements including impacts on water resources; land and ecosystem impacts; and material consumption and waste generation. The sustainability evaluation was used in conjunction with the core elements of the RCRA corrective measures alternatives evaluation to identify corrective measures alternatives that would balance effectiveness and sustainability.

5. Proposed Corrective Measures Alternative

Table 3 presents the proposed final corrective measures alternative based on the evaluation of the potential corrective measures with respect to the RCRA evaluation criteria. The proposed final corrective measures alternative for the Site includes:

- Land Use Restrictions
- Groundwater Use Restrictions
- Monitored Stability
- In-Situ Bioremediation

5.1 Land Use Restrictions

In order to meet the corrective action objective, land use restrictions will be implemented as part of the corrective measures alternative. A Declaration of Restrictive Covenant (DRC) will be recorded with the deed and will cover the following:

- Site-wide Land Use Restriction: Land use at the entire Site would be limited to non-residential uses, future structures would require considerations to prevent VI concerns, and if Owner elects to remove any slabs, pavement, or other impervious surface on the Property, Owner shall be responsible for any and all obligations under environmental laws arising from any such removal, alteration, or disturbance, whether or not caused by, arising from or related to, an environmental condition.
- Site-wide Contaminated Soil Management: All Site soils, media and/or debris will be managed in accordance with the applicable requirements of RCRA and all other relevant state and federal laws and this provision regarding contaminated soil management also applies in the event that the Owner elects to remove any slabs, pavement, or other impervious surface on the Property.

5.2 Groundwater Use Restrictions

In order to meet the corrective action objective, groundwater use restrictions will be included in the DRC recorded on the deed prohibiting the construction and use of wells or other devices on the Site to extract groundwater for consumption, irrigation, or any other purpose, except as provided below:

- Wells and other devices constructed as part of a response activity for the purpose of evaluating groundwater quality or to remediate subsurface contamination associated with a release of hazardous substances into the environment are permitted provided the construction of the wells or devices complies with all applicable local, state, and federal laws and regulations and does not cause or result in a new release, exacerbation of existing contamination, or any other violation of local, state, or federal laws or regulations.
- Short-term dewatering for construction purposes is permitted provided the dewatering, including management and disposal of the groundwater, is conducted in accordance with all applicable local, state, and federal laws and regulations and does not cause or result in a new release, exacerbation of existing contamination, or any other violation of local, state, and federal environmental laws and regulations.

5.3 Monitored Stability

Groundwater monitoring is an integral part of the corrective measures as it will provide important data to evaluate stability after completion of the proposed in situ bioremediation injection.

A five-year monitoring plan will be implemented after completion of the in situ bioremediation, consisting of three years of semi-annul monitoring followed by two years of annual monitoring. If the Site impacts are deemed stable after the evaluation is completed, groundwater monitoring would be discontinued. The DRC will also prohibit any activity that would interfere with the function of or obstruct access to any monitoring wells and devices located on the Site.

- In Situ Bioremediation

Regensis Hydrogen Release Compound (HRC) will be applied to an area of approximately 2,400 square feet in the north-central portion of the Site. The HRC will be applied using a grout pump and direct push methods at a rate of 10 pounds per foot. Injection will be conducted in five-foot vertical intervals designed to remediate the CVOC source in the silty clay soils underlying the saturated sand unit. The HRC will be applied in 85 injection points at a grid interval of approximately five feet. A single application is proposed, followed by verification groundwater monitoring. Due to the limited area of injection, and lack of other suitable corrective action measures, no pilot testing is proposed. The goal of the HRC injection is to reduce soil contamination to levels that furthers attenuation of groundwater contamination levels at and downgradient from the Site boundary.

The general location of the proposed HRC injection is depicted on Figure 5.

6. Schedule

A Corrective Measures Implementation (CMI) Work Plan will be submitted within 90 days of approval of the selected corrective measures alternative. The CMI Work Plan will include a draft Declaration of Restrictive Covenant, details for the HRC injection, details for groundwater monitoring, and an implementation schedule.

7. References

ARCADIS *Investigation Work Plan, Former Building 9, Delphi-Flint West Facility Flint, Michigan,* June 10, 2011

Æ February 12, 2013 Data Report

Æ June 23, 2013 Data Report

Æ Draft *725 EI Report*, July 1, 2013

Æ October 21, 2013 Data Report

Æ Draft *750 EI Report*, March 1, 2014

Æ June 23, 2014 Data Report

Æ October 3, 2014 Data Report

Michigan Department of Environmental Quality, Residential and Nonresidential Groundwater Criteria, December 30, 2013.

State of Michigan. 1994. Natural Resources and Environmental Protection Act. Act 451 of 1994. Including all amendments. Last amended May 8, 2013.

USEPA. 2005. Risk Management Strategy for Corrective Action Projects. EPA Region 5 RCRA Program. May.

United States Environmental Protection Agency. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Unified Guidance. Office of Resource Conservation and Recovery. EPA 530-R-09-007.

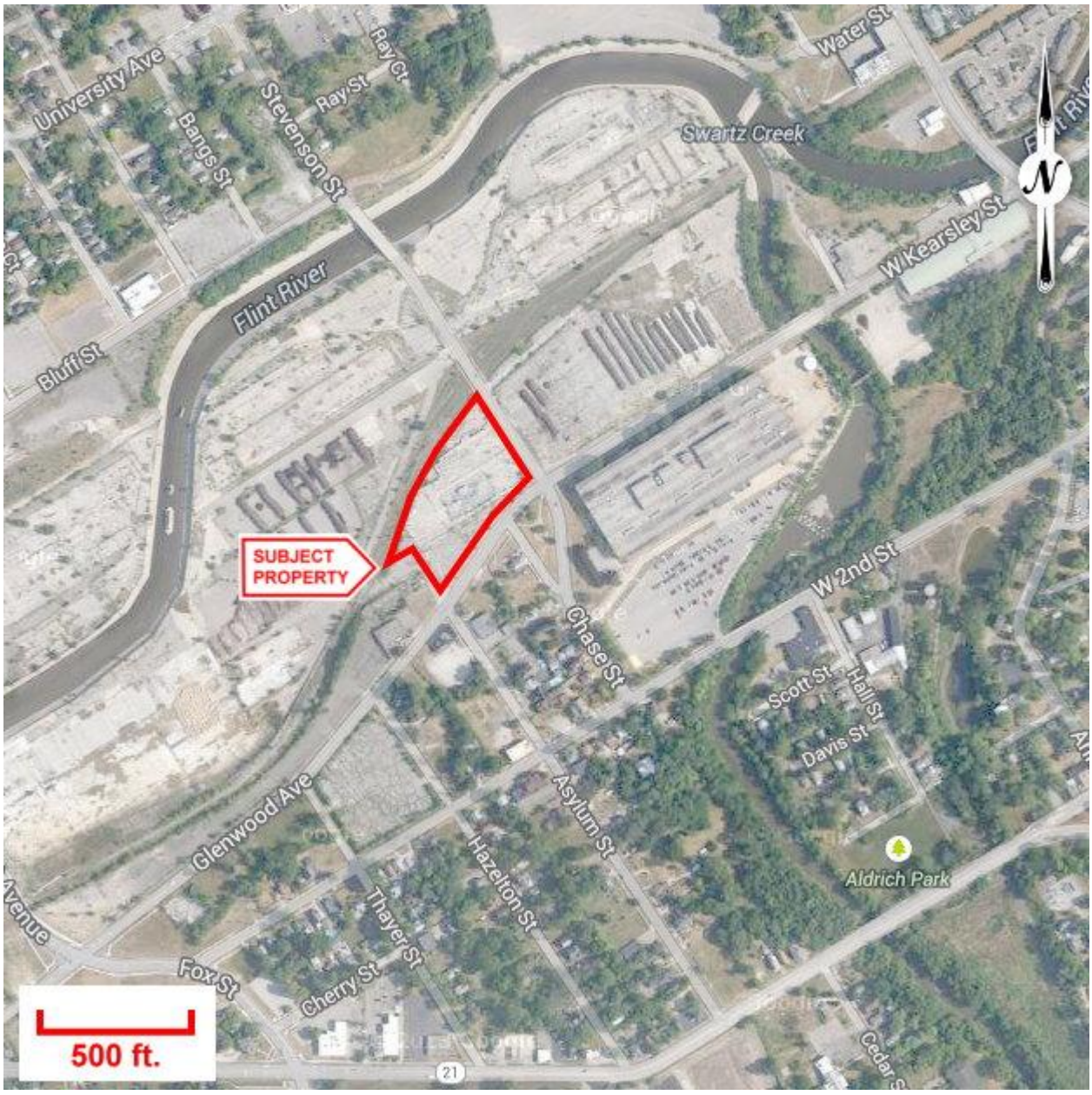
Michigan Department of Environmental Quality and Michigan State University Water Well Viewer, September 2, 2014.

FIGURES

SITE LOCATION MAP

RACER Flint West

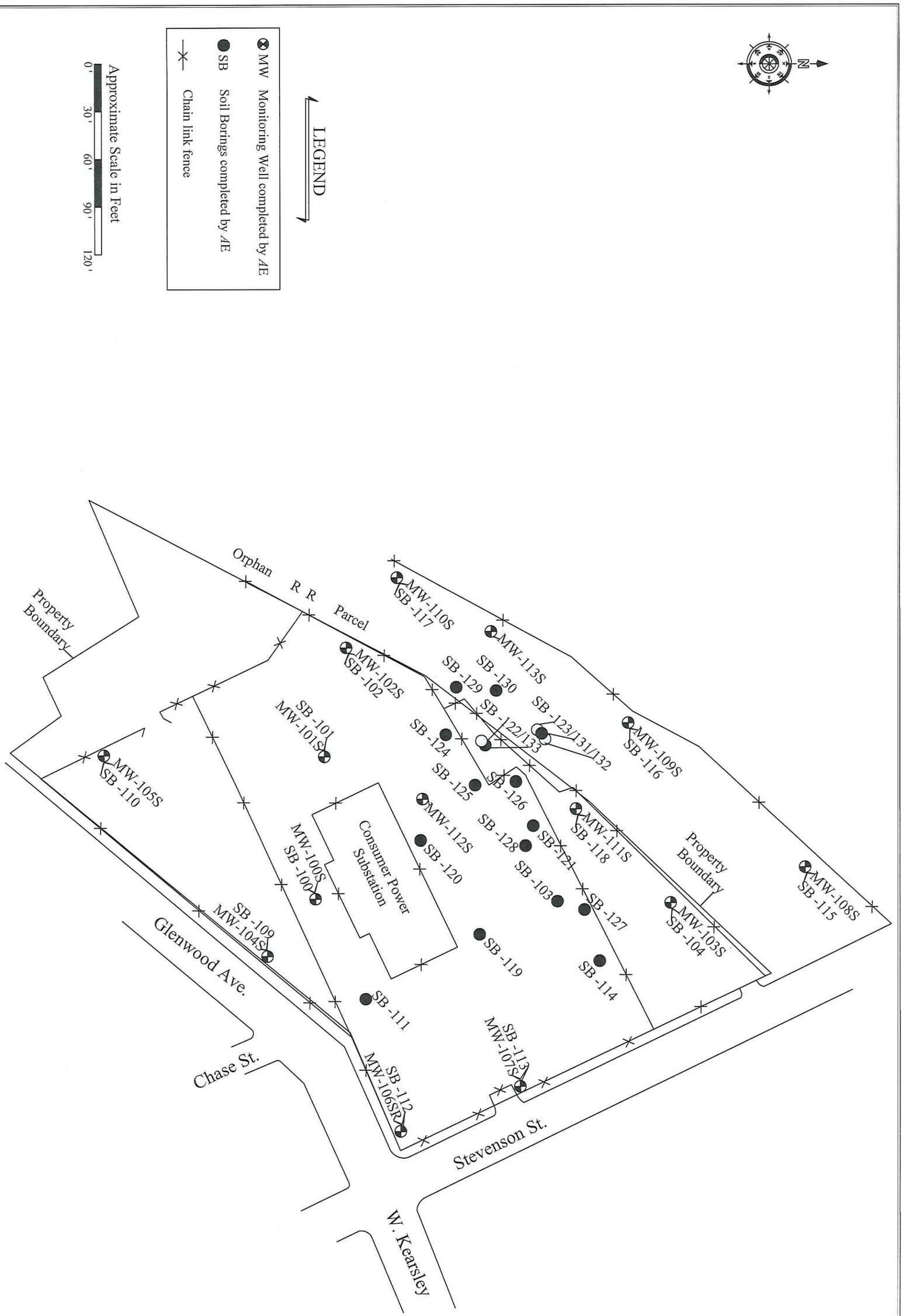
FIGURE	DATE	SCALE	PROJECT No.
1	2014	As Shown	11-4317-102



Source: United States Geological Survey	Property outline is approximate.

Applied EcoSystems, Inc.
Environmental Management, Consulting & Field Services

G-4300 South Saginaw Street
Burton, Michigan 48529
☎(810) 715-2525
FAX (810) 715-2526
www.AppliedEcoSystems.com



Applied EcoSystems, Inc.
Environmental Management, Consulting & Field Services
G-4300 South Saginaw Street, Burton, Michigan 48529
Phone: 810.715.2525; Fax: 810.715.2526

Site Map with Soil Boring and Monitoring Well Locations

Racer Flint West - 12990
Flint West Industrial Land, Flint, MI

DATE:	SCALE:
2014	As Shown
PROJECT:	FIGURE:
11-4317-102	2

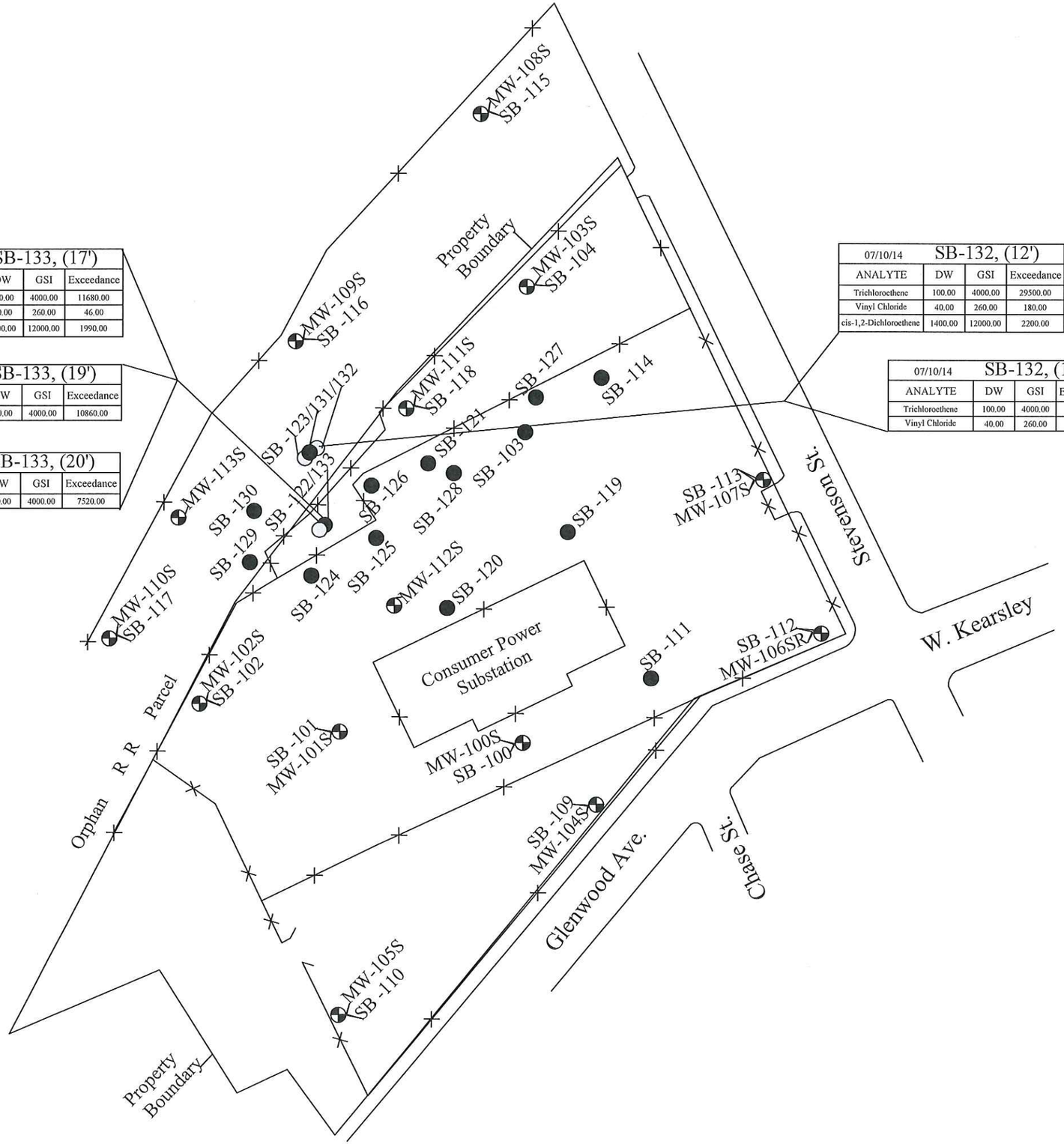
07/10/14	SB-133, (17')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100.00	4000.00	11680.00
Vinyl Chloride	40.00	260.00	46.00
cis-1,2-Dichloroethene	1400.00	12000.00	1990.00

07/10/14	SB-133, (19')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100.00	4000.00	10860.00

07/10/14	SB-133, (20')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100.00	4000.00	7520.00

07/10/14	SB-132, (12')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100.00	4000.00	29500.00
Vinyl Chloride	40.00	260.00	180.00
cis-1,2-Dichloroethene	1400.00	12000.00	2200.00

07/10/14	SB-132, (15')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100.00	4000.00	13700.00
Vinyl Chloride	40.00	260.00	89.00



LEGEND

- ⊗ MW Monitoring Well completed by *A*E
- ● SB Soil Borings completed by *A*E
- —×— Chain link fence

Soil Borings with no data attached indicate NO exceedences of DW or GSI Criteria.

