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January 30, 2014

Grace Ma
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EPA Region IX
75 Hawthorne Street
San Francisco, CA 94105

Subject: **Zero-Valent Iron Permeable Reactive Barrier Technology Evaluation and Treatability Study Work Plan**
401 National Avenue, Former Fairchild Building 9
Middlefield-Ellis-Whisman Area
Mountain View, California

Dear Ms. Ma:

Enclosed please find the Zero-Valent Iron (ZVI) Permeable Reactive Barrier (PRB) Technology Evaluation and Treatability Study Work Plan for the former Fairchild Building 9 property, located at 401 National Avenue, Mountain View, California. This document was prepared to address EPA's request that Schlumberger "*reassess and evaluate implementation of a treatability study of a funnel-and-gate system in the downgradient (northern) slurry wall in conjunction with and consideration of the [In Situ Chemical Oxidation] ISCO pilot study work and the redevelopment of the 401 National Avenue property*", which was included in a letter dated 23 September 2014 providing comments on the 3 July 2014 ISCO Pilot Study Work Plan for the subject site.

If you have any questions about the enclosed work plan, please feel free to contact me.

Very truly yours,

Virgilio Cocianni
Remediation Manager

Enclosure

CC: MEW Distribution List
Victor R. Fracaro, National Avenue Partners, LLC

Prepared for

Schlumberger Technology Corporation
205 Industrial Boulevard
Sugar Land, Texas 77478

ZERO-VALENT IRON PERMEABLE REACTIVE BARRIER TECHNOLOGY EVALUATION AND TREATABILITY STUDY WORK PLAN

401 NATIONAL AVENUE
FORMER FAIRCHILD BUILDING 9
MIDDLEFIELD-ELLIS-WHISMAN AREA
MOUNTAIN VIEW, CALIFORNIA

Prepared by

Geosyntec consultants

engineers | scientists | innovators

1111 Broadway, 6th Floor
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Project Number: WR1133C

30 January 2015

Zero-Valent Iron Permeable Reactive Barrier Technology Evaluation and Treatability Study Work Plan

401 National Avenue
Former Fairchild Building 9
Middlefield-Ellis-Whisman Area
Mountain View, California

Prepared by

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30 January 2015

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
1,1,1-TCA	1,1,1-trichloroethane
1,1-DCA	1,1-dichloroethene
AFRL	United States Air Force, Air Force Research Laboratory
AMEC	AMEC Environment and Infrastructure, Inc.
bgs	below ground surface
BP	biopolymer
cm/sec	centimeters per second
Canonie	Canonie Environmental
cDCE	cis-1,2-dichlorothene
Cl^-	chloride
cVOCs	chlorinated volatile organic compounds
DO	dissolved oxygen
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
Fairchild	Fairchild Semiconductor Corporation
Fe^{2+}	ferrous iron
FS	Feasibility Study
Geosyntec	Geosyntec Consultants, Inc.
GETS	groundwater extraction and treatment system
gpm	gallons per minute
GWFS	Groundwater Feasibility Study
HASP	health and safety plan
HLA	Harding Lawson Associates
IDW	investigation derived waste
ISCO	in situ chemical oxidation
ITRC	Interstate Technology & Regulatory Council

lbs	pounds
Locus	Locus Technologies
MCL	Maximum contaminant level
MEW	Middlefield-Ellis-Whisman
MIP	membrane interface probe
MnO_4^-	permanganate
MSL	mean sea level
mZVI	micro-scale ZVI
NE PRB	North East Permeable Reactive Barrier
NW PRB	North West Permeable Reactive Barrier
ORP	oxidation-reduction potential
PID	photoionization detector
PPE	personal protective equipment
PRB	permeable reactive barrier
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence
SCRWs	source control recovery wells
SCVWD	Santa Clara Valley Water District
Site	Building 9 facility located at 401 National Avenue in Mountain View, California
Smith	Smith Technology Corporation
STC	Schlumberger Technology Corporation
SUMCO	SUMCO Phoenix Corporation
SVE	soil vapor extraction

TCE	trichloroethene
TestAmerica	TestAmerica Laboratories, Inc.
USA	Underground Service Alert
VC	vinyl chloride
Vishay	Vishay GSI Inc.
ZVI	zero-valent iron

1. INTRODUCTION

This report presents an evaluation of zero-valent iron (ZVI) permeable reactive barriers (PRBs) as a potential alternative to groundwater extraction and treatment for addressing chlorinated volatile organic compounds (cVOCs) in groundwater at the former Fairchild Semiconductor Corporation (Fairchild) Building 9 facility located at 401 National Avenue[1] in Mountain View, California (Site, Figure 1 and Figure 2). Based on the conclusions of the evaluation, this report also includes a work plan for implementing a ZVI PRB treatability study at the Site. Geosyntec Consultants, Inc. (Geosyntec) prepared this report on behalf of Schlumberger Technology Corporation (STC) and at the request of the U.S. Environmental Protection Agency (EPA).

1.1 Purpose and Scope

In March 2013, EPA directed the Middlefield-Ellis-Whisman (MEW) Study Area Parties to perform pilot studies at their sites to evaluate alternative technologies or approaches for increasing the rate of cVOC mass removal.[2] On behalf of STC, Geosyntec submitted work plans for an in situ chemical oxidation (ISCO) pilot study as a means of increasing the rate of cVOC mass removal at the Site (Geosyntec, 2014c; 2014d; 2014e). EPA provided comments on the 3 July 2014 ISCO pilot study work plan (Geosyntec, 2014d) in a letter dated 23 September 2014 (EPA, 2014). In that letter, EPA stated:

> *"In addition, as part of the ongoing optimization efforts to accelerate groundwater cleanup and to evaluate the effectiveness of alternate groundwater technologies at facility-specific source areas at the MEW Site, EPA requests that Schlumberger reassess and evaluate implementation of a treatability study of a funnel-and-gate system in the downgradient (northern) slurry wall in conjunction with and consideration of the ISCO pilot study work and the redevelopment of the 401 National Avenue property."*

The ISCO pilot study work plan was revised to address EPA's comments, and a final work plan was submitted on 19 November 2014 (Geosyntec, 2014e). In the transmittal

[1] As part of a planned redevelopment, 401 National Avenue and the properties located to the immediate north (620 through 640 National Avenue) have been consolidated into a single address: 600 National Avenue (Figure 3). For consistency with historical project documents, the project site for the ZVI PRB treatability study will be referred to as the Site, former Building 9, or 401 National Avenue throughout this report.

[2] P.W. Reddy, EPA, Email Communication, 11 March 2013.

letter accompanying the final work plan, STC stated its intention to complete the requested evaluation and submit a separate work plan for a ZVI PRB (equivalent to the funnel-and-gate system described by EPA in the above statement) treatability study. This report includes both the requested evaluation and a work plan for implementation of a ZVI PRB treatability study.

The ZVI PRB technology evaluation includes:

- A brief discussion of ZVI technology and how it would be applied as an alternative to the existing remedy; and
- Evaluation of the potential applicability of ZVI PRBs at the Site, including:
    - Discussion of how EPA's prior comments related to technology efficacy and implementability can be addressed as part of ZVI PRB design and through implementation of appropriate contingencies;
    - Discussion of potential stakeholder concerns related to installation of ZVI PRBs and approaches to address or mitigate the concerns;
    - Evaluation of the compatibility of ZVI PRBs with the ISCO pilot study that has been proposed for the Site; and
    - Discussion of the consistency of the treatability study components with the ROD for the MEW Study Area.

The scope of work for the ZVI PRB treatability study includes:

- Supplemental data collection to: (1) assess the lithology of the areas adjacent to the proposed PRBs in detail; and (2) assess the efficacy of a micro-scale ZVI formulation that is proposed for addressing competing redox conditions upgradient of the ZVI PRBs;
- Destruction of the four source control recovery wells (SCRWs) located within the slurry wall footprint at 401 National Avenue;
- Targeted injections of micro-scale ZVI immediately upgradient of the ZVI PRBs to geochemically reduce groundwater before it enters the ZVI PRBs;
- Installation of ZVI PRBs at two locations along the downgradient (north) side of the 401 National Avenue slurry wall;
- Treatability study performance monitoring following installation; and
- A contingency plan for mitigating potential migration of cVOCs from the Site, if necessary based on performance monitoring data.

The proposed treatability study is not associated with, or part of, the planned redevelopment activities at 401 National Avenue. However, the planned redevelopment provides access to portions of 401 National presently occupied by buildings (Section 2.1).

1.2 Report Organization

The remainder of this report is organized as follows:

- Section 2, *Background*, presents a description of the local hydrogeology and cVOC distribution at the Site, a description of previous remedial actions, and summary of remedy performance;
- Section 3, *Technology Evaluation*, presents a description and assessment of ZVI as a remedial technology, addresses EPA's previous assessment of PRB technologies at the MEW sites, and addresses potential concerns raised by other stakeholders.
- Section 4, *Design Basis for Treatability Study*, summarizes the objectives for the ZVI PRBs, presents relevant data collected in September 2013 to support treatability study design, and presents the proposed approaches for PRB design, performance monitoring, and implementing contingencies to mitigate potential offsite migration of cVOCs;
- Section 5, *Implementation Work Plan*, provides a work plan for implementing the treatability study scope of work;
- Section 6, *Reporting and Schedule*, summarizes the reports that will be submitted to document the treatability study implementation and presents a schedule for implementing the treatability study; and
- Section 7, *References,* provides the references cited in this report.

Tables, figures, and appendices are provided at the end of this report.

2. BACKGROUND

The Site is located within the MEW Study Area in Mountain View, California. STC has been performing soil and groundwater remedies for cVOCs, primarily trichloroethene (TCE) and its breakdown products (cis-1,2-dichloroethene [cDCE] and vinyl chloride [VC]), at the former Building 9 facility since 1986. In conformance with the 1989 Record of Decision (ROD) and two subsequent Explanations of Significant Differences (ESDs) issued by the EPA for the MEW Study Area (EPA, 1989; 1990; 1996), the Building 9 facility-specific groundwater remedy consists of slurry wall containment (A-zone) and groundwater extraction and treatment (pump-and-treat).

2.1 Site Description and History

Building 9 operated as a facility for receiving, mixing, and delivering chemicals for Fairchild from 1966 to 1987. During the Remedial Investigation/Feasibility Study (RI/FS) completed in 1988 for the MEW Study Area (HLA, 1987; Canonie, 1988a), two potential source areas (LS28 and LS29) were identified at the Site. LS28 was located on the north side of Building 9 and consisted of four solvent storage tanks and a spill collection sump. LS29 was a pH neutralization system located inside Building 9 that consisted of three treatment sumps.

A number of remedial actions have been conducted as part of the facility-specific remedy for the Site, including (in chronological order):

1986: installation of a soil-bentonite slurry wall in the A-zone to a depth of approximately 40 feet below ground surface (bgs) (Figure 2). The slurry wall is an approximately 34 inches thick[3], with an average permeability coefficient (hydraulic conductivity) of 3.8×10^{-8} centimeters per second (cm/sec, 1.1×10^{-4} feet per day) based on post-construction quality control testing (Canonie, 1988b);

Ongoing since 1986: groundwater extraction at SCRWs AE/RW-9-1, AE/RW-9-2, RW-20A, and RW-21A located within the Site slurry wall (Figure 2);

Ongoing since 1996: groundwater extraction at SCRWs GSF-1A, GSF-1B1, and GSF-1B2 (Figure 2), which are operated jointly for both 401 National Avenue and the adjacent 405 National Avenue site (AMEC, 2013);

[3] Test pits across the uppermost 5 feet of the slurry wall were excavated in September 2013 and the maximum thickness of soil-bentonite backfill was observed to be approximately 35 inches (Geosyntec, 2014b) and post construction drawings indicate that the slurry wall is a minimum of 30 inches thick (Canonie, 1988b).

1995: 3,000 cubic yards of soil were excavated to a depth of 6 feet bgs and aerated at the Site (Smith, 1995; EPA, 2004); and,

1996 through 1997: soil vapor extraction (SVE) in shallow soil at depths from 6 feet bgs to 18 inches above the water table (Locus, 1997; Smith, 1997a; and Smith, 1997b).

In 2013, the 401 National Avenue property was purchased by National Avenue Partners, LLC and in May 2014 redevelopment of 401 National in conjunction with three properties to the north was approved by the City of Mountain View. The approved redevelopment activities include the demolition of the former Building 9 and the construction of a two-story aboveground parking garage over most of the current 401 National Avenue property, as shown in Figure 3.

Between 28 August and 27 September 2013, fieldwork was performed to collect data to support the ISCO pilot study design. A Data Collection Summary Report detailing the results of this field work was submitted to EPA on 3 July 2014 (Geosyntec, 2014b). Between 8 October and 26 November 2014, additional fieldwork was performed to support the ISCO pilot study design, as described in the 3 July 2014 ISCO Pilot Study Data Collection Work Plan (Geosyntec, 2014c). A summary of results from the 2014 ISCO data collection activities was submitted to EPA as part of the Addendum to the Final Work Plan for the ISCO Pilot Study (Geosyntec, 2015).

2.2 Local Hydrogeology

The MEW Study Area is located in the northern portion of the Santa Clara Valley Groundwater Sub-basin, the northernmost of three interconnected groundwater basins within Santa Clara County (Santa Clara Valley Water District [SCVWD], 2001). The groundwater flow direction is northerly, toward the San Francisco Bay, and generally sub-parallel to the ground slope. The hydrostratigraphy in this part of the sub-basin is divided into upper and lower water-bearing zones, separated by an extensive regional aquitard (SCVWD, 1989).

The upper water-bearing zone underlying the MEW Study Area is subdivided into two water-bearing zones: the A-zone (roughly between 14 and 40 feet bgs) and the B-zone (roughly between 45 and 160 feet bgs), which are separated by the A/B Aquitard. The B-zone is further subdivided into three zones (B1-, B2-, and B3-zones). The lower water-bearing zone occurs below a depth of about 200 feet bgs. The lower water bearing zone is subdivided into the C-zone (which extends to about 240 feet bgs) and the Deep zone. The aquitard separating the upper and lower water-bearing zones is represented as the B/C Aquitard and is the major confining layer beneath the Site.

Groundwater flow beneath the MEW Study Area is generally towards the north in the A- and B-zones under both non-pumping and pumping conditions. Groundwater hydraulic gradients are locally modified by the operation of groundwater recovery wells (both source control and regional recovery wells) and slurry walls, resulting in steeper gradients in the vicinity of pumping wells.

The A-zone is the primary groundwater unit monitored at the Site. Under pumping conditions, the potentiometric surface of the A-zone at the Site generally occurs under confined conditions. During the September 2013 semi-annual gauging event, groundwater at the Site was encountered at a depth of approximately 17 feet bgs, corresponding to groundwater elevations of approximately 26 feet above mean sea level (MSL) (Geosyntec, 2014a). Inward horizontal gradients are observed along most of the slurry wall during pumping, with the periodic exception of some locations along the northern, downgradient sections, and an upward vertical gradient is observed within the slurry wall footprint from the deeper B1-zone into the A-zone during pumping conditions (Geosyntec, 2014a).

2.3 Nature and Extent of cVOCs

The primary cVOCs in Site groundwater are TCE and its reductive dechlorination daughter products cDCE and VC. TCE concentrations in groundwater from Site monitoring wells sampled in 2012/2013 and grab groundwater samples collected in 2013/2014 are listed in Table 1 and posted on Figure 4. Plots of TCE, cDCE, and VC concentration versus time for select A-zone monitoring wells are included in Appendix A.

Over the last five years (2009 through 2013), the maximum concentration of TCE detected in Site groundwater monitoring wells or SCRWs was 13,000 micrograms per liter (µg/L) in AE/RW-9-2 in 2013 (Geosyntec, 2014a). TCE concentrations in grab groundwater samples collected in September 2013 and November 2014 ranged from 100 to 560,000 µg/L (Table 1). The TCE concentration measured in 2013 for Site well 123A, located upgradient (south) of the slurry wall, was 510 µg/L. TCE concentrations at Site wells 41A and 42A, located downgradient (north) of the slurry wall, were 580 and 470 µg/L, respectively (Figure 4).

Total cVOC concentrations detected in September 2013 and November 2014 ranged from approximately 1,800 to 630,000 µg/L and predominantly consisted of TCE and cDCE, with the exception of the central portion of the Site, where 1,1,1-trichloroethane (1,1,1-TCA) and 1,1-dichloroethene (1,1-DCA) were detected at concentrations ranging up to 3,500 and 4,900 µg/L, respectively (Table 1).

2.4 Current Groundwater Remedy

As specified in the ROD for the MEW Study Area, the current facility-specific groundwater remedy at the Site consists of slurry wall containment (A-zone) and groundwater extraction and treatment.

There are four A-zone SCRWs on Site within the area bounded by the slurry wall (referred to as the On-Site SCRWs) that are primarily used to recover cVOC mass and maintain inward and upward groundwater gradients within the slurry wall, as stipulated by the ROD (Figure 2). The On-Site SCRWs are connected to the Fairchild System 1 treatment facility (Geosyntec, 2014a).

Outside of the slurry wall, there are currently three SCRWs (one in each of the A-, B1-, and B2-zones) and one additional planned A-zone SCRW associated with the Site. The existing off-Site SCRWs are located approximately 200 feet downgradient (north) of the Site and primarily provide Site containment. The location of the A-zone SCRW outside the slurry wall (well GSF-1A) is shown in Figure 2. The SCRWs in the B1 and B2-zones outside of the slurry wall (wells GSF-1B1 and GSF-1B2) are immediately adjacent to GSF-1A. In addition, a new A-zone SCRW is planned to comply with EPA's directive for increased mass removal in the vicinity of monitoring well 116A, located approximately 70 feet downgradient of the 401 National slurry wall. STC and Vishay GSI Inc. (Vishay)/SUMCO Phoenix Corporation (SUMCO) jointly operate wells GSF-1A, GSF-1B1 and GSF-1B2 by agreement as part of the source control measures for both 401 National Avenue and the adjacent 405 National Avenue site. These wells (referred to as the Shared SCRWs) are connected to the 401/405 National Shared Treatment Plant (also referred to as the Vishay/SUMCO treatment facility) that is currently located on the Site.[4] This off-Site remedy is referred to as the Shared Remedy. The anticipated extraction well in the vicinity of monitoring well 116A will be operated as part of the Shared Remedy. The Shared Remedy provides containment of groundwater for Site areas outside of, and below, the slurry wall.

[4] The 401/405 National Shared Treatment Plant will be relocated on Site to accommodate the planned redevelopment activities. The off-Site SCRWs will continue to be connected to the plant following relocation.

3. TECHNOLOGY EVALUATION

This section presents an evaluation of the potential applicability of ZVI PRB technology at the Site, a discussion of the compatibility of the use of ZVI in close proximity to the ISCO pilot study currently underway at the Site, a discussion of previous EPA findings and recent stakeholder concerns related to the use of PRB technology in conjunction with slurry walls, and a discussion of the consistency with the existing ROD of the use of a treatability study to test the ZVI PRB technology.

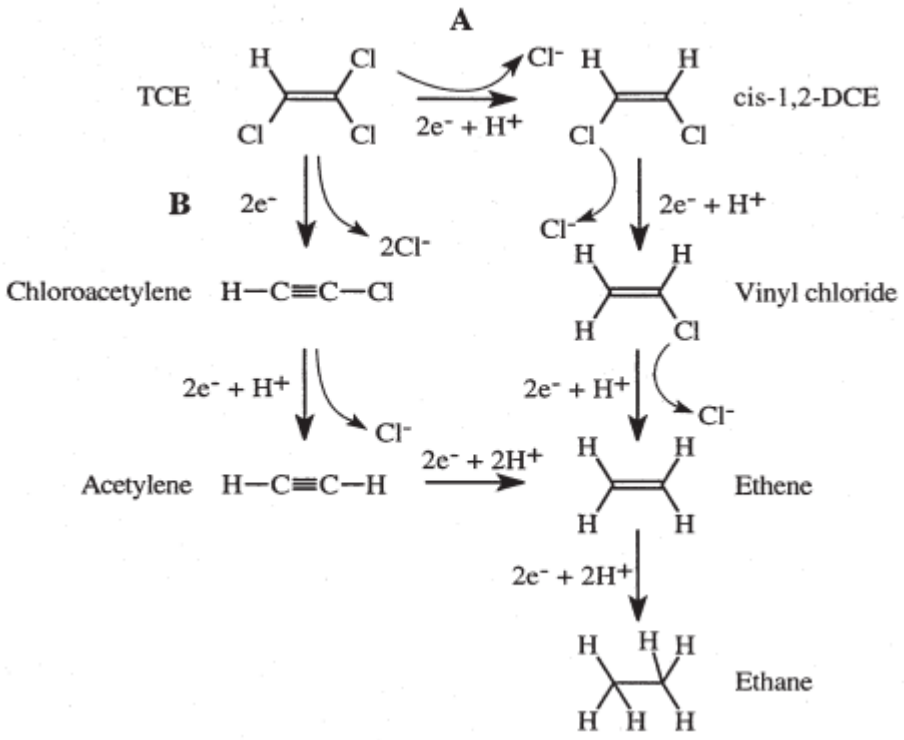
3.1 Technology Description

3.1.1 ZVI Chemistry

The degradation of cVOCs to nontoxic end products in the presence of ZVI has been extensively documented in both the laboratory and field (e.g., Gillham and O'Hannesin, 1994; EPA, 1998). This abiotic process involves the oxidation of ZVI, followed by the subsequent reductive dechlorination of dissolved cVOCs. The ultimate end products of the dechlorination reaction that occurs when cVOCs are in contact with ZVI are chloride (Cl^-), ferrous iron (Fe^{2+}), and non-chlorinated hydrocarbons including ethene and ethane. Dechlorination of cVOCs by ZVI can be generally represented by the following reaction:

$$Fe^0 + RCl + H^+ \rightarrow RH + Fe^{2+} + Cl^- \quad (1)$$

where RCl and RH represent an example cVOC prior to and following, reductive dechlorination, respectively. In reality, the degradation pathways for cVOCs by ZVI are more complex than represented by Equation 1. Specifically, the degradation of TCE by ZVI has been shown to occur through two competing pathways (Arnold and Roberts, 2000), as shown in the figure below.



TCE Degradation Pathways in Presence of ZVI (from EPA, 1998).

Pathway A: In Pathway A, TCE is sequentially degraded to lesser-chlorinated ethene compounds (cDCE, VC, and eventually ethene/ethane) through a process known as hydrogenolysis.

Pathway B: In Pathway B, TCE first undergoes a process known as β-elimination, which results in the production of chloroacetylene as an intermediate. This intermediate is unstable and rapidly degrades to acetylene, ethene, and ethane.

Pathway B is the dominant pathway for TCE degradation by ZVI, with over 90% of TCE typically degraded via the β-elimination pathway (Gillham et al., 2010). The predominance of Pathway B accounts for the rapid conversion of TCE to ethene and ethane that is typically observed in ZVI systems, with relatively minor formation of chlorinated ethene intermediates (e.g., cDCE and VC) observed.

3.1.2 ZVI PRB Application

ZVI PRBs are *in situ*, permeable treatment zones that are designed to intercept and remediate contaminants in groundwater. PRBs are designed to be more permeable than

the surrounding aquifer to promote groundwater flow through the barrier without significantly altering groundwater hydrology. Groundwater flows into the PRB under natural gradient conditions and, once inside the barrier, cVOCs in groundwater are degraded by the ZVI, with treated groundwater discharging from the downgradient side of the PRB.

The most common PRB configuration is a continuous trench in which the ZVI is backfilled. The trench is typically oriented perpendicular to the direction of groundwater flow. In some cases, trenched PRBs are installed as part of a funnel-and-gate configuration. In this configuration, low-permeability walls (the funnel) direct groundwater toward the permeable treatment zone (the gate) (Interstate Technology & Regulatory Council [ITRC], 2011). At this Site, portions of the downgradient side of the existing slurry wall that surrounds the Site would be excavated and replaced with ZVI gates. With this configuration, groundwater containing cVOCs would be treated as it flows off-Site in the downgradient direction.

ZVI PRBs have been widely applied throughout the United States to treat dissolved-phase cVOC plumes. As of 2011, over 200 PRB systems are known to have been installed (ITRC, 2011). As a result of this body of experience, techniques for installing and monitoring PRBs are well documented in the literature, with numerous guidance documents available (e.g., United States Air Force, 2000; ITRC, 2005; ITRC, 2011). These documents can be referred to when designing ZVI PRBs at the Site (Section 4) to ensure that the design is consistent with industry best practices.

At the Site, the ZVI PRBs installed as part of the treatability study would, in conjunction with the currently ongoing ISCO pilot study, replace the existing groundwater extraction and treatment system (GETS) as follows:

- **Containment:** Results of a modeling evaluation conducted for the Site (Section 4.3) indicate that, in the absence of groundwater extraction following ZVI PRB installation, groundwater within the slurry wall boundary would flow through the PRBs. Further, nearly all groundwater flowing upward into the slurry wall boundary from the B1-zone would subsequently flow through the PRBs prior to discharging downgradient of the Site. Because groundwater discharging from the Site will flow through the ZVI PRBs and cVOCs will be degraded within the PRBs, the ZVI PRBs will effectively replace the current GETS with respect to preventing off-Site migration of cVOCs.
- **Mass Removal:** cVOC mass removal during the ISCO pilot study will be primarily achieved through the implementation of multiple rounds of ISCO injections in areas of groundwater within the slurry wall boundary having high

concentrations of cVOCs. However, long-term mass removal would continue following the conclusion of the ISCO pilot study as groundwater containing cVOCs flows through the ZVI PRBs and is treated. The ZVI PRBs would therefore function as replacements to the existing groundwater extraction and treatment program as a technology for long-term mass removal.

3.2 Compatibility of ISCO and ZVI

An ISCO pilot study is currently underway in areas of high cVOC concentration located within the area bounded by the 401 National Avenue slurry wall to assess the potential for that technology to increase the rate of cVOC mass removal at the Site. It is expected that the oxidants applied during the ISCO pilot study will be rapidly consumed within the treatment area with limited, if any, transport into the ZVI PRBs. However, because the areas of ISCO application may be in close proximity to the ZVI PRBs, the compatibility of ICSO and ZVI was assessed, specifically with respect to the potential for oxidants in groundwater to enter the PRBs and consume the ZVI prematurely.

The ISCO pilot study planned for the Site will include the injection of sodium permanganate and sodium persulfate. Previous studies by others have shown that if permanganate (MnO_4^-) comes into contact with ZVI, the manganese in MnO_4^- will be reduced, and ZVI will be oxidized (Okwi et al., 2005). The reaction between MnO_4^- and ZVI will follow Equation 2 if ZVI is present in excess of MnO_4^- or Equation 3 if MnO_4^- is present in excess of ZVI:

$$5Fe^0 + 2MnO_4^- + 12H^+ \rightarrow 5Fe^{2+} + 2MnO + 6H_2O \quad (2)$$

$$Fe^0 + MnO_4^- + 4H^+ \rightarrow Fe^{3+} + MnO_{2(s)} + 2H_2O \quad (3)$$

Both reactions result in formation of manganese and iron solid phases in the form of insoluble oxyhydroxide and oxide precipitates that form films and coatings on ZVI grain surfaces. Although these precipitates are not expected to accumulate in a sufficient quantity to cause measurable decline in ZVI material permeability, oxidized surface films have been shown to cause the loss of ZVI reactivity toward cVOCs (Okwi et al., 2005).

These studies were conducted by flowing sustained volumes of high concentration MnO_4^- solution through a ZVI column. Therefore, the results may over-predict the impact on ZVI PRB performance at the Site because transport of oxidant into the ZVI PRBs is expected to be limited.

Interactions between persulfate and ZVI have been studied by others in relation to the use of ZVI as a persulfate activator (e.g., Oh et al., 2009; Al-Shamsi and Thomson, 2013; Rodriguez et al., 2014). The oxidation of ZVI by persulfate will follow Equation 4:

$$Fe^0 + S_2O_8^{2-} \rightarrow Fe^{2+} + 2SO_4^- \quad (4)$$

As with the oxidation of ZVI by permanganate, the above reaction may result in the formation of iron solid phases in the form of iron oxyhydroxide and iron sulfate precipitates that form films and coatings on ZVI grain surfaces (Al-Shamsi and Thomson, 2013).

As described above, both permanganate and persulfate may cause deactivation of ZVI if these compounds enter the ZVI PRBs at sufficiently high concentrations and sustained mass loadings. Although transport of these oxidants to the ZVI PRBs is not expected, this potential impact can be mitigated by creating an ISCO neutralization zone on the upgradient side of the ZVI PRBs installed in close proximity to the proposed ISCO injection areas. Given the known ability of ZVI to deactivate both permanganate and persulfate, the ISCO neutralization zone could be created by direct injections of micro-scale ZVI into the A-zone aquifer after the ISCO injections are complete and prior to construction of the ZVI PRBs.

3.3 EPA Findings and Stakeholder Concerns

The draft Supplemental Site-Wide Groundwater Feasibility Study (GWFS) for the MEW Study Area prepared by EPA in 2012 (EPA, 2012) included a screening of remedial technologies that could be potentially applicable at the MEW Study Area, including installation of PRBs either alone or within existing slurry walls as part of a funnel-and-gate configuration. The screening evaluation of ZVI PRBs was informed in part by a pilot-scale PRB that was installed by the Navy on Moffett Field (NAVFAC, 2005).

In the 2012 draft GWFS, EPA retained both the use of ZVI and the installation of PRBs as potentially viable technologies for groundwater at the MEW Study Area. EPA also concluded that modification to the existing slurry walls to create funnel-and-gate PRBs was technically plausible, but did not elect to retain the technology based on the following findings:

- Modification of an existing slurry wall to include a reactive gate is untested at the MEW Study Area.

- If the reactive gate is ineffective, modifying the slurry wall may result in the potential release and migration of high concentration areas of the plume.
- If the reactive gate is ineffective, restoration of the slurry wall could be difficult and expensive.

On 16 October 2014, a meeting was held between representatives of STC, EPA, and MEW stakeholders to discuss the proposed 401 National Avenue treatability studies. At that meeting, stakeholders noted the following concerns regarding the potential ZVI PRB component of the treatability studies:

- Modifying the slurry wall and discontinuing pumping within the slurry wall may result in the off-site migration of cVOCs.
- Implementation of contingencies following redevelopment would be disruptive to future tenants or Site occupants.

Approaches to address the EPA findings and stakeholder concerns are presented below.

3.3.1 Approaches to Address EPA Findings

EPA Finding: Modification of an existing slurry wall to include a reactive gate is untested at the MEW Study Area.

Approach: The fact that modification of an existing slurry wall is untested at the MEW Study Area is not a reason in and of itself to reject the technology. The purpose of a treatability study is to test the technology in the field prior to full-scale application. The treatability study can be designed to address the potential for technology failure and continue to meet the requirements of the MEW ROD. Thus, the treatability study will include the installation of appropriate contingencies to mitigate the potential for uncontrolled cVOC migration following the slurry wall modification.

EPA Finding: If the reactive gate is ineffective, modifying the slurry wall may result in the potential release and migration of high concentration areas of the plume.

Approach: A-zone groundwater within the slurry wall with high concentrations of cVOCs is being addressed separately through implementation of an ISCO pilot study (Geosyntec, 2014e). Successful implementation of the ISCO scope of work is expected to reduce cVOC concentrations in A-zone groundwater upgradient of potential slurry wall modifications. Groundwater extraction wells can be installed immediately downgradient of the ZVI PRBs to be operated in the event that the ZVI PRBs do not provide sufficient treatment to reduce cVOCs in groundwater to cleanup levels

specified in the MEW ROD (California Maximum Contaminant Levels [MCLs]). Operation of these contingency extraction wells would prevent the release and downgradient migration of cVOCs to areas outside the slurry wall.

EPA Finding: If the reactive gate is ineffective, restoration of the slurry wall could be difficult and expensive.

Approach: Restoration of the slurry wall will not be feasible in the event of insufficient PRB performance. However, through installation and operation of the contingency extraction wells described above, the need for slurry wall restoration would be eliminated.

3.3.2 Approaches to Address Stakeholder Concerns

Stakeholder Concern: Modifying the slurry wall and discontinuing pumping within the slurry wall may result in the off-Site migration of cVOCs.

Approach: As described above, A-zone groundwater within the slurry wall with high concentrations of cVOCs is being addressed separately through implementation of an ISCO pilot study. Successful implementation of the ISCO scope of work is expected to reduce cVOC concentrations in A-zone groundwater upgradient of potential slurry wall modifications. The ZVI PRB gates can be designed to reduce cVOCs to the cleanup levels specified in the MEW ROD (i.e., California MCLs) to prevent off-Site migration.

Groundwater extraction wells can also be installed immediately downgradient of the ZVI PRBs to be operated in the event that the ZVI PRBs do not provide sufficient treatment to reduce cVOCs in groundwater to cleanup levels specified in the MEW ROD. Operation of these contingency extraction wells would prevent the release and downgradient migration of cVOCs to areas outside the slurry wall.

Stakeholder Concern: Implementation of contingencies following redevelopment would be disruptive to future tenants or Site occupants.

Approach: In order to minimize the potential for disruption following redevelopment, the contingency extraction wells and associated piping and treatment can be constructed prior to redevelopment during PRB construction.

3.4 Summary of Technology Evaluation

This technology evaluation indicates the following with respect to the potential effectiveness of ZVI PRBs:

- ZVI can effectively degrade the cVOCs present at the Site. The predominant degradation pathway for TCE by ZVI does not generate cDCE or VC, limiting the potential for generation of daughter products by a ZVI PRB.
- PRB technology is well understood, with a large body of literature available to ensure that barrier design is consistent with industry best practices.
- The potential impacts to a ZVI PRB by the presence of residual oxidants in groundwater flowing through the barrier can be mitigated by installation of an ISCO neutralization zone immediately upgradient of the potential ZVI PRB locations.
- Implementation of the ISCO and ZVI treatability study will reduce cVOC mass at the Site, while effectively replacing the current GETS with respect to preventing off-Site migration of cVOCs.
- Previous EPA findings and stakeholder concerns can be addressed through the installation of contingency extraction wells located immediately downgradient of the ZVI PRB gates. The wells can be installed and connected to an existing treatment system during the PRB installation to avoid potential future disruptions to the Site and to allow for immediate resumption of groundwater extraction in the event the ZVI PRBs do not reduce cVOC to the cleanup levels specified in the MEW ROD.

Because the ZVI PRB technology appears to be viable for the Site and stakeholder concerns can be mitigated through careful design and implementation of engineering controls, STC has elected to move forward with a work plan for a ZVI PRB treatability study. The remainder of this document presents a design basis and scope of work for implementing the treatability study.

4. DESIGN BASIS FOR TREATABILITY STUDY

This section presents the objectives of the study, a summary of the results of pre-design activities, the design basis for the ZVI PRB treatability study, the proposed monitoring program, and a proposed contingency to be implemented if the PRBs do not perform as designed.

4.1 Treatability Study Objectives

The objective of the treatability study is to evaluate whether ZVI PRB technology can be practicably implemented as an alternative to groundwater extraction and treatment at the Site. As part of the treatability study, two ZVI PRBs will be installed at the Site (Figure 5), one near the northeast corner of the slurry wall (North East Permeable Reactive Barrier [NE PRB]) and one near the northwest corner of the slurry wall (North West Permeable Reactive Barrier [NW PRB]). The ZVI PRBs are designed to reduce cVOC concentrations in groundwater to less than California MCLs before groundwater discharges from the PRBs and flows off Site. The performance of the treatability study will be assessed based on the following:

- Observed groundwater elevations and subsequent evaluations of groundwater flow in the vicinity of the ZVI PRBs; and
- Observed reductions in cVOC concentration in groundwater flowing through the ZVI PRBs, based on groundwater monitoring data collected from within the PRBs.

4.2 Summary of Results of Pre-Design Activities

On 13 August 2013, Geosyntec submitted the Work Plan for Pilot Study Data Collection (Geosyntec, 2013). The work plan included the following activities to support the possible design of ZVI PRBs:

- Excavation of test pits at two locations along the slurry wall to evaluate the slurry wall width and to visually inspect the nature of the contact between the slurry wall and native formation;
- Collection of groundwater samples from AE/RW-9-2 and 137A to evaluate baseline conditions and for use in bench-scale treatability testing for the ZVI PRBs; and

- Measurement of water level response to a temporary shutdown of Site extraction wells to evaluate expected hydraulic conditions in the absence of groundwater extraction.

The data collection fieldwork and bench-scale testing were completed in September and October 2013. Relevant results from the supplemental data collection activities related to the ZVI PRBs were discussed in the Data Collection Summary Report (Geosyntec, 2014b) and are summarized below:

- Following shutdown of the four On-Site SCRWs on 30 August 2013, groundwater levels increased from 25.49 to 30.58 feet MSL at well 122A and from 25.62 to 29.63 feet MSL at well 37A over a period of 10 days. Water levels inside the slurry wall were still increasing when the extraction wells were restarted on 9 September 2013. Based on these observations, water levels inside the slurry wall may increase by 4 to 5 feet following shutdown and decommissioning of the four On-Site SCRWs.
- The maximum measured width of the slurry wall was 33 inches. This suggests that a 48-inch wide excavator bucket or larger will be sufficient for over-excavation of the slurry wall and installation of ZVI PRBs.
- A bench-scale ZVI treatability test was performed by SiREM Laboratories of Guelph, Ontario, Canada to obtain Site-specific first-order degradation half-lives for cVOCs present in the Site groundwater and their breakdown products under flowing conditions (Appendix B). The treatability test was conducted in a flow-through column using groundwater collected from On-Site SCRW AE/RW-9-2 and a commercial ZVI material for column packing. The results from the column test were modeled using a multicomponent, first-order degradation model to obtain half-lives for cVOC degradation. Because the half-lives were based on data collected at room temperature, they were subsequently adjusted to reflect the groundwater temperature at the Site of 19°C prior to use in the PRB design. The cVOC degradation half-lives from the bench-scale test were used in the design of the ZVI PRBs.
- Groundwater geochemistry at the Site, particularly the presence of calcium and alkalinity, may result in the gradual passivation of the ZVI PRBs due to mineral precipitation. An engineering safety factor was therefore incorporated into the ZVI PRB design to account for potential future passivation and thereby extend the long-term reactivity of the barriers.

4.3 ZVI PRB Design

As described in Section 3.1, a PRB is an *in situ* permeable treatment zone designed to intercept and treat contaminated groundwater. The treatment efficacy of a ZVI PRB is based on its ability to intercept contaminated groundwater and reduce concentrations of cVOCs in the intercepted groundwater, and is a function of the influent cVOC concentrations, the reactivity of the ZVI material in the PRB, and the residence time of the groundwater within the barrier, as determined by the groundwater velocity and PRB thickness. This section describes the proposed ZVI PRB construction approach, orientation, and dimensions, describes the implementation of a redox modification zone upgradient of the PRB, and presents the ZVI PRB design thickness and iron composition based on the parameters described above.

4.3.1 ZVI PRB Construction Approach

The ZVI PRBs will be constructed by first excavating the existing slurry wall using a hydraulic excavator. The methods for shoring the slurry wall excavation will be determined based in part on the results of supplemental PRB design data collection activities (Section 5.2). In general, it is expected that the excavation will be shored using one or both of the following approaches:

- Installation of sheet piling using a vibrating hammer, impact hammer, or comparable installation technique.
- Use of a biopolymer (BP) slurry as a means of providing trench support.

Once excavation is completed, the trenches will be backfilled with a mixture of ZVI and sand over the target interval for ZVI placement. The remainder of the trenches will be backfilled using a low hydraulic conductivity, clay-rich material that will be placed above the ZVI/sand to within 3 feet of the ground surface. The upper surface will be completed to match the surrounding area.

4.3.2 ZVI PRB Orientation and Dimensions

The two ZVI PRB locations are shown in Figure 5. The ZVI PRBs will be installed perpendicular to the shallow groundwater flow direction and oriented along the downgradient (northern) side of the Site. Each PRB will be approximately 26 feet deep and 50 feet long, and follow the strike of the slurry wall. Installation of the ZVI PRBs will involve excavation of two sections of the northern slurry wall and placement of ZVI at a depth corresponding to the shallow sand layer in the A-zone at the Site. The ZVI will be placed from 17 feet bgs to 26 feet bgs (Figure 6), with low permeability

material placed on top of the ZVI to prevent groundwater flow above the ZVI. The depth interval for ZVI placement was selected to correspond to the shallow coarse-grained layer generally encountered in the A-zone from approximately 17 to 23 feet bgs (Figure 7).

4.3.3 Redox Modification Zone

Figure 8 presents the alignment of the proposed ZVI PRBs along with the planned extent of the ISCO pilot study injections. As discussed in Section 3.2, the proximity of the ISCO injections to the NE PRB could result in direct contact of ISCO reagents (i.e., sodium permanganate and sodium persulfate) with the ZVI and increase the rate of ZVI passivation. To extend the lifespan of the ZVI PRB, a redox modification zone will be established immediately upgradient of the NE PRB to neutralize residual oxidant and geochemically reduce groundwater entering the PRB.

Based on implementability, short- and long-term effectiveness, and cost considerations, dispersed micro-scale ZVI (mZVI) has been selected for injection into the subsurface directly upgradient of the ZVI PRB to create the redox modification zone. The use of mZVI presents several advantages over other potential redox modification methods, including the following:

- ZVI has been shown to effectively neutralize both permanganate and persulfate;
- mZVI is more reactive than granular ZVI sources due to a higher surface area;
- Particulate mZVI material is expected to persist longer than liquid chemical reductants such as thiosulfate; and
- Direct injection of mZVI can be performed using standard injection approaches similar to those that will be used during implementation of the ISCO pilot study at the Site.

To promote formation of a continuous mZVI-amended zone upgradient of the northeast ZVI PRB, mZVI will be injected into two rows of staggered injection points (Figure 8). Geosyntec assumed the following in designing the redox modification zone:

- The approximate dimensions of the mZVI zone upgradient of the NE PRB will be 50 feet long by 20 feet wide;
- The targeted injection interval will correspond to the depth interval of ZVI in the northeast PRB (i.e., approximately 17 to 26 feet bgs); and

- Based on an estimated injection radius of influence (ROI) of 7 feet, the mZVI injection locations will be spaced approximately 10 feet on center in two parallel staggered rows of injection points (10 total injection points).

To provide a conservative basis for the redox modification zone design, mZVI loading in the targeted aquifer unit of 1.0% by soil weight was assumed. This mZVI application rate is consistent with the maximum injectable amount of mZVI observed at other sites at similar depths. Given the target mZVI loading of 1.0% by weight and the volume and density of soil within the injection area, a total of approximately 9,900 pounds (lbs) of mZVI will be injected to create the redox modification zone. This mZVI mass equates to approximately 990 lbs of mZVI injected into each of 10 injection locations over the target thickness of approximately 9 feet.

Column tests conducted by Okwi et al. (2005) indicate that the design mass of mZVI will be sufficient to neutralize at least 200 lbs of an oxidant such as permanganate. The published data were based on millimeter-scale ZVI and therefore a higher neutralizing capacity is anticipated for mZVI proposed at the Site, due to its higher surface area.

4.3.4 ZVI Material Selection

Commercial ZVI sources from Connelly GPM (Chicago, IL) and Peerless Metal Powders (Detroit, MI) have typically been used for trenched PRB applications in the US (ITRC, 2011). The treatability bench-scale test using Site groundwater and Connelly ZVI showed strong destruction rates; therefore, Connelly ZVI will be used for PRB construction at the Site.

4.3.5 ZVI PRB Residence Time, Thickness, and Composition

As previously described, the ability of a ZVI PRB to effectively treat cVOCs is dependent on the residence time of groundwater within the PRB and the rate of cVOC degradation by ZVI. Residence time requirements can be estimated based on several Site-specific parameters, including:

- Influent cVOC concentrations and cVOC degradation rates for Site groundwater in contact with ZVI;
- Anticipated groundwater velocities through the PRBs; and
- Site groundwater chemistry, which may affect the reactivity or longevity of the ZVI material.

PRB thickness and composition is based on residence time requirements and constructability considerations. The following sections detail how the Site-specific parameters were used to specify the design residence time, thickness, and composition of the two ZVI PRBs.

4.3.5.1 Influent cVOC Concentrations and cVOC Degradation Rates

The design influent concentrations for the NE and NW PRBs and half-lives obtained from the bench-scale treatability test are summarized in Table 2.

The following influent cVOC concentrations were assumed for the PRBs:

- NE PRB: cVOC concentrations measured in groundwater collected from extraction well AE/RW-9-2 during the 2013 annual sampling event were used as the design upgradient cVOC concentrations for the NE PRB. AE/RW-9-2 is located approximately 60 feet south of the slurry wall and is screened from 8 to 37 feet bgs. The 2013 cVOC concentrations measured at AE/RW-9-2 are the highest concentrations measured in the well over the last five years of sampling. These concentrations are expected to be conservatively high for the PRB design given that the ISCO pilot study will decrease cVOC mass in the area upgradient of the NE PRB prior to PRB installation.
- NW PRB: cVOC concentrations measured in groundwater collected from monitoring well 35A during the 2012 annual sampling event were used as the design upgradient cVOC concentrations for the NW PRB. Well 35A is located approximately 26 feet south of the slurry wall and is screened from 12 to 37 feet below ground surface.

4.3.5.2 Modeled Flow Rates through ZVI PRBs and Anticipated Flow Field after PRB Installation

The flow field through and around the ZVI PRBs following their installation was assessed using a version of the MEW Study Area regional groundwater flow model (Appendix C). The model was calibrated using the average pumping rates from 2010 through 2012 of the four extraction wells located within the slurry wall and simulated heads were compared to average observed water levels in the area of interest from 2010 through 2012.

The model was used to simulate the flow field across the two ZVI PRBs and within the slurry wall boundary. The simulated flow was used to estimate groundwater velocity within the PRBs. In the model, the PRBs are defined across two stratigraphic layers

located from 15 to 25 feet bgs. The model was also used to assess the presence of stagnation zones in the area bounded by the slurry wall and the potential for downward flow into the B1-zone following PRB construction.

Details of the modeling setup and results are provided in Appendix C. The key conclusions from the modeling are summarized below:

- Over 99% of groundwater that flows upward through the A/B1 aquitard into the area bounded by the slurry wall subsequently discharges through the PRBs. Less than 1% of the groundwater subsequently discharges downward through the A/B1 aquitard into the B1-zone.
- There is no downward component to groundwater flow over the depth interval where the PRBs will be installed. In other words, 100% of the groundwater flowing through the depth interval where the PRBs will be installed will be treated by the PRBs.
- The total flow through the two PRBs is approximately 3.1 gallons per minute (gpm). The total flow is divided as follows between the two PRBs:
    - NE PRB = 1.3 gpm
    - NW PRB = 1.8 gpm
- The groundwater flow through the PRBs is non-equally divided between the two 5-foot model layers that intersect the PRBs. The difference in modeled groundwater flow reflects the variation of the hydraulic conductivity field in the A-zone underlying the Site. As shown on Figure 7, the soil types encountered between 17 and 26 feet bgs at the Site vary from sand to silt and clay. The highest modeled flow rate through an individual 5-foot layer is 0.8 gpm for the NE PRB and 1.5 gpm for the NW PRB.

To ensure that the PRB design is conservative with respect to total flow and to accommodate possible variability in the flow regime, the highest modeled flow rates through a 5-foot layer were used to design the ZVI PRB thickness. The following approach was used to develop the design flow rate:

1) The highest modeled flow rates through a 5-foot interval were selected as the design basis for each of the PRBs. For the NE PRB, the selected flow rate was 0.8 gpm and for the NW PRB the selected flow rate was 1.5 gpm.
2) The highest modeled flow rates were then scaled up to a 9-foot interval, equivalent to a conservative scenario where the ZVI PRBs are installed entirely

across the most permeable lithologic unit at the Site. For the NE PRB, the scaled flow rate was 1.4 gpm and for the NW PRB, the scaled flow rate was 2.7 gpm.

These scaled flow rates are greater than the modeled total flow rates through the PRBs (1.3 and 1.8 for the NE and NW PRBs, respectively), and were therefore conservatively selected as the design flow rates for the PRBs.

4.3.5.3 PRB Residence Time Calculations

The adjusted half-lives and assumed influent cVOC concentrations were used to calculate the residence times required to reduce the influent concentrations to California MCLs within the ZVI PRBs. Detailed calculations of ZVI residence time requirements for each cVOC present at the Site based on influent cVOCs concentrations, compound-specific California MCLs, and modeled first-order degradation rates are included in Appendix D. The design influent concentrations for the NE and NW PRBs and half-lives obtained from the bench-scale treatability test are summarized in Table 2, along with the residence time required to achieve the California MCLs for each cVOC present in Site groundwater.

The cVOC with the longest residence time required to reduce concentrations to the California MCL was used for PRB design (cDCE for each of the PRBs). The design residence times for each of the ZVI PRBs are provided in the table below.

Location	Well Used for Influent Concentrations	cVOC with Longest Residence Time Requirement	Residence time (days)
NE PRB	AE/RW-9-2	cDCE	1.6
NW PRB	35A	cDCE	0.7

4.3.5.4 Long-Term Performance Considerations

As ZVI is exposed to groundwater, changes to aqueous chemistry induced by ZVI corrosion can result in formation of secondary precipitates that may result in a gradual loss of ZVI reactivity. Despite these processes, the longevity of ZVI in a typical ZVI PRB is expected to be on the order of at least 10 years, depending on groundwater chemistry, flow rate, and the design method (ITRC, 2011). Iron oxy-hydroxides and iron and calcium carbonates are expected to be the main secondary mineral phases created within the Site ZVI PRBs, based on column testing with Site groundwater (Appendix B).

Secondary mineral precipitates can impact PRB performance in two ways: a gradual loss in ZVI reactivity, and a potential decrease in PRB porosity. However, data obtained from the bench-scale laboratory test showed no substantial changes in reactivity or porosity within the test period (Appendix B). In addition, after eight years of operation, the pilot-scale ZVI PRB installed at Moffett Field showed no signs of accumulation of mineral precipitates or clogging due to biological activity (Battelle, 2002).

Although the available Site-specific bench-testing data and data from the Moffett Field PRB suggest that impacts to ZVI performance will be limited, the ZVI PRBs were conservatively designed by applying a safety factor of 1.5 to the design ZVI residence times to account for potential future reductions in ZVI reactivity.

4.3.5.5 PRB Thickness and Composition

As described in Section 5.5, the ZVI PRBs will be installed following excavation of the existing slurry wall material within 4-foot wide trenches. To accommodate the width of the installation trenches, the ZVI material will be mixed with sand of similar particle size to achieve the required equivalent thickness of ZVI within each PRB.

Table 3 presents the design dimensions of the two ZVI PRBs, including ZVI thickness and composition based on the assumed influent cVOC concentrations, the residence time required for degradation of cVOCs, and the design velocity through each PRB. The design flow velocity is calculated based on the design flow rate developed from the groundwater model as previously described, the PRB dimensions (perpendicular to the direction of groundwater flow) of 50 feet by 9 feet, and the expected porosity of the ZVI/sand mixture that will be used to construct the PRBs (0.45).

4.3.6 Conservatism in PRB Design

As discussed in the previous sections, a number of conservative assumptions were incorporated into the design of the ZVI PRBs. These considerations are provided in Table 3 and are summarized below:

- The design thickness of the NE PRB is based on the ZVI residence time required to reduce the current upgradient cVOC concentrations to below California MCLs. However, the planned ISCO pilot study at the Site is expected to reduce cVOC concentrations within the slurry wall boundary prior to installation of the NE PRB.
- The ZVI PRBs will intercept heterogeneous lithological units containing variable amounts of silt and sand. The modeled groundwater flow rates within

the intercepted lithological units differ by a factor of approximately 2 to 6, depending on the soil type. The groundwater velocity used to calculate the design ZVI PRB thicknesses was based on the highest modeled flow rates (equivalent to assuming the lithologic units intercepting the PRBs are comprised entirely of sand).

- A safety factor of 1.5 was applied to the design ZVI thicknesses to account for potential future reductions in the ZVI reactivity.

4.3.7 Supplemental PRB Design Data Collection

Prior to ZVI PRB installation, direct-push borings will be advanced immediately upgradient of the planned PRB locations. The borings will be used to:

- Four borings will be advanced to collect additional high-resolution data on the subsurface stratigraphy and geotechnical properties of soils in the vicinity of the PRBs to confirm that the design depth interval for ZVI placement (17 to 26 feet bgs) intersects the expected shallow sand layer; and
- Five borings will be advanced to collect additional data on the cVOC concentrations upgradient of the PRBs to confirm that the influent concentrations used to design the PRBs are consistent with Site conditions just prior to PRB construction.

The proposed soil boring and grab groundwater sample locations are shown in Figure 9, and additional details for implementation of this scope of work are provided in Section 5.2.

4.4 Monitoring Program

Following installation of the ZVI PRBs, performance monitoring will be conducted to evaluate removal of cVOCs in groundwater flowing through the PRBs, to calculate groundwater gradients across the PRBs, and to evaluate vertical gradients at the Site following the shutdown of the On-Site SCRWs.

The PRB performance monitoring network will include the following wells:

- One monitoring well installed within each of the ZVI PRBs, approximately 6 inches from the downgradient edge of the PRBs, to demonstrate cVOC degradation by the PRBs and evaluate groundwater gradients across the PRBs.

- One monitoring well installed directly upgradient of each of the PRBs to monitor influent cVOC concentrations and groundwater gradients across the PRB.
- One monitoring well installed directly downgradient of each of the PRBs, along with existing monitoring well (41A), which is located immediately downgradient and to the east of the proposed location of the NE PRB. Groundwater downgradient of the PRBs will not be treated by the PRBs and contains concentrations of cVOCs that exceed California MCLs (i.e., the design treatment objective for cVOCs by the PRBs). The downgradient wells therefore cannot be used to verify PRB performance in the short term, but will be used for monitoring groundwater gradients across the PRBs and to monitor for potential increases in cVOC concentration downgradient of the PRBs.
- Two monitoring wells, one located in the A-zone within the area bounded by the slurry wall (Well 37A), and one located in the B1-zone below the area bounded by the slurry wall (Well 69B1) to monitor the vertical groundwater gradients in proximity to the PRBs.

Effectiveness of the PRBs will be indicated if cVOC concentrations measured in the monitoring wells installed within the PRBs are below the ROD specified clean-up goals (i.e., California MCLs), and cVOC concentrations in downgradient wells do not increase above recent average concentrations.

In addition to monitoring of the ISCO and ZVI PRB treatability studies, routine monitoring of Site wells will be performed to assess the progress toward achieving the ROD-specified clean-up goals for groundwater at the Site. Routine monitoring will include groundwater sampling to evaluate the distribution of cVOCs in groundwater across the Site and groundwater gauging to calculate horizontal and vertical groundwater gradients at the Site. The full monitoring program for the Site, including both the routine monitoring and treatability study monitoring, is discussed in Section 5.9.

4.5 Contingency Plan

The following section presents the contingent equipment that will be installed during PRB construction and implemented if the PRBs are not effectively removing cVOCs during the treatability study.

4.5.1 Implementation Scenario and Plan

As part of the PRB construction and as described in Section 5.8, extraction wells (B9-EW01 and B9-EW02) will be installed immediately downgradient of both the NE PRB and the NW PRB. Each extraction well will be located within approximately 1 foot of the PRBs and screened from 21 to 26 feet bgs to capture the groundwater discharging from the PRBs.

If groundwater samples from the monitoring wells installed within one or both of the PRBs are determined to have cVOCs concentrations exceeding the California MCL, operation of the extraction wells will be initiated. The extracted groundwater would discharge through double-contained piping into the Fairchild System No. 1 piping network for treatment (Figure 10). The discharge piping will run adjacent to the 401/405 National Shared Treatment Plant to allow for potential installation of a pre-treatment system if required.

4.5.2 Groundwater Pumping and Control Requirements

As discussed in Section 4.3.5, the existing MEW Study Area regional groundwater model was modified to predict the groundwater flow through each ZVI PRB. The flow rates through NW PRB and NE PRB were predicted to be 2.7 and 1.4 gpm, respectively. Each of the contingency extraction wells will be installed within 1 foot of the PRBs, such that all of the groundwater discharging from the PRBs would be captured during operation.

The groundwater extraction pump for each contingency well will be designed to operate between flow rates of 1 and 10 gpm and will discharge into the Fairchild System No. 1 piping network. Based on the performance requirement of the pump and the geochemical conditions at the Site, pneumatic submersible groundwater pumps with 1-inch discharge piping will be installed in the contingency extraction wells.

Power for the extraction pumps will be provided by the Fairchild System No. 1 treatment facility. Controls and process monitoring equipment, including flow meters and totalizers, will be routed through the SCADA system located at the Fairchild System No. 1 treatment facility.

5. IMPLEMENTATION WORK PLAN

A work plan for implementing the ZVI PRB treatability study is provided in the sections below. Following EPA approval of this work plan, a ZVI PRB Treatability Study Design Report will be submitted. The Design Report will include design drawings, technical specifications, and a detailed schedule for construction of the ZVI PRBs.

5.1 Pre-Field Activities

5.1.1 Health and Safety Planning

The existing site-specific health and safety plan (HASP) will be updated to include all field activities associated with the ZVI PRB treatability study. The HASP will contain procedures for hazard identification and mitigation, emergency response including a map of the nearest hospital and emergency contact information, incident reporting, use of appropriate personal protective equipment (PPE), and air monitoring procedures.

Prior to the start of field activities each day, a safety tailgate meeting will be conducted that will include a discussion of the field activities to be performed, safe work practices, identification of potential hazards, use of PPE, decontamination procedures, and emergency response protocols.

5.1.2 Notifications, Access, and Permitting

Prior to the start of field activities, the following will be performed:

- Coordinate with National Avenue Partners, LLC regarding Site access and material staging;
- Coordinate and subcontract with the drilling contractor, contractor responsible for contingency construction, PRB installation contractor, ZVI vendor, and analytical laboratory;
- Obtain a grading/excavation permit from the City of Mountain View; and
- Obtain well destruction and installation permits from the Santa Clara Valley Water District (SCVWD).

EPA, National Avenue Partners, LCC, and other stakeholders will be notified of the planned work schedule prior to the start of field activities.

