STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
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December 24, 2009

Mr. Jim Sumner
Manager, Group Environmental Programs
General Electric Aircraft Engine
One Neumann Way MD T165
Cincinnati, OH 45215

Re: Washington State Department of Ecology's (Ecology) Determination that the Focused Feasibility Study for the Former GE Facility (220 South Dawson Street) is Ready for Public Comment

Dear Mr. Sumner:

Thank you for sending your November 30, 2009 letter to Ecology accepting the cleanup levels established in Ecology's July 13, 2009 response letter.

Now that we have resolved our discussion about the cleanup levels, we are now pleased to notify you that the FFS Report is ready for public comment. By "FFS Report," Ecology is referring to GE's revised draft FFS report dated October 17, 2008 as modified by Ecology response and comment letters dated July 13, 2009, October 1, 2008, and August 14, 2008 and other communications referenced therein.

Subject to Ecology's determination after public notice and comment, Ecology believes that the FFS Report contains sufficient information to select a remedial alternative. Moving forward, the Draft Cleanup Action Plan (DCAP) should be drafted based on Alternative 2 as described by Ecology in the FFS Report and in this letter. In particular, Ecology notes the following concepts which, while they do affect finalizing the FFS Report, may affect the DCAP: First, Ecology and GE appear to agree that the DCAP does not necessarily need to identify a future contingent remedy. We could perform the ISCO injections and rely on the reopeners in the Consent Decree if ISCO does not fully work. Second, Ecology is open to further considering when the pumps need to be on or off during ISCO performance monitoring as long as there are no unacceptable impacts to on-and off-properties. Ecology looks forward to further discussion with GE on this issue in the future.

For the next immediate step, Ecology proposes a meeting or telephone conference call with GE to discuss the schedule and process for GE to submit the first draft of the Ecology cleanup action plan, based on Alternative 2 as described by Ecology in the FFS Report and in this letter.

Ecology shares GE's goal of finalizing the DCAP in the near future and moving on to implementation as soon as possible.

Lastly, this letter does not constitute the *letter of satisfaction* contemplated by Section IX of the Agreed Order, DE-5477. The letter of satisfaction will not be issued until GE completes all work under the current Agreed Order, which includes ongoing groundwater monitoring and operation and maintenance of the groundwater recovery system. Alternatively, depending on the outcome of our negotiations, Ecology may agree in the future to supersede the current Agreed Order as part of entering into a subsequent cleanup agreement (e.g. Consent Decree) with GE.

Please feel free to call me at (425) 649-7264 if you have any questions regarding this letter.

Sincerely,

Dean Yasuda

Dean Yasuda, P.E.
Environmental Engineer
Hazardous Waste and Toxics Reduction Program

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July 13, 2009

Mr. Jim Sumner
Manager, Group Environmental Programs
General Electric Aircraft Engine
One Neumann Way MD T165
Cincinnati, OH 45215

Re: Ecology Comments on the Draft Revised Focused Feasibility Study (FFS) Report, dated October 17, 2008

Dear Mr. Sumner:

Thank you for submitting the revised draft FFS report to the Washington State Department of Ecology (Ecology) per the requirements of the RCRA Corrective Action Agreed Order DE-5477 (Agreed Order). Ecology shares the General Electric Company's (GE's) goal of finalizing the remedy selection and moving on to implementation as soon as possible.

Ecology carefully reviewed and considered GE's remedy evaluation and selection process in the revised draft FFS report, which included an additional modeling study and a proposal for an enhanced groundwater monitoring system under Alternative 5. Ecology appreciates GE's efforts and resources used to prepare this revision. GE's analysis throughout the FFS process has been useful in laying the foundation for the array of remedial alternatives. However, Ecology disagrees with GE's selected alternative and the supporting analysis. As more completely described in Attachment A, GE's remedy selection analysis falls short for the following main reasons:

- GE did not incorporate all of the Ecology required revisions in this revised FFS report. Attachment A indicates instances where those required revisions were not included.
- The analysis did not accurately incorporate the negative environmental and human health consequences of allowing the chlorinated solvent groundwater plume to expand and migrate downgradient when the groundwater recovery wells are shut off. As a result, Alternative 5, as identified in the revised FFS, falls short in many respects in comparison to Alternative 2, including but not limited to factors such as overall protectiveness, restoration timeframe, consideration of public concerns, and the disproportionate cost analysis (DCA) criteria.
- Ecology does not agree that the new modeling study included the appropriate and conservative input parameters and assumptions, and correspondingly does not agree with the results of the study.

- The proposed enhanced groundwater monitoring plan is not sufficiently effective to alert us to impending on-property, down or cross-gradient groundwater concentration increases in enough time to turn on the optimized hydraulic control system and prevent an exacerbation of existing conditions.

Alternative 2, along with the revisions stated in Ecology's Comment Letters (August 14, 2008, October 1, 2008, and today's comments), is the remedy that needs to be selected based on Ecology's FFS analysis. Alternative 2 meets threshold and other requirements under MTCA, such as protection of human health and the environment, reasonable restoration timeframe, and consideration of public concerns.

As stated in Ecology's November 25, 2008 certified letter, there are two procedural options for moving forward from this point. The first option is for the FFS to be revised again, fully incorporating all of the Ecology comments as written in this letter. The second option is for GE to agree to select Alternative 2 with the changes described in Ecology's Comment Letters, and to begin preparing a Draft Cleanup Action Plan (DCAP) accordingly.[1]

While further discussion on the draft revised FFS is not required by the Agreed Order, Ecology understands that neither of the options expressed above would be GE's preferred path forward. Thus, Ecology is willing to meet with GE to discuss today's comments. In an effort to meet our shared goal of moving on to implementation as soon as possible, Ecology would want this meeting to occur before mid-September 2009. As part of this meeting, GE may present a rebuttal of the Ecology comments with which GE disagrees.[2]

Assuming GE would like to meet, after the meeting Ecology will expect a decision about whether GE intends to move forward with option 1, submitting another revised FFS report or FFS addendum and incorporating all Ecology comments, accepting them as written as Ecology's viewpoint. Or, if GE selects option 2, then GE should submit a DCAP which incorporates changes to the FFS described in Ecology's Comment Letters, plus any changes agreed to during the proposed meeting.

Under option 2, before we move on to the DCAP, Ecology would, as a final process step, follow up with a letter to GE by (1) incorporating Ecology's Comment Letters into the FFS, (2) contingently indicating that the FS process is complete (pending Ecology's final determination after public comment), and (3) discussing next steps regarding preparation of the DCAP. While we hope to avoid dispute resolution altogether, we note that GE is free to invoke dispute resolution on today's letter, or on Ecology's subsequent letter contingently finalizing the FS.

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[1] There are certain details of the remedy that would still need to be established. For instance, there are still some issues concerning cleanup standards that Ecology would need to resolve in the Cleanup Action Plan, including but not limited to determining soil cleanup levels. A written explanation for the selection of Alternative 2 would be a necessary component of the DCAP. Finally, please note that after the FFS is further revised for Ecology's approval, it must still undergo public notice and comment, after which Ecology may require additional revisions to the FFS.
[2] If GE chooses to rebut any of Ecology's comments, Ecology expects the parties to discuss the issues at this meeting, prior to revision of the document. This gives GE an opportunity, prior to spending time on additional analysis, to determine whether GE's approach is likely to satisfactorily address Ecology's concerns.

Please be aware that under the first option it is likely the parties will need to spend more time in the feasibility study process which will add a number of months to the remediation schedule. The second option allows GE to begin drafting the DCAP in short order and thereby realize remedy implementation much sooner.

Please respond with your decision to move forward under option 1 or option 2 within 10 calendar days of your receipt of this letter. If you require more time to make this decision, please contact me to discuss your proposed time extension.

Ecology realizes that this comment letter is long. However, we felt it was important to be detailed and specific in our comments so that, in the spirit of the Agreed Order (Section VII.D and E), GE has clear direction on what parts of the revised report are not acceptable, with clear directions on what revisions are needed that would lead to Ecology approval.

Lastly, this letter does not constitute the *letter of satisfaction* contemplated by Section IX of the Agreed Order. The letter of satisfaction will not be issued until GE completes all work under the current Agreed Order, which includes ongoing groundwater monitoring in addition to completion of the FS work.

Please feel free to call me at (425) 649-7264 if you have any questions regarding this letter.

Sincerely,

Dean Yasuda

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Attachment A: Specific Ecology Comments on the Draft Revised FFS Report
Attachment B: Proposed Cleanup Levels

Attachment A: Specific Ecology Comments on the Draft Revised FFS Report:

While Ecology has made an attempt to highlight points of disagreement with the current draft FFS, Ecology's comments below are focused on revisions that are necessary for Ecology to select its final remedy. Thus, Ecology's silence as to a statement in GE's report does not necessarily indicate full agreement with any such statement.

Also, where Ecology provided comments below, but did not specifically request revisions to the draft FFS report, Ecology is indicating that GE needs to incorporate Ecology's comments in the revised FFS report.

Lastly, while Ecology has not required that GE use alternative terminology in the FFS, Ecology reiterates that GE has defined the "offsite treatment area" in this FFS report as that part of the contaminated aquifer that extends from 2nd Avenue South to Utah Street, as defined by groundwater chemical data. However, as a clarification, the "Site" defined by the Agreed Order is identical to the definition of Facility under RCW 70.105D.020(5), and includes the area where hazardous substances have come to be located. Ecology will require that this definition of "Site" be consistently applied in future cleanup documents.

Section 1: Introduction:

1. Page 1-3, Section 1.3, Paragraph 1, Second Sentence: GE needs to include the statement, *"Ecology did not provide informal input or concurrence on all independent work"*. For example, the installation of RW-1 and RW-2 was conducted without any input from Ecology. This added statement addresses the previous comment in Ecology's August 14, 2008 letter (Attachment B, comment 1).

2. Page 1-4, Section 1.4, Paragraph 4: This section needs to be revised to indicate that Ecology prepared its own capture zone analysis (CZA) that disagreed with the results of the GE CZA.

Section 2: Site Conceptual Model:

3. Page 2-3, Section 2.1.2.2, Last Sentence: This is an interpretation of GE not shared by Ecology. Ecology agrees that the quarterly monitoring data appear to indicate a minimal vertical hydraulic gradient, however, temporal and spatial variations of the vertical hydraulic gradient are not fully understood. Infiltrations at gravelly bare ground and leaky storm drain pipes may create downward vertical gradients during the rainy season. Furthermore, Ecology is not fully convinced that downgradient contamination at the deep aquifer zone (50 –60 feet bgs) was caused only by vertical dispersion or diffusion. The text needs to state "*Ecology reserves its differing technical opinion that the vertical gradients may have a significant influence on the hydrogeologic system.*"

4. Page 2-6, Section 2.2.2, Last Sentence and Table 2-2: The 1,4-dioxane screening levels for determining the extent of groundwater contamination is set at the MTCA Method B

groundwater cleanup level of 4.0 ug/L. Table 2-2 needs to be revised accordingly. Ecology's previous comment indicated the "proposed groundwater cleanup level" based on surface water cleanup levels (79 ug/L).

5. Figures 2-12 through 2-27: As stated previously in Ecology's August 14, 2008 response letter (Attachment B, comment 6), the concentration contour figures here were prepared by GE/ENSR based on their interpretation of the groundwater data. Ecology does not agree with this interpretation of the groundwater data or with the contouring approach used in these figures[3]. Ecology will expect the final remedy design in the Cleanup Action Plan (using Alternative 2 as modified by Ecology's Comment Letters) will reflect the assumption that the downgradient chlorinated volatile organic contaminants (CVOCs) groundwater plume is continuous. This point will be key to successful implementation of in-situ chemical oxidation (ISCO) at the site.

6. Page 2-11, Section 2.2.2.4, Paragraph 2 and Page 2-12, Section 2.2.2.4 Paragraph 2: The previous August 14, 2008 letter (Attachment B, comment 11) referred to both biotic and abiotic degradation of CVOCs. Therefore, Ecology's revisions were not made in the correct locations. The revised statements placed on page 2-11, Section 2.2.2.4, at the end of paragraph 1 need to be relocated to page 2-11, paragraph 2 AND page 2-12, paragraph 2 for improved clarity. In addition, the titles of Figures 2-30 and 2-31 must not state "degradation" because Ecology previously stated in its August 14, 2008 letter that there is insufficient information to be able to determine if degradation is the more prevalent attenuation process versus advection/dispersion/sorption or removal by the groundwater extraction system.

7. Page 2-18, Section 2.2.3.3: The previous Ecology August 14, 2008 letter (Attachment B, comment 15), states that it does not agree that the cross slab pressure readings show that vapor intrusion is negligible. In particular, the short duration of data collection is not representative of longer term conditions when the building is inhabited[4]. The text needs to be revised to include the statement, "*Ecology does not agree that the cross slab pressure readings show that vapor intrusion is negligible. In particular, the short duration of data collection is not representative of longer term conditions when the building is inhabited*".

Section 3: Cleanup Standards:

8. Page 3-2, Section 3.1.1, Paragraph 1. Last Sentence: GE states that there are exceedances of trichloroethylene (TCE) in soils (below the 220 South Dawson Street building) above the current MTCA Method A –soil cleanup levels for unrestricted land uses that are protective of groundwater cleanup levels, but no justification is provided as to why these exceedances are protective of groundwater cleanup levels. Ecology does not agree with GE's statement because residual soil concentrations of TCE exceed the cleanup level protective of

[3] One such important disagreement is GE/ENSR's contouring of isolated downgradient "islands" of CVOC contaminated groundwater around monitoring wells versus contouring smooth CVOC iso-concentration lines extending upgradient and downgradient. Ecology disagrees that these isolated "islands" of CVOC contaminated groundwater exist as drawn. This is not consistent with groundwater flow and CVOC concentrations consistently found in those wells.