Soil analytical results in ug/kg (ppb)

Soil analytical results reflect July 2014 sampling events only

Approximate Scale in Feet

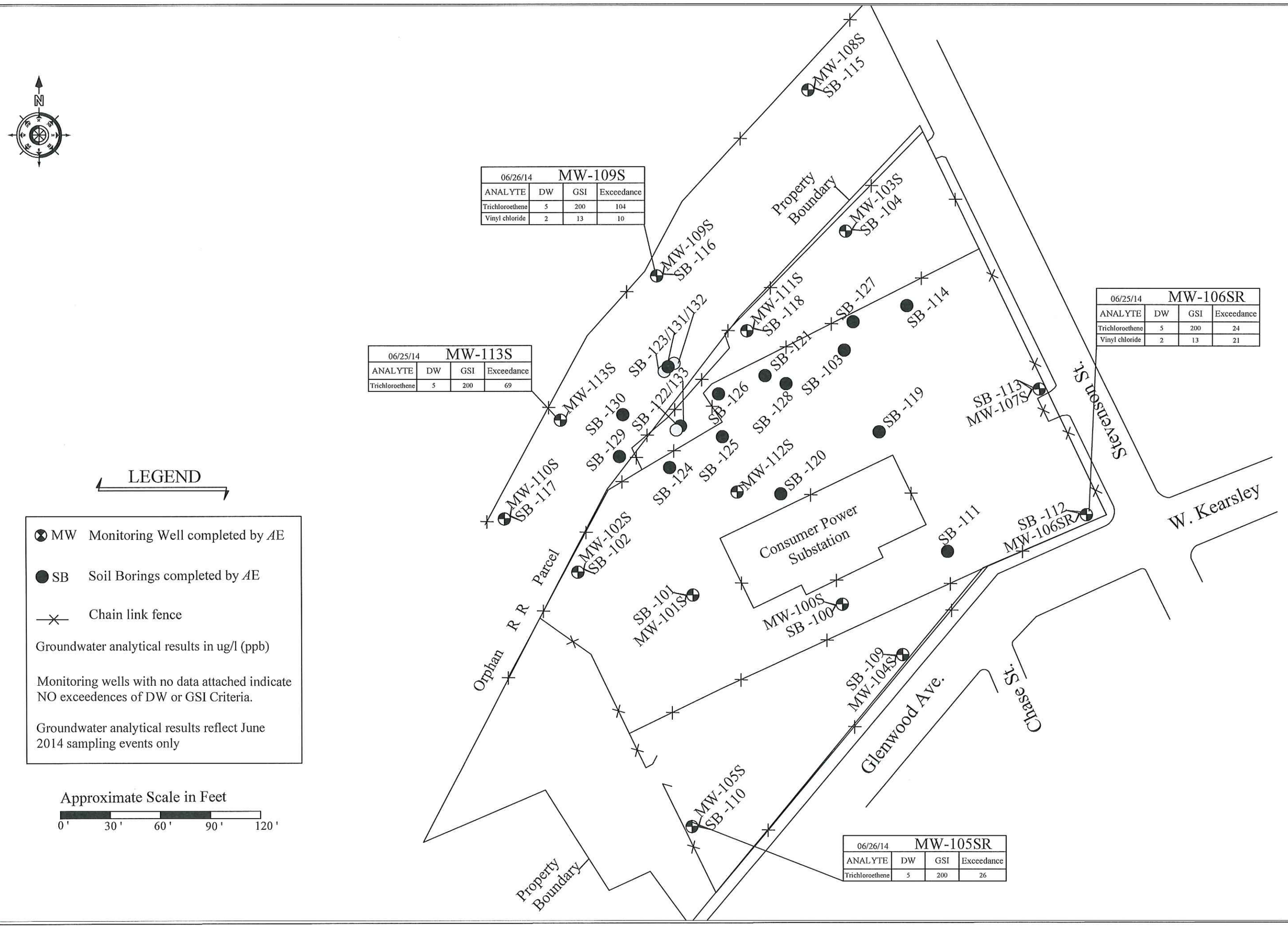
0 ' 30 ' 60 ' 90 ' 120 '

DATE:	SCALE:
2014	As Shown
PROJECT:	**FIGURE:**
11-4317-102	3

Summary of Drinking Water and GSI Exceedences in Soil
July 2014

Racer Flint West - 12990
Flint West Industrial Land, Flint, MI

Applied *Eco*Systems, Inc.
Environmental Management, Consulting & Field Services
G-4300 South Saginaw Street, Burton, Michigan 48529
Phone: 810.715.2525; Fax: 810.715.2526



06/26/14	MW-109S		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5	200	104
Vinyl chloride	2	13	10

06/25/14	MW-113S		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5	200	69

06/25/14	MW-106SR		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5	200	24
Vinyl chloride	2	13	21

06/26/14	MW-105SR		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5	200	26

LEGEND

- MW Monitoring Well completed by *A*E
- SB Soil Borings completed by *A*E
- Chain link fence

Groundwater analytical results in ug/l (ppb)

Monitoring wells with no data attached indicate NO exceedences of DW or GSI Criteria.

Groundwater analytical results reflect June 2014 sampling events only

Approximate Scale in Feet

0 ' 30 ' 60 ' 90 ' 120 '

DATE:	SCALE:
2014	As Shown
PROJECT:	**FIGURE:**
11-4317-102	4

Summary of Drinking Water and GSI Exceedences in Groundwater June 2014

Racer Flint West - 12990
Flint West Industrial Land, Flint, MI

Applied *Eco*Systems, Inc.
Environmental Management, Consulting & Field Services
G-4300 South Saginaw Street, Burton, Michigan 48529
Phone: 810.715.2525; Fax: 810.715.2526

12/12/13	MW-100S		
ANALYTE	DW	GSI	Exceedance
Zinc <dissolved>	2.4	0.026	0.2060

12/11/13	MW-101S		
ANALYTE	DW	GSI	Exceedance
Lead	0.0040	0.0280	0.0090
Zinc	2.4000	0.0260	0.0420

12/11/13	MW-102S		
ANALYTE	DW	GSI	Exceedance
Arsenic	0.0100	0.0100	0.0190
Copper	1.0000	0.0200	0.0250
Lead	0.0040	0.0280	0.0130
Zinc <dissolved>	2.4000	0.0260	0.0560
Zinc	2.4000	0.0260	0.0600

12/16/13	MW-103S		
ANALYTE	DW	GSI	Exceedance
Arsenic <dissolved>	0.0100	0.0100	0.0230
Arsenic	0.0100	0.0100	0.0240

12/17/13	MW-104S		
ANALYTE	DW	GSI	Exceedance
Copper	1.0000	0.0200	0.0200
Zinc <dissolved>	2.4000	0.0260	0.0400

12/16/13	MW-105S		
ANALYTE	DW	GSI	Exceedance
Chromium	0.1000	0.1600	3.4800
Copper	1.0000	0.0200	0.1180
Selenium <dissolved>	0.0500	0.0050	0.0100
Selenium	0.0500	0.0050	0.0100
Tetrachloroethane	5.0000	60.0000	22.0000

12/17/13	MW-106SR		
ANALYTE	DW	GSI	Exceedance
Arsenic	0.0100	0.0100	0.0990
Chromium	0.1000	0.1600	40.0000
Copper	1.0000	0.0200	0.7470
Lead	0.0040	0.0280	0.1460
Selenium	0.0500	0.0050	0.0080
Zinc <dissolved>	2.4000	0.0260	0.0820
Zinc	2.4000	0.0260	0.6570

12/17/13	MW-107S		
ANALYTE	DW	GSI	Exceedance
Arsenic	0.0100	0.0100	0.0200
Copper <dissolved>	1.0000	0.0200	0.1100
Lead	0.0040	0.0280	0.0300
Selenium	0.0500	0.0050	0.0100
Zinc <dissolved>	2.4000	0.0260	0.0600
Zinc	2.4000	0.0260	0.1900

12/11/13	MW-108S		
ANALYTE	DW	GSI	Exceedance
Arsenic	0.0100	0.0100	0.0130
Copper	1.0000	0.0200	0.0400
Lead	0.0040	0.0280	0.0550
Zinc <dissolved>	2.4000	0.0260	0.0720
Zinc	2.4000	0.0260	0.1210

12/11/13	MW-109S		
ANALYTE	DW	GSI	Exceedance
Arsenic	0.0100	0.0100	0.0450
Copper	1.0000	0.0200	0.0770
Lead	0.0040	0.0280	0.0590
Zinc <dissolved>	2.4000	0.0260	0.0630
Zinc	2.4000	0.0260	0.1780
Trichloroethane	5.0000	200.0000	161.0000
Vinyl Chloride	2.0000	13.0000	8.0000

12/11/13	MW-110S		
ANALYTE	DW	GSI	Exceedance
Arsenic	0.0100	0.0100	0.0410
Chromium	0.1000	0.1600	0.1010
Copper	1.0000	0.0200	0.2780
Lead	0.0040	0.0280	0.0610
Zinc <dissolved>	2.4000	0.0260	0.2600
Zinc	2.4000	0.0260	0.2000

12/16/13	MW-111S		
ANALYTE	DW	GSI	Exceedance
Vinyl Chloride	2.0000	13.0000	99.0000
1,1-Dichloroethane	7.0000	130.0000	18.0000
cis-1,2-Dichloroethane	70.0000	620.0000	160.0000
Trichloroethane	5.0000	200.0000	180.0000

12/12/13	MW-112S		
ANALYTE	DW	GSI	Exceedance
Arsenic	0.0100	0.0100	0.2740
Chromium	0.1000	0.1600	0.2560
Copper <dissolved>	1.0000	0.0200	0.0300
Copper	1.0000	0.0200	0.4180
Lead	0.0040	0.0280	0.2570
Zinc <dissolved>	2.4000	0.0260	0.1360
Zinc	2.4000	0.0260	0.9290
Vinyl Chloride	2.0000	13.0000	3.0000

12/11/13	MW-113S		
ANALYTE	DW	GSI	Exceedance
Arsenic	0.0100	0.0100	0.3640
Chromium	0.1000	0.1600	2.9200
Copper	1.0000	0.0200	4.1600
Lead	0.0040	0.0280	3.3100
Zinc <dissolved>	2.4000	0.0260	0.5020
Zinc	2.4000	0.0260	7.0300
Trichloroethane	5.0000	200.0000	62.0000

06/26/14	MW-105S		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5	200	26

06/25/14	MW-106SR		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5	200	24
Vinyl chloride	2	13	21

06/26/14	MW-109S		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5	200	104
Vinyl chloride	2	13	10

06/25/14	MW-113S		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5	200	69

04/03/14	MW-105S		
ANALYTE	DW	GSI	Exceedance
Tetrachloroethene	5.0	60.0	47.0

03/29/14	MW-109S		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5.0	200.0	102.0
Vinyl chloride	2.00	13.00	18.00

03/29/14	MW-111S		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5.0	200.0	92.0
Vinyl chloride	2.00	13.00	4.00

04/03/14	MW-112S		
ANALYTE	DW	GSI	Exceedance
Vinyl chloride	2.00	13.00	6.00

03/29/14	MW-113S		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5.0	200.0	23.0

04/21/14	SB-127 twt		
ANALYTE	DW	GSI	Exceedance
Vinyl chloride	2.00	13.00	5.00

04/22/14	SB-129 twt		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5.0	200.0	8.0

04/22/14	SB-129 twb		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5.0	200.0	9.0

04/22/14	SB-131 twt		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5.0	200.0	81.0

04/22/14	SB-131 twb		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	5.0	200.0	78.00

DATE:	2013 / 2014	SCALE:	As Shown
PROJECT:	11-4317-102	FIGURE:	4A

Summary of Drinking Water and GSI Exceedences in Groundwater 2013 / 2014

Racer Flint West - 12990
Flint West Industrial Land, Flint, MI

Applied EcoSystems, Inc.
Environmental Management, Consulting & Field Services
G-4300 South Saginaw Street, Burton, Michigan 48529
Phone: 810.715.2525; Fax: 810.715.2526

07/10/14	SB-133, (17')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100	4000	11680
Vinyl Chloride	40	260	46
cis-1,2-Dichloroethene	1400	12000	1990

07/10/14	SB-133, (19')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100	4000	10860

07/10/14	SB-133, (20')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100	4000	7520

07/10/14	SB-132, (12')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100	4000	29500
Vinyl Chloride	40	260	180
cis-1,2-Dichloroethene	1400	12000	2200

07/10/14	SB-132, (15')		
ANALYTE	DW	GSI	Exceedance
Trichloroethene	100	4000	13700
Vinyl Chloride	40	260	89

LEGEND

- MW Monitoring Well completed by *A*E
- SB Soil Borings completed by *A*E
- Chain link fence

Soil analytical results in ug/kg (ppb)

Soil analytical results reflect July 2014 sampling events only

Proposed H. R. C. Injection area, approx. 30' x 80'

Approximate Scale in Feet

0' 30' 60' 90' 120'

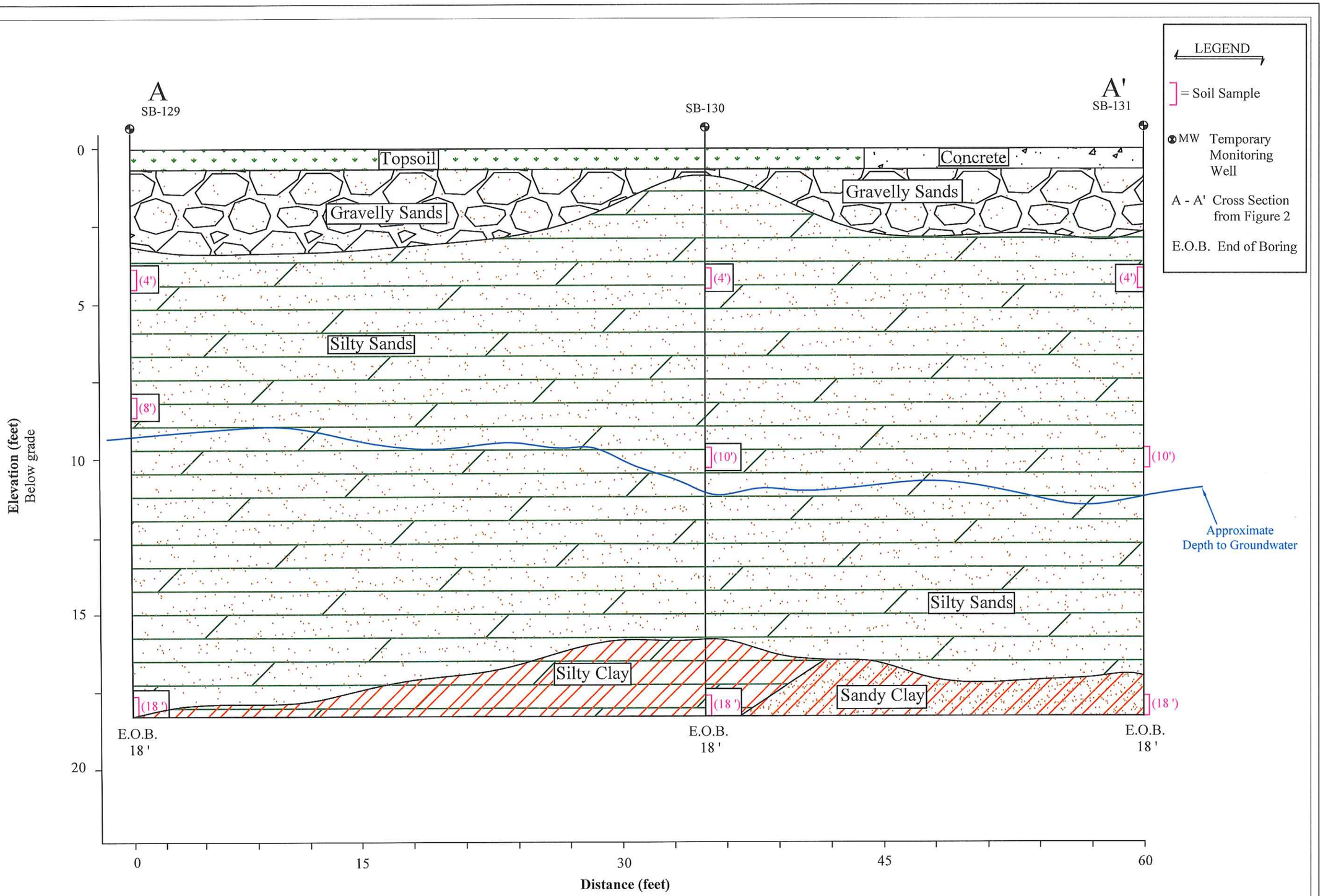
DATE:	SCALE:
2014	As Shown
PROJECT:	FIGURE:
11-4317-102	5

Summary of Drinking Water and GSI Exceedences in Soil
July 2014
Racer Flint West - 12990
Flint West Industrial Land, Flint, MI

Applied *Eco*Systems, Inc.
Environmental Management, Consulting & Field Services
G-4300 South Saginaw Street, Burton, Michigan 48529
Phone: 810.715.2525; Fax: 810.715.2526

Appendices

Appendix 1: Cross Section Diagrams

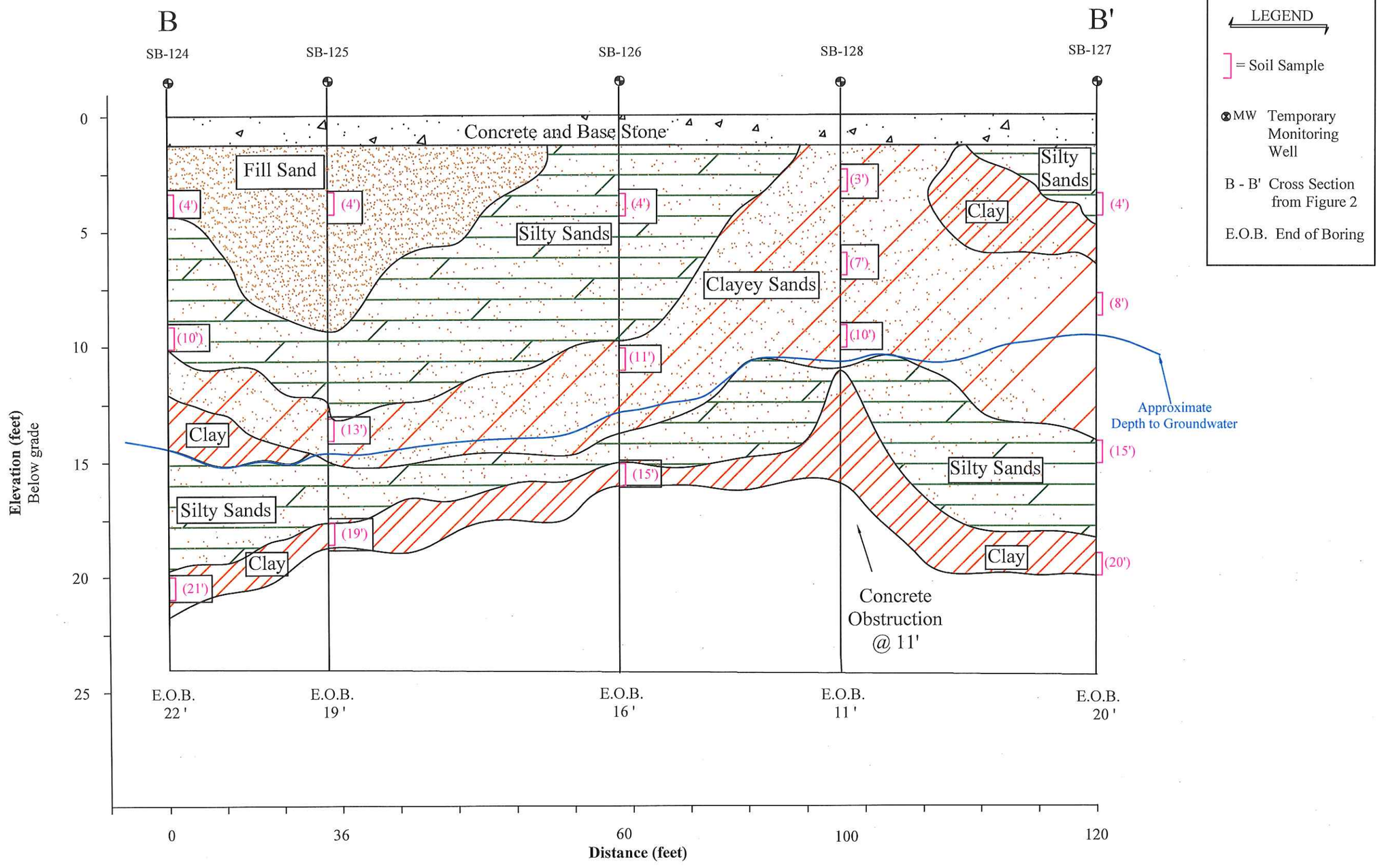


DATE:	2014
SCALE:	As Noted
PROJECT:	11-4317-102
Attachment:	1A

Cross Section Diagram A - A'
Spring Sampling Events

Racer Flint West - 12990
Flint West Industrial Land, Flint, MI

Applied EcoSystems, Inc.
Environmental Management, Consulting & Field Services
G-4300 South Saginaw Street, Burton, Michigan 48529
Phone: 810.715.2525; Fax: 810.715.2526