5.1.3 Utility Clearance

Boring and excavation locations will be marked with white paint and Underground Service Alert (USA) North will be contacted a minimum of 48 hours prior to commencement of intrusive subsurface activities. Additionally, a private utility locator will perform a geophysical survey in the vicinity of planned subsurface work to identify potential utilities, pipelines, or other subsurface obstructions prior to drilling.

5.1.4 ZVI PRB Material Procurement and Staging

Prior to PRB construction, ZVI will be procured from Connelly-GPM, Inc., or an alternative vendor offering a comparable product. The ZVI will be shipped to the Site via truck in 3,000-pound super sacks and stored in a secure temporary laydown area near the PRB installation area. The ZVI will be protected from rainfall or excessive moisture using tarps.

Clean washed coarse sand (free of stones, clay, debris, and organic material) for use in the iron-sand mixture will be procured from a local supplier. The particle size gradation of the sand will approximate that of the ZVI material. Other PRB construction materials (e.g., geotextile used to isolate the top of the ZVI/sand backfill from the overlying clay backfill) will be selected and procured based on from the professional judgment of the installation subcontractor. Materials will be stored in a secure temporary laydown area prior to PRB construction.

5.2 Supplemental PRB Design Data Collection Activities

The supplemental PRB design data collection fieldwork will include advancing soil borings using direct-push technology to evaluate subsurface conditions in detail at the proposed PRB locations (Figure 9). Data collection will include:

- Advancing direct-push continuous core soil borings to provide high resolution information on the lithology and geotechnical properties of soils located along the PRB orientations to confirm the depth interval for ZVI placement.
- Advancing borings to collect depth-discrete groundwater samples to evaluate cVOC concentrations upgradient and downgradient of the PRBs.

Soil borings will be advanced at the four locations shown in Figure 9. The total depth of each boring will be approximately 40 feet bgs (bottom of the A-zone). Data from the four soil cores will be used to supplement the current understanding of Site hydrostratigraphy in proximity to the PRBs. After the soil borings are completed,

additional step-out locations may be selected, if appropriate, based on the variability of the lithologic profiles in the primary borings.

Following collection of the continuous core soil data, five direct push soil borings (Figure 9) will be advanced to collect grab groundwater samples for VOC analysis from depth intervals corresponding to the anticipated depths of the PRBs (e.g., 17 to 26 feet bgs). Grab groundwater samples will be collected from a temporary polyvinyl chloride (PVC) casing installed within the direct push boring. The PVC will be screened over an interval spanning the proposed depth of each PRB to evaluate cVOC concentrations in groundwater upgradient and downgradient of the two PRB locations.

New polyethylene tubing will be used for each grab groundwater sample. Each sample will be collected in laboratory-supplied sample containers and labeled with project identification, sample location, analytical parameters to be measured, time and date of sampling, and any preservative added to the sample. Samples will be stored in an ice-cooled chest and maintained at approximately 4ºC for transport under chain-of-custody procedures to TestAmerica Laboratories, Inc. (TestAmerica) of Pleasanton, California for analysis of cVOCs by EPA Method 8260B (8010 analyte list).

Quality assurance/quality control (QA/QC) samples will be collected in accordance with the MEW Quality Assurance Project Plan (QAPP; Canonie, 1991), one duplicate, one field blank, and one equipment blank will be collected for every 20 groundwater samples collected for cVOC analysis. In addition, a laboratory-provided trip blank will be included with each cooler containing groundwater samples for cVOC analysis that is sent to the laboratory.

Following boring completion, the direct-push rods will be extracted, and the boring will be backfilled with neat cement grout in accordance with SCVWD requirements.

5.3 Preparation of Final Design and Specifications

Following completion of the data collection scope of work, the supplemental PRB design data will be used to finalize construction methods for installation of the ZVI PRBs. A ZVI PRB Treatability Study Design Report will be prepared. The Design Report will include design drawings, technical specifications, and a detailed schedule for construction of the ZVI PRBs and contingency extraction wells and will be submitted to EPA for review. Following EPA approval of the Design Report, the remaining components of the ZVI PRB treatability study will be implemented.

5.4 mZVI Injections for Redox Modification Zone

As described in Section 4.3, mZVI will be injected immediately upgradient of the NE PRB to promote formation of reduced geochemical conditions in groundwater flowing into the PRB. The mZVI will be emplaced via direct injection. The direct injection method uses a direct-push drill rig to advance injection rods with a specialized injection tip or disposable tip to the target depth. The mZVI material is pumped through the injection rods and tip into the formation. Pressurized injections will be used to overcome the hydrostatic back pressure and promote distribution of mZVI within the subsurface to the desired ROI.

A licensed C-57 driller will be contracted to complete the injections. Boring permits will be obtained from the SCVWD prior to conducting the mZVI injections. A total of 10 injection boreholes will be advanced using a direct-push drill rig to the target injection depths (Figure 8). Injections will be completed in a top-down manner, injecting into discreet 2- to 3-foot intervals over the targeted depth interval of 17 to 26 feet bgs. Up to 990 pounds of mZVI will be injected at each of the 10 injection locations. During the injections, mZVI will be injected as a slurry mixed with water. Water for the injections will be obtained from fire hydrant or similar source. If needed based on consultations with the injection contractor, guar gum may be used to enhance the distribution of the mZVI slurry during injections.

Because the mZVI injection points will be located in relatively close proximity to the slurry wall, injection pressures will be maintained below 100 pounds per square inch (psi) to prevent potential influences to the slurry wall integrity. A trial injection of mZVI at one location will be performed during the supplemental PRB data collection field program to evaluate whether pressures exceeding this threshold are necessary to distribute the mZVI. If the design ROI for the mZVI injections of 7 feet cannot be achieved below the threshold pressure, the number of mZVI injection points may be increased or a liquid reductant (i.e., thiosulfate) may be substituted for mZVI.

5.5 ZVI PRB Construction

The proposed locations of the ZVI PRBs are shown in Figure 5. Existing asphalt or concrete pavement over the excavation area will be removed prior to trenching for PRB installation. Locations of utilities and other physical impediments will be identified on as built drawing prior to excavation activities, and locations confirmed with a private utility locator and via potholing (if necessary for critical utilities adjacent to dig areas). If necessary, existing utilities will be shut off and locked-out/tagged-out.

The minimum width of the existing slurry wall is 2.5 feet according to slurry wall design drawings (Appendix E) and the maximum width of the slurry wall measured during the September 2013 test pit excavations was 2.9 feet (Geosyntec, 2014b). Membrane interface probe (MIP) borings advanced to a depth of 40 feet bgs approximately 6 inches from the edge of the slurry wall did not show evidence that the slurry had intruded into native soil. Based on these findings, the ZVI PRBs will be constructed within the gates created using a 48-inch wide excavator bucket (or larger) to allow for sufficient removal of the slurry material during excavation.

The PRB trenches will be excavated using a hydraulic excavator equipped with a minimum 4-foot wide bucket. The excavator will straddle the existing slurry wall and excavate downward. Excavated soil will be stockpiled onsite for characterization and offsite disposal. The excavation will be shored using one or both of the following approaches:

- Installation of sheet piling using a vibrating hammer, impact hammer, or comparable installation technique.
- Use of a BP slurry as a means of providing trench support.

A detailed excavation plan, along with necessary supporting drawings and calculations, will be provided in the ZVI PRB Treatability Study Design Report.

Spoils from the excavation will be placed in a prepared staging area in the vicinity of the work. The PRBs will be excavated to a depth of approximately 26 feet bgs. The excavation bottom will be sounded at the start of each work day to assess the amount of overnight sediment settling and/or sloughing in the bottom of the trench. Observed sediment will be removed from the trench prior to backfilling with ZVI.

Backfilling activities will include preparation of the ZVI/sand mixture for backfill and placement of the ZVI/sand mixture into the trench. A conceptual PRB construction diagram is provided in Figure 6. ZVI and sand will be mixed on-site using concrete truck mixers or stationary mixers. The design ZVI/sand ratios for the NE and NW PRBs are included in Table 3, but may be adjusted based on the supplemental PRB design data collection field program. Water will then be added to saturate the mixture in order to improve the flow of the mixture during delivery to the trench. The ZVI/sand mixture will be added to the trench by pouring into a tremie pipe suspended above the trench. The tremie is intended to reduce separation of the ZVI and sand as it is placed.

Once the ZVI/sand mixture has been placed within the PRBs, geotextile and a 3-inch thick zone of bentonite pellets will be placed on top of the ZVI/sand and allowed to

hydrate prior to placement of the backfill material to inhibit intrusion of impermeable backfill into the ZVI/sand. The backfill above the ZVI/sand mixture will be a low hydraulic conductivity, clay-rich material that will be placed above the ZVI/sand to within 3 feet of the ground surface using a tremie pipe. Final design of the backfill material and surface completions will be provided in the ZVI PRB Treatability Study Design Report.

5.6 Existing Extraction Well Destruction

As part of the PRB installation, the four On-Site SCRWs will be demolished. Prior to well destruction, the extraction pumps and associated piping, electrical lines, and controls will be removed from each well vault and the well vaults removed for offsite disposal. The conveyance piping from each of the On-Site SCRWs will be capped and abandoned in place.

Well destruction permits will be obtained from the SCVWD prior to destruction of the wells. The method of well destruction will be determined in consultation with EPA and the SCVWD. SCVWD typically accepts overdrilling followed by backfill with grout, or pressure grouting in place with neat cement grout. A licensed C-57 driller will be contracted to complete the well destruction activities. Soil and water generated during well destruction activities will be temporarily containerized onsite prior to disposal (Section 5.10).

5.7 Contingency Extraction Well Installation

After backfilling of the PRB excavations, one 4-inch diameter, Schedule 40 PVC extraction well will be installed approximately 1 foot downgradient of each PRB. Each well will be installed near the center of the 50-foot long PRBs. A conceptual design for the contingency wells is below, and a detailed design of the contingency wells and associated infrastructure will be provided in the ZVI PRB Treatability Study Design Report.

The wells will be installed by a C-57 licensed driller using a hollow stem auger drill rig under the oversight of Geosyntec field personnel. The well borings will be continuously cored for geologic logging by field staff under the direction of a California Professional Geologist using the Unified Soil Classification System. The soil will be field-screened using a photoionization detector (PID) and the readings recorded on the boring logs. All downhole equipment will be decontaminated prior to use.

The wells will be constructed through the hollow stem auger casing. The planned depth of extraction wells is 26 feet bgs, with screen intervals from approximately 21 to 26 feet

bgs. Actual total depths and screen intervals for individual monitoring wells may be adjusted based on subsurface conditions encountered during drilling. The well screen will be comprised of wire-wrapped PVC or a similar material. A coarse-graded silica sand pack will be tremied into the annular space across the screened interval of each extraction well and extending approximately 4 feet above the top of the well screen to span the vertical height of the PRBs (Figure 6). Approximately 2 to 3 feet of bentonite pellets or chips will be placed on top of the sand pack, and a neat cement grout will be placed above the bentonite layer four feet below the ground surface. A well vault will be installed over the well with an access hatch that is flush with the ground surface

Once installed, the concrete seal will be allowed to set for at least 72 hours prior to development. Development will consist of a combination of bailing, surging, and pumping and will serve to stabilize the filter pack and remove fines from the filter pack and well screen. Groundwater quality parameters (e.g., temperature, pH, specific conductance, and turbidity) will be measured during purging activities.

The north side of each well vault and PVC well casing will be surveyed for elevation and location by a California licensed surveyor. The wells will be surveyed using the same coordinate system and elevation datum as the existing MEW monitoring well network.

Following well installation, a 4-inch submersible, bottom-loading pneumatic groundwater pump with a 1-inch discharge will be installed at the bottom of each well. The discharge piping from both wells will be routed in underground, double contained PVC piping to the existing Fairchild System 1 piping network for treatment (Figure 10).

5.8 Performance Monitoring Network Installation

5.8.1 PRB Monitoring Well Installation

Following PRB installation, monitoring wells will be installed within each PRB near the center and approximately 6 inches from the downgradient edge of the PRBs (Figure 5 and Figure 6). The wells will be installed by a C-57 licensed drilling subcontractor under supervision of Geosyntec field personnel. Based on the current design for the PRBs, each monitoring well is expected to be installed to a total depth of 26 feet bgs, with screen intervals placed from approximately 17 to 26 feet bgs. Actual total depths and screen intervals for individual monitoring wells will be subject to revision by Geosyntec field personnel based on the final installation depths of the PRB gates.

A direct-push drill rig will be used to install the wells. The wells will be constructed of 2-inch diameter, Schedule 40 PVC, with flush-threaded casing, 0.020-inch factory-

slotted well screen, and a flush-threaded bottom cap. The monitoring wells will be used to monitor cVOC concentrations on the downgradient edge of the PRBs. The wells will be named B9-6A and B9-7A.

5.8.2 Upgradient and Downgradient Monitoring Well Installation

One 2-inch diameter monitoring well will be installed approximately 1 to 3 feet upgradient of each PRB gate, and one 2-inch diameter monitoring well will be installed approximately 1 to 3 feet downgradient of each PRB gate (Figure 5 and Figure 6). Each monitoring well is expected to be installed to a total depth of 26 feet bgs, with screen intervals placed from approximately 17 to 26 feet bgs. Actual total depths and screen intervals for the individual performance monitoring wells may be adjusted in the field based on the subsurface conditions encountered.

The monitoring wells will be installed by a C-57 licensed drilling subcontractor using hollow stem auger drilling methods. Geologic logging of the hollow stem auger soil cuttings will be conducted by Geosyntec field staff under the direction of a California Professional Geologist using the Unified Soil Classification System. The soil will be field-screened for volatile organic compounds using a PID and the readings recorded on the boring logs. All downhole equipment will be decontaminated prior to use and between boring locations.

Once the target depth is reached at each boring, the monitoring well will be constructed through the hollow stem auger casing. The monitoring wells will be constructed of 2-inch diameter, flush-threaded, Schedule 40 PVC casing, with 0.020-inch factory-slotted well screen, and a flush-threaded bottom cap. A graded silica sand pack will be tremie filled into the annular space across the screened interval of each monitoring well, extending approximately 1 foot above the top of the screen. Approximately 2 feet of bentonite pellets or chips will be placed on top of the sand pack and hydrated to provide a seal above the filter pack. The remainder of the borehole will be tremie filled with neat cement grout (maximum 6 gallons of water per 94 pound bag of cement) to one foot below the ground surface. A waterproof locking cap will be installed for each monitoring well within an appropriately-sized flush-mounted well box.

5.8.3 Monitoring Well Development

Once installed, the grout seal in the monitoring wells will be allowed to set for at least 72 hours prior to development. Monitoring well development will be performed by a subcontractor under supervision of Geosyntec field staff. Development will consist of a combination of bailing, surging, and pumping as described in the MEW QAPP (Canonie, 1991) and will serve to stabilize the filter pack and remove fines from the

filter pack and well screen. Groundwater quality parameters (temperature, pH, specific conductance, and turbidity) will be measured during monitoring well development. Groundwater generated during development will be temporarily stored onsite prior to disposal at one of the MEW Study Area groundwater treatment systems.

The north side of each well box and PVC well casing will be surveyed for elevation and location by a California-licensed surveyor. The wells will be surveyed using the same coordinate system and elevation datum as the existing MEW monitoring well network.

5.9 Performance Monitoring

Treatability study performance monitoring will begin one month after installation of the PRBs and contingency extraction wells. Performance monitoring will include groundwater gauging and sampling and will be conducted in accordance with the schedule provided in Table 4. Wells not included in the ISCO or PRB treatability study monitoring programs will be monitored during the 2015 annual sampling event for the MEW Study Area and would continue to be monitored on the schedule specified in the Fairchild O&M plans and previous annual reports. After the first year, the scope and frequency of the treatability study performance monitoring will be evaluated and modified in consultation with EPA, as appropriate.

During each performance monitoring sampling event, the wells will be purged three to five casing volumes prior to collection of groundwater samples. The wells will be purged using a submersible pump equipped with new disposable tubing. Water will be pumped through an enclosed flow-through cell fitted with a multi-parameter groundwater meter. Temperature, pH, electrical conductivity, turbidity, dissolved oxygen (DO), and oxidation-reduction potential (ORP) will be measured during purging. Groundwater will be purged until the field parameter values stabilize. Groundwater levels will be monitored during purging to confirm that drawdown stabilizes prior to sampling. Following stabilization of field parameters, groundwater samples will be collected and analyzed. The proposed PRB performance monitoring parameters, the rationale for parameter selection is provided in Table 5.

In addition to the collection of groundwater samples, groundwater elevations within the PRB monitoring wells will be monitored periodically to assess groundwater gradients across the PRBs (Table 4). As recommended in ITRC guidance on PRB performance monitoring (ITRC, 2011), groundwater elevations will be measured on a quarterly basis for the first year following installation of the PRBs.

5.10 Excavated Material and Investigation-Derived Waste (IDW) Management

All excavated soil and slurry, soil cuttings, and solid IDW will be containerized in covered roll-off bins, 55-gallon drums or other California Department of Transportation approved containers and stored onsite pending analysis and offsite disposal at an appropriate facility in accordance with state and federal regulations and STC's internal procedures for handling waste streams. Where possible, aqueous IDW will be transported to, treated, and disposed of using the onsite groundwater treatment system (Fairchild System No. 1). Aqueous IDW that cannot be disposed of through at Fairchild System No. 1 will be containerized onsite pending analysis and offsite disposal.

5.11 Startup of Contingency Extraction Wells

The contingency extraction wells will be started if one or both of the following conditions is observed:

- **PRB Monitoring Wells:** If cVOCs are detected in the monitoring wells installed within the PRB at concentrations exceeding California MCLs.
- **Downgradient Monitoring Wells:** If a statistically significant increase in cVOC concentrations is observed in the downgradient wells, when compared to available information on downgradient conditions over the past 10 years.

6. REPORTING AND SCHEDULE

Following EPA approval of this work plan, the supplemental PRB design data collection field program would be implemented. The results of the field program would be incorporated into the ZVI PRB Treatability Study Design Report, which would include the following:

- A summary of changes to the ZVI PRB design basis, if any, based on the findings of the field program;
- Design drawings and specifications for the ZVI PRB construction and contingency extraction wells; and
- A schedule for PRB and contingency construction, performance monitoring, and treatability study implementation reporting.

A preliminary schedule for implementing the treatability study is provided in Figure 11. Implementation of the data collection field program will begin within 30 days of EPA approval of this work plan. The ZVI PRB Treatability Study Design Report will be submitted to EPA within 45 days of completing the supplemental data collection activities.

Access for implementation of the ZVI PRB treatability study will be limited by the redevelopment activities at 600 National Avenue. Construction of the ZVI PRBs will occur adjacent to a parking structure that will be constructed on the 401 National Avenue property. Therefore, the ZVI PRB treatability study can only be implemented if construction of the ZVI PRBs can be completed in entirety before the mobilization for construction of the parking structure. The timing of such mobilization is not yet determined, but will likely be in the second half of 2015. In addition, coordination of access in consideration of activities associated with the 600 National building construction will be needed during construction of the ZVI PRBs under any circumstances.

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TABLES

Table 1
Groundwater Analytical Results: Detected cVOCs
401 National Avenue
Mountain View, California

Sample Location	Sample Date	Sample Depth (ft bgs)[1]	Concentration in µg/L by EPA method 8260B									
			PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl Chloride	1,1,1-TCA	1,1-DCA	1,1-DCE	Freon 113	Total VOCs[2]
Wells Inside Slurry Wall Enclosure												
35A	9/25/2012	12-37	<0.50	220	130	1.7	1.1	<0.50	3.6	2.5	2.1	360
36A	9/18/2012	35-40	<0.50	110	270	2.1	0.7	<0.50	3.3	2.7	0.64	390
37A	10/23/2013	15-30	<0.50	72	370	3.7	49	7.6	36	8.6	1.1	550
122A	9/26/2012	28-38	<0.50/<0.50	210/230	100/100	1.6/1.6	<0.50/<0.50	<0.50/<0.50	3.0/3.0	2.1/2.1	1.0/0.97	220
137A	10/23/2013	34-36	<5.0	6,400	4,300	41	<5.0	<5.0	<5.0	11	16	11,000
AE/RW-9-1	10/17/2013	8-33	1.5	810	710	7.7	13	45	53	12	3.9	1,700
AE/RW-9-2	10/17/2013	8-37	4.6	13,000	8,800	78	260	49	84	38	190	23,000
RW-20A	10/17/2013	26.5-36.5	1.7	1,100	940	7.0	4.1	9.1	12	9.3	7.2	2,100
RW-21A	10/17/2013	21-36	4.6	410	350	5.8	1.8	1.6	5.0	5.0	9.0	800
Well Upgradient of Slurry Wall Enclosure												
123A	10/23/2013	28-38	<5.0	510	260	<5.0	<5.0	<5.0	<5.0	<5.0	6.2	800
Wells Downgradient of Slurry Wall Enclosure												
41A	10/23/2013	13-25	<5.0	580	220	<5.0	<5.0	<5.0	<5.0	<5.0	7.0	800
42A	10/23/2013	10-35	1.9/1.7	480/470	87/85	1.4/1.3	1.1/1.0	1.8/1.7	1.4/1.4	2.2/2.1	6.8/6.5	600
Wells Transgradient of Slurry Wall Enclosure												
43A	10/23/2013	15-27	1.5	420	96	1.2	1.5	1.4	1.3	1.8	3.5	500
44A	10/23/2013	13.5-28	1.8	330	51	0.79	<0.50	1.0	0.7	1.2	2.4	400
126A	9/25/2012	23-38	<0.50	130	110	1.0	0.59	<0.50	4.0	2.8	1.7	300
138A	10/23/2013	34-37	<0.50	340	920	6.4	16	<0.50	3.2	3.6	<50	1,300
Grab Samples Inside Slurry Wall Enclosure 2013												
MIP-02	9/9/2013	21-25	<1,000	560,000	59,000	<1,000	3,000	<1,000	<1,000	<1,000	7,100	630,000
MIP-02	9/9/2013	33-36	<25	100	5,300	71	86	<25	<25	<25	<25	5,600
MIP-03	9/10/2013	18-22	<50	6,600	15,000	200	56	<50	<50	<50	<50	22,000
MIP-04	9/9/2013	16-20	<50	360	11,000	79	180	<50	<50	<50	<50	12,000
MIP-04	9/9/2013	33-36	<25/<25	1,200/1,200	2,700/2,700	<25/<25	25/25	<25/<25	<25/<25	<25/<25	<25/<25	3,900
MIP-08	9/10/2013	18-22	<50	2,100	1,200	<50	<50	<50	<50	<50	64	3,400
MIP-09	9/10/2013	20-23	<50	76,000	45,000	480	570	50	210	140	410	120,000
MIP-12	9/10/2013	18-22	<25	2,300	180	<25	<25	<25	<25	<25	36	2,500
MIP-12	9/10/2013	22-26	59	120,000	55,000	280	520	<50	310	160	1,200	180,000
MIP-12	9/10/2013	33-35	<50	770	2,400	<50	<50	<50	<50	<50	<50	3,200
Grab Samples Inside Slurry Wall Enclosure 2014												
HP01	11/20/2014	22-26	<5.0	270	930	12	9.2	230	260	62	<5.0	1,800
HP01	11/20/2014	33-36	<5.0	290	320	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	610
HP02	11/21/2014	22-26	<5.0	16	2,400	6.6	280	<5.0	800	51	<5.0	3,600
HP02	11/21/2014	33-36	<5.0/<5.0	3,000/2,700	6,600/6,100	39/40	71/73	<5.0/<5.0	6.6/6.6	20/20	<5.0/<5.0	9,700/8,900
HP03	11/21/2014	21-23	<5.0	11	3,900	19	180	<5.0	250	21	<5.0	4,400
HP03	11/21/2014	33.5-37.5	<5.0	1,900	7,000	37	81	<5.0	7.5	20	<5.0	9,000
HP04	11/21/2014	21-25	<5.0	<50	7,000	32	330	<5.0	66	<5.0	<5.0	7,400

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401 National Avenue
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Sample Location	Sample Date	Sample Depth (ft bgs)[1]	Concentration in µg/L by EPA method 8260B									
			PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl Chloride	1,1,1-TCA	1,1-DCA	1,1-DCE	Freon 113	Total VOCs[2]
Grab Samples Inside Slurry Wall Enclosure 2014 (continued)												
HP04	11/24/2014	33-36	<50	1,600	5,500	51	95	<50	<50	<50	<50	7,200
HP05	11/24/2014	18-21	<50	1,700	440	<50	<50	270	550	200	<50	3,200
HP05	11/24/2014	32.5-35.5	<5.0	450	190	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	640
HP06	11/24/2014	20-24	<50	110	400	<50	<50	630	1,900	150	<50	3,200
HP06	11/24/2014	33-36	<2.5	220	67	<2.5	<2.5	<2.5	4.0	<2.5	<2.5	290
HP07	11/25/2014	20-24	<50	280	1,300	<50	390	3,500	4,900	750	68	11,000
HP07	11/25/2014	32-36	<10	150	970	<10	56	<10	40	11	<10	1,200
HP08	11/25/2014	19.5-23.5	<50	2,200	2,400	<50	250	280	440	220	60	5,900
HP08	11/25/2014	32-36	<5.0	280	210	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	490
HP09	11/21/2014	20-24	<5.0	36	1,800	15	69	25	1,600	190	5.3	3,700
HP09	11/21/2014	32-36	<5.0	130	2,400	7.7	<5.0	<5.0	13	12	<5.0	2,600
HP10	11/25/2014	20-24	<50	<50	4,700	<50	650	<50	<50	<50	<50	5,400
HP10	11/25/2014	31-35	<50	3,300	3,200	<50	<50	<50	<50	<50	<50	6,500
HP11	11/24/2014	19.5-23.5	<50	29,000	12,000	94	370	93	210	120	760	43,000
HP11	11/24/2014	32-36	<25	160	1,100	<25	<25	<25	<25	<25	<25	1,300
HP12	11/25/2014	32-36	<5.0	320	1,300	8.9	20	<5.0	76	23	<5.0	1,700
HP13	11/25/2014	22-26	<50/<10	<50/<10	680/610	<50/<10	73/82	<50/12	2,600/2,300	150/140	<50/<10	3,500/3,100
HP13	11/25/2014	33-36	<0.50	40	23	0.54	<0.50	<0.50	1.2	<0.50	<0.50	65
HP14	11/25/2014	17-21	<5.0	47	430	13	<5.0	280	370	110	<5.0	1,300
HP15	11/26/2014	18-22	<25	<25	160	<25	<25	99	3,600	34	<25	4,200
HP16	11/26/2014	18-22	<2.5	45	160	5.1	<2.5	66	160	30	<2.5	470
HP16	11/26/2014	26-30	<25	410	1,700	<25	<25	<25	<25	<25	<25	2,100
HP16	11/26/2014	33-37	<2.5	86	220	3.0	<2.5	<2.5	4.7	<2.5	<2.5	310
HP17	11/26/2014	18-22	<10	13	81	<10	31	<10	840	42	<10	1,100
HP17	11/26/2014	26-30	<25	56	4,000	27	430	<25	3,100	220	<25	7,800

Notes:

1. Sample depth represents screen intervals for monitoring wells or grab sample depths
2. The Total VOCs values were rounded
ft bgs = feet below ground surface
µg/L = micrograms per liter
EPA = Environmental Protection Agency
1,200/1,200 indicates primary and duplicate sample results
< indicates analyte not detected above the reported detection limit
PCE = Tetrachloroethene
TCE = Trichloroethene
cis-1,2-DCE = cis-1,2-Dichloroethene
trans-1,2-DCE = trans-1,2-Dichloroethene
1,1,1-TCA = 1,1,1-Trichloroethane
1,1-DCA = 1,1-Dichloroethane
1,1-DCE = 1,1-Dichloroethene
Freon 113 = 1,1,2-Trichloro-1,2,2-trifluoroethane
VOC = volatile organic compounds
cVOCs = chlorinated volatile organic compounds

Table 2
PRB Influent cVOC Concentrations
401 National Avenue PRB Pilot Study
Mountain View, California

Compound[1]	Field Half-Life[2] (19°C) (hours)	Clean-Up Levels (µg/L)	NW PRB		NE PRB	
		Effluent Concentrations for PRB Design (CA MCL)[5]	Design Influent Concentration[3] (µg/L)	Residence time in ZVI required to achieve CA MCLs[4,5] (days)	Design Influent Concentration[6] (µg/L)	Residence time in ZVI required to achieve CA MCLs[4,5] (days)
TCE	2.7	5	220	0.6	13,000	1.3
cis-1,2-DCE	3.5	6	130	0.7	8,800	1.6
trans-1,2-DCE	11.6	10	1.7	--	78	1.5
1,1-DCE	11.6	6	2.5	--	38	1.3
VC	1.9	0.5	1.1	0.3	260	1.3
1,1,1-TCA	1.0	200	0.5	--	49	--
1,1-DCA	6.9	5	3.6	--	84	1.3
Freon 113	1	1,200	2.1	--	190	--
Design Resdence Time (days)			0.7		1.6	

Abbreviations:

°C = degrees Celsius
µg/L = micrograms per liter
MCL = maximum contaminant level
cVOC = chlorinated volatile organic compounds
ZVI = zero valent iron
PRB = permeable reactive barrier
TCE - Trichloroethene
cis-1,2-DCE = cis-1,2-Dichloroethene
trans-1,2-DCE = trans-1,2-Dichloroethene
1,1-DCE - 1,2-Dichloroethene
VC - Vinyl Chloride
1,1,1-TCA = 1,1,1-Trichloroethane
1,1-DCA = 1,1-Dichloroethane
Freon 113 = trichlorotriflourethane

Notes

1 - Compound - Site specific compound being treated by ZVI PRB

2 - Half-Life generated during SiREM bench scale column test using Site water collected from AE/RW-9-2 and corrected to 19 degrees C for anticipated site groundwater temperatures

3 - Estimated Influent Concentration for NW PRB - cVOC concentrations measured in well 35A during the 2012 annual groundwater sampling event

4 - Based on VOC degradation simulation using the listed VOC degradation half-lives and influent concentrations, as presented in Appendix E

5 - CA MCL - California Department of Public Health (CDPH) maximum contaminant levels (MCLs) for Regulated Drinking Water Contaminants

6 - Estimated Influent Concentration for NE PRB - cVOC concentrations measured in well AE/RW-9-2 during the 2013 annual groundwater sampling event

Table 3
PRB Conceptual Design
401 National Avenue PRB Pilot Study
Mountain View, California

Design Parameter	NW PRB	NE PRB	Notes
ZVI Installation Depth (ft bgs)	17 - 26	17 - 26	Based on Site lithology (Figure 7)
ZVI Vertical Interval (ft)	9	9	Based on Site lithology (Figure 7)
ZVI PRB Width (ft)	50	50	--
ZVI Cross Sectional Area (ft^2)	450	450	= ZVI Vertical Interval (ft) x ZVI PRB Width (ft)
Design Porosity (%)	45	45	Based on ZVI Material Properties
Design Flow Rate (gpm)	2.7	1.4	From Site model (Section 4.3.5)
Design Flow Velocity through Gate (ft/day)	2.7	1.3	= [Flow Rate (gpm) x 1440 min/day]/[Porosity (-) x Cross-Sectional Area (ft^2) x 7.485 gal/ft^3)]
Well Used for Estimated Influent Concentrations	35A	AE/RW-9-2	See Table 2
Residence Time in ZVI to Degrade Influent Concentrations to below CA MCLs (days)	0.7	1.6	Developed based on VOC degradation rates obtained in a column test performed with site groundwater (see Appendix E)
Equivalent ZVI Thickness Needed (ft)	1.9	2.2	= Design Flow Velocity (ft/day) x Residence Time (day)
Safety Factor	1.5	1.5	Specified in Design to account for potential losses in ZVI reactivity with time
Design ZVI Thickness (ft)	2.8	3.3	= Equivalent ZVI Thickness (ft) x Safety Factor (ft)
PRB Thickness (ft)	4	4	Specified based on data collection activities (Section 4.2)
% ZVI Required in 4 foot Gate	71%	81%	= Design ZVI Thickness (ft) / PRB Thickness (ft)
ZVI Volume (ft^3)	1275	1463	= Design ZVI Thickness (ft) x ZVI Cross-Sectional Area (ft^2)
ZVI Density (ton/ft^3)	0.075	0.075	Based on ZVI Material Properties
ZVI Mass Required (tons)	96	110	= ZVI Volume (ft^3) x ZVI Density (ton/ft^3)

Abbreviations:
ft - feet
ft bgs - feet below ground surface
ft/day - feet per day
gpm- gallons per minute
CA MCL - California Department of Public Health (CDPH) maximum contaminant levels (MCLs) for Regulated Drinking Water Contaminants
NW - North West
NE - North East
VOC - volatile organic compounds
ZVI - Zero Valent Iron
PRB - Permeable Reactive Barrier

Table 4
Monitoring Schedule
401 National Avenue PRB Pilot Study
Mountain View, California

Well ID	Reference Elevation[1] (ft msl)	Diameter (inches)	Total Well Depth (ft bgs)	Top of Screened Interval (ft bgs)	Bottom of Screened Interval (ft bgs)	Top of Sand Pack (ft bgs)	Bottom of Sand Pack (ft bgs)	Well Type	Gauging Frequency	Sampling Frequency	Gauging Purpose[2]	Sampling Purpose[3]
Current A Zone Well Located Inside Slurry Wall[4]												
35A	42.67	2	37	12	37	12	37	Mon	Quarterly	Annually	Well pair with 126A	Routine
36A	42.32	2	40	35	40	15	40	Mon	Annually	Annually	Annual gradients	Routine
37A	43.21	2	30	15	30	12	30	Mon	Quarterly	Quarterly*	Well pair with 69B1	ISCO/PRB
122A	44.23	4	38	28	38	18	39	Mon	Quarterly	Annually	Well pair with 123A	Routine
137A	43.68	4	36	34	36	32	38	Mon	Quarterly	Quarterly*	Well pair with 138A and B9-4A	ISCO
A Zone Well Located Outside Slurry Wall												
31A	43.87	2	27	14.5	27	10	27	Mon	Monthly*	Monthly*	ISCO Gradients	ISCO
39A	42.77	2	35	15	35	12	35	Mon	Monthly*	Monthly*	ISCO Gradients	ISCO
40A	43.44	2	27	11.5	27	12	27	Mon	Annually	Annually	Annual gradients	Routine
41A	42.40	2	25	13	25	13	25	Mon	Monthly*	Monthly*	ISCO/PRB Gradients	ISCO/PRB
42A	42.97	2	35	10	35	12	35	Mon	Annually	Annually	Annual gradients	Routine
43A	43.38	2	27	15	27	15	27	Mon	Monthly*	Monthly*	ISCO Gradients	ISCO
44A	43.13	2	28	13.5	28	13.5	28	Mon	Annually	Annually	Annual gradients	Routine
69A	42.48	2	31	21	31	10	31	Mon	--	--	--	--
116A[5]	40.97	4	41	19	39	17	41	Mon[3]	Monthly*	Monthly*	ISCO Gradients	ISCO
123A	44.37	4	38	28	38	18	39	Mon	Quarterly	Annually	Well pair with 122A	Routine
126A	42.85	4	38	23	38	18	40	Mon	Quarterly	Annually	Well pair with 35A	Routine
138A	43.60	4	37	34	37	32	38	Mon	Monthly*	Monthly*	Well pair with 137A	ISCO
EX-1[6]	44.20	NA	29.7	9.9	28.5	8.5	29.7	Ext	--	Monthly*	--	ISCO
EX-2[6]	44.10	NA	29.0	9.4	27.9	8.1	29.0	Ext	--	Monthly*	--	ISCO
EX-3[6]	43.80	NA	30.1	9.9	29.3	8.5	30.1	Ext	--	Monthly*	--	ISCO
EX-4[6]	43.70	NA	31.1	10.4	28.6	8.5	31.1	Ext	--	Monthly*	--	ISCO
GSF-1A	39.46	NA	35	19	34	17.0	35.0	Ext	--	Monthly*	--	ISCO
B1 Zone Wells												
69B1	42.62	4	59	54	59	50	61	Mon	Monthly*	Monthly*	Well pair with 37A	ISCO/PRB
GSF-1B1	39.43	NA	71	63.6	70.5	61	71	Ext	--	Monthly*	--	ISCO
Proposed Temporary A Zone Well Located Inside Slurry Wall[7]												
B9-1A	--	2	24	17	24	16	24	Mon	Quarterly*	Quarterly*	ISCO Gradients	ISCO
B9-2A	--	2	24	17	24	16	24	Mon	Quarterly*	Quarterly*	ISCO Gradients	ISCO
B9-3A	--	2	24	17	24	16	24	Mon	Quarterly*	Quarterly*	ISCO Gradients	ISCO
B9-4A	--	2	24	17	24	16	24	Mon	Quarterly*	Quarterly*	ISCO Gradients	ISCO
B9-5A	--	2	36	31	36	30	36	Mon	Quarterly*	Quarterly*	ISCO Gradients	ISCO
B9-6A	--	2	26	17	26	16	26	Mon	Quarterly*	Quarterly*	PRB gradients	PRB
B9-7A	--	2	26	17	26	16	26	Mon	Quarterly*	Quarterly*	PRB gradients	PRB
Proposed A Zone Well Located Inside PRB[7]												
B9-8A	--	2	26	17	26	17	26	Mon	Quarterly*	Quarterly*	PRB gradients	PRB
B9-9A	--	2	26	17	26	17	26	Mon	Quarterly*	Quarterly*	PRB gradients	PRB
Proposed A Zone Well Located Outside of Slurry Wall[7]												
B9-10A	--	2	26	17	26	16	26	Mon	Annually	Annually	PRB gradients	PRB
B9-11A	--	2	26	17	26	16	26	Mon	Annually	Annually	PRB gradients	PRB

Notes:
1. Reference Elevations are in National Geodetic Vertical Datum from 1929 (NGVD 29).
2. Slurry wall well pairs monitor horizontal and vertical gradients across the slurry wall enclosure.
3. Sampling will conducted to monitor the performance of the various pilot study components and evaluate the extent of the TCE Routine at the Site.
4. SCRWs located inside the slurry wall (AE/RW-9-1, AE/RW-9-2, RW-20A, RW-21A) will be demolished during PRB installation.
5. 116A will be converted into an SCRW to support the STC/Vishay shared remedy.
6. Wells drilled at a 45 degree angle to the east. Construction depths are approximate depths below ground surface. See Section 4.4 of work plan for monitoring program details.
7. Actual total depths and screen intervals for the individual monitoring wells may be adjusted in the field based on the subsurface conditions encountered.

* After the first year, the scope and frequency of monitoring will be evaluated and modified, as appropriate. Monitoring inside the PRBs will be performed quarterly for a minimum of 2 years.

Abbreviations:
ft msl = feet mean sea level
ft bgs = feet below ground surface
Ext = extraction well
ISCO - In Situ Chemical Oxidation
Mon = monitoring well
PRB = Permeable Reactive Barrier

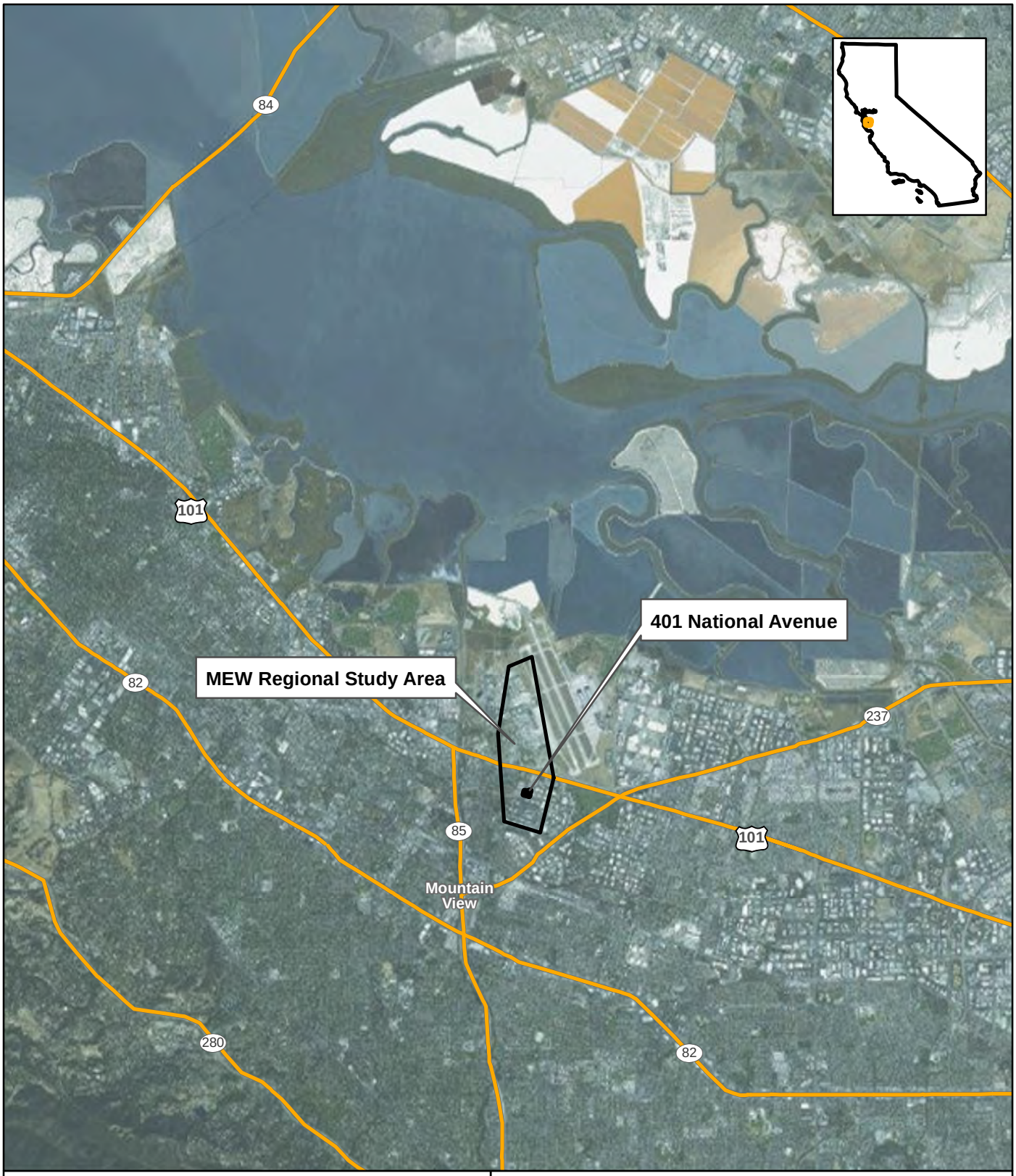
Table 5
PRB Performance Monitoring Parameters List
401 National Avenue PRB Pilot Study
Mountain View, California

Analyte(s)	Analytical Method	Purpose
cVOCs	EPA 8260B (8010 Analyte List)	Evaluate the in-situ destruction of TCE and related compounds within ZVI PRB
Sulfate, nitrate, nitrite	EPA 300.0	Evaluate reduction of SO4 and NO3/NO2 in ZVI PRBs
Chloride	EPA 300.0	Evaluate if chloride formation in ZVI PRB
DO, ORP, pH, electrical conductivity, temperature	Field measurement	Evaluate changes in groundwater geochemistry in contact with ZVI PRB
Dissolved iron, manganese, calcium, magnesium, silicon, sodium	EPA 6010B	Identify changes in cation concentrations as indicators of secondary precipitation
Ethene, ethane, acetylene, methane	RSK-175M	Evaluate degradation of cVOCs and formation of reaction products
TOC	EPA 415.1	Identify changes in organic carbon across ZVI zone
Alkalinity	SM 2320B	Identify losses in alkalinity as indicators of carbonate precipitation
TDS	SM 2540C	Evaluate losses in TDS as an indication of the amount of secondary precipitation

Note:
Performance monitoring parameters will be collected on a quarterly basis for four quarters following installation of the PRB. After the first year, the scope and frequency of monitoring will be evaluated and modified, as appropriate.

Abbreviations:
cVOCs = chlorinated volatile organic compounds
DO = dissolved oxygen
ORP = oxidation reduction potential
PRB = permeable reactive barrier
TDS = total dissolved solids
TOC = total organic carbon
ZVI = zero-valent iron

FIGURES



N

0 5 Miles

Basemap Sources: USGS, ESRI, TANA, AND, DeLorme, NPS

Site Location Map

401 National Avenue
Mountain View, California

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Figure **1**

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Legend

- Recovery Well
- Recovery Well (Inactive)
- Monitoring Well
- 401 National Avenue
- ==== Slurry Wall

N

50 25 0 50 Feet

Notes:
Aerial Source: USGS April 2011

Site Plan Prior to Redevelopment

401 National Avenue
Mountain View, California

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Figure **2**

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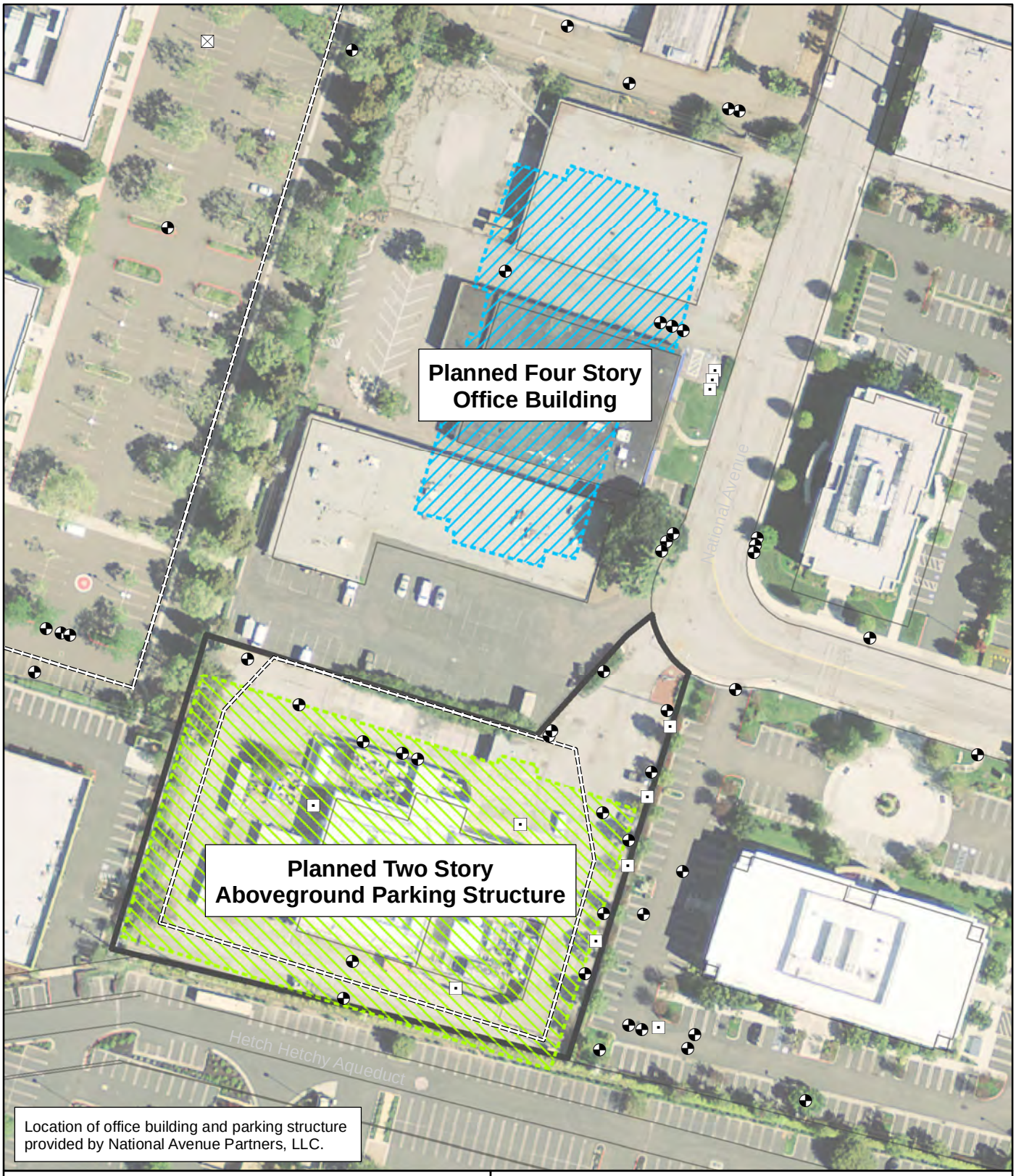

Legend

- Recovery Well
- Recovery Well (Inactive)
- Monitoring Well
- Slurry Wall
- 401 National Avenue
- Planned Four Story Office Building
- Planned Two Story Aboveground Parking Structure

N

50 25 0 50 Feet

Notes:
Aerial Source: USGS April 2011

Redevelopment Plan

401 National Avenue
Mountain View, California

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Figure **3**

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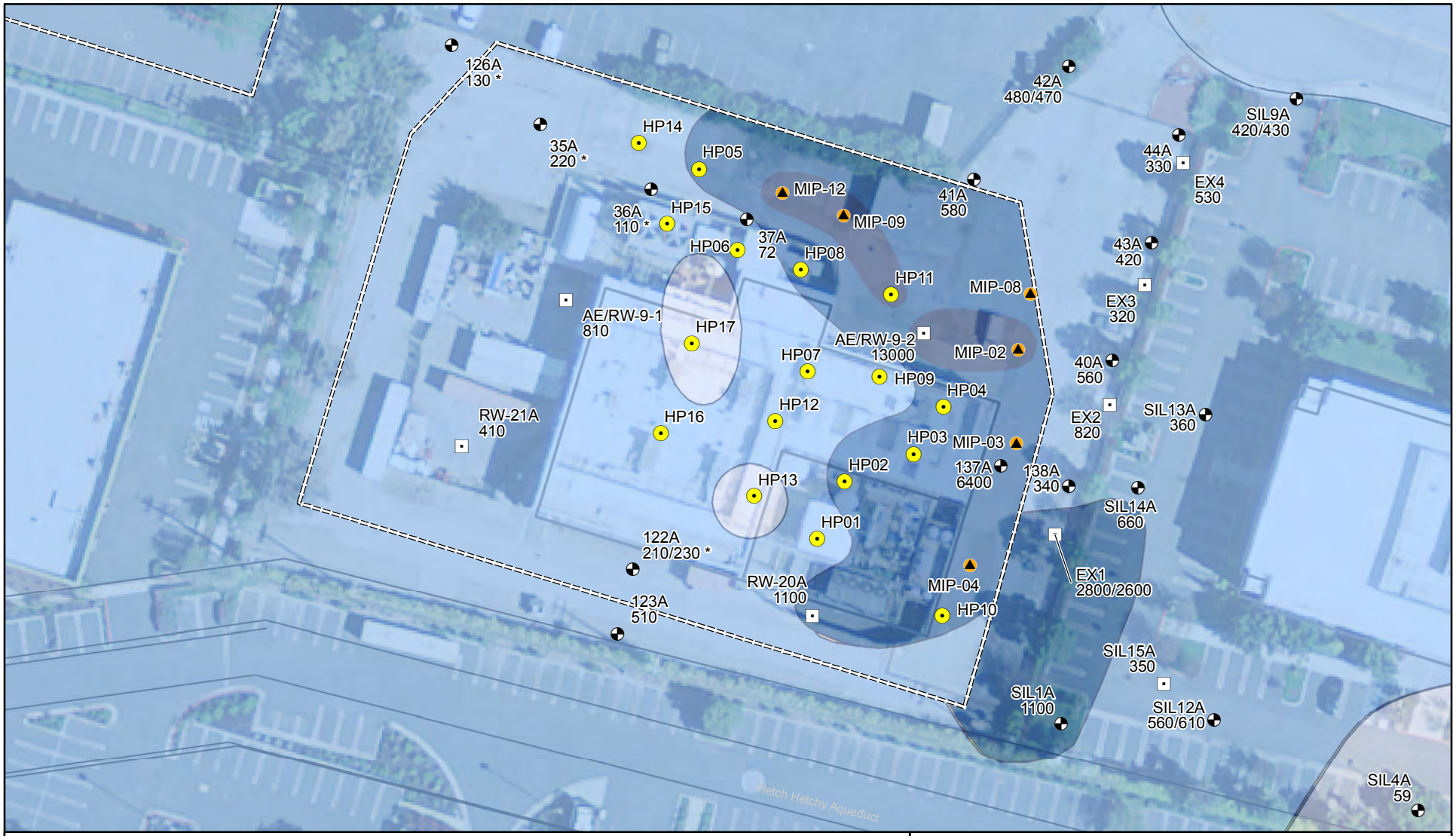

Legend

TCE Concentration

- 5 - 100 ug/L
- 100 - 1,000 ug/L
- 1,000 - 10,000 ug/L
- Greater than 10,000 ug/L

- Hydropunch Sample Location (September 2013)
- Hydropunch Sample Location (November 2014)
- Recovery Well
- Monitoring Well
- 123A / 510 — Well ID / TCE Concentration (µg/L)
- ==== Slurry Wall

N

30 15 0 30 Feet

Notes:
TCE = Trichloroethene
ug/L = micrograms per liter
* Only wells sampled in 2012 or 2013 shown in Figure. Star indicates well last sampled in 2012.
TCE concentration contours are based on data presented in the 2013 Annual Monitoring Report (Geosyntec, 2014) and 2014 Hydropunch sample results.