[4] Also refer to Ecology's March 10, 2006 letter (certified # 7005 2570 0001 0182 2817) to GE.

groundwater under WAC 173-340-747(4). Also, Ecology does not agree that Method A cleanup levels are appropriate for this site, so the report needs to be revised to refer to Method B cleanup levels. GE needs to state in the report that subsurface soil contamination is not currently protective of Site groundwater cleanup levels. In addition, the revised FFS report needs to clearly state that GE may not need to remove these soils[5] with CVOC concentrations above MTCA Method B soil cleanup levels protective of groundwater and indoor air cleanup levels. Then, the FFS report needs to justify this conclusion. And, the FFS report needs to state that under the scenario where Ecology allows soil above cleanup levels to remain, institutional controls will be necessary at the 220 South Dawson Street building to prevent future disturbance of those contaminated soils and use of the building in a manner that increases migration of and exposure to CVOC contaminants. Disturbance of those contaminated soils may result in additional groundwater contamination and TCE vapor intrusion into the above building. Furthermore, the report needs to state that (1) further excavation of these contaminated soils may be required in the future (if the building is demolished in the future or access for soil removal becomes feasible) or (2) in-situ ISCO treatment of these soils may be required (under the final cleanup) if continuous CVOC vadose zone soil leaching is responsible for ISCO treatment not meeting the groundwater cleanup levels or volatilization of CVOCs in the soil continues to result in exceedances of MTCA Method B indoor air cleanup levels. Also refer to comment #10 below.

9. <u>Page 3-2, Section 3.1.1, Paragraph 2</u>: This paragraph needs to be deleted since there is no definition of <u>chemicals of interest</u> in the Agreed Order, nor is any definition other than contaminants of concern (COC) required for this revised FFS report.

10. <u>Page 3-3, Section 3.1.1.1, Paragraph 5 and 8</u>: Ecology required that GE propose soil COC cleanup levels that are protective of groundwater and indoor air cleanup levels, <u>not</u> that GE will monitor current conditions to ensure that soil cleanup levels are protective of groundwater cleanup levels (as stated in the revised FFS).

    GE also states that it is not required to show that soil cleanup levels are protective of indoor air cleanup levels under WAC 173-340-740(3)(b)(iii)(C)(III). The soil concentrations of TCE[6] are known to be significantly above the soil cleanup levels that are protective of groundwater for drinking water beneficial use, and therefore, Ecology does not agree that this exemption applies. In addition, under WAC 173-340-740(1)(c)(vi), Ecology has determined that the soil to indoor air pathway is significant at this Site, therefore the development of soil cleanup levels protective of the indoor air is necessary. These residual on-property CVOC contaminated subsurface soils along with the CVOC contaminated groundwater are the source of the unacceptable TCE vapor intrusion into the 220 South Dawson Street building. This was the reason why Ecology required that GE install, operate and maintain the vapor intrusion mitigation (VIM) system for that building.

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[5] Due to the risk of further excavations creating structural damage to the 220 South Dawson building.

[6] Concentrations above MTCA Method B soil CULs for TCE were verified in the remaining soils after the 1996 contaminated soil excavation. (refer to Area 7 which had 1.16 ppm TCE in confirmation soils).

Soil cleanup levels[7] protective of the groundwater cleanup levels can be calculated using the three-phase partitioning modeling approach described in WAC 173-340-747(4). However, MTCA also requires that residual soil contamination is protective of indoor air (via direct volatilization). After on-property groundwater cleanup levels are met, without additional CVOC contaminated soil removal, GE needs to collect a sufficient number of indoor air and sub-slab vapor samples[8] to verify that subsurface soil contamination levels have sufficiently decreased by other natural attenuation processes to be protective of indoor air under the current building occupancy and operating conditions. Meeting and sustaining the indoor air cleanup levels after the groundwater cleanup levels are met[9] will be the compliance indicator Ecology uses to determine if the subsurface soil contamination levels are acceptably protective of indoor air cleanup levels under current building conditions and whether the VIM may remain off.[10] However, in order for the subsurface soil contamination to be protective of indoor air in future building scenarios (different building uses or new construction), the measured and sustained sub-slab vapor concentrations must be less than 10 times the indoor air cleanup levels.[11] If sub-slab vapor concentrations for volatile CVOCs consistently meet this 10 times indoor air concentration, Ecology does not anticipate a need for further institutional controls to address the soil to indoor air pathway. If indoor air cleanup levels are met for the current building, without the VIM system operating, but sub-slab vapors remain above the 10 times indoor air cleanup level, GE will need institutional controls to ensure that for example: a) future changes to the building do not lead to unacceptable vapor intrusion (VI) impacts, b) new construction or property activities in the future do not create a new, or exacerbate an existing VI exposure pathway, and (c) routine indoor air sampling in the new construction or renovated building is in place to ensure future protectiveness. If indoor air is again contaminated above indoor air cleanup levels, contaminated subsurface soils must be removed or sub-slab depressurization system must be restarted or installed. Note that this section discusses institutional controls to address the soil to vapor pathway only. Institutional controls will be necessary under the circumstances described in WAC 173-340-440(4), as also discussed in paragraphs 18, 19, 23, 34 and 35, such as if soil above cleanup standards remains in place. The specific terms and requirements of any necessary institutional controls would be set later in the cleanup process, as part of the Cleanup Action Plan. Refer to comment #8.

11. Page 3-4, Section 3.1.2.1, Bullet #1: This section was revised by GE, however, it does not clearly express Ecology disagreement over the statements that a construction worker would only be exposed to contaminated groundwater during work on buried sewer lines. GE needs to include the statement that, "*Construction worker may be exposed to contaminated*

[7] If groundwater CULs are met and sustained by ISCO or contingent remedy treatment without remediating subsurface soils to their cleanup levels (protective of groundwater CULs), Ecology will assume the levels of subsurface soil contamination are protective of the groundwater CULs.
[8] After Ecology agrees to shut off the VIM system after groundwater cleanup levels protective of indoor air CULs are met and sustained.
[9] Sub-slab vapor samples may still need to be collected concurrently with indoor air samples to verify if indoor air contaminants are likely from vapor intrusion.
[10] If subsequently, indoor air concentrations rise above the indoor air cleanup levels, then the VIM system will be restarted.
[11] This is based on the 95% Upper confidence limit on sub-slab to indoor air attenuation factors calculated in the USEPA Vapor Intrusion Data Base, Preliminary Evaluation Attenuation Factors, March 2008.

groundwater and volatile contaminated vapors from groundwater during any future excavation work (i.e. building construction) scenario. "

12. Page 3-4, Section 3.1.1.2, Table 3-1: GE has proposed Method A TPH soil cleanup levels for unrestricted land uses[12] that would not result in free product (NAPL) accumulating on the water table. However, TPH soil cleanup levels also need to be protective of TPH groundwater cleanup levels. This was communicated in Ecology's August 14, 2008 response letter (Attachment B, comment #18) and must be included in the revised FFS report. The revised FFS also must include the groundwater cleanup level for TPH-oil set at the MTCA Method A groundwater cleanup level of 500 ug/L. GE will need to demonstrate that current subsurface TPH soil concentrations do not result in current exceedances of the TPH-oil groundwater cleanup level. This could be performed by collected groundwater samples in or immediately downgradient of the TPH-oil contamination. Or, GE may propose to calculate a soil cleanup level based on methods described in WAC 173-340-747. Based on our current understanding of the site, Ecology does not expect TPH-oil soil and groundwater cleanup levels to drive site cleanup actions. ISCO injections will treat TPH, if present in groundwater.

13. Page 3-9, Section 3.1.2.3, Paragraph 2: Although Ecology's previous August 14, 2008 response letter (Attachment B, comment 23) expressed disagreement, this section still cites that a utility worker is less exposed than a construction worker. Without being provided any facts to support GE's hypothesis, Ecology still disagrees and these statements need to be removed. Furthermore, GE still only discusses construction workers contacting contaminated groundwater through installation, operation and maintenance of a dewatering system. The revised FFS report also needs to state, *"Utility and Construction workers may also contact contaminated groundwater or inhale volatile contaminant vapors from groundwater as a result of excavating or working within the excavation."*

14. Page 3-10, Section 3.1.2.3, Paragraph 2: The proposed groundwater cleanup levels for volatile organics at the site based on the most stringent of the following: MTCA Method B surface water cleanup levels[13], exposures to construction workers/trenchers, aquatic water quality criteria, and protection of the indoor air pathway (Method B) for 1,1,1-trichloroethane (TCA), tetrachloroethylene (PCE), trans-1,2-dichloroethylene (DCE), 1,1-DCE, cis-1,2-DCE, TCE, vinyl chloride (VC) are listed in Attachment B for incorporation into the revised FFS report. Where COCs are non carcinogenic, those (four) individual cleanup levels (and remediation levels) were adjusted so that the individual hazard quotient (HQ) is 0.25 for each constituent and therefore ensuring the total hazard quotient (HQ) is less than 1.0. Ecology does not necessarily approve of all of assumptions behind the construction worker/trencher cleanup level calculations in the revised FFS – appendix D, but does agree that these values will be higher than the cleanup levels calculated using Method B surface water and indoor air cleanup equations. Thus the disagreement need not be

[12] The Method A unrestricted TPH soil cleanup levels are also identical to the Method A industrial TPH soil cleanup levels.
[13] Based on the Asian and Pacific Islander (API) fish ingestion rate of 57 grams/day, a reduced body weight of 63 kg, and the fish diet fraction increased to one. Ecology certified letter (7007 0220 0004 7250 3522) to GE dated March 4, 2008.

resolved at the current time. Refer to Attachment B at the end of this letter for further explanation on the derived groundwater contaminant cleanup levels.

15. Page 3-12, Section 3.1.2.3: This section was revised by GE. However, following our receipt of additional information and written technical comments[14] from Liberty Ridge, LLC, Ecology concluded that it would be inappropriate to apply Method C indoor air cleanup levels for the Site. As explained in the Liberty Ridge comments, the Site is currently being used for commercial purposes and not solely industrial purposes. Therefore, it is not appropriate to apply an industrial worker risk level to office or commercial workers. Instead, the revised FFS report needs to use Method B to establish these cleanup levels that ultimately must be met and are more consistent with planned and current commercial uses at the Site. A protective Method B indoor air immediate action level (IAL)[15] must also be used in the DCAP as the level that must immediately be met in indoor air to protect human health while the cleanup is progressing. Ecology expects the Method B indoor air cleanup level will be achieved when the groundwater and soil cleanup levels protective of indoor air cleanup levels are met. At this time, based on operation of the two groundwater recovery wells, current groundwater contaminant concentrations and current building use/design, Ecology does not foresee the need for indoor air assessments in buildings near and below the CVOC groundwater contamination.

    In addition, the Method B groundwater cleanup levels protective of indoor air need to be calculated as follows:

    a. Use of the empirically derived groundwater cleanup levels protective of indoor air. To meet this requirement, GE needs to use the PSC-Georgetown values for individual groundwater CVOCs resulting in a 1EE-06 excess cancer risk or total Site Hazard Index equal to 1.0 in indoor air and apply to the Site under a Method B scenario. The PSC-Georgetown and GE cleanup Sites have the same volatile COCs within different areas of the same shallow aquifer, and therefore, it is not necessary to re-calculate these values. Buildings with crawl spaces, such as the Interior Environments building, have a greater risk for unacceptable vapor intrusion, and therefore, Ecology may require additional indoor air sampling based on future changes in groundwater CVOC concentrations and building use/design. Ecology is assuming that the optimized hydraulic control system will be operational. As you recall, Ecology required indoor and crawl space air samples at the Interior Environments building instead of relying on modeling under the Johnson-Ettinger model (JEM), and

    b. After Ecology received the revised draft FFS report, the TCE Method B indoor air cleanup level has increased by a factor of 4.5[16]. Therefore, the Method B (unrestricted) groundwater inhalation pathway interim measure action level (IPIMAL) for TCE – protective of an indoor air concentration of approximately 0.1 ug/m^3 – has increased to 1.8 ug/L. This value is slightly more stringent than the Method B surface water cleanup

[14] Technical memorandums from Environmental Partners, Inc. dated August 25, 2008 and November 17, 2008
[15] RLs based on a 10 hour work day, 5 work days per week and 50 work weeks per year.
[16] The result of a change in the inhalation cancer slope factor used by the Washington State Department of Ecology.

level of 2.9 ug/L. Other CVOC Method B groundwater cleanup levels are shown in Attachment B.

As stated in our August 14, 2008 response letter (Attachment A, comment V and Attachment B, comment 26), the revised FFS report needs to state that Ecology plans to use indoor air, sub-slab vapor and groundwater concentration measurements at the 220 South Dawson Street building to determine the permanent shutoff timing of the VIM system.

16. Page 3-14, Section 3.1.3.2, Paragraph 3 and Table 3-8: In accordance with Ecology's previous comment letter dated August 14, 2008 (Attachment B, comment #26), sub-slab vapor screening levels alone are not appropriate for use as cleanup levels and need to be removed from Table 3-8. Those sub-slab screening levels only applied to the VIM interim action and do not apply to the Site cleanup.