LEGEND

] = Soil Sample

⊗MW Temporary Monitoring Well

B - B' Cross Section from Figure 2

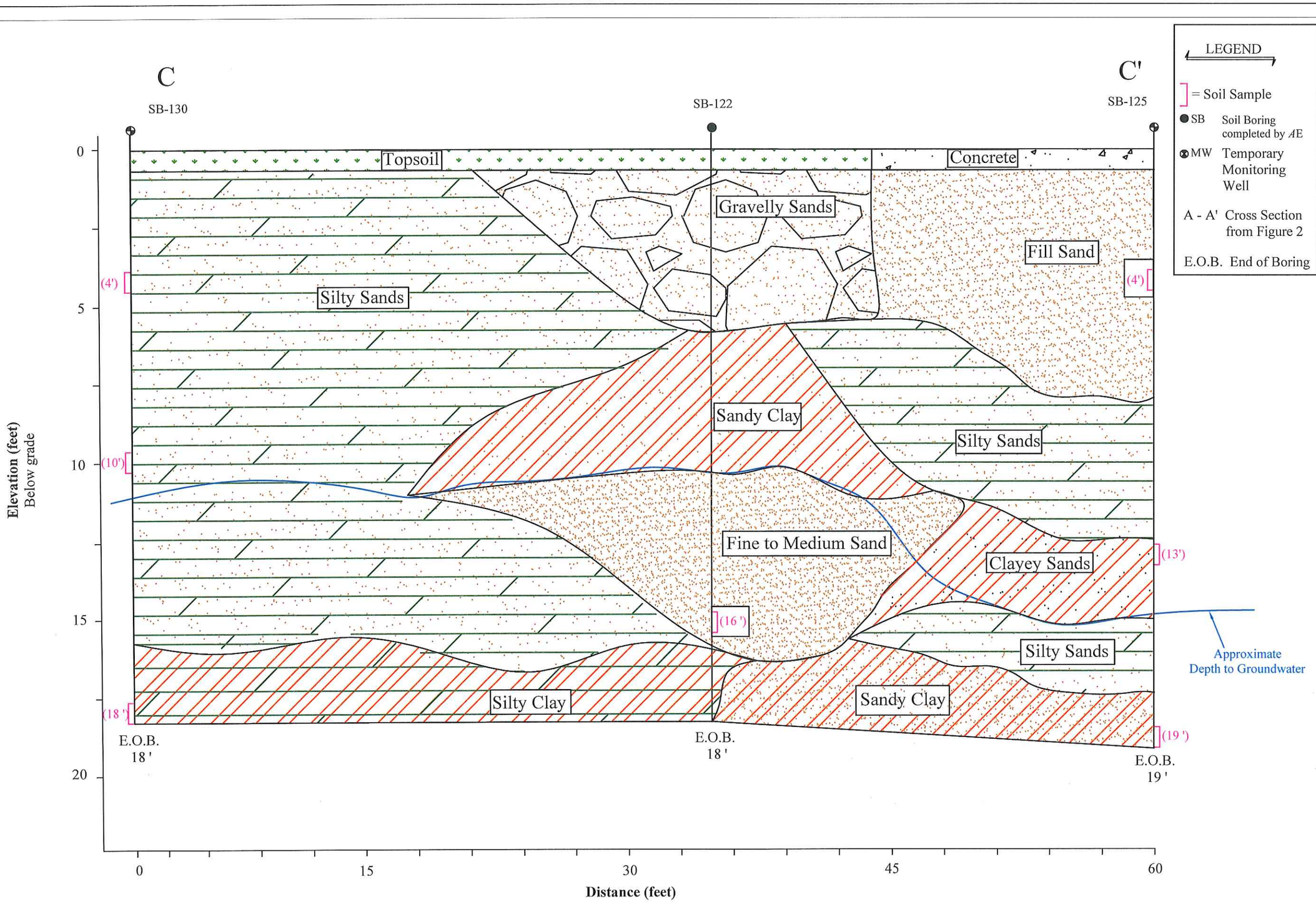
E.O.B. End of Boring

DATE: 2014	SCALE: As Noted
PROJECT: 11-4317-102	Attachment: 1B

Cross Section Diagram B - B'
Spring Sampling Events

Racer Flint West - 12990
Flint West Industrial Land, Flint, MI

Applied EcoSystems, Inc.
Environmental Management, Consulting & Field Services
G-4300 South Saginaw Street, Burton, Michigan 48529
Phone: 810.715.2525; Fax: 810.715.2526



DATE: 2014	SCALE: As Noted
PROJECT: 11-4317-102	Attachment: 1C

Cross Section Diagram C - C'
Spring Sampling Events

Racer Flint West - 12990
Flint West Industrial Land, Flint, MI

Applied EcoSystems, Inc.
Environmental Management, Consulting & Field Services
G-4300 South Saginaw Street, Burton, Michigan 48529
Phone: 810.715.2525; Fax: 810.715.2526

Appendix 2: Groundwater Analytical Tables

GROUNDWATER ANALYTICAL DATA
RACER - Flint West #12990

	Sample ID			MW-100S	MW-101S	MW-102S	MW-103S	MW-104S	MW-105SR	MW-106S	MW-107S	MW-108S	MW-109S	MW-110S	MW-111S	MW-112S	MW-113S	SB124-TWT	SB125-TWT	SB127-TWT	SB129-TWT	SB130-TWT	SB131-TWT	SB124-TWB	SB125-TWB	SB127-TWB	SB129-TWB	SB130-TWB	SB131-TWB	Dup1	Dup2	Dup3
	Date Collected				4/3/14	4/3/14	3/29/14	4/3/14	4/3/14	4/3/14	4/3/14	3/29/14	3/29/14	3/29/14	3/29/14	4/3/14	3/29/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	3/29/14		
ANALYTE (ug/L)	DW	GSI																														
Arsenic (dissolved)	10.00	10.00					11.00			4.00				21.00		19.00			17.00	57.00	4.00	3.00	2.00	3.00	30.00	38.00						
Chromium (dissolved)	100.00	160.00	G			35.00		22.00	18.00					7.00	12.00		128.00	13.00			147.00	64.00	25.00	16.00		17.00	89.00	19.00	33.00	14.00		
Copper (dissolved)	1,000.00	20.00	G											28.00				21.00		5.00	22.00	140.00	28.00	42.00		12.00	24.00	94.00	144.00			
Lead (dissolved)	4.00	28.00	G											24.00				29.00		5.00	23.00	208.00	16.00	47.00	1.00	19.00	11.00	31.00	14.00			
Selenium (dissolved)	50.00	5.00							6.00	5.00		5.00						12.00				4.00		12.00				5.00	3.00			
Zinc (dissolved)	2,400.00	26.00	G		97.00		23.00	5.00		62.00	5.00	16.00	18.00	81.00	21.00	9.00	24.00	311.00	167.00	82.00	323.00	326.00	103.00	241.00	400.00	166.00	68.00	241.00	191.00	12.00		

	Sample ID			MW-100S	MW-101S	MW-102S	MW-103S	MW-104S	MW-105SR	MW-106S	MW-107S	MW-108S	MW-109S	MW-110S	MW-111S	MW-112S	MW-113S	SB124-TWT	SB125-TWT	SB127-TWT	SB129-TWT	SB130-TWT	SB131-TWT	SB124-TWB	SB125-TWB	SB127-TWB	SB129-TWB	SB130-TWB	SB131-TWB	Dup1	Dup2	Dup3
	Date Collected																															
ANALYTE (ug/L)	DW	GSI																														
Acetone	730	1,700			1.13	2.36		0.88	1.82	3.58	3.82		1.22	2.11	0.72	5.17	0.93	5.7		9.1	5.7			10.3	66	25.8	5.9		5.8	1.06		
Methyl iodide	NC	NC																														
Carbon disulfide	800	NC																							0.86	0.4						
2 Butanone (MEK)	13,000	2,200			0.73	0.86		0.41	0.83	0.78	0.94					2.98									11.6	8.6						
Chloromethane	260	NC																						0.33		0.61						
Vinyl Chloride	2.0	13									0.64		18		4	6	0.45			5			2			2			2	4		
Chloroethane	430	1,100													0.6	1.13				1.07						0.77						
trichlorofluoromethane	2,600	NA																														
1,1-Dichloroethene	7.0	130											4		1	0.40				1						0.81				1		
Methylene Chloride	5.0	1,500																														
trans-1,2-Dichloroethene	100	1,500											0.92		0.24	0.23													0.28	0.26		
1,1-Dichloroethane	880	740									0.21		3.00		2	0.69	2.00						3.00						2.00	2.00		
cis-1,2-Dichloroethene	70	620									3		59		46	2	26			0.042	0.69	2	21			0.36	0.93	3.00	21.00	43.00		
Tetrahydrofuran	95	11,000																														
Chloroform	80	350						3.00				0.35	0.35		0.29								0.042						0.41	0.29		
1,1,1-Trichloroethane	200	89											0.48		0.75								0.72						0.71	0.73		
4-Methyl-2-pentanone (M	1800	1000000000														0.67				0.390					0.590	2.190						
2-Hexanone	1000	1000000000																		0.750				0.210	2.170	4.570						
Carbontetrachloride	5.0	45										2																				
Benzene	5.0	200									0.25									0.43	0.12			0.17	0.21	0.81	0.21	0.16	0.23			
Bromodichloromethane	80.0	NC						0.89																								
Trichloroethene	5.0	200			3	2					4		102		92	3	23				8	3	81	0.55			8	5	78	86		
Toluene	790	270								0.35	0.63							0.23		0.39	0.20			0.38	0.30	1.00	0.35	0.24	0.44			
Tetrachloroethene	5.0	60							47														0.180						0.17			
Chlorobenzene	100	25																														
Styrene	100	80																		0.43												
Ethylbenzene	74	18																						0.12	0.11	0.31			0.11			
Total Xylenes	280	41																								0.79						
1,2 -Dichlorobenzene	600	13																														
1,2,4-Trimethylbenzene	63	17																							0.22	0.31						
1,2,3-Trimethylbenzene	NC	NC								0.07	0.07														0.20	0.18						
Naphthalene	520	11																0.34		0.31				0.75	1.68	0.55						
2-Methylnaphthalene	260	19																0.51		0.40				0.47	0.88	0.47						

NOTES:

	Blank cells indicate no detectable concentrations
X	Exceeds DW criteria
X	Exceeds GSI criteria G
X	Exceeds both DW and GSI criteria
X	Compound also found in associated method blank, suggesting a laboratory artifact.
NC	Insufficient data to develop criterion/no criterion
G	Groundwater to Surface Water Interface Criteria - calculated based on 257ppm total hardness in the Flint River

GROUNDWATER ANALYTICAL DATA
RACER - Flint West #12990

	Sample ID			MW-100S	MW-101S	MW-102S	MW-103S	MW-104S	MW-105SR	MW-106S	MW-107S	MW-108S	MW-109S	MW-110S	MW-111S	MW-112S	MW-113S	Dup1	Dup2	Dup3
	Date Collected			6/25/14	6/25/14	6/25/14	6/26/14	6/25/14	6/26/14	6/25/14	6/25/14	6/26/14	6/26/14	6/26/14	6/26/14	6/25/14	6/26/14			
ANALYTE (ug/L)	DW	GSI																		
Arsenic (dissolved)	10.00	10.00														19				
Chromium (dissolved)	100.00	160.00	G			51											152			
Copper (dissolved)	1,000.00	20.00	G														4			
Lead (dissolved)	4.00	28.00	G					25	22	23				15			5			
Selenium (dissolved)	50.00	5.00				66			8			6								
Zinc (dissolved)	2,400.00	26.00	G	5	11		10				5	7				8	13			

	Sample ID			MW-100S	MW-101S	MW-102S	MW-103S	MW-104S	MW-105SR	MW-106S	MW-107S	MW-108S	MW-109S	MW-110S	MW-111S	MW-112S	MW-113S	Dup1	Dup2	Dup3
	Date Collected			6/25/14	6/25/14	6/25/14	6/26/14	6/25/14	6/26/14	6/25/14	6/25/14	6/26/14	6/26/14	6/26/14	6/26/14	6/25/14	6/26/14			
ANALYTE (ug/L)	DW	GSI																		
Acetone	730	1,700		1.74	1.45	2.04	2.67	1.55	1.86	1.59	2.82	1.32	1.47	1.29	1.48	4.93	1.32			
Methyl iodide	NC	NC																		
Carbon disulfide	800	NC														0.42	0.36			
2 Butanone (MEK)	13,000	2,200									0.4	0.65	0.29		0.29	1.99				
Chloromethane	260	NC		0.32				0.34									0.29			
Vinyl Chloride	2.0	13											10			21	2			
Chloroethane	430	1,100														2.9				
trichlorofluoromethane	2,600	NA																		
1,1-Dichloroethene	7.0	130											4			2.00	0.39			
Methylene Chloride	5.0	1,500																		
trans-1,2-Dichloroethene	100	1,500											0.7			0.64	0.24			
1,1-Dichloroethane	880	740														1.00	3.00			
cis-1,2-Dichloroethene	70	620		0.62									3			7	59			
Tetrahydrofuran	95	11,000											70.0							
Chloroform	80	350						5.00		0.22		0.5	0.37				0.320			
1,1,1-Trichloroethane	200	89											0.50				1.00			
4-Methyl-2-pentanone (M	1800	1000000000														0.83				
2-Hexanone	1000	1000000000														1.46				
Carbontetrachloride	5.0	45										2								
Benzene	5.0	200																		
Bromodichloromethane	80.0	NC						0.82												
Trichloroethene	5.0	200		5	1	3			26		2		104		2	24	69			
Toluene	790	270																		
Tetrachloroethene	5.0	60																		
Chlorobenzene	100	25																		
Styrene	100	80																		
Ethylbenzene	74	18																		
Total Xylenes	280	41																		
1,2 -Dichlorobenzene	600	13																		
1,2,4-Trimethylbenzene	63	17																		
1,2,3-Trimethylbenzene	NC	NC																		
Naphthalene	520	11																		
2-Methylnaphthalene	260	19																		

NOTES:

	Blank cells indicate no detectable concentrations
X	Exceeds DW criteria
X	Exceeds GSI criteria G
X	Exceeds both DW and GSI criteria
X	Compound also found in associated method blank, suggesting a laboratory artifact.
NC	Insufficient data to develop criterion/no criterion
G	Groundwater to Surface Water Interface Criteria - calculated based on 257ppm total hardness in the Flint River

Appendix 3: Soil Analytical Tables

SOIL ANALYTICAL DATA (Metals and Detected VOCs)
RACER - Flint West #12990

	Sample ID			SB124-4	SB124-10	SB124-21	SB125-4	SB125-13	SB125-19	SB126-4	SB126-11	SB126-15	SB127-4	SB127-8	SB127-15	SB127-20	SB128-3	SB128-7	SB128-10	SB129-4	SB129-8	SB129-18	SB130-4	SB130-10	SB130-18	SB131-4	SB131-10	SB131-18
	Date Collected			4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14
ANALYTE (ug/kg)	DW	GSI																										
Arsenic	5,800.00	5,800.00	D&G=B	1,130.00	1,100.00	1,830.00	570.00	1,440.00	1,410.00	1,300.00	1,250.00	1,180.00	410.00	1,630.00	2,060.00	1,780.00	500.00	1,550.00	1,150.00	2,790.00	1,740.00	1,460.00	3,580.00	1,700.00	1,980.00	1,630.00	1,300.00	2,080.00
Chromium	18,000.00	18,000.00	D&G=B	1,220.00	1,460.00	3,350.00	2,050.00	3,260.00	4,240.00	1,220.00	2,920.00	2,870.00	1,980.00	2,560.00	4,540.00	610.00	1,460.00	2,860.00	5,890.00	2,550.00	4,080.00	4,730.00	3,090.00	1,150.00	2,770.00	1,640.00	2,800.00	2,620.00
Copper	5,800,000.00	120,000.00	GX	1,700.00	2,300.00	8,200.00	7,400.00	6,100.00	11,400.00	3,400.00	3,100.00	5,600.00	1,600.00	3,000.00	5,800.00	1,200.00	3,900.00	5,600.00	5,300.00	13,000.00	3,600.00	7,200.00	17,700.00	1,700.00	9,800.00	8,500.00	3,100.00	7,900.00
Lead	700,000.00	5,000,000.00	GX	2,510.00	3,120.00	7,580.00	13,800.00	5,100.00	8,590.00	2,280.00	3,790.00	5,470.00	4,710.00	5,740.00	7,330.00	950.00	6,250.00	11,400.00	6,950.00	104,000.00	6,100.00	7,420.00	123,000.00	2,110.00	6,510.00	36,400.00	4,740.00	6,020.00
Selenium	4,000.00	410.00	G=B			210.00			210.00			160.00								130.00		150.00	140.00					
Zinc	2,400,000.00	2,600,000.00	G=B	4,600.00	5,100.00	19,000.00	11,400.00	12,200.00	20,800.00	5,900.00	8,600.00	14,700.00	3,700.00	10,300.00	20,300.00	2,400.00	6,000.00	13,200.00	9,900.00	21,300.00	13,100.00	19,200.00	51,800.00	5,800.00	18,000.00	16,800.00	13,600.00	18,600.00

ANALYTE (ug/kg)	DW	GSI																										
2 Butanone (MEK)	260,000.00	44,000.00		45.00	71.00	56.00		165.00	79.00	82.00	150.00	75.00	46.00	66.00	148.00	126.00	44.00	123.00	127.00	40.00	53.00	82.00	69.00	68.00	70.00	79.00	65.00	164.00
Vinyl Chloride	40.00	260.00							23.00																**73.00**			**90.00**
1,1-Dichloroethene	140.00	2,600.00																							34.00			18.00
trans-1,2-Dichloroethene	2,000.00	30,000.00																							100.00			62.00
1,1-Dichloroethane	18,000.00	15,000.00																							69.00			35.00
cis-1,2-Dichloroethene	1,400.00	12,000.00				58.00			350.00													300.00			**6,380.00**			**2,820.00**
Tetrahydrofuran	1,900.00	220,000.00		**170.00**	190.00	**190.00**	**150.00**	**180.00**	**180.00**	140.00	190.00	210.00	190.00	190.00	170.00	190.00	150.00	150.00	140.00	150.00	180.00	180.00	180.00	170.00	160.00	150.00	180.00	160.00
Chloroform	1,600.00	7,000.00							16.00																			
1,1,1-Trichloroethane	4,000.00	1,800.00							11.00													33.40						
Benzene	100.00	4,000.00																							36.00			
Trichloroethene	100.00	4,000.00				**1,420.00**			**3,650.00**													**6,170.00**			**6,080.00**	28.00		**12,160.00**
Toluene	16,000.00	5,400.00		11.00																13.00		19.00	31.00			45.00		
Ethylbenzene	1,500.00	360.00																					15.00					
Total Xylenes	5,600.00	820.00																		21.00			92.00			91.00		
Isopropylbenzene	91,000.00	3,200.00																16.00					13.00					
n-Propylbenzene	1,600.00	NC																					16.00					
1,2 -Dichlorobenzene	14,000.00	280.00																21.00										
1,2,4-Trimethylbenzene	2,100.00	570.00																		14.00			24.00			22.00		
1,2,3-Trimethylbenzene	NC	NC																13.50					13.40			11.80		
Naphthalene	35,000.00	730.00		10.80			14.40	17.00		13.70			12.90		14.30			345.70	46.90	39.50	12.50		51.50			100.30		
2-Methylnaphthalene	57,000.00	4,200.00		10.20			14.00	**39.00**		13.00	19.00				30.00		10.00	820.00	46.00	43.00			54.10			71.80		

NOTES:

	Blank cells indicate no detectable concentrations
X	Exceeds DW criteria
X	Exceeds GSI criteria
X	Exceeds both DW and GSI criteria
X	Compound also found in associated method blank, suggesting a laboratory artifact.
NC	Insufficient data to develop criterion/no criterion
GX	Groundwater to Surface Water Interface Criteria - calculated based on 257ppm total hardness in the Flint River

G

SOIL ANALYTICAL DATA (Detected VOCs)
RACER - Flint West #12990

	Sample ID			SB132-12	SB132-15	SB133-17	SB133-19	SB133-20
	Date Collected			7/10/14	7/10/14	7/10/14	7/10/14	7/10/14
ANALYTE (ug/kg)	**DW**	GSI						
2 Butanone (MEK)	260,000.00	44,000.00						
Vinyl Chloride	40.00	260.00		**180**	**89**	**46**		
1,1-Dichloroethene	140.00	2,600.00						
trans-1,2-Dichloroethene	2,000.00	30,000.00				18.00		
1,1-Dichloroethane	18,000.00	15,000.00				13.00		
cis-1,2-Dichloroethene	1,400.00	12,000.00		**2200.00**	1200.00	**1990.00**	530.00	270.00
Tetrahydrofuran	1,900.00	220,000.00		1500.00	300.00	150.00	160.00	117.00
Chloroform	1,600.00	7,000.00						
1,1,1-Trichloroethane	4,000.00	1,800.00				24.90	35.20	17.80
Benzene	100.00	4,000.00						
Trichloroethene	100.00	4,000.00		**29500**	**13700**	**11680**	**10860**	**7520**
Tetrachloroethene	100.00	1,200.00					17	
Toluene	16,000.00	5,400.00						
Ethylbenzene	1,500.00	360.00						
Total Xylenes	5,600.00	820.00						
Isopropylbenzene	91,000.00	3,200.00						
n-Propylbenzene	1,600.00	NC						
1,2 -Dichlorobenzene	14,000.00	280.00						
1,2,4-Trimethylbenzene	2,100.00	570.00						
1,2,3-Trimethylbenzene	NC	NC						
Naphthalene	35,000.00	730.00						
2-Methylnaphthalene	57,000.00	4,200.00				15.00	12.00	9.20

NOTES:

	Blank cells indicate no detectable concentrations
X	Exceeds DW criteria
X	Exceeds GSI criteria
X	Exceeds both DW and GSI criteria
X	Compound also found in associated method blank, suggesting a laboratory artifact.
NC	Insufficient data to develop criterion/no criterion
GX	Groundwater to Surface Water Interface Criteria - calculated based on 257ppm total hardness in the Flint River

G

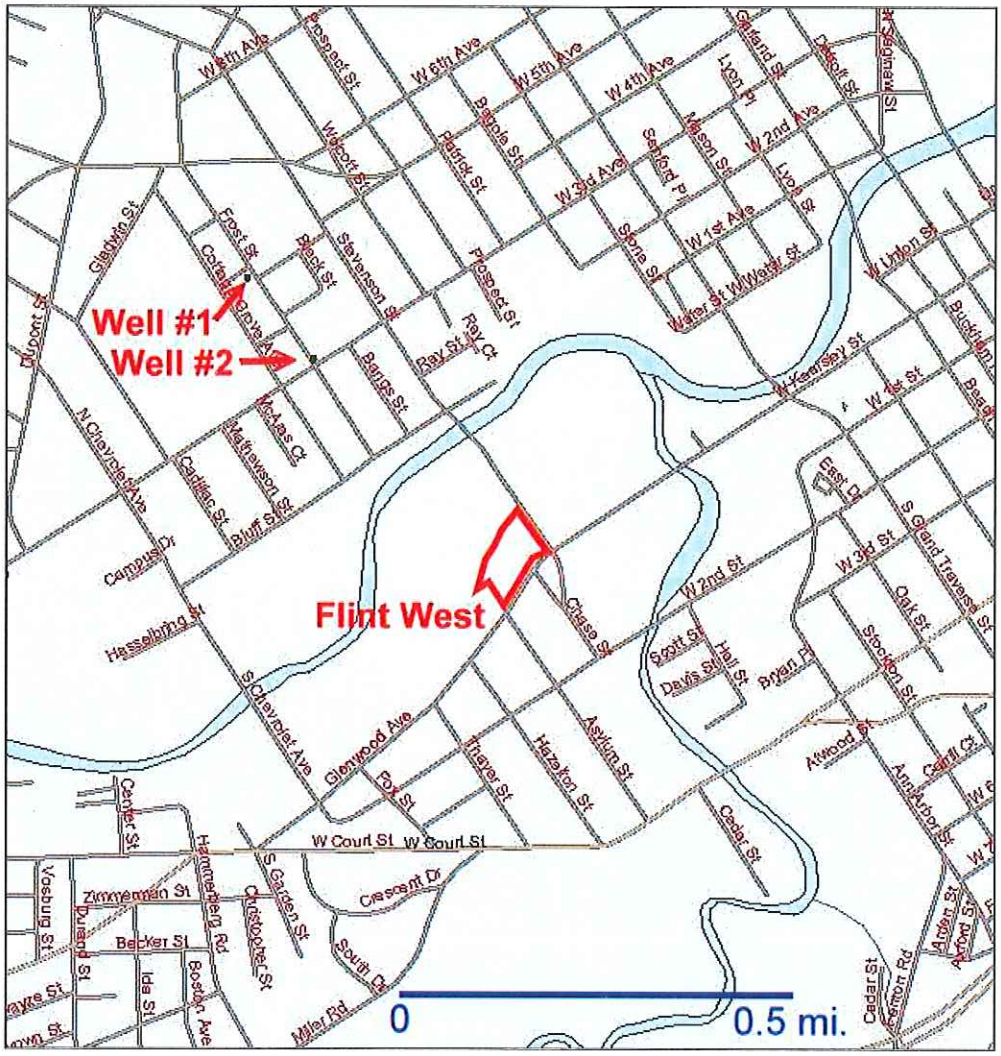
Appendix 4: Off-Site Drinking Water Well Records

AREA WELL LOCATIONS

RACER TRUST (#12990-11-01)
Flint West Industrial Land
Flint, Michigan

FIGURE	PROJECT NUMBER	DATE
2	11-4317-102	2014

Source: Michigan Department of Environmental Quality and Michigan State University Water Well Viewer.



Applied EcoSystems, Inc.
Environmental Management, Consulting & Field Services

G-4300 South Saginaw Street
Burton, Michigan 48529
☎(810) 715-2525
FAX (810) 715-2526

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Import ID: 25077613001

Tax No:	Permit No:	County: Genesee	Township: Flint			
		Town/Range: 07N 06E	Section: 13	Well Status:	WSSN:	Source ID/Well No:

Well ID: 25000001932

Elevation: 760 ft.
Latitude: 43.0172211561
Longitude: -83.7091694481
Method of Collection: Interpolation-Map

Distance and Direction from Road Intersection: SW CORNER FROST & FIFTH, S. OF FIFTH, 20' W. OF FROST

Well Owner: CITY OF FLINT, MICHIGAN

Well Address: FLINT, MI

Owner Address: 1101 S. SAGINAW ST. FLINT, MI 48502

Drilling Method: Auger/Bored
Well Depth: 96.00 ft. **Well Use:** Other
Well Type: Replacement **Date Completed:** 9/17/1981
Casing Type: Unknown **Height:** 0.00 ft. below grade
Casing Joint: Unknown
Casing Fitting: None

Diameter: 12.00 in. to 96.00 ft. depth

Borehole:

Pump Installed: No
Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level: 999.99 ft. Below Grade
Well Yield Test: **Yield Test Method:** Unknown

Screen Installed: Yes **Filter Packed:** No
Screen Diameter: 0.00 in. **Blank:** 0.00 ft. Above
Screen Material Type:

Slot	Length	Set Between
0.00	12.00 ft.	84.00 ft. and 96.00 ft.

Fittings: None

Formation Description	Thickness	Depth to Bottom
Yellow Clay	15.00	15.00
Gray Clay Hard	40.00	55.00
Silt & Clay Dry	7.00	62.00
Silt Sandy	21.00	83.00
Clay	2.00	85.00
Sand Wet/Moist	3.00	88.00
Clay	8.00	96.00

Well Grouted: Yes **Grouting Method:** Unknown

Grouting Material	Bags	Additives	Depth
Unknown	0.00	None	0.00 ft. to 0.00 ft.

Wellhead Completion: Unknown

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
None		

Abandoned Well Plugged: No
Reason Not Plugged:

Drilling Machine Operator Name:
Employment: Unknown

Contractor Type: Unknown **Reg No:**
Business Name:
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor **Date**

General Remarks: Added UM-Flint, 4/93
Other Remarks: Well Use:Type Use Unknown

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Import ID: 25077613002

Tax No:	Permit No:	County: Genesee	Township: Flint		
		Town/Range: 07N 06E	**Section:** 13	**Well Status:**	**WSSN:**	**Source ID/Well No:**

Well ID: 25000001933

Elevation: 770 ft.
Latitude: 43.0157299927
Longitude: -83.7075896893
Method of Collection: Interpolation-Map

Distance and Direction from Road Intersection:
60' NORTH OF C/L 3RD. AVE. 20'W. OF C/L FROST ST.

Well Owner: CITY OF FLINT, MICHIGAN

Well Address:	Owner Address:
FLINT, MI	1101 S. SAGINAW ST. FLINT, MI 48502

Drilling Method: Auger/Bored
Well Depth: 100.00 ft. **Well Use:** Other
Well Type: Replacement **Date Completed:**
Casing Type: Unknown **Height:** 0.00 ft. below grade
Casing Joint: Unknown
Casing Fitting: None

Diameter: 12.00 in. to 100.00 ft. depth

Borehole:

Pump Installed: No
Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level: 70.00 ft. Below Grade
Well Yield Test: **Yield Test Method:** Unknown

Screen Installed: Yes **Filter Packed:** No
Screen Diameter: 0.00 in. **Blank:** 0.00 ft. Above
Screen Material Type:

Slot	Length	Set Between
0.00	20.00 ft.	80.00 ft. and 100.00 ft.

Fittings: None

Formation Description	Thickness	Depth to Bottom
Yellow Clay	18.00	18.00
Gray Clay Soft	12.00	30.00
Hardpan	33.00	63.00
Clay Gravely W/Boulders	9.00	72.00
Gray Sand	8.00	80.00
Gray Sand W/Gravel	18.00	98.00
Clay Silty	2.00	100.00

Well Grouted: Yes **Grouting Method:** Unknown

Grouting Material	Bags	Additives	Depth
Unknown	0.00	None	0.00 ft. to 0.00 ft.

Wellhead Completion: Unknown

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
None		

Abandoned Well Plugged: No
Reason Not Plugged:

Drilling Machine Operator Name:
Employment: Unknown

Contractor Type: Unknown **Reg No:**
Business Name:
Business Address:

Water Well Contractor's Certification

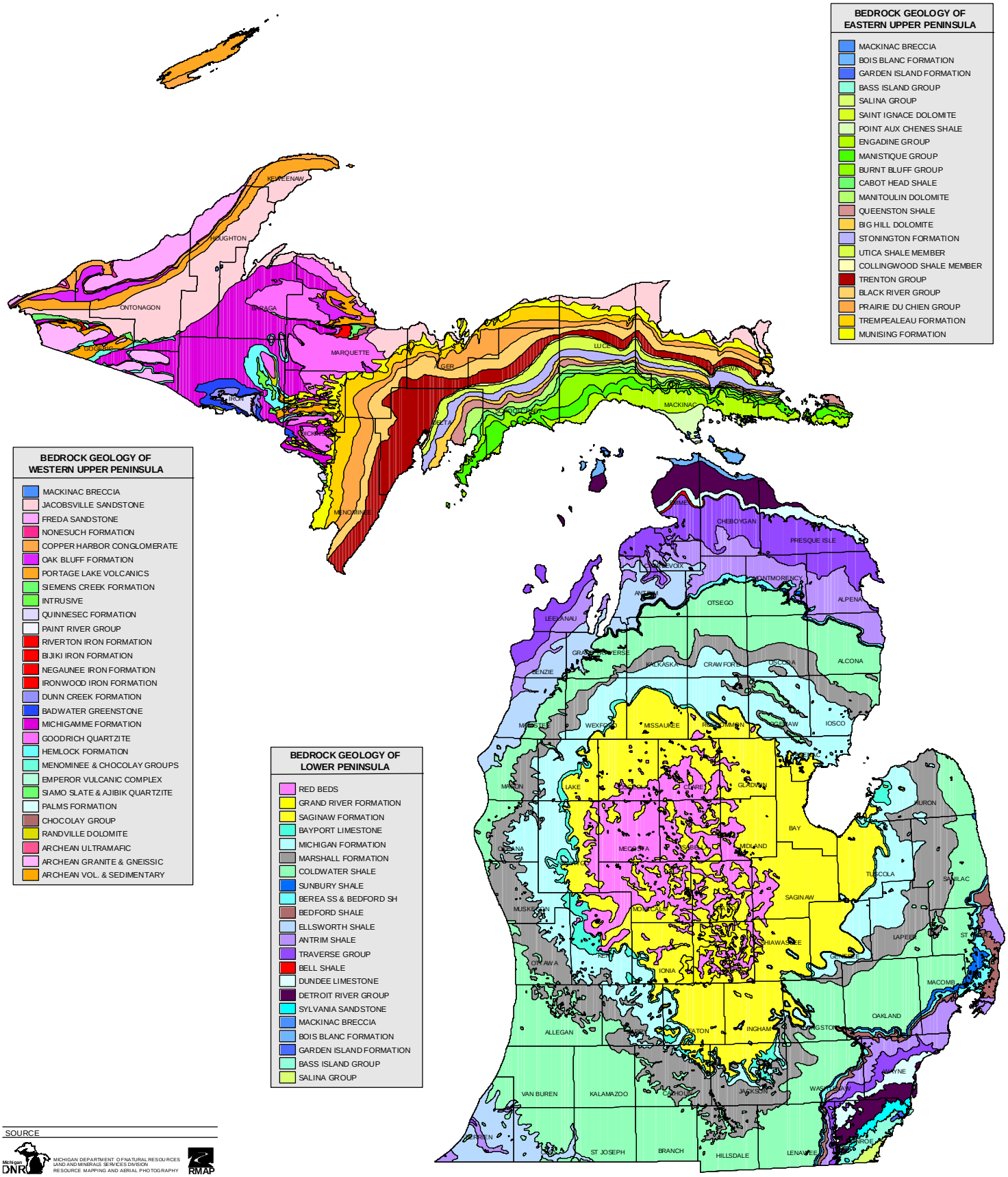
This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor **Date**

General Remarks: Added UM-Flint, 4/93
Other Remarks: Well Use:Type Use Unknown

Appendix 5: Bedrock Geology of Michigan, 1987

1987 BEDROCK GEOLOGY OF MICHIGAN



BEDROCK GEOLOGY OF EASTERN UPPER PENINSULA

- MACKINAC BRECCIA
- BOIS BLANC FORMATION
- GARDEN ISLAND FORMATION
- BASS ISLAND GROUP
- SALINA GROUP
- SAINT IGNACE DOLOMITE
- POINT AUX CHENES SHALE
- ENGADINE GROUP
- MANISTIQUE GROUP
- BURNT BLUFF GROUP
- CABOT HEAD SHALE
- MANITOULIN DOLOMITE
- QUEENSTON SHALE
- BIG HILL DOLOMITE
- STONINGTON FORMATION
- UTICA SHALE MEMBER
- COLLINGWOOD SHALE MEMBER
- TRENTON GROUP
- BLACK RIVER GROUP
- PRAIRIE DU CHIEN GROUP
- TREMPEALEAU FORMATION
- MUNISING FORMATION

BEDROCK GEOLOGY OF WESTERN UPPER PENINSULA

- MACKINAC BRECCIA
- JACOBSVILLE SANDSTONE
- FREDA SANDSTONE
- NONESUCH FORMATION
- COPPER HARBOR CONGLOMERATE
- OAK BLUFF FORMATION
- PORTAGE LAKE VOLCANICS
- SIEMENS CREEK FORMATION
- INTRUSIVE
- QUINNESEC FORMATION
- PAINT RIVER GROUP
- RIVERTON IRON FORMATION
- BIJIKI IRON FORMATION
- NEGAUNEE IRON FORMATION
- IRONWOOD IRON FORMATION
- DUNN CREEK FORMATION
- BADWATER GREENSTONE
- MICHIGAMME FORMATION
- GOODRICH QUARTZITE
- HEMLOCK FORMATION
- MENOMINEE & CHOCOLAY GROUPS
- EMPEROR VULCANIC COMPLEX
- SIAMO SLATE & AJIBIK QUARTZITE
- PALMS FORMATION
- CHOCOLAY GROUP
- RANDVILLE DOLOMITE
- ARCHEAN ULTRAMAFIC
- ARCHEAN GRANITE & GNEISSIC
- ARCHEAN VOL. & SEDIMENTARY

BEDROCK GEOLOGY OF LOWER PENINSULA

- RED BEDS
- GRAND RIVER FORMATION
- SAGINAW FORMATION
- BAYPORT LIMESTONE
- MICHIGAN FORMATION
- MARSHALL FORMATION
- COLDWATER SHALE
- SUNBURY SHALE
- BEREA SS & BEDFORD SH
- BEDFORD SHALE
- ELLSWORTH SHALE
- ANTRIM SHALE
- TRAVERSE GROUP
- BELL SHALE
- DUNDEE LIMESTONE
- DETROIT RIVER GROUP
- SYLVANIA SANDSTONE
- MACKINAC BRECCIA
- BOIS BLANC FORMATION
- GARDEN ISLAND FORMATION
- BASS ISLAND GROUP
- SALINA GROUP

SOURCE

Michigan DNR — MICHIGAN DEPARTMENT OF NATURAL RESOURCES
LAND AND MINERALS SERVICES DIVISION
RESOURCE MAPPING AND AERIAL PHOTOGRAPHY
RMAP

Michigan Resource Information System
Part 609, Resource Inventory, of the Natural Resources and Environmental Petection Act, 1994 PA 451, as amended.

Automated from "Bedrock Geology of Michigan," 1987, 1:500,000 scale, which was compiled from a variety of sources by the Michigan Department of Environmental Quality, Geological Survey Division.

Date 11/12/99

0 20 40 Miles

Appendix 6: ISCO Case Studies

Case History H-12

REGENESIS

HRC® HYDROGEN RELEASE COMPOUND

Hydrogen Release Compound (HRC®)

PCE and TCE at a Manufacturing Facility – Cookeville, TN

SITE SUMMARY

Subsurface investigations at this operating manufacturing facility revealed the presence of elevated concentrations of PCE and TCE in the groundwater. Accelerated bioremediation using HRC was selected because it would not interrupt the site's on-going operations. This application is also considered significant because HRC effectively reduced high levels, over 100 mg/L, of PCE and TCE in a tight clay formation.

REMEDIATION APPROACH

- **Remediation Objective**: Reduce concentrations of VOCs to target concentrations at the entire site. See following table.
- **Application Type:** Grid (Direct-Push Injection)
- **Product:** HRC
- **Quantity Applied:** 13,140 lb
- **Application Rate:** Plume – 3.6 lb/ft; Source – 10.5 lb/ft
- **Injection Spacing:** Plume – 20 ft on-center; Source – 10 ft on-center
- **Product Cost:** $76,900

Table 1. Target Concentrations

Contaminant	Concentration
PCE	5 ug/L
TCE	5 ug/L
Cis-1,2-DCE	70 ug/L
VC	2 ug/L

SITE CHARACTERISTICS

General

- **Name:** Cookeville
- **Location:** Cookeville, TN
- **Industry:** Manufacturing
- **Contaminants of Concern:**

Contaminant	Concentration
PCE	115,000 ug/L
TCE	110,000 ug/L
DCE	1,280 ug/L
VC	180 ug/L

Hydrogeology

- **Treatment Area:** 9,100 ft^2
- **Soil Type:** silty clay and silty sand
- **Groundwater Velocity:** 0.68 ft/day
- **Groundwater Flow Direction:** Northeast
- **Depth to Groundwater:** Unknown

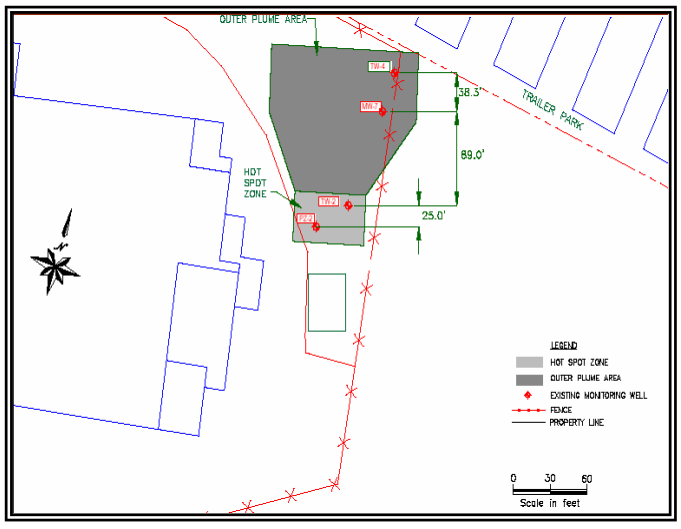


Figure 1. Site Map

RESULTS

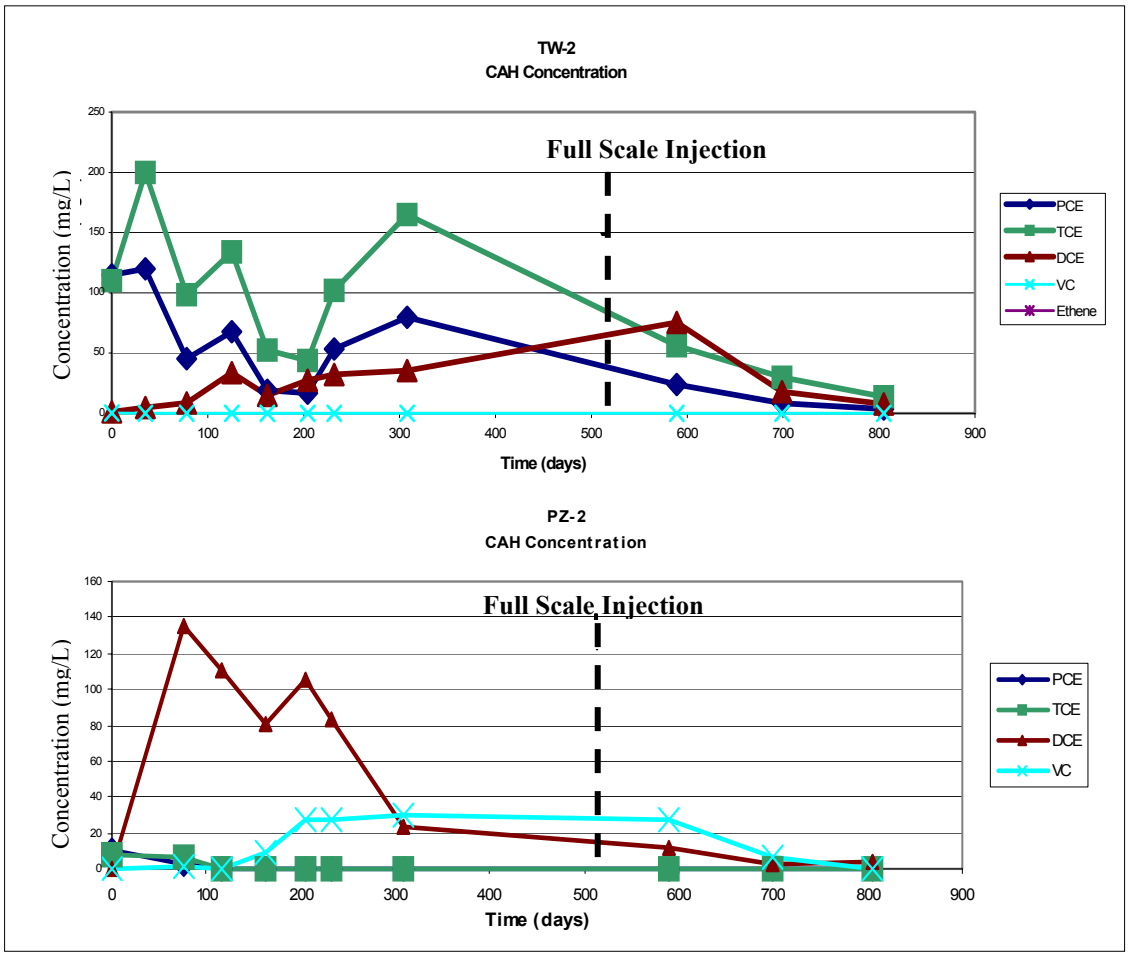
Percent Contaminant Reduction

Contaminant	Percent Reduction
PCE	97%
TCE	88%
DCE	Increase
VC	99%

Post Treatment Concentrations

Contaminant	Concentration
PCE	3.46 µg/L
TCE	13.7 µg/L
DCE	7.7 µg/L
VC	ND

Concentrations vs. Time



CONCLUSION

To date, this site has been treated with a pilot application and a single full-scale application. The results from the applications are promising and an additional full-scale application is planned for installation before the end of 2002. HRC has been so effective that the site owners are expecting to be granted site closure sometime in 2004.