A-Zone TCE Concentrations

401 National Avenue
Mountain View, California

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Figure 4

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Legend

- Recovery Well
- Monitoring Well
- ==== Slurry Wall
- Recovery Well To Be Destroyed
- Proposed Monitoring Well Location
- Proposed ZVI PRB Location
- Proposed ZVI PRB Monitoring Point

N

Notes:
ZVI = Zero Valent Iron
PRB = Permeable Reactive Barrier

60 30 0 60 Feet

ZVI PRB Locations and Performance Monitoring Points

401 National Avenue
Mountain View, California

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Figure **5**

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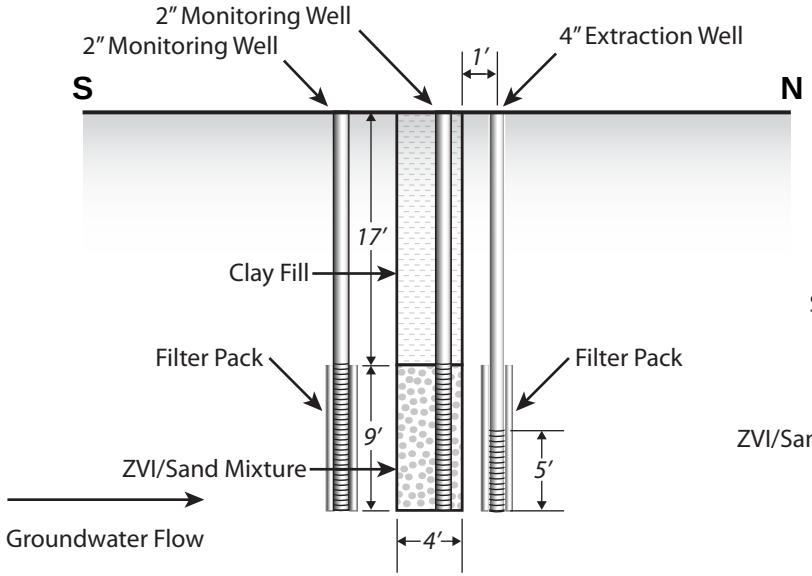
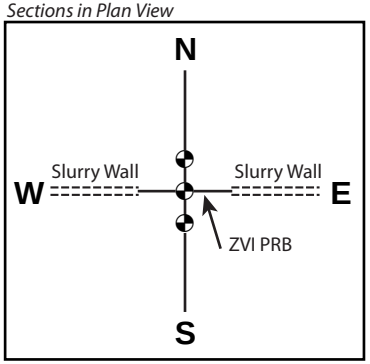
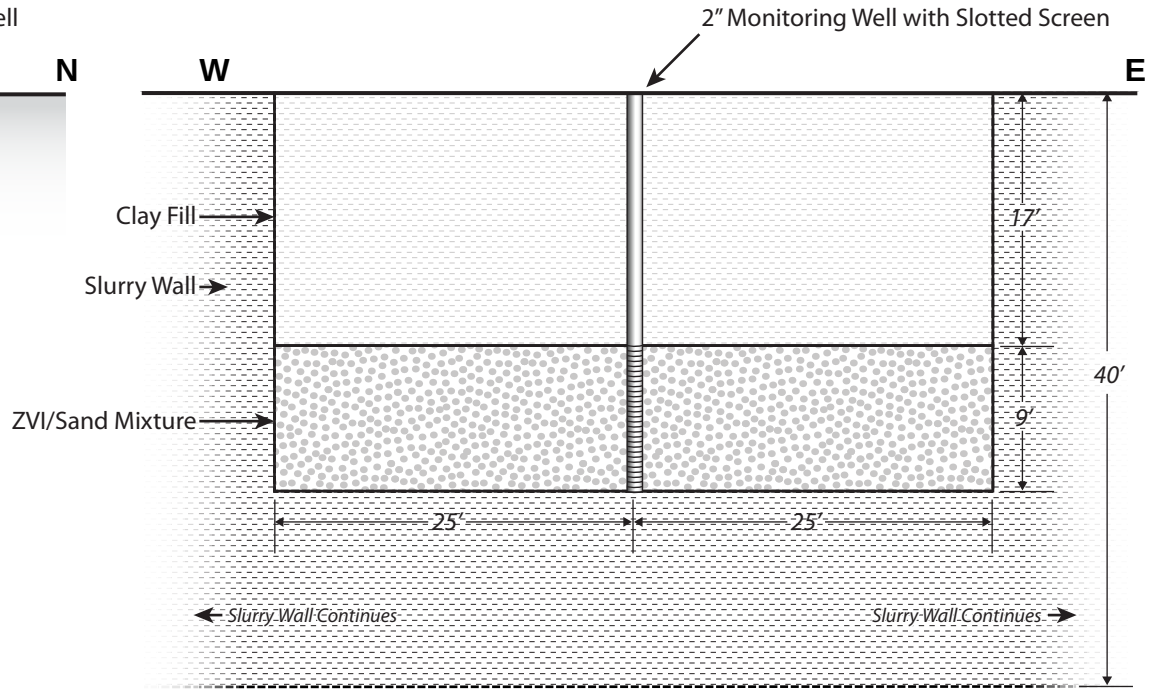
Side View of ZVI PRB



Sections in Plan View



Front View of ZVI PRB



Slurry Wall Total Depth ~ 40 ′ bgs

Notes:
All Dimensions are Approximate
ZVI = Zero Valent Iron
PRB = Permeable Reactive Barrier

Conceptual ZVI PRB and Contingency Extraction Well Construction Diagram

401 National Avenue
Mountain View, California

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Figure 6

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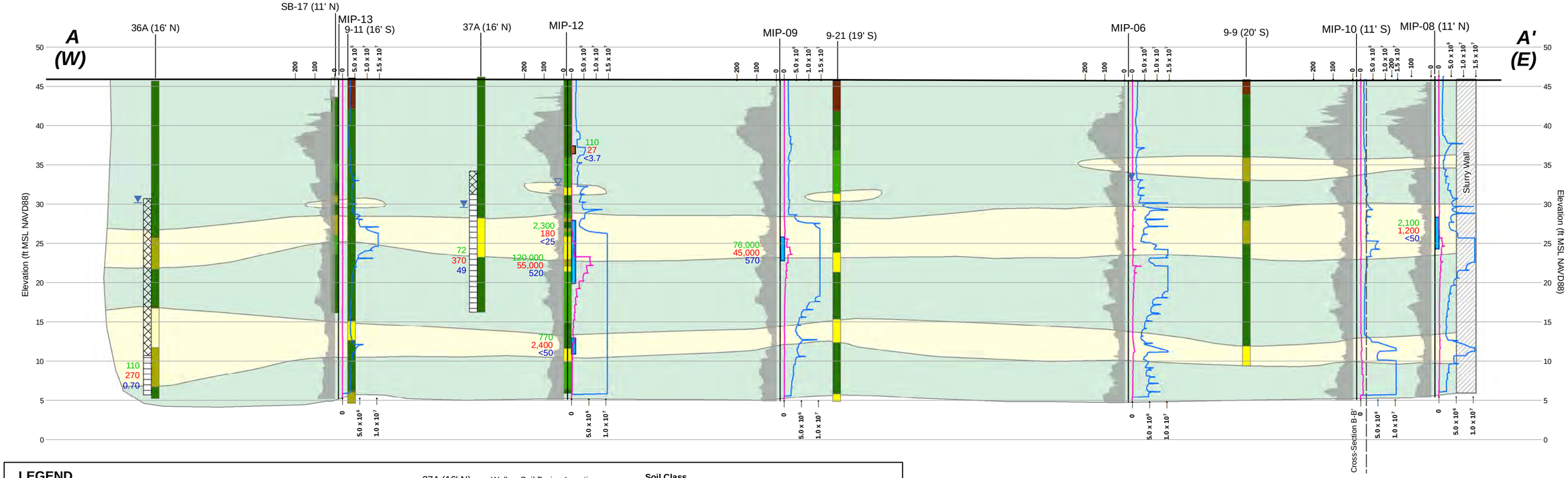


LEGEND

MIP Location with Distance and Direction Projected to Cross-Section — **MIP-01 (20' N)**

SCP response range in mS/M — ECD response range in uV

September 2013 Sample Results
Trichloroethene Concentration [ug/Kg] 770
cis-1,2-Dichloroethene Concentration [ug/Kg] 2,400
Vinyl Chloride Concentration [ug/Kg] <50
— Soil Sample

SCP response

ECD response

September 2013 Sample Results
Trichloroethene Concentration [ug/L] 770
cis-1,2-Dichloroethene Concentration [ug/L] 2,400
Vinyl Chloride Concentration [ug/L] <50
— PID response
— Grab Groundwater Sample

PID response range in uV

37A (16' N) — Well or Soil Boring Location with Distance and Direction Projected to Cross-Section

Filter Pack

Well Screen

September 2012 and October 2013 Sample Results (see Note)
190 Trichloroethene Concentration [ug/L]
120 cis-1,2 Dichloroethene Concentration [ug/L]
<0.50 Vinyl Chloride Concentration [ug/L]

Groundwater Elevation (September 2013)

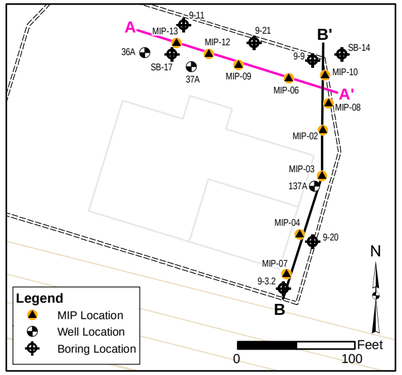
Groundwater Elevation During Drilling (September 2013)

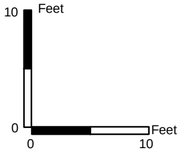
Soil Class
- No Recovery
- Asphalt; Fill
- Sand and Gravel Fill Material
- Topsoil
- CL Clay
- ML Silt
- SC-SM Clayey Sand to Silty Sand
- SP-SW Poorly Graded Sand to Well Graded Sand
- SW-GW Well Graded Gravelly Sand to Well Graded Gravel

Lithology
- Generalized Fine-Grained Layer
- Generalized Coarse-Grained Layer

Abbreviations:
ft MSL = Feet above Mean Sea Level
MIP = Membrane Interface Probe
PID = Photoionization Detector
ECD = Electron Capture Detector
SCP = Soil Conductivity Probe
mS/M = milliSiemens per meter
uV = microvolts
ug/Kg = micrograms per kilogram
ug/L = micrograms per liter

Notes:
- Groundwater elevation for MIP-12 was measured on 6 September 2013, monitoring well groundwater measurements are from September 2013.
- Monitoring wells 37A and 41A were sampled in October 2013. Monitoring well 36A was sampled in September 2013.
- Boring logs for Site monitoring wells and "9-#" borings were logged using ~12-inch soil samples collected approximately every 5 feet. Lithology interpretations between these samples were estimated on historical boring logs. "MIP" soil borings and SCP borings advanced in 2013 were logged continuously and are expected to be more representative of subsurface conditions.
- Slurry wall location adjusted 5 feet east on cross-section to include log for MIP-8 inside slurry wall.
- Ground surface from topographic survey found in construction drawings provided by Kenneth Rodrigues and Partners, Inc., December, 2013.





Cross-Section A-A'
401 National Avenue
Mountain View, California

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Figure 7

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Legend

- Recovery Well
- Monitoring Well
- mZVI Injection Point
- ISCO Pilot Study Injection Area
- Recovery Well To Be Destroyed
- ZVI PRB Location
- ==== Slurry Wall

N

60 30 0 60 Feet

Notes:
Figure shows only wells located at 401 National Avenue.
mZVI = Micro-scale Zero Valent Iron

Redox Modification Zone Location

401 National Avenue
Mountain View, California

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Figure **8**

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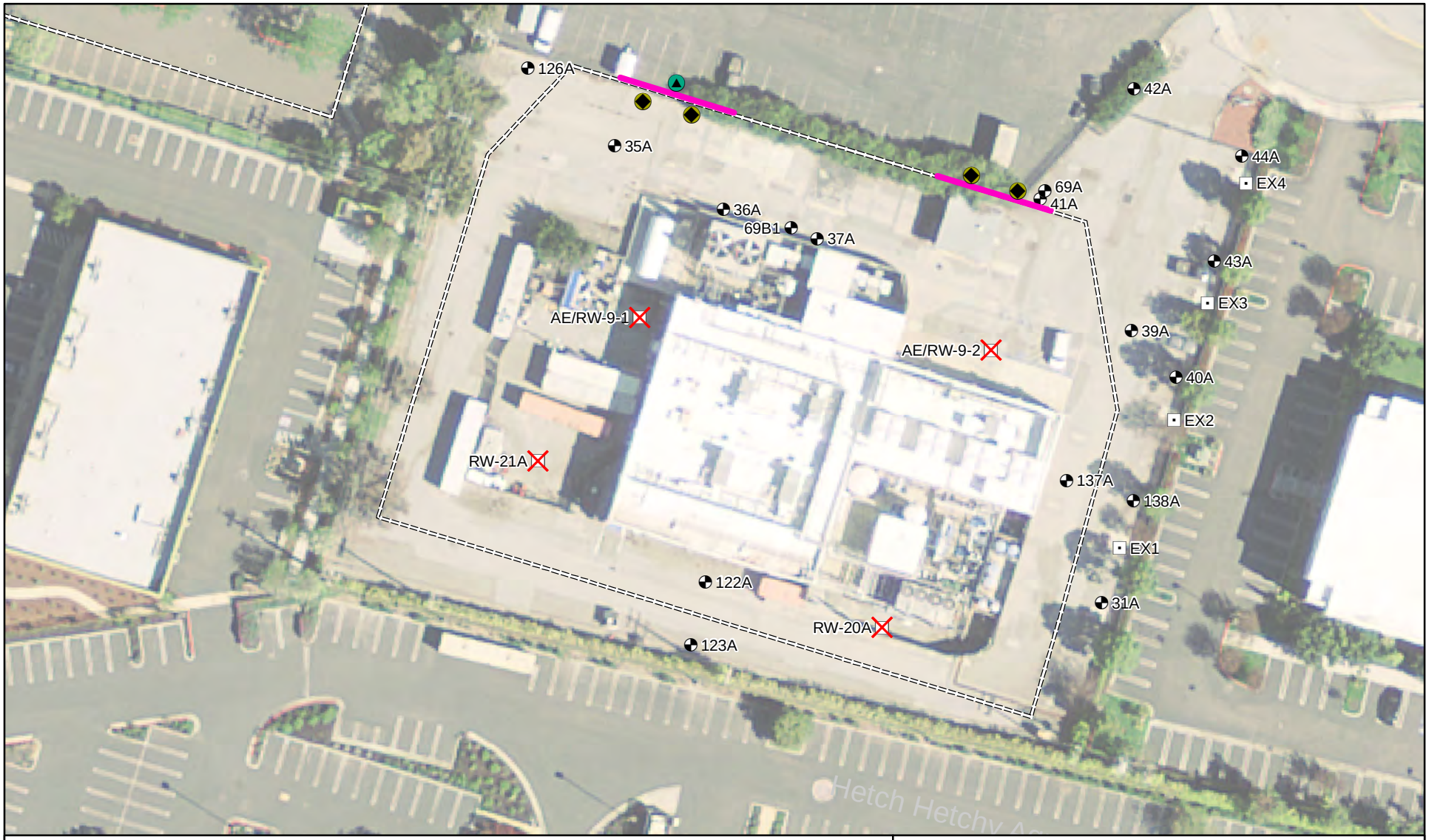

Legend

- Recovery Well
- Monitoring Well
- Recovery Well To Be Destroyed
- Proposed ZVI PRB Location
- Proposed Soil Boring & Grab Groundwater Sample Location
- Proposed Grab Groundwater Sample Location
- ==== Slurry Wall

N

60 30 0 60 Feet

Notes:
ZVI = Zero Valent Iron
PRB = Permeable Reactive Barrier
Figure shows only wells located at 401 National Avenue.

Supplemental PRB Design Data Collection Locations

401 National Avenue
Mountain View, California

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Figure 9

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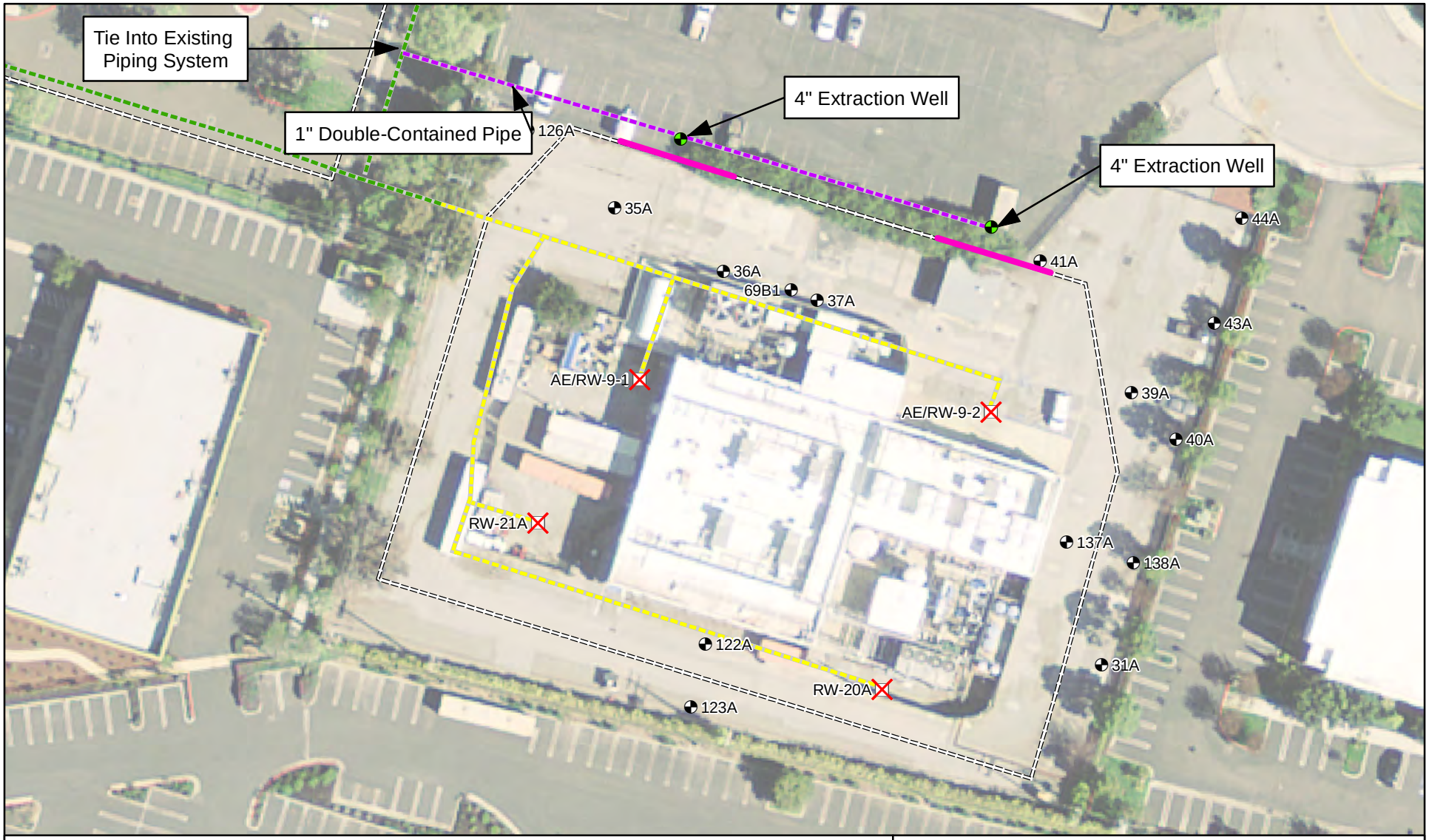

Legend

- Monitoring Well
- Recovery Well
- Current Pipeline to be Abandoned in Place
- Proposed Discharge Pipeline
- Current Discharge Pipeline
- Recovery Well To Be Destroyed
- Proposed Extraction Well Location
- Proposed ZVI PRB Location
- ==== Slurry Wall

N

Notes:
ZVI = Zero Valent Iron
PRB = Permeable Reactive Barrier
Figure shows only wells located at 401 National Avenue.
Location of pipelines are approximate

60 30 0 60 Feet

Contingency Extraction Well Piping Alignment

401 National Avenue
Mountain View, California

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Figure **10**

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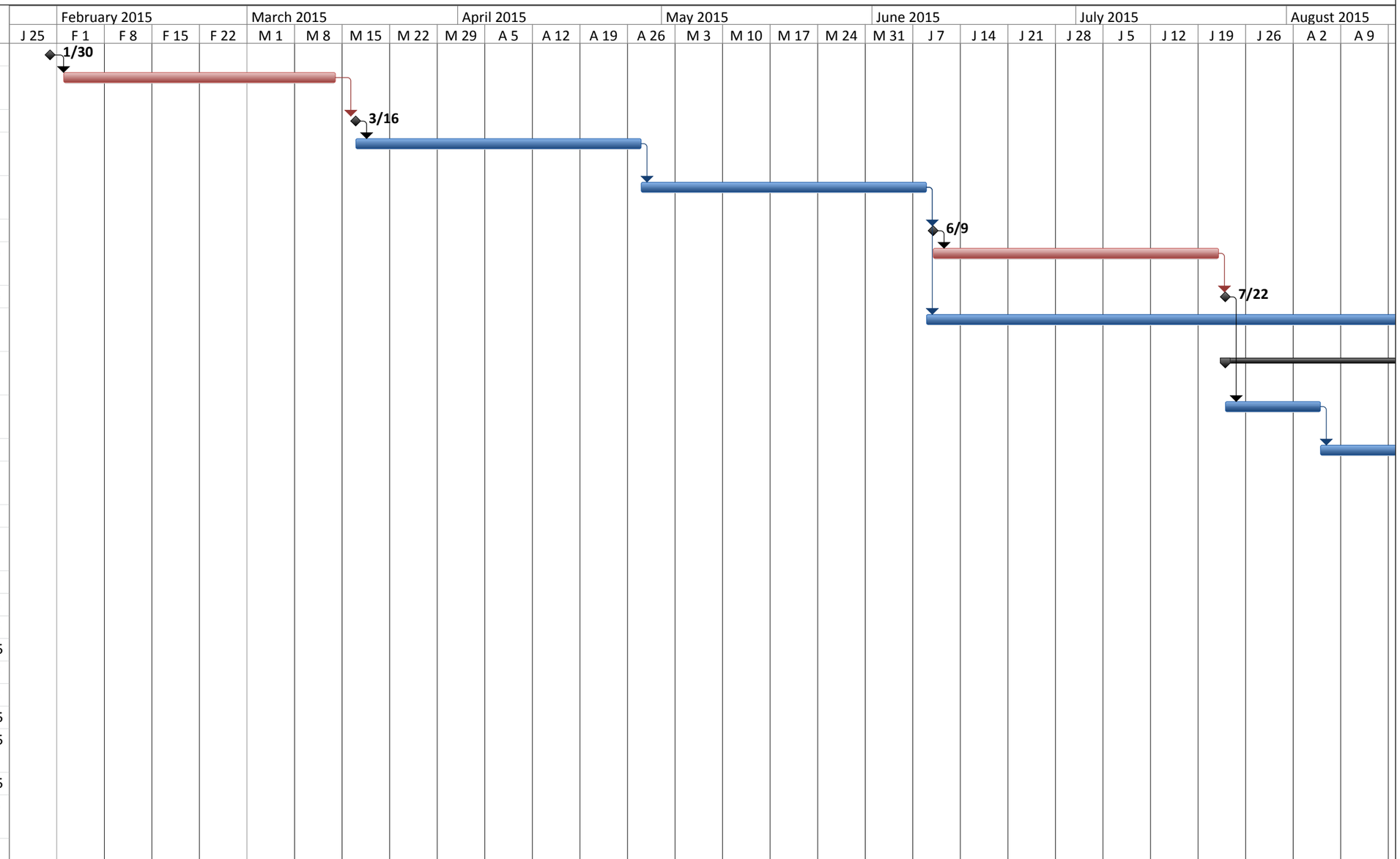
Figure 11
Preliminary Schedule
401 National Avenue ZVI PRB Treatability Study
Mountain View, California

ID	Task Name	Start
1	Submit Work Plan to EPA	Fri 1/30/15
2	EPA/Stakeholder Review of Work Plan	Mon 2/2/15
3	EPA Approval of Work Plan	Mon 3/16/15
4	Implement PRB Design Data Collection Fieldwork	Tue 3/17/15
5	Prepare ZVI PRB Treatability Study Design Report	Tue 4/28/15
6	Submit Design Report to EPA	Tue 6/9/15
7	EPA/Stakeholder Review of Deisgn Report	Wed 6/10/15
8	EPA Approval of Design Report	Wed 7/22/15
9	Submit Grading Permits to City of Mountain View	Tue 6/9/15
10	Redox Modification Zone Implementation	Thu 7/23/15
11	Material Procurement and Mobilization	Thu 7/23/15
12	mZVI Injections	Thu 8/6/15
13	Redox Modification Zone Monitoring	Thu 8/20/15
14	ZVI PRB Installation	Thu 10/1/15
15	Material Procurement and Mobilization	Thu 10/1/15
16	ZVI PRB Excavation and Backfill	Thu 10/22/15
17	Extraction Well Destruction	Thu 10/22/15
18	Mobilization	Thu 10/22/15
19	Well Destruction	Mon 10/26/15
20	Well Installations	Thu 11/19/15
21	Mobilization	Thu 11/19/15
22	Monitoring Well Installation	Mon 11/23/15
23	Contingency Well and Conveyance Piping Installation	Mon 11/30/15
24	PRB Monitoring - Quarterly	Mon 12/14/15
25	Submittal of Construction Completion Report to EPA	Mon 2/15/16



Project: Figure 1 - Schedule_prev
Date: Wed 1/28/15

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline			
Split	External Tasks	Inactive Summary	Manual Summary	Progress			
Milestone	External Milestone	Manual Task	Start-only				
Summary	Inactive Task	Duration-only	Finish-only				

Figure 11
Preliminary Schedule
401 National Avenue ZVI PRB Treatability Study
Mountain View, California

ID	Task Name	Start
1	Submit Work Plan to EPA	Fri 1/30/15
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5	Prepare ZVI PRB Treatability Study Design Report	Tue 4/28/15
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8	EPA Approval of Design Report	Wed 7/22/15
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17	Extraction Well Destruction	Thu 10/22/15
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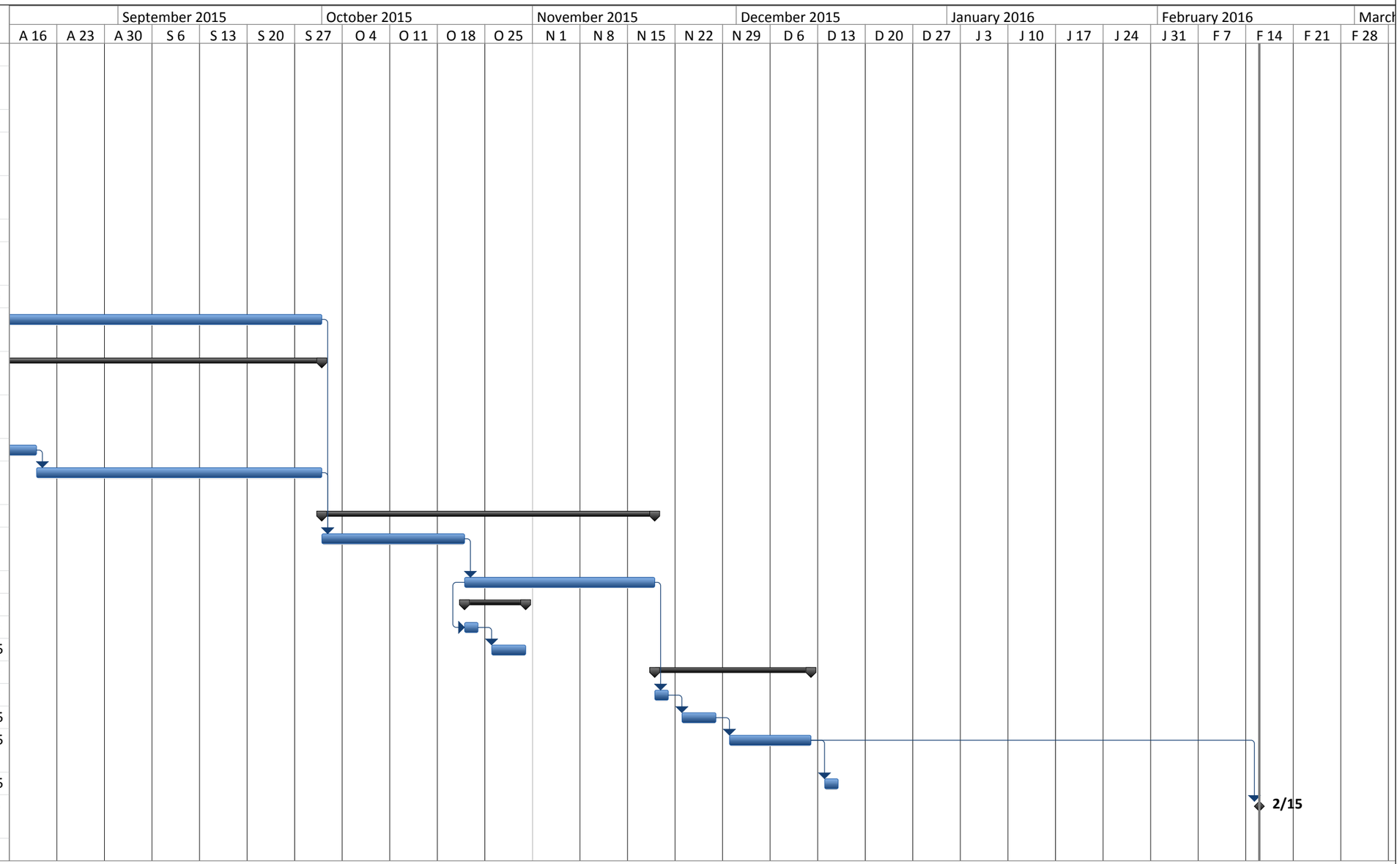
19	Well Destruction	Mon 10/26/15
20	Well Installations	Thu 11/19/15
21	Mobilization	Thu 11/19/15
22	Monitoring Well Installation	Mon 11/23/15
23	Contingency Well and Conveyance Piping Installation	Mon 11/30/15
24	PRB Monitoring - Quarterly	Mon 12/14/15
25	Submittal of Construction Completion Report to EPA	Mon 2/15/16

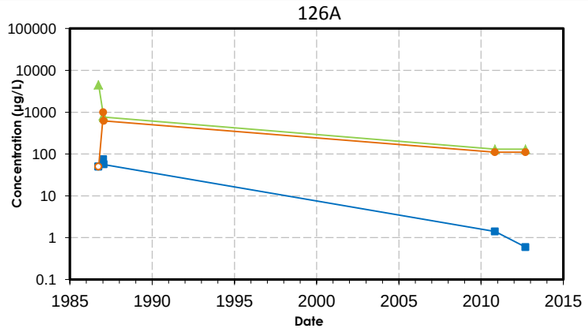


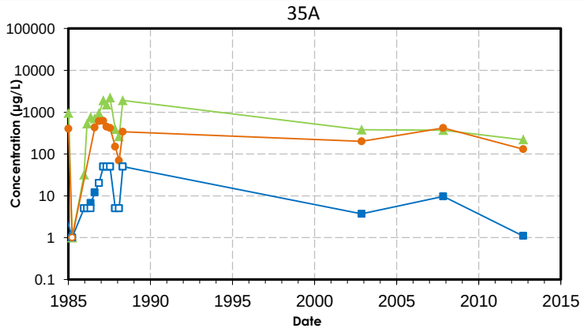
Project: Figure 1 - Schedule_prev
Date: Wed 1/28/15

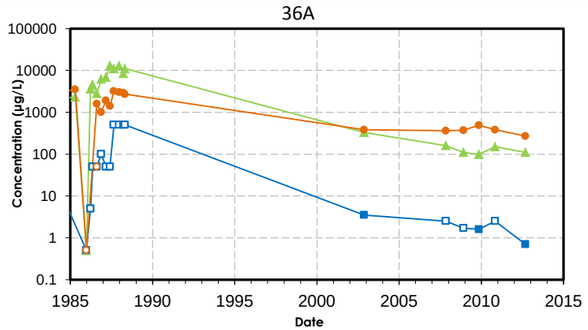
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline	
Split	External Tasks	Inactive Summary	Manual Summary	Progress	
Milestone	External Milestone	Manual Task	Start-only		
Summary	Inactive Task	Duration-only	Finish-only		

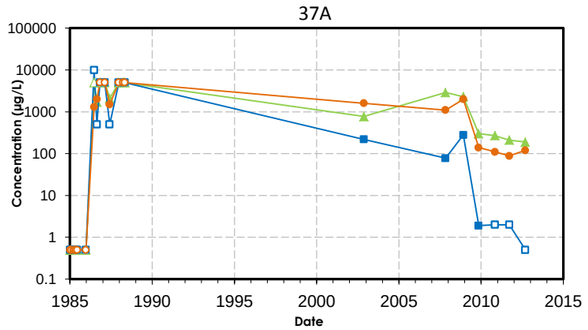
APPENDIX A

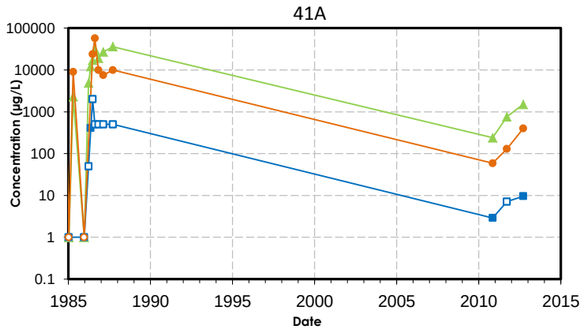
VOCs vs. Time Graphs

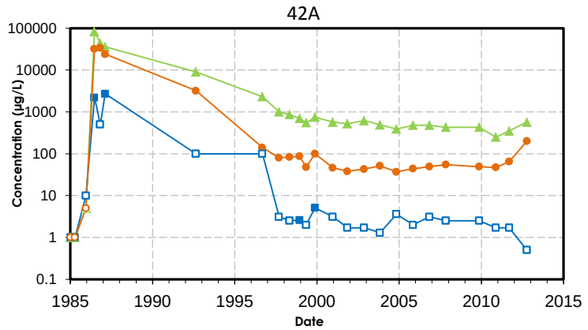


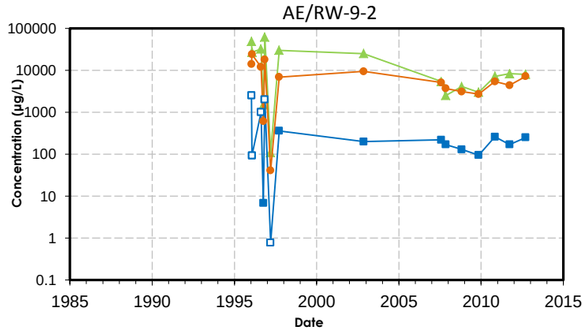


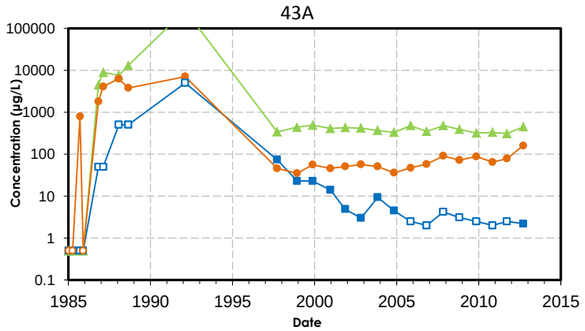


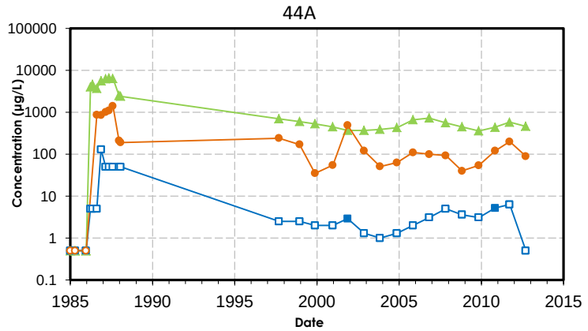


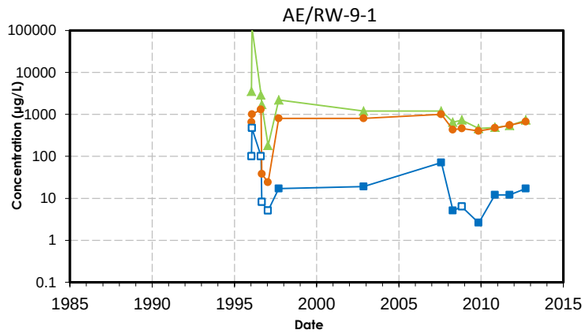


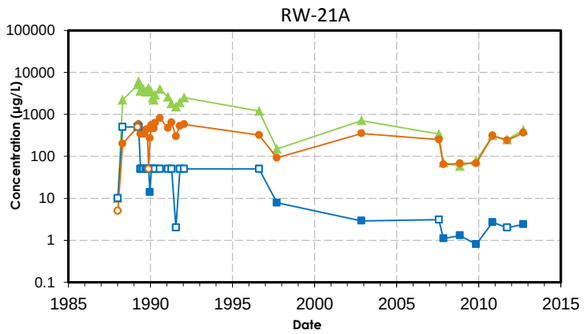


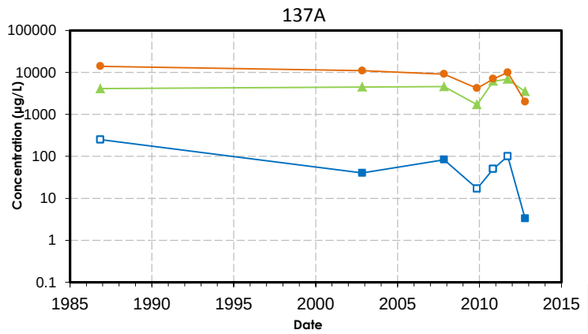


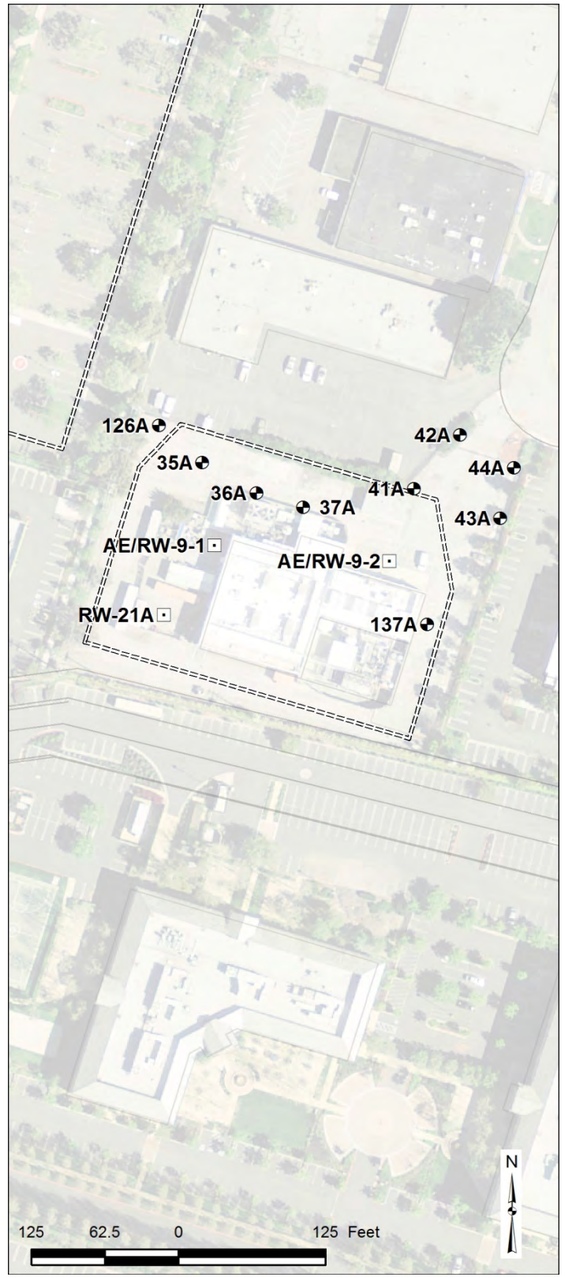












Trichloroethene
cis-1,2-Dichloroethene
Vinyl Chloride

Note:
Open symbols are non-detects, presented at limit of quantification

35A Monitoring Well
RW-21A Extraction Well (On)

VOCs vs. Time Graphs

401 National Avenue
Mountain View, California

Geosyntec consultants

Figure **A-1**

Oakland | January 2015

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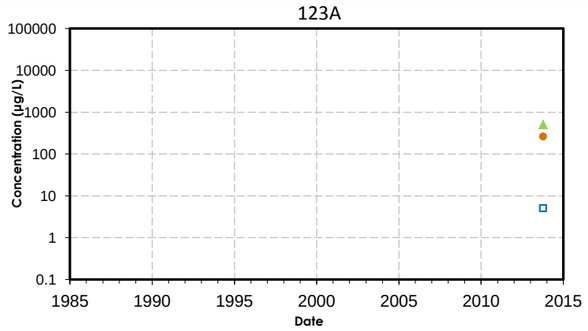

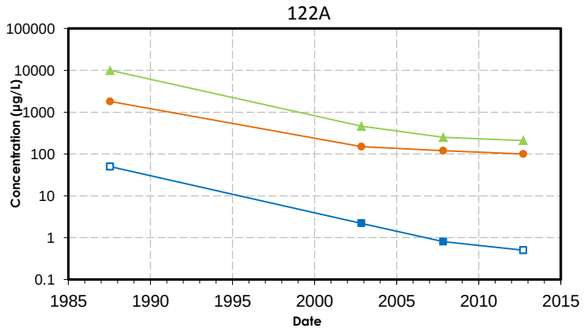

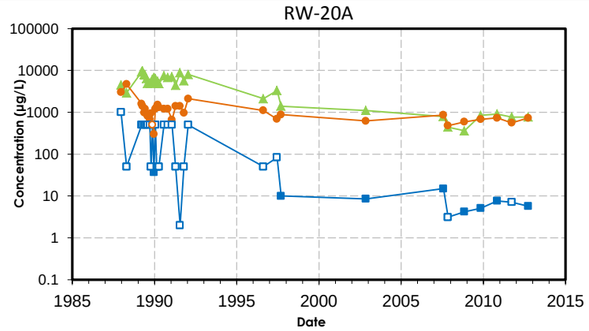

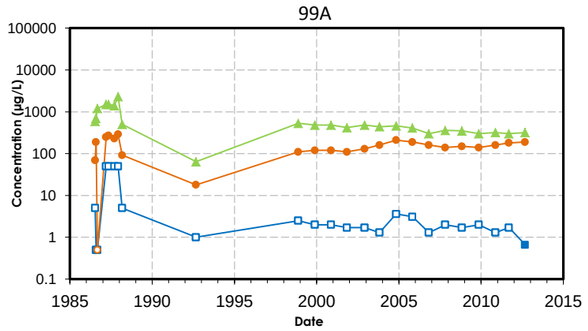

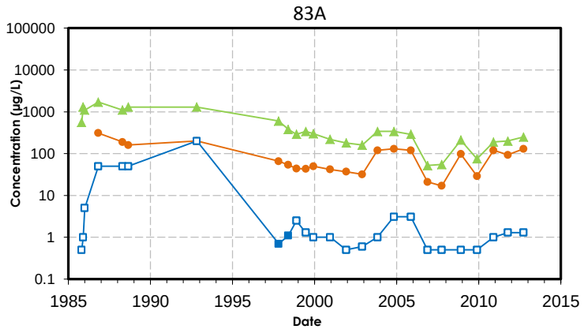

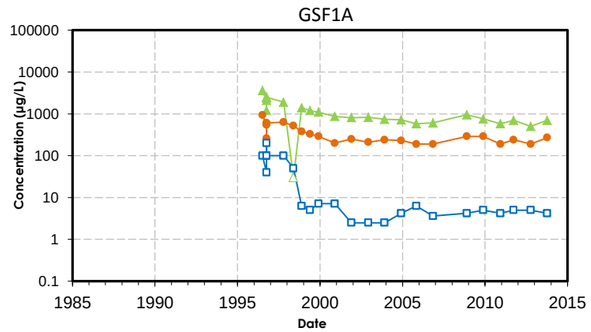

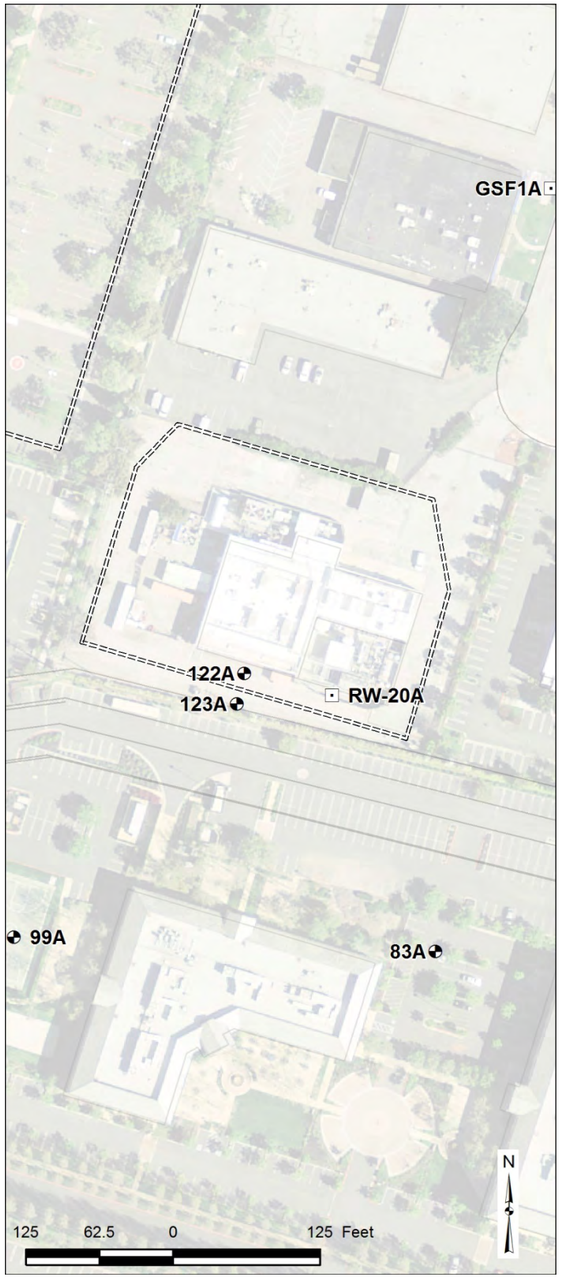

Trichloroethene
cis-1,2-Dichloroethene
Vinyl Chloride

Note:
Open symbols are non-detects,
presented at limit of quantification

35A Monitoring Well
RW-21A Extraction Well (On)

VOCs vs. Time Graphs

401 National Avenue
Mountain View, California

Geosyntec consultants

Figure
A-2

Oakland | January 2015

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APPENDIX B

ZVI Treatability Study Report

Prepared for:

Geosyntec
1111 Broadway, 6th floor
Oakland, CA, 94607

FINAL

Treatability Study Report

Column Study to Evaluate Remediation of Chlorinated Solvents in Groundwater Using Zero Valent Iron

Mountain View, California

Prepared by:

130 Research Lane, Suite 2
Guelph, Ontario N1G 5G3

SiREM Ref: WR1133A.03.3-1

1 April 2014

siremlab.com

TABLE OF CONTENTS

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LIST OF ABBREVIATIONS

CO_2	carbon dioxide
cDCE	cis 1,2-dichloroethene
°C	degrees Celsius
°C/min	degrees Celsius per minute
cm	centimeters
°F	degrees Fahrenheit
ft	feet
ft/day	feet per day
DHG	dissolved hydrocarbon gases
GC	gas chromatograph
g	grams
$t_{½}$	half-life
hrs	hours
IC	ion chromatograph
ICP-AES	inductively coupled plasma – atomic emission spectroscopy
MCLs	maximum contaminant levels
µg/L	micrograms per liter
µL	microliters
mg/L	milligrams per liter
mL	milliliters
mL/min	milliliters per minute
min	minute
mm	millimeters
mM	millimolar
mmol/kg Fe/day	millimoles per kilogram iron per day
mV	millivolts
ORP	oxidation reduction potential
%	per cent
PRB	permeable reactive barrier
RPM	revolutions per minute
QL	quantitation limit
r^2	coefficient of determination
SiO_3^{2-}	silica
SiREM	SiREM Laboratories
PCE	tetrachloroethene
TDS	total dissolved solids
TCE	trichloroethene
TOC	total organic carbon
VC	vinyl chloride
VOC	volatile organic compound
ZVI	zero valent iron

1 Introduction

SiREM Laboratory (SiREM) was retained by Geosyntec to perform a bench scale treatability column study to assess the use of the zero valent iron (ZVI) permeable reactive barrier (PRB) technology for the remediation of halogenated volatile organic compounds (VOCs) in groundwater from the site in Mountain View, California (the site).

This report contains the study objectives and scope of work (Section 2); experimental methods (Section 3); cVOC results and discussion including calculation of cVOC degradation half-lives (Section 4); estimation of residence time required for ZVI PRB design (Section 5); discussion of inorganic chemistry changes during the column study (Section 6); and the study conclusions (Section 7). Report references are provided in Section 8.

2 Objectives and Scope of Work

This section provides the study objectives and the scope of work completed to satisfy the project objectives.

2.1 Objectives

The primary objectives of the laboratory ZVI column study were to:

- Determine degradation rates for the compounds of potential concern (COPCs), including trichloroethene [TCE], cis-1,2-dichloroethene, [cDCE], trans-1,2-dichloroethene [tDCE], vinyl chloride [VC], 1,1,1-trichloroethane [1,1,1-TCA], 1,1-dichloroethane [1,1-DCA] and 1,1,2-trichloro 1,2,2-trifluoroethane [CFC-113]) in groundwater from the Site.

- Characterize halogenated breakdown products of the COPCs and to quantify the rates of their degradation; and

- Evaluate changes in inorganic geochemistry caused by ZVI corrosion chemistry, including possible mineral precipitation.

2.2 Scope of Work

A single ZVI column was set up and performed using 100 per cent (%) granular ZVI (Connelly GPM Inc.) and site groundwater containing VOCs. On 6 September 2013 the granular ZVI was packed into the column with care. The column and ZVI material specifications are provided in Table 1. A schematic of the column is provided in Figure 1.

Initial groundwater for this study was collected by Geosyntec from the site on 28 August 2013 and was received by SiREM on 29 August 2013. On 9 September 2013 an additional volume of groundwater sufficient for the duration of the study was collected by Geosyntec and received by SiREM on 10 September 2013. The combined site groundwater was transferred to a 20L tedlar reservoir bag on 12 September 2013.

The initial TCE, VC, 1,1-DCA, 1,1,1-TCA and CFC-113 concentrations in the influent reservoir were below the target concentrations of 8,000, 300, 100, 100, and 100 micrograms per liter (µg/L), respectively. Therefore, on 17 September 2013 the influent reservoir water was amended with 68 microliters (µL) of neat TCE, 0.92 milliliters (mL) of VC (gas), 316 µL of a saturated 1,1-DCA water stock solution, 1,070 µL of a saturated 1,1,1-TCA water stock solution and 1.03 µL of neat CFC-113 to achieve the target concentrations. On 18 September 2013 the pump used to feed the water from the influent reservoir vertically upward through the column for a period of seven weeks. A flow velocity of approximately 1.5 feet/day was selected in consultation with Geosyntec to allow the study to be completed in a reasonable time. This flow rate has been used in previous ZVI column tests to assure a sufficient volume of groundwater passes through the column within the test period in order to assess potential long-term changes to VOC treatment efficacy. During the course of the study decreases in the influent reservoir

concentrations of select target VOCs were observed and two additional amendments of the COCs occurred to adjust the influent concentrations. On 2 October 2013 the influent reservoir water was amended with 1.84 mL of VC (gas) and on 18 October 2013 the influent reservoir water was amended with 25 µL of neat TCE, 24 µL of neat cDCE and 0.86 (mL) volume of VC (gas) to maintain target concentrations. The losses in VOC concentrations were most likely attributable to biological activity and/or some volatile losses in the influent reservoir.

Water samples were collected from seven sampling ports located along the column length as well as from the column influent and effluent for analysis of pH, oxidation-reduction potential (ORP), cVOCs, dissolved hydrocarbon gases (DHGs), cations, anions, alkalinity, total dissolved solids (TDS), and total organic carbon (TOC), according to the schedule presented in Table 2.

The VOC concentration trends from the column study were used to calculate the degradation rates for each compound detected using a multicomponent first-order kinetic model. The degradation rates obtained, expressed as half-lives, were then corrected for groundwater temperature and used to calculate the residence time required in the field to achieve the regulatory criteria for all compounds. Finally, the column water chemistry data were used to assess the potential effects of water chemistry on the long-term reactivity of ZVI under site conditions.

3 Study Methods and Materials

This section describes the methods used to construct and operate the ZVI columns, and to collect water samples for analysis during the ZVI column treatability study.

3.1 Column Construction

The column study consisted of one column containing 100% granular ZVI (CC-1004) provided by Connelly-GPM Inc. (Chicago, IL). This commercial ZVI source has been used for numerous ZVI PRB applications (Gillham et al., 2010). Based on the manufacturer's specifications, the granular ZVIs used in the column study have a particle size range from 0.25 to 2.0 millimeters (mm; 8 to 50 US Mesh). Based on previous characterization of the Connelly ZVI batch used in the test, the hydraulic conductivity of the tested material was 1.5×10^{-2} cm/sec (determined by a constant head permeability test) and the specific surface area was 2.3 m^2/g (determined by the BET method).

The columns were constructed of Plexiglas™ with a length of 1.64 feet (ft) (50 centimeters [cm]) and an internal diameter of 0.12 ft (1.5 inches, 3.8 cm) (Figure 1). Seven sampling ports were positioned vertically along the central axis of the columns at distances of 0.08, 0.16, 0.33, 0.50, 0.66, 1.0 and 1.3 ft from the influent end. The column influent and effluent ports were also sampled. All sampling ports within the columns (excluding influent and effluent) were constructed using a nylon Swagelok compression fitting tapped into the column. A 16 gauge needle was positioned through the fitting and secured by tightening the ferrule. Glass wool was threaded through the needle to ensure minimal particulates from entering the samples. Each sample port was then fitted with a Luer-Lock™ fitting so that a glass syringe could be attached to the port for collection of water samples.

To ensure a homogeneous column material bed, the ZVI was packed vertically in the columns in 100 gram (g) increments. Values of bulk density, porosity, and pore volume were determined by weight and are provided in Table 1. The column experiment was performed at room temperature (22±1 degrees Celsius [ºC]). After column packing, the dry ZVI material was purged with carbon dioxide (CO_2) gas for 2 hours prior to saturation with water to remove air. CO_2 is a more soluble gas compared to oxygen and nitrogen and assures that any trapped gas dissolves in water and prevents creation of gas bubbles in the columns.

A Masterflex® peristaltic pump was used to feed site water vertically upwards through the columns. The pump tubing consisted of Viton® 2-stop tubing. All other tubing was 1/16 inch inside diameter Teflon® tubing.

3.2 Site Groundwater Storage and Usage

Five (5) 1-litre bottles marked AE/RW-9-2 were received by SiREM personnel on 29 August 2013 and stored in cold storage (4°C) until an additional receipt of five (5) 4-litre bottles marked AE/RW-9-2 on 10 September 2013. The Chain of Custody Records for water received from the site are provided in Appendix A. The Site groundwater was transferred into the influent reservoir

(i.e., a Tedlar bag) with minimal headspace. The influent reservoir contained two Swagelok fittings with Teflon® septa.

3.3 Sampling Procedure

After removing the stagnant water from the sampling needles, 4.0 mL samples were collected from the sampling ports using glass on glass syringes. A 250 µL to 1 mL water sample (depending on the sample location and dilution required) was removed from the glass syringe and transferred immediately into an autosampler vial for gas chromatograph (GC) analysis of cVOCs/DHGs. The remaining sample volume was transferred into a 5 mL plastic vial for ORP and pH measurement. When anion sample collection was required a 0.5 mL sample was transferred to 1.5 mL eppendorf tubes, which were stored frozen until time of analysis.

Water samples for cation, alkalinity, TDS and TOC analyses were collected from the column influent and effluent only. For cations, 60 mL unfiltered samples were collected into 110 mL bottles acidified to a pH of 2 with nitric acid. For alkalinity, 40 mL unfiltered samples were collected into VOA vials with zero headspace and left unpreserved. For TDS, a 75 mL sample was collected into a 110 mL bottle and left unpreserved. For TOC, 40 mL unfiltered samples were collected into VOA vials with zero headspace and preserved with sulfuric acid. Confirmatory samples for cVOC analysis were also collected from the influent and effluent into 40 mL VOA vials preserved with hydrochloric acid.

Water samples for cation, alkalinity, TDS metals and confirmatory cVOC analyses were placed in coolers with ice packs and shipped via overnight delivery under chain of custody to Test America in Pleasanton, CA.

3.4 Analytical Methods

This section describes the methods of analysis for pH, ORP, cVOCs, DHGs, cations, anions, alkalinity, TDS and TOC's.

3.4.1 Analysis of ORP and pH

The ORP measurements were performed at SiREM using a Corning 313 meter with double junction ORP electrode (Ag/AgCl reference). A 3.0 mL sample was collected (as described in section 2.3) and the ORP probe was inserted into the sample vial on the lab bench. A single point calibration of the meter was performed at each sampling event with Zobell ORP calibration solution.

The pH measurements were performed using an Oakton pH spear with a combination pH electrode (Oakton, Vernon Hills, IL). Immediately after ORP measurement the pH probe was inserted into the same sample vial on the lab bench for pH measurement. The pH spear was calibrated at each sampling event according to the manufacturer's instructions using pH 4.0, 7.0 and 10 standards.

3.4.2 Analysis of cVOCs and Dissolved Hydrocarbon Gases

Water sample cVOC and DHG (i.e., ethene, ethane and methane) analyses were performed at SiREM using a Hewlett-Packard (Hewlett Packard 7890) GC equipped with an auto sampler (Hewlett Packard G1888) programmed to heat each sample vial to 75°C for 45 min prior to headspace injection into a GSQ Plot column (0.53 millimeters x 30 meters, J&W) or DB-624 column (0.53 millimeters x 30 meters, J&W) and a flame ionization detector. Sample vials were heated to ensure that all cVOCs in the aqueous sample would partition into the headspace. The injector temperature was 200°C, and the detector temperature was 250°C. For both columns the oven temperature was programmed as follows: 35°C for 2 min, increased to 100°C at 50 degrees Celsius per minute (°C/min), then increased to 185°C at 25°C/min and held at 185°C for 6.80 min. The carrier gas was helium at a flow rate of 11 milliliters per minute (mL/min).

After withdrawing a 250 µL to 1 mL sample, the sample was injected into a 10 mL auto sampler vial containing between 5.75 and 5.0 mL of acidified deionized water (pH ~2). The water was acidified to inhibit microbial activity between microcosm sampling and GC analysis. The vial was sealed with an inert Teflon®-lined septum and aluminum crimp cap for automated injection of 3 mL of headspace onto the GC. One cVOC standard was analyzed with each set of samples to verify the instrument five-point calibration curve using methanolic stock solutions containing known concentrations of the target analytes. Calibration was performed using external standards purchased as standard solutions (Sigma, St Louis, Missouri), where known volumes of standard solutions were added to acidified water in auto sampler vials and analyzed as described above for column samples. The calibration concentrations range from 10 to 10,000 µg/L. Data were integrated using Chemstation Software (Agilent Technologies, Santa Clara, California).

The quantitation limits (QL) for the cVOCs and DHGs were typically 10 µg/L to 20 µg/L based on the lowest concentration standards that were included in the linear calibration trend and the dilution factor applied for a particular sample.

As outlined in the sampling schedule in Table 2, samples from the influent and effluent were also collected at time 0, week 4 and week 7 and sent to Test America (Pleasanton, CA) for cVOC analyses using EPA Method 8260B.

3.4.3 Analysis of Major Anions

Anion (chloride, nitrate-nitrogen [nitrate], nitrite-nitrogen [nitrite], phosphate, bromide, chlorate and sulfate) analyses were performed at SiREM on a Dionex DX-600 ion chromatograph (IC) equipped with a Dionex AS-40 auto sampler and an AS18 column, the sample loop volume was 25 µL. An isocratic separation was performed using 33 millimolar (mM) reagent grade sodium hydroxide (Fisher Scientific, Ottawa, ON) eluent for 13 min. One standard was analysed with each set of samples tested in order to verify the seven-point calibration using external standards of known concentrations. External standards were prepared gravimetrically using chemicals of the highest purity available (Sigma St Louis, MO or Bioshop, Burlington, ON). Data were integrated using Peaknet Chromatography software (Dionex, Oakville, ON). The calibration concentrations ranged from 100 to 10,000 µg/L.

A 0.5 mL sample was withdrawn, after which the sample was placed in a 1.5 mL micro-centrifuge tube. Samples were centrifuged for five minutes at 13,000 revolutions per minute (RPM) to remove solids. The supernatant was removed, diluted 50-fold in deionized water and placed in a Dionex auto sampler vial with a cap that filters the sample during automated injection onto the IC.

3.4.4 Analysis of Cations, Alkalinity, TDS and TOC's

Water sample cation, alkalinity, TDS and TOC analyses were performed by Test America of Pleasanton, CA. Cations were analyzed using inductively coupled plasma atomic emission spectroscopy (ICP-AES) (US EPA Method 6010B). Carbonate alkalinity (expressed as milligrams $CaCO_3$ per liter) in water was determined using method US EPA Method SM 2320B. TDS was determined using US EPA Method SM 2540C and TOC was determined using US EPA Method SM 5310C.

4 VOC Results, Reaction Pathways and Degradation Parameters

This section discusses the observed water VOC concentration trends. The column data are then quantified in terms of anticipated VOC degradation pathways and kinetic rates.

4.1 VOC Results

At a nominal flow velocity of 1.5 ft/day, approximately 40 pore volumes (PVs) of groundwater passed through the Connelly ZVI column during the test. One pore volume corresponded to a residence time of approximately 27 hrs. The water sample cVOC compounds detected (PCE, TCE, cDCE, tDCE, 1,1-DCE, VC, 1,1,1-TCA, 1,1-DCA, CFC-113 and CFC-123a) as well as dechlorination products (ethene and ethane) and methane are provided in Table 3. Concentration trends for cVOCs and DHGs from the last complete sampling events are presented in Figures 2 and 3.