17. Page 3-16, Section 3.2.1 Soil Point of Compliance: The revised FFS needs to include the following text from the MTCA regulations:

    a. For soil cleanup levels based on protection from vapors, the point of compliance shall be established in the soils throughout the site from the ground surface to the uppermost ground water saturated zone (e.g., from the ground surface to the uppermost water table), WAC 173-340-740(6)(c).

    b. For soil cleanup levels based on the protection of ground water, the point of compliance shall be established in the soils throughout the site. (WAC 173-340-740(6)(b)) In this case, since the 220 South Dawson Street property is considered the source of groundwater contamination at the Site, the soil point of compliance here refers to soils throughout the 220 South Dawson Street property.

18. Page 3-17, Table 3-10: Under MTCA, the groundwater cleanup levels must be protective of the vapor intrusion pathway and groundwater exposure pathways, where groundwater is not a current drinking water source. Normally, the groundwater cleanup levels for TCE, PCE, VC, 1,1,1-TCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE and 1,4-dioxane at the Site need to be based on the lower of the following: MTCA Method B surface water cleanup levels (adjusted for API fish ingestion pathway), groundwater concentrations that are protective of Method B air cleanup levels (based on IPIMALs), and aquatic water quality criteria. However, based on the specific conditions at this Site, the vapor intrusion pathway only appears relevant down to 20 feet below ground surface (bgs) in the aquifer. Under current groundwater conditions, groundwater below 20 feet bgs does not mix with groundwater above 20 feet bgs in sufficient quantities to cause a vapor intrusion pathway exceedence. As a side benefit, there is also some efficiency to the selection of 20 feet in particular at this Site because many of the shallow groundwater monitoring wells are already screened over this vertical interval. Because the vapor intrusion pathway is only relevant down to 20 feet bgs, the Site groundwater cleanup levels for the water table zone (aquifer at 20 feet or less bgs) will need to meet groundwater cleanup levels protective of indoor air cleanup levels, surface water cleanup levels and ecological aquatic criteria. Below 20 feet bgs within the aquifer,

the groundwater cleanup levels will need to meet surface water cleanup levels and aquatic water quality criteria. Ecology has calculated these COC groundwater cleanup levels and presented the results in Attachment B for incorporation into the revised FFS report. Performance and long-term confirmational groundwater monitoring will be required to verify that the water table zone COC concentrations do not increase above the cleanup levels due to higher COC concentrations in the lower aquifer zone. Additionally, because the assumptions at this Site about the vapor pathway are based on current groundwater conditions, institutional controls preventing activities that could significantly alter the groundwater conditions at the Site will also be necessary.

The soil cleanup levels cannot be based on MTCA Method C cleanup levels as these values are neither protective of groundwater or indoor air cleanup levels. At a minimum, soil cleanup levels shall be protective of groundwater cleanup levels and Method B indoor air cleanup levels. Based on current site data, existing on-property CVOC contaminated soils are contributing to unacceptable TCE indoor air and groundwater concentrations and do not currently meet these cleanup levels. Refer to comment 10 above. MTCA Method B cleanup levels (except for TPH-oil and arsenic) are required for the Site. Ecology has provided these values in Attachment B.

Section 4: Technology Screening:

19. Page 4-2, Section 4.2: GE revised this section of the FFS, however further revision is required to be in compliance with the MTCA regulations and Ecology's previous August 14, 2008 response letter (Attachment A, comment II). The revised FFS needs to state: *MTCA requires that GE make a good faith effort to secure an environmental restrictive covenant on the 220 South Dawson Street property and any downgradient properties when institutional controls are required by WAC 173-340-440(4). For example: (1) any properties with* ***soil contamination*** *above applicable MTCA soil cleanup standards; or (2)* ***groundwater contamination*** *at the site above the potable standard.* This statement needs to be included in Sections 4.2, 5.3 and 5.6 where institutional controls are discussed.

Section 5.0 Evaluation of Remedial Alternatives:

20. Section 5.0: Ecology stated in its previous August 14, 2008 response letter (Attachment B, comment 32) that in a few cases the text in these summary paragraphs are not exact quotes from the MTCA. Ecology sees no reason to provide comment on these sections since they reference the correct remedy selection sections in WAC 173-340-360. However, in the event of any conflict between the summary of MTCA or its regulations in GE's report and the actual provisions of MTCA, the language of MTCA and its implementing regulations will govern.

21. Page 5-3, Section 5.2, Paragraph 2: Ecology's August 14, 2008 letter (Attachment B, comment 33) required revisions of text to include the use of the term *capture zone* NOT *cone of depression or cone of influence* in this FFS section. These revisions were not made and are necessary in the revised FFS report.

22. Soil Vapor Extraction/Air Sparging System, Vapor Intrusion, Institutional Controls, 5.2.1 Threshold Requirements, 5.2.2 Restoration Timeframe, 5.2.3 MTCA Evaluation Criteria: Ecology did not require a revision in the FFS report, however, Ecology reiterates that it agrees with GE that this technology has the potential to result in slightly longer restoration timeframes than ISCO or enhanced anaerobic bioremediation (EAB). However, the restoration timeframe would not be so much longer as to immediately eliminate the technology from consideration. We can proceed with final remedy selection while agreeing to disagree on these matters.

23. Page 5-6, Institutional Controls Section: Refer to above comment #19.

24. Page 5-8, Section 5.2.4, Paragraph 2: GE did not include discussion that Ecology has reviewed GE/ENSR's capture zone analysis results (ENSR 2007) and disagreed with a number of its conclusions as required by the Ecology August 14, 2008 response letter (Attachment B, comments 20 and 33). For the purpose of revising this FFS report, add the text, "*Ecology's capture zone analysis report, dated October 31, 2007, describes the technical basis for Ecology's conclusions regarding incomplete capture and Ecology's basis for stating that optimized hydraulic control of contaminated groundwater at the 220 South Dawson Street property needs to be evaluated as part of final selected remedy.*"

25. Page 5-8, Section 5.3: For clarity and consistency with the previous August 14, 2008 Ecology letter (Attachment A, Comment V), bullet #3 needs to be rewritten as: "*The continued operation of the vapor intrusion mitigation system and routine groundwater, indoor air and sub-slab vapor sampling as required.*"

26. Page 5-8, Section 5.3, Last Paragraph, Last Sentence: For clarity and consistency the statement needs to read, "*The objective of the current groundwater recovery network is to contain and recover contaminated groundwater, focusing on areas in the northern portion of property.*"

27. **Section 5.4 Alternative 3 – Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation (EAB) and Vapor Intrusion Mitigation**: Ecology did not require revisions to alternative 3 as part of the final remedy selection. However, Ecology reiterates its disagreement with the comparative analysis between EAB and ISCO as well as the analysis with and without optimized hydraulic control. Ecology is not requesting these revisions to Section 5.4 of the draft FFS, however, Ecology plans to require that EAB will be the contingent remedy.

28. Page 5-10, Section 5.3, Paragraph 1, First Sentence: Ecology reiterates that the FFS will not finalize the "exact" location of ISCO injections, however, the depths and lateral areas of treatment will be described in the FFS. GE needs to state this in the revised FFS report.

29. Page 5-10, Section 5.3, Paragraph 3, Fourth Sentence: Per Ecology's August 14, 2008 letter, (Attachment A, Comment I.d), GE did not, and needs to, revise the text to include ISCO

injections to the full depth of the off property plume, at 55 feet bgs. (Ecology notes that Figures 5-3 and 5-6 stated these deeper injections would occur). In addition, per Ecology's August 14, 2008 letter, GE did not, but needs to, revise these figures and the Section 5.3 text to include ISCO injections at 2nd Avenue South, upgradient of the Western Cartage building.

30. Page 5-10, Section 5.3, Paragraph 3, Ninth Sentence: The revised text needs to state that ISCO injections outside the 220 South Dawson Street building will need to target areas of residual CVOC contamination in the subsurface (vadose and saturated zone) where the former degreasers were located in the north east corner of the building.

31. Page 5-10, Section 5.3, Paragraph 4, Third through Fifth Sentence: Ecology disagrees with the rationale behind GE's assertion that operation of the pump and discharge system "might" impede the effectiveness of the ISCO system. Ecology stated during the September 25, 2008 meeting with GE, that we disagree that there will be negative impacts to ISCO treatment with an optimized hydraulic control system operating. Our stated reasons were as follows: (1) the Ecology capture zone analysis (CZA) indicates that there is a very limited radius of influence (ROI) around recovery wells; (2) ISCO injection zones of influence are typically no more than 25-30 feet in highly conductive aquifers; and (3) we expect the reagent travel distance from the injection well toward the recovery wells to be no more than 7.5 feet before it is completely consumed (this is based on the FFS's stated groundwater flow velocity range of 0.3 – 1.5 ft/day and the stated maximum ISCO chemical lifespan in the aquifer of five days). The distance between ISCO injection wells and recovery wells is simply too far to result in any ISCO short-circuiting.

    If GE remains concerned that short-circuiting could occur between the ISCO injection wells and the groundwater recovery wells, then GE could consider moving the operating recovery well RW-3 further west (near 2nd Avenue South) after the ISCO injections proceed from the east to the west side of the alley. The revised text needs to include the Ecology's above stated justification.

    Ecology notes that the GE revised FFS did not provide a technical rebuttal to Ecology's justification for concluding that an optimized hydraulic containment system will not adversely impact ISCO treatment effectiveness.

32. Page 5-11, Section 5.3, Paragraphs 1 and 2: The revised FFS report needs to state that the groundwater performance monitoring plan is not being finalized in this document. Furthermore, the FFS report revisions need to state the following Ecology requirements:

    a. Ecology will require two (2) or more rounds of groundwater sampling over a multiple month period to verify ISCO effectiveness and monitor potential rebound. The necessity of additional post-injection groundwater monitoring will be based on the results of the previous post-injection groundwater sampling data.
    b. Based on Ecology experience, it expects that a minimum post-injection monitoring period of 3 to 6 months for each phase of the ISCO injection will be required to evaluate the ISCO effectiveness.

c. A long term monitoring program needs to be implemented after all phases of ISCO are completed. The timing and frequency of such long-term monitoring shall be finalized in a separate GW monitoring plan.
d. Lastly, GE did not and needs to add cadmium, chromium, nickel, selenium and trans-1,2-DCE to the list of performance monitoring chemicals (Table 5-3) as required in the Ecology August 14, 2008 letter (Attachment A, Comment IV).

33. Page 5-11, Section 5.3, Vapor Intrusion System: The revised text needs to include Ecology's previous statements in its August 14, 2008 letter, (Attachment A, comment V and Attachment B, comment #26) that indoor air, sub-slab vapor and groundwater sampling will be collected to determine if the potential for unacceptable vapor intrusion still exists. GE's states that only indoor air sampling will be performed. Also refer to above comment 15 regarding the use of Method B air cleanup levels.

34. Page 5-11, Section 5.3, Institutional Controls Section: Refer to above comment #19.

35. Page 5-11, Section 5.3.1 MTCA Threshold Requirements, Bullet #2, Second Sentence: Refer to above comment #19.

36. Page 5-12, Section 5.3.2, Paragraph 1: GE provides no technical basis for its eight year restoration timeframe per the requirements of the Agreed Order, Task 1.7. It appears that this timeframe is based on GE's assumption that alternative 2 will take two extra years to implement over alternative 5 due to the GE's claim that the optimized groundwater recovery system will negatively impact ISCO effectiveness. Ecology has a fundamental disagreement with this premise. Refer to comment #31. Remove statements that the alternative 2 restoration timeframe will be longer than alternative 5.

37. Page 5-12, Section 5.3.2, Paragraph 2: As stated previously, Ecology does not agree with GE's hypothesis that operation of the optimized hydraulic control system will impede ISCO effectiveness. Please refer to above comment #31.

In addition, the reaction time for permanganate oxidation of chlorinated solvent (when not dealing with large mass globules) is instantaneous, therefore, increasing *contact time*, by itself, should not significantly improve treatment effectiveness. What is more important is that there is "contact" between the permanganate and the chlorinated solvent throughout the zone being treated. GE properly states that there is uncertainty in the restoration timeframe, but does not mention that uncertainty could result in a shorter restoration timeframe than what GE stated.

The FFS also fails to acknowledge the possibility that additional on-property and off-property[17] ISCO treatments will be required if the CVOC groundwater plume is allowed to expand within and beyond the 220 South Dawson Street property boundaries. This would result in an increased restoration timeframe and additional costs to both Ecology and GE.

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[17] Under the McKinstry and other off-property buildings.

The revised text needs to remove all statements that optimized hydraulic control will impede ISCO effectiveness and replace them with Ecology's technical opinions above.

38. Page 5-12, Section 5.3.2, Paragraph 3: This additional 2 year treatment period is an assertion that Ecology does not agree with nor is it supported by any Ecology-concurred justification, site groundwater data or Ecology approved predictive modeling. Per Ecology's comment #31 above, Ecology does not expect any negative effect of the optimized hydraulic control system on the effectiveness of the ISCO treatment. GE needs to remove all sentences that state or infer that alternative 2 will have a longer restoration timeframe than alternative 5, and include the statement, *"With groundwater recovery wells shut off, an expanding CVOC groundwater plume on-property and downgradient will increase restoration timeframes."*

39. Page 5-12, Section 5.3.2, Paragraph 4, First Sentence: GE needs to remove this sentence and replace it with, *"The final restoration timeframe could be longer or shorter than the current estimates."*

40. Page 5-12, Section 5.3.2, Paragraph 5: Please remove the last sentence and replace it with these statements, *"If the ISCO treatment does not initially result in the attainment of cleanup levels (west of 2nd Avenue South) in the expected restoration timeframe, GE will first re-evaluate the ISCO performance and propose additional ISCO treatment. If ISCO treatment continues to be ineffective, then GE would implement the contingent remedy. The results of the Liberty Ridge, LLC site characterization (EPI, February 12, 2001) do not show that Liberty Ridge is a source of CVOC groundwater contamination at the 5050 1st Avenue South property. However, as a final resort, GE may propose additional characterization work to be performed concurrent with ISCO treatment optimization and/or contingent remedy implementation."* These statements describe Ecology's process for analyzing less-than-expected ISCO performance.