CONTACTS

Consultant: George Yu
Mactec
Phone: (865) 531 – 1922

Regenesis: Drew Baird
Southcentral District Manager
Phone: (864) 240 – 9181
dbaird@regenesis.com

ENHANCED BIOREMEDIATION IN CLAY SOILS

Ms. Zahra M. Zahiraleslamzadeh (FMC Corporation, San Jose, CA)
Jeffrey C. Bensch (GeoTrans, Rancho Cordova, CA)

ABSTRACT: This case study evaluates the full-scale in-situ application of an electron donor to enhance biodegradation of chlorinated solvents in clay soils and groundwater beneath an active light industrial property in a congested urban setting. A pilot test was successful by varying degrees in three test areas as shown by the production of biodegradation daughter products and microbial end products. The results of the pilot test were used to design and implement the full-scale remediation with minimal disturbances to ongoing business operations. After twelve months of remediation monitoring, the trichloroethylene (TCE) is degrading to vinyl chloride (VC) and ethylene.

Organic acid, oxidation-reduction potential, and hydrogen monitoring results indicate that the microbial environment for reductive dechlorination was improved throughout the remediation area. TCE concentrations were significantly reduced, while cis-1,2 dichloroethylene concentrations increased then declined during the twelve months following the full-scale application. Elevated sulfate concentrations also declined coincident with the reductions in TCE concentrations. VC and ethylene concentrations, however, have increased significantly. It is expected that VC will continue to degrade to ethylene, based on the observed increases in ethylene and other microbial end products. Additional applications of the electron donor are anticipated to complete the remedy. If necessary, a sequential in-situ aerobic remediation process may be required to fully degrade the VC.

INTRODUCTION

The biological reductive dehalogenation process of chlorinated solvents, such as tetrachloroethylene (PCE) and trichloroethylene (TCE), is an accepted viable groundwater remediation process. Various enhancements are available to stimulate biological activity and accelerate the dehalogenation process. Applying these enhancements to the subsurface for effective remediation can be difficult and uncertain. This paper presents the results of a full-scale remediation involving the injection of hydrogen release compound (HRC®) into a silty clay soil to stimulate biodechlorination of TCE in groundwater.

The site is a 4.1-acre, relatively flat, property with a 76,000 square-foot light-industrial retail building and paved areas in a congested commercial/light industrial neighborhood. The site was used as agricultural land before the 1960s, then for various heavy manufacturing purposes through 1988. The building is currently leased to various light-industrial tenants.

Site soils are homogenous silty clays from ground surface to a depth of approximately 45 to 50 feet. A gravelly sand unit, approximately 30 to 35 feet thick, underlies the silty clay. The depth to groundwater is approximately 7 to 10 feet

Proceedings of the Battelle sponsored Sixth International In Situ and On-Site Bioremediation Symposium, San Diego, California, June 4-7, 2001. Published by Battelle Press, ISBN 1-57477-110-8, 2001.

below ground surface in wells screened in the silty clay, and the groundwater flow velocity is approximately 10 feet per year.

The site is impacted with volatile organic compounds (VOCs) in soil and shallow groundwater in the northeastern corner of the property (Figure 1).

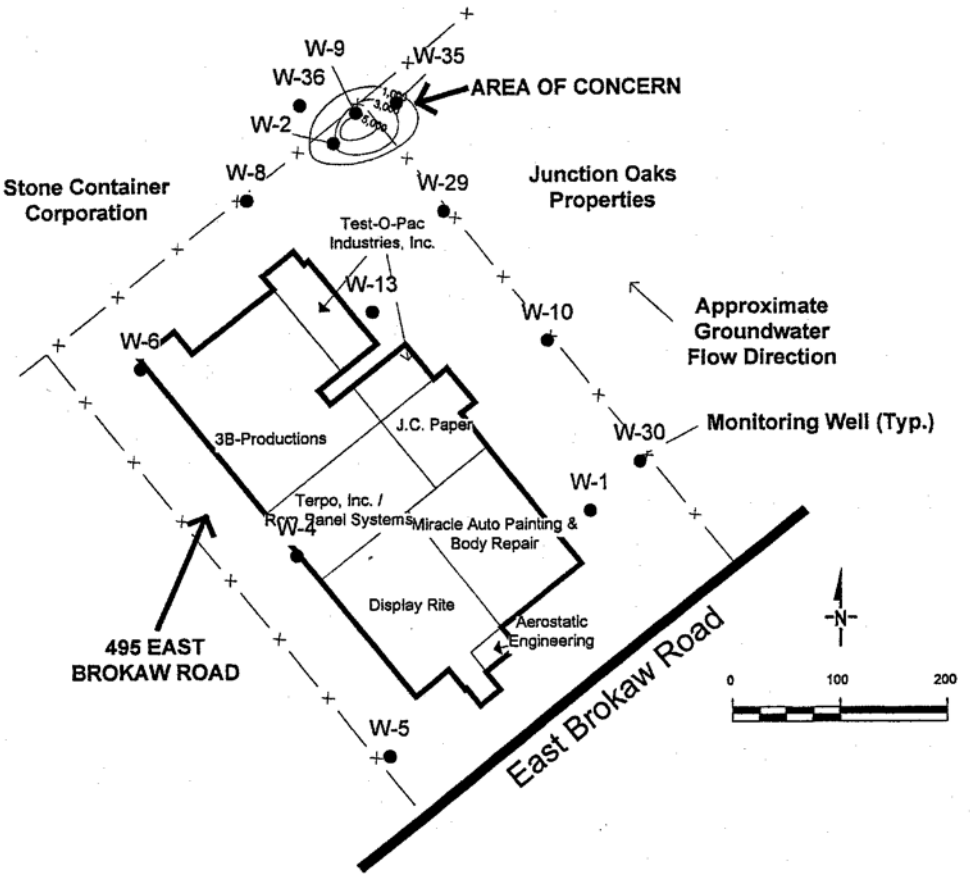


FIGURE 1. Site Features

Anaerobic biodegradation of VOCs occurs in environments free of oxygen, where the parent chlorinated compound is progressively dechlorinated into daughter products. The process at this site is the dechlorination of TCE into subsequent daughter compounds: cis-1,2 dichloroethylene (*cis*-1,2-DCE), vinyl chloride (VC), and ethylene. Microorganisms mediate this process using chlorinated compounds as electron acceptors and a source of hydrogen as the electron donor.

In the anaerobic biodechlorination process, the *cis*-1,2-DCE isomer is produced preferentially to the *trans*-1,2-DCE and 1,1-DCE isomers (Wiedemeier, et.a1.,1996). As such, evidence for reductive dehalogenation of TCE can be obtained by observing the formation of cis-1,2-DCE in excess of t*rans*-1,2-DCE and 1,1-DCE, e.g., a *cis/trans* ratio greater than one. Increasing concentrations of VC and the microbial end product ethylene suggest the process is continuing toward completion.

TCE is among the most susceptible VOCs to reductive dechlorination because it is well oxidized (i.e., contains more chlorine atoms than hydrogen atoms). VC is the least susceptible to reductive dechlorination because it is the least oxidized

Of the daughter product compounds (Wiedemeier, et.al.,1996). Anaerobic destruction of VC has been observed in study cases (Comuet, et.al., 2000), although it is more easily degraded in aerobic environments (Morse, et.al., 1998). The slower dechlorination of VC than TCE can result in an accumulation of VC.

Intrinsic biodegradation testing and evaluations were conducted at the site in 1998 using methods similar to the Air Force Center for Environmental Excellence (AFCEE) protocols (Wiedemeier, et.al.,1996). Field parameters, organic and inorganic parameters, microbial end products, microbial community structure, and dechlorinated daughter products were evaluated. The dissolved oxygen, pH, and oxidation reduction potential (ORP) indicated that the site was anaerobic, slightly reducing, and suggested that iron reduction may be the dominant redox process. The total organic carbon (TOC) concentrations and biomass as measured by phospholipid fatty acids (PLFA) analyses indicated the site could support a microbial population suitable for anaerobic reductive dechlorination. The nitrate and sulfate concentrations were elevated with respect to desirable levels for reductive dechlorination. Sulfate concentrations ranging from 130 to 320 milligrams per liter (mg/L) indicated that sulfate reducing bacteria may compete for available hydrogen and hinder the reductive dechlorination processes. The dechlorination daughter products indicated formation of *cis*-1,2-DCE in groundwater at the site. The ratio of cis/trans-isomers indicated that this formation was likely due to a reductive dechlorination process. Microbial end-products were not present during the initial investigations. This indicated that reductive dechlorination was not continuing through completion. In summary, the 1998 investigation indicated that biodegradation of VOCs occurred in the past, but it was very slow or in a dormant stage at the time of the evaluation.

A pilot study was implemented to evaluate the reductive dechlorination process in an isolated area at the site (Zahiraleslamzadeh, 2000). HRC was applied in three adjacent areas with varying degrees of TCE impacted groundwater. Following HRC application, significant reductions of TCE concentrations were observed with the accompanied increases in concentrations of daughter products and microbial end-products. The results of the pilot study indicated that reductive dechlorination could be stimulated at the site and a full-scale HRC application was warranted.

MATERIALS AND METHODS

The scope of the full-scale remediation included injecting approximately 12,000 pounds of HRC through 103 direct-push points in the northeast corner of the property and along the northern property boundary to remediate an apparent TCE source area and to provide a barrier to downgradient TCE migration, respectively. As shown in Figure 2, the injection points were located on a 5-foot by 10-foot grid in most areas and a 5-foot by 5-foot grid in the apparent TCE source area.

The HRC application was conducted during 10 days of field work between May 16 and May 31, 2000. HRC injections were completed using a top-down approach starting approximately eight feet below ground surface and ending at 28 feet below ground surface. Top-down injection was accomplished using a steel rod perforated near the bottom four feet of pipe. After the perforated rod was driven to

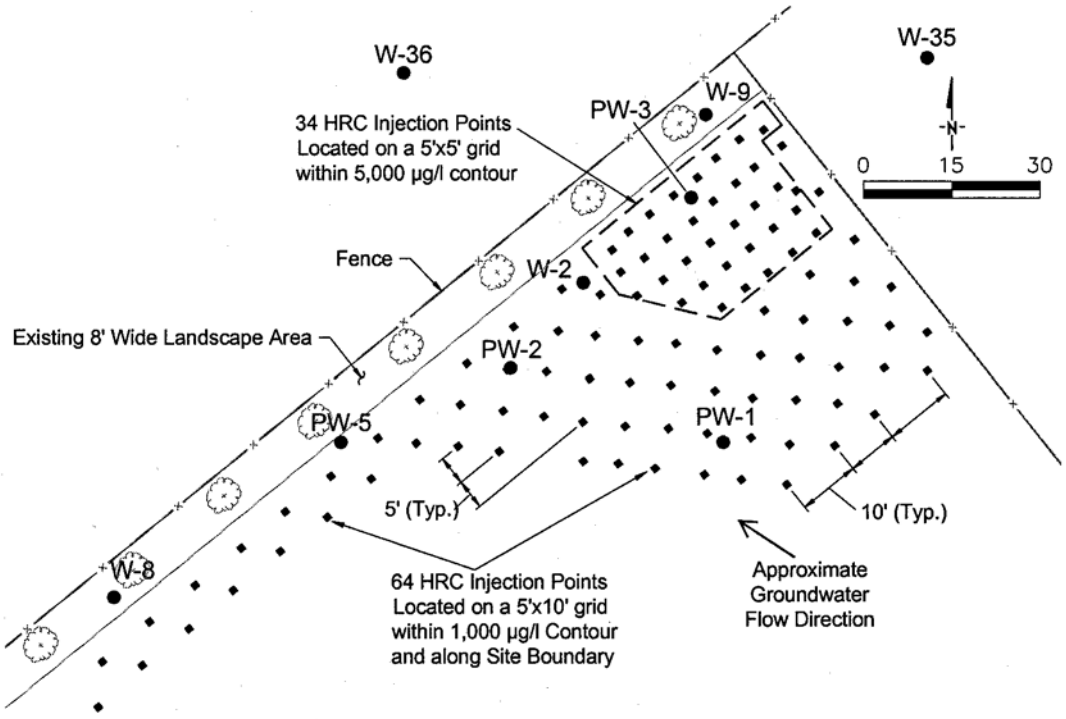


FIGURE 2. HRC Injection Locations and Monitoring Wells

the desired depth, it was coupled to a high pressure hose and pump. A specific amount of HRC was injected and the rod was then driven to the next depth interval. Approximately 12 gallons of HRC were applied to each injection point.

Groundwater samples for baseline testing were collected prior to HRC injection from monitoring wells. As shown on Figure 2, wells PW-3 and W-2 are located in the area where TCE concentrations are approximatley 5,000 micrgrams per liter (ug/L), and wells PW-2 and W-9 are close by where TCE concentrations are approximately 3,000 ug/L. Well PW-1 is in the upgradient area of impacts and wells PW-5 and W-8 are along the property boundary where TCE concentrations are less than 1,000 ug/L. Wells W-35 and W-36 have TCE concentrations-in the 2,000 ug/L and 200 ug/L ranges, respectively. These wells are located outside the HRC application area.

Monitoring was conducted every other month for six months from June through November 2000, then at three month intervals in February and May 2001 (5 events after HRC injection).

RESULTS AND DISCUSSION

Time series trend evaluations for TCE, *cis*-1,2-DCE, VC, and ethylene provide an indication of the remediation effectiveness at each monitoring well. A time series graph for well PW-1, and selected monitoring data for monitoring wells PW-1 and W-9 are presented to illustrate the remediation performance in areas of high and low biodechlorination activity.

High Biodechlorination Activity Wells. Significant TCE biodechlorination was observed at wells PW-1, PW-2, PW-3, and W-2. The TCE and daughter product concentrations in well PW-1 changed dramatically by July 2000, when the level of TCE dropped an order of magnitude. A corresponding rise in the concentration of daughter products *cis*-1,2-DCE and VC further indicated enhanced TCE breakdown. By September 2000, the concentration of daughter product *cis*-1,2 DCE also began to decrease. The increase of ethylene concentrations in July, September, and November 2000 indicated that the TCE dechlorination process was continuing through VC to completion. Ethylene concentrations declined, however, in February and May 2001.

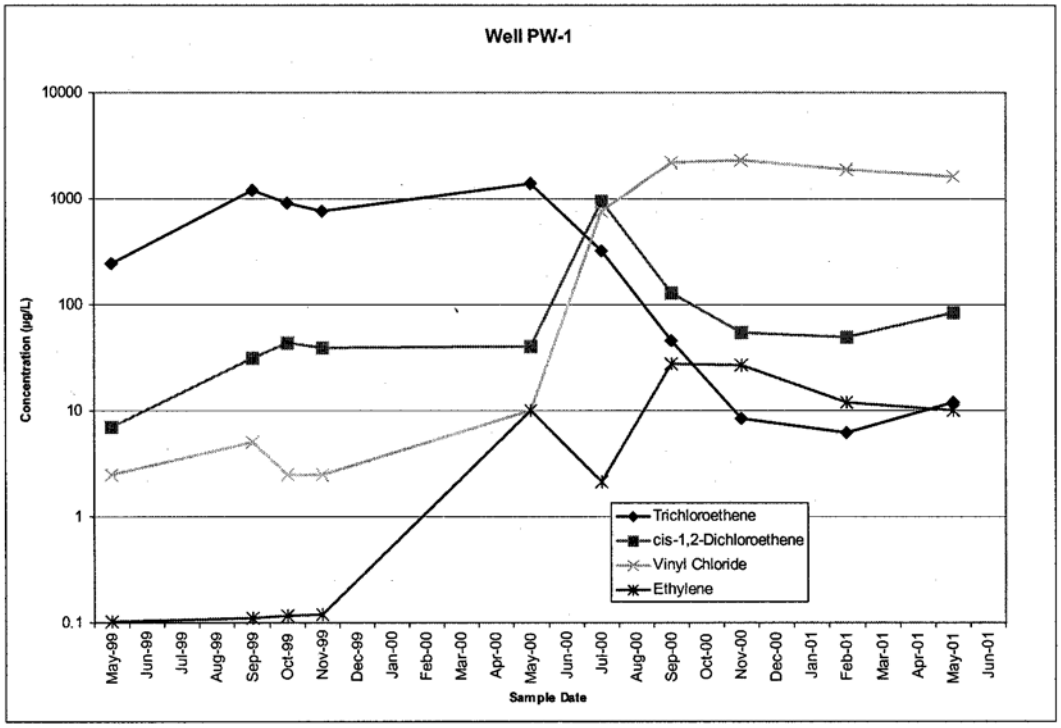


Figure 3. Time Series Evaluation Well PW-1

The hydrogen concentrations in some wells were extremely high during the six months following HRC injection. Well W-2 contained 153,248 nano-moles (nM) and PW-3 contained 1,161 nM in July 2000; PW-2 contained 6,600 nM in November 2000. These elevated hydrogen concentrations together with the initially low ORP measurements, indicate that methanogenic conditions existed through May 2001 in many of the high activity wells. This is further supported by increasing methane concentrations in these wells. Hydrogen concentrations have declined, and the corresponding dechlorination performance versus methane production is being monitored.

Sulfate concentrations dropped to less than 10 mg/L in some wells coincident with high hydrogen concentrations and the significant declines in TCE concentrations. This observation is consistent with Yang and McCarty (1998), where

Table 1. Selected Data for Well PW-1

Parameter	Units	May 2000	July 2000	Sep 2000	Nov 2000	Feb 2001	May 2001
TCE	ug/L	1400	320	46	8	6	12
cis-1,2 DCE	ug/L	40	950	130	55	49	84
Vinyl Chloride	ug/L	<20	760	2200	2300	1900	1600
Ethylene	ug/L	<20	2.15	27.4	27	12	10
Sulfate	mg/L	273	127	23	30	18	91
Methane	ug/L	34	93.2	117	4100	7000	6000
Hydrogen	nM	1.75	12.3	4.05	5.6	3.2	1.8
ORP	mV	-89	-253	-30	135	-165	-258

competing methanogenic and dehalogenation reactions were studied with respect to hydrogen concentrations. Although the competing reactions may be an inefficient use of the available hydrogen, sulfate reduction has eliminated a competing biological reduction process. As such, the remaining hydrogen should become more available for methanogenises and reductive dechlorination rather than sulfate reduction.