In the last column sampling event, an influent TCE concentration of 4,726 µg/L was degraded to below the detection limit at a residence time of 8.1 hours (Table 3, Figure 2). An influent cDCE concentration of 7,397 µg/L decreased to a non-detectable value at a residence time of 10.8 hours. The tDCE concentration decreased from 71 µg/L to a non-detectable value at a residence time of 21.5 hours. An influent 1,1,1-TCA concentration of 76 µg/L was degraded to below the detection limit at a residence time of 2.6 hours. An influent 1,1-DCA concentration of 132 ug/L was degraded to below the detection limit at a residence time of 13.4 hours. An influent CFC-113 concentration of 50 µg/L was degraded to a non-detectable value at a residence time of 5.4 hours. Concentrations of CFC-123a, present in the influent at a concentration of 40 µg/L increased to approximately 70 µg/L in the initial part of the column and then decreased gradually to 45 µg/L in the column effluent. The initial increase was likely caused by partial dechlorination of CFC-113. VC concentrations in the influent reservoir were below the detection limit, but an increase to 22 µg/L at the first sampling port and 23 µg/L at the second sampling port, followed by a decrease to a non-detectable value at a residence time of 8.1 hrs. The intermittent increase in VC is attributed to partial dechlorination of cDCE.

4.2 Quality Control VOC Analysis

Confirmatory cVOC samples analyzed by US EPA Method 8260B were collected during baseline and column influent and effluent sampling at time 0, week 4 and week 7. Table 5 presents the cVOC analytical data from SiREM and Test America. In general, the TCE, cDCE, VC and 1,1,1-TCA concentrations measured by SiREM in the baseline and column influent samples ranged between 6% to 40% higher than those measured by Test America. At week 4 and week 7 all measured cVOC concentrations from SiREM and Test America were within 10% of each other. Week 4 and week 7 analytical results for column effluent samples were measured as below the given detection limits for both SiREM and Test America (with the exception of CFC-123a detected at 45 µg/L by SiREM, Test America did not report CFC-123a).

SiREM analyzed the VOC samples immediately after collection from the column. Volatile losses during shipping and sample handling may have contributed to the lower VOC concentrations measured at Test America.

It should be noted that 1,1-DCA data was not available from SiREM at time zero and for the first two column profiles due to co-elution with cDCE on the GSQ plot column. The time zero Test America data for 1,1-DCA (130 µg/L) indicated that the target spiking of 100 µg/L was achieved in the influent reservoir. Starting at the third profile (15.6 pore volumes) the SiREM samples were also analyzed on a DB-624 column to separate 1,1-DCA and cDCE and 1,1-DCA was available thereafter.

4.3 cVOC Reaction Pathways and Kinetic Expressions

Two dominant pathways of degradation of chlorinated hydrocarbon compounds by ZVI include hydrogenolysis and reductive *β*-elimination (Gillham et al., 2010). In the hydrogenolysis reaction, a chlorine atom is replaced by a hydrogen atom, accompanied by the addition of two electrons (from the iron). Reductive *β*-elimination involves release of two chlorine atoms and the formation of an additional carbon-carbon bond. Both pathways are thought to occur simultaneously (Arnold and Roberts, 2000). Figure 4 illustrates those pathways for the chlorinated ethene sequence starting from PCE, through TCE, DCE-isomers, VC and finally ethene and ethane. Both of the chlorinated acetylenes are highly unstable and degrade rapidly, primarily through reductive dechlorination to acetylene (Arnold and Roberts, 2000). Another ZVI-mediated transformation mechanism, hydrogenation, involves the addition of two hydrogen atoms across two carbon atoms with the removal of a C-C bond (e.g., reduction of acetylene to ethane, and ethene to ethane as shown in Figure 4).

Previous CFC-113 degradation studies with ZVI showed the compound degraded via single electron reaction pathway, producing CFC-123a and through double electron reaction pathway, producing HCFC-1113 (Vidumsky et al., 2004; Archbold et al., 2012). CFC-1113 was then rapidly degraded to acetate, HCL and HF, without the generation of intermediate halogenated compounds. Chlorinated ethanes such as 1,1,1-TCA undergo predominantly reduction via stepwise hydrogenolysis. In controlled experiments, 1,1-DCA and ethane were detected as major 1,1,1-TCA degradation products (Fennelly and Roberts, 1998).

Based on previous research, the VOC degradation in contact with ZVI appears to be first-order with respect to the concentration of the contaminant (pseudo first-order) (Gillham et al., 2010):

$$\frac{\partial C}{\partial t} = -kt \tag{1}$$

After integration, the equation can be presented in the form of the exponential decay equation:

$$C = C_0 e^{-kt} \tag{2}$$

Where: C is the concentration in solution at a particular time (t),
C_o is the initial concentration, and
k is the first-order rate constant.

The rate constant (k) is a measure of the reaction rate and can be calculated directly from Equation 2. The time at which the initial concentration declines by one-half, ($C/C_o = 0.5$), is the half-life ($t_{1/2}$).

$$t_{1/2} = \frac{\ln(2)}{k} \tag{3}$$

4.4 Determination of Degradation Parameters from Column Data

Due to the complexity of the ZVI-induced dechlorination mechanisms (Figure 4), the laboratory data were interpreted using a multi-component kinetic model to quantify degradation rates of compounds that are present in the water initially, as well as potential degradation products. In the model, potential breakdown products are concurrently produced and degraded as described by first-order kinetic equations. Each pathway is characterized by a rate constant (k) and the mole fraction of the compound that follows that particular path (f). Since chlorinated acetylenes are unstable, short-lived, intermediates are rapidly reduced to ethene (Arnold and Roberts, 2000). These compounds are not typically detected in the solution phase and are therefore not explicitly contained in the degradation model. Therefore, first-order rate equations for each cVOC included in the model are as follows:

$$\frac{\partial PCE}{\partial t} = -k_{PCE} PCE \tag{4}$$

$$\frac{\partial TCE}{\partial t} = f_{PCE1} k_{PCE} PCE - k_{TCE} TCE \tag{5}$$

$$\frac{\partial cDCE}{\partial t} = f_{PCE2} k_{PCE} PCE + f_{TCE1} k_{TCE} TCE - k_{cDCE} cDCE \tag{6}$$

$$\frac{\partial VC}{\partial t} = f_{PCE3} k_{PCE} PCE + f_{TCE2} k_{TCE} TCE + f_{cDCE} k_{cDCE} cDCE - k_{VC} VC \tag{7}$$

These equations were adapted for the computer program Scientist® Version 3.0 (Micromath Research, 2008). A set of analogous equations was used to simulate degradation of chlorinated ethanes and CFCs, based on the known pathways (Vidumsky et al., 2004; Fennelly and Roberts, 1998). The program can be used to fit the first-order equations to experimental data using the least squares best-fit method. The degradation rate and molar conversion are determined for each compound sequentially starting with the most chlorinated VOC.

The results from the model fitting of column data include half-lives for all cVOCs selected and statistical fit data including coefficient of determination (r^2) values. The half-lives determined from the VOC profiles from the last three column sampling events are shown in Table 5, along with the corresponding r^2 values and molar conversion rates. Results of data fitting are provided in Appendix C.

The obtained half-lives were in general at the lower end of the ranges achieved in previous commercial ZVI studies for the compounds reported by Gillham et al. (2010). Two VOCs, tDCE and 1,1-DCA exhibited markedly higher half-lives compared to the other VOCs, with values at the end of the test of 7.8 hrs and 4.6 hrs, respectively (Table 5). The slower degradation of

1,1-DCA was expected. In particular previous results for treatment of 1,1-DCA resulted in half-lives as high as 10 to 15 hrs at room temperature. The relatively high half-life value obtained in this test for tDCE was somewhat surprising. We note however, that tDCE has not been present at appreciable concentrations in the site waters tested in previous ZVI experiments. The extremely high half-lives obtained for CFC123a agree with previous results which showed it was practically non-degradable by ZVI. Degradation rates for all VOC compounds present in the site groundwater were used in the PRB residence time calculation presented in Section 5.

A degradation half-life for 1,1-DCE has not been determined due to a low concentration present in the column influent. A detectable 1,1-DCE concentration of 15 ug/L was present only in the first sampling event performed at 5.7 PVs of flow (Table 3). Based on the concentration profiles from that initial sampling event, the degradation half-life for 1,1-DCE was in the range of those for cDCE and tDCE. However, the 1,1-DCE half-life at the end of the test could not be determined and compared to the cDCE and tDCE half-life values used in the PRB design. Given the same degree of chlorination and a similar thermodynamic reduction potentials of the dechlorination reactions (Roberts et al., 1996) for 1,1-DCE and 1,2-DCE isomers, the 1,1-DCE half-life is expected to be similar to those two compounds.

Half-lives of VOCs gradually increased with time indicating passivation of ZVI with respect to VOC dehalogenation. The gradual loss in reactivity should be accounted for in the PRB design to provide sufficient residence time for cVOC treatment to cleanup levels (see Section 6.2).

5 Field Scale PRB Design Considerations

The laboratory half-lives were obtained at a temperature of 22°C (72 degrees Fahrenheit [°F]). Field groundwater temperature was not provided at the time of this report. For the purpose of this evaluation, we have assumed the minimum field groundwater temperature is approximately 19°C (66°F). Based on the previous research, cVOC degradation half-lives increase by 100% per every 6°C to 8°C temperature decrease within a temperature range of 5 to 25°C (O'Hannesin et al., 2004). Therefore, the laboratory half-life values were increased by a factor of 1.5 to obtain the anticipated field values (Table 6).

An initial residence time calculation for the field ZVI PRB were performed assuming the VOC concentration values in the water used for the bench scale test and using the temperature corrected laboratory half-lives (Table 6). The Scientist® program described in Section 4.4 was used to simulate the change in VOC concentrations over time using the first-order kinetic equations. In simulation mode, the model calculates the VOC concentrations over time, from which the time required for the VOCs to degrade to their regulatory criteria can be determined.

Based on the simulation performed, the residence time required to achieve California maximum contaminant levels (MCLs) for the VOC concentrations assumed using Connelly GPM ZVI is 1.6 days (Table 6). The required ZVI thickness can be obtained by multiplying the residence time required by the groundwater flow rate anticipated in the location of the proposed PRB. It is recommended that an engineering safety factor be included in the ZVI volume design calculations for the proposed ZVI PRB to assure long-term efficiency (see Section 6.2).

6 Inorganic Chemistry Results and Discussion

Previous research has shown that the inorganic composition of the treated groundwater can have a profound influence on the reactivity of commercial granular ZVI materials. Most of these effects are related to long-term performance. Therefore, evaluation of changes in inorganic chemistry along the flow path through the ZVI column is a crucial component of design considerations for a ZVI PRB.

6.1 Column Data

Inorganic parameter samples were collected at baseline and on week 1, 4 and 8. The water sample inorganic chemical concentration data are summarized in Tables 7, 8 and 9. Laboratory reports of analysis for the cations, alkalinity, TDS and metals are compiled in Appendix C.

When iron is exposed to water, several reactions occur as a result of iron corrosion:

$$Fe^{\circ} \rightarrow Fe^{2+} + 2e^{-} \quad (8)$$

This iron corrosion drives the geochemical changes that occur as groundwater flows through the PRB. When groundwater first contacts the granular iron, any dissolved oxygen present is consumed via iron corrosion:

$$4Fe^{\circ} + 3O_{2(aq)} + 12H^{+} \rightarrow 4Fe^{3+} + 6H_2O \quad (9)$$

It should be noted that dissolved oxygen (DO) was not measured in the test. It is likely that the water in the influent bag was likely oxygenated. The solubility of DO at the test temperature of 22°C is approximately 9 mg/L, and based on the low redox potential obtained in the ZVI column, DO was consumed completely within the column.

After the initial, rapid depletion of any dissolved oxygen and other oxidizers (e.g., nitrate which was not present in the site water), the water corrosion of iron dominates to produce hydrogen and hydroxide resulting in an increase in pH and decline in ORP:

$$Fe^{\circ} + 2H_2O \rightarrow Fe^{2+} + H_{2(aq)} + 2OH^{-} \quad (10)$$

The ORP and pH profiles within the columns are presented in Table 7 and Figure 5. At the end of the test, the ORP decreased within the column from approximately +42 milliVolts (mV) in the influent to -224 mV. The pH values increased from an influent value of 7.9 to approximately 9.0 in the column which was the expected result of the reaction shown in Eq. 10.

Dechlorination of cVOCs is a redox reaction, whereby ZVI acts as an electron donor and cVOC compounds are electron acceptors. For example, dechlorination of TCE can be represented by the following reaction:

$$3Fe^{0} + C_2HCl_3 + 3H^{+} \rightarrow C_2H_4 + 3Fe^{2+} + 3Cl^{-} \quad (11)$$

Therefore, degradation of VOCs consumes ZVI and generates dissolved iron. The oxidized iron contributes to the creation of secondary precipitates on ZVI grains, as described below. Some iron minerals created by oxidized iron may be passivating (hematite/goethite or siderite), while others such as magnetite or green rust allow electron transfer from the core of ZVI grains to aqueous phase and do not impede ZVI corrosion substantially (Gillham et al., 2010).

The influent calcium concentration of approximately 51 mg/L decreased to 23 mg/L in effluent of the column (Table 9). Magnesium decreased from an influent value of 47 mg/L to 31 mg/L in the effluent. The carbonate alkalinity value decreased from an initial value of 160 mg/L to 6 mg/L in the effluent (Table 9). The losses of calcium, magnesium and alkalinity indicate the formation of calcium carbonate minerals and potentially mixed Ca-Mg carbonate minerals:

$$\text{Aragonite/Calcite: } Ca^{2+} + CO_3^{2-} \rightarrow CaCO_{3(s)} \quad (12)$$

$$\text{Siderite: } Fe^{2+} + CO_3^{2-} \rightarrow FeCO_{3(s)} \quad (13)$$

Chloride behaved as conservative tracers in ZVI systems and, as expected, the concentration remained essentially unchanged within the column (Table 8).

Dissolved iron remained unchanged from a non-detectable value measured in the influent (Table 9). Tests conducted with different types of ZVI materials resulted in water corrosion rates on the order of 0.1 to 0.6 millimoles per kilogram iron per day (mmol/kg Fe/day), with a value of 0.3 mmol/kg Fe/day measured for granular ZVI such as Connelly (Reardon, 2005). Based on a corrosion rate of 0.3 mmol/kg Fe/day, approximately 90 mg/L dissolved iron would be expected in the column effluent at the flow rate used. Since no change in dissolved iron was observed in the column, the ferrous iron generated by the reaction illustrated in Eq. 10 and 11 was retained within the ZVI zone and consumed by precipitation of iron (oxy)hydroxides and siderite.

The trends in sulfate concentration ranging from approximately 100 to 150 mg/L in the influent indicated no change along the column during the test (Table 8). Based on previous experience, sulfate concentrations are expected to decrease in mature ZVI PRB field applications. Since sulfate reduction is mediated by biological activity, it is typically not observed in bench-scale ZVI column tests. However, declines in sulfate concentrations have been observed at most field sites as groundwater passes through the iron treatment zones. Evidence for the formation of marcasite in cores from several PRB field sites has been reported (Battelle, 2002; Wilkin et al., 2003).

Silicon was present at a concentration of 11 mg/L in the water sample analyzed for baseline chemistry. This background Si concentration is typical of Si composition in previously tested site groundwaters. Silica (SiO_3^{2-}) is thought to precipitate or adsorb on ZVI surfaces leading to the formation of a silica film or gel on the ZVI surface that may hinder contaminant access to active sites (Klausen et al., 2003). Silicon was not measured at the end of the study.

Total organic carbon (TOC) was present in the influent water at concentrations ranging from a non-detectable value to 1.2 mg/L (Table 9). A column effluent value of 3.9 mg/L was reported (Table 9), but that may be an artifact of the instrumental interference. Although approximately

2%-3% of carbon is contained in the structure of ZVI (gray cast iron), it is present as graphite and therefore ZVI is not expected to leach off organic carbon.

The overall change in geochemical composition of site water after contact with the ZVI column is shown in Figure 6. Potential effects of this chemical change in relation to long-term performance of ZVI treatment zone at the site is presented below.

6.2 Possible Mineral Precipitates and Their Effect

Iron corrosion reactions (Equations 8-10) promote the reductive dechlorination reactions, but at the same time are sources of ferrous iron and alkalinity. Because dissolved iron was detected in the column effluent, iron (oxy) hydroxides and iron carbonate are expected to form throughout a PRB. Iron (oxy)hydroxides ultimately transform to magnetite, which is electron-conducting, they do not substantially reduce the reactivity of the iron and the rate of formation is not expected to cause a significant decline in permeability (Gillham et al., 2010). However, the potential adverse effects of other secondary precipitates, such as iron (oxy)hydroxides, calcium and iron carbonate, created on ZVI grains need to be considered in terms of long-term efficiency of the PRB system.

Based on the observed levels of calcium and carbonate in site groundwater, carbonate precipitation on ZVI grains is expected to be the main process influencing the ZVI longevity at the site. While there is little doubt that inorganic precipitates (mostly iron oxy-hydroxides and carbonates) will form over time in a ZVI PRB at the site, their impact should be evaluated in terms of the mass flux of the passivating constituents expected in the life-time of the PRB. That is, it is anticipated that a ZVI PRB designed based on the cVOC degradation rates from this column test, including a safety factor to account for the observed gradual increases in cVOC half-lives, would be able to last for a long time without the need for rehabilitation.

7 Summary and Conclusions

Bench-scale column treatability testing using site water indicated that:

i) Connelly ZVI degraded the VOCs present in the site water at rates that were generally at the lower end of the ranges achieved in previous commercial ZVI studies for the compounds reported and other groundwaters with comparable VOC composition.

ii) Degradation of a minor VOC, tDCE was slower than expected, but still manageable at a residence time needed to degrade the major VOCs. All chlorinated breakdown products were degraded completely. CFC-123a present in site water and that created from partial degradation of CFC-113 was not degraded by ZVI, as expected.

iii) Based on the anticipated half-lives obtained at the end of the study at site field groundwater temperature (66ºF/19ºC) and the VOC concentration scenario assumed, a residence time of approximately 1.6 days would be required in a Connelly ZVI PRB to achieve the California MCL target levels of all regulated VOCs.

iv) Due to the presence of calcium and alkalinity in the site groundwater, gradual ZVI passivation due to mineral precipitation such as carbonates and iron oxy-hydroxides is expected to occur with time and influence the long-term efficiency of the PRB at the site. Therefore, it is recommended that an engineering safety factor be included in the ZVI volume design calculations for the proposed PRB to assure long-term efficiency.

8 References

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TABLES

TABLE 1
COLUMN AND ZVI MATERIALS SPECIFICATIONS
Mountain View, CA

ZVI Supplier	Connelly GPM
ZVI Size Range	US Mesh 8 to 50 (0.25 - 2.0 mm)
Hydraulic Conductivity	1.5×10^{-2} cm/sec
Specific Surface Area	2.3 m^2/g
ZVI Content	100 percent
ZVI Dry Weight	1,706 g
Column Length	1.64 feet (50 cm)
Column Inside Diameter	0.12 feet (3.8 cm)
Measured Pore Volume	310 mL
Volume of Column	567 cm3
Porosity	0.55
Bulk Density	3.0 g/cm^3
ZVI:Solution Ratio	5.5 g/mL
Average Flow rate	1.46 ft/day
Average Residence Time	27 hours

Notes:
g/cm^3 - grams per cubic centimeter
g/mL - grams per milliliter
ZVI - zero valent iron

TABLE 2
ZVI COLUMN SAMPLING SCHEDULE
Mountain View, CA

Event		Baseline (Week 0)								Weekly (7) sampling events			Week 4 & 7	Week 7			
Sample Location		pH, ORP	cVOCs	DHGs	Anions	Cations	Alkalinity	TDS	TOC	pH, ORP	cVOCs	DHGs	Anions	Cations	TDS	Alkalinity	TOC
Column Influent		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Sampling Ports	A									●	●	●	●				
	B									●	●	●	●				
	C									●	●	●	●				
	D									●	●	●	●				
	E									●	●	●	●				
	F									●	●	●	●				
	G									●	●	●	●				
Column Effluent										●	●	●	●	●	●	●	●

Notes:
TDS - total dissolved solids
cVOCs - chlorinated volatile organic compounds
DHGs - dissolved hydrocarbon gases
ORP - oxidation-reduction potential
TOC - total organic carbon
ZVI - zero valent iron
● indicates sample collected

TABLE 3
WATER SAMPLE cVOC AND DHG RESULTS
Mountain View, CA

Sample Location		Influent	Port A	Port B	Port C	Port D	Port E	Port F	Port G	Effluent	Residence
Column Distance (feet)		0.00	0.16	0.33	0.49	0.66	0.82	0.98	1.31	1.64	time
Residence Time (hours)		0.00	2.6	5.4	8.1	10.8	13.4	16.1	21.5	26.9	(hrs)
Compound	PV	Concentration (µg/L)									
PCE	0.0	<10	--	--	--	--	--	--	--	--	--
	5.7	<10	<10	<10	<10	<10	<10	<10	<10	<10	30.2
	11.2	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.7
	15.6	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.4
	21.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.3
	27.4	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.0
	32.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	27.2
	39.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	26.9
TCE	0.0	6,500	--	--	--	--	--	--	--	--	--
	5.7	6,243	1,017	<10	<10	<10	<10	<10	<10	<10	30.2
	11.2	5,448	986	130	44	71	51	105	63	75	29.7
	15.6	4,392	663	32	<10	58	<10	114	12	<10	29.4
	21.3	3,120	595	20	29	<10	<10	<10	<10	<10	29.3
	27.4	7,172	2,335	360	<10	<10	<10	<10	17	<10	29.0
	32.3	5,898	1,893	403	<10	<10	<10	<10	<10	<10	27.2
	39.3	4,726	2,030	413	<10	<10	<10	<10	10	<10	26.9
cis 1,2-DCE	0.0	6,600	--	--	--	--	--	--	--	--	--
	5.7	5,974	3,136	1,423	68	<10	<10	<10	<10	<10	30.2
	11.2	5,739	2,392	1,114	65	<10	<10	<10	<10	<10	29.7
	15.6	5,474	1,693	627	14	<10	<10	<10	<10	<10	29.4
	21.3	3,980	1,444	386	<10	<10	<10	<10	<10	<10	29.3
	27.4	8,911	4,049	1,841	113	<10	<10	<10	<10	<10	29.0
	32.3	8,073	3,574	1,890	148	<10	<10	<10	<10	<10	27.2
	39.3	7,397	4,299	1,840	93	<10	<10	<10	<10	<10	26.9
trans 1,2-DCE	0.0	56	--	--	--	--	--	--	--	--	--
	5.7	71	44	<10	<10	<10	<10	<10	<10	<10	30.2
	11.2	50	24	35	17	11	<10	<10	<10	<10	29.7
	15.6	48	33	26	14	11	<10	<10	<10	<10	29.4
	21.3	25	25	27	18	13	11	<10	<10	<10	29.3
	27.4	55	67	57	29	21	15	<10	<10	<10	29.0
	32.3	59	34	37	36	25	29	<10	<10	<10	27.2
	39.3	71	40	37	34	29	36	12	<10	<10	26.9
1,1-DCE	0.0	12	--	--	--	--	--	--	--	--	--
	5.7	15	14	<10	<10	<10	<10	<10	<10	<10	30.2
	11.2	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.7
	15.6	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.4
	21.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.3
	27.4	<10	10	<10	<10	<10	<10	<10	<10	<10	29.0
	32.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	27.2
	39.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	26.9
VC	0.0	210	--	--	--	--	--	--	--	--	--
	5.7	10	39	34	<10	<10	<10	<10	<10	<10	30.2
	11.2	<10	30	25	<10	<10	<10	<10	<10	<10	29.7
	15.6	34	22	15	<10	<10	<10	<10	<10	<10	29.4
	21.3	<10	16	<10	<10	<10	<10	<10	<10	<10	29.3
	27.4	14	34	31	<10	<10	<10	<10	<10	<10	29.0
	32.3	<10	25	24	<10	<10	<10	<10	<10	<10	27.2
	39.3	<10	22	23	<10	<10	<10	<10	<10	<10	26.9
1,1,1-TCA	0.0	90	--	--	--	--	--	--	--	--	--
	5.7	90	<10	<10	<10	<10	<10	<10	<10	<10	30.2
	11.2	65	<10	<10	<10	<10	<10	<10	<10	<10	29.7
	15.6	84	<10	<10	<10	<10	<10	<10	<10	<10	29.4
	21.3	65	<10	<10	<10	<10	<10	<10	<10	<10	29.3
	27.4	79	<10	<10	<10	<10	<10	<10	<10	<10	29.0
	32.3	77	<10	<10	<10	<10	<10	<10	<10	<10	27.2
	39.3	76	<10	<10	<10	<10	<10	<10	<10	<10	26.9
1,1-DCA	0.0	NA**	--	--	--	--	--	--	--	--	--
	5.7	NA**	NA**	NA**	NA**	NA**	NA**	NA**	NA**	NA**	30.2
	11.2	NA**	NA**	NA**	NA**	NA**	NA**	NA**	NA**	NA**	29.7
	15.6	145	119	79	21	<10	<10	<10	<10	<10	29.4
	21.3	120	116	79	25	<10	<10	<10	<10	<10	29.3
	27.4	138	132	131	31	15	<10	<10	<10	<10	29.0
	32.3	140	117	101	52	19	<10	<10	<10	<10	27.2
	39.3	132	125	109	46	25	<10	<10	<10	<10	26.9

TABLE 3
WATER SAMPLE cVOC AND DHG RESULTS
Mountain View, CA

Sample Location		Influent	Port A	Port B	Port C	Port D	Port E	Port F	Port G	Effluent	Residence
Column Distance (feet)		0.00	0.16	0.33	0.49	0.66	0.82	0.98	1.31	1.64	time
Residence Time (hours)		0.00	2.6	5.4	8.1	10.8	13.4	16.1	21.5	26.9	(hrs)
Compound	PV	Concentration (µg/L)									
CFC-113	0.0	110	--	--	--	--	--	--	--	--	--
	5.7	108	<10	<10	<10	<10	<10	<10	<10	<10	30.2
	11.2	81	<10	<10	11	<10	<10	<10	22	<10	29.7
	15.6	83	<10	<10	<10	<10	<10	<10	20	<10	29.4
	21.3	99	<10	<10	<10	<10	<10	19	<10	<10	29.3
	27.4	55	40	<10	<10	<10	<10	65	18	<10	29.0
	32.3	69	<10	<10	<10	<10	<10	<10	<10	<10	27.2
	39.3	50	28	<10	<10	44	<10	<10	<10	<10	26.9
CFC-123a	0.0	40	--	--	--	--	--	--	--	--	--
	5.7	<10	<10	66	22	15	13	12	14	13	30.2
	11.2	45	32	30	85	80	80	83	79	78	29.7
	15.6	51	83	83	64	69	67	66	61	64	29.4
	21.3	35	63	75	71	60	67	62	58	57	29.3
	27.4	43	79	51	87	72	67	67	57	42	29.0
	32.3	55	42	71	74	63	64	46	50	58	27.2
	39.3	40	61	67	69	66	71	46	45	45	26.9
Chloro Ethane	0.0	<10	--	--	--	--	--	--	--	--	--
	5.7	<10	<10	<10	<10	<10	<10	<10	<10	<10	30.2
	11.2	<10	<10	<10	<10	<10	<10	<10	<10	18	29.7
	15.6	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.4
	21.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.3
	27.4	<10	<10	<10	<10	<10	<10	<10	<10	<10	29.0
	32.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	27.2
	39.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	26.9
Ethene	0.0	--	--	--	--	--	--	--	--	--	--
	5.7	<10	839	928	704	651	555	506	537	629	30.2
	11.2	<10	728	655	358	299	271	181	127	115	29.7
	15.6	<10	554	419	186	145	107	56	30	28	29.4
	21.3	<10	394	374	150	92	72	36	15	11	29.3
	27.4	<10	750	832	449	236	159	97	49	19	29.0
	32.3	<10	646	596	414	227	191	54	34	36	27.2
	39.3	<10	459	611	396	232	185	61	35	23	26.9
Ethane	0.0	--	--	--	--	--	--	--	--	--	--
	5.7	<10	839	659	858	956	935	994	1,057	804	30.2
	11.2	<10	370	720	709	940	1,101	1,340	1,494	1,569	29.7
	15.6	<10	425	612	550	798	856	1,004	1,076	1,338	29.4
	21.3	<10	377	876	652	696	735	839	768	757	29.3
	27.4	<10	499	1,023	1,138	1,126	1,086	1,323	1,254	898	29.0
	32.3	<10	472	648	1,019	789	1,187	726	886	1,252	27.2
	39.3	<10	262	690	995	879	1,222	523	508	515	26.9
Methane	0.0	--	--	--	--	--	--	--	--	--	--
	5.7	25	33	35	37	40	41	50	65	90	30.2
	11.2	23	30	32	31	33	36	40	46	49	29.7
	15.6	23	29	29	29	30	32	34	37	41	29.4
	21.3	22	27	31	27	28	29	32	31	31	29.3
	27.4	22	27	31	29	30	28	35	31	29	29.0
	32.3	23	28	27	29	27	30	28	28	31	27.2
	39.3	24	26	29	30	28	33	27	29	27	26.9

Notes:

µg/L - micrograms per liter
1,1-DCE - 1,1 dichloroethene
1,1,1-TCA - 1,1,1 trichloroethane
1,1-DCA - 1,1 dichloroethane
trans - 1,2-DCE - trans - 1,2-dichloroethene
CFC-113 - 1,1,2-Trichlorotrifluoroethane
CFC-123a - 1,2-Dichloro-1,1,2-trifluoroethane
cDCE - cis-1,2-dichloroethene
< - compound not detected, the associated value is the quantitation limit
NA** - not available due to co-elution with cDCE on GSQ GC column

cVOC - chlorinated volatile organic compounds
DHG - dissolved hydrocarbon gases
PCE - tetrachloroethene
PV - pore volumes
TCE - trichloroethene
VC - vinyl chloride
-- - sample not collected

TABLE 4
VOC ANALYTICAL RESULTS COMPARISON BETWEEN SIREM AND TEST AMERICA
Mountain View, CA

Analyte		SIREM		Test America	
		Concentration (µg/L)			
		Influent	***Effluent***	***Influent***	***Effluent***
Time 0	PCE	<10		<.50	
	TCE	6,500		6,100	
	cDCE	6,600		6,000	
	trans-1,2-DCE	56		36	
	1,1-DCE	12		14	
	VC	210		140	
	1,1,1-TCA	90		54	
	1,1-DCA	NA**		130	
	CFC-113	110		99	
	CFC-123a	40		NA	
	Chloro Ethane	<10		<1.0	
Midpoint (PV: 21.3)	PCE	<10	<10	<50	<.50
	TCE	3,120	<10	3,200	<.50
	cDCE	3,980	<10	4,300	<.50
	trans-1,2-DCE	25	<10	<50	<.50
	1,1-DCE	<10	<10	<50	<.50
	VC	<10	<10	<50	<.50
	1,1,1-TCA	65	<10	61	<.50
	1,1-dca	120	<10	110	<.50
	CFC-113	<10	<10	<50	<.50
	CFC-123a	35	57	NA	NA
	Chloro Ethane	<10	<10	<100	<100
Endpoint (PV: 39.3)	PCE	<10	<10	<100	<50
	TCE	4,726	<10	5,200	<.50
	cDCE	7,397	<10	6,700	<.50
	trans-1,2-DCE	71	<10	<100	<100
	1,1-DCE	<10	<10	<100	<.50
	VC	<10	<10	<100	<.50
	1,1,1-TCA	76	<10	<100	<.50
	1,1-DCA	132	<10	120	<.50
	CFC-113	50	<10	<100	<100
	CFC-123a	40	45	NA	NA
	Chloro Ethane	<10	<10	<200	<1.0

Notes:

µg/L - micrograms per liter
1,1-DCE - 1,1 dichloroethene
1,1,1-TCA - 1,1,1 trichloroethane
1,1-DCA - 1,1 dichloroethane
trans - 1,2-DCE - trans - 1,2-dichloroethene
CFC-113 - 1,1,2-Trichlorotrifluoroethane
CFC-123a - 1,2-Dichloro-1,1,2-trifluoroethane
cDCE - cis-1,2-dichloroethene
NA** - not available due to co-elution with cDCE on GSQ GC column
< - compound not detected, the associated value is the quantitation limit
cVOC - chlorinated volatile organic compounds
PCE - tetrachloroethene
PV - pore volumes
TCE - trichloroethene
VC - vinyl chloride
NA - not available

TABLE 5
CALCULATED VOC HALF-LIFE VALUES IN ZVI COLUMN
Mountain View, CA

Compound	Pore Volume	Influent Concentration (µg/L)	Half-life[a] (hours)	Molar Conversion	r^2
Trichlorethene	27.4	7,172	1.6		0.989
	32.3	5,898	1.6		0.998
	39.3	4,726	1.8		0.992
cis 1,2-Dichloroethene				TCE=>cDCE	
	27.4	8,911	2.3	0.06	0.995
	32.3	8,073	2.2	0.10	0.992
	39.3	7,397	2.3	0.12	0.981
trans 1,2-Dichloroethene				TCE=>cDCE	
	27.4	55	5.0	0.00	0.980
	32.3	59	7.6	0.00	0.840
	39.3	71	7.8	0.00	0.852
Vinyl Chloride				cDCE=>VC	
	27.4	15	1.4	0.01	0.914
	32.3	ND	1.3	0.02	0.907
	39.3	ND	1.3	0.02	0.881
1,1,1-Trichloroethane	27.4	79	0.71		0.999
	32.3	77	0.65		0.999
	39.3	76	0.64		0.999
1,1-Dichloroethane				1,1,1-TCA=>1,1-DCA	
	27.4	138	4.6	0.55	0.870
	32.3	140	4.3	0.55	0.950
	39.3	132	4.6	0.55	0.924
CFC-113	27.4	55	2.5		0.999
	32.3	69	0.68		0.999
	39.3	69	0.67		0.999
CFC-123a				CFC-113=>CFC-123a	
	27.4	43	42	0.52	0.714
	32.3	55	137	0.20	0.972
	39.3	40	52	0.57	0.687

Notes:

ND - compound not detected
-- not applicable
ug/L - micrograms per liter
r^2 - coefficient of determination
µg/L - micrograms per liter
1,1,1-TCA - 1,1,1 trichloroethane
1,1-DCA - 1,1 dichloroethane
CFC-113 - 1,1,2-Trichlorotrifluoroethane
CFC-123a - 1,2-Dichloro-1,1,2-trifluoroethane
cDCE - cis-1,2-dichloroethene
TCE - trichloroethene
VC - vinyl chloride

TABLE 6
RESIDENCE TIME CALCULATIONS FOR PRB DESIGN
Mountain View, CA

Compound	Anticipated Influent Concentration[a] (µg/L)	Target Level[b] (µg/L)	Connelly ZVI	
			Field Anticipated Half-lives[c] (hrs)	Residence Time[d] (days)
TCE	8,000	5	2.7	1.6
cDCE	6,000	6	3.5	
trans-1,2-DCE	100	10	11.6	
VC	300	0.5	1.9	
1,1,1-TCA	100	200	1.0	
1,1,-DCA	100	5	6.9	
CFC-113	100	1,200	1.0	

Notes:

µg/L - micrograms per liter

[a] cVOC concentrations anticipated at the location of the PRB

[b] CDHS Maximum Contaminant Levels assumed

[c] Laboratory room temperature values at end of the test corrected by a factor of 1.5 to account for lower groundwater temperature

[d] The value represent degradation parameters obtained at the end of the test. Additional safety factor is recommend to accommodate long-term loss of ZVI reactivity as described in the report (Section 6.2)

TCE - trichloroethene

VC - vinyl chloride

CFC-113 - 1,1,2-Trichlorotrifluoroethane

trans - 1,2-DCE - trans - 1,2-dichloroethene

cDCE - cis-1,2-dichloroethene

1,1,1-TCA - 1,1,1 trichloroethane

1,1-DCA - 1,1 dichloroethane

TABLE 7
WATER SAMPLE pH and ORP RESULTS
Mountain View, CA

Sample Location		Influent	Port A	Port B	Port C	Port D	Port E	Port F	Port G	Effluent
Column Distance (feet)		**0.00**	**0.16**	**0.33**	**0.49**	**0.66**	**0.82**	**0.98**	**1.31**	**1.64**
Residence Time (hours)		**0.00**	**2.6**	**5.4**	**8.1**	**10.8**	**13.5**	**16.1**	**21.5**	**26.9**
TEST	PV	Instrument Readings								
pH	0.0	7.7	--	--	--	--	--	--	--	--
	5.7	7.7	7.9	8.6	8.6	8.1	7.3	8.7	8.5	8.5
	11.2	7.5	7.9	8.7	8.9	8.5	8.0	8.7	8.6	8.4
	15.6	7.8	7.9	8.1	8.7	7.9	7.4	9.1	8.2	7.8
	21.3	7.7	7.8	8.5	9.2	9.0	8.0	8.3	8.2	8.4
	27.4	7.8	7.9	8.4	8.9	8.9	8.9	9.0	8.6	7.7
	32.3	7.8	7.9	7.9	8.8	8.0	8.8	8.2	7.9	8.6
	39.3	7.9	7.9	8.4	8.7	8.7	8.9	8.8	8.8	8.2
ORP (mV)	0.0	-44	--	--	--	--	--	--	--	--
	5.7	30	-348	-323	-337	-414	-263	-263	-232	-214
	11.2	95	-238	-251	-218	-317	-310	-252	-158	-146
	15.6	65	-242	-213	-192	-289	-325	-427	-136	-185
	21.3	-16	-258	-338	-340	-425	-308	-328	-136	-89
	27.4	53	-418	-555	-308	-311	-381	-285	-360	-361
	32.3	-15	-286	-129	-263	-249	-275	-381	-307	-293
	39.3	42	-75	-183	-180	-207	-56	-186	-170	-224

Notes:
mV - millivolts
ORP - Oxidation Reduction Potential
PV - pore volumes
-- - sample not collected

TABLE 8
WATER SAMPLE ANION RESULTS
Mountain View, CA

Sample Location		Influent	Port A	Port B	Port C	Port D	Port E	Port F	Port G	Effluent
Column Distance (feet)		**0.00**	**0.16**	**0.33**	**0.49**	**0.66**	**0.82**	**0.98**	**1.31**	**1.64**
Residence Time (hours)		**0.00**	**2.6**	**5.4**	**8.1**	**10.8**	**13.5**	**16.1**	**21.5**	**26.9**
Analyte	PV									
Chloride	0.0	44	--	--	--	--	--	--	--	--
	4.9	57	56	54	56	52	53	50	47	46
	21.3	42	42	43	42	42	40	40	37	38
	39.3	37	42	42	46	49	45	46	45	44
Nitrite-Nitrogen	0.0	<0.36	--	--	--	--	--	--	--	--
	4.9	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09
	21.3	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09
	39.3	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09
Nitrate-Nitrogen	0.0	1.1	--	--	--	--	--	--	--	--
	4.9	<0.09	<0.09	<0.09	<0.09	<0.09	0.09	<0.09	0.23	0.25
	21.3	<0.09	<0.09	<0.09	<0.09	0.09	<0.09	<0.09	0.20	0.24
	39.3	0.22	<0.09	<0.09	0.09	<0.09	<0.09	<0.09	0.09	0.11
Sulfate	0.0	148	--	--	--	--	--	--	--	--
	4.9	148	162	171	142	134	137	138	152	152
	21.3	122	122	110	111	111	106	105	102	111
	39.3	106	101	92	99	96	97	106	109	111
Phosphate	0.0	<0.28	--	--	--	--	--	--	--	--
	4.9	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
	21.3	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
	39.3	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Bromide	0.0	2.7	--	--	--	--	--	--	--	--
	4.9	0.38	0.39	0.35	0.49	<0.08	<0.08	<0.08	<0.08	<0.08
	21.3	2.1	1.9	2.0	2.3	1.7	1.5	1.3	0.88	1.6
	39.3	2.6	3.7	4.6	4.4	5.6	6.4	6.7	6.5	6.3
Chlorate	0.0	<0.32	--	--	--	--	--	--	--	--
	4.9	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
	21.3	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
	39.3	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

Notes:
mg/L - milligrams per liter
PV - pore volumes
-- - sample not collected
< - compount not detected, the associated value is the quantitation limit

TABLE 9
WATER SAMPLE CATION, ALKALINITY, TDS, AND TOC RESULTS
Mountain View, CA

Analyte	Reporting Limit (mg/L)	Time 0	Week 7 (PV: 39.3)	
		(Influent)	Influent	Effluent
	Concentration (mg/L)			
Calcium	0.20	130	51	23
Iron	0.20	<0.20	<0.20	<0.20
Magnesium	0.20	43	47	31
Manganese	0.02	0.38	<0.02	<0.02
Arsenic	0.010	0.01	0.01	0.01
Barium	0.005	0.09	0.08	0.16
Beryllium	0.002	<0.002	<0.002	<0.002
Cadmium	0.0025	<0.0025	<0.0025	<0.0025
Chromium	0.01	<0.01	<0.01	<0.01
Copper	0.02	<0.02	<0.02	<0.02
Nickel	0.01	<0.01	<0.01	<0.01
Lead	0.005	<0.005	<0.005	<0.005
Antimony	0.01	<0.01	<0.01	<0.01
Potassium	0.150	1.2	1.2	1.2
Sodium	0.100	32	32	31
Selenium	0.002	<0.002	<0.002	<0.002
Thallium	0.01	<0.01	<0.01	<0.01
Zinc	0.02	<RL	<0.02	<0.02
Alkalinity	5	390	160	5.50
Total Organic Carbon	1	1.20	<1	3.90
Total Dissolved Solids	10	645	490	390

Notes:

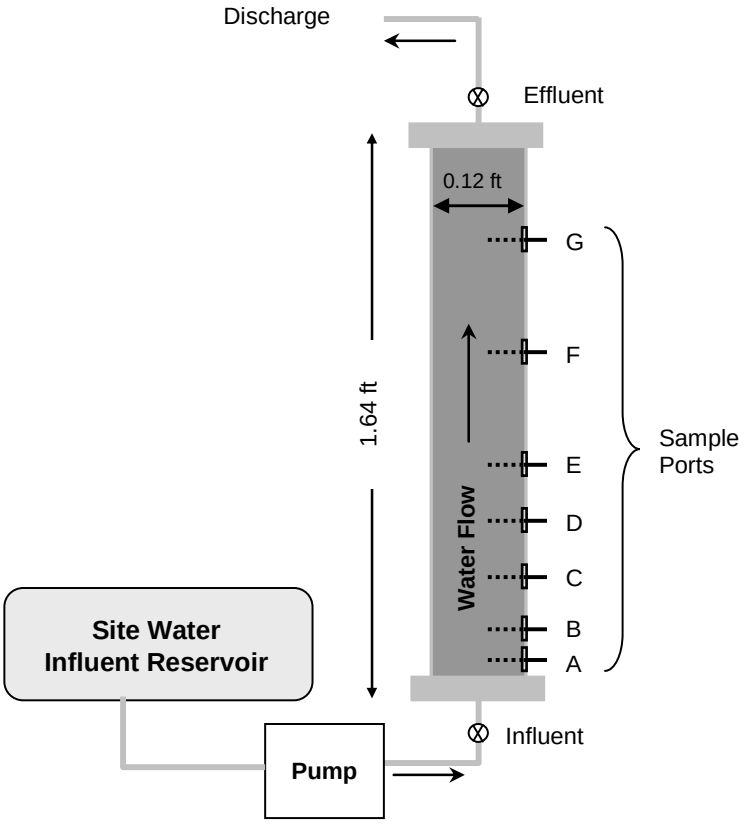
mg/L - milligrams per liter

< - compound not detected, the associated value is the reporting limit

TOC - total organic carbon

TDS - total dissolved solids

FIGURES



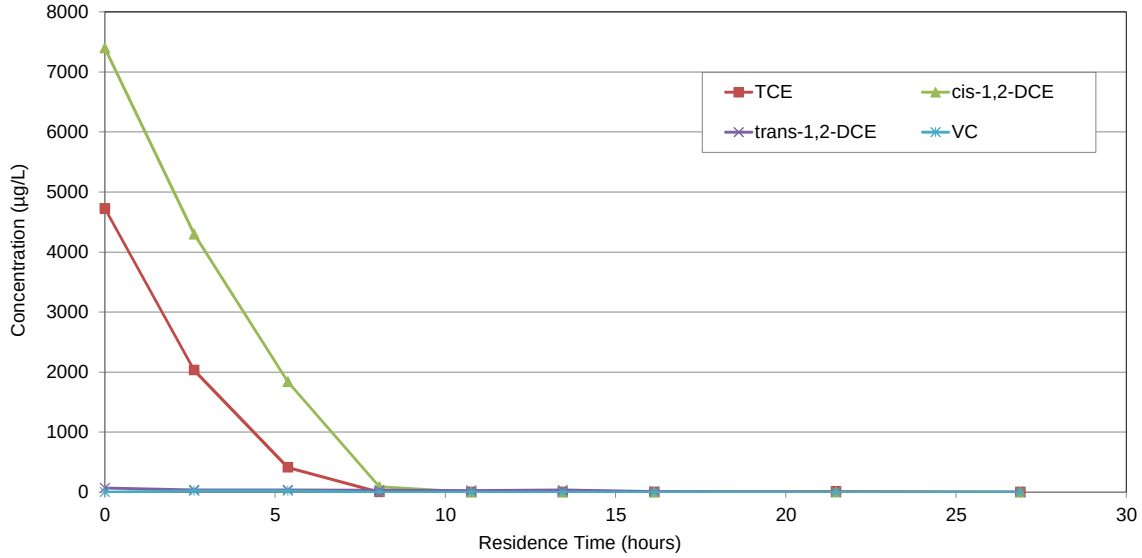
Notes:
ft - feet

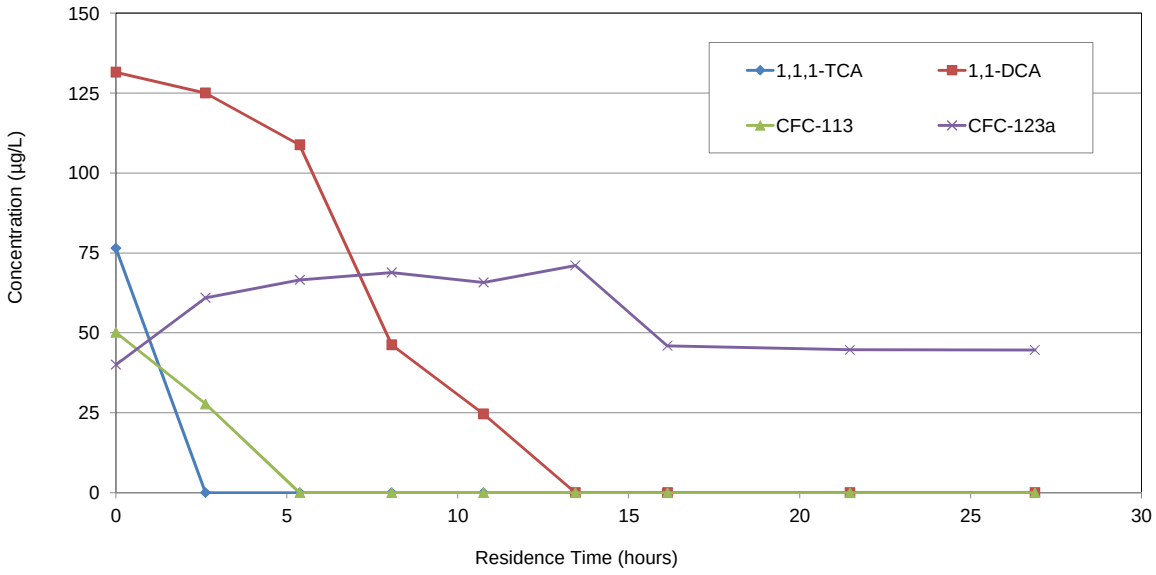
Schematic of Column Study Set Up
Mountain View, CA

SiREM

April 2014

Figure: **1**





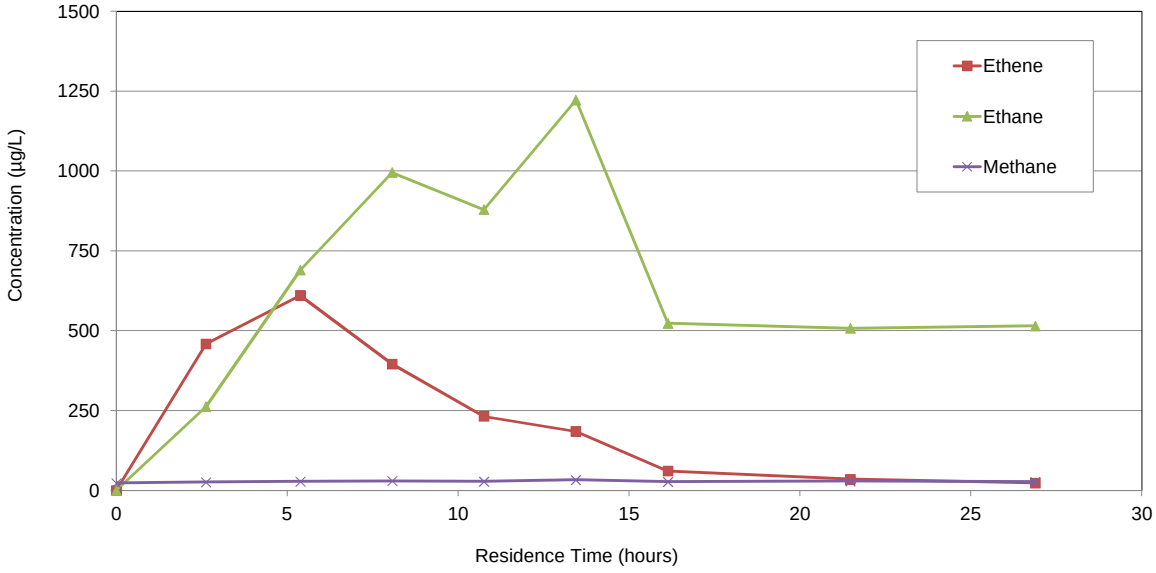
VOC - volatile organic compound

ZVI Column Water VOC Concentrations
Versus Residence Time at End of Study
Mountain View, CA

SiREM

April 2014

Figure: **2**



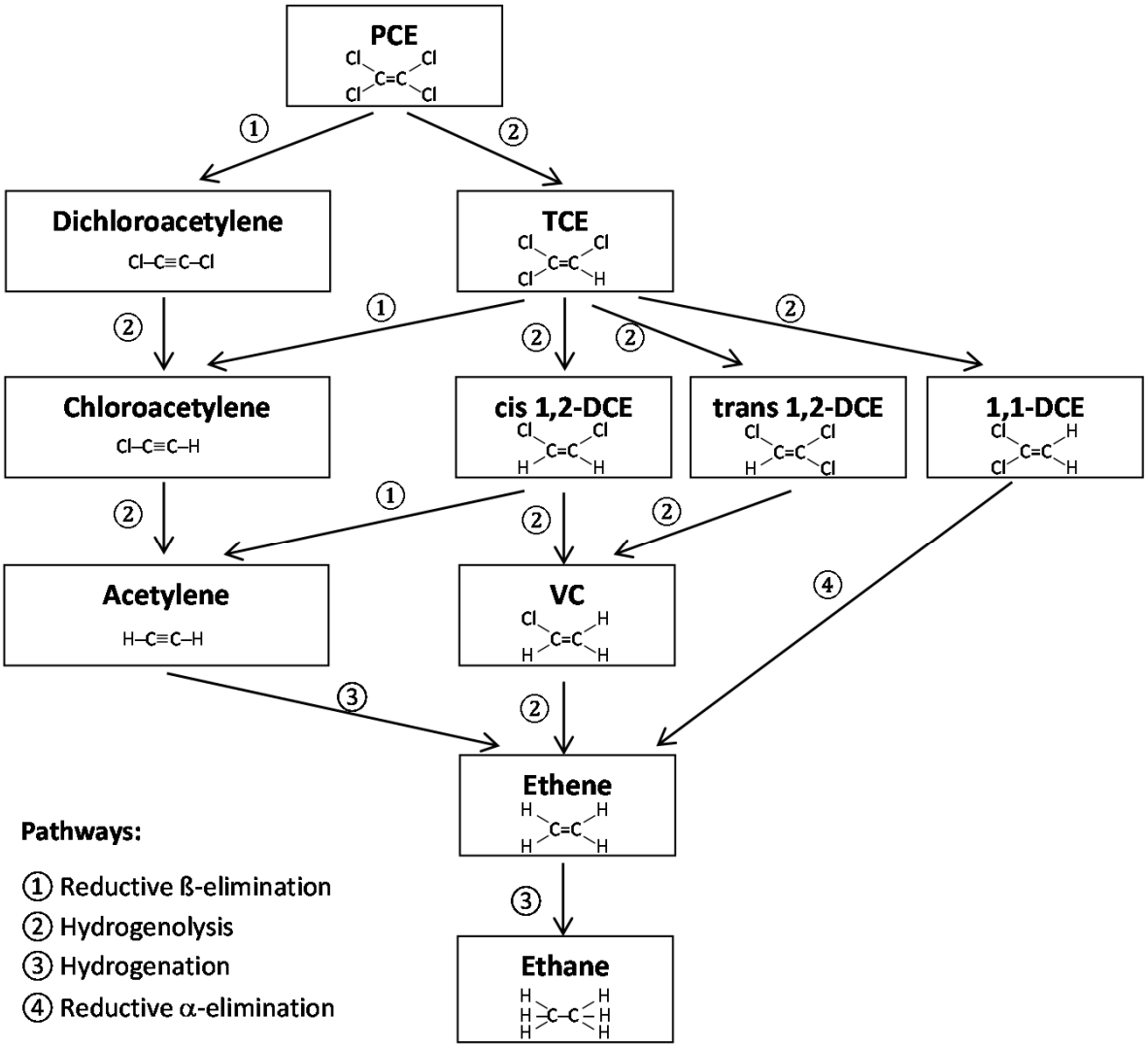
ZVI Column Water DHG Concentrations
Versus Residence Time at End of Study
Mountain View, CA

SiREM

April 2014

Figure: **3**

DHG - dissolved hydrocarbon gases



(modified from Arnold and Roberts, 2000)

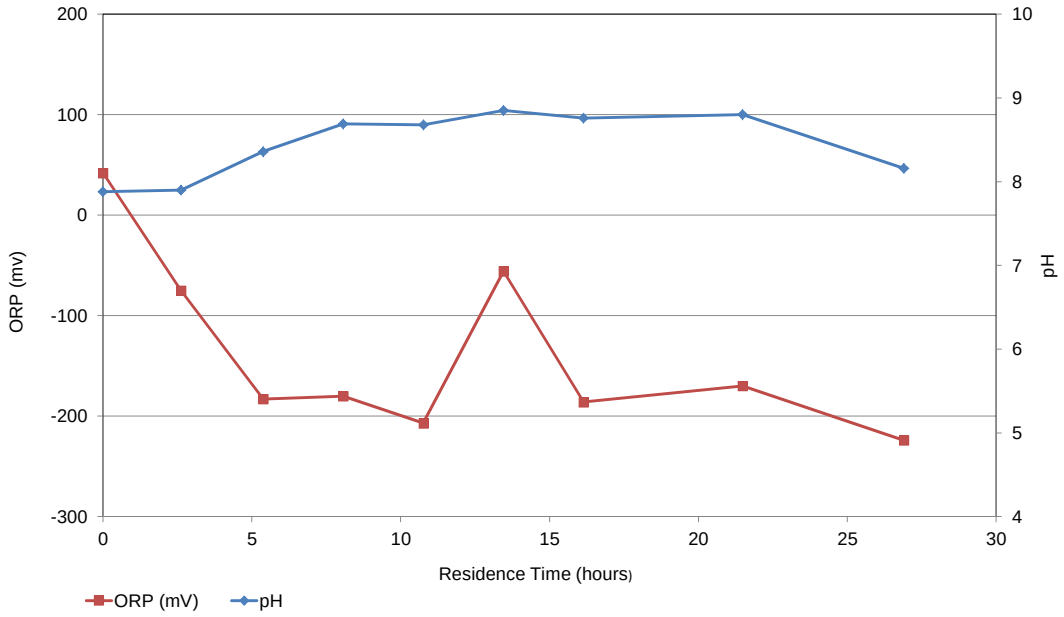
Chlorinated Ethene Degradation Pathways with ZVI

Mountain View, CA

SiREM

April 2014

Figure: **4**



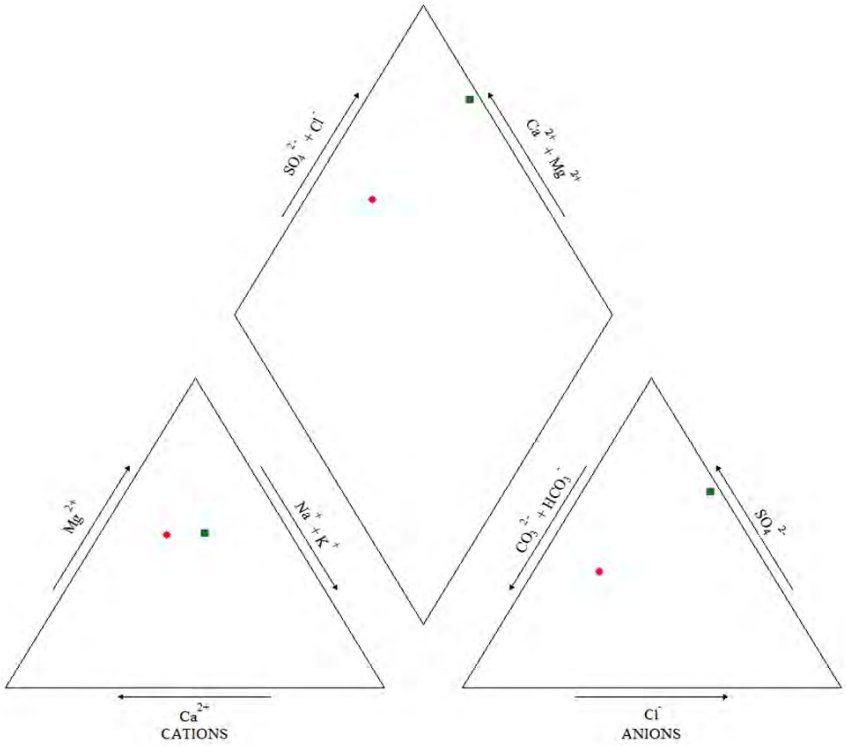
mV - millivolts
ORP - oxidation reduction potential