41. Page 5-12, Section 5.3.3: The MTCA DCA and evaluative criteria listed in this section only apply if the threshold criteria (WAC 173-340-360(2)(a)) are met. As previously stated in Ecology's August 14, 2008 response letter (Attachment A, comment I.a), optimized hydraulic control is necessary to meet the threshold requirements of WAC 173-340-360(2)(a)(i) and (ii): *protect human health and the environment* AND *comply with cleanup standards.* Alternative 5 as identified in the FFS falls short in many other respects in comparison to Alternative 2, including but not limited to factors such as overall protectiveness, restoration timeframe, consideration of public concerns, and the DCA criteria. Ecology also evaluates and weighs the criteria in the DCA differently than GE, resulting in an overall conclusion that Alternative 2 best meets these requirements. Please remove this re-evaluation and use Ecology's scoring and criteria evaluation stated below:

    a. Overall Protectiveness: Ecology disagrees with GE's qualitative moderate ranking. Ecology ranks Alternative 2 **high** for this category due to mitigating the risks (unacceptable vapor intrusion on the tenants at the 220 South Dawson Street building and cross/downgradient buildings). Keeping the optimized hydraulic control system operating during on-property ISCO injections actually ensures that the 220 South Dawson Street VIM system will work as designed because of a stable (non-expanding) TCE groundwater plume beneath the building. Operation of the optimized hydraulic control system will not negatively impact on-property ISCO injection effectiveness. Refer to above comment #31.

b. Remedy Cost and Cost Effectiveness: Ecology ranks Alternative 2 **high** (most likely the lowest cost) for this category. There are significant errors or erroneous assumptions in the calculation of the alternative 2 cost resulting in a higher cost. Refer to Ecology comments on Appendix B.

c. Long Term Effectiveness: Ecology disagrees with GE's moderate ranking. Ecology ranks alternative 2 **high** for this category as it should achieve the cleanup standards in a reasonable timeframe. GE stated and Ecology agrees that the permanence of alternative 2 is high. Ecology disagrees that this remedy will take 2 years longer to implement than alternative 5 based solely on the concurrent operation of the optimized hydraulic control system. GE's comments in this section are more applicable to comparative restoration timeframe and not long term effectiveness. Alternative 2 prevents the on-property and off-property expansion and migration of the TCE groundwater plume therefore reducing the on-property and off-property restoration timeframe. Maintaining a stable plume length, width and concentrations (under optimized hydraulic control) helps ensure that the planned frequency and locations of the ISCO injections are correct.

d. Short Term Management of Risk: As stated in Ecology's previous comment letter dated August 14, 2008 (Attachment B, comment 38), Ecology disagrees with GE's medium ranking. Ecology ranks alternative 2 **high** for this category. Ecology previously stated that maintenance of optimized hydraulic control system is a common task for environmental consultants and does not pose a large burden to warrant a reduced ranking from high to moderate. In addition, Ecology places a lower weighting on this criterion compared to Overall Protectiveness and Permanence[18].

e. Implementability: As stated in Ecology's previous comment letter dated August 14, 2008 (Attachment B, comment 38), this alternative is practical and implementable. Therefore, Ecology ranks alternative 2 **high** for this category. Maintenance of the groundwater extraction well system will not entail significant additional work, and we disagree that it should warrant a reduced score for implementability for that reason (compared to identical alternatives without an operating optimized hydraulic control system). Maintenance of groundwater extraction well systems are common practice and the current system has been operated and maintained for 12 years so Ecology assumes that GE has experience in this matter. It is probable that ISCO implementation may be much more difficult than maintaining the optimized hydraulic control system, due to more

[18] WAC 173-340-360(3)(e)(ii)(C): *The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. In particular, the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action.*

severe injection and monitoring well clogging and fouling compared with the extraction/monitoring wells. In addition, Ecology places a lower weighting on this criterion compared to Overall Protectiveness and Permanence.

f. Consideration of Public Concerns: Ecology ranks alternative 2 **high** for this category as the remedy is permanent to maximum extent practicable, protective of human health and the environment and allows for restoration in a reasonable timeframe. This section of the FFS report was revised but did not include comments from Mason Supply Company on their concurrence to install the VIM system. This was a stated requirement of Ecology's August 14, 2008 response letter (Attachment B, comment 35). The following statements need to be added to this section, "*The Mason Supply business communicated to Ecology its concerns regarding CVOC vapor intrusion into its offices and they supported the installation of the vapor intrusion mitigation system. The Western Cartage building owner (Liberty Ridge, LLC as represented by its environmental consultant, Environmental Partners, Inc) has provided comments*[19] *on the draft FFS and revised draft FFS reports. These comments state a clear preference for maintaining optimized hydraulic control over the CVOC groundwater plume during on-property ISCO injections. Liberty Ridge, LLC states that eliminating hydraulic control of the on-property CVOC groundwater plume presents an unacceptable risk to Liberty Ridge due to the spread of additional contamination onto its downgradient property. Liberty Ridge, LLC disagrees that the current hydraulic control system is effective in preventing the CVOC groundwater plume from migrating off-property and recommends that the system be "enhanced". Ecology has also proposed an optimized hydraulic control system. Liberty also states that if hydraulic control is eliminated, it will not be readily possible to recover spreading groundwater contaminants by restarting the groundwater recovery wells. Ecology agrees with these comments.*"

42. **Section 5.5 Alternative 4 – Soil Vapor Extraction/Air Sparging**:
Ecology did not require revisions to alternative 4 and did not require further evaluation of vapor extraction/air sparging as part of the final remedy. Ecology agrees with GE that this technology has the potential to result in a slightly longer restoration timeframe than ISCO or EAB. However, Ecology reiterates that the timeframe will not be so much longer that the technology's use should be immediately eliminated from consideration.

43. Page 5-21, Section 5.6, Paragraph 3: Per the Ecology August 14, 2008 response letter (Attachment A, Comment I.d), GE did not, and needs to revise the text to include ISCO injections to the full depth of the off property plume, at 55 feet bgs. (Ecology notes that Figures 5-3 and 5-6 stated these deeper injections would occur). Also, per the Ecology August 14, 2008 response letter, GE did not but needs to revise the figures and the Section 5.3 text to include ISCO injections at 2nd Avenue South, upgradient of the Western Cartage building.

44. Page 5-21, Section 5.6, Paragraph 4: As stated in the previous Ecology August 14, 2008 response letter (Attachment A, Comment IV), the baseline groundwater analytes need to

[19] Technical memorandums from Environmental Partners, Inc. dated August 25, 2008 and November 17, 2008

include: cadmium, chromium, nickel, selenium and trans-1,2-DCE. Revise this section and Table 5-5.

45. Page 5-21, Section 5.6, Paragraph 6: Same as above comment #32.

46. Page 5-22, Section 5.6.1 Potential Expansion of the CVOC Plume, Paragraph 2: The revised FFS needs to include the following regarding Ecology's opinion on the expansion of the CVOC plume, "*CVOC groundwater concentrations on-property and off-property will increase after shutting off the groundwater recovery wells due to the following additional points: (1) CVOCs in the on and off-property groundwater will no longer be captured by the optimized hydraulic control system; (2) On and off-property CVOC plume expansion and migration will occur due to advection (primarily downgradient) and dispersion (both down- and cross-gradient) processes and CVOC desorption; AND (3) the converging gradient from downgradient and lateral directions created by the recovery wells no longer exists.* GE statements contrary to this text need to be removed.

47. Page 5-22, Section 5.6.1, Paragraphs 3 and 4: Ecology does not agree that "*changes in the CVOC concentrations after the recovery system is turned off would be minor*" nor does Ecology agree that the results of the GE modeling study are a conservative (or accurate) prediction of groundwater contaminant plume expansion and migration. GE needs to remove this statement. Refer to Appendix C comments.

    Ecology asserts that a better assessment of the CVOC groundwater plume behavior as a result of shutting off the current hydraulic control system is presented by comparing the CVOC concentrations in groundwater before and after RW-3 was operational. CVOC plume widening and increasing CVOC concentrations (rebound) is expected if the current hydraulic control system is turned off. In particular, compare the pre RW-3 TCE groundwater concentrations at **MW-4** (200 ug/L TCE in August 2003 to 86 ug/L TCE in November 2003 after RW-3 was operational with continual decreases in TCE concentrations), **MW-7** (TCE groundwater concentrations decreased from 6.9 ug/L TCE in August 2003 to 2.8 ug/L in November 2003), **WP-16**[20] (42 ug/L TCE in November 1997), and **WP-17** (97 ug/L TCE in November 1997). When the optimized hydraulic control system is shut off, this pre-pumping groundwater data is a more reasonable bound than the model prediction of how groundwater CVOC concentrations will increase.

    Furthermore, at off-centerline plume well MW-3, TCE groundwater concentrations decreased from 11 to 1.2 ug/L TCE after RW-1 was turned on in August 1996, and MW-6 TCE groundwater concentrations decreased from 530 ug/L in August 1996 to 90 ug/L in November 1996 after RW-2 was turned on.

    The revised FFS report needs to include the above technical position.

48. Page 5-23, Section 5.6.1, Paragraph 1: Ecology does not agree that the ability to restart the

[20] Although there is no post August 2003 groundwater data near WP16 and WP17, Ecology expects similar TCE decreases due to the operation of RW-3

optimized hydraulic control system will ensure that TCE that has migrated beyond the 220 S. Dawson Street property can be *pulled back* to the 220 South Dawson Street property and therefore, the revised FFS needs to remove this reasoning. Liberty Ridge, LLC also agrees with Ecology.[21] Instead, the report needs to include the following analysis:

a. The capture zone of the currently installed hydraulic control system is small[22].

b. The groundwater velocities calculated using the Ecology transmissivities will result in groundwater flow rates that require monitoring on unreasonably short time intervals (1 week or less).

c. The velocity at which the TCE plume moves beyond the recovery wells RW-2 and RW-3 could be as high as 1.5 feet per day[23], or 11 feet per week. After sample collection, chemical analysis, data validation and data submittal to Ecology, discussions/agreement[24] on restarting the optimized hydraulic control system, re-starting the optimized hydraulic control system and aquifer system equilibrium time will not prevent additional TCE migration beyond the 220 South Dawson Street property or on-property plume expansion.

d. Even with a greatly enhanced monitoring well network and frequent (weekly or more often) groundwater sampling and chemical analysis, it is not possible to accurately and quickly detect the CVOC plume migration and restart the optimized hydraulic control system in time to prevent (a) plume migration beyond the capture zone of the groundwater extraction wells, (b) plume migration under the McKinstry building, and (c) plume expansion under the 220 South Dawson Street building.

e. Additional onsite and offsite[25] ISCO treatments are required if the CVOC groundwater plume is allowed to expand on- and off-property. This results in an increased restoration timeframe and additional costs to Ecology and GE.

f. Shutting off the optimized hydraulic control system leads to potential additional vapor intrusion risk at buildings where underlying TCE groundwater contamination exists. As stated in the Ecology August 14, 2008 response letter (Attachment A, comment I.b), the current 220 South Dawson Street building VIM system will be under-designed for a widening groundwater plume with higher TCE groundwater concentrations (which we expect to occur when the optimized hydraulic control system is shut off). Cross gradient (McKinstry) and downgradient buildings will also be threatened by vapor intrusion if underlying TCE groundwater concentrations increase. The Interior Environments building will be more susceptible to increased vapor intrusion due to the presence of a crawl space below a portion of the work floor.

[21] Technical memorandums from Environmental Partners, Inc. dated August 25, 2008 and November 17, 2008
[22] Ecology capture zone analysis dated, October 31, 2007
[23] Up to 1.5 ft/day as stated in Section 2.1.2.3 of the revised FFS.
[24] This includes following the dispute resolution process outlined in the Order as necessary.
[25] Under the McKinstry and other off-property buildings.

g. The expense of additional high frequency monitoring only to later restart the optimized hydraulic control system results in a more costly remedy and longer restoration timeframe than alternative 2.

h. There is too great a risk that "released" TCE to downgradient areas would not be completely recovered by restarting the optimized hydraulic control system, or that such releases would pose an unacceptable vapor intrusion risk to tenants in overlying buildings, particularly in this context where there is a more reliable, practicable alternative. Operating the optimized hydraulic control system during on-property ISCO injections and post-injection monitoring provides that alternative.

GE has not to date indicated what CVOC concentrations, measured at the proposed enhanced monitoring wells, would trigger re-starting the optimized hydraulic control system. Ecology requested this information in its October 1, 2008 letter as necessary for evaluating the effectiveness of this enhanced monitoring proposal. This is an important criterion that Ecology asked GE to calculate in order to assist in evaluating if GE's proposal can effectively meet the goal of preventing exacerbation of off-property conditions and is as effective and protective as Ecology's preferred remedy (operating the optimized hydraulic control system during ISCO implementation and performance monitoring). Although this information was not provided, Ecology now has adequate information to conclude that the proposed enhanced groundwater monitoring plan is inadequate. Enhanced groundwater monitoring would not be adequate, possible or practicable to implement given the site conditions for the reasons explained above. Therefore, further discussion of the trigger criterion is not necessary.