Field measurements gave further evidence of enhanced biodegradation occurring at these wells. Dissolved oxygen readings were typically less than 1.0 mg/L, indicating an anaerobic environment suitable for TCE degradation, while the pH measurements were typically within the desirable range of 5 to 9. ORP measurements remained less than 50 millivolts (mV) through May 2001 in these high activity wells, except in November 2000 where a faulty instrument reported elevated values.

Low Biodechlorination Activity Wells. Low biodechlorination activity was observed in wells PW-5, W-8, and W-9. Results from well W-9 show concentration trends with little indication of reductive dechlorination of TCE or sulfate reduction until November 2000; although cis-1,2-DCE, VC, ethylene, and methane concentrations increased slightly from May through November 2000. Substantial reductions in TCE and sulfate concentrations were observed in February 2001; followed by an apparent rebound effect observed in May 2001. This may be indicating enhanced biodegradation of TCE at well W-9, while the TCE concentrations are maintained through desorption of TCE from the soil matrix, or this rebound effect could be migration of dechlorination by products into the vicinity of well W-9.

Hydrogen concentrations at well W-9, and other low biodechlorination activity wells, were elevated above 2 nM, but did not achieve the levels or sustain the elevated concentrations for as long of duration as in wells PW-2, PW-3, and W-2. The TCE reduction in W-9 occurred from November 2000 through February 2001 when hydrogen concentrations were significantly lower than their peak concentration of 123 nM in September 2000. This is also consistent with the findings of Yang and

McCarty (1998) where the dechlorination bacteria were shown to compete best against methanogens within a hydrogen concentration range of 2 to 11 nM. The TCE reduction also correlates closely with the increase in methane concentration in February 2001, indicating that the reductive dechlorination in the vicinity of W-9 may be a cometabolic reaction under methanogenic conditions.

Table 2. Selected Data for Well W-9

Parameter	Units	May 2000	July 2000	Sep 2000	Nov 2000	Feb 2001	May 2001
TCE	ug/L	3,620	4,400	4,500	4,500	410	600
cis-1,2 DCE	ug/L	81	230	280	1,000	1,300	2,800
Vinyl Chloride	ug/L	17	81	100	350	1,100	2,000
Ethylene	ug/L	<20	0.21	1.4	9.1	16	60
Sulfate	mg/L	161	195	200	189	24	72
Methane	ug/L	108	175	210	310	1,900	1,600
Hydrogen	nM	1.71	2.13	123	4.5	4.7	1.2
ORP	mV	145	-28	50	197	-88	-242

Field measurements in these low activity wells indicate that the environment was capable of supporting enhanced biodegradation. DO measurements were close to 0.5 mg/L, and ORP measurements were below 50 mV. The ORP at well W-9 dropped from 145 during the baseline monitoring to -28 mV in July 2000. The ORP remained below 50 mV throughout the year except for the anomalous reading in November 2000.

Given historical groundwater flow rates less than 10 feet per year, wells W-35 and W-36 lie well outside of the area of influence from the full-scale HRC implementation. As expected, wells W-35 and W-36 did not show evidence of enhanced bioremediation from the addition of HRC. These wells have been used successfully as control wells to evaluate the remedy effectiveness.

CONCLUSIONS

The HRC application enhanced biological reductive dechlorination of TCE in all of the monitoring wells within the HRC application area. The enhanced biodechlorination effectiveness is shown to be a function of the amount and proximity of HRC addition to a monitoring well. A high volume of HRC injected close to a well resulted in greater evidence of the dechlorination of TCE. Wells-PW-1, PW-3, and W-2 are located in the highest density of HRC injection locations and these wells exhibit the greatest evidence of biodechlorination. The limited biodechlorination at well W-9 appears to be due to a delayed development of the reductive dechlorination processes.

The accumulation of VC in the site groundwater is a recognized concern. It is expected that VC will accumulate through the dechlorination of cis-1,2 DCE, which is faster than the dechlorination of VC to ethylene. The elevated

concentrations of VC should continue to decrease with time, as illustrated in well PW-1. The VC concentrations at other wells also appear to have peaked, while the ethylene concentrations are increasing in most wells. If VC does not biodechlorinate to ethylene as anticipated, an aerobic environment may be needed to complete the destruction of this daughter product. Further monitoring efforts are ongoing to determine the long term effectiveness of the HRC application.

REFERENCES

Cornuet, Thomas S., C. Sandefur, W. Eliason, S. Johnson, C. Serna, 2000. *Accelerated Bioremediation of Chlorinated Compounds in Groundwater - Aerobic and Anaerobic Bioremediation of cis-1,2-Dichloroethene and VC*, International Conference on Remediation of Chlorinated and Recalcitrant Compounds, 2nd:2000, C2-4, Battelle Press, 2000.

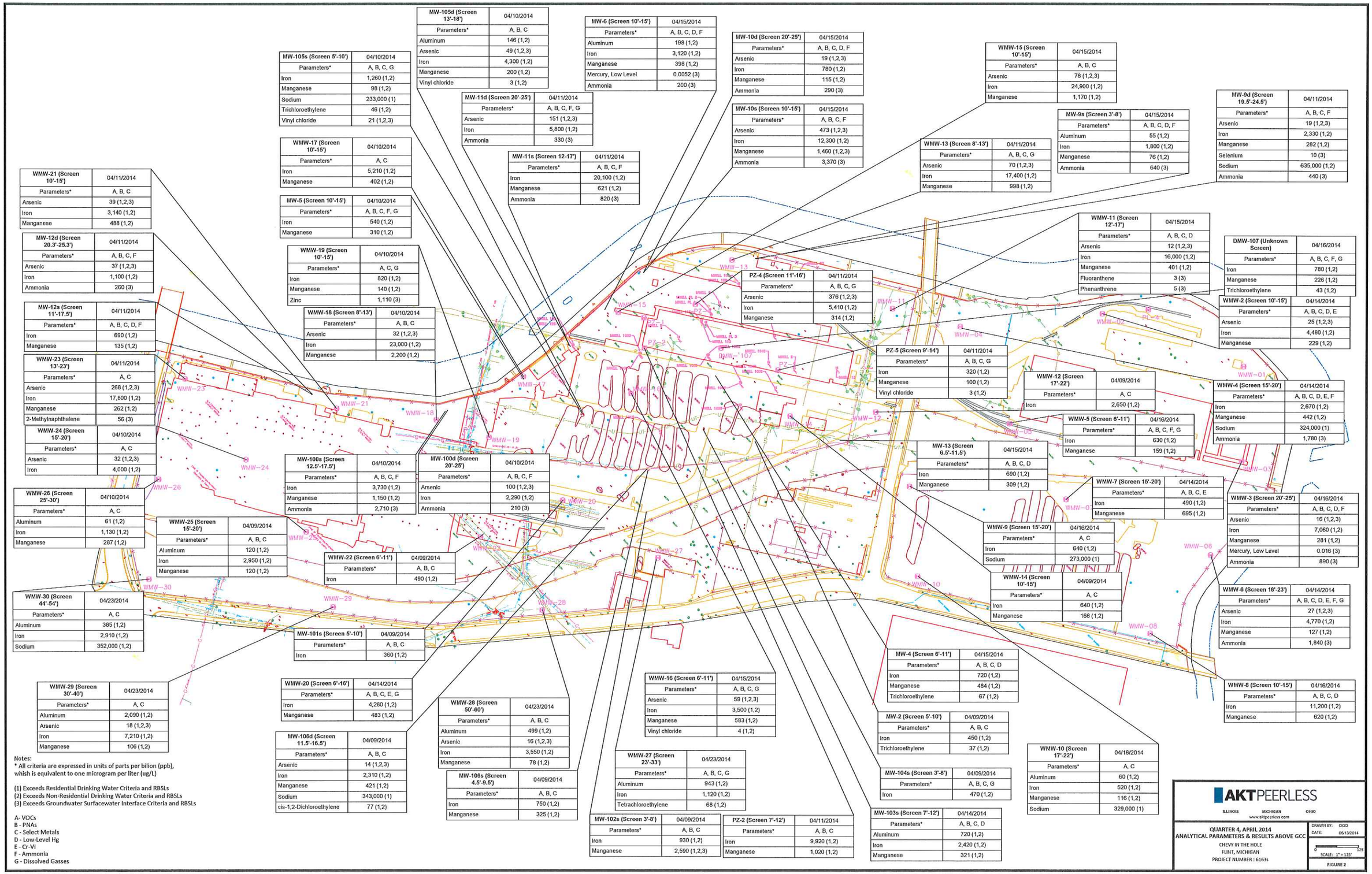
Morse, Jeff J., Alleman, B.C., Gossett, J.M., Zindler, S.H., Fennell, D.E., Sewell, G., Vogel, C.M., 1998. *Draft Technical Protocol - A Treatability Test for Evaluating the Potential Applicability of the Reductive Anaerobic Biological In Situ Treatment Technology (RABITT) to Remediate Chloroethenes,* Department of Defense Environmental Security Technology Certification Program, 1998.

Wiedemeier, Todd H., M. Swanson, and D. Moutoux, E. K. Gordon; Drs. J. Wilson, B. Wilson, and D. Kampbell; J. Hansen and P. Haas; Dr. F. Chapelle, 1996. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater.* Air Force Center for Environmental Excellence, November 1996.

Yang, Yanru, and P. McCarty, 1998. *Competition for Hydrogen within a Chlorinated Solvent Dehalogenating Anaerobic Mixed Culture,* Environmental Science & Technology, 1998.

Zahiraleslamzadeh, Zahra M., J. Bensch, 2000. *Enhanced Bioremediation Using Hydrogen Release Compound (HRC^{TM}) in Clay Soils,* International Conference on Remediation of Chlorinated and Recalcitrant Compounds, 2nd:2000, C2-4, Battelle Press, 2000.

Appendix 7: AKT Peerless Analytical Map, Chevy-in-the-Hole April 2014



MW-105s (Screen 5'-10')	04/10/2014
Parameters*	A, B, C, G
Iron	1,260 (1,2)
Manganese	98 (1,2)
Sodium	233,000 (1)
Trichloroethylene	46 (1,2)
Vinyl chloride	21 (1,2,3)

MW-105d (Screen 13'-18')	04/10/2014
Parameters*	A, B, C
Aluminum	146 (1,2)
Arsenic	49 (1,2,3)
Iron	4,300 (1,2)
Manganese	200 (1,2)
Vinyl chloride	3 (1,2)

MW-6 (Screen 10'-15')	04/15/2014
Parameters*	A, B, C, D, F
Aluminum	198 (1,2)
Iron	3,120 (1,2)
Manganese	398 (1,2)
Mercury, Low Level	0.0052 (3)
Ammonia	200 (3)

MW-10d (Screen 20'-25')	04/15/2014
Parameters*	A, B, C, D, F
Arsenic	19 (1,2,3)
Iron	780 (1,2)
Manganese	115 (1,2)
Ammonia	290 (3)

WMW-15 (Screen 10'-15')	04/15/2014
Parameters*	A, B, C
Arsenic	78 (1,2,3)
Iron	24,900 (1,2)
Manganese	1,170 (1,2)

MW-11d (Screen 20'-25')	04/11/2014
Parameters*	A, B, C, F, G
Arsenic	151 (1,2,3)
Iron	5,800 (1,2)
Ammonia	330 (3)

MW-10s (Screen 10'-15')	04/15/2014
Parameters*	A, B, C, F
Arsenic	473 (1,2,3)
Iron	12,300 (1,2)
Manganese	1,460 (1,2,3)
Ammonia	3,370 (3)

MW-9s (Screen 3'-8')	04/15/2014
Parameters*	A, B, C, D, F
Aluminum	55 (1,2)
Iron	1,800 (1,2)
Manganese	76 (1,2)
Ammonia	640 (3)

MW-9d (Screen 19.5'-24.5')	04/11/2014
Parameters*	A, B, C, F
Arsenic	19 (1,2,3)
Iron	2,330 (1,2)
Manganese	282 (1,2)
Selenium	10 (3)
Sodium	635,000 (1,2)
Ammonia	440 (3)

WMW-17 (Screen 10'-15')	04/10/2014
Parameters*	A, C
Iron	5,210 (1,2)
Manganese	402 (1,2)

MW-11s (Screen 12-17')	04/11/2014
Parameters*	A, B, C, F
Iron	20,100 (1,2)
Manganese	621 (1,2)
Ammonia	820 (3)

WMW-13 (Screen 8'-13')	04/11/2014
Parameters*	A, B, C, G
Arsenic	70 (1,2,3)
Iron	17,400 (1,2)
Manganese	998 (1,2)

WMW-21 (Screen 10'-15')	04/11/2014
Parameters*	A, B, C
Arsenic	39 (1,2,3)
Iron	3,140 (1,2)
Manganese	488 (1,2)

MW-5 (Screen 10'-15')	04/10/2014
Parameters*	A, B, C, F, G
Iron	540 (1,2)
Manganese	310 (1,2)

WMW-19 (Screen 10'-15')	04/10/2014
Parameters*	A, C, G
Iron	820 (1,2)
Manganese	140 (1,2)
Zinc	1,110 (3)

MW-12d (Screen 20.3'-25.3')	04/11/2014
Parameters*	A, B, C, F
Arsenic	37 (1,2,3)
Iron	1,100 (1,2)
Ammonia	260 (3)

WMW-18 (Screen 8'-13')	04/10/2014
Parameters*	A, B, C
Arsenic	32 (1,2,3)
Iron	23,000 (1,2)
Manganese	2,200 (1,2)

PZ-4 (Screen 11'-16')	04/11/2014
Parameters*	A, B, C, G
Arsenic	376 (1,2,3)
Iron	5,410 (1,2)
Manganese	314 (1,2)

WMW-11 (Screen 12'-17')	04/15/2014
Parameters*	A, B, C, D
Arsenic	12 (1,2,3)
Iron	16,000 (1,2)
Manganese	401 (1,2)
Fluoranthene	3 (3)
Phenanthrene	5 (3)

DMW-107 (Unknown Screen)	04/16/2014
Parameters*	A, B, C, F, G
Iron	780 (1,2)
Manganese	226 (1,2)
Trichloroethylene	43 (1,2)

MW-12s (Screen 11'-17.5')	04/11/2014
Parameters*	A, B, C, D, F
Iron	690 (1,2)
Manganese	135 (1,2)

PZ-5 (Screen 9'-14')	04/11/2014
Parameters*	A, B, C, G
Iron	320 (1,2)
Manganese	100 (1,2)
Vinyl chloride	3 (1,2)

WMW-2 (Screen 10'-15')	04/14/2014
Parameters*	A, B, C, D, E
Arsenic	25 (1,2,3)
Iron	4,480 (1,2)
Manganese	229 (1,2)

WMW-23 (Screen 13'-23')	04/11/2014
Parameters*	A, C
Arsenic	268 (1,2,3)
Iron	17,800 (1,2)
Manganese	262 (1,2)
2-Methylnaphthalene	56 (3)

WMW-12 (Screen 17'-22')	04/09/2014
Parameters*	A, C
Iron	2,650 (1,2)

WMW-4 (Screen 15'-20')	04/14/2014
Parameters*	A, B, C, D, E, F
Iron	2,670 (1,2)
Manganese	442 (1,2)
Sodium	324,000 (1)
Ammonia	1,780 (3)

WMW-24 (Screen 15'-20')	04/10/2014
Parameters*	A, C
Arsenic	32 (1,2,3)
Iron	4,000 (1,2)

MW-100s (Screen 12.5'-17.5')	04/10/2014
Parameters*	A, B, C, F
Iron	3,730 (1,2)
Manganese	1,150 (1,2)
Ammonia	2,710 (3)

MW-100d (Screen 20'-25')	04/10/2014
Parameters*	A, B, C, F
Arsenic	100 (1,2,3)
Iron	2,290 (1,2)
Ammonia	210 (3)

WMW-5 (Screen 6'-11')	04/16/2014
Parameters*	A, B, C, F, G
Iron	630 (1,2)
Manganese	159 (1,2)

MW-13 (Screen 6.5'-11.5')	04/15/2014
Parameters*	A, B, C, D
Iron	690 (1,2)
Manganese	309 (1,2)

WMW-7 (Screen 15'-20')	04/14/2014
Parameters*	A, B, C, E
Iron	490 (1,2)
Manganese	695 (1,2)

WMW-26 (Screen 25'-30')	04/10/2014
Parameters*	A, C
Aluminum	61 (1,2)
Iron	1,130 (1,2)
Manganese	287 (1,2)

WMW-25 (Screen 15'-20')	04/09/2014
Parameters*	A, B, C
Aluminum	120 (1,2)
Iron	2,950 (1,2)
Manganese	120 (1,2)

WMW-22 (Screen 6'-11')	04/09/2014
Parameters*	A, B, C
Iron	490 (1,2)

WMW-9 (Screen 15'-20')	04/16/2014
Parameters*	A, C
Iron	640 (1,2)
Sodium	273,000 (1)

WMW-3 (Screen 20'-25')	04/16/2014
Parameters*	A, B, C, D, F
Arsenic	16 (1,2,3)
Iron	7,060 (1,2)
Manganese	281 (1,2)
Mercury, Low Level	0.016 (3)
Ammonia	890 (3)

WMW-14 (Screen 10'-15')	04/09/2014
Parameters*	A, C
Iron	640 (1,2)
Manganese	166 (1,2)

WMW-6 (Screen 18'-23')	04/14/2014
Parameters*	A, B, C, D, E, F, G
Arsenic	27 (1,2,3)
Iron	4,770 (1,2)
Manganese	127 (1,2)
Ammonia	1,840 (3)

WMW-30 (Screen 44'-54')	04/23/2014
Parameters*	A, C
Aluminum	385 (1,2)
Iron	2,910 (1,2)
Sodium	352,000 (1,2)

MW-101s (Screen 5'-10')	04/09/2014
Parameters*	A, B, C
Iron	360 (1,2)

WMW-29 (Screen 30'-40')	04/23/2014
Parameters*	A, C
Aluminum	2,090 (1,2)
Arsenic	18 (1,2,3)
Iron	7,210 (1,2)
Manganese	106 (1,2)

WMW-20 (Screen 6'-16')	04/14/2014
Parameters*	A, B, C, E, G
Iron	4,280 (1,2)
Manganese	483 (1,2)

WMW-28 (Screen 50'-60')	04/23/2014
Parameters*	A, B, C
Aluminum	499 (1,2)
Arsenic	16 (1,2,3)
Iron	3,550 (1,2)
Manganese	78 (1,2)

MW-106d (Screen 11.5'-16.5')	04/09/2014
Parameters*	A, B, C
Arsenic	14 (1,2,3)
Iron	2,310 (1,2)
Manganese	421 (1,2)
Sodium	343,000 (1)
cis-1,2-Dichloroethylene	77 (1,2)

MW-106s (Screen 4.5'-9.5')	04/09/2014
Parameters*	A, B, C
Iron	750 (1,2)
Manganese	325 (1,2)

WMW-16 (Screen 6'-11')	04/15/2014
Parameters*	A, B, C, G
Arsenic	59 (1,2,3)
Iron	3,500 (1,2)
Manganese	583 (1,2)
Vinyl chloride	4 (1,2)

MW-4 (Screen 6'-11')	04/15/2014
Parameters*	A, B, C, D
Iron	720 (1,2)
Manganese	484 (1,2)
Trichloroethylene	67 (1,2)

WMW-8 (Screen 10'-15')	04/16/2014
Parameters*	A, B, C, D
Iron	11,200 (1,2)
Manganese	620 (1,2)

MW-2 (Screen 5'-10')	04/09/2014
Parameters*	A, B, C
Iron	450 (1,2)
Trichloroethylene	37 (1,2)

WMW-27 (Screen 23'-33')	04/23/2014
Parameters*	A, B, C, G
Aluminum	943 (1,2)
Iron	1,120 (1,2)
Tetrachloroethylene	68 (1,2)