ZVI Column Water ORP and pH Values
Versus Residence Time at End of Study
Mountain View, CA

SiREM

April 2014

Figure: **5**



Piper Diagram Illustrating Chemistry Change Along ZVI Column
Mountain View, CA

SiREM

April 2014

Figure: **6**

APPENDIX A
CHAIN OF CUSTODY RECORD

SiREM

Leading Science · Lasting Solutions

Chain-of-Custody Form

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

www.siremlab.com

3492

Page ____ of ____

Lab # S-2958

Project Name: 401 National Ave.	Project #: WR1133A.03		
Project Manager: Deepa Gandhi			
Email Address: dgandhi@geosyntec.com lkane@geosyntec.com			
Company: Geosyntec			
Address: 1111 Broadway Oakland CA 94607			
Phone #: 510-285-2746	Fax #		
Sampler's Signature	Sampler's Printed Name: Jeff Parker		

Analysis

Preservative

Gene-Trac Dhc | Gene-Trac VC | Gene-Trac Dhb | ZVI Column Study

Preservative Key
0. None
1. HCl
2. Other ____
3. Other ____

Customer Sample ID	Sampling Date	Sampling Time	Matrix	# of Containers	Gene-Trac Dhc	Gene-Trac VC	Gene-Trac Dhb	ZVI Column Study	Other Information
AE/RW-9-2	9/9/13	1015	water	5			X		

Sample Receipt
Cooler Condition: Good.
Cooler Temperature: 10°C
Custody Seals: Yes ☐ No ☒

Billing Information
P.O. #:
Bill To:

Turnaround Time Requested
Normal ☐
Rush ☐

For Lab Use Only
Proposal #: ____

Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature	Signature	Signature	Signature	Signature	Signature
Printed Name: J. Parker	Printed Name: Lea Kane	Printed Name: Lea Kane	Printed Name: D. Vespoli	Printed Name:	Printed Name:
Firm: Weiss	Firm: Geosyntec	Firm: Geosyntec	Firm: SiREM	Firm:	Firm:
Date/Time: 9/9/13 @ 1100	Date/Time: 9/9/13 1100	Date/Time: 9/9/13 1530	Date/Time: Sept 10/13 2:40pm	Date/Time:	Date/Time:

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

SiREM

Chain-of-Custody Form

siremlab.com

130 Research Lane, Ste 2
Guelph ON, Canada N1G 5G3
(519) 822-2265

Lab # S-2942

Project Name	MEW-401 National ave.
Project #	WR1133A.03.3.1
Project Manager	Eric Suchomel / Deepa Gandhi
Email	dgandhi@geosyntec.com / lkane@geosyntec.com
Company	Geosyntec
Address	1111 Broadway 6th FL, Oakland CA 94607
Phone #	510-285-2700
Fax #	
Sampler's Signature	L Kane
Sampler's Printed Name	Lea Kane

Analysis

Preservative

Client Sample ID	Lab ID	Sampling Date	Sampling Time	Matrix	# of Containers	Dehalococcoides/vcrA enumeration (gene-trac)	Column Test	Other Information
AE/RW-9-2		8/28/13	1115	GW	5	X	X	
137A		8/28/13	0920	GW	1	X		

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

Sample Receipt

Cooler Condition:	good
Cooler Temperature:	9°C
Custody Seals:	Yes ☐ No ☒

Invoice Information

P.O. #	
Bill To:	WR1133A.03.3.1

For Lab Use Only

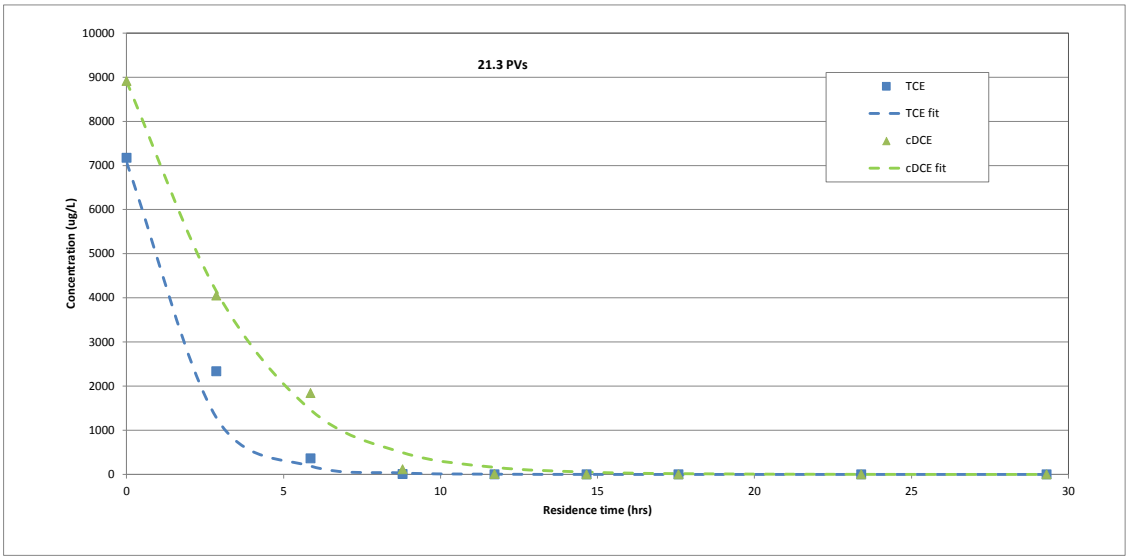
	Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature	[signature]	Lea Kane	Lea Kane	Kela Ashworth		
Printed Name	Jeff Parker	Lea Kane	Lea Kane	Kela Ashworth		
Firm	WEISS	Geosyntec	Geosyntec	SiREM		
Date/Time	8/28/13 @1430	8/28/13 @ 1430	8/28/13 1600	29 Aug 13 14:00		

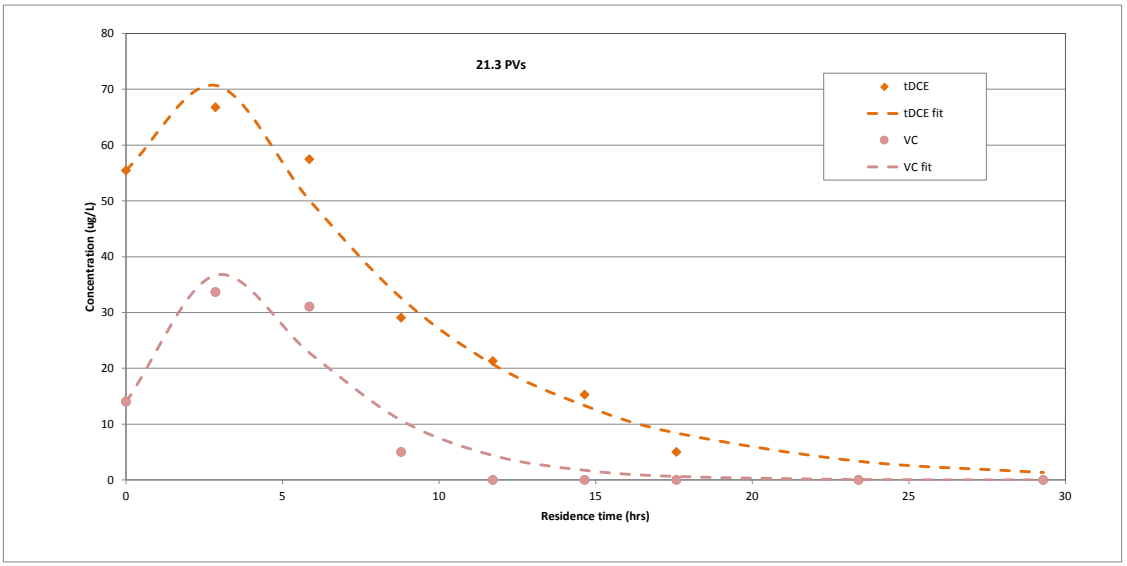
Distribution: White - Return to Originator: Yellow - Lab Copy: Pink - Retained by Client

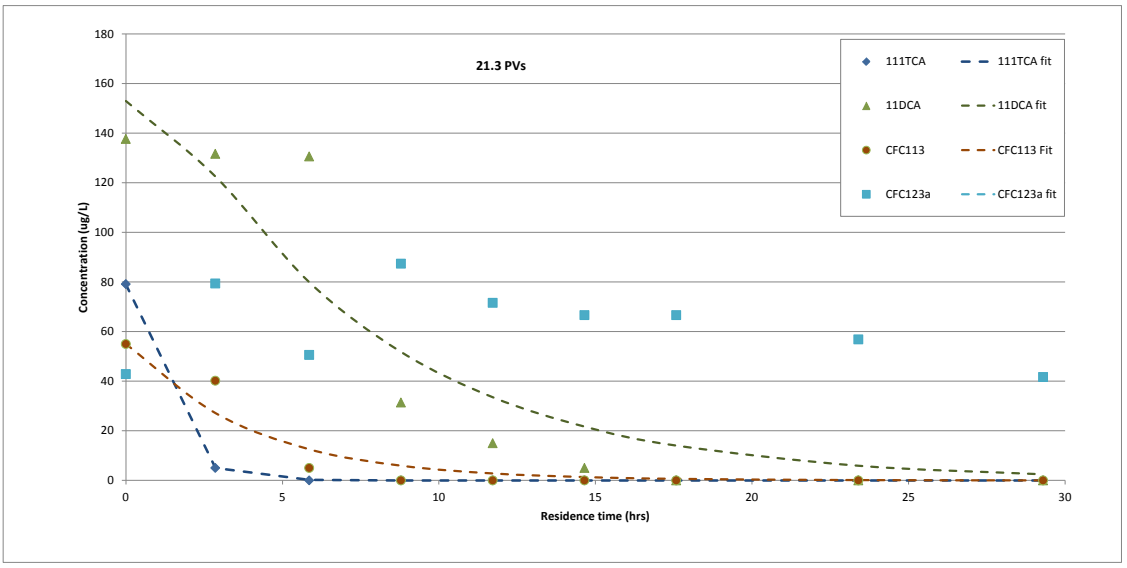
In the absence of an executed agreement, submission of samples to SiREM implies consent for performance of analyses specified on this Chain-of-Custody form and agreement with the terms and conditions of the SiREM Laboratory Services Agreement. The entity submitting samples shall be responsible for payment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

APPENDIX B:
FIRST-ORDER FITTING RESULTS USING MULTI-COMPONENT DEGRADATION MODEL

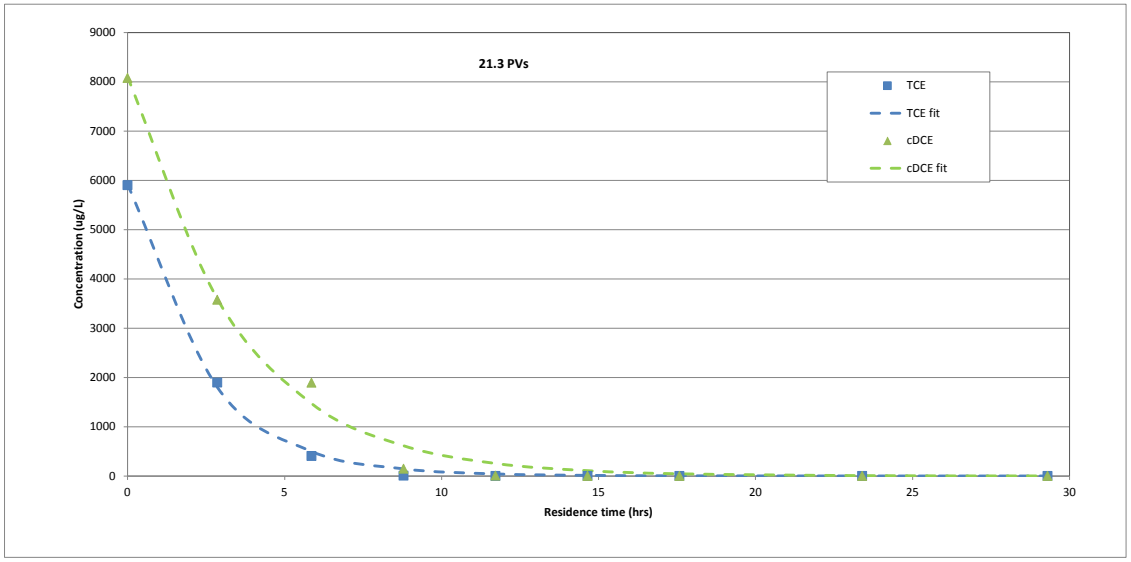
First-order Fitting Results Using Multi-Component Degradation Model and the Least Square Method (27.4 pVs)

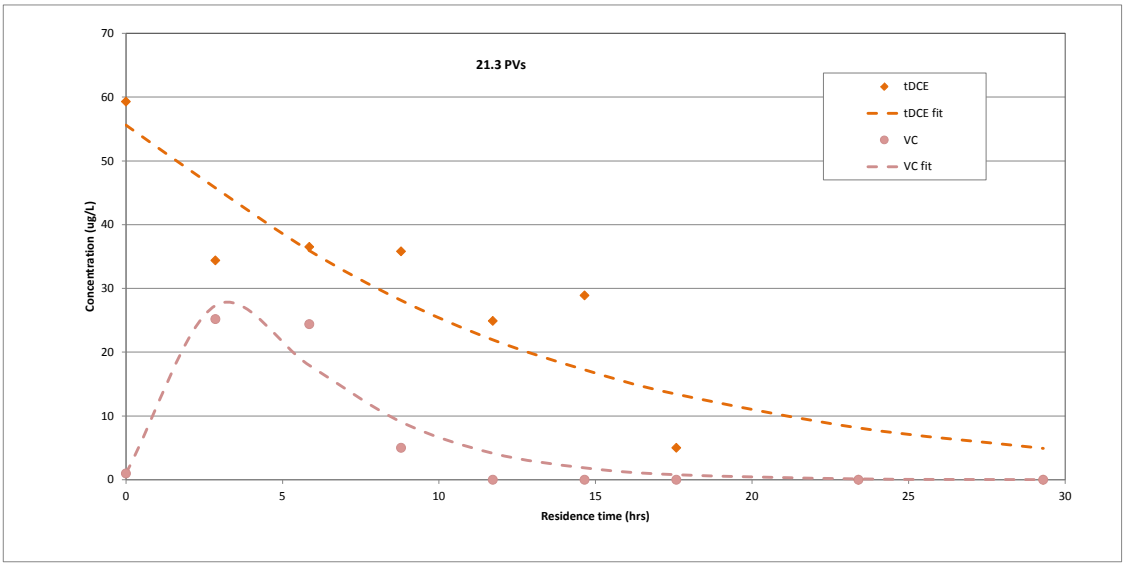


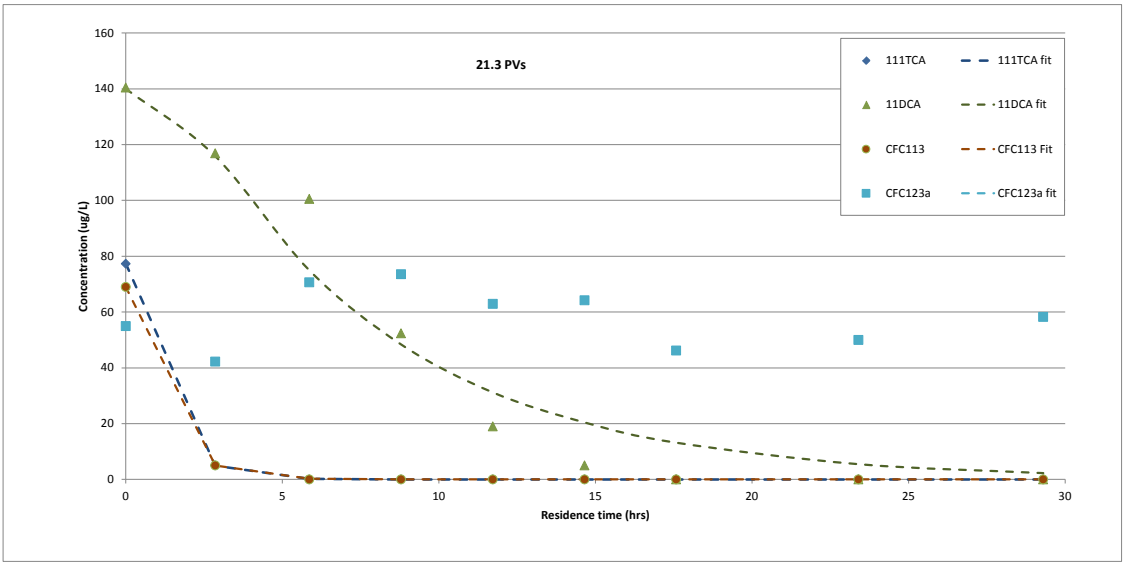




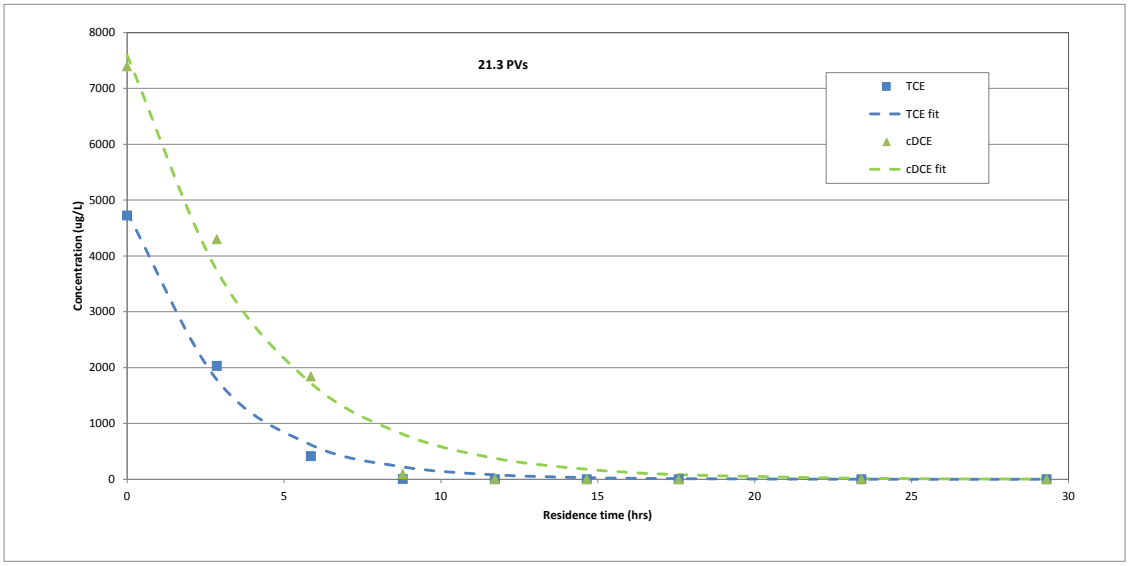
First-order Fitting Results Using Multi-Component Degradation Model and the Least Square Method (32.3 PVs)

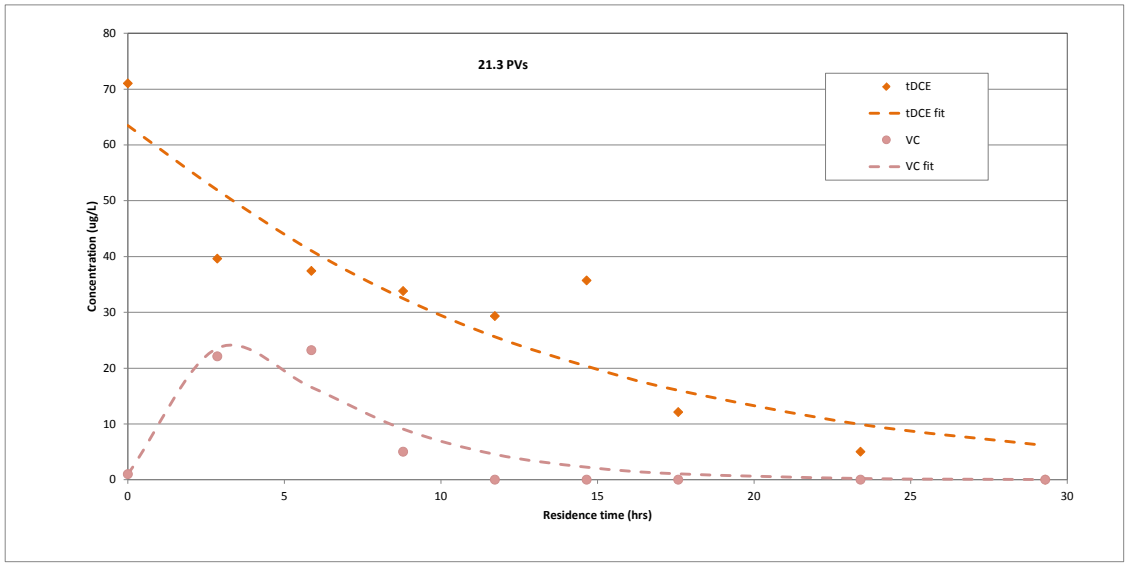


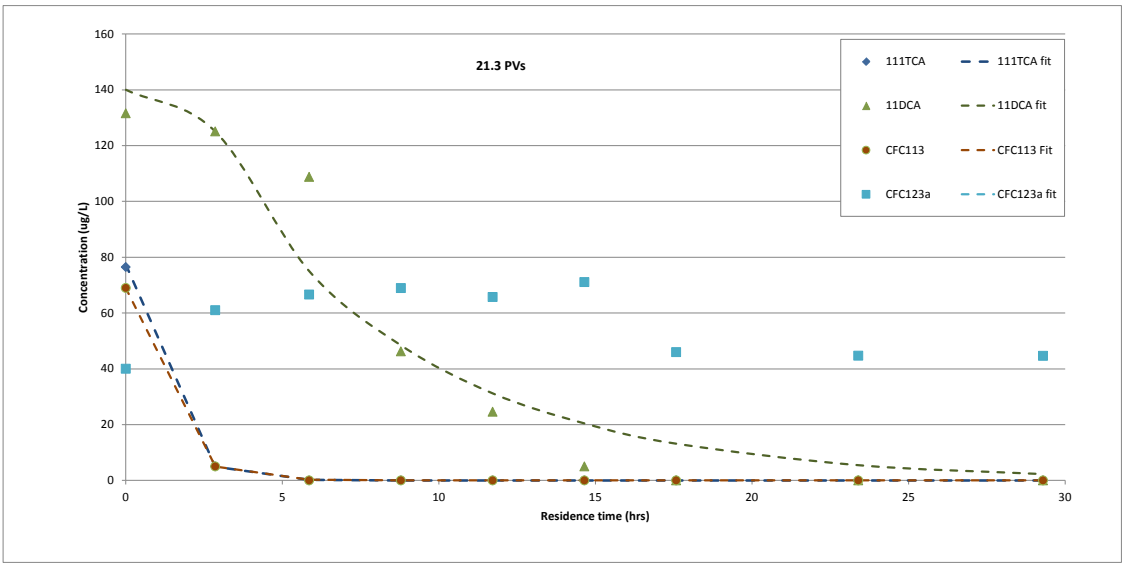




First-order Fitting Results Using Multi-Component Degradation Model and the Least Square Method (39.3 PVs)







APPENDIX C:
EXTERNAL LABORATORY REPORTS

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Pleasanton
1220 Quarry Lane
Pleasanton, CA 94566
Tel: (925)484-1919

TestAmerica Job ID: 720-51960-2
Client Project/Site: WR1133A_03 / MEW, Mountain

For:
Geosyntec Consultants, Inc.
1111 Broadway
6th Floor
Oakland, California 94612

Attn: Mr. Eric Suchomel

Authorized for release by:
8/30/2013 4:45:32 PM

Micah Smith, Project Manager I
micah.smith@testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 720-51960-2

Laboratory: TestAmerica Pleasanton

Narrative

Job Narrative
720-51960-2

Comments
No additional comments.

Receipt
The samples were received on 8/28/2013 1:10 PM; the samples arrived in good condition, properly preserved and, where required, on ice.
The temperature of the cooler at receipt was 3.4º C.

GC/MS VOA
Method(s) 8260B: There was no MS/MSD reported for batch#143259 due to bad purge.

No other analytical or quality issues were noted.

Detection Summary

Client: Geosyntec Consultants, Inc.
Project/Site: WR1133A_03 / MEW, Mountain

TestAmerica Job ID: 720-51960-2

Client Sample ID: 137A — Lab Sample ID: 720-51960-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,1-Dichloroethene	13		0.50		ug/L	1		8260B	Total/NA
1,1-Dichloroethane	5.0		0.50		ug/L	1		8260B	Total/NA
Vinyl chloride	2.4		0.50		ug/L	1		8260B	Total/NA
trans-1,2-Dichloroethene	25		0.50		ug/L	1		8260B	Total/NA
cis-1,2-Dichloroethene	3000		10		ug/L	20		8260B	Total/NA
Trichloroethene	3300		10		ug/L	20		8260B	Total/NA
Tetrachloroethene	1.2		0.50		ug/L	1		8260B	Total/NA
1,1,2-Trichloro-1,2,2-trifluoroethane	16		0.50		ug/L	1		8260B	Total/NA

Client Sample ID: AE/RW-9-2 — Lab Sample ID: 720-51960-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,1-Dichloroethene	23		0.50		ug/L	1		8260B	Total/NA
1,1-Dichloroethane	86		0.50		ug/L	1		8260B	Total/NA
Vinyl chloride	330		10		ug/L	20		8260B	Total/NA
trans-1,2-Dichloroethene	77		0.50		ug/L	1		8260B	Total/NA
cis-1,2-Dichloroethene	7300		50		ug/L	100		8260B	Total/NA
1,1,1-Trichloroethane	35		0.50		ug/L	1		8260B	Total/NA
Trichloroethene	9800		50		ug/L	100		8260B	Total/NA
Tetrachloroethene	3.6		0.50		ug/L	1		8260B	Total/NA
1,1,2-Trichloro-1,2,2-trifluoroethane	71		0.50		ug/L	1		8260B	Total/NA

Client Sample ID: FD1 — Lab Sample ID: 720-51960-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,1-Dichloroethene	50		0.50		ug/L	1		8260B	Total/NA
1,1-Dichloroethane	110		0.50		ug/L	1		8260B	Total/NA
Vinyl chloride	210		10		ug/L	20		8260B	Total/NA
trans-1,2-Dichloroethene	88		0.50		ug/L	1		8260B	Total/NA
cis-1,2-Dichloroethene	7300		50		ug/L	100		8260B	Total/NA
1,1,1-Trichloroethane	65		0.50		ug/L	1		8260B	Total/NA
Trichloroethene	8200		50		ug/L	100		8260B	Total/NA
Tetrachloroethene	5.0		0.50		ug/L	1		8260B	Total/NA
1,1,2-Trichloro-1,2,2-trifluoroethane	190		0.50		ug/L	1		8260B	Total/NA

Client Sample ID: TB01 — Lab Sample ID: 720-51960-4

No Detections.

This Detection Summary does not include radiochemical test results.

Method: 8260B - Volatile Organic Compounds (GC/MS)

Client Sample ID: 137A — **Lab Sample ID: 720-51960-1**
Date Collected: 08/28/13 09:20 — **Matrix: Water**
Date Received: 08/28/13 13:10

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	**13**		0.50		ug/L			08/28/13 20:48	1
1,1-Dichloroethane	**5.0**		0.50		ug/L			08/28/13 20:48	1
Dichlorodifluoromethane	ND		0.50		ug/L			08/28/13 20:48	1
Vinyl chloride	**2.4**		0.50		ug/L			08/28/13 20:48	1
Chloroethane	ND		1.0		ug/L			08/28/13 20:48	1
Trichlorofluoromethane	ND		1.0		ug/L			08/28/13 20:48	1
Methylene Chloride	ND		5.0		ug/L			08/28/13 20:48	1
trans-1,2-Dichloroethene	**25**		0.50		ug/L			08/28/13 20:48	1
cis-1,2-Dichloroethene	**3000**		10		ug/L			08/29/13 12:20	20
Chloroform	ND		1.0		ug/L			08/28/13 20:48	1
1,1,1-Trichloroethane	ND		0.50		ug/L			08/28/13 20:48	1
Carbon tetrachloride	ND		0.50		ug/L			08/28/13 20:48	1
1,2-Dichloroethane	ND		0.50		ug/L			08/28/13 20:48	1
Trichloroethene	**3300**		10		ug/L			08/29/13 12:20	20
1,2-Dichloropropane	ND		0.50		ug/L			08/28/13 20:48	1
Dichlorobromomethane	ND		0.50		ug/L			08/28/13 20:48	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 20:48	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 20:48	1
1,1,2-Trichloroethane	ND		0.50		ug/L			08/28/13 20:48	1
Tetrachloroethene	**1.2**		0.50		ug/L			08/28/13 20:48	1
Chlorodibromomethane	ND		0.50		ug/L			08/28/13 20:48	1
Chlorobenzene	ND		0.50		ug/L			08/28/13 20:48	1
Bromoform	ND		1.0		ug/L			08/28/13 20:48	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			08/28/13 20:48	1
1,3-Dichlorobenzene	ND		0.50		ug/L			08/28/13 20:48	1
1,4-Dichlorobenzene	ND		0.50		ug/L			08/28/13 20:48	1
1,2-Dichlorobenzene	ND		0.50		ug/L			08/28/13 20:48	1
Chloromethane	ND		1.0		ug/L			08/28/13 20:48	1
Bromomethane	ND		1.0		ug/L			08/28/13 20:48	1
1,1,2-Trichloro-1,2,2-trifluoroethane	**16**		0.50		ug/L			08/28/13 20:48	1
EDB	ND		0.50		ug/L			08/28/13 20:48	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			08/28/13 20:48	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*96*		*70 - 130*		*08/28/13 20:48*	*1*
Toluene-d8 (Surr)	*99*		*70 - 130*		*08/29/13 12:20*	*20*
4-Bromofluorobenzene	*100*		*67 - 130*		*08/28/13 20:48*	*1*
4-Bromofluorobenzene	*101*		*67 - 130*		*08/29/13 12:20*	*20*
1,2-Dichloroethane-d4 (Surr)	*114*		*72 - 130*		*08/28/13 20:48*	*1*
1,2-Dichloroethane-d4 (Surr)	*95*		*72 - 130*		*08/29/13 12:20*	*20*

Client Sample ID: AE/RW-9-2 — **Lab Sample ID: 720-51960-2**
Date Collected: 08/28/13 11:15 — **Matrix: Water**
Date Received: 08/28/13 13:10

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	**23**		0.50		ug/L			08/28/13 21:16	1
1,1-Dichloroethane	**86**		0.50		ug/L			08/28/13 21:16	1
Dichlorodifluoromethane	ND		0.50		ug/L			08/28/13 21:16	1
Vinyl chloride	**330**		10		ug/L			08/29/13 12:48	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Client Sample ID: AE/RW-9-2
Date Collected: 08/28/13 11:15
Date Received: 08/28/13 13:10

Lab Sample ID: 720-51960-2
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloroethane	ND		1.0		ug/L			08/28/13 21:16	1
Trichlorofluoromethane	ND		1.0		ug/L			08/28/13 21:16	1
Methylene Chloride	ND		5.0		ug/L			08/28/13 21:16	1
trans-1,2-Dichloroethene	**77**		0.50		ug/L			08/28/13 21:16	1
cis-1,2-Dichloroethene	**7300**		50		ug/L			08/29/13 13:43	100
Chloroform	ND		1.0		ug/L			08/28/13 21:16	1
1,1,1-Trichloroethane	**35**		0.50		ug/L			08/28/13 21:16	1
Carbon tetrachloride	ND		0.50		ug/L			08/28/13 21:16	1
1,2-Dichloroethane	ND		0.50		ug/L			08/28/13 21:16	1
Trichloroethene	**9800**		50		ug/L			08/29/13 13:43	100
1,2-Dichloropropane	ND		0.50		ug/L			08/28/13 21:16	1
Dichlorobromomethane	ND		0.50		ug/L			08/28/13 21:16	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 21:16	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 21:16	1
1,1,2-Trichloroethane	ND		0.50		ug/L			08/28/13 21:16	1
Tetrachloroethene	**3.6**		0.50		ug/L			08/28/13 21:16	1
Chlorodibromomethane	ND		0.50		ug/L			08/28/13 21:16	1
Chlorobenzene	ND		0.50		ug/L			08/28/13 21:16	1
Bromoform	ND		1.0		ug/L			08/28/13 21:16	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			08/28/13 21:16	1
1,3-Dichlorobenzene	ND		0.50		ug/L			08/28/13 21:16	1
1,4-Dichlorobenzene	ND		0.50		ug/L			08/28/13 21:16	1
1,2-Dichlorobenzene	ND		0.50		ug/L			08/28/13 21:16	1
Chloromethane	ND		1.0		ug/L			08/28/13 21:16	1
Bromomethane	ND		1.0		ug/L			08/28/13 21:16	1
1,1,2-Trichloro-1,2,2-trifluoroethane	**71**		0.50		ug/L			08/28/13 21:16	1
EDB	ND		0.50		ug/L			08/28/13 21:16	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			08/28/13 21:16	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*93*		*70 - 130*		*08/28/13 21:16*	*1*
Toluene-d8 (Surr)	*99*		*70 - 130*		*08/29/13 12:48*	*20*
Toluene-d8 (Surr)	*98*		*70 - 130*		*08/29/13 13:43*	*100*
4-Bromofluorobenzene	*101*		*67 - 130*		*08/28/13 21:16*	*1*
4-Bromofluorobenzene	*101*		*67 - 130*		*08/29/13 12:48*	*20*
4-Bromofluorobenzene	*102*		*67 - 130*		*08/29/13 13:43*	*100*
1,2-Dichloroethane-d4 (Surr)	*112*		*72 - 130*		*08/28/13 21:16*	*1*
1,2-Dichloroethane-d4 (Surr)	*93*		*72 - 130*		*08/29/13 12:48*	*20*
1,2-Dichloroethane-d4 (Surr)	*95*		*72 - 130*		*08/29/13 13:43*	*100*

Client Sample ID: FD1
Date Collected: 08/28/13 11:30
Date Received: 08/28/13 13:10

Lab Sample ID: 720-51960-3
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	**50**		0.50		ug/L			08/28/13 21:43	1
1,1-Dichloroethane	**110**		0.50		ug/L			08/28/13 21:43	1
Dichlorodifluoromethane	ND		0.50		ug/L			08/28/13 21:43	1
Vinyl chloride	**210**		10		ug/L			08/29/13 13:15	20
Chloroethane	ND		1.0		ug/L			08/28/13 21:43	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Client Sample ID: FD1
Date Collected: 08/28/13 11:30
Date Received: 08/28/13 13:10

Lab Sample ID: 720-51960-3
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Trichlorofluoromethane	ND		1.0		ug/L			08/28/13 21:43	1
Methylene Chloride	ND		5.0		ug/L			08/28/13 21:43	1
trans-1,2-Dichloroethene	**88**		0.50		ug/L			08/28/13 21:43	1
cis-1,2-Dichloroethene	**7300**		50		ug/L			08/29/13 14:10	100
Chloroform	ND		1.0		ug/L			08/28/13 21:43	1
1,1,1-Trichloroethane	**65**		0.50		ug/L			08/28/13 21:43	1
Carbon tetrachloride	ND		0.50		ug/L			08/28/13 21:43	1
1,2-Dichloroethane	ND		0.50		ug/L			08/28/13 21:43	1
Trichloroethene	**8200**		50		ug/L			08/29/13 14:10	100
1,2-Dichloropropane	ND		0.50		ug/L			08/28/13 21:43	1
Dichlorobromomethane	ND		0.50		ug/L			08/28/13 21:43	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 21:43	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 21:43	1
1,1,2-Trichloroethane	ND		0.50		ug/L			08/28/13 21:43	1
Tetrachloroethene	**5.0**		0.50		ug/L			08/28/13 21:43	1
Chlorodibromomethane	ND		0.50		ug/L			08/28/13 21:43	1
Chlorobenzene	ND		0.50		ug/L			08/28/13 21:43	1
Bromoform	ND		1.0		ug/L			08/28/13 21:43	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			08/28/13 21:43	1
1,3-Dichlorobenzene	ND		0.50		ug/L			08/28/13 21:43	1
1,4-Dichlorobenzene	ND		0.50		ug/L			08/28/13 21:43	1
1,2-Dichlorobenzene	ND		0.50		ug/L			08/28/13 21:43	1
Chloromethane	ND		1.0		ug/L			08/28/13 21:43	1
Bromomethane	ND		1.0		ug/L			08/28/13 21:43	1
1,1,2-Trichloro-1,2,2-trifluoroethane	**190**		0.50		ug/L			08/28/13 21:43	1
EDB	ND		0.50		ug/L			08/28/13 21:43	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			08/28/13 21:43	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*93*		*70 - 130*		*08/28/13 21:43*	*1*
Toluene-d8 (Surr)	*97*		*70 - 130*		*08/29/13 13:15*	*20*
Toluene-d8 (Surr)	*98*		*70 - 130*		*08/29/13 14:10*	*100*
4-Bromofluorobenzene	*100*		*67 - 130*		*08/28/13 21:43*	*1*
4-Bromofluorobenzene	*100*		*67 - 130*		*08/29/13 13:15*	*20*
4-Bromofluorobenzene	*100*		*67 - 130*		*08/29/13 14:10*	*100*
1,2-Dichloroethane-d4 (Surr)	*113*		*72 - 130*		*08/28/13 21:43*	*1*
1,2-Dichloroethane-d4 (Surr)	*96*		*72 - 130*		*08/29/13 13:15*	*20*
1,2-Dichloroethane-d4 (Surr)	*99*		*72 - 130*		*08/29/13 14:10*	*100*

Client Sample ID: TB01
Date Collected: 08/28/13 07:00
Date Received: 08/28/13 13:10

Lab Sample ID: 720-51960-4
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		0.50		ug/L			08/28/13 20:19	1
1,1-Dichloroethane	ND		0.50		ug/L			08/28/13 20:19	1
Dichlorodifluoromethane	ND		0.50		ug/L			08/28/13 20:19	1
Vinyl chloride	ND		0.50		ug/L			08/28/13 20:19	1
Chloroethane	ND		1.0		ug/L			08/28/13 20:19	1
Trichlorofluoromethane	ND		1.0		ug/L			08/28/13 20:19	1

Client: Geosyntec Consultants, Inc.
Project/Site: WR1133A_03 / MEW, Mountain

TestAmerica Job ID: 720-51960-2

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Client Sample ID: TB01
Date Collected: 08/28/13 07:00
Date Received: 08/28/13 13:10

Lab Sample ID: 720-51960-4
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Methylene Chloride	ND		5.0		ug/L			08/28/13 20:19	1
trans-1,2-Dichloroethene	ND		0.50		ug/L			08/28/13 20:19	1
cis-1,2-Dichloroethene	ND		0.50		ug/L			08/28/13 20:19	1
Chloroform	ND		1.0		ug/L			08/28/13 20:19	1
1,1,1-Trichloroethane	ND		0.50		ug/L			08/28/13 20:19	1
Carbon tetrachloride	ND		0.50		ug/L			08/28/13 20:19	1
1,2-Dichloroethane	ND		0.50		ug/L			08/28/13 20:19	1
Trichloroethene	ND		0.50		ug/L			08/28/13 20:19	1
1,2-Dichloropropane	ND		0.50		ug/L			08/28/13 20:19	1
Dichlorobromomethane	ND		0.50		ug/L			08/28/13 20:19	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 20:19	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 20:19	1
1,1,2-Trichloroethane	ND		0.50		ug/L			08/28/13 20:19	1
Tetrachloroethene	ND		0.50		ug/L			08/28/13 20:19	1
Chlorodibromomethane	ND		0.50		ug/L			08/28/13 20:19	1
Chlorobenzene	ND		0.50		ug/L			08/28/13 20:19	1
Bromoform	ND		1.0		ug/L			08/28/13 20:19	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			08/28/13 20:19	1
1,3-Dichlorobenzene	ND		0.50		ug/L			08/28/13 20:19	1
1,4-Dichlorobenzene	ND		0.50		ug/L			08/28/13 20:19	1
1,2-Dichlorobenzene	ND		0.50		ug/L			08/28/13 20:19	1
Chloromethane	ND		1.0		ug/L			08/28/13 20:19	1
Bromomethane	ND		1.0		ug/L			08/28/13 20:19	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		0.50		ug/L			08/28/13 20:19	1
EDB	ND		0.50		ug/L			08/28/13 20:19	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			08/28/13 20:19	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*99*		*70 - 130*		*08/28/13 20:19*	*1*
4-Bromofluorobenzene	*99*		*67 - 130*		*08/28/13 20:19*	*1*
1,2-Dichloroethane-d4 (Surr)	*111*		*72 - 130*		*08/28/13 20:19*	*1*

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 720-143212/4
Matrix: Water
Analysis Batch: 143212

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		0.50		ug/L			08/28/13 15:41	1
1,1-Dichloroethane	ND		0.50		ug/L			08/28/13 15:41	1
Dichlorodifluoromethane	ND		0.50		ug/L			08/28/13 15:41	1
Vinyl chloride	ND		0.50		ug/L			08/28/13 15:41	1
Chloroethane	ND		1.0		ug/L			08/28/13 15:41	1
Trichlorofluoromethane	ND		1.0		ug/L			08/28/13 15:41	1
Methylene Chloride	ND		5.0		ug/L			08/28/13 15:41	1
trans-1,2-Dichloroethene	ND		0.50		ug/L			08/28/13 15:41	1
cis-1,2-Dichloroethene	ND		0.50		ug/L			08/28/13 15:41	1
Chloroform	ND		1.0		ug/L			08/28/13 15:41	1
1,1,1-Trichloroethane	ND		0.50		ug/L			08/28/13 15:41	1
Carbon tetrachloride	ND		0.50		ug/L			08/28/13 15:41	1
1,2-Dichloroethane	ND		0.50		ug/L			08/28/13 15:41	1
Trichloroethene	ND		0.50		ug/L			08/28/13 15:41	1
1,2-Dichloropropane	ND		0.50		ug/L			08/28/13 15:41	1
Dichlorobromomethane	ND		0.50		ug/L			08/28/13 15:41	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 15:41	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			08/28/13 15:41	1
1,1,2-Trichloroethane	ND		0.50		ug/L			08/28/13 15:41	1
Tetrachloroethene	ND		0.50		ug/L			08/28/13 15:41	1
Chlorodibromomethane	ND		0.50		ug/L			08/28/13 15:41	1
Chlorobenzene	ND		0.50		ug/L			08/28/13 15:41	1
Bromoform	ND		1.0		ug/L			08/28/13 15:41	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			08/28/13 15:41	1
1,3-Dichlorobenzene	ND		0.50		ug/L			08/28/13 15:41	1
1,4-Dichlorobenzene	ND		0.50		ug/L			08/28/13 15:41	1
1,2-Dichlorobenzene	ND		0.50		ug/L			08/28/13 15:41	1
Chloromethane	ND		1.0		ug/L			08/28/13 15:41	1
Bromomethane	ND		1.0		ug/L			08/28/13 15:41	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		0.50		ug/L			08/28/13 15:41	1
EDB	ND		0.50		ug/L			08/28/13 15:41	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			08/28/13 15:41	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*100*		*70 - 130*		*08/28/13 15:41*	*1*
4-Bromofluorobenzene	*100*		*67 - 130*		*08/28/13 15:41*	*1*
1,2-Dichloroethane-d4 (Surr)	*109*		*72 - 130*		*08/28/13 15:41*	*1*

Lab Sample ID: LCS 720-143212/5
Matrix: Water
Analysis Batch: 143212

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1-Dichloroethene	25.0	26.3		ug/L		105	64 - 128
1,1-Dichloroethane	25.0	26.8		ug/L		107	70 - 130
Dichlorodifluoromethane	25.0	20.0		ug/L		80	34 - 132
Vinyl chloride	25.0	28.2		ug/L		113	54 - 135
Chloroethane	25.0	27.7		ug/L		111	62 - 138

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 720-143212/5
Matrix: Water
Analysis Batch: 143212

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Trichlorofluoromethane	25.0	28.9		ug/L		116	66 - 132
Methylene Chloride	25.0	26.2		ug/L		105	70 - 147
trans-1,2-Dichloroethene	25.0	25.9		ug/L		104	68 - 130
cis-1,2-Dichloroethene	25.0	27.9		ug/L		112	70 - 130
Chloroform	25.0	27.7		ug/L		111	70 - 130
1,1,1-Trichloroethane	25.0	24.6		ug/L		98	70 - 130
Carbon tetrachloride	25.0	22.9		ug/L		91	70 - 146
1,2-Dichloroethane	25.0	29.6		ug/L		118	61 - 132
Trichloroethene	25.0	26.3		ug/L		105	70 - 130
1,2-Dichloropropane	25.0	28.7		ug/L		115	70 - 130
Dichlorobromomethane	25.0	28.3		ug/L		113	70 - 130
trans-1,3-Dichloropropene	25.0	27.6		ug/L		111	70 - 140
cis-1,3-Dichloropropene	25.0	28.7		ug/L		115	70 - 130
1,1,2-Trichloroethane	25.0	29.7		ug/L		119	70 - 130
Tetrachloroethene	25.0	26.3		ug/L		105	70 - 130
Chlorodibromomethane	25.0	27.7		ug/L		111	70 - 145
Chlorobenzene	25.0	25.3		ug/L		101	70 - 130
Bromoform	25.0	27.0		ug/L		108	68 - 136
1,1,2,2-Tetrachloroethane	25.0	27.5		ug/L		110	70 - 130
1,3-Dichlorobenzene	25.0	25.4		ug/L		102	70 - 130
1,4-Dichlorobenzene	25.0	25.5		ug/L		102	70 - 130
1,2-Dichlorobenzene	25.0	25.4		ug/L		102	70 - 130
Chloromethane	25.0	24.7		ug/L		99	52 - 175
Bromomethane	25.0	26.6		ug/L		106	43 - 151
1,1,2-Trichloro-1,2,2-trifluoroethane	25.0	25.9		ug/L		103	42 - 162
EDB	25.0	28.7		ug/L		115	70 - 130
1,2,4-Trichlorobenzene	25.0	24.9		ug/L		100	70 - 130
m-Xylene & p-Xylene	50.0	47.2		ug/L		94	70 - 142
o-Xylene	25.0	24.9		ug/L		100	70 - 130

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Toluene-d8 (Surr)	*103*		*70 - 130*
4-Bromofluorobenzene	*101*		*67 - 130*
1,2-Dichloroethane-d4 (Surr)	*108*		*72 - 130*

Lab Sample ID: LCSD 720-143212/6
Matrix: Water
Analysis Batch: 143212

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1-Dichloroethene	25.0	22.7		ug/L		91	64 - 128	15	20
1,1-Dichloroethane	25.0	27.0		ug/L		108	70 - 130	1	20
Dichlorodifluoromethane	25.0	19.8		ug/L		79	34 - 132	1	20
Vinyl chloride	25.0	28.8		ug/L		115	54 - 135	2	20
Chloroethane	25.0	27.2		ug/L		109	62 - 138	2	20
Trichlorofluoromethane	25.0	29.2		ug/L		117	66 - 132	1	20
Methylene Chloride	25.0	25.9		ug/L		104	70 - 147	1	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCSD 720-143212/6
Matrix: Water
Analysis Batch: 143212

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
trans-1,2-Dichloroethene			25.0	26.0		ug/L		104	68 - 130	1	20
cis-1,2-Dichloroethene			25.0	28.2		ug/L		113	70 - 130	1	20
Chloroform			25.0	27.9		ug/L		112	70 - 130	1	20
1,1,1-Trichloroethane			25.0	25.4		ug/L		102	70 - 130	3	20
Carbon tetrachloride			25.0	24.4		ug/L		97	70 - 146	6	20
1,2-Dichloroethane			25.0	29.3		ug/L		117	61 - 132	1	20
Trichloroethene			25.0	26.6		ug/L		106	70 - 130	1	20
1,2-Dichloropropane			25.0	28.8		ug/L		115	70 - 130	1	20
Dichlorobromomethane			25.0	28.8		ug/L		115	70 - 130	2	20
trans-1,3-Dichloropropene			25.0	27.8		ug/L		111	70 - 140	1	20
cis-1,3-Dichloropropene			25.0	28.7		ug/L		115	70 - 130	0	20
1,1,2-Trichloroethane			25.0	29.2		ug/L		117	70 - 130	2	20
Tetrachloroethene			25.0	26.8		ug/L		107	70 - 130	2	20
Chlorodibromomethane			25.0	27.7		ug/L		111	70 - 145	0	20
Chlorobenzene			25.0	26.0		ug/L		104	70 - 130	3	20
Bromoform			25.0	26.8		ug/L		107	68 - 136	1	20
1,1,2,2-Tetrachloroethane			25.0	26.6		ug/L		107	70 - 130	3	20
1,3-Dichlorobenzene			25.0	25.7		ug/L		103	70 - 130	1	20
1,4-Dichlorobenzene			25.0	25.8		ug/L		103	70 - 130	1	20
1,2-Dichlorobenzene			25.0	25.6		ug/L		103	70 - 130	1	20
Chloromethane			25.0	23.9		ug/L		96	52 - 175	3	20
Bromomethane			25.0	26.0		ug/L		104	43 - 151	2	20
1,1,2-Trichloro-1,2,2-trifluoroethane			25.0	26.0		ug/L		104	42 - 162	0	20
EDB			25.0	28.3		ug/L		113	70 - 130	1	20
1,2,4-Trichlorobenzene			25.0	25.7		ug/L		103	70 - 130	3	20
m-Xylene & p-Xylene			50.0	48.1		ug/L		96	70 - 142	2	20
o-Xylene			25.0	25.5		ug/L		102	70 - 130	2	20

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*102*		*70 - 130*
4-Bromofluorobenzene	*102*		*67 - 130*
1,2-Dichloroethane-d4 (Surr)	*106*		*72 - 130*

Lab Sample ID: MB 720-143259/4
Matrix: Water
Analysis Batch: 143259

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		0.50		ug/L			08/29/13 08:39	1
1,1-Dichloroethane	ND		0.50		ug/L			08/29/13 08:39	1
Dichlorodifluoromethane	ND		0.50		ug/L			08/29/13 08:39	1
Vinyl chloride	ND		0.50		ug/L			08/29/13 08:39	1
Chloroethane	ND		1.0		ug/L			08/29/13 08:39	1
Trichlorofluoromethane	ND		1.0		ug/L			08/29/13 08:39	1
Methylene Chloride	ND		5.0		ug/L			08/29/13 08:39	1
trans-1,2-Dichloroethene	ND		0.50		ug/L			08/29/13 08:39	1
cis-1,2-Dichloroethene	ND		0.50		ug/L			08/29/13 08:39	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 720-143259/4
Matrix: Water
Analysis Batch: 143259

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloroform	ND		1.0		ug/L			08/29/13 08:39	1
1,1,1-Trichloroethane	ND		0.50		ug/L			08/29/13 08:39	1
Carbon tetrachloride	ND		0.50		ug/L			08/29/13 08:39	1
1,2-Dichloroethane	ND		0.50		ug/L			08/29/13 08:39	1
Trichloroethene	ND		0.50		ug/L			08/29/13 08:39	1
1,2-Dichloropropane	ND		0.50		ug/L			08/29/13 08:39	1
Dichlorobromomethane	ND		0.50		ug/L			08/29/13 08:39	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			08/29/13 08:39	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			08/29/13 08:39	1
1,1,2-Trichloroethane	ND		0.50		ug/L			08/29/13 08:39	1
Tetrachloroethene	ND		0.50		ug/L			08/29/13 08:39	1
Chlorodibromomethane	ND		0.50		ug/L			08/29/13 08:39	1
Chlorobenzene	ND		0.50		ug/L			08/29/13 08:39	1
Bromoform	ND		1.0		ug/L			08/29/13 08:39	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			08/29/13 08:39	1
1,3-Dichlorobenzene	ND		0.50		ug/L			08/29/13 08:39	1
1,4-Dichlorobenzene	ND		0.50		ug/L			08/29/13 08:39	1
1,2-Dichlorobenzene	ND		0.50		ug/L			08/29/13 08:39	1
Chloromethane	ND		1.0		ug/L			08/29/13 08:39	1
Bromomethane	ND		1.0		ug/L			08/29/13 08:39	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		0.50		ug/L			08/29/13 08:39	1
EDB	ND		0.50		ug/L			08/29/13 08:39	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			08/29/13 08:39	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*99*		*70 - 130*		*08/29/13 08:39*	*1*
4-Bromofluorobenzene	*99*		*67 - 130*		*08/29/13 08:39*	*1*
1,2-Dichloroethane-d4 (Surr)	*91*		*72 - 130*		*08/29/13 08:39*	*1*

Lab Sample ID: LCS 720-143259/5
Matrix: Water
Analysis Batch: 143259

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1-Dichloroethene	25.0	24.1		ug/L		96	64 - 128
1,1-Dichloroethane	25.0	24.8		ug/L		99	70 - 130
Dichlorodifluoromethane	25.0	20.5		ug/L		82	34 - 132
Vinyl chloride	25.0	26.7		ug/L		107	54 - 135
Chloroethane	25.0	26.3		ug/L		105	62 - 138
Trichlorofluoromethane	25.0	25.3		ug/L		101	66 - 132
Methylene Chloride	25.0	23.7		ug/L		95	70 - 147
trans-1,2-Dichloroethene	25.0	25.2		ug/L		101	68 - 130
cis-1,2-Dichloroethene	25.0	24.0		ug/L		96	70 - 130
Chloroform	25.0	24.1		ug/L		96	70 - 130
1,1,1-Trichloroethane	25.0	23.9		ug/L		96	70 - 130
Carbon tetrachloride	25.0	23.7		ug/L		95	70 - 146
1,2-Dichloroethane	25.0	22.5		ug/L		90	61 - 132
Trichloroethene	25.0	24.4		ug/L		98	70 - 130

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 720-143259/5
Matrix: Water
Analysis Batch: 143259

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2-Dichloropropane	25.0	25.4		ug/L		101	70 - 130
Dichlorobromomethane	25.0	24.1		ug/L		96	70 - 130
trans-1,3-Dichloropropene	25.0	25.3		ug/L		101	70 - 140
cis-1,3-Dichloropropene	25.0	25.7		ug/L		103	70 - 130
1,1,2-Trichloroethane	25.0	24.5		ug/L		98	70 - 130
Tetrachloroethene	25.0	25.1		ug/L		100	70 - 130
Chlorodibromomethane	25.0	24.9		ug/L		100	70 - 145
Chlorobenzene	25.0	25.1		ug/L		100	70 - 130
Bromoform	25.0	24.1		ug/L		97	68 - 136
1,1,2,2-Tetrachloroethane	25.0	25.1		ug/L		100	70 - 130
1,3-Dichlorobenzene	25.0	25.0		ug/L		100	70 - 130
1,4-Dichlorobenzene	25.0	25.1		ug/L		100	70 - 130
1,2-Dichlorobenzene	25.0	24.6		ug/L		98	70 - 130
Chloromethane	25.0	25.5		ug/L		102	52 - 175
Bromomethane	25.0	25.8		ug/L		103	43 - 151
1,1,2-Trichloro-1,2,2-trifluoroethane	25.0	24.5		ug/L		98	42 - 162
EDB	25.0	24.8		ug/L		99	70 - 130
1,2,4-Trichlorobenzene	25.0	25.9		ug/L		104	70 - 130
m-Xylene & p-Xylene	50.0	48.0		ug/L		96	70 - 142
o-Xylene	25.0	24.6		ug/L		99	70 - 130

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Toluene-d8 (Surr)	*100*		*70 - 130*
4-Bromofluorobenzene	*95*		*67 - 130*
1,2-Dichloroethane-d4 (Surr)	*89*		*72 - 130*

Lab Sample ID: LCSD 720-143259/6
Matrix: Water
Analysis Batch: 143259

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1-Dichloroethene	25.0	24.3		ug/L		97	64 - 128	1	20
1,1-Dichloroethane	25.0	25.1		ug/L		101	70 - 130	1	20
Dichlorodifluoromethane	25.0	21.0		ug/L		84	34 - 132	3	20
Vinyl chloride	25.0	27.6		ug/L		110	54 - 135	3	20
Chloroethane	25.0	26.9		ug/L		107	62 - 138	2	20
Trichlorofluoromethane	25.0	25.3		ug/L		101	66 - 132	0	20
Methylene Chloride	25.0	23.7		ug/L		95	70 - 147	0	20
trans-1,2-Dichloroethene	25.0	25.0		ug/L		100	68 - 130	1	20
cis-1,2-Dichloroethene	25.0	24.3		ug/L		97	70 - 130	1	20
Chloroform	25.0	24.0		ug/L		96	70 - 130	0	20
1,1,1-Trichloroethane	25.0	23.7		ug/L		95	70 - 130	1	20
Carbon tetrachloride	25.0	23.8		ug/L		95	70 - 146	0	20
1,2-Dichloroethane	25.0	22.2		ug/L		89	61 - 132	1	20
Trichloroethene	25.0	24.7		ug/L		99	70 - 130	1	20
1,2-Dichloropropane	25.0	25.4		ug/L		101	70 - 130	0	20
Dichlorobromomethane	25.0	24.2		ug/L		97	70 - 130	0	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCSD 720-143259/6
Matrix: Water
Analysis Batch: 143259

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
trans-1,3-Dichloropropene			25.0	25.0		ug/L		100	70 - 140	1	20
cis-1,3-Dichloropropene			25.0	25.7		ug/L		103	70 - 130	0	20
1,1,2-Trichloroethane			25.0	24.5		ug/L		98	70 - 130	0	20
Tetrachloroethene			25.0	24.7		ug/L		99	70 - 130	1	20
Chlorodibromomethane			25.0	24.7		ug/L		99	70 - 145	1	20
Chlorobenzene			25.0	25.1		ug/L		100	70 - 130	0	20
Bromoform			25.0	24.3		ug/L		97	68 - 136	1	20
1,1,2,2-Tetrachloroethane			25.0	24.8		ug/L		99	70 - 130	1	20
1,3-Dichlorobenzene			25.0	25.1		ug/L		100	70 - 130	0	20
1,4-Dichlorobenzene			25.0	24.8		ug/L		99	70 - 130	1	20
1,2-Dichlorobenzene			25.0	24.7		ug/L		99	70 - 130	0	20
Chloromethane			25.0	26.3		ug/L		105	52 - 175	3	20
Bromomethane			25.0	26.3		ug/L		105	43 - 151	2	20
1,1,2-Trichloro-1,2,2-trifluoroethane			25.0	24.9		ug/L		99	42 - 162	1	20
EDB			25.0	24.8		ug/L		99	70 - 130	0	20
1,2,4-Trichlorobenzene			25.0	25.9		ug/L		103	70 - 130	0	20
m-Xylene & p-Xylene			50.0	48.2		ug/L		96	70 - 142	0	20
o-Xylene			25.0	24.5		ug/L		98	70 - 130	1	20

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*100*		*70 - 130*
4-Bromofluorobenzene	*97*		*67 - 130*
1,2-Dichloroethane-d4 (Surr)	*90*		*72 - 130*

GC/MS VOA

Analysis Batch: 143212

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-51960-1	137A	Total/NA	Water	8260B	
720-51960-2	AE/RW-9-2	Total/NA	Water	8260B	
720-51960-3	FD1	Total/NA	Water	8260B	
720-51960-4	TB01	Total/NA	Water	8260B	
LCS 720-143212/5	Lab Control Sample	Total/NA	Water	8260B	
LCSD 720-143212/6	Lab Control Sample Dup	Total/NA	Water	8260B	
MB 720-143212/4	Method Blank	Total/NA	Water	8260B	

Analysis Batch: 143259

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-51960-1	137A	Total/NA	Water	8260B	
720-51960-2	AE/RW-9-2	Total/NA	Water	8260B	
720-51960-2	AE/RW-9-2	Total/NA	Water	8260B	
720-51960-3	FD1	Total/NA	Water	8260B	
720-51960-3	FD1	Total/NA	Water	8260B	
LCS 720-143259/5	Lab Control Sample	Total/NA	Water	8260B	
LCSD 720-143259/6	Lab Control Sample Dup	Total/NA	Water	8260B	
MB 720-143259/4	Method Blank	Total/NA	Water	8260B	

Lab Chronicle

Client: Geosyntec Consultants, Inc.
Project/Site: WR1133A_03 / MEW, Mountain

TestAmerica Job ID: 720-51960-2

Client Sample ID: 137A

Lab Sample ID: 720-51960-1

Date Collected: 08/28/13 09:20
Matrix: Water
Date Received: 08/28/13 13:10

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	143212	08/28/13 20:48	PDR	TAL PLS
Total/NA	Analysis	8260B		20	143259	08/29/13 12:20	PDR	TAL PLS

Client Sample ID: AE/RW-9-2

Lab Sample ID: 720-51960-2

Date Collected: 08/28/13 11:15
Matrix: Water
Date Received: 08/28/13 13:10

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	143212	08/28/13 21:16	PDR	TAL PLS
Total/NA	Analysis	8260B		20	143259	08/29/13 12:48	PDR	TAL PLS
Total/NA	Analysis	8260B		100	143259	08/29/13 13:43	PDR	TAL PLS

Client Sample ID: FD1

Lab Sample ID: 720-51960-3

Date Collected: 08/28/13 11:30
Matrix: Water
Date Received: 08/28/13 13:10

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	143212	08/28/13 21:43	PDR	TAL PLS
Total/NA	Analysis	8260B		20	143259	08/29/13 13:15	PDR	TAL PLS
Total/NA	Analysis	8260B		100	143259	08/29/13 14:10	PDR	TAL PLS

Client Sample ID: TB01

Lab Sample ID: 720-51960-4

Date Collected: 08/28/13 07:00
Matrix: Water
Date Received: 08/28/13 13:10

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	143212	08/28/13 20:19	PDR	TAL PLS

Laboratory References:

TAL PLS = TestAmerica Pleasanton, 1220 Quarry Lane, Pleasanton, CA 94566, TEL (925)484-1919

Certification Summary

Client: Geosyntec Consultants, Inc.
Project/Site: WR1133A_03 / MEW, Mountain

TestAmerica Job ID: 720-51960-2

Laboratory: TestAmerica Pleasanton

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
California	State Program	9	2496	01-31-14

Method Summary

Client: Geosyntec Consultants, Inc.
Project/Site: WR1133A_03 / MEW, Mountain

TestAmerica Job ID: 720-51960-2

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL PLS

Protocol References:

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL PLS = TestAmerica Pleasanton, 1220 Quarry Lane, Pleasanton, CA 94566, TEL (925)484-1919

Sample Summary

Client: Geosyntec Consultants, Inc.
Project/Site: WR1133A_03 / MEW, Mountain

TestAmerica Job ID: 720-51960-2

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
720-51960-1	137A	Water	08/28/13 09:20	08/28/13 13:10
720-51960-2	AE/RW-9-2	Water	08/28/13 11:15	08/28/13 13:10
720-51960-3	FD1	Water	08/28/13 11:30	08/28/13 13:10
720-51960-4	TB01	Water	08/28/13 07:00	08/28/13 13:10

Chain of Custody Record

TestAmerica Pleasanton
1220 Quarry Lane
Pleasanton, CA 94566
phone 925.484.1919 fax 925.600.3002

720-51960

TestAmerica — THE LEADER IN ENVIRONMENTAL TESTING — TestAmerica Laboratories, Inc.
148257

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Client Contact	
Your Company Name here	Geosyntec
Address	1111 Broadway, 6th Floor
City/State/Zip	Oakland CA, 94607
Phone	(510) 836-3034
FAX	(510) 836-3036
Project Name:	WR1133A_03
Site:	MEW, Mountain View
P O #	

Project Manager: Eric Suchomel
Tel/Fax: See notes
Site Contact: L. Kane
Lab Contact:
Date: 8/28/13
Carrier:
COC No: 1 of 1 COCs
Sampler:

Analysis Turnaround Time
☐ CALENDAR DAYS ☐ WORKING DAYS
TAT if different from Below ______
☐ 2 weeks
☐ 1 week
☐ 2 days
☐ 1 day

For Lab Use Only:
Walk-in Client:
Lab Sampling:
Job / SDG No.:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	VOC, EPA 8260B	sulfate, nitrate, chloride, alkalinity EPA 300.0/SM 2320B	phosphate, 4500-P_E ortho	dissolved iron, magnesium EPA 6010B	dissolved calcium, sodium, magnesium, potassium silica, EPA 6010B	Ethene, ethane, acetylene methane, RSK-175M	TOC, SM5310C	Dehalococcoides/VcrA enumeration, gene-Trac	48 hr. rush (VOC)	Sample Specific Notes:
137A	8/28/13	0920	G	water	12			X	X	X	X	X	X	X		X	
AE/RW-9-2	↓	1115	G	water	12			X	X	X	X	X	X	X		X	
FD1	↓	1130	G	water	3			X								X	
TB01	↓	0700	G	water	2			X								X	

RUSH

720-51960 Chain of Custody

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ______

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return to Client ☒ Disposal by Lab ☐ Archive for ______ Months

Special Instructions/QC Requirements & Comments:
Send results to: LKane@geosyntec.com 510-285-2746
DGandhi@geosyntec.com 510-285-2745

3.4°C

Custody Seals Intact: ☐ Yes ☐ No
Custody Seal No.:
Cooler Temp (°C): Obs'd: ______ Corr'd: ______ Therm ID No.: ______

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
(Jeff Pelkie)	Weiss	8/28/13 @ 1200	Lea Kane	Geosyntec	8/28/13 1220
Lea Kane	Geosyntec	8/28/13 @ 1230	[signature]	TAP	08/28/13 @ 12:30
[signature]	TAP	08/28/13 @ 1310	Received in Laboratory by: [signature]	TAP	8/28/13 1310

Form No. CA-C-WI-002, Rev. 4.2, dated 04/02/2013

Smith, Micah 720-51960

From: Deepa Gandhi [dgandhi@Geosyntec.com]
Sent: Wednesday, August 28, 2013 1:56 PM
To: Smith, Micah; Lea Kane
Cc: Molly Holleran
Subject: RE: sample bottle order
Attachments: 2013-08-28 12-29.pdf

Micah,

You should be receiving our samples today – see attached COC. A couple of corrections/clarifications:

- We only need the 8010 list of compounds reported for the VOC analysis;
- We want chloride analysis, not chlorate; and
- The dehaloccoides/vcrA is being sent to another lab.