The proposed enhanced groundwater monitoring costs are best re-allocated toward operation of the optimized hydraulic control system. This approach avoids assuming additional risks of increased TCE vapor intrusion and increased costs for additional on- and off-property ISCO injections to treat an expanding CVOC plume. This approach also minimizes the possibility of extending the restoration timeframe by having to address an expanding CVOC plume. The above reasoning and analysis needs to be incorporated into the FFS report.

49. Page 5-23, Section 5.6.1, Paragraph 2, First sentence: Ecology disagrees that historical groundwater data indicates changes to the CVOC will be "*minor and can be monitored*" if the optimized hydraulic control system is turned off. GE needs to remove this sentence. This statement is based on modeling that Ecology does not agree with. Refer to above comments #47 and #48.

50. Page 5-23, Section 5.6.1, Paragraph 2, Third sentence: The chlorinated solvent degreasers operated up to the early 1990s. GE's statement that releases were more significant in the 1960s and 1970s is speculative and not supported by any facility operational information or site groundwater data. Neither GE nor Ecology knows what "the maximum historical loading" was at that time. GE needs to remove these statements.

51. Page 5-23, Section 5.6.1, Paragraph 2, Seventh and Eighth sentences: GE contends that it is possible to monitor the plume movement before significant off-property plume migration occurs. It is not possible or practical to monitor plume movement as such and these statements need to be removed. Refer to above comment #48 and Ecology comments on Appendix C.

52. Page 5-23, Section 5.6.1.1, Paragraph 1 and Bullet#1: The residual TCE mass calculations do not appear to take into account the mass of saturated zone contamination which acts as the residual TCE groundwater source. Nor is the flux of groundwater through this TCE source material in the saturated zone accounted for in the modeling. GE states that there is limited saturated zone TCE source material, but this is not supported by any data. Because only the soil vadose zone TCE residual mass was used as the source term, the results must be qualified as "*highly uncertain*" and "*biased low*". The revised FFS report needs to state the above concerns using those terms.

    Furthermore, consistent with above comment #47 above, the revised FFS report needs to state that historical groundwater analytical data show a higher potential TCE rebound concentrations in groundwater after shutting off the groundwater recovery wells.

53. Page 5-24, Section 5.6.1.1, TCE Concentrations in Groundwater Paragraph: Consistent with above comment #47, the revised FFS report needs to state that the historical groundwater analytical data show higher potential TCE rebound concentrations in groundwater after shutting off the groundwater recovery wells.

54. Page 5-24, Section 5.6.1.2 Paragraphs 1 and 2: The title of this section, "Hydraulic Simulation" is not accurate and needs to be renamed "*Fate and Transport Modeling*". This is because the governing equation cited and accompanying text clearly shows a predictive CVOC groundwater "fate and transport" modeling exercise with simplified groundwater flow conditions. "Hydraulic simulation" commonly refers to groundwater flow modeling (simulations) without a contaminant fate and transport component. In addition, Ecology notes that GE prefers to use the term, *simulation* rather than *modeling*. To Ecology, the two terms share the same meaning within the discussions of this FFS report.

    Ecology disagrees with GE's statements that the TCE simulations represent "the most conservative or worst case conditions". Ecology also disagrees that *"the simulation bounds the maximum possible TCE movement and concentrations"*. Ecology's specific comments on the modeling are based on its comments on **Appendix C**.

55. Page 5-25, Section 5.6.1.2, Paragraph 1: The revised text needs to state that there is uncertainty in the calculated TCE mass flux of 0.006 kg/day because this value is based on vadose zone residual TCE alone and does not account for any saturated zone residual TCE. Also refer to above comment #52. Furthermore, based on the model governing equation presented on page 5-24, the model simulates contaminant concentrations, not mass fluxes. GE did not, but needs to explain how a mass flux rate of 0.006 kg TCE/day was calculated and how this was applied in the model.

56. Page 5-25, Section 5.6.1.2, Paragraphs 2 and 3: Ecology does not understand why the TCE fate and transport was modeled for only 60 and 90 days and does not accept these results as accurate predictions of CVOC groundwater plume expansion and migration while the groundwater recovery wells are shut off. As such, these 60 and 90-day model results must not be included in the revised FFS report as supporting the selection of alternative 5. The contaminant fate and transport modeling needs to be simulated until plume migration reaches a steady state, resulting in the highest CVOC groundwater concentrations migrating off-property. Refer to above comments on Appendix C.

57. Page 5-25, Section 5.6.1.2, Paragraphs 2: Figures 5-9 and 5-10 are not the figures that the text referred to. The figure discrepancy needs to be corrected.

58. Page 5-25, Section 5.6.1.3, Paragraph 1, Third through Fifth Sentences: Ecology disagrees with GE's statement that it is unlikely that CVOC groundwater concentrations will increase such that indoor air concentrations would exceed cleanup levels. These statements need to be removed. Refer to above comment #48. Ecology does not agree with the results of the GE predictive modeling study, and these results may not be used to support the selection of alternative 5. Refer to above comments #48, #52 and Ecology comments on Appendix C. Lastly, GE states that CVOC groundwater concentrations will decrease with ISCO treatment, and this is justification for GE's expectation of small CVOC indoor air increases without operating the optimized hydraulic control system. Ecology disagrees. As Ecology previously stated in its August 14, 2008 response letter (Attachment A, comment I.a.i), the revised FFS report needs to state there is uncertainty in the effectiveness of the ISCO treatment, and therefore, one cannot automatically assume complete and rapid treatment via ISCO.

59. Page 5-25, Section 5.6.1.3, Paragraph 2: This section needs to include Ecology's position from its August 14, 2008 letter (Attachment A, Comment I.b) that the current 220 South Dawson Street building VIM system will be underdesigned for a wider groundwater plume with higher TCE groundwater concentrations resulting from shutting off the groundwater hydraulic control system. Refer to above comment #48.

60. Page 5-25, Section 5.6.1.3, Paragraph 3, Bullet #2: This statement assumes that ISCO will be quickly and completely effective. Ecology does not agree that there will be adequate reduction of CVOC groundwater contamination if ISCO injections occur without concurrent on-property optimized hydraulic control (alternative 5). Therefore, Ecology does not agree that indoor air CVOC concentrations are not expected to increase. This statement needs to be removed. Refer to above comment #58.

61. Page 5-25, Section 5.6.1.3, Paragraph 3, Bullet #3: This bullet needs to be removed and replaced with the following: "*Even though changes in the groundwater flow direction may be small, significant lateral plume migration to the north under the McKinstry building is expected because radial flow toward RW-3 does not exist when RW-3 is shut off. Plume lateral dispersion will increase under the flatter hydraulic gradient conditions near MW-3.*"

Note that one of the purposes of installing RW-3 was to "shrink" the TCE groundwater plume and to prevent further migration to the north before GE was required to evaluate the vapor intrusion pathway.

62. Page 5-26, Section 5.6.1.3, Paragraph 1, Bullet #1: Ecology has previously stated that it disagrees with GE's predictive modeling results. GE needs to remove this bullet. Refer to comments on Appendix C. In addition, Ecology does not agree that enhanced groundwater monitoring is adequate, possible or practicable in lieu of the more reliable Ecology preference to operate the optimized hydraulic control system during on-property ISCO injections and post-injection monitoring. Refer to above comment #48.

63. Page 5-26, Section 5.6.1.3, Paragraph 2: Ecology does not agree that downgradient buildings are unlikely to be impacted by shutting off the optimized hydraulic control system. We also disagree that any risk to these buildings is corrected by restarting the optimized hydraulic control system. Liberty Ridge, LLC also disagrees. These statements need to be removed. Refer to above comment #48.

    In addition, GE states that "engineering controls" could be installed to mitigate any new vapor intrusion risks. Ecology agrees and the revised report needs to state "*that under alternative 5 increased rates of TCE vapor intrusion into buildings may require the installation of additional mitigation systems.*" But, Ecology prefers to avoid this scenario by operating the optimized hydraulic control system during on-property ISCO injections. The revised text needs to state, "*The cost of the 220 South Dawson Street VIM system was estimated at $74,300*[26] *and included only one year of monitoring, operating and maintenance (O&M) costs*[27]*. Each year of O&M was estimated at $11,900. Ecology would expect the cost to adequately mitigate other buildings in this area to be similarly expensive. Additionally, there could be un-accounted for costs to owners and tenants if the necessary mitigation causes an interruption of business operations on the properties. There is also the possibility that building owners or their tenants might oppose mitigation altogether, adding to the transaction costs and decreasing the ease with which this option could be implemented.*"

64. Page 5-26, Section 5.6.1.3, Paragraph 3: This statement assumes that ISCO will be quickly and completely effective. Ecology does not agree that there will be adequate reduction of CVOC groundwater contamination if ISCO injections occur without concurrent on-property optimized hydraulic control (alternative 5). Therefore, Ecology does not agree that indoor air CVOC concentrations are not expected to increase. This statement needs to be removed. Refer to above comment #58.

65. Page 5-26, Section 5.6.2, Paragraph 1: The text needs to be revised to state that "*Groundwater mounding is expected from injecting specific volumes of aqueous*

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[26] Sub-Surface VI Interim Measures Work Plan and Design, dated January 29, 2007 as contingently approved with the Ecology letter dated February 23, 2007.

[27] The additional time and expense to reroute the eastern portion of the VIM system to allow for the conversion of warehouse space to office space was an additional cost not included in the design estimate.

permanganate into several closely spaced injection wells. The injection rate of aqueous permanganate will be faster than natural groundwater flow processes, therefore leading to localized groundwater head increases. This concern is based on general hydrogeologic principles, and for this reason, Ecology required that the ISCO performance monitoring plan include measures to identify groundwater mounding and possible movement of TCE contaminated groundwater in directions other than that driven by natural groundwater flow processes.[28] *In addition, based on general hydrogeologic principles, it is reasonable to expect displacement of TCE contaminated groundwater ahead of the ISCO injectant front."*

66. Page 5-26, Section 5.6.2, Paragraph 2: GE states that mounding will be "small" and plume movement "insignificant". This statement needs to be removed. Neither Ecology nor GE will know the magnitude of the mounding and resulting plume movement. Actual mounding will be dependent on the final injection volumes, injection well spacing and local geology. Without additional information, Ecology cannot assume mounding will be small and plume movement insignificant.

67. Page 5-26, Section 5.6.3, Paragraph 1: Ecology previously stated that it disagrees that Site conditions can be effectively monitoring if the optimized hydraulic control system is shut off. This enhanced monitoring may not be used to justify selection of alternative 5. Refer to above comments #48.

68. Page 5-27, Section 5.6.3, Paragraph 1: As clarification, Ecology did not propose enhanced monitoring in lieu of operating an optimized hydraulic control system during on-property ISCO injections. Instead, this was GE's proposal, and Ecology only clarified the requirements for proposing this enhanced monitoring system for Ecology review (Ecology October 1, 2008 letter). In addition, Ecology disagrees that the threshold criteria for restarting the optimized hydraulic control system can be deferred to the cleanup action plan and this statement needs to be removed. Refer to above comment #48.

69. Page 5-27, Section 5.6.3, Paragraph 2: Ecology disagrees that the proposed enhanced monitoring plan is adequate under alternative 5 and may not be used to justify the selection of alternative 5. Refer to above comment #48.

70. Page 5-27, Section 5.6.3, Paragraph 3: Ecology disagrees that the threshold criteria for restarting the optimized hydraulic control system can be deferred to the cleanup action plan and this statement needs to be removed. Refer to above comment #48.

71. Page 5-27, Section 5.6.4, Bullet #1: Alternative 5 with the proposed enhanced monitoring is not equally protective and effective as alternative 2 (with revisions stated in Ecology's Comment Letters) and does not meet this threshold requirement. The modeling study does not accurately or conservatively predict CVOC migration beyond 2nd Avenue South. This bullet needs to be revised as stated above. Refer to above comment #48 and Ecology comments on Appendix C.

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[28] Ecology response letter dated August 14, 2008, Attachment A, Consideration IV.

72. Page 5-27, Section 5.6.4, Bullet #2: There is a high probability that alternative 5 will not reach cleanup standards or may only achieve this requirement after unplanned additional on-property and off-property ISCO injections are performed, additional VIM systems installed, and additional vapor intrusion assessments are performed; all at additional time and expense. Ecology disagrees that the GE proposed enhanced monitoring is an acceptable alternative to operating an optimized hydraulic control system concurrent with on-property ISCO injections, nor does the modeling study accurately or conservatively predict CVOC migration beyond 2nd Avenue South. Refer to above comment #48 and Ecology Comments on Appendix C. This bullet needs to be revised as stated above.

73. Page 5-28, Section 5.6.4, Bullet #1: Since alternative 5 does not meet the threshold requirements under WAC 173-340-360(2)(a)(ii), then it will not meet the threshold requirement for compliance with applicable state and federal laws. This bullet needs to be revised as stated above. Additionally, regarding bullet #2, refer to above comment #33.

74. Page 5-28, Section 5.6.5, Paragraph 2, Sentence 1: Ecology does not expect that the restoration timeframe for alternative 5 will be shorter than alternative 2. In fact, the gamble of allowing the on- and off-property CVOC plume to expand laterally and downgradient, with the optimized hydraulic control system shut off, has the potential to increase alternative 5's restoration timeframe. In such an event, additional and currently unplanned ISCO treatment would be required at the 220 South Dawson Street property and all adjacent and downgradient properties beneath the expanding CVOC groundwater plume.