MW-104s (Screen 3'-8')	04/09/2014
Parameters*	A, B, C, G
Iron	470 (1,2)

WMW-10 (Screen 17'-22')	04/16/2014
Parameters*	A, C
Aluminum	60 (1,2)
Iron	520 (1,2)
Manganese	116 (1,2)
Sodium	329,000 (1)

MW-102s (Screen 3'-8')	04/09/2014
Parameters*	A, B, C
Iron	930 (1,2)
Manganese	2,590 (1,2,3)

PZ-2 (Screen 7'-12')	04/11/2014
Parameters*	A, B, C
Iron	9,920 (1,2)
Manganese	1,020 (1,2)

MW-103s (Screen 7'-12')	04/14/2014
Parameters*	A, B, C, D
Aluminum	720 (1,2)
Iron	2,420 (1,2)
Manganese	321 (1,2)

Notes:
* All criteria are expressed in units of parts per billion (ppb), whish is equivalent to one microgram per liter (ug/L)

(1) Exceeds Residential Drinking Water Criteria and RBSLs
(2) Exceeds Non-Residential Drinking Water Criteria and RBSLs
(3) Exceeds Groundwater Surfacewater Interface Criteria and RBSLs

A- VOCs
B - PNAs
C - Select Metals
D - Low-Level Hg
E - Cr-VI
F - Ammonia
G - Dissolved Gasses

AKTPEERLESS
ILLINOIS MICHIGAN OHIO
www.aktpeerless.com

QUARTER 4, APRIL 2014
ANALYTICAL PARAMETERS & RESULTS ABOVE GCC
CHEVY IN THE HOLE
FLINT, MICHIGAN
PROJECT NUMBER : 6163s

DRAWN BY: OGO
DATE: 05/13/2014
0 125
SCALE: 1" = 125'
FIGURE 2

TABLE 1
CMS Report
Corrective Measures Alternatives Matrix
RACER Flint West - 12990

Associated AOI	Summary of Applicable Exceedances	Identified Corrective Measures	Protective of Human Health and the Environment (Yes/No)	Attain Media Clean Up Objectives (Yes/No)	Control the Source or Demonstrate Stability (Yes/No)	Potential Corrective Measures Alternatives for Further Evaluation
AOC-2B	SOIL CVOCs above residential and non- residential DWP, GSIP criteria CVOCs above residential SVIAC	Land Use Restriction	Yes	Yes	No	Land Use Restrictions, Groundwater Use Restrictions, Monitored Stability Targeted Excavation Multi-Phase Extraction
		Groundwater Use Restrictions	Yes	Yes	No	
		Monitored Stability	Yes	No	Yes	
		Cap	No	No	No	
		Targeted Excavation	Yes	No	Yes	
		Soil Vapor Extraction	No	No	No	
		Multi-Phase Extraction	Yes	Yes	Yes	
	GROUNDWATER CVOCs above residential and non- residential DWP, GSI	Land Use Restriction	Yes	Yes	No	Land Use Restrictions, Groundwater Use Restrictions, Monitored Stability, In-situ Bioremediation.
		Groundwater Use Restrictions	Yes	Yes	No	
		Monitored Stability	Yes	No	Yes	
		In-situ Bioremediation	Yes	Yes	Yes	
		Hydraulic Control	Yes	No	No	
		Pump and Treat	No	No	No	
Site-Wide	SOIL CVOCs above residential and non- residential DWP, GSIP criteria CVOCs above residential SVIAC	Land Use Restriction	Yes	Yes	No	Land Use Restrictions, Groundwater Use Restrictions, Monitored Stability
		Groundwater Use Restrictions	Yes	Yes	No	
		Monitored Stability	Yes	No	Yes	
	GROUNDWATER CVOCs above residential and non- residential DWP, GSI	Land Use Restriction	Yes	Yes	No	Land Use Restrictions, Groundwater Use Restrictions, Monitored Stability,
		Groundwater Use Restrictions	Yes	Yes	No	
		Monitored Stability	Yes	No	Yes	

Acronyms and Abbreviations:

AOI Area of Interest
CMS Corrective Measures Study
DWP Drinking Water Protection Criteria
GSI Criteria Groundwater to Surface Water Interface
GSIP Protection Criteria Groundwater to Surface Water Interface
NA Not Applicable
SVIAC Criteria Soil Volatilization to Indoor Air Inhalation
ug/L Micro Grams per Liter
CVOC Chlorinated Volatile Organic Compounds

TABLE 2
CMS Report
Evaluation of Corrective Measures Alternatives
RACER Flint West - 12990

Plant and Investigation Area	Site Wide		
Media	Soil and Groundwater		
Corrective Measures Alternative	Land Use Restrictions	Groundwater Use Restrictions	Monitored Stability
Description	Land Use Restrictions: includes limiting future use of the Site to non-residential, Site-wide contaminated soil management, Site-wide vapor intrusion exposure restrictions, and health and safety requirement for intrusive activities [2].	Groundwater Use Restrictions: includes prohibiting the construction and use of wells or other devices on the Site to extract groundwater for consumption, irrigation, or any other purpose with the exception of evaluating groundwater, remediation of subsurface contamination, or short-term dewatering for construction purposes.	Monitored Stability: consists of ongoing monitoring to collect the data required to develop trends and verify the stability of the groundwater impacts.
Long-term Reliability and Effectiveness	Restrictions are a reliable legal mechanism to restrict current and future land use at the Site.	Restrictions are a reliable legal mechanism to restrict current and future groundwater use at the Site.	A groundwater monitoring program would verify the stability of the groundwater impacts over time.
Reduction in the Toxicity, Mobility, or Volume of Waste	Land use restrictions do not reduce the toxicity, mobility, or volume of waste at the Site.	Groundwater use restrictions do not reduce the toxicity, mobility, or volume of waste at the Site.	The groundwater monitoring program would monitor stability and the reduction in COC mass present at the Site from natural processes.
Short-term Effectiveness	Restrictions are a reliable legal mechanism to restrict land use at the Site once they are registered.	Restrictions are a reliable legal mechanism to restrict groundwater use at the Site once they are registered.	Based on current data, the groundwater impact is expected to be stable.
Implementability	Restrictions would be easy to implement, as RACER currently owns all the property that would be restricted.	Restrictions would be easy to implement, as RACER currently owns all the property that would be restricted.	Monitored stability would be easy to implement, as the existing monitoring well network would be used for the groundwater monitoring, with some possible downgradient monitoring on the Chevy-in-the-Hole Site.
Community Acceptance	The restrictions are consistent with current zoning for the Site (industrial). Vapor intrusion exposure restrictions would eliminate the SVIAC exposure risk for future property owners.	Water is available via a municipal system; therefore, it is unlikely future property owners would require groundwater wells on the Site. Restriction of groundwater use is consistent with the City of Flint's approach to the downgradient Chevy-in-the-Hole Site.	Monitored stability presents a low impact to the public and surrounding use. Community acceptance is likely.
MDEQ Acceptance	The restrictions are consistent with current zoning for the Site (industrial) and are readily acceptable by the MDEQ. Vapor intrusion exposure restrictions have been accepted by the MDEQ to address vapor intrusion exposure risk.	Groundwater use restrictions in areas with municipal services are acceptable to the MDEQ.	Data collected during groundwater monitoring would be provided to the EPA/MDEQ to show that the groundwater impact remains stable over time.
Pre-Design Testing	None	None	None
Sustainability	Restrictions do not generate waste, have energy requirements, or increase emissions.	Restrictions do not generate waste, have energy requirements, or increase emissions.	The groundwater monitoring program would generate minimal waste.
Corrective Measure Area	Site Wide	Site Wide	Site Wide
Cost [3]	$5,000	$4,000	Cost for 5 Year Monitoring/Maintenance $39,840

TABLE 2B
CMS Report
Evaluation of Corrective Measures Alternatives
RACER Flint West - 12990

	Area AOC-2B		
Media	Soil and Groundwater		
Corrective Measures Alternative [1]	**Targeted Soil Excavation**	**In-Situ Bioremediation**	**Multi-Phase Extraction**
Description	Targeted excavations would be completed to remove soils exceeding GSIP and DWP near the property boundary. Excavated soils would be transported and disposed of in accordance with applicable requirements of RCRA and all other relevant state and federal laws.	Injection of bioremediation agent through injection wells to reduce groundwater concentrations.	A groundwater pump would be used to depress the groundwater table in the area of highest impact, through a network of extraction wells. Groundwater would be filtered with a two-stage carbon system with the effluent discharged either to the municipal sanitary sewer or the Flint River. A vacuum blower would be used to strip VOCs from the soils through a network of extraction points. The exhaust would likely require an air discharge permit and treatment, such as with a catalytic oxidizer.
Long-term Reliability and Effectiveness	Targeted excavation would be a reliable and effective way to remove soils exceeding DWP and GSIP near the property boundary. Removal of these soils will eliminate a potential long-term source to groundwater near the property boundary.	Injections would be conducted to reduce bulk levels of contaminants and is therefore an effective long-term strategy.	Because the highest soil impact is in silty clay soils, the effectiveness of this option is likely to be limited.
Reduction in the Toxicity, Mobility, or Volume of Waste	Removal of impacted soil reduces the toxicity, mobility, and volume of impacted soils at the Site.	This option does reduce the toxicity, mobility, and volume of impacted groundwater at the Site in the area of the injections.	This option does reduce the toxicity, mobility, and volume of impacted groundwater at the Site in the area of treatment.
Short-term Effectiveness	Targeted excavation would be effective in removing soils exceeding DWP and GSIP.	In the short-term, rebound (the diffusion of COCs from the non-mobile to mobile pore space after treatment) is likely to occur, multiple injections may be required.	Limited short-term effectiveness is expected with multi-phase extraction.
Implementability	Based on estimated depth (approximately 20 feet) and the adjacent concrete structures, excavation would require sheet pile but would be implementable. Dewatering would also be necessary.	Injections are implementable at the Site. There are no above- or below-grade structures likely to impair injection.	There is sufficient space on the Site for installation of a multi-phase system, and utility infrastructure is present.
Community Acceptance	Targeted excavation would eliminate soil exceeding DWP and GSIP only on the subject Site; therefore, it may not be acceptable to the community.	A groundwater injection waiver may be required by the MDEQ. Injection is likely to provide downgradient benefits that are not likely with soil excavation. Positive impacts to downgradeint property owned by the City of Flint and projected to be future parkland are likely to have community support.	Targeted excavation would eliminate soil exceeding DWP and GSIP only on the subject Site. Aesthetic impacts, including noise, will result. This option may have limited community acceptance.
MDEQ Acceptance	Excavations are widely accepted by the MDEQ as a remedial option.	Bioremediation is widely accepted by the state as a remedial option.	Multi-phase extraction is widely accepted by the MDEQ; however, in this case, the success is likely to be limited.
Pre-Design Testing	None.	The initial injection would be used to determine the scope of future injections, if needed.	Pre-design testing, including aquifer pump tests, carbon filtration rates, air volume extraction rates, and exhaust filtering will be needed.
Sustainability	Targeted excavation activities would generate hazardous waste, have some energy requirements (fuel consumption), and minor emissions related to the construction and transport activities.	Injection activities would generate minimal waste, have some energy requirements (electric/fuel consumption), and minor emissions related to the injection activities.	Multi-phase extraction would involve large volumes of resource/materials consumption to construct the system Operation of the system would involve consumable products such as air and groundwater filtration equipment/media. Long-term electrical consumption will also be needed.
Treatment Area or Excavation Volume [2]	Targeted Excavation Volume for DWP and GSIP (assuming 20% volume increase after excavation:: 1,400 cubic yards	2,400 sq. ft. with a 5-foot vertical treatment zone (approximately 15-20 feet below grade)	Groundwater would be depressed to approximately 20 feet over a 1,600 square foot area. The extent of a dewatering network has not been determined but would be much larger than the treatment area.
Cost [3]	$347,080	$166,820	$890,440

General Notes:

Corrective measures alternatives also include land use restrictions, groundwater use restrictions, and monitored plume stability as evaluated on Table 2a. Cap inspection and maintenance cost are included with the monitored plume stability cost.

1. Excavation volumes are rounded estimates.

2. Cost estimates are rounded engineering estimates, +/- 30 to 50 percent.

3. Major cost assumptions for targeted excavation are:

- Excavated material is not classified as a Listed or Hazardous Waste.
- No shoring will be required and any materials removed for excavation benching and sloping will not require offsite transport and disposal.
- Benching, sloping, groundwater management/disposal activities are incidental to the project and are not subject to unit rates.
- DC volume based on RFI investigation data, DC exceedance location(s) to the next clean boring location.
- SVIIC volume based on RFI investigation data, SVIIC exceedance location(s) to half way to the next clean boring location. Cost also includes investigation to refine excavation.

4. Major cost assumptions for targeted excavation are:

- Full scale installation of 12 injection wells to a maximum depth of 10 feet with a 5 foot treatment interval.
- Injection wells installed on 20 foot centers, with a 10 foot radius of influence
- Mobile porosity of 0.1 (injection volume of 1,175 gallons per well), injection flow rate of 3 gallons per minute per well.
- Two injections to reach treatment objectives.

Acronyms and Abbreviations:

CMS	Corrective Measures Study
cyds.	cubic yards
DC	Direct Contact Criteria
ft.	feet
MDEQ	Michigan Department of Environmental Quality
RACER	Revitalizing Auto Communities Environmental Response
RC	Restrictive Covenant
RCRA	Resource Conservation and Recovery Act
SVIIC	Soil Volatilization to Indoor Air Inhalation Criteria
sq. ft.	square feet

TABLE 3
CMS Report
Proposed Corrective Measures Alternative
RACER Flint West – 12990

Cost Estimate Site-wide	Flint West
Land and Groundwater Use Restrictions:	$9,000
Monitored Stability (5 year):	$39,840
Bioremediation Injection	$166,820
Total:	$215,660

General Notes:

1. Cost estimates are rounded engineering estimates, +/- 30 to 50 percent.

Acronyms and Abbreviations:

CMS	Corrective Measures Study
GW	Groundwater
RACER	Revitalizing Auto Communities Environmental Response

Table 4: Groundwater Analytical Tables

GROUNDWATER ANALYTICAL DATA
RACER - Flint West #12990

	Sample ID			MW-100S	MW-101S	MW-102S	MW-103S	MW-104S	MW-105SR	MW-106S	MW-107S	MW-108S	MW-109S	MW-110S	MW-111S	MW-112S	MW-113S	SB124-TWT	SB125-TWT	SB127-TWT	SB129-TWT	SB130-TWT	SB131-TWT	SB124-TWB	SB125-TWB	SB127-TWB	SB129-TWB	SB130-TWB	SB131-TWB	Dup1	Dup2	Dup3
	Date Collected				4/3/14	4/3/14	3/29/14	4/3/14	4/3/14	4/3/14	4/3/14	3/29/14	3/29/14	3/29/14	3/29/14	4/3/14	3/29/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	3/29/14		
ANALYTE (ug/L)	DW	GSI																														
Arsenic (dissolved)	10.00	10.00					11.00			4.00				21.00		19.00			17.00	57.00	4.00	3.00	2.00	3.00	30.00	38.00						
Chromium (dissolved)	100.00	160.00	G			35.00		22.00	18.00					7.00	12.00		128.00	13.00			147.00	64.00	25.00	16.00		17.00	89.00	19.00	33.00	14.00		
Copper (dissolved)	1,000.00	20.00	G											28.00				21.00		5.00	22.00	140.00	28.00	42.00		12.00	24.00	94.00	144.00			
Lead (dissolved)	4.00	28.00	G											24.00				29.00		5.00	23.00	208.00	16.00	47.00	1.00	19.00	11.00	31.00	14.00			
Selenium (dissolved)	50.00	5.00							6.00	5.00		5.00						12.00				4.00		12.00				5.00	3.00			
Zinc (dissolved)	2,400.00	26.00	G		97.00		23.00	5.00		62.00	5.00	16.00	18.00	81.00	21.00	9.00	24.00	311.00	167.00	82.00	323.00	326.00	103.00	241.00	400.00	166.00	68.00	241.00	191.00	12.00		

	Sample ID			MW-100S	MW-101S	MW-102S	MW-103S	MW-104S	MW-105SR	MW-106S	MW-107S	MW-108S	MW-109S	MW-110S	MW-111S	MW-112S	MW-113S	SB124-TWT	SB125-TWT	SB127-TWT	SB129-TWT	SB130-TWT	SB131-TWT	SB124-TWB	SB125-TWB	SB127-TWB	SB129-TWB	SB130-TWB	SB131-TWB	Dup1	Dup2	Dup3
	Date Collected																															
ANALYTE (ug/L)	DW	GSI																														
Acetone	730	1,700			1.13	2.36		0.88	1.82	3.58	3.82		1.22	2.11	0.72	5.17	0.93	5.7		9.1	5.7			10.3	66	25.8	5.9		5.8	1.06		
Methyl iodide	NC	NC																														
Carbon disulfide	800	NC																							0.86	0.4						
2 Butanone (MEK)	13,000	2,200			0.73	0.86		0.41	0.83	0.78	0.94					2.98									11.6	8.6						
Chloromethane	260	NC																						0.33		0.61						
Vinyl Chloride	2.0	13									0.64		18		4	6	0.45			5			2			2			2	4		
Chloroethane	430	1,100													0.6	1.13				1.07						0.77						
trichlorofluoromethane	2,600	NA																														
1,1-Dichloroethene	7.0	130											4		1	0.40				1						0.81				1		
Methylene Chloride	5.0	1,500																														
trans-1,2-Dichloroethene	100	1,500											0.92		0.24	0.23													0.28	0.26		
1,1-Dichloroethane	880	740									0.21		3.00		2	0.69	2.00						3.00						2.00	2.00		
cis-1,2-Dichloroethene	70	620									3		59		46	2	26			0.042	0.69	2	21			0.36	0.93	3.00	21.00	43.00		
Tetrahydrofuran	95	11,000																														
Chloroform	80	350						3.00				0.35	0.35		0.29								0.042						0.41	0.29		
1,1,1-Trichloroethane	200	89											0.48		0.75								0.72						0.71	0.73		
4-Methyl-2-pentanone (M	1800	1000000000														0.67				0.390					0.590	2.190						
2-Hexanone	1000	1000000000																		0.750				0.210	2.170	4.570						
Carbontetrachloride	5.0	45										2																				
Benzene	5.0	200									0.25									0.43	0.12			0.17	0.21	0.81	0.21	0.16	0.23			
Bromodichloromethane	80.0	NC						0.89																								
Trichloroethene	5.0	200			3	2					4		102		92	3	23				8	3	81	0.55			8	5	78	86		
Toluene	790	270								0.35	0.63							0.23		0.39	0.20			0.38	0.30	1.00	0.35	0.24	0.44			
Tetrachloroethene	5.0	60							47														0.180						0.17			
Chlorobenzene	100	25																														
Styrene	100	80																		0.43												
Ethylbenzene	74	18																						0.12	0.11	0.31			0.11			
Total Xylenes	280	41																								0.79						
1,2 -Dichlorobenzene	600	13																														
1,2,4-Trimethylbenzene	63	17																							0.22	0.31						
1,2,3-Trimethylbenzene	NC	NC								0.07	0.07														0.20	0.18						
Naphthalene	520	11																0.34		0.31				0.75	1.68	0.55						
2-Methylnaphthalene	260	19																0.51		0.40				0.47	0.88	0.47						

NOTES:

	Blank cells indicate no detectable concentrations
X	Exceeds DW criteria
X	Exceeds GSI criteria G
X	Exceeds both DW and GSI criteria
X	Compound also found in associated method blank, suggesting a laboratory artifact.
NC	Insufficient data to develop criterion/no criterion
G	Groundwater to Surface Water Interface Criteria - calculated based on 257ppm total hardness in the Flint River

GROUNDWATER ANALYTICAL DATA
RACER - Flint West #12990

	Sample ID			MW-100S	MW-101S	MW-102S	MW-103S	MW-104S	MW-105SR	MW-106S	MW-107S	MW-108S	MW-109S	MW-110S	MW-111S	MW-112S	MW-113S	Dup1	Dup2	Dup3
	Date Collected			6/25/14	6/25/14	6/25/14	6/26/14	6/25/14	6/26/14	6/25/14	6/25/14	6/26/14	6/26/14	6/26/14	6/26/14	6/25/14	6/26/14			
ANALYTE (ug/L)	DW	GSI																		
Arsenic (dissolved)	10.00	10.00														19				
Chromium (dissolved)	100.00	160.00	G			51											152			
Copper (dissolved)	1,000.00	20.00	G														4			
Lead (dissolved)	4.00	28.00	G					25	22	23				15			5			
Selenium (dissolved)	50.00	5.00				66			8			6								
Zinc (dissolved)	2,400.00	26.00	G	5	11		10				5	7				8	13			