Lea will be back in the office tomorrow and can follow-up with you.

Thanks,

Deepa Gandhi, PE
Senior Engineer
595 Market Street, Suite 610
San Francisco, California 94105
Main: 415.678.1988
Direct. 510.285.2745
Fax: 415.243.0821
www.Geosyntec.com

Geosyntec consultants

From: Smith, Micah [mailto:Micah.Smith@testamericainc.com]
Sent: Friday, August 23, 2013 3:14 PM
To: Lea Kane
Cc: Molly Holleran; Deepa Gandhi
Subject: RE: sample bottle order

Lea,
We'll get this kit ready for Monday delivery To answer your question about container combining, each analysis will have its own container but Sulfate, nitrate, Chloride, Alkalinity and all be combined to one 500 ml poly
Thanks

MICAH SMITH
Project Manager

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

1220 Quarry Lane
Pleasanton, CA 94566

Login Sample Receipt Checklist

Client: Geosyntec Consultants, Inc.

Job Number: 720-51960-2

Login Number: 51960

List Source: TestAmerica Pleasanton

List Number: 1

Creator: Bullock, Tracy

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	N/A	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Pleasanton
1220 Quarry Lane
Pleasanton, CA 94566
Tel: (925)484-1919

TestAmerica Job ID: 720-52463-1
Client Project/Site: Mountainview ZVI Column Study

For:
Sirem, div of Geosyntec Consultants
130 Research Lane
Suite 2
Guelph, Ontario N1G 5G3

Attn: Jason White

Authorized for release by:
10/4/2013 3:37:15 PM

Micah Smith, Project Manager I
()
micah.smith@testamericainc.com

Table of Contents

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 720-52463-1

Laboratory: TestAmerica Pleasanton

Narrative

Job Narrative
720-52463-1

Comments
No additional comments.

Receipt
The samples were received on 9/20/2013 10:00 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 6.0º C.

Except:

The following sample(s) was received with headspace in the sample vial: S-2492-09192013-INFL 1A @ for VOC's .

Received only 1x40ml Hcl for VOC's and 1-40ml H2S04 vial per sample for TOC.
Sample time on COC 11:00am, sample time on vials 11:00pm.

GC/MS VOA
No analytical or quality issues were noted.

Metals
No analytical or quality issues were noted.

General Chemistry
No analytical or quality issues were noted.

Detection Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Client Sample ID: S-2492-09182013-INFL 1A — Lab Sample ID: 720-52463-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	0.094		0.0050		mg/L	1		6010B	Total/NA
Calcium	130		0.20		mg/L	1		6010B	Total/NA
Magnesium	43		0.20		mg/L	1		6010B	Total/NA
Manganese	0.38		0.020		mg/L	1		6010B	Total/NA
Sodium	33		0.50		mg/L	1		6010B	Total/NA
Sr	0.45		0.010		mg/L	1		6010B	Total/NA
Alkalinity	390		5.0		mg/L	1		SM 2320B	Total/NA
Bicarbonate Alkalinity as CaCO3	390		5.0		mg/L	1		SM 2320B	Total/NA
TOC Dup	1.4		1.0		mg/L	1		SM 5310C	Total/NA

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Total Dissolved Solids	650		10		mg/L	1		SM 2540C	Total/NA

Client Sample ID: S-2492-09182013-INFL 1B — Lab Sample ID: 720-52463-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	0.095		0.0050		mg/L	1		6010B	Total/NA
Calcium	130		0.20		mg/L	1		6010B	Total/NA
Magnesium	43		0.20		mg/L	1		6010B	Total/NA
Manganese	0.38		0.020		mg/L	1		6010B	Total/NA
Sodium	32		0.50		mg/L	1		6010B	Total/NA
Sr	0.46		0.010		mg/L	1		6010B	Total/NA
Alkalinity	390		5.0		mg/L	1		SM 2320B	Total/NA
Bicarbonate Alkalinity as CaCO3	390		5.0		mg/L	1		SM 2320B	Total/NA
TOC Dup	1.2		1.0		mg/L	1		SM 5310C	Total/NA

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Total Dissolved Solids	640		10		mg/L	1		SM 2540C	Total/NA

Client Sample ID: S-2492-09192013-INFL 1A — Lab Sample ID: 720-52463-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,1-Dichloroethene	13		0.50		ug/L	1		8260B	Total/NA
1,1-Dichloroethane	130		0.50		ug/L	1		8260B	Total/NA
Vinyl chloride	140		0.50		ug/L	1		8260B	Total/NA
Methylene Chloride	13		5.0		ug/L	1		8260B	Total/NA
trans-1,2-Dichloroethene	36		0.50		ug/L	1		8260B	Total/NA
cis-1,2-Dichloroethene	5800		50		ug/L	100		8260B	Total/NA
1,1,1-Trichloroethane	82		0.50		ug/L	1		8260B	Total/NA
Trichloroethene	5900		50		ug/L	100		8260B	Total/NA
1,1,2-Trichloroethane	0.51		0.50		ug/L	1		8260B	Total/NA
1,1,2-Trichloro-1,2,2-trifluoroethane	97		0.50		ug/L	1		8260B	Total/NA

Client Sample ID: S-2492-09192013-INFL 1B — Lab Sample ID: 720-52463-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,1-Dichloroethene	14		0.50		ug/L	1		8260B	Total/NA
1,1-Dichloroethane	130		0.50		ug/L	1		8260B	Total/NA
Vinyl chloride	140		0.50		ug/L	1		8260B	Total/NA
Methylene Chloride	13		5.0		ug/L	1		8260B	Total/NA
trans-1,2-Dichloroethene	36		0.50		ug/L	1		8260B	Total/NA
cis-1,2-Dichloroethene	6200		50		ug/L	100		8260B	Total/NA

This Detection Summary does not include radiochemical test results.

TestAmerica Pleasanton

Client Sample ID: S-2492-09192013-INFL 1B (Continued) **Lab Sample ID: 720-52463-4**

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,1,1-Trichloroethane	81		0.50		ug/L	1		8260B	Total/NA
Trichloroethene	6300		50		ug/L	100		8260B	Total/NA
1,1,2-Trichloroethane	0.57		0.50		ug/L	1		8260B	Total/NA
1,1,2-Trichloro-1,2,2-trifluoroethane	100		0.50		ug/L	1		8260B	Total/NA

This Detection Summary does not include radiochemical test results.

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Client Sample ID: S-2492-09182013-INFL 1A
Date Collected: 09/18/13 13:00
Date Received: 09/20/13 10:00

Lab Sample ID: 720-52463-1
Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Aluminum	ND		0.20		mg/L		09/23/13 07:41	09/26/13 12:51	1
Arsenic	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Barium	**0.094**		0.0050		mg/L		09/23/13 07:41	09/26/13 12:51	1
Beryllium	ND		0.0020		mg/L		09/23/13 07:41	09/26/13 12:51	1
Cadmium	ND		0.0025		mg/L		09/23/13 07:41	09/26/13 12:51	1
Calcium	**130**		0.20		mg/L		09/23/13 07:41	09/26/13 12:51	1
Chromium	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Cobalt	ND		0.0020		mg/L		09/23/13 07:41	09/26/13 12:51	1
Copper	ND		0.020		mg/L		09/23/13 07:41	09/26/13 12:51	1
Lead	ND		0.0050		mg/L		09/23/13 07:41	09/26/13 12:51	1
Molybdenum	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Iron	ND		0.20		mg/L		09/23/13 07:41	09/26/13 12:51	1
Nickel	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Potassium	ND		1.0		mg/L		09/23/13 07:41	09/26/13 12:51	1
Selenium	ND		0.020		mg/L		09/23/13 07:41	09/26/13 12:51	1
Magnesium	**43**		0.20		mg/L		09/23/13 07:41	09/26/13 12:51	1
Manganese	**0.38**		0.020		mg/L		09/23/13 07:41	09/26/13 12:51	1
Thallium	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Vanadium	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Sodium	**33**		0.50		mg/L		09/23/13 07:41	09/26/13 22:22	1
Zinc	ND		0.020		mg/L		09/23/13 07:41	09/26/13 12:51	1
Sr	**0.45**		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Sn	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1
Ti	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:51	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	**390**		5.0		mg/L			09/25/13 14:24	1
Bicarbonate Alkalinity as CaCO3	**390**		5.0		mg/L			09/25/13 14:24	1
Carbonate Alkalinity as CaCO3	ND		5.0		mg/L			09/25/13 14:24	1
Hydroxide Alkalinity	ND		5.0		mg/L			09/25/13 14:24	1
TOC Dup	**1.4**		1.0		mg/L			09/25/13 14:07	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**650**		10		mg/L			09/24/13 16:49	1

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Client Sample ID: S-2492-09182013-INFL 1B
Date Collected: 09/18/13 13:00
Date Received: 09/20/13 10:00

Lab Sample ID: 720-52463-2
Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Aluminum	ND		0.20		mg/L		09/23/13 07:41	09/26/13 12:55	1
Arsenic	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Barium	**0.095**		0.0050		mg/L		09/23/13 07:41	09/26/13 12:55	1
Beryllium	ND		0.0020		mg/L		09/23/13 07:41	09/26/13 12:55	1
Cadmium	ND		0.0025		mg/L		09/23/13 07:41	09/26/13 12:55	1
Calcium	**130**		0.20		mg/L		09/23/13 07:41	09/26/13 12:55	1
Chromium	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Cobalt	ND		0.0020		mg/L		09/23/13 07:41	09/26/13 12:55	1
Copper	ND		0.020		mg/L		09/23/13 07:41	09/26/13 12:55	1
Lead	ND		0.0050		mg/L		09/23/13 07:41	09/26/13 12:55	1
Molybdenum	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Iron	ND		0.20		mg/L		09/23/13 07:41	09/26/13 12:55	1
Nickel	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Potassium	ND		1.0		mg/L		09/23/13 07:41	09/26/13 12:55	1
Selenium	ND		0.020		mg/L		09/23/13 07:41	09/26/13 12:55	1
Magnesium	**43**		0.20		mg/L		09/23/13 07:41	09/26/13 12:55	1
Manganese	**0.38**		0.020		mg/L		09/23/13 07:41	09/26/13 12:55	1
Thallium	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Vanadium	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Sodium	**32**		0.50		mg/L		09/23/13 07:41	09/26/13 22:26	1
Zinc	ND		0.020		mg/L		09/23/13 07:41	09/26/13 12:55	1
Sr	**0.46**		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Sn	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1
Ti	ND		0.010		mg/L		09/23/13 07:41	09/26/13 12:55	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	**390**		5.0		mg/L			09/25/13 14:31	1
Bicarbonate Alkalinity as CaCO3	**390**		5.0		mg/L			09/25/13 14:31	1
Carbonate Alkalinity as CaCO3	ND		5.0		mg/L			09/25/13 14:31	1
Hydroxide Alkalinity	ND		5.0		mg/L			09/25/13 14:31	1
TOC Dup	**1.2**		1.0		mg/L			09/25/13 14:31	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**640**		10		mg/L			09/24/13 16:49	1

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Client Sample ID: S-2492-09192013-INFL 1A
Date Collected: 09/19/13 11:00
Date Received: 09/20/13 10:00

Lab Sample ID: 720-52463-3
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	**13**		0.50		ug/L			09/25/13 11:10	1
1,1-Dichloroethane	**130**		0.50		ug/L			09/25/13 11:10	1
Dichlorodifluoromethane	ND		0.50		ug/L			09/25/13 11:10	1
Vinyl chloride	**140**		0.50		ug/L			09/25/13 11:10	1
Chloroethane	ND		1.0		ug/L			09/25/13 11:10	1
Trichlorofluoromethane	ND		1.0		ug/L			09/25/13 11:10	1
Methylene Chloride	**13**		5.0		ug/L			09/25/13 11:10	1
trans-1,2-Dichloroethene	**36**		0.50		ug/L			09/25/13 11:10	1
cis-1,2-Dichloroethene	**5800**		50		ug/L			09/25/13 18:10	100
Chloroform	ND		1.0		ug/L			09/25/13 11:10	1
1,1,1-Trichloroethane	**82**		0.50		ug/L			09/25/13 11:10	1
Carbon tetrachloride	ND		0.50		ug/L			09/25/13 11:10	1
1,2-Dichloroethane	ND		0.50		ug/L			09/25/13 11:10	1
Trichloroethene	**5900**		50		ug/L			09/25/13 18:10	100
1,2-Dichloropropane	ND		0.50		ug/L			09/25/13 11:10	1
Dichlorobromomethane	ND		0.50		ug/L			09/25/13 11:10	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			09/25/13 11:10	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			09/25/13 11:10	1
1,1,2-Trichloroethane	**0.51**		0.50		ug/L			09/25/13 11:10	1
Tetrachloroethene	ND		0.50		ug/L			09/25/13 11:10	1
Chlorodibromomethane	ND		0.50		ug/L			09/25/13 11:10	1
Chlorobenzene	ND		0.50		ug/L			09/25/13 11:10	1
Bromoform	ND		1.0		ug/L			09/25/13 11:10	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			09/25/13 11:10	1
1,3-Dichlorobenzene	ND		0.50		ug/L			09/25/13 11:10	1
1,4-Dichlorobenzene	ND		0.50		ug/L			09/25/13 11:10	1
1,2-Dichlorobenzene	ND		0.50		ug/L			09/25/13 11:10	1
Chloromethane	ND		1.0		ug/L			09/25/13 11:10	1
Bromomethane	ND		1.0		ug/L			09/25/13 11:10	1
1,1,2-Trichloro-1,2,2-trifluoroethane	**97**		0.50		ug/L			09/25/13 11:10	1
EDB	ND		0.50		ug/L			09/25/13 11:10	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			09/25/13 11:10	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*99*		*70 - 130*		*09/25/13 11:10*	*1*
Toluene-d8 (Surr)	*100*		*70 - 130*		*09/25/13 18:10*	*100*
4-Bromofluorobenzene	*98*		*67 - 130*		*09/25/13 11:10*	*1*
4-Bromofluorobenzene	*102*		*67 - 130*		*09/25/13 18:10*	*100*
1,2-Dichloroethane-d4 (Surr)	*99*		*72 - 130*		*09/25/13 11:10*	*1*
1,2-Dichloroethane-d4 (Surr)	*119*		*72 - 130*		*09/25/13 18:10*	*100*

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Client Sample ID: S-2492-09192013-INFL 1B
Date Collected: 09/19/13 11:00
Date Received: 09/20/13 10:00

Lab Sample ID: 720-52463-4
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	**14**		0.50		ug/L			09/25/13 11:38	1
1,1-Dichloroethane	**130**		0.50		ug/L			09/25/13 11:38	1
Dichlorodifluoromethane	ND		0.50		ug/L			09/25/13 11:38	1
Vinyl chloride	**140**		0.50		ug/L			09/25/13 11:38	1
Chloroethane	ND		1.0		ug/L			09/25/13 11:38	1
Trichlorofluoromethane	ND		1.0		ug/L			09/25/13 11:38	1
Methylene Chloride	**13**		5.0		ug/L			09/25/13 11:38	1
trans-1,2-Dichloroethene	**36**		0.50		ug/L			09/25/13 11:38	1
cis-1,2-Dichloroethene	**6200**		50		ug/L			09/25/13 18:37	100
Chloroform	ND		1.0		ug/L			09/25/13 11:38	1
1,1,1-Trichloroethane	**81**		0.50		ug/L			09/25/13 11:38	1
Carbon tetrachloride	ND		0.50		ug/L			09/25/13 11:38	1
1,2-Dichloroethane	ND		0.50		ug/L			09/25/13 11:38	1
Trichloroethene	**6300**		50		ug/L			09/25/13 18:37	100
1,2-Dichloropropane	ND		0.50		ug/L			09/25/13 11:38	1
Dichlorobromomethane	ND		0.50		ug/L			09/25/13 11:38	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			09/25/13 11:38	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			09/25/13 11:38	1
1,1,2-Trichloroethane	**0.57**		0.50		ug/L			09/25/13 11:38	1
Tetrachloroethene	ND		0.50		ug/L			09/25/13 11:38	1
Chlorodibromomethane	ND		0.50		ug/L			09/25/13 11:38	1
Chlorobenzene	ND		0.50		ug/L			09/25/13 11:38	1
Bromoform	ND		1.0		ug/L			09/25/13 11:38	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			09/25/13 11:38	1
1,3-Dichlorobenzene	ND		0.50		ug/L			09/25/13 11:38	1
1,4-Dichlorobenzene	ND		0.50		ug/L			09/25/13 11:38	1
1,2-Dichlorobenzene	ND		0.50		ug/L			09/25/13 11:38	1
Chloromethane	ND		1.0		ug/L			09/25/13 11:38	1
Bromomethane	ND		1.0		ug/L			09/25/13 11:38	1
1,1,2-Trichloro-1,2,2-trifluoroethane	**100**		0.50		ug/L			09/25/13 11:38	1
EDB	ND		0.50		ug/L			09/25/13 11:38	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			09/25/13 11:38	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*98*		*70 - 130*		*09/25/13 11:38*	*1*
Toluene-d8 (Surr)	*99*		*70 - 130*		*09/25/13 18:37*	*100*
4-Bromofluorobenzene	*97*		*67 - 130*		*09/25/13 11:38*	*1*
4-Bromofluorobenzene	*98*		*67 - 130*		*09/25/13 18:37*	*100*
1,2-Dichloroethane-d4 (Surr)	*101*		*72 - 130*		*09/25/13 11:38*	*1*
1,2-Dichloroethane-d4 (Surr)	*124*		*72 - 130*		*09/25/13 18:37*	*100*

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 720-144891/4
Matrix: Water
Analysis Batch: 144891

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		0.50		ug/L			09/25/13 08:35	1
1,1-Dichloroethane	ND		0.50		ug/L			09/25/13 08:35	1
Dichlorodifluoromethane	ND		0.50		ug/L			09/25/13 08:35	1
Vinyl chloride	ND		0.50		ug/L			09/25/13 08:35	1
Chloroethane	ND		1.0		ug/L			09/25/13 08:35	1
Trichlorofluoromethane	ND		1.0		ug/L			09/25/13 08:35	1
Methylene Chloride	ND		5.0		ug/L			09/25/13 08:35	1
trans-1,2-Dichloroethene	ND		0.50		ug/L			09/25/13 08:35	1
cis-1,2-Dichloroethene	ND		0.50		ug/L			09/25/13 08:35	1
Chloroform	ND		1.0		ug/L			09/25/13 08:35	1
1,1,1-Trichloroethane	ND		0.50		ug/L			09/25/13 08:35	1
Carbon tetrachloride	ND		0.50		ug/L			09/25/13 08:35	1
1,2-Dichloroethane	ND		0.50		ug/L			09/25/13 08:35	1
Trichloroethene	ND		0.50		ug/L			09/25/13 08:35	1
1,2-Dichloropropane	ND		0.50		ug/L			09/25/13 08:35	1
Dichlorobromomethane	ND		0.50		ug/L			09/25/13 08:35	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			09/25/13 08:35	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			09/25/13 08:35	1
1,1,2-Trichloroethane	ND		0.50		ug/L			09/25/13 08:35	1
Tetrachloroethene	ND		0.50		ug/L			09/25/13 08:35	1
Chlorodibromomethane	ND		0.50		ug/L			09/25/13 08:35	1
Chlorobenzene	ND		0.50		ug/L			09/25/13 08:35	1
Bromoform	ND		1.0		ug/L			09/25/13 08:35	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			09/25/13 08:35	1
1,3-Dichlorobenzene	ND		0.50		ug/L			09/25/13 08:35	1
1,4-Dichlorobenzene	ND		0.50		ug/L			09/25/13 08:35	1
1,2-Dichlorobenzene	ND		0.50		ug/L			09/25/13 08:35	1
Chloromethane	ND		1.0		ug/L			09/25/13 08:35	1
Bromomethane	ND		1.0		ug/L			09/25/13 08:35	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		0.50		ug/L			09/25/13 08:35	1
EDB	ND		0.50		ug/L			09/25/13 08:35	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			09/25/13 08:35	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*970*		*17 - 937*		*7/ 2052 93 78:35*	*9*
4-Bromofluorobenzene	*977*		*61 - 937*		*7/ 2052 93 78:35*	*9*
9,0-Dichloroethane-d4 (Surr)	*975*		*10 - 937*		*7/ 2052 93 78:35*	*9*

Lab Sample ID: LCS 720-144891/5
Matrix: Water
Analysis Batch: 144891

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1-Dichloroethene	25.0	24.4		ug/L		98	64 - 128
1,1-Dichloroethane	25.0	25.5		ug/L		102	70 - 130
Dichlorodifluoromethane	25.0	25.0		ug/L		100	34 - 132
Vinyl chloride	25.0	26.0		ug/L		104	54 - 135
Chloroethane	25.0	25.4		ug/L		102	62 - 138

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 720-144891/5
Matrix: Water
Analysis Batch: 144891

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Trichlorofluoromethane	25.0	26.1		ug/L		105	66 - 132
Methylene Chloride	25.0	22.0		ug/L		88	70 - 147
trans-1,2-Dichloroethene	25.0	24.8		ug/L		99	68 - 130
cis-1,2-Dichloroethene	25.0	25.9		ug/L		104	70 - 130
Chloroform	25.0	25.0		ug/L		100	70 - 130
1,1,1-Trichloroethane	25.0	25.9		ug/L		103	70 - 130
Carbon tetrachloride	25.0	26.5		ug/L		106	70 - 146
1,2-Dichloroethane	25.0	26.4		ug/L		106	61 - 132
Trichloroethene	25.0	25.2		ug/L		101	70 - 130
1,2-Dichloropropane	25.0	24.6		ug/L		98	70 - 130
Dichlorobromomethane	25.0	25.7		ug/L		103	70 - 130
trans-1,3-Dichloropropene	25.0	27.1		ug/L		108	70 - 140
cis-1,3-Dichloropropene	25.0	25.6		ug/L		102	70 - 130
1,1,2-Trichloroethane	25.0	25.0		ug/L		100	70 - 130
Tetrachloroethene	25.0	25.3		ug/L		101	70 - 130
Chlorodibromomethane	25.0	26.5		ug/L		106	70 - 145
Chlorobenzene	25.0	24.3		ug/L		97	70 - 130
Bromoform	25.0	24.4		ug/L		98	68 - 136
1,1,2,2-Tetrachloroethane	25.0	23.9		ug/L		96	70 - 130
1,3-Dichlorobenzene	25.0	25.5		ug/L		102	70 - 130
1,4-Dichlorobenzene	25.0	24.6		ug/L		98	70 - 130
1,2-Dichlorobenzene	25.0	24.7		ug/L		99	70 - 130
Chloromethane	25.0	24.5		ug/L		98	52 - 175
Bromomethane	25.0	25.1		ug/L		100	43 - 151
1,1,2-Trichloro-1,2,2-trifluoroethane	25.0	25.5		ug/L		102	42 - 162
EDB	25.0	25.3		ug/L		101	70 - 130
1,2,4-Trichlorobenzene	25.0	26.0		ug/L		104	70 - 130

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Toluene-d8 (Surr)	*979*		*17 - 937*
4-Bromofluorobenzene	*/ 6*		*61 - 937*
9,0-Dichloroethane-d4 (Surr)	*970*		*10 - 937*

Lab Sample ID: LCSD 720-144891/6
Matrix: Water
Analysis Batch: 144891

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1-Dichloroethene	25.0	24.4		ug/L		97	64 - 128	0	20
1,1-Dichloroethane	25.0	25.3		ug/L		101	70 - 130	1	20
Dichlorodifluoromethane	25.0	24.9		ug/L		99	34 - 132	0	20
Vinyl chloride	25.0	26.1		ug/L		104	54 - 135	0	20
Chloroethane	25.0	25.9		ug/L		104	62 - 138	2	20
Trichlorofluoromethane	25.0	25.7		ug/L		103	66 - 132	2	20
Methylene Chloride	25.0	22.4		ug/L		89	70 - 147	2	20
trans-1,2-Dichloroethene	25.0	24.8		ug/L		99	68 - 130	0	20
cis-1,2-Dichloroethene	25.0	26.1		ug/L		104	70 - 130	1	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCSD 720-144891/6
Matrix: Water
Analysis Batch: 144891

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Chloroform			25.0	24.9		ug/L		100	70 - 130	0	20
1,1,1-Trichloroethane			25.0	25.3		ug/L		101	70 - 130	2	20
Carbon tetrachloride			25.0	25.7		ug/L		103	70 - 146	3	20
1,2-Dichloroethane			25.0	26.5		ug/L		106	61 - 132	0	20
Trichloroethene			25.0	25.2		ug/L		101	70 - 130	0	20
1,2-Dichloropropane			25.0	24.2		ug/L		97	70 - 130	2	20
Dichlorobromomethane			25.0	25.9		ug/L		104	70 - 130	1	20
trans-1,3-Dichloropropene			25.0	26.8		ug/L		107	70 - 140	1	20
cis-1,3-Dichloropropene			25.0	25.8		ug/L		103	70 - 130	1	20
1,1,2-Trichloroethane			25.0	25.6		ug/L		102	70 - 130	2	20
Tetrachloroethene			25.0	25.3		ug/L		101	70 - 130	0	20
Chlorodibromomethane			25.0	26.4		ug/L		106	70 - 145	0	20
Chlorobenzene			25.0	24.0		ug/L		96	70 - 130	1	20
Bromoform			25.0	25.8		ug/L		103	68 - 136	5	20
1,1,2,2-Tetrachloroethane			25.0	25.2		ug/L		101	70 - 130	5	20
1,3-Dichlorobenzene			25.0	25.1		ug/L		101	70 - 130	1	20
1,4-Dichlorobenzene			25.0	24.4		ug/L		98	70 - 130	1	20
1,2-Dichlorobenzene			25.0	25.3		ug/L		101	70 - 130	3	20
Chloromethane			25.0	25.4		ug/L		102	52 - 175	4	20
Bromomethane			25.0	25.7		ug/L		103	43 - 151	2	20
1,1,2-Trichloro-1,2,2-trifluoroethane			25.0	25.8		ug/L		103	42 - 162	1	20
EDB			25.0	26.5		ug/L		106	70 - 130	5	20
1,2,4-Trichlorobenzene			25.0	25.7		ug/L		103	70 - 130	1	20

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*977*		*17 - 937*
4-Bromofluorobenzene	*/ 8*		*61 - 937*
9,0-Dichloroethane-d4 (Surr)	*973*		*10 - 937*

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 720-144719/1-A
Matrix: Water
Analysis Batch: 144775

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 144719

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Aluminum	ND		0.20		mg/L		09/23/13 07:41	09/23/13 16:11	1
Arsenic	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Barium	ND		0.0050		mg/L		09/23/13 07:41	09/23/13 16:11	1
Beryllium	ND		0.0020		mg/L		09/23/13 07:41	09/23/13 16:11	1
Cadmium	ND		0.0025		mg/L		09/23/13 07:41	09/23/13 16:11	1
Calcium	ND		0.20		mg/L		09/23/13 07:41	09/23/13 16:11	1
Chromium	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Cobalt	ND		0.0020		mg/L		09/23/13 07:41	09/23/13 16:11	1
Copper	ND		0.020		mg/L		09/23/13 07:41	09/23/13 16:11	1
Lead	ND		0.0050		mg/L		09/23/13 07:41	09/23/13 16:11	1

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: MB 720-144719/1-A
Matrix: Water
Analysis Batch: 144775

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 144719

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Molybdenum	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Iron	ND		0.20		mg/L		09/23/13 07:41	09/23/13 16:11	1
Nickel	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Potassium	ND		1.0		mg/L		09/23/13 07:41	09/23/13 16:11	1
Selenium	ND		0.020		mg/L		09/23/13 07:41	09/23/13 16:11	1
Magnesium	ND		0.20		mg/L		09/23/13 07:41	09/23/13 16:11	1
Manganese	ND		0.020		mg/L		09/23/13 07:41	09/23/13 16:11	1
Thallium	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Vanadium	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Sodium	ND		0.50		mg/L		09/23/13 07:41	09/23/13 16:11	1
Zinc	ND		0.020		mg/L		09/23/13 07:41	09/23/13 16:11	1
Sr	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Sn	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1
Ti	ND		0.010		mg/L		09/23/13 07:41	09/23/13 16:11	1

Lab Sample ID: LCS 720-144719/2-A
Matrix: Water
Analysis Batch: 144775

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 144719

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	1.00	0.962		mg/L		96	80 - 120
Aluminum	10.0	10.4		mg/L		104	80 - 120
Arsenic	1.00	0.970		mg/L		97	80 - 120
Barium	1.00	0.986		mg/L		99	80 - 120
Beryllium	1.00	0.993		mg/L		99	80 - 120
Cadmium	1.00	0.979		mg/L		98	80 - 120
Calcium	10.0	10.2		mg/L		102	80 - 120
Chromium	1.00	0.994		mg/L		99	80 - 120
Cobalt	1.00	0.994		mg/L		99	80 - 120
Copper	1.00	0.988		mg/L		99	80 - 120
Lead	1.00	1.01		mg/L		101	80 - 120
Molybdenum	1.00	0.993		mg/L		99	80 - 120
Iron	10.0	9.65		mg/L		97	80 - 120
Nickel	1.00	0.993		mg/L		99	80 - 120
Potassium	10.0	9.70		mg/L		97	80 - 120
Selenium	1.00	0.950		mg/L		95	80 - 120
Magnesium	10.0	10.1		mg/L		101	80 - 120
Manganese	1.00	0.988		mg/L		99	80 - 120
Thallium	1.00	0.998		mg/L		100	80 - 120
Vanadium	1.00	0.986		mg/L		99	80 - 120
Sodium	10.0	10.3		mg/L		103	80 - 120
Zinc	1.00	0.977		mg/L		98	80 - 120
Sr	1.00	0.980		mg/L		98	80 - 120
Sn	1.00	0.998		mg/L		100	80 - 120
Ti	1.00	0.975		mg/L		98	80 - 120

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: LCSD 720-144719/3-A
Matrix: Water
Analysis Batch: 144775

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 144719

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Antimony	1.00	1.01		mg/L		101	80 - 120	5	20
Aluminum	10.0	11.0		mg/L		110	80 - 120	5	20
Arsenic	1.00	1.02		mg/L		102	80 - 120	5	20
Barium	1.00	1.05		mg/L		105	80 - 120	6	20
Beryllium	1.00	1.06		mg/L		106	80 - 120	6	20
Cadmium	1.00	1.03		mg/L		103	80 - 120	5	20
Calcium	10.0	10.7		mg/L		107	80 - 120	5	20
Chromium	1.00	1.03		mg/L		103	80 - 120	4	20
Cobalt	1.00	1.04		mg/L		104	80 - 120	5	20
Copper	1.00	1.02		mg/L		102	80 - 120	4	20
Lead	1.00	1.06		mg/L		106	80 - 120	5	20
Molybdenum	1.00	1.05		mg/L		105	80 - 120	6	20
Iron	10.0	10.2		mg/L		102	80 - 120	6	20
Nickel	1.00	1.05		mg/L		105	80 - 120	5	20
Potassium	10.0	10.5		mg/L		105	80 - 120	8	20
Selenium	1.00	0.998		mg/L		100	80 - 120	5	20
Magnesium	10.0	10.8		mg/L		108	80 - 120	6	20
Manganese	1.00	1.02		mg/L		102	80 - 120	4	20
Thallium	1.00	1.05		mg/L		105	80 - 120	5	20
Vanadium	1.00	1.02		mg/L		102	80 - 120	4	20
Sodium	10.0	10.9		mg/L		109	80 - 120	6	20
Zinc	1.00	1.02		mg/L		102	80 - 120	5	20
Sr	1.00	1.02		mg/L		102	80 - 120	4	20
Sn	1.00	1.05		mg/L		105	80 - 120	5	20
Ti	1.00	1.02		mg/L		102	80 - 120	5	20

Method: SM 2320B - Alkalinity

Lab Sample ID: MB 720-144990/3
Matrix: Water
Analysis Batch: 144990

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	ND		5.0		mg/L			09/25/13 14:04	1
Bicarbonate Alkalinity as CaCO3	ND		5.0		mg/L			09/25/13 14:04	1
Carbonate Alkalinity as CaCO3	ND		5.0		mg/L			09/25/13 14:04	1
Hydroxide Alkalinity	ND		5.0		mg/L			09/25/13 14:04	1

Lab Sample ID: LCS 720-144990/4
Matrix: Water
Analysis Batch: 144990

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Alkalinity	250	261		mg/L		104	80 - 120

Method: SM 2320B - Alkalinity (Continued)

Lab Sample ID: LCSD 720-144990/5
Matrix: Water
Analysis Batch: 144990

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Alkalinity	250	260		mg/L		104	80 - 120	0	20

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 720-144867/2
Matrix: Water
Analysis Batch: 144867

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10		mg/L			09/24/13 16:49	1

Lab Sample ID: LCS 720-144867/1
Matrix: Water
Analysis Batch: 144867

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	1000	948		mg/L		95	85 - 115

Method: SM 5310C - TOC

Lab Sample ID: MB 500-204234/3
Matrix: Water
Analysis Batch: 204234

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
TOC Dup	ND		1.0		mg/L			09/25/13 11:07	1

Lab Sample ID: LCS 500-204234/4
Matrix: Water
Analysis Batch: 204234

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
TOC Result 1	10.0	9.86		mg/L		99	80 - 120
TOC Result 2	10.0	9.89		mg/L		99	80 - 120
TOC Dup	10.0	9.87		mg/L		99	80 - 120

GC/MS VOA

Analysis Batch: 144891

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-52463-3	S-2492-09192013-INFL 1A	Total/NA	Water	8260B	
720-52463-3	S-2492-09192013-INFL 1A	Total/NA	Water	8260B	
720-52463-4	S-2492-09192013-INFL 1B	Total/NA	Water	8260B	
720-52463-4	S-2492-09192013-INFL 1B	Total/NA	Water	8260B	
LCS 720-144891/5	Lab Control Sample	Total/NA	Water	8260B	
LCSD 720-144891/6	Lab Control Sample Dup	Total/NA	Water	8260B	
MB 720-144891/4	Method Blank	Total/NA	Water	8260B	

Metals

Prep Batch: 144719

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-52463-1	S-2492-09182013-INFL 1A	Total/NA	Water	3010A	
720-52463-2	S-2492-09182013-INFL 1B	Total/NA	Water	3010A	
LCS 720-144719/2-A	Lab Control Sample	Total/NA	Water	3010A	
LCSD 720-144719/3-A	Lab Control Sample Dup	Total/NA	Water	3010A	
MB 720-144719/1-A	Method Blank	Total/NA	Water	3010A	

Analysis Batch: 144775

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 720-144719/2-A	Lab Control Sample	Total/NA	Water	6010B	144719
LCSD 720-144719/3-A	Lab Control Sample Dup	Total/NA	Water	6010B	144719
MB 720-144719/1-A	Method Blank	Total/NA	Water	6010B	144719

Analysis Batch: 145026

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-52463-1	S-2492-09182013-INFL 1A	Total/NA	Water	6010B	144719
720-52463-2	S-2492-09182013-INFL 1B	Total/NA	Water	6010B	144719

Analysis Batch: 145064

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-52463-1	S-2492-09182013-INFL 1A	Total/NA	Water	6010B	144719
720-52463-2	S-2492-09182013-INFL 1B	Total/NA	Water	6010B	144719

General Chemistry

Analysis Batch: 144867

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-52463-1	S-2492-09182013-INFL 1A	Total/NA	Water	SM 2540C	
720-52463-2	S-2492-09182013-INFL 1B	Total/NA	Water	SM 2540C	
LCS 720-144867/1	Lab Control Sample	Total/NA	Water	SM 2540C	
MB 720-144867/2	Method Blank	Total/NA	Water	SM 2540C	

Analysis Batch: 144990

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-52463-1	S-2492-09182013-INFL 1A	Total/NA	Water	SM 2320B	
720-52463-2	S-2492-09182013-INFL 1B	Total/NA	Water	SM 2320B	
LCS 720-144990/4	Lab Control Sample	Total/NA	Water	SM 2320B	
LCSD 720-144990/5	Lab Control Sample Dup	Total/NA	Water	SM 2320B	
MB 720-144990/3	Method Blank	Total/NA	Water	SM 2320B	

General Chemistry (Continued)

Analysis Batch: 204234

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-52463-1	S-2492-09182013-INFL 1A	Total/NA	Water	SM 5310C	
720-52463-2	S-2492-09182013-INFL 1B	Total/NA	Water	SM 5310C	
LCS 500-204234/4	Lab Control Sample	Total/NA	Water	SM 5310C	
MB 500-204234/3	Method Blank	Total/NA	Water	SM 5310C	

Lab Chronicle

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Client Sample ID: S-2492-09182013-INFL 1A

Lab Sample ID: 720-52463-1

Date Collected: 09/18/13 13:00
Matrix: Water
Date Received: 09/20/13 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3010A			144719	09/23/13 07:41	ECT	TAL PLS
Total/NA	Analysis	6010B		1	145026	09/26/13 12:51	EFH	TAL PLS
Total/NA	Analysis	6010B		1	145064	09/26/13 22:22	SLK	TAL PLS
Total/NA	Analysis	SM 5310C		1	204234	09/25/13 14:07	KD1	TAL CHI
Total/NA	Analysis	SM 2540C		1	144867	09/24/13 16:49	EYT	TAL PLS
Total/NA	Analysis	SM 2320B		1	144990	09/25/13 14:24	MJK	TAL PLS

Client Sample ID: S-2492-09182013-INFL 1B

Lab Sample ID: 720-52463-2

Date Collected: 09/18/13 13:00
Matrix: Water
Date Received: 09/20/13 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3010A			144719	09/23/13 07:41	ECT	TAL PLS
Total/NA	Analysis	6010B		1	145026	09/26/13 12:55	EFH	TAL PLS
Total/NA	Analysis	6010B		1	145064	09/26/13 22:26	SLK	TAL PLS
Total/NA	Analysis	SM 5310C		1	204234	09/25/13 14:31	KD1	TAL CHI
Total/NA	Analysis	SM 2540C		1	144867	09/24/13 16:49	EYT	TAL PLS
Total/NA	Analysis	SM 2320B		1	144990	09/25/13 14:31	MJK	TAL PLS

Client Sample ID: S-2492-09192013-INFL 1A

Lab Sample ID: 720-52463-3

Date Collected: 09/19/13 11:00
Matrix: Water
Date Received: 09/20/13 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		100	144891	09/25/13 18:10	ASC	TAL PLS
Total/NA	Analysis	8260B		1	144891	09/25/13 11:10	ASC	TAL PLS

Client Sample ID: S-2492-09192013-INFL 1B

Lab Sample ID: 720-52463-4

Date Collected: 09/19/13 11:00
Matrix: Water
Date Received: 09/20/13 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	144891	09/25/13 11:38	ASC	TAL PLS
Total/NA	Analysis	8260B		100	144891	09/25/13 18:37	ASC	TAL PLS

Laboratory References:

TAL CHI = TestAmerica Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

TAL PLS = TestAmerica Pleasanton, 1220 Quarry Lane, Pleasanton, CA 94566, TEL (925)484-1919

Certification Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Laboratory: TestAmerica Pleasanton

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
California	State Program	9	2496	01-31-14

Laboratory: TestAmerica Chicago

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Alabama	State Program	4	40461	04-30-14
California	NELAP	9	01132CA	04-30-14
Georgia	State Program	4	N/A	04-30-14
Hawaii	State Program	9	N/A	04-30-14
Illinois	NELAP	5	100201	04-30-14
Indiana	State Program	5	C-IL-02	04-30-14
Iowa	State Program	7	82	05-01-14
Kansas	NELAP	7	E-10161	10-31-13
Kentucky	State Program	4	90023	12-31-13
Kentucky (UST)	State Program	4	66	04-30-14
Louisiana	NELAP	6	30720	06-30-14
Massachusetts	State Program	1	M-IL035	06-30-14
Mississippi	State Program	4	N/A	04-30-14
North Carolina DENR	State Program	4	291	12-31-13
North Dakota	State Program	8	R-194	04-30-14
Oklahoma	State Program	6	8908	08-31-14
South Carolina	State Program	4	77001	10-30-13 *
Texas	NELAP	6	T104704252-09-TX	02-28-14
USDA	Federal		P330-12-00038	02-06-15
Wisconsin	State Program	5	999580010	08-31-14
Wyoming	State Program	8	8TMS-Q	04-30-14

* Expired certification is currently pending renewal and is considered valid.

Method Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL PLS
6010B	Metals (ICP)	SW846	TAL PLS
SM 2320B	Alkalinity	SM	TAL PLS
SM 2540C	Solids, Total Dissolved (TDS)	SM	TAL PLS
SM 5310C	TOC	SM	TAL CHI

Protocol References:

SM = "Standard Methods For The Examination Of Water And Wastewater",

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = TestAmerica Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

TAL PLS = TestAmerica Pleasanton, 1220 Quarry Lane, Pleasanton, CA 94566, TEL (925)484-1919

Sample Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-52463-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
720-52463-1	S-2492-09182013-INFL 1A	Water	09/18/13 13:00	09/20/13 10:00
720-52463-2	S-2492-09182013-INFL 1B	Water	09/18/13 13:00	09/20/13 10:00
720-52463-3	S-2492-09192013-INFL 1A	Water	09/19/13 11:00	09/20/13 10:00
720-52463-4	S-2492-09192013-INFL 1B	Water	09/19/13 11:00	09/20/13 10:00

720-52463

148756

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

Project Number S-2942 20066.005

Project Name: Mountainview ZVI Column Study

Point of Contact Jeff Roberts (519) 515-0840

Vendor: SiRem — 130 Research Lane, Suite 2, Guelph, ON N1G 5G3, Canada

Vendor Contact: Jeff Roberts - 519-515-0840

Possible Hazards: None Flammable Radioactive Poison Other

Delivery Service:

AirBill No.:

TAT Requested: As per CoC otherwise normal 10 BD

Zone

Area

Number of Coolers: 1

CoC Page(s):

Analyses: Alkalinity; Cations; TDS; TOC; 8260B (cVOC's)

Bottle Type and Preservative (Use Lab's bottle order for combined analyses)

Sample ID	Date	Time	Matrix	# Cont.	40mL and 20mL VOA's (unpreserved) (Alkalinity)	175mL poly bottles preserved with HNO3 (Cations)	175mL poly bottles upreserved (TDS)	40mL VOA's preserved with H2SO4 (TOC)	40mL VOAs preserved with HCL (8260B (cVOC's))
S-2942-09182013-INFL 1A	18-Sep-13	1:00pm	groundwater	5	x	x	x	x	
S-2942-09182013-INFL 1B	18-Sep-13	1:00pm	groundwater	5	x	x	x	x	
S-2942-09192013-INFL 1A	19-Sep-13	11:00am	groundwater	1					x
S-2942-09192013-INFL 1B	19-Sep-13	11:00am	groundwater	1					x

720-52463 Chain of Custody

	Relinquished by	Received by	Received by
Signature	[signature]	[signature]	
Printed Name	JASON WHITE	Mullen	
Firm	SiREM	TestAmerica	
Date/Time	2:30pm 19/09/13	9-20-13 1000	

Lab Remarks: Custody Intact? YES NO

Cooler Temperature: 6 °C

Other:

Login Sample Receipt Checklist

Client: Sirem, div of Geosyntec Consultants

Job Number: 720-52463-1

Login Number: 52463

List Source: TestAmerica Pleasanton

List Number: 1

Creator: Bullock, Tracy

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	False	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	False	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Sirem, div of Geosyntec Consultants

Job Number: 720-52463-1

Login Number: 52463
List Number: 1
Creator: Kelsey, Shawn M

List Source: TestAmerica Chicago
List Creation: 09/24/13 11:37 AM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	True	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Pleasanton
1220 Quarry Lane
Pleasanton, CA 94566
Tel: (925)484-1919

TestAmerica Job ID: 720-53136-1
Client Project/Site: Mountainview ZVI Column Study

For:
Sirem, div of Geosyntec Consultants
130 Research Lane
Suite 2
Guelph, Ontario N1G 5G3

Attn: Jason White

Authorized for release by:
10/29/2013 5:26:13 PM

Micah Smith, Project Manager I
()
micah.smith@testamericainc.com

Table of Contents

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 720-53136-1

Laboratory: TestAmerica Pleasanton

Narrative

Job Narrative
720-53136-1

Comments
No additional comments.

Receipt
The samples were received on 10/18/2013 9:20 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 5.9º C.

Except:

The following sample(s) was received with headspace in the sample vial: S-2942-10142013-INFL: 1 of 1 Voa.

GC/MS VOA
No analytical or quality issues were noted.

Detection Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53136-1

Client Sample ID: S-2942-10142013-INFL — Lab Sample ID: 720-53136-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,1-Dichloroethane	110		50		ug/L	100		8260B	Total/NA
cis-1,2-Dichloroethene	4300		50		ug/L	100		8260B	Total/NA
1,1,1-Trichloroethane	61		50		ug/L	100		8260B	Total/NA
Trichloroethene	3200		50		ug/L	100		8260B	Total/NA

Client Sample ID: S-2942-10142013-EFFL — Lab Sample ID: 720-53136-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Chloroethane	9.9		1.0		ug/L	1		8260B	Total/NA
Methylene Chloride	17		5.0		ug/L	1		8260B	Total/NA

This Detection Summary does not include radiochemical test results.