    The necessity of restarting the groundwater extraction system and potentially needing to reassess vapor intrusion in ALL buildings above the expanded CVOC groundwater footprint – in addition to the possible installation of additional vapor intrusion mitigation systems in those impacted buildings – will result in additional Ecology and GE time and resources to achieve remedy completion. Operating an optimized hydraulic control system during ISCO treatment does not pose these potential problems.

    The revised FFS report needs to be revised to include these statements.

75. Page 5-28, Section 5.6.5, Paragraph 2, Sentence 2: Ecology disagrees with this statement and GE needs to remove it and replace it with the following: *"There will be larger CVOC groundwater concentration increases (when the recovery wells are shut off) than the GE model predicts."* Refer to above comment #47 and Ecology comments on Appendix C.

76. Page 5-28, Section 5.6.5, Paragraph 2, Sentence 4: Ecology disagrees with this statement and GE needs to remove it and replace it with the following: *"Concentrations of TCE in MW-4 have decreased since the recovery well RW-3 was operational. Shutting off the optimized hydraulic control system will result in larger CVOC groundwater concentration increases."* Refer to above comment #47.

77. Page 5-28, Section 5.6.5, Paragraph 2, Sentence 5: GE maintains that increases in CVOC groundwater concentrations will be "small" after the optimized hydraulic control system is shut off, however, this is not consistent with the pre-pumping groundwater analytical data. Ecology disagrees and GE needs to remove this statement. Refer to above comment #47.

78. Page 5-28, Section 5.6.5, Paragraph 2, Sentence 6: Ecology does not agree that alternative 2 will take an additional 2 years to complete the remediation compared to alternative 5. Ecology disagrees and GE needs to remove this statement. Ecology has previously stated that the location of the groundwater recovery wells will not negatively impact ISCO performance. Refer to above comments #31 and #37.

79. Page 5-28, Section 5.6.5, Paragraph 3: The timeline for alternative 5 is underestimated and needs to be corrected to show that it will be longer than alternative 2, in accordance with above comment #74.

80. Page 5-28, Section 5.6.5, Paragraph 4: GE needs to replace the last sentence with the statement in the above comment #40

81. Page 5-28, Section 5.6.6: Page 5-28, Section 5.6.6: The MTCA DCA evaluative criteria for Alternative 5 only apply if the threshold criteria (WAC 173-340-360(2)(a)) are met. That is, if threshold criteria are not met, the "alternative" cannot be selected as the site's cleanup action.

    Even though alternative 5 does not meet the threshold criteria, we have provided responses below to GE's analysis of the DCA criteria. Ecology also evaluates and weighs the criteria in the DCA differently than GE, resulting in an overall conclusion that optimized hydraulic control concurrent with on-property ISCO injections is permanent to the maximum extent practicable. The revised FFS report needs to replace GE scoring and criteria evaluation with Ecology's scoring and criteria evaluation stated below:

    a. Overall Protectiveness: **Ecology ranks alternative 5 low for this category, below alternative 2.** GE's evaluation of alternative 5 overall protectiveness under this section only considers the use of the ISCO technology and does not fully consider the disadvantages of shutting off the optimized hydraulic control system.
    GE only states that the optimized hydraulic control system could be restarted if alternative 5 does not perform well, however, Ecology is doubtful that the restart will be both effective and quick. Refer to above comments #48 and #74.

    b. Remedy Costs and Cost Effectiveness: Alternative 5 is likely to cost more than alternative 2. Ecology ranks alternative 5 **medium**, or below alternative 2. There are significant errors or erroneous assumptions in the calculation of the alternative 5 cost resulting in a biased-low cost. Refer to Ecology comments on Appendix B. Given the stated +/- 30% uncertainty in the cost estimates and the fact that GE did not include increased costs of alternative 5 due to increased vapor intrusion, additional on- and off-property ISCO injection costs, and the restart of the optimized hydraulic control system, Ecology cannot agree that alternative 2 costs are greater than those for alternative 5.

c. Long Term Effectiveness: **Ecology ranks alternative 5 low, below alternative 2 for this category.** The injection of ISCO chemicals within the 220 South Dawson Street property without operating the optimized hydraulic control system has the potential to yield less than acceptable results in the likely event that the CVOC groundwater plume expands laterally and off-property. After many years of operating the current hydraulic control system, the CVOC groundwater plume is currently stable. Shutting off the optimized hydraulic control system will shift the CVOC groundwater plume into a non-equilibrium and expanding state. The design of the ISCO injection location and volumes are best done with a CVOC plume that is stable (not expanding or increasing in concentration), and the success and long term effectiveness of ISCO is critically dependent on having a very good understanding of the CVOC plume characterization (best if stable and not expanding with time). Also refer to above comment #74.

d. Short Term Risk Management: **Ecology ranks alternative 5 low, below alternative 2 for this category.** Under alternative 5, GE states that it is willing to take the chance that the expanding CVOC groundwater plume will not result in additional unacceptable vapor intrusion risks to any building occupants above or adjacent to the GE CVOC groundwater plume. GE proposes that if it turns out to be incorrect, GE would install vapor intrusion mitigation systems in those impacted buildings to protect the workers. However, in this context there is no need to take such a risk of increased exposure to workers and the risk of increased mitigation costs (including but not limited to costs of the mitigation itself, as well as potential costs to impacted property owners and operators) when a practicable alternative exists. Operating an optimized hydraulic control system during ISCO treatment at the 220 South Dawson Street property will avoid this unwanted risk.

e. Implementability: **Ecology ranks alternative 5 low/medium.** There are **negative** implementability factors due to the additional vapor intrusion mitigation system installations (and maintenance), additional vapor intrusion assessments and additional required enhanced/protection groundwater monitoring required under alternative 5. These additional alternative 5 activities outweigh alternative 2 pump and discharge optimization implementability raised by GE in Section 5.3.

f. Consideration of Public Concerns: Ecology ranks alternative 5 **low** for this category because of the short term risks, reduced long term effectiveness without optimized hydraulic control and longer implementation timeframe. Refer to comment #41(f)

82. Page 5-31, Comparative Evaluation of Alternatives, Section 5.8 and Table 5-1: Section 5.8 is titled, "*Comparative Evaluation of Alternatives*". However, this section seems to focus on DCA criteria only. Table 5-1 does include an evaluation of threshold criteria and other minimum requirements for a cleanup action under WAC 173-340-360(2). For easier understanding, the discussion of the threshold criteria and restoration timeframe analysis (both limited to Table 5-1) needs to be included as part of the text of Section 5.8, analyzing

first the threshold requirements under WAC 173-340-360(2)(a), and then moving on to the DCA re-analysis in Section 5.8 and analysis of the "other requirements from WAC 173-340-360(2)(b) for alternatives that pass the threshold analysis. Substantively, Ecology does not agree with GE's threshold evaluation of alternatives 5 and alternative 2 as shown in Table 5-1. Ecology performed its own threshold re-evaluation based on the methodology required in MTCA (WAC 173-340-360(2)(a)). GE needs to replace the existing threshold re-analysis with Ecology's analysis as provided below.

Threshold Criteria (WAC 173-340-360(2)(a):
Optimized hydraulic control is necessary to meet *the threshold requirements of WAC 173-340-360(2)(a)(i) and (ii): protect human health and the environment* AND *comply with cleanup standards.* Under Ecology's preferred alternative, GE may turn off one or more groundwater extraction wells after the cleanup levels on the 220 South Dawson Street property (POC) are met, but not before. Alternative 5 does not meet the threshold criteria of (i) *protection of human and the environment* and (ii) *compliance with cleanup standards.* In fact, the only practicable means of modifying alternative 5 to meet these threshold criteria is to add the optimized hydraulic control and other criteria that in fact would transform it into alternative 2. Given the failure of alternative 5 to meet these two threshold criteria, alternative 5 would also fail the minimum requirement of *compliance with applicable state and federal laws* that pertain to protection of human health and the environment.

Ecology also disagrees with GE's evaluation of the other minimum cleanup requirements as defined in WAC 173-340-360(2)(b). GE needs to replace the existing text with Ecology's re-evaluation below:

Other Criteria (WAC 173-340-360(2)(b): The **restoration timeframe** of alternative 2 will be shorter than alternative 5. Refer to comment #74. With regard to the **consideration of public concerns**, Liberty Ridge LLC[29] (owner of two downgradient buildings that lie over the CVOC groundwater plume) has already stated its preference for maintaining optimized hydraulic control over the CVOC groundwater plume during ISCO injections, and Ecology agrees. Liberty Ridge, LLC has also expressed concern regarding TCE vapor intrusion into these two commercial buildings. Maintaining "optimized hydraulic control" during on-property ISCO injections ensures that increases in TCE vapor intrusion above current acceptable levels will not occur on a transient or long-term basis. GE's preference to implement alternative 5 does not provide this level of assurance.

Ecology also makes the following comments on the DCA analysis provided by GE in Section 5.8. GE needs to replace the existing text with Ecology's DCA re-evaluation below:

a. Section 5.8.1 Overall Protectiveness, Paragraphs 2 and 3: **Ecology ranks alternative 2 higher than alternative 5 for this category.** Ecology has already stated its disagreement with GE's position that operation of the optimized hydraulic control system will limit ISCO effectiveness. Refer to above comment #31. Alternative 5 is less

[29] Technical memorandums from Environmental Partners, Inc. dated August 25, 2008 and November 17, 2008

protective than the operating an optimized hydraulic control system concurrent with on-property ISCO injections. Refer to above comments #41(a), #48, #74, and #81(a).

b. Section 5.8.2 Permanence, Paragraph 2: **Ecology ranks alternative 2 higher than alternative 5 for this category.** Alternative 2 results in a more permanent remedy than alternative 5 because the former does not allow further dilution of on-property CVOC groundwater contamination prior to on- and off-property ISCO treatment.

c. Section 5.8.3, Long Term Effectiveness, Paragraphs 2 through 4: **Ecology ranks alternative 2 higher than alternative 5 for this category.** Ecology previously stated it disagreed with GE's premise that alternative 2 is less effective than alternative 5. Refer to above comment #31. Enhanced monitoring under alternative 5 will not be effective. Refer to above comment #48. Alternative 5 will take longer to implement than alternative 2. Refer to above comment #74.

d. Section 5.8.4, Short Term Risk Management, Paragraph 2: **Ecology ranks alternative 2 higher than alternative 5 for this category.** Ecology disagrees that there is more short term risk with operating an optimized hydraulic control system concurrent with ISCO injections compared to Alternative 5. On the contrary, there is more short term risk with alternative 5. Refer to above comments #41(d) and #81(d).

e. Section 5.8.5, Implementability, Paragraph 1, last sentence: Implementability is not a threshold criteria.

f. Section 5.8.5, Implementability, Paragraphs 2 and 3: **Ecology ranks alternative 2 higher than alternative 5 for this category.** Alternative 5 is more difficult to implement than alternative 2. Refer to above comments #41(e) and #81(e).

g. Section 5.8.6, Consideration of Public Concerns: **Ecology ranks alternative 2 higher than alternative 5 for this category.** Refer to above comments #41(f) and #81(f).

83. Page 5-34, Section 5.8.7, Disproportionate Cost Analysis (DCA) Alternatives 2 and 5: The GE cover letter and Summary of Responses states that Section 5.9 contains the DCA. However, no such section exists in the revised FFS report. Ecology assumes that GE is referring to Section 5.8.7 instead.

Alternative 2 is a more protective and cost-effective remedy than Alternative 5. Optimized hydraulic control is necessary to meet the threshold requirements of WAC 173-340-360(2)(a)(i) and (ii). Optimized hydraulic control system operation concurrent with on-property ISCO injections meets all threshold requirements. Optimized hydraulic control of the shallow CVOC groundwater plume (220 South Dawson Street property) is required until the on-property ISCO treatment (or other contingency treatment, if required) is completed as verified by performance and confirmational groundwater monitoring.

Even though Alternative 5 does not meet threshold requirements, Ecology provides the following comments on GE's DCA analysis. Ecology disagreed with much of this analysis, and the revised FFS report needs to be rewritten to only include Ecology's criteria evaluation stated below:

a. Paragraph 1: The disproportionate cost analysis is only necessary if the threshold requirements are met for alternatives 2 and 5. This does not appear to be the case for alternative 5.

b. Paragraph 2: Ecology's ranking of alternative 2 is higher in all categories than alternative 5. Therefore, even if alternative 5 met the threshold criteria, the DCA would show that the preferred remedy should be alternative 2.

c. Paragraph 3: The risks associated with shutting off the optimized hydraulic control system are not small nor can be effectively managed with enhanced monitoring. Refer to above comments #48, #74 and #81(d).

d. Paragraph 4: The cost of alternative 5 with the inclusion of contingencies for restart of the optimized hydraulic control system, installation of additional vapor intrusion mitigation systems, and additional ISCO injections to treat an expanding CVOC groundwater plume are expected to exceed the cost of alternative 2. Ecology disagrees with the cost analysis presented in Appendix B. Refer to above comments #41(b) and #81(b).