	Sample ID			MW-100S	MW-101S	MW-102S	MW-103S	MW-104S	MW-105SR	MW-106S	MW-107S	MW-108S	MW-109S	MW-110S	MW-111S	MW-112S	MW-113S	Dup1	Dup2	Dup3
	Date Collected			6/25/14	6/25/14	6/25/14	6/26/14	6/25/14	6/26/14	6/25/14	6/25/14	6/26/14	6/26/14	6/26/14	6/26/14	6/25/14	6/26/14			
ANALYTE (ug/L)	DW	GSI																		
Acetone	730	1,700		1.74	1.45	2.04	2.67	1.55	1.86	1.59	2.82	1.32	1.47	1.29	1.48	4.93	1.32			
Methyl iodide	NC	NC																		
Carbon disulfide	800	NC														0.42	0.36			
2 Butanone (MEK)	13,000	2,200									0.4	0.65	0.29		0.29	1.99				
Chloromethane	260	NC		0.32				0.34									0.29			
Vinyl Chloride	2.0	13											10			21	2			
Chloroethane	430	1,100														2.9				
trichlorofluoromethane	2,600	NA																		
1,1-Dichloroethene	7.0	130											4			2.00	0.39			
Methylene Chloride	5.0	1,500																		
trans-1,2-Dichloroethene	100	1,500											0.7			0.64	0.24			
1,1-Dichloroethane	880	740														1.00	3.00			
cis-1,2-Dichloroethene	70	620		0.62									3			7	59			
Tetrahydrofuran	95	11,000											70.0							
Chloroform	80	350						5.00		0.22		0.5	0.37				0.320			
1,1,1-Trichloroethane	200	89											0.50				1.00			
4-Methyl-2-pentanone (M	1800	1000000000														0.83				
2-Hexanone	1000	1000000000														1.46				
Carbontetrachloride	5.0	45										2								
Benzene	5.0	200																		
Bromodichloromethane	80.0	NC						0.82												
Trichloroethene	5.0	200		5	1	3			26		2		104		2	24	69			
Toluene	790	270																		
Tetrachloroethene	5.0	60																		
Chlorobenzene	100	25																		
Styrene	100	80																		
Ethylbenzene	74	18																		
Total Xylenes	280	41																		
1,2 -Dichlorobenzene	600	13																		
1,2,4-Trimethylbenzene	63	17																		
1,2,3-Trimethylbenzene	NC	NC																		
Naphthalene	520	11																		
2-Methylnaphthalene	260	19																		

NOTES:

	Blank cells indicate no detectable concentrations
X	Exceeds DW criteria
X	Exceeds GSI criteria G
X	Exceeds both DW and GSI criteria
X	Compound also found in associated method blank, suggesting a laboratory artifact.
NC	Insufficient data to develop criterion/no criterion
G	Groundwater to Surface Water Interface Criteria - calculated based on 257ppm total hardness in the Flint River

Table 5: Soil Analytical Tables

SOIL ANALYTICAL DATA (Metals and Detected VOCs)
RACER - Flint West #12990

	Sample ID			SB124-4	SB124-10	SB124-21	SB125-4	SB125-13	SB125-19	SB126-4	SB126-11	SB126-15	SB127-4	SB127-8	SB127-15	SB127-20	SB128-3	SB128-7	SB128-10	SB129-4	SB129-8	SB129-18	SB130-4	SB130-10	SB130-18	SB131-4	SB131-10	SB131-18
	Date Collected			4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/21/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14	4/22/14
ANALYTE (ug/kg)	DW	GSI																										
Arsenic	5,800.00	5,800.00	D&G=B	1,130.00	1,100.00	1,830.00	570.00	1,440.00	1,410.00	1,300.00	1,250.00	1,180.00	410.00	1,630.00	2,060.00	1,780.00	500.00	1,550.00	1,150.00	2,790.00	1,740.00	1,460.00	3,580.00	1,700.00	1,980.00	1,630.00	1,300.00	2,080.00
Chromium	18,000.00	18,000.00	D&G=B	1,220.00	1,460.00	3,350.00	2,050.00	3,260.00	4,240.00	1,220.00	2,920.00	2,870.00	1,980.00	2,560.00	4,540.00	610.00	1,460.00	2,860.00	5,890.00	2,550.00	4,080.00	4,730.00	3,090.00	1,150.00	2,770.00	1,640.00	2,800.00	2,620.00
Copper	5,800,000.00	120,000.00	GX	1,700.00	2,300.00	8,200.00	7,400.00	6,100.00	11,400.00	3,400.00	3,100.00	5,600.00	1,600.00	3,000.00	5,800.00	1,200.00	3,900.00	5,600.00	5,300.00	13,000.00	3,600.00	7,200.00	17,700.00	1,700.00	9,800.00	8,500.00	3,100.00	7,900.00
Lead	700,000.00	5,000,000.00	GX	2,510.00	3,120.00	7,580.00	13,800.00	5,100.00	8,590.00	2,280.00	3,790.00	5,470.00	4,710.00	5,740.00	7,330.00	950.00	6,250.00	11,400.00	6,950.00	104,000.00	6,100.00	7,420.00	123,000.00	2,110.00	6,510.00	36,400.00	4,740.00	6,020.00
Selenium	4,000.00	410.00	G=B			210.00			210.00			160.00								130.00		150.00	140.00					
Zinc	2,400,000.00	2,600,000.00	G=B	4,600.00	5,100.00	19,000.00	11,400.00	12,200.00	20,800.00	5,900.00	8,600.00	14,700.00	3,700.00	10,300.00	20,300.00	2,400.00	6,000.00	13,200.00	9,900.00	21,300.00	13,100.00	19,200.00	51,800.00	5,800.00	18,000.00	16,800.00	13,600.00	18,600.00

ANALYTE (ug/kg)	DW	GSI																										
2 Butanone (MEK)	260,000.00	44,000.00		45.00	71.00	56.00		165.00	79.00	82.00	150.00	75.00	46.00	66.00	148.00	126.00	44.00	123.00	127.00	40.00	53.00	82.00	69.00	68.00	70.00	79.00	65.00	164.00
Vinyl Chloride	40.00	260.00							23.00																**73.00**			**90.00**
1,1-Dichloroethene	140.00	2,600.00																							34.00			18.00
trans-1,2-Dichloroethene	2,000.00	30,000.00																							100.00			62.00
1,1-Dichloroethane	18,000.00	15,000.00																							69.00			35.00
cis-1,2-Dichloroethene	1,400.00	12,000.00				58.00			350.00													300.00			**6,380.00**			**2,820.00**
Tetrahydrofuran	1,900.00	220,000.00		**170.00**	190.00	**190.00**	**150.00**	**180.00**	**180.00**	140.00	190.00	210.00	190.00	190.00	170.00	190.00	150.00	150.00	140.00	150.00	180.00	180.00	180.00	170.00	160.00	150.00	180.00	160.00
Chloroform	1,600.00	7,000.00							16.00																			
1,1,1-Trichloroethane	4,000.00	1,800.00							11.00													33.40						
Benzene	100.00	4,000.00																							36.00			
Trichloroethene	100.00	4,000.00				**1,420.00**			**3,650.00**													**6,170.00**			**6,080.00**	28.00		**12,160.00**
Toluene	16,000.00	5,400.00		11.00																13.00		19.00	31.00			45.00		
Ethylbenzene	1,500.00	360.00																					15.00					
Total Xylenes	5,600.00	820.00																		21.00			92.00			91.00		
Isopropylbenzene	91,000.00	3,200.00																16.00					13.00					
n-Propylbenzene	1,600.00	NC																					16.00					
1,2 -Dichlorobenzene	14,000.00	280.00																21.00										
1,2,4-Trimethylbenzene	2,100.00	570.00																		14.00			24.00			22.00		
1,2,3-Trimethylbenzene	NC	NC																13.50					13.40			11.80		
Naphthalene	35,000.00	730.00		10.80			14.40	17.00		13.70			12.90		14.30			345.70	46.90	39.50	12.50		51.50			100.30		
2-Methylnaphthalene	57,000.00	4,200.00		10.20			14.00	**39.00**		13.00	19.00				30.00		10.00	820.00	46.00	43.00			54.10			71.80		

NOTES:

	Blank cells indicate no detectable concentrations
X	Exceeds DW criteria
X	Exceeds GSI criteria
X	Exceeds both DW and GSI criteria
X	Compound also found in associated method blank, suggesting a laboratory artifact.
NC	Insufficient data to develop criterion/no criterion
GX	Groundwater to Surface Water Interface Criteria - calculated based on 257ppm total hardness in the Flint River

G

SOIL ANALYTICAL DATA (Detected VOCs)
RACER - Flint West #12990

	Sample ID			SB132-12	SB132-15	SB133-17	SB133-19	SB133-20
	Date Collected			7/10/14	7/10/14	7/10/14	7/10/14	7/10/14
ANALYTE (ug/kg)	**DW**	GSI						
2 Butanone (MEK)	260,000.00	44,000.00						
Vinyl Chloride	40.00	260.00		**180**	**89**	**46**		
1,1-Dichloroethene	140.00	2,600.00						
trans-1,2-Dichloroethene	2,000.00	30,000.00				18.00		
1,1-Dichloroethane	18,000.00	15,000.00				13.00		
cis-1,2-Dichloroethene	1,400.00	12,000.00		**2200.00**	1200.00	**1990.00**	530.00	270.00
Tetrahydrofuran	1,900.00	220,000.00		1500.00	300.00	150.00	160.00	117.00
Chloroform	1,600.00	7,000.00						
1,1,1-Trichloroethane	4,000.00	1,800.00				24.90	35.20	17.80
Benzene	100.00	4,000.00						
Trichloroethene	100.00	4,000.00		**29500**	**13700**	**11680**	**10860**	**7520**
Tetrachloroethene	100.00	1,200.00					17	
Toluene	16,000.00	5,400.00						
Ethylbenzene	1,500.00	360.00						
Total Xylenes	5,600.00	820.00						
Isopropylbenzene	91,000.00	3,200.00						
n-Propylbenzene	1,600.00	NC						
1,2 -Dichlorobenzene	14,000.00	280.00						
1,2,4-Trimethylbenzene	2,100.00	570.00						
1,2,3-Trimethylbenzene	NC	NC						
Naphthalene	35,000.00	730.00						
2-Methylnaphthalene	57,000.00	4,200.00				15.00	12.00	9.20

NOTES:

	Blank cells indicate no detectable concentrations
X	Exceeds DW criteria
X	Exceeds GSI criteria
X	Exceeds both DW and GSI criteria
X	Compound also found in associated method blank, suggesting a laboratory artifact.
NC	Insufficient data to develop criterion/no criterion
GX	Groundwater to Surface Water Interface Criteria - calculated based on 257ppm total hardness in the Flint River

G

TABLE 6
RFI Table Reference
RACER Flint West - 12990

Associated AOI	AOI Summary	RFI Phase 1 Investigation	RFI Phase 2 Investigation Sequence/Results	Constituents of Concern > PART 201 GRCCs				Potential Corrective Measures
				VOCs	SVOCs	PCBs	Metals	
AOI 2-B	RFI investigations identified CVOCs in soil above the GSIP and DWP criteria and in groundwater above the GSI and DW criteria for residential land use. CVOC contamination was also detected above residential SVIAC. This area is on the north-central portion of the Site and appears to be commingled with contamination originating on the off-site property to the north. The contamination is likely to have occurred from materials handling and storage.	Collected soil and groundwater samples from the Site and identified metals in soils and groundwater that exceed criteria but are believed to be naturally-occurring. CVOCs were detected above the DWP, GSIP, GSI, and DW criteria in soils and groundwater.	Additional monitoring wells were installed on the Site and additional soil borings were conducted with soil and groundwater sampling for various metals and CVOCs on the Site and on the adjacent abandoned railroad parcel to the north. Data from the downgradient Chevy-in-the-Hole property was also evaluated. Several groundwater monitoring events were also conducted. The Phase 2 investigations identified additional soil and groundwater CVOC contamination on the north-central portion of the Site and on the abandoned railroad parcel to the north above DWP, GSIP, DW, GSI, and residential SVIAC. The soil contamination appears to be concentrated in a silty clay layer on top of the bedrock at approximately 20 feet below grade. Evaluation of Site data and data collected from areas to the north, the groundwater contamination does not appear to pose a likely threat to the Flint River, located downgradient to the north.	SOIL: CVOCs > GSIP, DWP CVOCs > SVIA Metals > DWP & GSIP GW: CVOCs > GSI and DW Metals > DW & GSI				1) Restrict potable use of groundwater. 2) Restrict non-residential use. 3) Conduct groundwater monitoring for stability 4) Bioremediation of soil to remediate soil and groundwater

Notes:
(1) - Target analytes based on analytes detected during the RFI sampling activities and take into consideration the past use of the Area Of Interest, prior sampling density (i.e., assessment vs. characterization) and analytes detected upgradient and/or in surrounding AOIs.
(2) - Sampling step-out grid based on the size of the Investigation Area or AOI and the recommendations provided by the MDEQ Sampling Strategies and Statistical Training Manual (MDEQ RRD 2002); Small Area = $(\sqrt{A}/\pi)/2$, Large Area = $(\sqrt{A}/\pi)/4$ (results rounded to the nearest 5 feet)
(3) - Target media based on Phase 1 and historical results for soil and groundwater. For example, if soil impacts are defined vertically, the Phase 2 initial assessment will focus on horizontal delineation in soil first to determine if there is a viable source of target analytes before investigating groundwater.
(4) - Sample density is based on the amount of data available and the soil/groundwater analytical results for an area collected during the RFI Phase 1. For example, if an area has low-level detections of SVOCs in one or two borings and no indication of groundwater impacts, initial sampling will be completed based on field screening or otherwise at approximately 10-foot intervals ("normal") throughout the vadose zone. If soil and groundwater data suggest the area may be a source of COCs, soil and groundwater sampling will be completed at nominal 5-foot spacing ("higher resolution").

Abbreviations -
VOC - volatile organic compounds
SVOCs - semi-volatile organic compounds
CVOCs - Chlorinated volatile organic compounds
GSI - Groundwater-Surface Water Interface Criteria
DWP - Residential Drinking Water Protection Criteria
GSIP - Groundwater-Surface Water Interface Protection Criteria
SVIAC - Soil Volatilization to Indoor Air Inhalation Criteria
GW - groundwater

Table 7a
Corrective Measures Alternative Cost Estimate Backup
CMS Report
RACER - Flint West 12990

Restrictive Covenant Cost Detail

Assumptions:
1. The existing survey will be used
2. Cost estimates may vary 30-50%
3. Markup is included in subcontractor costs

Item	Unit	# Units	Rate	Total
Æ Labor				
Senior Project Manager	hour	80	$90	$7,200
Field Technician	hour		$60	$0
Field Geologist	hour		$80	$0
Clerical	hour	36	$40	$1,440
Subtotal				**$8,640**
Expenses				
Mileage	mile	320	$0.50	$160
Misc. expenses				$200
Subtotal				**$360**
Subcontractors				$0
Subtotal				$0
GRAND TOTAL				**$ 9,000**

Table 7b
Corrective Measures Alternative Cost Estimate Backup
CMS Report
RACER - Flint West 12990

Soil Excavation

Assumptions:
1. Cost estimates may vary 30-50%
2. Markup is included in subcontractor costs

Item	Unit	# Units	Rate	Total
Æ Labor				
Senior Project Manager	hour	90	$90	$8,100
Field Technician	hour	80	$60	$4,800
Field Geologist	hour	80	$80	$6,400
Clerical	hour	30	$40	$1,200
Subtotal				**$20,500**
Expenses				
Mileage	mile	280	$0.50	$140
Misc equipment and expenses	day	8	$200	$1,600
Subtotal				**$1,740**
Subcontractors				
Sheet piling (installed)	SF	4,000	$43	$172,000
Soil (hazardous) excavation, transport, disposal	CY	1,400	$94	$131,600
Dewatering (transport and disposal)	Gallon	36,000	$0.19	$6,840
Backfill	CY	1,200	$8	$9,600
Subtotal				**$320,040**
Short-term Well Monitoring	**(Collect and analyze 6 GW samples plus 3 QA/QC samples)**			
Collection/analysis - six wells	per event	2	2,400	$4,800
Subtotal				**$4,800**
GRAND TOTAL				**$ 347,080**

Table 7c
Corrective Measures Alternative Cost Estimate Backup
CMS Report
RACER - Flint West 12990

Annual Monitoring - Three Years Semi-annual followed by Two Years anually

Assumptions:
1. Eight wells will be sampled per annual monitoring event
2. Cost estimates may vary 30-50%
3. Markup is included in subcontractor costs

Item	Unit	# Units	Rate	Total
Æ Labor				
Senior Project Manager	hour	16	$90	$ 1,440.00
Field Technician	hour	12	$60	$ 720.00
Field Geologist	hour	8	$80	$ 640.00
Clerical	hour	20	$40	$ 800.00
Subtotal				**$ 3,600.00**
Expenses				
Pump and low-flow system	day	1	$500	$ 500.00
Water level meter	day	1	$50	$ 50.00
Field pack	day	1	$50	$ 50.00
Mileage	mile	20	$0.50	$ 10.00
Subtotal				**$ 610.00**
Subcontractors				
Laboratory Analysis (VOCs)	sample	11	$70	$ 770.00
Subtotal				**$ 770.00**
GRAND TOTAL (PER EVENT)				**$ 4,980.00**

Table 7d
Corrective Measures Alternative Cost Estimate Backup
CMS Report
RACER - Flint West 12990

Insitu Bioremediation Cost Detail

Assumptions:
1. Cost estimates may vary 30-50%
2. Markup is included in subcontractor costs

Item	Unit	# Units	Rate	Total
Æ Labor				
Senior Project Manager	hour	180	$90	$16,200
Field Technician	hour	180	$60	$10,800
Field Geologist	hour	160	$80	$12,800
Clerical	hour	140	$40	$5,600
Subtotal				**$45,400**
Expenses				
Geoprobe, supply trailer, pump, other equipment	day	12	$6,200	$74,400
Mileage	mile	440	$0.50	$220
Misc equipment and expenses	day	12	$100	$1,200
Subtotal				**$75,820**
Subcontractors				
Regenesis HRC (includes shipping/handling)	pound	4,250	$10	$42,500
Subtotal				**$42,500**
Short-term Well Monitoring	**(Collect and analyze 6 GW samples plus 3 QA/QC samples)**			
Collection/analysis - six wells	per event	2	2,400	$4,800
Subtotal				**$4,800**
GRAND TOTAL				**$ 168,520**

Table 7e
Corrective Measures Alternative Cost Estimate Backup
CMS Report
RACER - Flint West 12990

Multi-Phase Extraction

Assumptions:
1. Cost estimates may vary 30-50%
2. Markup is included in subcontractor costs
3. Assuming five-year operation period

Item	Unit	# Units	Rate	Total
Æ Labor (design, permitting, installation oversight, O&M, reporting - 5 years)				
Senior Project Manager	hour	640	$90	$57,600
Field Technician	hour	1,200	$60	$72,000
Field Geologist	hour	220	$80	$17,600
Clerical	hour	220	$40	$8,800
Subtotal				**$156,000**
System Installation				
Geoprobe, supply trailer	day	12	$2,600	$31,200
SVE well materials/plumbing	per well	20	$850	$17,000
Extraction wells (6" wells, installed)	per well	4	$3,400	$13,600
Equipment shed/electrical connection		1	$6,800	$6,800
Mileage	mile	880	$0.50	$440
Misc equipment and expenses	day	12	$600	$7,200
Subtotal				**$76,240**
Operating Expenses				
Dual Phase System Rental (includes carbon change-outs)	month	60	$8,900	$534,000
Electricity	month	60	$1,100	$66,000
Telemtry	month	60	$90	$5,400
Effluent monitoring	month	60	$800	$48,000
Subtotal				**$653,400**
Short-term Well Monitoring **(Collect and analyze 6 GW samples plus 3 QA/QC samples)**				
Collection/analysis - six wells	per event	2	2,400	$4,800
Subtotal				**$4,800**
GRAND TOTAL				**$ 890,440**