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53136-1

Client Sample ID: S-2942-10142013-INFL
Date Collected: 10/17/13 11:00
Date Received: 10/18/13 09:20

Lab Sample ID: 720-53136-1
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		50		ug/L			10/25/13 14:09	100
1,1-Dichloroethane	**110**		50		ug/L			10/25/13 14:09	100
Dichlorodifluoromethane	ND		50		ug/L			10/25/13 14:09	100
Vinyl chloride	ND		50		ug/L			10/25/13 14:09	100
Chloroethane	ND		100		ug/L			10/25/13 14:09	100
Trichlorofluoromethane	ND		100		ug/L			10/25/13 14:09	100
Methylene Chloride	ND		500		ug/L			10/25/13 14:09	100
trans-1,2-Dichloroethene	ND		50		ug/L			10/25/13 14:09	100
cis-1,2-Dichloroethene	**4300**		50		ug/L			10/25/13 14:09	100
Chloroform	ND		100		ug/L			10/25/13 14:09	100
1,1,1-Trichloroethane	**61**		50		ug/L			10/25/13 14:09	100
Carbon tetrachloride	ND		50		ug/L			10/25/13 14:09	100
1,2-Dichloroethane	ND		50		ug/L			10/25/13 14:09	100
Trichloroethene	**3200**		50		ug/L			10/25/13 14:09	100
1,2-Dichloropropane	ND		50		ug/L			10/25/13 14:09	100
Dichlorobromomethane	ND		50		ug/L			10/25/13 14:09	100
trans-1,3-Dichloropropene	ND		50		ug/L			10/25/13 14:09	100
cis-1,3-Dichloropropene	ND		50		ug/L			10/25/13 14:09	100
1,1,2-Trichloroethane	ND		50		ug/L			10/25/13 14:09	100
Tetrachloroethene	ND		50		ug/L			10/25/13 14:09	100
Chlorodibromomethane	ND		50		ug/L			10/25/13 14:09	100
Chlorobenzene	ND		50		ug/L			10/25/13 14:09	100
Bromoform	ND		100		ug/L			10/25/13 14:09	100
1,1,2,2-Tetrachloroethane	ND		50		ug/L			10/25/13 14:09	100
1,3-Dichlorobenzene	ND		50		ug/L			10/25/13 14:09	100
1,4-Dichlorobenzene	ND		50		ug/L			10/25/13 14:09	100
1,2-Dichlorobenzene	ND		50		ug/L			10/25/13 14:09	100
Chloromethane	ND		100		ug/L			10/25/13 14:09	100
Bromomethane	ND		100		ug/L			10/25/13 14:09	100
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		50		ug/L			10/25/13 14:09	100
EDB	ND		50		ug/L			10/25/13 14:09	100
1,2,4-Trichlorobenzene	ND		100		ug/L			10/25/13 14:09	100

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*90*		*70 - 130*		*10/25/13 14:09*	*100*
4-Bromofluorobenzene	*84*		*67 - 130*		*10/25/13 14:09*	*100*
1,2-Dichloroethane-d4 (Surr)	*95*		*72 - 130*		*10/25/13 14:09*	*100*

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53136-1

Client Sample ID: S-2942-10142013-EFFL
Date Collected: 10/17/13 11:00
Date Received: 10/18/13 09:20

Lab Sample ID: 720-53136-2
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		0.50		ug/L			10/25/13 15:37	1
1,1-Dichloroethane	ND		0.50		ug/L			10/25/13 15:37	1
Dichlorodifluoromethane	ND		0.50		ug/L			10/25/13 15:37	1
Vinyl chloride	ND		0.50		ug/L			10/25/13 15:37	1
Chloroethane	**9.9**		1.0		ug/L			10/25/13 15:37	1
Trichlorofluoromethane	ND		1.0		ug/L			10/25/13 15:37	1
Methylene Chloride	**17**		5.0		ug/L			10/25/13 15:37	1
trans-1,2-Dichloroethene	ND		0.50		ug/L			10/25/13 15:37	1
cis-1,2-Dichloroethene	ND		0.50		ug/L			10/25/13 15:37	1
Chloroform	ND		1.0		ug/L			10/25/13 15:37	1
1,1,1-Trichloroethane	ND		0.50		ug/L			10/25/13 15:37	1
Carbon tetrachloride	ND		0.50		ug/L			10/25/13 15:37	1
1,2-Dichloroethane	ND		0.50		ug/L			10/25/13 15:37	1
Trichloroethene	ND		0.50		ug/L			10/25/13 15:37	1
1,2-Dichloropropane	ND		0.50		ug/L			10/25/13 15:37	1
Dichlorobromomethane	ND		0.50		ug/L			10/25/13 15:37	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			10/25/13 15:37	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			10/25/13 15:37	1
1,1,2-Trichloroethane	ND		0.50		ug/L			10/25/13 15:37	1
Tetrachloroethene	ND		0.50		ug/L			10/25/13 15:37	1
Chlorodibromomethane	ND		0.50		ug/L			10/25/13 15:37	1
Chlorobenzene	ND		0.50		ug/L			10/25/13 15:37	1
Bromoform	ND		1.0		ug/L			10/25/13 15:37	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			10/25/13 15:37	1
1,3-Dichlorobenzene	ND		0.50		ug/L			10/25/13 15:37	1
1,4-Dichlorobenzene	ND		0.50		ug/L			10/25/13 15:37	1
1,2-Dichlorobenzene	ND		0.50		ug/L			10/25/13 15:37	1
Chloromethane	ND		1.0		ug/L			10/25/13 15:37	1
Bromomethane	ND		1.0		ug/L			10/25/13 15:37	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		0.50		ug/L			10/25/13 15:37	1
EDB	ND		0.50		ug/L			10/25/13 15:37	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			10/25/13 15:37	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*93*		*70 - 130*		*10/25/13 15:37*	*1*
4-Bromofluorobenzene	*84*		*67 - 130*		*10/25/13 15:37*	*1*
1,2-Dichloroethane-d4 (Surr)	*92*		*72 - 130*		*10/25/13 15:37*	*1*

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 720-147031/5
Matrix: Water
Analysis Batch: 147031

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		0.50		ug/L			10/25/13 12:14	1
1,1-Dichloroethane	ND		0.50		ug/L			10/25/13 12:14	1
Dichlorodifluoromethane	ND		0.50		ug/L			10/25/13 12:14	1
Vinyl chloride	ND		0.50		ug/L			10/25/13 12:14	1
Chloroethane	ND		1.0		ug/L			10/25/13 12:14	1
Trichlorofluoromethane	ND		1.0		ug/L			10/25/13 12:14	1
Methylene Chloride	ND		5.0		ug/L			10/25/13 12:14	1
trans-1,2-Dichloroethene	ND		0.50		ug/L			10/25/13 12:14	1
cis-1,2-Dichloroethene	ND		0.50		ug/L			10/25/13 12:14	1
Chloroform	ND		1.0		ug/L			10/25/13 12:14	1
1,1,1-Trichloroethane	ND		0.50		ug/L			10/25/13 12:14	1
Carbon tetrachloride	ND		0.50		ug/L			10/25/13 12:14	1
1,2-Dichloroethane	ND		0.50		ug/L			10/25/13 12:14	1
Trichloroethene	ND		0.50		ug/L			10/25/13 12:14	1
1,2-Dichloropropane	ND		0.50		ug/L			10/25/13 12:14	1
Dichlorobromomethane	ND		0.50		ug/L			10/25/13 12:14	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			10/25/13 12:14	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			10/25/13 12:14	1
1,1,2-Trichloroethane	ND		0.50		ug/L			10/25/13 12:14	1
Tetrachloroethene	ND		0.50		ug/L			10/25/13 12:14	1
Chlorodibromomethane	ND		0.50		ug/L			10/25/13 12:14	1
Chlorobenzene	ND		0.50		ug/L			10/25/13 12:14	1
Bromoform	ND		1.0		ug/L			10/25/13 12:14	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			10/25/13 12:14	1
1,3-Dichlorobenzene	ND		0.50		ug/L			10/25/13 12:14	1
1,4-Dichlorobenzene	ND		0.50		ug/L			10/25/13 12:14	1
1,2-Dichlorobenzene	ND		0.50		ug/L			10/25/13 12:14	1
Chloromethane	ND		1.0		ug/L			10/25/13 12:14	1
Bromomethane	ND		1.0		ug/L			10/25/13 12:14	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		0.50		ug/L			10/25/13 12:14	1
EDB	ND		0.50		ug/L			10/25/13 12:14	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			10/25/13 12:14	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*89*		*07 - 197*		*173 23 19 1/ 5 14*	*1*
4-: roB omuorof enbene	*89*		*z0 - 197*		*173 23 19 1/ 5 14*	*1*
1,/ -Dichloroethane-d4 (Surr)	*62*		*0/ - 197*		*173 23 19 1/ 5 14*	*1*

Lab Sample ID: LCS 720-147031/6
Matrix: Water
Analysis Batch: 147031

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1-Dichloroethene	25.0	27.1		ug/L		109	64 - 128
1,1-Dichloroethane	25.0	27.2		ug/L		109	70 - 130
Dichlorodifluoromethane	25.0	23.5		ug/L		94	34 - 132
Vinyl chloride	25.0	24.6		ug/L		98	54 - 135
Chloroethane	25.0	25.2		ug/L		101	62 - 138

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 720-147031/6
Matrix: Water
Analysis Batch: 147031

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Trichlorofluoromethane	25.0	24.1		ug/L		97	66 - 132
Methylene Chloride	25.0	24.3		ug/L		97	70 - 147
trans-1,2-Dichloroethene	25.0	25.9		ug/L		103	68 - 130
cis-1,2-Dichloroethene	25.0	27.9		ug/L		112	70 - 130
Chloroform	25.0	26.7		ug/L		107	70 - 130
1,1,1-Trichloroethane	25.0	27.7		ug/L		111	70 - 130
Carbon tetrachloride	25.0	27.4		ug/L		110	70 - 146
1,2-Dichloroethane	25.0	26.4		ug/L		105	61 - 132
Trichloroethene	25.0	26.9		ug/L		108	70 - 130
1,2-Dichloropropane	25.0	26.6		ug/L		106	70 - 130
Dichlorobromomethane	25.0	27.9		ug/L		111	70 - 130
trans-1,3-Dichloropropene	25.0	28.8		ug/L		115	70 - 140
cis-1,3-Dichloropropene	25.0	28.1		ug/L		112	70 - 130
1,1,2-Trichloroethane	25.0	27.3		ug/L		109	70 - 130
Tetrachloroethene	25.0	27.3		ug/L		109	70 - 130
Chlorodibromomethane	25.0	27.9		ug/L		111	70 - 145
Chlorobenzene	25.0	26.1		ug/L		104	70 - 130
Bromoform	25.0	27.1		ug/L		109	68 - 136
1,1,2,2-Tetrachloroethane	25.0	27.8		ug/L		111	70 - 130
1,3-Dichlorobenzene	25.0	26.6		ug/L		107	70 - 130
1,4-Dichlorobenzene	25.0	26.5		ug/L		106	70 - 130
1,2-Dichlorobenzene	25.0	25.6		ug/L		102	70 - 130
Chloromethane	25.0	23.9		ug/L		96	52 - 175
Bromomethane	25.0	25.0		ug/L		100	43 - 151
1,1,2-Trichloro-1,2,2-trifluoroetha ne	25.0	25.1		ug/L		100	42 - 162
EDB	25.0	27.5		ug/L		110	70 - 130
1,2,4-Trichlorobenzene	25.0	25.9		ug/L		103	70 - 130

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Toluene-d8 (Surr)	*60*		*07 - 197*
4-: roB orhuorof enbene	*62*		*z0 - 197*
1,/ -Dichloroethane-d4 (Surr)	*6/*		*0/ - 197*

Lab Sample ID: LCSD 720-147031/7
Matrix: Water
Analysis Batch: 147031

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1-Dichloroethene	25.0	27.7		ug/L		111	64 - 128	2	20
1,1-Dichloroethane	25.0	27.5		ug/L		110	70 - 130	1	20
Dichlorodifluoromethane	25.0	24.3		ug/L		97	34 - 132	3	20
Vinyl chloride	25.0	25.1		ug/L		100	54 - 135	2	20
Chloroethane	25.0	25.1		ug/L		101	62 - 138	0	20
Trichlorofluoromethane	25.0	25.0		ug/L		100	66 - 132	3	20
Methylene Chloride	25.0	24.9		ug/L		100	70 - 147	3	20
trans-1,2-Dichloroethene	25.0	26.6		ug/L		106	68 - 130	3	20
cis-1,2-Dichloroethene	25.0	28.2		ug/L		113	70 - 130	1	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCSD 720-147031/7
Matrix: Water
Analysis Batch: 147031

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Chloroform			25.0	26.8		ug/L		107	70 - 130	0	20
1,1,1-Trichloroethane			25.0	28.5		ug/L		114	70 - 130	3	20
Carbon tetrachloride			25.0	27.8		ug/L		111	70 - 146	2	20
1,2-Dichloroethane			25.0	26.3		ug/L		105	61 - 132	0	20
Trichloroethene			25.0	27.2		ug/L		109	70 - 130	1	20
1,2-Dichloropropane			25.0	26.4		ug/L		106	70 - 130	1	20
Dichlorobromomethane			25.0	27.5		ug/L		110	70 - 130	1	20
trans-1,3-Dichloropropene			25.0	27.5		ug/L		110	70 - 140	4	20
cis-1,3-Dichloropropene			25.0	27.6		ug/L		110	70 - 130	2	20
1,1,2-Trichloroethane			25.0	26.6		ug/L		106	70 - 130	3	20
Tetrachloroethene			25.0	26.9		ug/L		108	70 - 130	1	20
Chlorodibromomethane			25.0	27.0		ug/L		108	70 - 145	3	20
Chlorobenzene			25.0	25.8		ug/L		103	70 - 130	1	20
Bromoform			25.0	26.7		ug/L		107	68 - 136	2	20
1,1,2,2-Tetrachloroethane			25.0	27.1		ug/L		108	70 - 130	3	20
1,3-Dichlorobenzene			25.0	26.8		ug/L		107	70 - 130	1	20
1,4-Dichlorobenzene			25.0	26.4		ug/L		106	70 - 130	0	20
1,2-Dichlorobenzene			25.0	25.8		ug/L		103	70 - 130	1	20
Chloromethane			25.0	24.4		ug/L		98	52 - 175	2	20
Bromomethane			25.0	24.7		ug/L		99	43 - 151	1	20
1,1,2-Trichloro-1,2,2-trifluoroetha ne			25.0	25.9		ug/L		103	42 - 162	3	20
EDB			25.0	26.8		ug/L		107	70 - 130	3	20
1,2,4-Trichlorobenzene			25.0	26.3		ug/L		105	70 - 130	2	20

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*60*		*07 - 197*
4-: roB orhuorof enbene	*6z*		*z0 - 197*
1,/ -Dichloroethane-d4 (Surr)	*69*		*0/ - 197*

Lab Sample ID: 720-53136-1 MS
Matrix: Water
Analysis Batch: 147031

Client Sample ID: S-2942-10142013-INFL
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1-Dichloroethene	ND		2500	2860		ug/L		113	60 - 140
1,1-Dichloroethane	110		2500	2950		ug/L		113	60 - 140
Dichlorodifluoromethane	ND		2500	2430		ug/L		97	38 - 140
Vinyl chloride	ND		2500	2430		ug/L		96	58 - 140
Chloroethane	ND		2500	2440		ug/L		98	51 - 140
Trichlorofluoromethane	ND		2500	2460		ug/L		98	60 - 140
Methylene Chloride	ND		2500	2550		ug/L		102	40 - 140
trans-1,2-Dichloroethene	ND		2500	2750		ug/L		108	60 - 140
cis-1,2-Dichloroethene	4300		2500	7500		ug/L		127	60 - 140
Chloroform	ND		2500	2780		ug/L		111	60 - 140
1,1,1-Trichloroethane	61		2500	3030		ug/L		119	60 - 140
Carbon tetrachloride	ND		2500	2930		ug/L		117	60 - 140
1,2-Dichloroethane	ND		2500	2690		ug/L		107	60 - 140

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 720-53136-1 MS
Matrix: Water
Analysis Batch: 147031

Client Sample ID: S-2942-10142013-INFL
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Trichloroethene	3200		2500	6300		ug/L		124	60 - 140
1,2-Dichloropropane	ND		2500	2790		ug/L		112	60 - 140
Dichlorobromomethane	ND		2500	2880		ug/L		115	60 - 140
trans-1,3-Dichloropropene	ND		2500	2930		ug/L		116	60 - 140
cis-1,3-Dichloropropene	ND		2500	2910		ug/L		116	60 - 140
1,1,2-Trichloroethane	ND		2500	2790		ug/L		112	60 - 140
Tetrachloroethene	ND		2500	2980		ug/L		119	60 - 140
Chlorodibromomethane	ND		2500	2830		ug/L		113	60 - 140
Chlorobenzene	ND		2500	2690		ug/L		108	60 - 140
Bromoform	ND		2500	2740		ug/L		110	56 - 140
1,1,2,2-Tetrachloroethane	ND		2500	2790		ug/L		112	60 - 140
1,3-Dichlorobenzene	ND		2500	2780		ug/L		111	60 - 140
1,4-Dichlorobenzene	ND		2500	2740		ug/L		109	60 - 140
1,2-Dichlorobenzene	ND		2500	2670		ug/L		107	60 - 140
Chloromethane	ND		2500	2340		ug/L		94	52 - 140
Bromomethane	ND		2500	2400		ug/L		96	23 - 140
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		2500	2740		ug/L		108	60 - 140
EDB	ND		2500	2830		ug/L		113	60 - 140
1,2,4-Trichlorobenzene	ND		2500	2650		ug/L		104	60 - 140

Surrogate	*MS %Recovery*	*MS Qualifier*	*Limits*
Toluene-d8 (Surr)	*66*		*07 - 197*
4-: roB orhuorof enbene	*62*		*z0 - 197*
1,/ -Dichloroethane-d4 (Surr)	*61*		*0/ - 197*

Lab Sample ID: 720-53136-1 MSD
Matrix: Water
Analysis Batch: 147031

Client Sample ID: S-2942-10142013-INFL
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1-Dichloroethene	ND		2500	2850		ug/L		113	60 - 140	0	20
1,1-Dichloroethane	110		2500	2910		ug/L		112	60 - 140	1	20
Dichlorodifluoromethane	ND		2500	2340		ug/L		93	38 - 140	4	20
Vinyl chloride	ND		2500	2370		ug/L		94	58 - 140	3	20
Chloroethane	ND		2500	2360		ug/L		94	51 - 140	4	20
Trichlorofluoromethane	ND		2500	2370		ug/L		95	60 - 140	4	20
Methylene Chloride	ND		2500	2530		ug/L		101	40 - 140	1	20
trans-1,2-Dichloroethene	ND		2500	2740		ug/L		108	60 - 140	0	20
cis-1,2-Dichloroethene	4300		2500	7360		ug/L		121	60 - 140	2	20
Chloroform	ND		2500	2720		ug/L		109	60 - 140	2	20
1,1,1-Trichloroethane	61		2500	2990		ug/L		117	60 - 140	1	20
Carbon tetrachloride	ND		2500	2900		ug/L		116	60 - 140	1	20
1,2-Dichloroethane	ND		2500	2660		ug/L		106	60 - 140	1	20
Trichloroethene	3200		2500	6240		ug/L		121	60 - 140	1	20
1,2-Dichloropropane	ND		2500	2770		ug/L		111	60 - 140	1	20
Dichlorobromomethane	ND		2500	2840		ug/L		114	60 - 140	2	20
trans-1,3-Dichloropropene	ND		2500	2930		ug/L		116	60 - 140	0	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 720-53136-1 MSD
Matrix: Water
Analysis Batch: 147031

Client Sample ID: S-2942-10142013-INFL
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
cis-1,3-Dichloropropene	ND		2500	2900		ug/L		116	60 - 140	0	20
1,1,2-Trichloroethane	ND		2500	2790		ug/L		111	60 - 140	0	20
Tetrachloroethene	ND		2500	2930		ug/L		117	60 - 140	2	20
Chlorodibromomethane	ND		2500	2850		ug/L		113	60 - 140	1	20
Chlorobenzene	ND		2500	2660		ug/L		106	60 - 140	1	20
Bromoform	ND		2500	2710		ug/L		108	56 - 140	1	20
1,1,2,2-Tetrachloroethane	ND		2500	2780		ug/L		111	60 - 140	1	20
1,3-Dichlorobenzene	ND		2500	2770		ug/L		111	60 - 140	0	20
1,4-Dichlorobenzene	ND		2500	2740		ug/L		109	60 - 140	0	20
1,2-Dichlorobenzene	ND		2500	2650		ug/L		106	60 - 140	1	20
Chloromethane	ND		2500	2330		ug/L		93	52 - 140	0	20
Bromomethane	ND		2500	2340		ug/L		94	23 - 140	2	20
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		2500	2730		ug/L		107	60 - 140	0	20
EDB	ND		2500	2800		ug/L		112	60 - 140	1	20
1,2,4-Trichlorobenzene	ND		2500	2680		ug/L		106	60 - 140	1	20

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*68*		*07 - 197*
4-: roB ortuorof enbene	*64*		*z0 - 197*
1,/ -Dichloroethane-d4 (Surr)	*67*		*0/ - 197*

QC Association Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53136-1

GC/MS VOA

Analysis Batch: 147031

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-1	S-2942-10142013-INFL	Total/NA	Water	8260B	
720-53136-1 MS	S-2942-10142013-INFL	Total/NA	Water	8260B	
720-53136-1 MSD	S-2942-10142013-INFL	Total/NA	Water	8260B	
720-53136-2	S-2942-10142013-EFFL	Total/NA	Water	8260B	
LCS 720-147031/6	Lab Control Sample	Total/NA	Water	8260B	
LCSD 720-147031/7	Lab Control Sample Dup	Total/NA	Water	8260B	
MB 720-147031/5	Method Blank	Total/NA	Water	8260B	

Lab Chronicle

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53136-1

Client Sample ID: S-2942-10142013-INFL — **Lab Sample ID: 720-53136-1**
Date Collected: 10/17/13 11:00 — **Matrix: Water**
Date Received: 10/18/13 09:20

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		100	147031	10/25/13 14:09	LPL	TAL PLS

Client Sample ID: S-2942-10142013-EFFL — **Lab Sample ID: 720-53136-2**
Date Collected: 10/17/13 11:00 — **Matrix: Water**
Date Received: 10/18/13 09:20

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	147031	10/25/13 15:37	LPL	TAL PLS

Laboratory References:

TAL PLS = TestAmerica Pleasanton, 1220 Quarry Lane, Pleasanton, CA 94566, TEL (925)484-1919

Certification Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53136-1

Laboratory: TestAmerica Pleasanton

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
California	State Program	9	2496	01-31-14

Method Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53136-1

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL PLS

Protocol References:

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL PLS = TestAmerica Pleasanton, 1220 Quarry Lane, Pleasanton, CA 94566, TEL (925)484-1919

Sample Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53136-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
720-53136-1	S-2942-10142013-INFL	Water	10/17/13 11:00	10/18/13 09:20
720-53136-2	S-2942-10142013-EFFL	Water	10/17/13 11:00	10/18/13 09:20

720-53136

149438

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

Project Number: S-2942	Project Name: Mountainview ZVI Column Study
Point of Contact: Jeff Roberts: (519) 515-0840	
Vendor: SiRem — 130 Research Lane, Suite 2, Guelph, ON N1G 5G3, Canada	
Vendor Contact: Jeff Roberts - 519-515-0840	Possible Hazards: (None) Flammable Radioactive Poison Other
Delivery Service: FED-EX	AirBill No.:
TAT Requested: As per CoC otherwise normal 10 BD	

Number of Coolers: 1

CoC Page(s):

Attn - Micah Smith
Test America
1220 Quarry Lane
Pleasanton, CA

Bottle Type and Preservative (Use Lab's bottle order for combined analyses)

Zone:	Area:				8260B (cVOC's)	
Sample ID	Date	Time	Matrix	# Cont.	40mL VOAs preserved with HCL	
S-2942-10172013-INFL	17-Oct-13	11:00am	groundwater	1	x	
S-2942-10172013-EFFL	17-Oct-13	11:00am	groundwater	1	x	

720-53136 Chain of Custody

Relinquished by	Received by		Received by	
Signature	Signature		Signature 10-18-13 920	
Printed Name: JASON WHITE	Printed Name		Printed Name	
Firm: SIREM	Firm		Firm	Lab Remarks: Custody Intact? YES NO; Cooler Temperature: 5.9 °C; Other:
Date/Time: 17-Oct-2013 11:00am	Date/Time		Date/Time	

Login Sample Receipt Checklist

Client: Sirem, div of Geosyntec Consultants

Job Number: 720-53136-1

Login Number: 53136

List Source: TestAmerica Pleasanton

List Number: 1

Creator: Gonzales, Justinn

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	False	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Pleasanton
1220 Quarry Lane
Pleasanton, CA 94566
Tel: (925)484-1919

TestAmerica Job ID: 720-53638-1
Client Project/Site: Mountainview ZVI Column Study

For:
Sirem, div of Geosyntec Consultants
130 Research Lane
Suite 2
Guelph, Ontario N1G 5G3

Attn: Jason White

Authorized for release by:
11/18/2013 3:38:15 PM

Micah Smith, Project Manager I
()
micah.smith@testamericainc.com

Table of Contents

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Qualifiers

General Chemistry

Qualifier	Qualifier Description
B	Compound was found in the blank and sample.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Job ID: 720-53638-1

Laboratory: TestAmerica Pleasanton

Narrative

Job Narrative
720-53638-1

Comments
No additional comments.

Receipt
The samples were received on 11/8/2013 9:25 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 3.6º C.

Except:

For 8260 and TOC analyses should receive 3 containers per analysis but only one vial was recieved.

GC/MS VOA
Method(s) 8260B: Hits confirmed by re-analysis for sample 720-53638-2.

No other analytical or quality issues were noted.

Metals
No analytical or quality issues were noted.

General Chemistry
Method(s) SM 2320B: Due to a limited amount of sample, a sample duplicate for batch 148396 was not performed.

Method(s) SM 2540C: The method blank for batch 148280 contained TDS above the reporting limit (RL). There was insufficient sample to perform a re-extraction and/or re-analysis; therefore, the data have been reported.

Method(s) SM 2540C: There was insufficient sample to run a duplicate for this batch.

No other analytical or quality issues were noted.

Detection Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Client Sample ID: S-2942-11072013-INFL — Lab Sample ID: 720-53638-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,1-Dichloroethane	120		100		ug/L	200		8260B	Total/NA
cis-1,2-Dichloroethene	6700		100		ug/L	200		8260B	Total/NA
Trichloroethene	3500		100		ug/L	200		8260B	Total/NA
Barium	0.075		0.0050		mg/L	1		6010B	Total/NA
Calcium	51		0.20		mg/L	1		6010B	Total/NA
Potassium	1.2		1.0		mg/L	1		6010B	Total/NA
Magnesium	47		0.20		mg/L	1		6010B	Total/NA
Sodium	32		0.50		mg/L	1		6010B	Total/NA
Sr	0.39		0.010		mg/L	1		6010B	Total/NA
Alkalinity	160		5.0		mg/L	1		SM 2320B	Total/NA
Bicarbonate Alkalinity as CaCO3	160		5.0		mg/L	1		SM 2320B	Total/NA

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Total Dissolved Solids	490	B	10		mg/L	1		SM 2540C	Total/NA

Client Sample ID: S-2942-11072013-EFFL — Lab Sample ID: 720-53638-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Chloroethane	9.8		1.0		ug/L	1		8260B	Total/NA
Methylene Chloride	15		5.0		ug/L	1		8260B	Total/NA
Chloromethane	1.7		1.0		ug/L	1		8260B	Total/NA
Barium	0.16		0.0050		mg/L	1		6010B	Total/NA
Calcium	23		0.20		mg/L	1		6010B	Total/NA
Potassium	1.2		1.0		mg/L	1		6010B	Total/NA
Magnesium	31		0.20		mg/L	1		6010B	Total/NA
Manganese	0.14		0.020		mg/L	1		6010B	Total/NA
Sodium	31		0.50		mg/L	1		6010B	Total/NA
Sr	0.099		0.010		mg/L	1		6010B	Total/NA
Alkalinity	5.5		5.0		mg/L	1		SM 2320B	Total/NA
Bicarbonate Alkalinity as CaCO3	5.5		5.0		mg/L	1		SM 2320B	Total/NA
TOC Dup	3.9		1.0		mg/L	1		SM 5310C	Total/NA

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Total Dissolved Solids	390	B	10		mg/L	1		SM 2540C	Total/NA

This Detection Summary does not include radiochemical test results.

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Client Sample ID: S-2942-11072013-INFL
Date Collected: 11/07/13 11:00
Date Received: 11/08/13 09:25

Lab Sample ID: 720-53638-1
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		100		ug/L			11/14/13 19:19	200
1,1-Dichloroethane	**120**		100		ug/L			11/14/13 19:19	200
Dichlorodifluoromethane	ND		100		ug/L			11/14/13 19:19	200
Vinyl chloride	ND		100		ug/L			11/14/13 19:19	200
Chloroethane	ND		200		ug/L			11/14/13 19:19	200
Trichlorofluoromethane	ND		200		ug/L			11/14/13 19:19	200
Methylene Chloride	ND		1000		ug/L			11/14/13 19:19	200
trans-1,2-Dichloroethene	ND		100		ug/L			11/14/13 19:19	200
cis-1,2-Dichloroethene	**6700**		100		ug/L			11/14/13 19:19	200
Chloroform	ND		200		ug/L			11/14/13 19:19	200
1,1,1-Trichloroethane	ND		100		ug/L			11/14/13 19:19	200
Carbon tetrachloride	ND		100		ug/L			11/14/13 19:19	200
1,2-Dichloroethane	ND		100		ug/L			11/14/13 19:19	200
Trichloroethene	**3500**		100		ug/L			11/14/13 19:19	200
1,2-Dichloropropane	ND		100		ug/L			11/14/13 19:19	200
Dichlorobromomethane	ND		100		ug/L			11/14/13 19:19	200
trans-1,3-Dichloropropene	ND		100		ug/L			11/14/13 19:19	200
cis-1,3-Dichloropropene	ND		100		ug/L			11/14/13 19:19	200
1,1,2-Trichloroethane	ND		100		ug/L			11/14/13 19:19	200
Tetrachloroethene	ND		100		ug/L			11/14/13 19:19	200
Chlorodibromomethane	ND		100		ug/L			11/14/13 19:19	200
Chlorobenzene	ND		100		ug/L			11/14/13 19:19	200
Bromoform	ND		200		ug/L			11/14/13 19:19	200
1,1,2,2-Tetrachloroethane	ND		100		ug/L			11/14/13 19:19	200
1,3-Dichlorobenzene	ND		100		ug/L			11/14/13 19:19	200
1,4-Dichlorobenzene	ND		100		ug/L			11/14/13 19:19	200
1,2-Dichlorobenzene	ND		100		ug/L			11/14/13 19:19	200
Chloromethane	ND		200		ug/L			11/14/13 19:19	200
Bromomethane	ND		200		ug/L			11/14/13 19:19	200
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		100		ug/L			11/14/13 19:19	200
EDB	ND		100		ug/L			11/14/13 19:19	200
1,2,4-Trichlorobenzene	ND		200		ug/L			11/14/13 19:19	200

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*91*		*70 - 130*		*11/14/13 19:19*	*200*
4-Bromofluorobenzene	*88*		*67 - 130*		*11/14/13 19:19*	*200*
1,2-Dichloroethane-d4 (Surr)	*99*		*72 - 130*		*11/14/13 19:19*	*200*

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1
Aluminum	ND		0.20		mg/L		11/12/13 07:54	11/12/13 18:44	1
Arsenic	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1
Barium	**0.075**		0.0050		mg/L		11/12/13 07:54	11/12/13 18:44	1
Beryllium	ND		0.0020		mg/L		11/12/13 07:54	11/12/13 18:44	1
Cadmium	ND		0.0025		mg/L		11/12/13 07:54	11/12/13 18:44	1
Calcium	**51**		0.20		mg/L		11/12/13 07:54	11/12/13 18:44	1
Chromium	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1
Cobalt	ND		0.0020		mg/L		11/12/13 07:54	11/12/13 18:44	1
Copper	ND		0.020		mg/L		11/12/13 07:54	11/12/13 18:44	1

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Client Sample ID: S-2942-11072013-INFL
Date Collected: 11/07/13 11:00
Date Received: 11/08/13 09:25

Lab Sample ID: 720-53638-1
Matrix: Water

Method: 6010B - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		0.0050		mg/L		11/12/13 07:54	11/12/13 18:44	1
Molybdenum	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1
Iron	ND		0.20		mg/L		11/12/13 07:54	11/13/13 16:39	1
Nickel	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1
Potassium	**1.2**		1.0		mg/L		11/12/13 07:54	11/12/13 18:44	1
Selenium	ND		0.020		mg/L		11/12/13 07:54	11/12/13 18:44	1
Magnesium	**47**		0.20		mg/L		11/12/13 07:54	11/12/13 18:44	1
Manganese	ND		0.020		mg/L		11/12/13 07:54	11/12/13 18:44	1
Thallium	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1
Vanadium	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1
Sodium	**32**		0.50		mg/L		11/12/13 07:54	11/13/13 16:39	1
Zinc	ND		0.020		mg/L		11/12/13 07:54	11/12/13 18:44	1
Sr	**0.39**		0.010		mg/L		11/12/13 07:54	11/15/13 23:15	1
Sn	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1
Ti	ND		0.010		mg/L		11/12/13 07:54	11/12/13 18:44	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	**160**		5.0		mg/L			11/15/13 10:30	1
Bicarbonate Alkalinity as CaCO3	**160**		5.0		mg/L			11/15/13 10:30	1
Carbonate Alkalinity as CaCO3	ND		5.0		mg/L			11/15/13 10:30	1
Hydroxide Alkalinity	ND		5.0		mg/L			11/15/13 10:30	1
TOC Dup	ND		1.0		mg/L			11/13/13 10:12	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**490**	**B**	10		mg/L			11/13/13 22:05	1

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Client Sample ID: S-2942-11072013-EFFL
Date Collected: 11/07/13 11:00
Date Received: 11/08/13 09:25

Lab Sample ID: 720-53638-2
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		0.50		ug/L			11/14/13 16:21	1
1,1-Dichloroethane	ND		0.50		ug/L			11/14/13 16:21	1
Dichlorodifluoromethane	ND		0.50		ug/L			11/14/13 16:21	1
Vinyl chloride	ND		0.50		ug/L			11/14/13 16:21	1
Chloroethane	**9.8**		1.0		ug/L			11/14/13 16:21	1
Trichlorofluoromethane	ND		1.0		ug/L			11/14/13 16:21	1
Methylene Chloride	**15**		5.0		ug/L			11/14/13 16:21	1
trans-1,2-Dichloroethene	ND		0.50		ug/L			11/14/13 16:21	1
cis-1,2-Dichloroethene	ND		0.50		ug/L			11/14/13 16:21	1
Chloroform	ND		1.0		ug/L			11/14/13 16:21	1
1,1,1-Trichloroethane	ND		0.50		ug/L			11/14/13 16:21	1
Carbon tetrachloride	ND		0.50		ug/L			11/14/13 16:21	1
1,2-Dichloroethane	ND		0.50		ug/L			11/14/13 16:21	1
Trichloroethene	ND		0.50		ug/L			11/14/13 16:21	1
1,2-Dichloropropane	ND		0.50		ug/L			11/14/13 16:21	1
Dichlorobromomethane	ND		0.50		ug/L			11/14/13 16:21	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			11/14/13 16:21	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			11/14/13 16:21	1
1,1,2-Trichloroethane	ND		0.50		ug/L			11/14/13 16:21	1
Tetrachloroethene	ND		0.50		ug/L			11/14/13 16:21	1
Chlorodibromomethane	ND		0.50		ug/L			11/14/13 16:21	1
Chlorobenzene	ND		0.50		ug/L			11/14/13 16:21	1
Bromoform	ND		1.0		ug/L			11/14/13 16:21	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			11/14/13 16:21	1
1,3-Dichlorobenzene	ND		0.50		ug/L			11/14/13 16:21	1
1,4-Dichlorobenzene	ND		0.50		ug/L			11/14/13 16:21	1
1,2-Dichlorobenzene	ND		0.50		ug/L			11/14/13 16:21	1
Chloromethane	**1.7**		1.0		ug/L			11/14/13 16:21	1
Bromomethane	ND		1.0		ug/L			11/14/13 16:21	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		0.50		ug/L			11/14/13 16:21	1
EDB	ND		0.50		ug/L			11/14/13 16:21	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			11/14/13 16:21	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*93*		*70 - 130*		*11/14/13 16:21*	*1*
4-Bromofluorobenzene	*87*		*67 - 130*		*11/14/13 16:21*	*1*
1,2-Dichloroethane-d4 (Surr)	*95*		*72 - 130*		*11/14/13 16:21*	*1*

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1
Aluminum	ND		0.20		mg/L		11/12/13 07:59	11/12/13 18:49	1
Arsenic	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1
Barium	**0.16**		0.0050		mg/L		11/12/13 07:59	11/12/13 18:49	1
Beryllium	ND		0.0020		mg/L		11/12/13 07:59	11/12/13 18:49	1
Cadmium	ND		0.0025		mg/L		11/12/13 07:59	11/12/13 18:49	1
Calcium	**23**		0.20		mg/L		11/12/13 07:59	11/12/13 18:49	1
Chromium	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1
Cobalt	ND		0.0020		mg/L		11/12/13 07:59	11/12/13 18:49	1
Copper	ND		0.020		mg/L		11/12/13 07:59	11/12/13 18:49	1

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Client Sample ID: S-2942-11072013-EFFL
Date Collected: 11/07/13 11:00
Date Received: 11/08/13 09:25

Lab Sample ID: 720-53638-2
Matrix: Water

Method: 6010B - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		0.0050		mg/L		11/12/13 07:59	11/12/13 18:49	1
Molybdenum	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1
Iron	ND		0.20		mg/L		11/12/13 07:59	11/13/13 16:43	1
Nickel	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1
Potassium	**1.2**		1.0		mg/L		11/12/13 07:59	11/12/13 18:49	1
Selenium	ND		0.020		mg/L		11/12/13 07:59	11/12/13 18:49	1
Magnesium	**31**		0.20		mg/L		11/12/13 07:59	11/12/13 18:49	1
Manganese	**0.14**		0.020		mg/L		11/12/13 07:59	11/12/13 18:49	1
Thallium	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1
Vanadium	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1
Sodium	**31**		0.50		mg/L		11/12/13 07:59	11/13/13 16:43	1
Zinc	ND		0.020		mg/L		11/12/13 07:59	11/12/13 18:49	1
Sr	**0.099**		0.010		mg/L		11/12/13 07:59	11/15/13 23:20	1
Sn	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1
Ti	ND		0.010		mg/L		11/12/13 07:59	11/12/13 18:49	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	**5.5**		5.0		mg/L			11/15/13 10:36	1
Bicarbonate Alkalinity as CaCO3	**5.5**		5.0		mg/L			11/15/13 10:36	1
Carbonate Alkalinity as CaCO3	ND		5.0		mg/L			11/15/13 10:36	1
Hydroxide Alkalinity	ND		5.0		mg/L			11/15/13 10:36	1
TOC Dup	**3.9**		1.0		mg/L			11/13/13 10:56	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**390**	**B**	10		mg/L			11/13/13 22:05	1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 720-148337/6
Matrix: Water
Analysis Batch: 148337

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	ND		0.50		ug/L			11/14/13 13:58	1
1,1-Dichloroethane	ND		0.50		ug/L			11/14/13 13:58	1
Dichlorodifluoromethane	ND		0.50		ug/L			11/14/13 13:58	1
Vinyl chloride	ND		0.50		ug/L			11/14/13 13:58	1
Chloroethane	ND		1.0		ug/L			11/14/13 13:58	1
Trichlorofluoromethane	ND		1.0		ug/L			11/14/13 13:58	1
Methylene Chloride	ND		5.0		ug/L			11/14/13 13:58	1
trans-1,2-Dichloroethene	ND		0.50		ug/L			11/14/13 13:58	1
cis-1,2-Dichloroethene	ND		0.50		ug/L			11/14/13 13:58	1
Chloroform	ND		1.0		ug/L			11/14/13 13:58	1
1,1,1-Trichloroethane	ND		0.50		ug/L			11/14/13 13:58	1
Carbon tetrachloride	ND		0.50		ug/L			11/14/13 13:58	1
1,2-Dichloroethane	ND		0.50		ug/L			11/14/13 13:58	1
Trichloroethene	ND		0.50		ug/L			11/14/13 13:58	1
1,2-Dichloropropane	ND		0.50		ug/L			11/14/13 13:58	1
Dichlorobromomethane	ND		0.50		ug/L			11/14/13 13:58	1
trans-1,3-Dichloropropene	ND		0.50		ug/L			11/14/13 13:58	1
cis-1,3-Dichloropropene	ND		0.50		ug/L			11/14/13 13:58	1
1,1,2-Trichloroethane	ND		0.50		ug/L			11/14/13 13:58	1
Tetrachloroethene	ND		0.50		ug/L			11/14/13 13:58	1
Chlorodibromomethane	ND		0.50		ug/L			11/14/13 13:58	1
Chlorobenzene	ND		0.50		ug/L			11/14/13 13:58	1
Bromoform	ND		1.0		ug/L			11/14/13 13:58	1
1,1,2,2-Tetrachloroethane	ND		0.50		ug/L			11/14/13 13:58	1
1,3-Dichlorobenzene	ND		0.50		ug/L			11/14/13 13:58	1
1,4-Dichlorobenzene	ND		0.50		ug/L			11/14/13 13:58	1
1,2-Dichlorobenzene	ND		0.50		ug/L			11/14/13 13:58	1
Chloromethane	ND		1.0		ug/L			11/14/13 13:58	1
Bromomethane	ND		1.0		ug/L			11/14/13 13:58	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		0.50		ug/L			11/14/13 13:58	1
EDB	ND		0.50		ug/L			11/14/13 13:58	1
1,2,4-Trichlorobenzene	ND		1.0		ug/L			11/14/13 13:58	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*90*		*70 - 130*		*11/12/13 13:48*	*1*
2-: roB omuorof enbene	*83*		*z7 - 130*		*11/12/13 13:48*	*1*
16 -Dichloroethane-d2 (Surr)	*100*		*7, - 130*		*11/12/13 13:48*	*1*

Lab Sample ID: LCS 720-148337/7
Matrix: Water
Analysis Batch: 148337

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1-Dichloroethene	25.0	21.5		ug/L		86	64 - 128
1,1-Dichloroethane	25.0	26.3		ug/L		105	70 - 130
Dichlorodifluoromethane	25.0	23.5		ug/L		94	34 - 132
Vinyl chloride	25.0	21.6		ug/L		86	54 - 135
Chloroethane	25.0	21.8		ug/L		87	62 - 138

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 720-148337/7
Matrix: Water
Analysis Batch: 148337

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Trichlorofluoromethane	25.0	27.4		ug/L		109	66 - 132
Methylene Chloride	25.0	23.4		ug/L		94	70 - 147
trans-1,2-Dichloroethene	25.0	23.6		ug/L		95	68 - 130
cis-1,2-Dichloroethene	25.0	28.5		ug/L		114	70 - 130
Chloroform	25.0	26.9		ug/L		108	70 - 130
1,1,1-Trichloroethane	25.0	28.3		ug/L		113	70 - 130
Carbon tetrachloride	25.0	27.4		ug/L		109	70 - 146
1,2-Dichloroethane	25.0	26.6		ug/L		107	61 - 132
Trichloroethene	25.0	26.3		ug/L		105	70 - 130
1,2-Dichloropropane	25.0	26.9		ug/L		108	70 - 130
Dichlorobromomethane	25.0	27.8		ug/L		111	70 - 130
trans-1,3-Dichloropropene	25.0	27.8		ug/L		111	70 - 140
cis-1,3-Dichloropropene	25.0	27.5		ug/L		110	70 - 130
1,1,2-Trichloroethane	25.0	26.1		ug/L		105	70 - 130
Tetrachloroethene	25.0	25.8		ug/L		103	70 - 130
Chlorodibromomethane	25.0	26.8		ug/L		107	70 - 145
Chlorobenzene	25.0	27.0		ug/L		108	70 - 130
Bromoform	25.0	26.5		ug/L		106	68 - 136
1,1,2,2-Tetrachloroethane	25.0	28.2		ug/L		113	70 - 130
1,3-Dichlorobenzene	25.0	28.3		ug/L		113	70 - 130
1,4-Dichlorobenzene	25.0	28.0		ug/L		112	70 - 130
1,2-Dichlorobenzene	25.0	26.8		ug/L		107	70 - 130
Chloromethane	25.0	24.0		ug/L		96	52 - 175
Bromomethane	25.0	21.5		ug/L		86	43 - 151
1,1,2-Trichloro-1,2,2-trifluoroetha ne	25.0	24.7		ug/L		99	42 - 162
EDB	25.0	25.8		ug/L		103	70 - 130
1,2,4-Trichlorobenzene	25.0	25.6		ug/L		102	70 - 130

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Toluene-d8 (Surr)	*100*		*70 - 130*
2-: roB orhuorof enbene	*103*		*z7 - 130*
16 -Dichloroethane-d2 (Surr)	*97*		*7, - 130*

Lab Sample ID: LCSD 720-148337/8
Matrix: Water
Analysis Batch: 148337

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1-Dichloroethene	25.0	19.9		ug/L		80	64 - 128	7	20
1,1-Dichloroethane	25.0	24.6		ug/L		98	70 - 130	7	20
Dichlorodifluoromethane	25.0	22.9		ug/L		92	34 - 132	2	20
Vinyl chloride	25.0	23.2		ug/L		93	54 - 135	7	20
Chloroethane	25.0	23.7		ug/L		95	62 - 138	9	20
Trichlorofluoromethane	25.0	26.5		ug/L		106	66 - 132	3	20
Methylene Chloride	25.0	21.6		ug/L		86	70 - 147	8	20
trans-1,2-Dichloroethene	25.0	22.1		ug/L		88	68 - 130	7	20
cis-1,2-Dichloroethene	25.0	26.5		ug/L		106	70 - 130	7	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCSD 720-148337/8
Matrix: Water
Analysis Batch: 148337

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Chloroform			25.0	25.3		ug/L		101	70 - 130	6	20
1,1,1-Trichloroethane			25.0	26.1		ug/L		104	70 - 130	8	20
Carbon tetrachloride			25.0	25.4		ug/L		102	70 - 146	7	20
1,2-Dichloroethane			25.0	24.8		ug/L		99	61 - 132	7	20
Trichloroethene			25.0	24.7		ug/L		99	70 - 130	6	20
1,2-Dichloropropane			25.0	25.3		ug/L		101	70 - 130	6	20
Dichlorobromomethane			25.0	26.1		ug/L		104	70 - 130	7	20
trans-1,3-Dichloropropene			25.0	26.4		ug/L		106	70 - 140	5	20
cis-1,3-Dichloropropene			25.0	26.3		ug/L		105	70 - 130	5	20
1,1,2-Trichloroethane			25.0	24.4		ug/L		98	70 - 130	7	20
Tetrachloroethene			25.0	24.2		ug/L		97	70 - 130	6	20
Chlorodibromomethane			25.0	25.1		ug/L		100	70 - 145	6	20
Chlorobenzene			25.0	25.4		ug/L		101	70 - 130	6	20
Bromoform			25.0	24.7		ug/L		99	68 - 136	7	20
1,1,2,2-Tetrachloroethane			25.0	25.7		ug/L		103	70 - 130	9	20
1,3-Dichlorobenzene			25.0	26.2		ug/L		105	70 - 130	8	20
1,4-Dichlorobenzene			25.0	25.9		ug/L		103	70 - 130	8	20
1,2-Dichlorobenzene			25.0	24.5		ug/L		98	70 - 130	9	20
Chloromethane			25.0	23.5		ug/L		94	52 - 175	2	20
Bromomethane			25.0	23.4		ug/L		94	43 - 151	9	20
1,1,2-Trichloro-1,2,2-trifluoroetha ne			25.0	22.7		ug/L		91	42 - 162	8	20
EDB			25.0	24.4		ug/L		98	70 - 130	6	20
1,2,4-Trichlorobenzene			25.0	24.3		ug/L		97	70 - 130	5	20

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*99*		*70 - 130*
2-: roB orhuorof enbene	*103*		*z7 - 130*
16 -Dichloroethane-d2 (Surr)	*9z*		*7, - 130*

Lab Sample ID: 720-53638-1 MS
Matrix: Water
Analysis Batch: 148337

Client Sample ID: S-2942-11072013-INFL
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1-Dichloroethene	ND		5000	4750		ug/L		95	60 - 140
1,1-Dichloroethane	120		5000	5400		ug/L		106	60 - 140
Dichlorodifluoromethane	ND		5000	4180		ug/L		84	38 - 140
Vinyl chloride	ND		5000	4370		ug/L		87	58 - 140
Chloroethane	ND		5000	4790		ug/L		96	51 - 140
Trichlorofluoromethane	ND		5000	4910		ug/L		98	60 - 140
Methylene Chloride	ND		5000	4720		ug/L		94	40 - 140
trans-1,2-Dichloroethene	ND		5000	4950		ug/L		98	60 - 140
cis-1,2-Dichloroethene	6700		5000	12700		ug/L		121	60 - 140
Chloroform	ND		5000	5390		ug/L		108	60 - 140
1,1,1-Trichloroethane	ND		5000	5730		ug/L		113	60 - 140
Carbon tetrachloride	ND		5000	5530		ug/L		111	60 - 140
1,2-Dichloroethane	ND		5000	5380		ug/L		108	60 - 140

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 720-53638-1 MS
Matrix: Water
Analysis Batch: 148337

Client Sample ID: S-2942-11072013-INFL
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Trichloroethene	3500		5000	9110		ug/L		113	60 - 140
1,2-Dichloropropane	ND		5000	5430		ug/L		109	60 - 140
Dichlorobromomethane	ND		5000	5560		ug/L		111	60 - 140
trans-1,3-Dichloropropene	ND		5000	5660		ug/L		113	60 - 140
cis-1,3-Dichloropropene	ND		5000	5540		ug/L		111	60 - 140
1,1,2-Trichloroethane	ND		5000	5260		ug/L		105	60 - 140
Tetrachloroethene	ND		5000	5400		ug/L		108	60 - 140
Chlorodibromomethane	ND		5000	5420		ug/L		108	60 - 140
Chlorobenzene	ND		5000	5360		ug/L		107	60 - 140
Bromoform	ND		5000	5240		ug/L		105	56 - 140
1,1,2,2-Tetrachloroethane	ND		5000	5380		ug/L		108	60 - 140
1,3-Dichlorobenzene	ND		5000	5550		ug/L		111	60 - 140
1,4-Dichlorobenzene	ND		5000	5460		ug/L		109	60 - 140
1,2-Dichlorobenzene	ND		5000	5200		ug/L		104	60 - 140
Chloromethane	ND		5000	4490		ug/L		90	52 - 140
Bromomethane	ND		5000	4620		ug/L		92	23 - 140
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		5000	5090		ug/L		101	60 - 140
EDB	ND		5000	5230		ug/L		105	60 - 140
1,2,4-Trichlorobenzene	ND		5000	5080		ug/L		101	60 - 140

Surrogate	*MS %Recovery*	*MS Qualifier*	*Limits*
Toluene-d8 (Surr)	*101*		*70 - 130*
2-: roB orhuorof enbene	*10,*		*z7 - 130*
16 -Dichloroethane-d2 (Surr)	*9z*		*7, - 130*

Lab Sample ID: 720-53638-1 MSD
Matrix: Water
Analysis Batch: 148337

Client Sample ID: S-2942-11072013-INFL
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1-Dichloroethene	ND		5000	4930		ug/L		99	60 - 140	4	20
1,1-Dichloroethane	120		5000	5560		ug/L		109	60 - 140	3	20
Dichlorodifluoromethane	ND		5000	4350		ug/L		87	38 - 140	4	20
Vinyl chloride	ND		5000	4670		ug/L		93	58 - 140	7	20
Chloroethane	ND		5000	5000		ug/L		100	51 - 140	4	20
Trichlorofluoromethane	ND		5000	5040		ug/L		101	60 - 140	3	20
Methylene Chloride	ND		5000	4880		ug/L		98	40 - 140	3	20
trans-1,2-Dichloroethene	ND		5000	5100		ug/L		101	60 - 140	3	20
cis-1,2-Dichloroethene	6700		5000	12900		ug/L		124	60 - 140	1	20
Chloroform	ND		5000	5470		ug/L		109	60 - 140	1	20
1,1,1-Trichloroethane	ND		5000	5830		ug/L		115	60 - 140	2	20
Carbon tetrachloride	ND		5000	5540		ug/L		111	60 - 140	0	20
1,2-Dichloroethane	ND		5000	5440		ug/L		109	60 - 140	1	20
Trichloroethene	3500		5000	9070		ug/L		112	60 - 140	0	20
1,2-Dichloropropane	ND		5000	5420		ug/L		108	60 - 140	0	20
Dichlorobromomethane	ND		5000	5560		ug/L		111	60 - 140	0	20
trans-1,3-Dichloropropene	ND		5000	5630		ug/L		113	60 - 140	0	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 720-53638-1 MSD
Matrix: Water
Analysis Batch: 148337

Client Sample ID: S-2942-11072013-INFL
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
cis-1,3-Dichloropropene	ND		5000	5550		ug/L		111	60 - 140	0	20
1,1,2-Trichloroethane	ND		5000	5230		ug/L		105	60 - 140	1	20
Tetrachloroethene	ND		5000	5190		ug/L		104	60 - 140	4	20
Chlorodibromomethane	ND		5000	5340		ug/L		107	60 - 140	2	20
Chlorobenzene	ND		5000	5310		ug/L		106	60 - 140	1	20
Bromoform	ND		5000	5150		ug/L		103	56 - 140	2	20
1,1,2,2-Tetrachloroethane	ND		5000	5460		ug/L		109	60 - 140	2	20
1,3-Dichlorobenzene	ND		5000	5560		ug/L		111	60 - 140	0	20
1,4-Dichlorobenzene	ND		5000	5500		ug/L		110	60 - 140	1	20
1,2-Dichlorobenzene	ND		5000	5230		ug/L		105	60 - 140	1	20
Chloromethane	ND		5000	4730		ug/L		95	52 - 140	5	20
Bromomethane	ND		5000	4840		ug/L		97	23 - 140	5	20
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		5000	5220		ug/L		104	60 - 140	2	20
EDB	ND		5000	5190		ug/L		104	60 - 140	1	20
1,2,4-Trichlorobenzene	ND		5000	5150		ug/L		102	60 - 140	1	20

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*99*		*70 - 130*
2-: roB ortuorof enbene	*102*		*z7 - 130*
16 -Dichloroethane-d2 (Surr)	*98*		*7, - 130*

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 720-148142/1-A
Matrix: Water
Analysis Batch: 148204

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 148142

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1
Aluminum	ND		0.20		mg/L		11/12/13 07:54	11/12/13 17:40	1
Arsenic	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1
Barium	ND		0.0050		mg/L		11/12/13 07:54	11/12/13 17:40	1
Beryllium	ND		0.0020		mg/L		11/12/13 07:54	11/12/13 17:40	1
Cadmium	ND		0.0025		mg/L		11/12/13 07:54	11/12/13 17:40	1
Calcium	ND		0.20		mg/L		11/12/13 07:54	11/12/13 17:40	1
Chromium	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1
Cobalt	ND		0.0020		mg/L		11/12/13 07:54	11/12/13 17:40	1
Copper	ND		0.020		mg/L		11/12/13 07:54	11/12/13 17:40	1
Lead	ND		0.0050		mg/L		11/12/13 07:54	11/12/13 17:40	1
Molybdenum	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1
Nickel	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1
Potassium	ND		1.0		mg/L		11/12/13 07:54	11/12/13 17:40	1
Selenium	ND		0.020		mg/L		11/12/13 07:54	11/12/13 17:40	1
Magnesium	ND		0.20		mg/L		11/12/13 07:54	11/12/13 17:40	1
Manganese	ND		0.020		mg/L		11/12/13 07:54	11/12/13 17:40	1
Thallium	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1
Vanadium	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: MB 720-148142/1-A — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148204 — **Prep Batch: 148142**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Zinc	ND		0.020		mg/L		11/12/13 07:54	11/12/13 17:40	1
Sn	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1
Ti	ND		0.010		mg/L		11/12/13 07:54	11/12/13 17:40	1

Lab Sample ID: MB 720-148142/1-A — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148271 — **Prep Batch: 148142**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		0.20		mg/L		11/12/13 07:54	11/13/13 16:09	1
Sodium	ND		0.50		mg/L		11/12/13 07:54	11/13/13 16:09	1

Lab Sample ID: MB 720-148142/1-A — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148480 — **Prep Batch: 148142**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sr	ND		0.010		mg/L		11/12/13 07:54	11/15/13 22:44	1

Lab Sample ID: LCS 720-148142/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148204 — **Prep Batch: 148142**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	1.00	1.02		mg/L		102	80 - 120
Aluminum	10.0	11.1		mg/L		111	80 - 120
Arsenic	1.00	1.04		mg/L		104	80 - 120
Barium	1.00	1.06		mg/L		106	80 - 120
Beryllium	1.00	1.08		mg/L		108	80 - 120
Cadmium	1.00	1.04		mg/L		104	80 - 120
Calcium	10.0	11.4		mg/L		114	80 - 120
Chromium	1.00	1.06		mg/L		106	80 - 120
Cobalt	1.00	1.04		mg/L		104	80 - 120
Copper	1.00	1.09		mg/L		109	80 - 120
Lead	1.00	1.08		mg/L		108	80 - 120
Molybdenum	1.00	1.08		mg/L		108	80 - 120
Nickel	1.00	1.07		mg/L		107	80 - 120
Potassium	10.0	11.2		mg/L		112	80 - 120
Selenium	1.00	1.01		mg/L		101	80 - 120
Magnesium	10.0	11.6		mg/L		116	80 - 120
Manganese	1.00	1.05		mg/L		105	80 - 120
Thallium	1.00	1.09		mg/L		109	80 - 120
Vanadium	1.00	1.08		mg/L		108	80 - 120
Zinc	1.00	1.02		mg/L		102	80 - 120
Sn	1.00	1.06		mg/L		106	80 - 120
Ti	1.00	1.04		mg/L		104	80 - 120

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: LCS 720-148142/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148271 — **Prep Batch: 148142**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Iron	10.0	10.5		mg/L		105	80 - 120
Sodium	10.0	10.0		mg/L		100	80 - 120

Lab Sample ID: LCS 720-148142/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148480 — **Prep Batch: 148142**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sr	1.00	0.932		mg/L		93	80 - 120

Lab Sample ID: LCSD 720-148142/3-A — **Client Sample ID: Lab Control Sample Dup**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148204 — **Prep Batch: 148142**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Antimony	1.00	1.00		mg/L		100	80 - 120	1	20
Aluminum	10.0	11.0		mg/L		110	80 - 120	1	20
Arsenic	1.00	1.03		mg/L		103	80 - 120	1	20
Barium	1.00	1.04		mg/L		104	80 - 120	2	20
Beryllium	1.00	1.06		mg/L		106	80 - 120	2	20
Cadmium	1.00	1.02		mg/L		102	80 - 120	2	20
Calcium	10.0	11.2		mg/L		112	80 - 120	1	20
Chromium	1.00	1.04		mg/L		104	80 - 120	2	20
Cobalt	1.00	1.03		mg/L		103	80 - 120	2	20
Copper	1.00	1.07		mg/L		107	80 - 120	2	20
Lead	1.00	1.06		mg/L		106	80 - 120	1	20
Molybdenum	1.00	1.07		mg/L		107	80 - 120	1	20
Nickel	1.00	1.06		mg/L		106	80 - 120	1	20
Potassium	10.0	10.8		mg/L		108	80 - 120	4	20
Selenium	1.00	1.00		mg/L		100	80 - 120	1	20
Magnesium	10.0	11.3		mg/L		113	80 - 120	2	20
Manganese	1.00	1.03		mg/L		103	80 - 120	1	20
Thallium	1.00	1.08		mg/L		108	80 - 120	1	20
Vanadium	1.00	1.06		mg/L		106	80 - 120	1	20
Zinc	1.00	0.995		mg/L		100	80 - 120	2	20
Sn	1.00	1.04		mg/L		104	80 - 120	1	20
Ti	1.00	1.04		mg/L		104	80 - 120	0	20

Lab Sample ID: LCSD 720-148142/3-A — **Client Sample ID: Lab Control Sample Dup**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148271 — **Prep Batch: 148142**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Iron	10.0	10.5		mg/L		105	80 - 120	0	20
Sodium	10.0	9.63		mg/L		96	80 - 120	4	20

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: LCSD 720-148142/3-A — **Client Sample ID: Lab Control Sample Dup**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148480 — **Prep Batch: 148142**

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Sr			1.00	0.938		mg/L		94	80 - 120	1	20

Method: SM 2320B - Alkalinity

Lab Sample ID: MB 720-148396/3 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148396

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	ND		5.0		mg/L			11/15/13 10:11	1
Bicarbonate Alkalinity as CaCO3	ND		5.0		mg/L			11/15/13 10:11	1
Carbonate Alkalinity as CaCO3	ND		5.0		mg/L			11/15/13 10:11	1
Hydroxide Alkalinity	ND		5.0		mg/L			11/15/13 10:11	1

Lab Sample ID: LCS 720-148396/4 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148396

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Alkalinity			250	257		mg/L		103	80 - 120		

Lab Sample ID: LCSD 720-148396/5 — **Client Sample ID: Lab Control Sample Dup**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148396

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Alkalinity			250	257		mg/L		103	80 - 120	0	20

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 720-148280/2 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148280

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	52.0		10		mg/L			11/13/13 22:05	1

Lab Sample ID: LCS 720-148280/1 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 148280

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Total Dissolved Solids			1000	1030		mg/L		103	85 - 115		

Method: SM 5310C - TOC

Lab Sample ID: MB 500-211548/3
Matrix: Water
Analysis Batch: 211548

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
TOC Dup	ND		1.0		mg/L			11/13/13 09:34	1

Lab Sample ID: LCS 500-211548/4
Matrix: Water
Analysis Batch: 211548

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
TOC Result 1	10.0	9.72		mg/L		97	80 - 120
TOC Result 2	10.0	9.80		mg/L		98	80 - 120
TOC Dup	10.0	9.76		mg/L		98	80 - 120