84. Page 6-1, Section 6.1 Conclusions: Ecology disagrees with many of the conclusions. GE needs to revise FFS report and use only the Ecology's scoring and criteria evaluation stated below:

a. Compliance with Threshold Criteria: **FFS Alternative 5 does not meet threshold criteria and should not be selected as the preferred alternative.** Optimized hydraulic control is necessary to meet the threshold requirements of WAC 173-340-360(2)(a)(i) and (ii): *protect human health and the environment* AND *comply with cleanup standards.*

b. Use of a reasonable restoration timeframe: **The restoration timeframe for alternative 2 is expected to be shorter than for alternative 5.** Refer to above comments #48 and #74.

c. Use of Permanent Solution to the Maximum Extent Practicable: **Alternative 2 results in a more permanent remedy than alternative 5.** Alternative 2 does not allow further dilution of on-property CVOC groundwater contamination prior to on- and off-property ISCO treatment. Refer to above comments #46 and #82(b).

d. Implementability and Overall Protectiveness: **Alternative 2 is more protective than alternative 5.** Refer to above comments 41(a) and #81(a). **Alternative 5 is more difficult to implement than alternative 2.** Refer to above comments #41(e) and #81(e).

e. Remedial Technologies: This is not a criteria under MTCA for evaluating a final remedy under WAC 173-340-360(2).

f. Benefit Cost Analysis: Alternative 5 is likely to cost more than alternative 2. Refer to above comments #41(b), #81(b), and Appendix B.

g. On Site Area: Under alternative 5, shutting off the optimized hydraulic control system will have negative consequences: vapor intrusion is a likely threat to indoor air quality in unmitigated buildings, the remedy will become more expensive, and all of which results in a longer timeframe to achieve groundwater cleanup levels throughout the expanding plume. Alternative 2 provides for the operation of optimized hydraulic control during on-property groundwater treatment and addresses these issues. Refer to above comments #48 and #74.

h. Offsite Area: See comments under g above.

85. Page 6-2, Section 6.2 Contingent Remedy: The conceptual details of the in-situ enhanced bioremediation contingent remedy will be described in more detail in the DCAP, and are expected to be consistent with the alternative 3 (includes operation of the optimized hydraulic control system) description in the revised FFS report.

Ecology expects that in-situ enhanced bioremediation will be the primary contingent remedy if ISCO treatment is not effective in attaining cleanup levels throughout the Site. However, GE may propose another contingent remedy in the DCAP besides in-situ enhanced bioremediation for Ecology's consideration, for example if ISCO is almost entirely effective, but does not achieve cleanup standards throughout the Site. The details of the contingent remedy, and when it will be triggered, will be discussed in the DCAP.

Appendix A:

86. This is tabulated historical groundwater data only. Ecology has no comments.

Appendix B: Cost Estimates: The revised FFS report needs to incorporate Ecology's comments below on the cost estimates for alternative 2 and alternative 5.

87. With the optimized hydraulic control system operating concurrent with on-property ISCO injections, the cost estimate for Alternative 2 provided in Appendix B is too high. Some of the main factors in our reasoning include:

a. Ecology also does not anticipate requiring additional vapor intrusion assessments in down- and cross-gradient buildings if the optimized hydraulic control system is left on during on-property ISCO treatments. These costs need to be removed from the cost estimate for Alternative 2.

b. GE's costs for two additional years of ISCO injections and twice the ISCO injectant volume (compared to alternative 5) for on-property ISCO injections and groundwater monitoring are based on their opinion that operation of the optimized hydraulic control system will impede ISCO effectiveness. Since Ecology does not concur with the premise, these added costs need to be removed. Refer to above comment #31.

c. Additional injections (more than alternative 5) are not expected for off-property areas solely due to the operation of the optimized hydraulic control system concurrent with on-property ISCO injections. These added costs need to be removed. In fact, turning off the optimized hydraulic control system will result in requiring additional (not currently planned) ISCO injections to treat a larger – or higher concentration – off property CVOC plume under alternative 5.

88. The FFS's cost estimate for Alternative 5 is too low. This is because:

a. Turning off the optimized hydraulic control system will result in the need for more on- and off-property ISCO injections (compared to alternative 2) to treat a larger (or higher concentration CVOC plume). On–property CVOC groundwater plume expansion would require more ISCO injection points south and more total injections to treat the CVOC plume as it increases in size. Off-property ISCO injections would increase to account for higher CVOC mass input flux and large off-property plume. These costs are not and need to be included in the cost estimate for alternative 5.

b. Per the Ecology October 1, 2008 letter, the expense of re-starting and maintaining the optimized hydraulic control system is not and needs to be included in the cost estimate for alternative 5.

c. Shutting off the optimized hydraulic control system leads potentially to additional vapor intrusion risk at buildings where underlying TCE groundwater concentrations increase. The cost of installing additional vapor intrusion mitigation systems in cross-gradient or down-gradient buildings is not and must be included in the cost estimate of alternative 5, even as a contingency cost. Note that the 220 South Dawson Street VIM system cost was estimated at $74,300[30] and included only one year of monitoring, operating and maintenance (O&M) costs. Each year of O&M was estimated at $11,900. Ecology would expect the costs to adequately mitigate other buildings would also fall within this same price range (approximately $100,000 each).

d. Alternative 2 does not and needs to include the potential costs for re-designing and upgrading the 220 South Dawson Street VIM system, even as a contingency cost. This system will be under-designed for a larger (spatially) and more highly concentrated CVOC groundwater plume. Recall that the original agreed order required the installation of RW-3 and operation of RW-3 to reduce the CVOC groundwater plume size to help reduce TCE vapor intrusion into that building.

[30] The additional time and expense to reroute the eastern portion of the VIM system to allow for the conversion of warehouse space to office space was an additional cost not included in the design estimate.

Appendix C: Modeling, TCE Residual Source Estimate and Enhanced Monitoring: Ecology does not agree that the results of the GE modeling study support GE's selection of alternative 5 for the reasons stated below. Additionally, the model did not include the proper and conservative input parameters and assumptions. Ecology is also not requesting that GE revise and resubmit this (or a different) modeling study because pre-pumping high CVOC groundwater data, uncertainty in the input parameters and results of any modeling study and risks[31] posed if the modeling study are incorrect do not warrant turning off the groundwater recovery wells during on-property ISCO injections. Furthermore, further modeling is not necessary and would be an inefficient use of resources.

The analytical model (equation by Wexler [1982] presented on page 5-24 assumes uniform one-dimensional groundwater flow conditions. It is a standard simplified model to simulate transient solute transport with one-dimensional advection, two-dimensional dispersion, retardation (by sorption) and first-order decay. It does not account for TCE vertical migration to deep aquifer zones.

89. Appendix C, Section 1.0: Ecology does not agree that the results of the GE modeling study are a conservative (or accurate) prediction of groundwater contaminant plume expansion and migration for the scenario where the optimized hydraulic control system is turned off during on-property ISCO injections. GE states that *"the purpose of the analysis was to assess a worst-case groundwater migration scenario and evaluate appropriate and conservative groundwater monitoring programs"*. Based on our review of the modeling simulation results, this general objective was not achieved.

    One of our primary concerns is the selection of site data assumed to best represent a scenario where optimized hydraulic control is no longer active. The pre-pumping groundwater data set is the best indication available to us to show how the CVOC plume will expand once the optimized hydraulic control system is shut off. Refer to above comment #47.

90. Appendix C, Section 1.1: The analytical model used by GE is applicable for simulating contaminant spatial distributions at a given time under uniform and steady state groundwater flow conditions. The model is suited to predict potential maximum plume concentrations if simulation time and other input parameters are conservative. However, it is not designed to accurately calculate a time interval (after the recovery wells are shutdown) within which groundwater monitoring would detect plume expansion/migration.

    There are two types of uncertainty associated with the model's output: (1) there are uncertainties in the time elapsed for any amount of plume migration to occur (or when maximum plume concentrations are reached); and (2) there are uncertainties in those plume concentrations at any time after the groundwater recovery wells are shut off. GE has not considered that plume migration may occur faster than the model's predictions. The results of the GE 60 and 90 day model runs not only have uncertainties in the "CVOC plume

[31] Unacceptable vapor intrusion into buildings and further expansion and migration of the CVOC groundwater plume.

magnitude and distribution," but ALSO have uncertainties in the "time" element (i.e., how long it takes to reach that new unsteady plume state). GE needs to include these stated uncertainties into the revised FFS report.

In addition, many of the input parameters for GE's model are not conservative or appropriate for predicting CVOC plume special distributions at any time following shut down of the optimized hydraulic control system. The model run times chosen by GE are too short, and the model results do not compare well with historical pre-pumping groundwater data.

91. Appendix C, Section 2.1: GE needs to define the x and y-coordinates in figures for the modeling area. The origin of the coordinates need to be defined so that the sources defined in Table 2 can be located in the modeling/simulation result figures presented in Appendix C.

92. Appendix C, Section 2.2, Third bullet: This bullet needs to clearly state that the analytical model is based on "uniform" flow conditions in addition to being limited to homogeneous and isometric aquifers. That is, the groundwater flow at site is assumed to be one-dimensional with constant hydraulic gradient. In addition, GE needs to revise the text to state that the aquifer hydrogeologic system is not at steady state soon after the recovery wells are shut off. Therefore, the uniform flow assumption is not valid and making the assumption that the hydrogeologic system is at equilibrium is not necessarily conservative. Therefore, this assumption may result in an over-prediction or under-prediction of contaminant concentrations at certain locations.

    Ecology agrees that some of the simplifying assumptions for the site conditions are necessary in order to conduct the analytical modeling. However, the text repetitively states the model is overly conservative and yields a "high-end" or "worst-case plausible estimate of TCE migration and plumes. This is not true because the selection of source locations, source strength, simulation time (only 60 and 90 days) and other input parameters are not conservative. GE needs to include these statements.

93. Appendix C, Section 2.2, Fourth bullet: Homogeneous mixing of the aquifer contaminants throughout the vertical dimension is not considered conservative if this results in the dilution of shallow groundwater CVOCs that serve as the source of vapor intrusion into buildings. GE should not use homogeneous aquifer mixing as an example of a conservative model input parameter.

94. Appendix C, Section 3.1: It is unclear how the source mass flux (or source strength) was calculated and GE needs to provide a clear explanation. If the mass flux is a required input parameter of the model instead of a constant source concentration, this needs to be stated in the text and the calculations of this flux or source strength of 0.006 kg/day must be clearly presented. It appears that GE assumed that the maximum rebound TCE concentration is 150 μg/L, and back-calculated the source flux from that assumption. This assumption is not conservative. GE needs to remove the statement that this source calculation is conservative as this assumption is not supported by the site data when pre-pumping TCE concentrations were shown to be much higher. In addition, it appears that GE did not account for saturated

zone TCE soil contamination in the source strength calculations and the revised FFS report needs to state this shortcoming. Refer to above comment #52.

95. Appendix C, Section 3.2.2, Aquifer Thickness: The base case aquifer thickness of 9 meters for the fate and transport simulation is not a conservative input parameter. To be reasonably conservative, a smaller aquifer thickness (for example, 10 feet) needs to have been used for the base case. Ecology understands that this parameter is difficult to determine and any number can be considered arbitrary because the actual aquifer thickness is unknown and likely greater than 150 feet. Ecology also understands that a different aquifer thickness results in a different groundwater linear velocity based on the transmissivity value. However, the aquifer thickness used in the fate and transport modeling actually represents the "contaminant mixing depth". Therefore, the thicker the aquifer is assumed to be, the more vertical dilution of the groundwater plume. Using a standard well screen length as the contaminant mixing depth is a common practice for sites with a large aquifer of unknown thickness. Ten-foot screened monitoring wells are common at the Site and mixing over longer vertical intervals can not be conservatively supported by site data. Figures 2-17 and 2-22 of this FFS report show that TCE mixing depths are only a few to 15 feet at the former GE facility. For the reasons stated above, GE needs to remove statements indicating that aquifer thickness is an example of a conservative model input parameter.

96. Appendix C, Section 3.2.4, Dispersivity: Ecology disagrees that the longitudinal dispersivity value used in the model base case (20 meters) is always conservative and *"produced a conservatively high estimate of both migration and dispersion"*. A lower longitudinal dispersivity may slow down the plume migration rate, but certainly will generate higher TCE concentrations when the plume reaches the steady-state or at the site boundary. This was an important point not explained in the FFS. A common practice or "rule of thumb" is that the longitudinal dispersivity is equal to about one tenth (10%) of simulated plume length. Because the simulation time periods are short (60 and 90 days), the simulated plume length is also small. Therefore, the dispersivities are overestimated based on a smaller plume length. Although the toe of the TCE groundwater plume will reach 2nd Avenue South at an earlier time with a higher dispersivity, the leading edge TCE concentrations will be lower due to the higher dispersion. For the reasons stated above, GE needs to remove dispersivity as an example of a conservative model input parameter.

97. Appendix C, Section 3.2.5, Retardation: Ecology disagrees that the assumption of no retardation represents *"the worst-case plume migration scenario"*. The site-specific fraction organic carbon content values are low and Ecology does not expect retardation to be a significant attenuation mechanism. Therefore, Ecology doesn't see very much conservativism gained by making the assumption of no retardation. The TCE sorption coefficient is well published, and GE has site data available to calculate this site specific retardation factor. Based on the above discussion, GE needs to remove no retardation as an example of a conservative model input parameter.

98. Appendix C, Section 3.2.5.2, Elapsed time: The results of the 60 and 90 day modeling/simulation are not accepted by Ecology, and GE needs to remove these results in

future FFS revisions as supporting documentation for selecting alternative 5 for the following reasons: The modeling/simulation time GE chose to use is too short. Because the analytical model simulates transient contaminant migration under a steady-state flow condition, snap-shot plume distributions after an arbitrary source release for 60 or 90 days does not provide the worst case scenario (highest CVOC groundwater concentrations at on- or off-property locations). Instead, the on- and off-property CVOC plume will continue to expand laterally and migrate to downgradient areas after 90 days.