Lab Sample ID: MB 500-211705/3
Matrix: Water
Analysis Batch: 211705

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
TOC Dup	ND		1.0		mg/L			11/13/13 09:39	1

Lab Sample ID: LCS 500-211705/4
Matrix: Water
Analysis Batch: 211705

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
TOC Result 1	10.0	9.80		mg/L		98	80 - 120
TOC Result 2	10.0	9.90		mg/L		99	80 - 120
TOC Dup	10.0	9.85		mg/L		98	80 - 120

GC/MS VOA

Analysis Batch: 148337

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-C	, -2942-CC0720C3-INFL	TotanMNA	8 ater	6210B	
720-53136-Cw,	, -2942-CC0720C3-INFL	TotanMNA	8 ater	6210B	
720-53136-Cw, D	, -2942-CC0720C3-INFL	TotanMNA	8 ater	6210B	
720-53136-2	, -2942-CC0720C3-EFFL	TotanMNA	8 ater	6210B	
Ll , 720-C46337M	Lab l oStron, ampre	TotanMNA	8 ater	6210B	
Ll , D 720-C46337M	Lab l oStron, ampre DPp	TotanMNA	8 ater	6210B	
wB 720-C46337M	wethov BraSk	TotanMNA	8 ater	6210B	

Metals

Prep Batch: 148142

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-C	, -2942-CC0720C3-INFL	TotanMNA	8 ater	30C0A	
720-53136-2	, -2942-CC0720C3-EFFL	TotanMNA	8 ater	30C0A	
Ll , 720-C46C42M-A	Lab l oStron, ampre	TotanMNA	8 ater	30C0A	
Ll , D 720-C46C42M-A	Lab l oStron, ampre DPp	TotanMNA	8 ater	30C0A	
wB 720-C46C42MC-A	wethov BraSk	TotanMNA	8 ater	30C0A	

Analysis Batch: 148204

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-C	, -2942-CC0720C3-INFL	TotanMNA	8 ater	10C0B	C46C42
720-53136-2	, -2942-CC0720C3-EFFL	TotanMNA	8 ater	10C0B	C46C42
Ll , 720-C46C42M-A	Lab l oStron, ampre	TotanMNA	8 ater	10C0B	C46C42
Ll , D 720-C46C42M-A	Lab l oStron, ampre DPp	TotanMNA	8 ater	10C0B	C46C42
wB 720-C46C42MC-A	wethov BraSk	TotanMNA	8 ater	10C0B	C46C42

Analysis Batch: 148271

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-C	, -2942-CC0720C3-INFL	TotanMNA	8 ater	10C0B	C46C42
720-53136-2	, -2942-CC0720C3-EFFL	TotanMNA	8 ater	10C0B	C46C42
Ll , 720-C46C42M-A	Lab l oStron, ampre	TotanMNA	8 ater	10C0B	C46C42
Ll , D 720-C46C42M-A	Lab l oStron, ampre DPp	TotanMNA	8 ater	10C0B	C46C42
wB 720-C46C42MC-A	wethov BraSk	TotanMNA	8 ater	10C0B	C46C42

Analysis Batch: 148480

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-C	, -2942-CC0720C3-INFL	TotanMNA	8 ater	10C0B	C46C42
720-53136-2	, -2942-CC0720C3-EFFL	TotanMNA	8 ater	10C0B	C46C42
Ll , 720-C46C42M-A	Lab l oStron, ampre	TotanMNA	8 ater	10C0B	C46C42
Ll , D 720-C46C42M-A	Lab l oStron, ampre DPp	TotanMNA	8 ater	10C0B	C46C42
wB 720-C46C42MC-A	wethov BraSk	TotanMNA	8 ater	10C0B	C46C42

General Chemistry

Analysis Batch: 148280

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-C	, -2942-CC0720C3-INFL	TotanMNA	8 ater	, w 2540l	
720-53136-2	, -2942-CC0720C3-EFFL	TotanMNA	8 ater	, w 2540l	
Ll , 720-C46260MC	Lab l oStron, ampre	TotanMNA	8 ater	, w 2540l	
wB 720-C46260M	wethov BraSk	TotanMNA	8 ater	, w 2540l	

General Chemistry (Continued)

Analysis Batch: 148396

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-C	, -2942-CC0720C3-INFL	TotanMNA	8 ater	, w 2320B	
720-53136-2	, -2942-CC0720C3-EFFL	TotanMNA	8 ater	, w 2320B	
LI , 720-C46391M4	Lab l oStron, ampre	TotanMNA	8 ater	, w 2320B	
LI , D 720-C46391M5	Lab l oStron, ampre DPp	TotanMNA	8 ater	, w 2320B	
wB 720-C46391M3	wethov BraSk	TotanMNA	8 ater	, w 2320B	

Analysis Batch: 211548

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-2	, -2942-CC0720C3-EFFL	TotanMNA	8 ater	, w 53C0l	
LI , 500-2CC546M4	Lab l oStron, ampre	TotanMNA	8 ater	, w 53C0l	
wB 500-2CC546M3	wethov BraSk	TotanMNA	8 ater	, w 53C0l	

Analysis Batch: 211705

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
720-53136-C	, -2942-CC0720C3-INFL	TotanMNA	8 ater	, w 53C0l	
LI , 500-2CC705M4	Lab l oStron, ampre	TotanMNA	8 ater	, w 53C0l	
wB 500-2CC705M3	wethov BraSk	TotanMNA	8 ater	, w 53C0l	

Client Sample ID: S-2942-1103201N-IF 7L — **Lab Sample ID: 320-5N6NM-1**

Date Collecte/ : 11R03RIN 11:00 — **x atriW d ater**

Date v ecei8e/ : 11R0MRIN 09:25

Prep Type	Batch Type	Batch x etho/	v un	Dilution 7actor	Batch Fumber	Prepare/ or Analyze/	Analyst	Lab
Total/NA	Analysis	8260B		200	148337	11/14/13 19:19	ASC	TAL PLS
Total/NA	Analysis	6010B		1	148204	11/12/13 18:44	SLK	TAL PLS
Total/NA	Prep	3010A			148142	11/12/13 07:54	ECT	TAL PLS
Total/NA	Analysis	6010B		1	148271	11/13/13 16:39	SLK	TAL PLS
Total/NA	Prep	3010A			148142	11/12/13 07:54	ECT	TAL PLS
Total/NA	Analysis	6010B		1	148480	11/15/13 23:15	SLK	TAL PLS
Total/NA	Analysis	SM 5310C		1	211705	11/13/13 10:12	KD1	TAL CHI
Total/NA	Analysis	SM 2540C		1	148280	11/13/13 22:05	EYT	TAL PLS
Total/NA	Analysis	SM 2320B		1	148396	11/15/13 10:30	MJK	TAL PLS

Client Sample ID: S-2942-1103201N-E77L — **Lab Sample ID: 320-5N6NM-2**

Date Collecte/ : 11R03RIN 11:00 — **x atriW d ater**

Date v ecei8e/ : 11R0MRIN 09:25

Prep Type	Batch Type	Batch x etho/	v un	Dilution 7actor	Batch Fumber	Prepare/ or Analyze/	Analyst	Lab
Total/NA	Analysis	8260B		1	148337	11/14/13 16:21	ASC	TAL PLS
Total/NA	Prep	3010A			148142	11/12/13 07:59	ECT	TAL PLS
Total/NA	Analysis	6010B		1	148204	11/12/13 18:49	SLK	TAL PLS
Total/NA	Prep	3010A			148142	11/12/13 07:59	ECT	TAL PLS
Total/NA	Analysis	6010B		1	148271	11/13/13 16:43	SLK	TAL PLS
Total/NA	Analysis	6010B		1	148480	11/15/13 23:20	SLK	TAL PLS
Total/NA	Analysis	SM 5310C		1	211548	11/13/13 10:56	KD1	TAL CHI
Total/NA	Analysis	SM 2540C		1	148280	11/13/13 22:05	EYT	TAL PLS
Total/NA	Analysis	SM 2320B		1	148396	11/15/13 10:36	MJK	TAL PLS

Laboratory v eferences:

TAL CHI = TestAmerica Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

TAL PLS = TestAmerica Pleasanton, 1220 Quarry Lane, Pleasanton, CA 94566, TEL (925)484-1919

Certification Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Laboratory: TestAmerica Pleasanton

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
California	State Program	9	2496	01-31-14

Laboratory: TestAmerica Chicago

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Alabama	State Program	4	40461	04-30-14
California	NELAP	9	01132CA	04-30-14
Georgia	State Program	4	N/A	04-30-14
Hawaii	State Program	9	N/A	04-30-14
Illinois	NELAP	5	100201	04-30-14
Indiana	State Program	5	C-IL-02	04-30-14
Iowa	State Program	7	82	05-01-14
Kansas	NELAP	7	E-10161	10-31-14 *
Kentucky	State Program	4	90023	12-31-13
Kentucky (UST)	State Program	4	66	04-30-14
Louisiana	NELAP	6	30720	06-30-14
Massachusetts	State Program	1	M-IL035	06-30-14
Mississippi	State Program	4	N/A	04-30-14
North Carolina DENR	State Program	4	291	12-31-13
North Dakota	State Program	8	R-194	04-30-14
Oklahoma	State Program	6	8908	08-31-14
South Carolina	State Program	4	77001	04-30-14
Texas	NELAP	6	T104704252-09-TX	02-28-14
USDA	Federal		P330-12-00038	02-06-15
Wisconsin	State Program	5	999580010	08-31-14
Wyoming	State Program	8	8TMS-Q	04-30-14

* Expired certification is currently pending renewal and is considered valid.

Method Summary

Client: Sirem, div of Geosyntec Consultants
Project/Site: Mountainview ZVI Column Study

TestAmerica Job ID: 720-53638-1

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL PLS
6010B	Metals (ICP)	SW846	TAL PLS
SM 2320B	Alkalinity	SM	TAL PLS
SM 2540C	Solids, Total Dissolved (TDS)	SM	TAL PLS
SM 5310C	TOC	SM	TAL CHI

Protocol References:

SM = "Standard Methods For The Examination Of Water And Wastewater",

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = TestAmerica Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

TAL PLS = TestAmerica Pleasanton, 1220 Quarry Lane, Pleasanton, CA 94566, TEL (925)484-1919

Sample Summary

l nieSt: , iremdvif oGy eosuStec l oSsPntaSts
j ro/ectMite: w oPStaiSf ieZ V9l l onPmS , tPvu

TestAmerica Job ID: 720-53136-C

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
720-53136-C	, -24N2-CC0720C3-IF LW	8 ater	CCM07M03 CC:00	CCM06M03 04:25
720-53136-2	, -24N2-CC0720C3-ELLW	8 ater	CCM07M03 CC:00	CCM06M03 04:25

720-53638

149922

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

Project Number: S-2942 20066.005	Project Name: Mountainview ZVI Column Study
Point of Contact: Jeff Roberts: (519) 515-0840	
Vendor: **SiRem** 130 Research Lane, Suite 2 Guelph, ON N1G 5G3 Canada	Possible Hazards: None Flammable Radioactive Poison Other
Vendor Contact: Jeff Roberts - 519-515-0840	
Delivery Service:	AirBill No.:
TAT Requested: As per CoC otherwise normal 10 BD	
Zone:	Area:

Number of Coolers: 1

CoC Page(s):

Bottle Type and Preservative (Use Lab's bottle order for combined analyses)

Sample ID	Date	Time	Matrix	# Cont.	8260B (cVOC's) 40mL VOA preserved with HCL	Cations poly bottles preserved with HNO3	Alkalinity 40mL VOA's (unpreserved)	TDS poly bottles upreserved	TOC 40mL VOA preserved with H2SO4
S-2942-11072013-INFL	7-Nov-13	11:00am	groundwater	5	x	x	x	x	x
S-2942-11072013-EFFL	7-Nov-13	11:00am	groundwater	5	x	x	x	x	x

720-53638 Chain of Custody

	Relinquished by	Received by	Received by
Signature	[signature]	[signature]	[signature]
Printed Name	JASON WHITE		CRISELDA CAPARAS
Firm	SiREM		TestAmerica
Date/Time	07-Nov-2013 11:00 am		11-8-13 925

Lab Remarks:	Custody Intact? YES NO	Cooler Temperature:	Other:
		3.6 °C	

Page 1 of 2

Login Sample Receipt Checklist

Client: Sirem, div of Geosyntec Consultants

Job Number: 720-53638-1

Login Number: 53638

List Source: TestAmerica Pleasanton

List Number: 1

Creator: Mullen, Joan

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	False	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Sirem, div of Geosyntec Consultants

Job Number: 720-53638-1

Login Number: 53638
List Number: 1
Creator: Lunt, Jeff T

List Source: TestAmerica Chicago
List Creation: 11/09/13 12:18 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	True	

APPENDIX C

Numerical Model Supporting Information

Appendix C – Numerical Model Supporting Information

This memorandum was prepared to describe the numerical modeling performed to assess groundwater flow field after slurry wall breaching and support the design of the ZVI treatment wall at the subject site described in our Work Plan for Zero-Valent Iron Permeable Reactive Barrier Treatability Study (Work Plan).

This assessment was performed by: (i) developing a numerical groundwater flow model of the Site; (ii) assessing groundwater flow field after slurry wall breaching; and (iii) estimating the groundwater flow through the Zero-Valent Iron (ZVI) Permeable Reactive Barrier (PRB).

1. NUMERICAL GROUNDWATER FLOW MODEL

1.1 Numerical Model Domain, Grid, and Layers

The three-dimensional model for flow was developed using MODFLOW, industry standard finite-difference codes. Groundwater flow in the model is assumed to be steady-state.

The domain of the numerical model used at the Site is based on the Middlefield-Ellis-Whisman (MEW) regional groundwater flow model (Geosyntec, 2008). The model domain and the Site location are shown in Figure C-1.

The numerical model is similar to the revised regional groundwater flow model for MEW (Geosyntec, 2014a) and to the numerical model developed for assessing potential fate and transport of residual permanganate following injections and described in our Final Work Plan for In Situ Chemical Oxidation Pilot Study (Geosyntec, 2014b). The details of the model development are given below.

The layering is not based on the A-, B1-, and B2-zone stratigraphy at MEW. Rather, each model layer is of uniform thickness and the distribution of soil types from site borings are used to interpolate the variation in material properties within each layer.

The model domain was divided into 13 layers as follows. The top seven layers were defined to match the stratigraphy observed at the Site. The layers below were chosen to

best group materials of similar soil type, and remained the same as for the regional model.

- Layer 1 = 0 – 15 feet below ground surface (bgs); the top layer (Layer 1) is mostly dry and was therefore not active in the model simulations.
- Layer 2 = 15 – 20 feet bgs
- Layer 3 = 20 – 25 feet bgs
- Layer 4 = 25 – 32 feet bgs
- Layer 5 = 32 – 37 feet bgs
- Layer 6 = 37 – 45 feet bgs
- Layer 7 = 45 – 50 feet bgs
- Layer 8 = 50 – 60 feet bgs
- Layer 9 = 60 – 70 feet bgs
- Layer 10 = 70 – 80 feet bgs
- Layer 11 = 80 – 100 feet bgs
- Layer 12 = 100 feet bgs – top of the B3 aquifer (determined based on the top of the sandy layer observed in boring logs below 100 feet bgs)
- Layer 13 = B3 aquifer.

The top of the model domain was interpolated from a Digital Elevation Model (DEM) file obtained from USGS database.

The grid cells are 50 feet x 50 feet in most of the model domain and are refined to 2.9 feet x 3.3 feet in the vicinity of the Site.

1.2 Model Stratigraphy

The model stratigraphy was defined following the same approach as for the revised regional groundwater flow model, with interpolated sand fraction maps created for the Layers 2 through 7 based on available boring and membrane interface probe (MIP) logs for the Site. The model stratigraphy below 50 feet bgs was not changed from the revised regional model.

1.3 Groundwater Flow Model

1.3.1 Observation Data – Head

The groundwater flow model has been calibrated to water level measurements collected between 2010 and 2012 from monitoring wells located inside the model domain.

1.3.2 Model Boundaries and Stresses

The model boundaries are unchanged from the regional flow model. Constant head boundaries were applied to the northern and southern edges of the model and no-flow boundaries were applied to the eastern and western sides of the model domain.

Recharge from direct precipitation was defined over the entire domain with a rate of 1 inch per year. Evapotranspiration was defined in the northern part of the domain, corresponding to the non-residential area of the model domain.

In the vicinity of the Site, the main stresses are the extraction wells and the presence of the slurry wall. The slurry wall was modeled with the horizontal flow barrier (HFB) package in MODFLOW. The HFB representing the slurry wall was defined down to 45 feet bgs (Layer 6). The HFB hydraulic parameter was defined assuming a constant slurry wall thickness of 3 feet and a hydraulic conductivity of 0.001 foot/day, which are consistent with information presented in the Slurry Cutoff Walls Record of Construction (Canonie, 1988).

The extraction wells were defined based on the screen interval. Average pumping rates from 2010-2012 were applied in all extraction wells for model calibration. Well construction and groundwater pumping rate information are included in the Annual Progress Report for the Site (Geosyntec, 2013).

The locations of the Building 9 slurry wall and extraction and monitoring wells in the vicinity of the Site are shown in Figure C-2.

1.3.3 Material Properties

Aquifer hydraulic conductivity was defined using the same approach as for the regional model. A relationship between hydraulic conductivity and sand fraction was used to calculate hydraulic conductivity field in the refined model layers. The relationship

between horizontal hydraulic conductivity (K_H in feet/day) and sand fraction (SF in %) is:

$$K_H = \begin{cases} 300 \cdot SF^3 & if\ SF \leq 50\% \\ 75 \cdot SF & if\ SF \geq 50\% \end{cases}$$

The ratio between horizontal and vertical hydraulic conductivity was set equal to 10.

The vertical hydraulic conductivity value of the low conductivity layer present at the bottom of the slurry wall was estimated to be 0.1 to 0.2 foot/day based on observed drawdown inside the slurry wall under pumping conditions. The median vertical hydraulic conductivity value of layer 6 (located from 37 to 45 feet bgs) in the slurry wall footprint is 0.14 foot/day based on the hydraulic conductivity relationship described above.

1.4 Model Calibration

The flow model was calibrated to fit the average observed head at the monitoring wells between 2010 and 2012. At the regional scale (including all observation data), the root mean square error (RMSE) was 3.8 feet, corresponding to 5.3% of the range of the observed water levels.

The observed and simulated heads at the monitoring wells in the vicinity of the Site are summarized below. The locations of the monitoring wells are shown in Figure C-2.

Monitoring Wells	Observed Head (feet msl)[1]	Simulated Head (feet msl)	Residual (feet)[2]
116A	29.97	28.28	1.69
122A	28.31	28.38	-0.07
123A	32.22	32.40	-0.18
126A	30.08	29.72	0.36
137A	28.03	27.46	0.57
138A	31.48	30.36	1.12
36A	28.07	29.44	-1.37
39A	30.84	28.46	2.38
69A	30.19	28.54	1.65
108A	30.14	28.40	1.74
31A	31.39	30.81	0.58
35A	28.07	28.22	-0.15
37A	27.8	27.64	0.16
40A	31.03	28.63	2.40
41A	30.22	28.49	1.73
42A	30.37	28.43	1.94
43A	30.84	28.20	2.64
44A	30.76	28.22	2.54
SIL12A	31.80	31.97	-0.17
SIL2A	31.92	31.84	0.08
SIL13A	31.22	29.66	1.56
SIL14A	31.26	29.97	1.29
SIL1A	32.15	32.09	0.06
SIL4A	32.39	32.82	-0.43
SIL9A	30.67	28.78	1.89
104B1	28.58	29.69	-1.11
109B1	28.62	29.52	-0.90
69B1	30.98	30.30	0.68
RMSE[3]			**1.40**

1. Average observed head between 2010 and 2012
2. Residual = Observed Head – Simulated Head
3. RMSE = Root Mean Square Error

2. MODELING ZVI PRB

Pumping rates were set to 0 at the four on-site extraction wells. The other boundary conditions remained unchanged.

2.1 PRB Locations and Dimensions

The ZVI PRBs were modeled by removing the HFB conditions at the PRB locations. The PRB locations are shown in Figure 5. The PRB were simulated from the bottom of layer 1 at 15 ft bgs (corresponding to the bottom of the upper clay layer) to 25 ft bgs, corresponding to the bottom of layer 3 (see Section 1.1). The modeled Gates are higher (10 ft) than the design Gates (9 ft, see Section 4.4.1 in the Work Plan); this difference might result in a higher modeled flow rates through the PRBs.

2.2 Simulated Flow Field and Flow through PRBs

The simulated flow is summarized in the table below. With selected PRB locations, downward flow from the PRB depth-interval is negligible. Limited downward flow is simulated to occur inside the slurry wall between the lower layers inside the slurry wall and the B1-zone, at a rate of 0.03 gallons per minute (gpm). The flow through the PRB is estimated around 3.0 gpm. These flow rates and the simulated hydraulic heads are illustrated in Figure C-3.

The groundwater flow through the Gates is non-equally divided between the two 5-foot model layers. The difference in groundwater flow reflects the variation of the hydraulic conductivity field. The estimated flow rates through the North West PRB (NW PRB) and the North East PRB (NE PRB) are summarized in the table below.

Flow Rate (gpm)	NE PRB	NW PRB	Total
Through PRB	1.3	1.8	3.0
Through Layer 2	0.8	0.3	1.1
Through Layer 3	0.4	1.5	1.9

REFERENCES

Canonie, 1988. Slurry Cutoff Walls Record of Construction, Prepared for Fairchild Semiconductor Corporation, July 22.

Geosyntec, 2008. Optimization Evaluation - Regional Groundwater Remediation Program, Middlefield-Ellis-Whisman ("MEW") Area, Mountain View, California, September 3.

Geosyntec, 2013. 2012 Annual Progress Report for Former Fairchild Buildings 1-4, 9, and 18, Mountain View, California, April 15.

Geosyntec, 2014a. Memorandum Groundwater Flow Model, Middlefield-Ellis-Whisman, Mountain View, California. May 2.

Geosyntec, 2014b. Final Work Plan for In Situ Chemical Oxidation Pilot Study. 401 National Avenue, Former Fairchild Building 9, Middlefield-Ellis-Whisman Area, Mountain View, California. November 19.

* * * * *

401 National Avenue

Legend

401 National Avenue

Model Domain

N

Notes:
Basemap Source: OpenStreetMap, October 2014

1,500 750 0 1,500 Feet

Model Domain

401 National Avenue
Mountain View, California

Geosyntec consultants

Oakland | January 2015

Figure

C-1

P:\GIS\MEW\Project\Fairchild\Building9\2014_ISCOWorkplan\FigC-1_ModelDomain.mxd

Legend

- Recovery Well
- Proposed Recovery Well
- Monitoring Well
- 401 National Avenue
- === Slurry Wall

N

70 35 0 70 Feet

Notes:
SCRW - Source Control Recovery Well
Aerial Source: USGS April 2011

Local A- and B1-Zone Groundwater SCRWs and Monitoring Wells

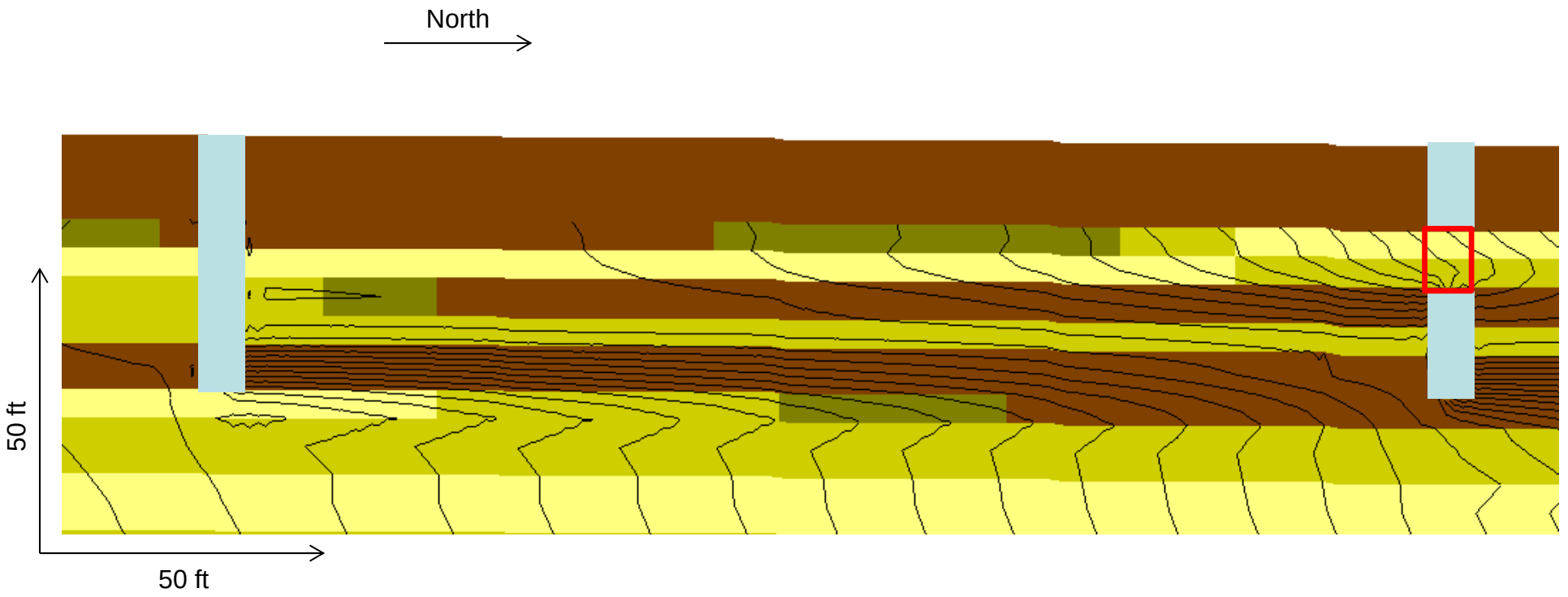
401 National Avenue
Mountain View, California

Geosyntec consultants

Oakland | January 2015

Figure **C-2**

P:\GIS\MEW\Project\Fairchild\Building9\2014_ISCOWorkplan\FigC-2_LocalGroundwaterSCRWs.mxd



Horizontal Hydraulic Conductivity (feet/day)

- 0 - 5
- 5 - 10
- 10 - 25
- 25 - 70

Hydraulic Head Contours (0.1 ft)

Slurry Wall (horizontal thickness exaggerated)

Proposed PRB location

Simulated Hydraulic Head in Slurry Wall with PRBs

401 National Avenue
Mountain View, California

Geosyntec consultants

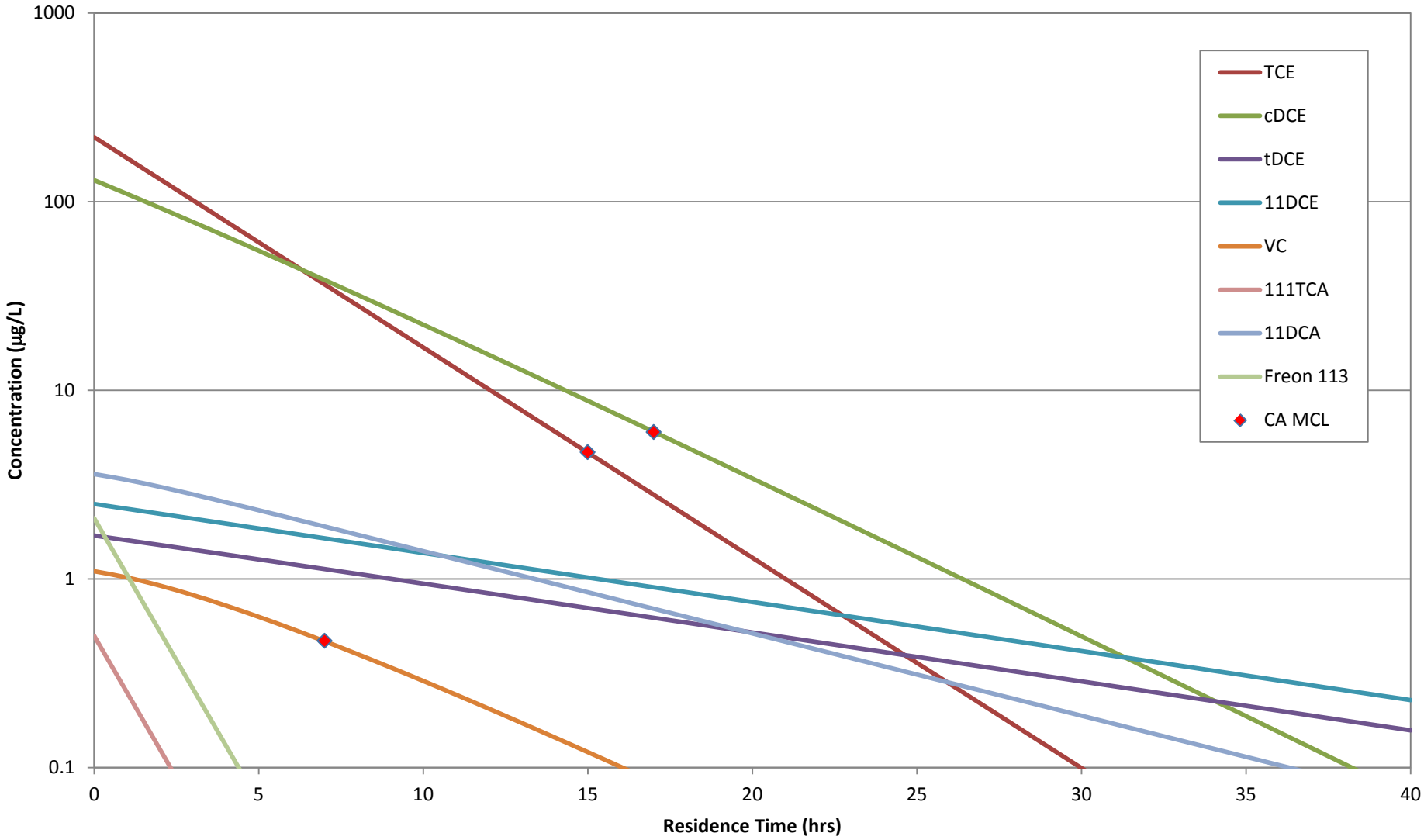
Oakland | January 2015

Figure C-3

P:\\Data\PRJ2003REM\MEW Fairchild\19_Bldg 9 Redevelopment (401 National)\Deliverables\Work Plans\ZVI PRB Work Plan\Appendices\Figure_Hydraulic Head_Flow_Rates.pptx"

APPENDIX D

ZVI Residence Time Supporting Information



Abbreviations:
µg/L – micrograms per liter
hrs – hours
VC-Vinyl Chloride
TCE = Trichloroethene
cDCE = cis-1,2-Dichloroethene
tDCE = trans-1,2-Dichloroethene
Freon 113 = trichlorotriflourethane
11DCA = 1,1-Dichloroethane
11DCE = 1,1-Dichloroethene
CA MCL = California Department of Public Health (CDPH) maximum contaminant levels (MCLs) for Regulated Drinking Water Contaminants

Note:
Anticipated influent concentrations of tDCE, 11DCE, 111TCA, 11DCA, and Freon 113 are below the respective MCLs (Table 2)

North-West PRB Residence Time Simulation

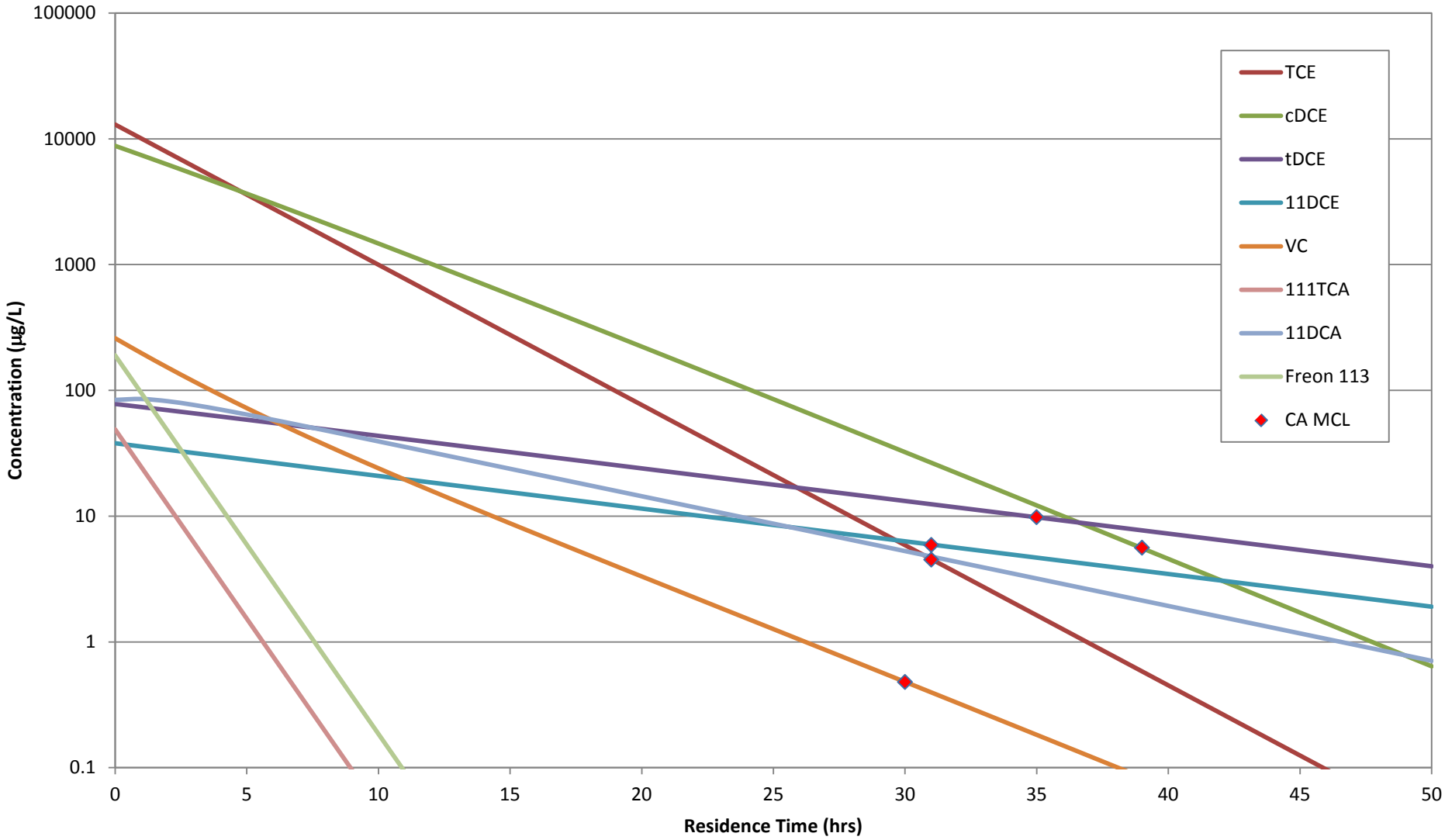
401 National Avenue
Mountain View, California

Geosyntec consultants

Oakland | January 2015

Figure D-1

P:\GIS\MEW\Project\Fairchild\Building9\2015_PRBWorkplan\[FigD-1-2.xlsx]



Abbreviations:
µg/L – micrograms per liter
hrs – hours
VC-Vinyl Chloride
TCE = Trichloroethene
cDCE = cis-1,2-Dichloroethene
tDCE = trans-1,2-Dichloroethene
Freon 113 = trichlorotriflourethane
11DCA = 1,1-Dichloroethane
11DCE = 1,1-Dichloroethene
CA MCL = California Department of Public Health (CDPH) maximum contaminant levels (MCLs) for Regulated Drinking Water Contaminants

Note:
Anticipated influent concentrations of 111TCA and Freon 113 are below the respective MCLs (Table 2)

North-East PRB Residence Time Simulation

401 National Avenue
Mountain View, California

Geosyntec consultants

Oakland | January 2015

Figure D-2

P:\GIS\MEW\Project\Fairchild\Building9\2015_PRBWorkplan\[FigD-1-2.xlsx]

APPENDIX E

Existing Slurry Wall Design Drawings

DRAWING NUMBER CE82-023-E652

DRAWN BY	E. MINNER	10-28-86
CHECKED BY		
APPROVED BY		

NO.	DATE
REVISIONS	

BUILDING 9
SLURRY WALL
ALIGNMENT

PIPE GROUP CROSSING
5 UTILITIES IN TRENCH
P,T,G,DI,FW, STA. 0+08
TO 0+20

PIPE GROUP CROSSING
4 UTILITIES T,P,DI,FW,
STA 7+35 TO 7+58

PIPE GROUP CROSSING GP1
7 UTILITIES IN TRENCH
DI AND (6) UNKNOWN
STA 7+25 TO 7+35

PIPE GROUP CROSSING
4 UTILITIES SS,SD,CW,P
STA. 5+15

Berm 444

STA 0+00 = 9+35

ADT LINE

Tanks

Ramp

Posts

UTILITY PROTECTION
BUILDING 9

STATION NO.	UTILITY TYPE	MATERIAL	SIZE (IN)	DEPTH (IN)	TYPE PROTECTION	COMMENTS
0+08 to 0+20	Electrical Telephone Gas Deionized Water Fire Water	Encased together in concrete	18x45 18x45 18x45 4 12	30 30 30 19 36	F F F F F	Five utilities 0+08 to 0+20 protected in one slab.
1+80	Gas (GAL)		1	32	E	
2+57	Deionized Water		4	21	F	15" steel casing installed.
2+57	Deionized Water		6	21	F	15" steel casing installed.
2+85	Fire Water		10	24	E	
3+00	Gas		3	36	E	
5+15	Sanitary Sewer		8	60	F	Four utilities at 5+15 protected in one slab.
5+15	Storm Drain		12	48	F	
5+15	Electrical		1		F	
5+15	Water		1		F	
7+25 to 7+35	Deionized Water	PVC	6		F	Sewer pipes in utility trench 7+25 to 7+35 protected in one slab.
	Unknown	Copper	1		F	
	Unknown	PVC	3		F	
	Unknown	PVC	6		F	
	Unknown	Iron	1		F	
	Unknown	PVC	4		F	
	Unknown	Copper	1		F	
7+50	ADT Line	PVC	1	23	D	
7+35	Telephone	Encased in Concrete	18x24	26	F	Four utilities 7+35 to 7+58 protected in one slab.
7+40	Electrical	Encased in Concrete	18x24	26	F	
7+43	Deionized Water	PVC	4	28	F	
7+58	Fire Water	Transite	12	34	F	

NOTES: TYPES OF UTILITY PROTECTION

TYPE	DESCRIPTION
A	Utility line dead. Line was severed, capped and not reinstalled.
B	Utility line was severed, capped and reinstalled after completion of slurry wall.
C	Utility line already encased in concrete. No further protection provided.
D	No protection provided.
E	Single line protected in place with structural concrete slab. See Sheet 8.
F	Two or more lines protected in place as a group with a single structural concrete slab. See Sheet 8.

LEGEND:

- DEIONIZED WATER(DI)
- ELECTRIC(P)
- GAS(G)
- FIRE LINE(FW)
- IRRIGATION WATER(IW)
- OVERHEAD LINES(OH)
- STORM DRAIN(SD)
- SANITARY SEWER(SS)
- TELEPHONE(T)
- PROTECTION OF UTILITY LINE AT SLURRY WALL CROSSING WITH STRUCTURAL CONCRETE SLAB (SEE SHEET 8 FOR DETAILS)

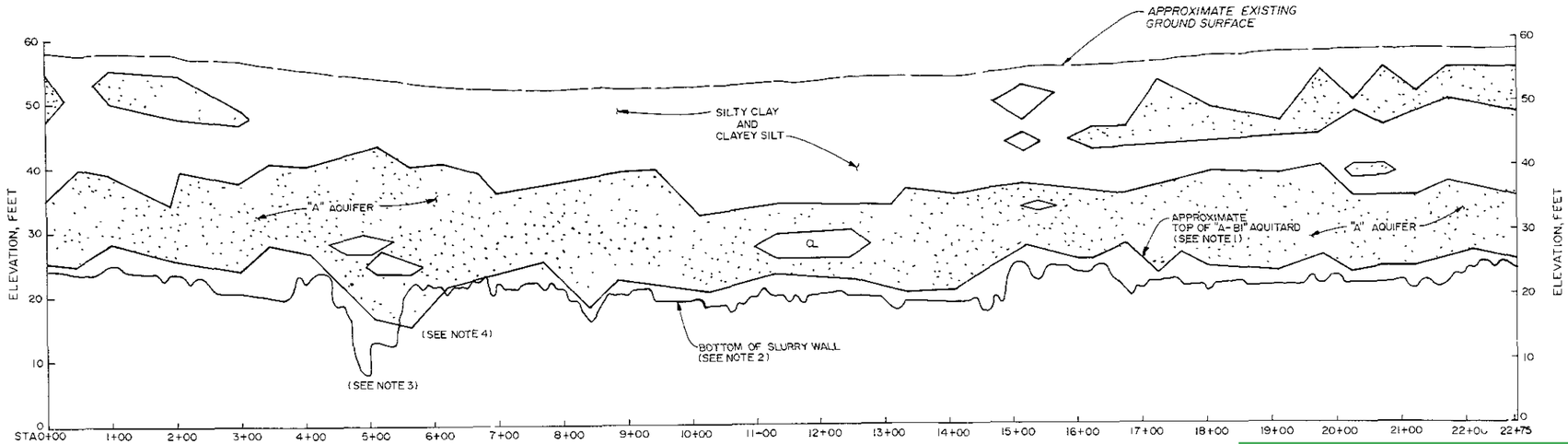
SCALE
20 0 20 40 FEET

AS BUILT PLAN
UTILITY LOCATION AND PROTECTION
BUILDING 9
MOUNTAIN VIEW, CALIFORNIA
PREPARED FOR
FAIRCHILD
SEMICONDUCTOR CORP.

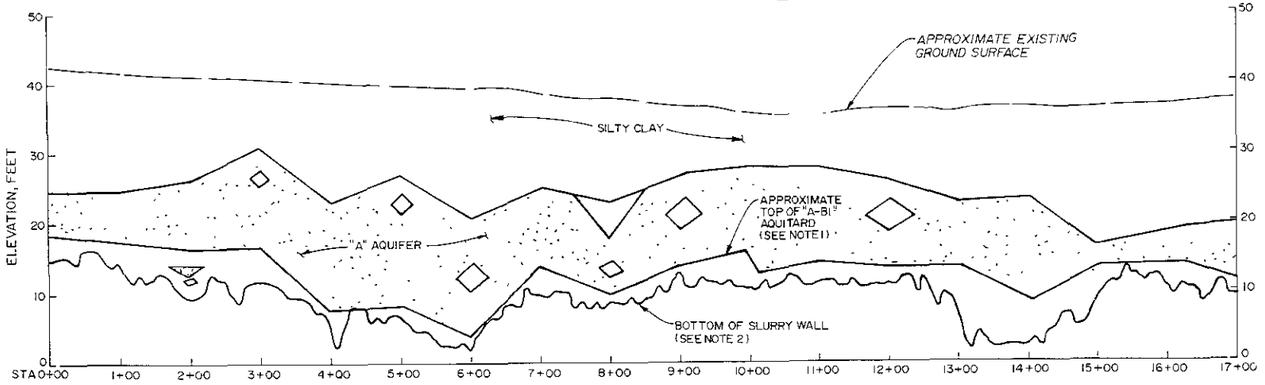
Canonie Environmental

DATE: 10-28-86	SHEET 5 of 10	DRAWING NUMBER CE82-023-E652
SCALE: AS SHOWN		

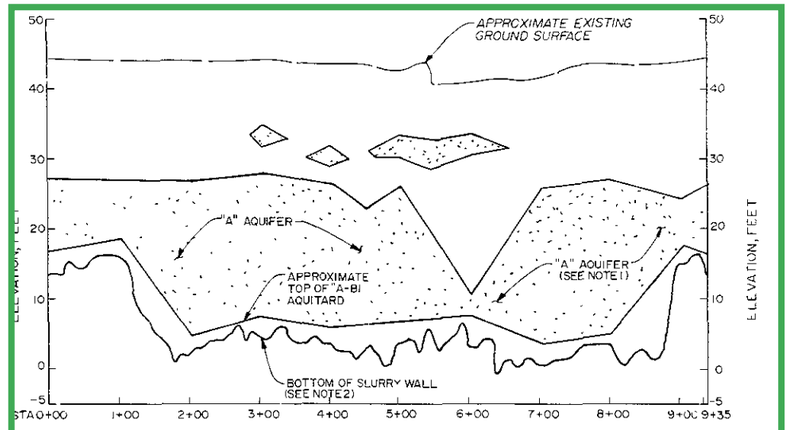
BLU-LINE INC



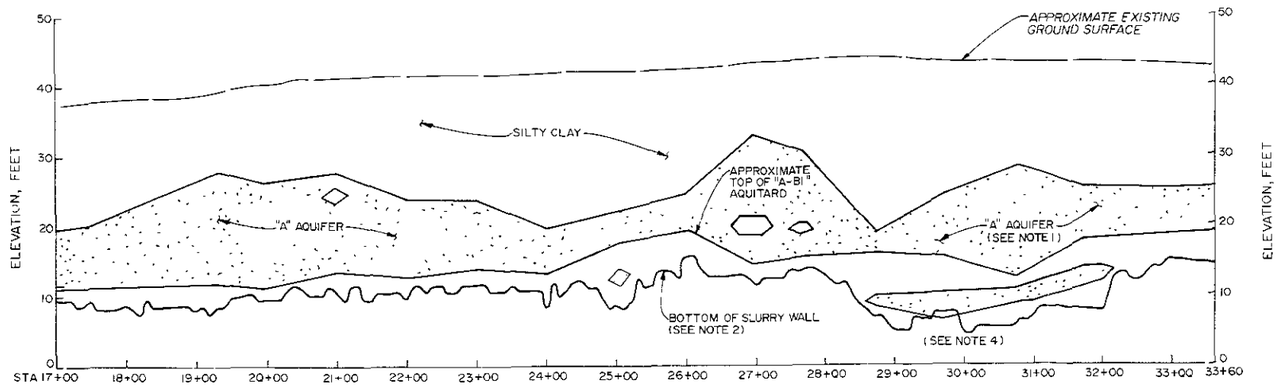
BUILDING 19



BUILDINGS 1,2,3,AND 4



BUILDING 9



BUILDINGS 1,2,3, AND 4 (CONT'D)

NOTES:

1. AQUIFER AND AQUITARD LOCATIONS SHOWN WERE TAKEN FROM ORIGINAL EXPLORATORY BORINGS (SEE DESIGN CONSTRUCTION DRAWINGS FOR BORING LOCATIONS)
2. MEASURED DEPTH AND STATION NUMBERS FOR BOTTOM OF SLURRY WALL ARE PROVIDED IN CONSTRUCTION COMPLETION REPORT, APPENDIX F
3. SLURRY WALL IS KEYED INTO A-B1 AQUITARD A MINIMUM OF 12" EXCEPT AS NOTED ON DETAIL SHEET 8
4. CONTINUOUS CLAY MATERIAL AND PENETRATION OF AQUITARD WAS DOCUMENTED CONFORMATION SAMPLES WERE OBTAINED AT 50 FT INTERVALS OR WHERE DESIGN DEPTHS WERE SIGNIFICANTLY DIFFERENT FROM ACTUAL DEPTHS

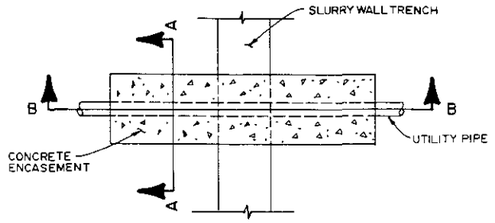
AS-BUILT SLURRY WALL PROFILES
BUILDINGS 1,2,3,4,9 AND 19
MOUNTAIN VIEW, CALIFORNIA
PREPARED FOR
FAIRCHILD SEMICONDUCTOR CORP

Canonie Environmental

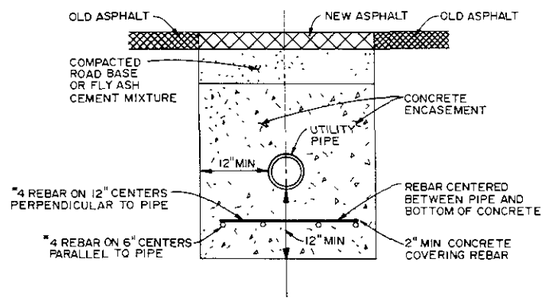
DATE: 10-18-86	SHEET 7 of 10	DRAWING NUMBER CE82-023-E654
SCALE: AS SHOWN		

REVISIONS	NO.	DATE
UNDERGROUND NOTES	1	10-5-87

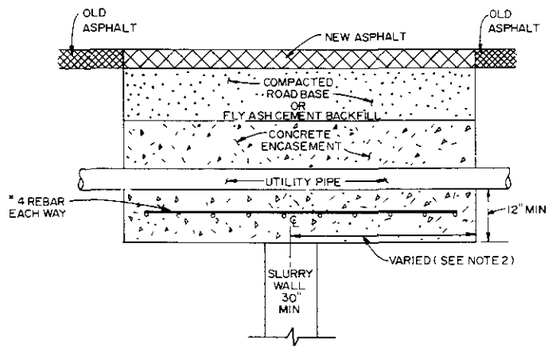
DRAWN BY	E MINNER	10-18-86
CHECKED BY	BW	2/9/87
APPROVED BY	RJG	2/9/87
DRAWING NUMBER	CE82-023-E654	



PLAN VIEW
NTS



SECTION A-A
NTS



SECTION B-B
NTS

TYPE E AND F PROTECTION DETAILS

NOTES:

1 STRUCTURAL CONCRETE SLAB USED FOR UTILITY LINE PROTECTION AT SLURRY WALL CROSSING

2 CONCRETE ENCASEMENT EXTENDED 8' MINIMUM FOR BUILDINGS 9 AND 19, AND 5' MINIMUM FOR BUILDINGS 1,2,3 AND 4

3 EXCAVATION FOR UTILITIES USED VERTICAL TRENCH WALLS AND HYDRAULIC SHORING WHERE NECESSARY VERTICAL WALLS SERVED AS CONCRETE FORM

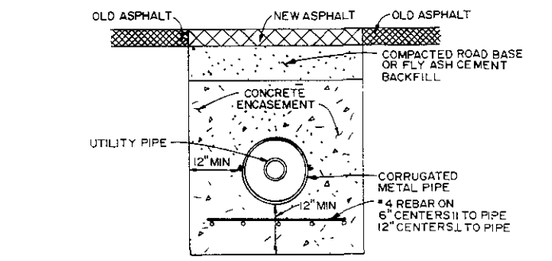
4 LOCATIONS OF ALTERNATE PROTECTION ARE NOTED IN THE COMMENTS COLUMN OF THE UTILITY TABLES ON SHEETS 4,5,&6

5 CONCRETE ENCASEMENT EXTENDS A MINIMUM OF 12" HORIZONTALLY AND VERTICALLY ON EACH SIDE OF THE UTILITY

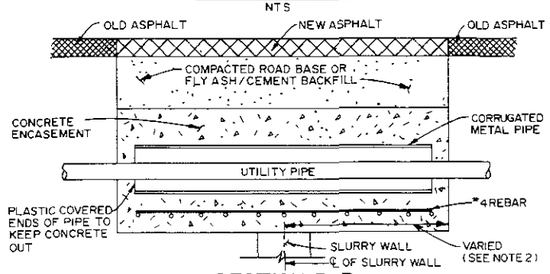
6 WHERE MUTIPLE PIPES ARE PROTECTED BY ONE ENCASEMENT, CONCRETE EXTENDS 12" MINIMUM BELOW THE LOWEST PIPE AND 12" HORIZONTALLY ON EACH SIDE OF THE EDGE UTILITY PIPES

7 CONCRETE 3,000psi

8 REBAR WAS NOT TYPICALLY PLACED ABOVE THE UTILITY PIPE



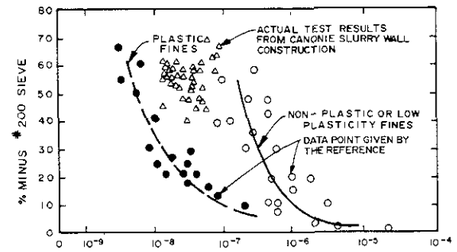
SECTION A-A
NTS



SECTION B-B
NTS

ALTERNATE 1 PROTECTION

(SEE NOTES - TYPE E AND F PROTECTION DETAILS)



(ACTUAL LABORATORY TEST RESULTS FROM CANONIE SLURRY WALL CONST.)

PERMEABILITY OF SOIL-BENTONITE BACKFILL RELATED TO FINES CONTENT*

*REFERENCE

JOURNAL OF THE GEOTECHNICAL ENGINEERING DIVISION, ASCE VOLUME 106, PAPER BY D J D'APPOLONIA, APRIL 1980

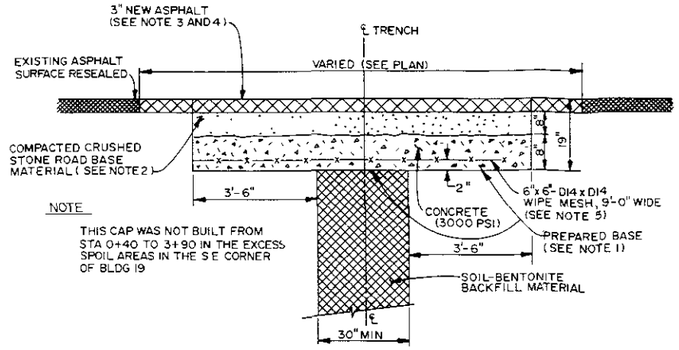
SURVEY CONTROL DATA(1) SETTLEMENT PINS

Settlement Pin No.	Depth(2) (Ft.)	Elevation (Ft.)
1	0.078	42.69
2	-0.688	43.01
3	0.006	44.20
4	0.005	43.70
5	-0.078	43.09
6	0.026	52.46
7	0.010	55.69
8	0.250	52.68

NOTES:

(1) See sheets 2 and 3 for plan location of settlement pins.

(2) + Denotes distance above plastic pipe (see detail this sheet).

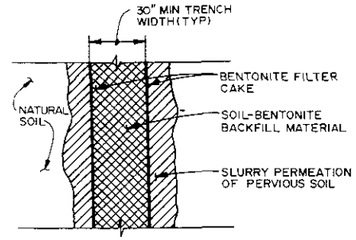


NOTE

THIS CAP WAS NOT BUILT FROM STA 0+40 TO 3+90 IN THE EXCESS SPOIL AREAS IN THE S E CORNER OF BLDG 19

SLURRY WALL CAP DETAILS TRAFFIC AREA (PAVED AREA)

NTS



TRENCH CROSS SECTION

NTS

NOTES:

1 BASE BENEATH CAP WAS GRADED AND COMPACTED

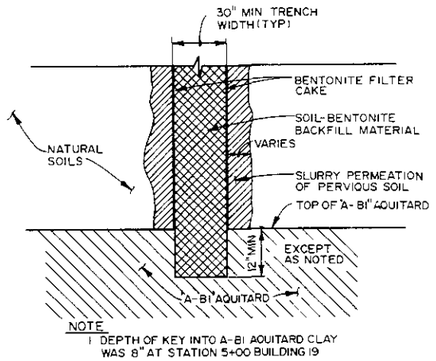
2 CRUSHED STONE MET THE FOLLOWING SPECIFICATIONS

SIEVE	PERCENT PASSING
1 1/2"	100

3 ASPHALT CONFORMED TO THE REQUIREMENTS OF THE SPECIFICATIONS

4 EXISTING ASPHALT WAS REMOVED AND REPLACED WITH A 3" THICKNESS OF NEW ASPHALT PAVEMENT AFTER SLURRY WALL COMPLETION ANY CRACKED ASPHALT BEYOND THE 9'-6" WIDE CAP WIDTH WAS REMOVED AND RESURFACED THE RESURFACED AREA IS SHOWN ON SHEETS 2&3

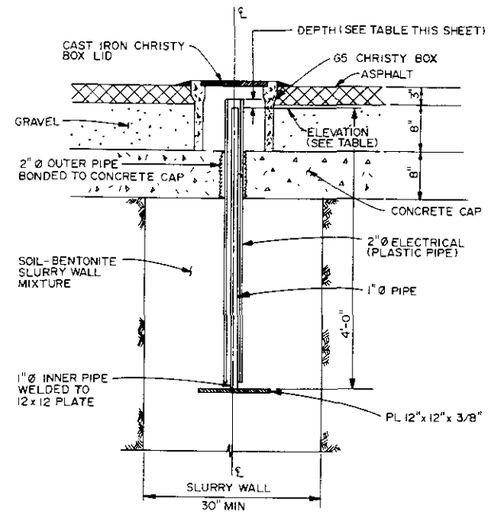
5 NOMINAL DIAMETER OF D14 WIRE WAS 422 INCHES 6-INCH BY 6-INCH ON CENTERS



NOTE

1 DEPTH OF KEY INTO A-B1 AQUITARD CLAY WAS 8" AT STATION 5+00 BUILDING 19

SLURRY WALL KEY DETAIL



SETTLEMENT PIN DETAIL

NTS

NOTE:

1 SETTLEMENT PIN LOCATIONS ARE SHOWN ON SHEETS 2 AND 3

2 SURVEY CONTROL DATA FOR EACH SETTLEMENT PIN IS PROVIDED ON TABLE, THIS SHEET

SLURRY WALL
CONSTRUCTION DETAILS
MOUNTAIN VIEW, CALIFORNIA
PREPARED FOR

FAIRCHILD
SEMICONDUCTOR CORP.

Canonie Environmental

DATE: 10-18-86	SHEET 8 of 10	DRAWING NUMBER CE82-023-E655
SCALE: AS SHOWN		

DRAWN BY: E MINNER 10-18-86 | CHECKED BY: RW 2/9/87 | APPROVED BY: ASG 2/9/87 | DRAWING NUMBER: CE82-023-E655

REVISIONS

NO.	DATE	
1	10-5-87	CHANGED NOTE IN DETAIL DMA/JVA