GE repeatedly states that the model results represent worst case estimations. This should be the goal, certainly, but the work presented does not support that goal. The selected snap-shot plumes are far from worst case plume distributions. Worst-case on- and off-property contaminant distribution and migration are expected to be represented by the longer simulation times closer to the steady state.

In addition, as stated in comment #90 above, there is uncertainty in how long it will take the plume to reach maximum on- and off-property concentrations. For a complete development of contaminant migration patterns and worst-case CVOC plume distributions, the model's elapsed times need to cover a wide range (e.g., 1, 5, 10, 30, 60, 90, 180, 365, 730, and 1825 days[32]), with the understanding that the actual time it takes to reach those CVOC plume distributions may be shorter than the input times. GE does not intend to complete the ISCO remediation in 60-90 days in any case. Therefore, model simulation runs using such short time frames is difficult to justify, and as noted above, cannot be expected to predict maximum and worst-case CVOC groundwater concentrations on- and off-property (after the optimized hydraulic control system is shut off).

99. Appendix C, Section 3.2.5.3, Number of point sources: The selected three point sources and their locations are not justified by site data, and GE needs to remove them in future FFS revisions as representing the most representative (or worst case scenario) future observed plumes for the following reasons: Even though GE did not provide Ecology with the exact x- and y- coordinates of the three selected sources in Table 2, Ecology can visually estimate that the three sources are not located near the highest CVOC concentrated source areas (Areas 2, 7, and 8). The source locations were instead located to the south near the center of the former GE building, and the result is the model predicted less plume expansion under the McKinstry Building. If the modeled sources were located appropriately near Area 8 or in the alley between the former GE Building and McKinstry Building, based on general fate and transport mechanisms, the simulated plumes would further expand under McKinstry Building. Lastly, Ecology has previously stated that the historical groundwater data shows more CVOC groundwater plume expansion and migration after the recovery wells are shut off.

100. Appendix C, Section 3.2.5.4, Grid: The model grid was not and needs to be presented in a plan view grid map with the site features and source areas overlaid. The modeled sources x- and y- coordinate locations were not and need to be identified on the grid map.

[32] Assuming this range covers the elapsed time associated with the steady-state transport scenario

101. Appendix C, Section 4.0, Base–case Results: Ecology does not agree with the model result discussions because we do not agree with some of the key model input parameters, such as elapsed time, point source locations and other input parameters discussed in previous paragraphs. The model results do not compare well with historical pre-pumping (2003) groundwater data. Therefore, GE needs to remove use of the base case and any of the other case results to justify selecting alternative 5.

102. Appendix C, Section 5.0, Sensitivity Analysis: Ecology agrees that sensitivity analysis is an important part of any modeling effort. However, Ecology can not comment on the current sensitivity analysis since Ecology does not agree with the base case input parameters used. Refer to above comments #92 to #100.

103. Appendix C, Section 6.0, Conclusions: For the reasons stated in the previous paragraphs, Ecology does not agree with the modeling results. Therefore, GE may not use these results to justify selecting alternative 5 for the following reasons:

a. Ecology does not agree that the results reflect upper bound (worst case) limits for CVOC groundwater contamination migration in the event the optimized hydraulic control system is shut off during on-property ISCO injections. This is because we do not agree with some of the choices made for key model input parameters, such as elapsed time, point source locations, and other input parameters discussed in the paragraphs above. Also as stated in comment #90 above, the model is being used inappropriately to estimate enhanced monitoring frequencies. In addition, the model results do not compare well with historical pre-pumping (2003 or 1996) groundwater data which show more CVOC groundwater plume expansion and migration in the absence of optimized hydraulic control. Refer to above comment #47.

b. GE concludes that the plume will reach the site boundary in a timeframe ranging from 60 to 90 days. But this does not appear to be based on conservative assumptions about source locations. Nor are some key input parameter values reasonably conservative, given what we know about the Site.

c. In addition, there are uncertainties in the model's ability to:

   I. predict the on- and off-property TCE groundwater plume concentration distribution (or maximum concentration) at any selected time after the groundwater recovery wells are shut off; and

   II. predict how long it will take for the TCE groundwater plume to reach its maximum on- and off-property concentrations (or any concentration distribution below that maximum value).

d. Even though the modeling results presented to Ecology are insufficiently conservative and under-predict plume expansion, revised FFS Figures 2-36, 5-2, and Appendix C Figures 6, 7, and 16 all show TCE groundwater plume expansion resulting in increased

TCE groundwater concentrations under the 220 South Dawson Street facility (at locations that are beyond the effective influence of the current vapor intrusion mitigation system) and under the McKinstry building (to the north). These figures represent GE's own analysis. Such results support Ecology's position that shutting off the optimized hydraulic control system will likely result in creating conditions the current VIM system was not designed to address and create unacceptable vapor intrusion in the McKinstry building. Therefore, these figures show if Alternative 5 were selected, GE would therefore need to implement a VIM system assessment and construct improvements in that VIM system (at a minimum sub-slab vapor sampling and indoor air sampling potentially followed by redesigning the VIM system) at the 220 South Dawson Street building. GE would also need to conduct vapor intrusion assessments in the McKinstry building and possibly install VIM system there. With the amount of predicted TCE groundwater plume expansion under the 220 South Dawson Street building, additional ISCO injections and injection locations need to be added to effectively treat a wider on-property and off-property groundwater plume.

Attachment B: Proposed Site Cleanup Levels

	MTCA MTD B CUL Air (ug/m^3) CR = 1EE-06 or HI = 0.25	MTCA MTD B IAL[33] Air (ug/m^3) CR = 1EE-06 or HI = 0.25	MTCA MTD B CUL[34] GW Water Table to 20 feet bgs (ug/L)	MTCA MTD B CUL GW Below 20 feet bgs (ug/L)	MTCA MTD B CUL Soil (mg/kg) (based on protection of GW[35] CUL) CR = 1EE-06 HI = 0.25 Or ORNL Eco[36]
TCE	0.1	0.35	1.8	2.9	0.012
PCE	0.42	1.47	0.17	0.17	0.002
VC	0.28	0.98	1.0	1.6	0.006
cis-1,2-DCE	4	14	183	341	0.92
trans-1,2 -DCE	8	28	163	590	0.89
1,1-DCE	23	80	25	25	0.18
1,1,1-TCA	1200	4190	11	11	0.09
1,4-dioxane	Not VOC	Not VOC	79	79	NA
Arsenic	Not VOC	Not VOC	5.0[37]	5.0	NA
TPH-Oil	Not VOC	Not VOC	500	500	TBD[38]

[33] Immediate Action Level (IAL) - Based on an office worker scenario: 10 hours/day, 5 days/week, and 50 weeks/year exposure scenario.
[34] Based on new TCE CPF = 0.089 (mg/kg-day)$^{-1}$ and lower of CULs based on API fish ingestion scenario (MTCA Equation 730-1: FDF=1, ABW = 63 kg, FCR = 57 g/day); PSC Georgetown based VI IPIMAL; and Oak Ridge National Laboratory Surface Water Benchmarks http://www.esd.ornl.gov/programs/ecorisk/benchmark_reports.html.
[35] Based in protection of SW CUL
[36] Assumes no 1,4, dioxane in the soils above the water table
[37] Based on Background in Washington State
[38] To be calculated in based on protection of TPH-Oil Groundwater CUL, see Ecology comment #12

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October 1, 2008

CERTIFIED MAIL
7007 3020 0000 3068 2938

Mr. Jim Sumner
Manager, Group Environmental Programs
General Electric Aircraft Engine
One Neumann Way MD T165
Cincinnati, OH 45215

Dear Mr. Sumner:

RE: Ecology Time Extension Approval-Revised Focused Feasibility Study (FFS) Report Submittal

Thank you for attending the meeting with the Washington State Department of Ecology (Ecology) on September 25, 2008, to discuss your questions on Ecology's August 14, 2008, response letter to the draft focused feasibility study (FFS) report.

I am writing today's letter in response to your September 25, 2008 letter requesting a two-week time extension to submit the revised FFS report. Ecology hereby approves the requested two-week time extension and in accordance with Agreed Order, DE-5477 the deadline for submitting the revised FFS report is now October 17, 2008. The revised FFS report submitted on that date should incorporate all of the revisions requested and described in Ecology's August 14, 2008, comment letter. Per GE's request at the meeting, however, GE may elect to call Ecology's alternative #7 *alternative #2* provided that all of the revision requirements for that alternative (#7) requested in the Ecology's comment letter are fully incorporated.

In addition, based on GE's meeting statements regarding ISCO monitoring, Ecology now understands that GE feels that if the hydraulic control system is shut off during oxidant injection, it will be possible to detect any increases in chlorinated volatile organic compound (CVOC) levels at the 220 South Dawson property as well as down- and cross-gradient of the site in a timely manner. As we understood your position, this monitoring system could be sufficiently effective as to alert us to impending down or cross-gradient concentration increases in enough time to turn on the hydraulic control system and prevent an exacerbation of existing conditions. If such a monitoring system could be practicably designed and installed, this would certainly better assure us that the CVOC mass no longer being captured by the hydraulic control system was not leading to increased CVOC concentration levels beyond the building footprint.

If GE proposes this monitoring/re-start element as part of a remedial alternative in the revised FFS report, the proposal must include sufficient details so that Ecology can understand how the proposal will be implemented and how it will effectively meet the goal of preventing exacerbation of off-property conditions. This includes: a) a detailed discussion of the number, location and screened intervals of all monitoring wells (both existing and any additional wells) that would be used for this purpose; b) sampling frequency; c) decision timing and criteria ("trigger" observations); d) proposed groundwater recovery well extraction rates, in the event the wells were needed to capture the CVOC plume (and the rationale for choosing those rates); and e) proposed groundwater recovery well locations, if GE believes that the wells should be re-located or increased in number. You should also provide estimated costs for this monitoring, as well as anticipated costs of having to re-start the hydraulic control system. It is important that Ecology have enough information to fully evaluate this alternative and compare it to the alternative with the recovery wells operating, as required under WAC 173-340-360(2).

Lastly, based on GE's meeting statements, Ecology now understands that GE will provide an analysis as part of the revised FFS report to quantify the amount of CVOC contaminated groundwater that migrates offsite and cross-gradient if the groundwater recovery wells are shut off. Ecology does not know what model(s) GE may have used or how those models were used to make this demonstration, but GE should, at a minimum: (a) provide a clear explanation of why any model(s) used are appropriate for the site; (b) justify all input parameters used and assumptions applied (which should include an explanation for why you believe your inputs and assumptions are reasonably conservative); and, (c) include a sensitivity analysis that shows how uncertainty in input parameters impacts the results of the model. In addition, if pre-recovery well data are used as part of the analysis, GE should be clear about which data were used, and what you feel these data represent. Ecology will provide comments on the results of this analysis as part of the Ecology FFS response letter.

Please feel free to call me at (425) 649-7264 if you have any questions regarding this letter.

Sincerely,

De Yasuda

Dean Yasuda, P.E.
Environmental Engineer
Hazardous Waste and Toxics Reduction Program

DY:SA

cc: Julie Sellick, HWTR/NWRO
Ed Jones, Ecology HWTR/NWRO
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Thomas Morin, Environmental Partners, Inc

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August 14, 2008

CERTIFIED MAIL
7008 0150 0003 7591 3641

Mr. Jim Sumner
Manager, Group Environmental Programs
General Electric Aircraft Engine
One Neumann Way MD T165
Cincinnati, OH 45215

Dear Mr. Sumner:

Re: Ecology Comments on the Draft Focused Feasibility Study (FFS) Report, dated June 17, 2008

Thank you for submitting the draft FFS report to the Washington State Department of Ecology (Ecology) per the requirements of the RCRA Corrective Action Agreed Order (AO) DE-5477. Ecology appreciates the time you took from your busy schedule to meet with us on June 17, 2008, and to personally hand deliver the draft report. Ecology also thanks you for participating in our August 5, 2008 meeting by phone to briefly discuss some of Ecology's preliminary comments on the draft FFS report.

Now that the remedial investigation (RI) phase has been completed (subject to public notice and comment), Ecology shares the General Electric Company's (GE's) goal of finalizing and implementing the final site remedy as soon as possible.

Ecology has carefully reviewed GE's remedy selection analysis in the draft FFS report. During our review Ecology also reviewed historical site data (soil, groundwater and indoor air) obtained over the course of the RI. GE's additional FFS analysis of the three Ecology-required remedial action options is an important part of the June 2008 document, and assisted Ecology in understanding the remedial options for the site. Ecology also appreciates GE's commitment to use a standard groundwater point of compliance and to propose <u>active</u> remediation of offsite chlorinated volatile organic contaminant (CVOC) groundwater contamination (as opposed to proposing use of natural attenuation exclusively). Ecology believes that GE's preferred remedy provides for a good starting point for selecting the final cleanup action.

GE's draft FFS report should be revised to include technical and regulatory re-analysis, and cost estimates for alternative #5. Additionally, the revised FFS report should include a comparison of the revised Alternative #5 with the following additional alternative, which Ecology will refer to as Alternative #7:

- GE's alternative #5 (with minor design modifications described later). This alternative – GE's preferred option – already includes vapor intrusion mitigation system operation and groundwater monitoring[1]
- Optimized on-site hydraulic control (at the 220 South Dawson Street property)
- Additional instititutional controls, beyond what GE has proposed in alternative #5 (refer to Attachment A, Paragraph II)
- Contingent actions if in-situ chemical oxidation (ISCO) does not adequately achieve cleanup levels in a reasonable timeframe, or if access to CVOC source zones is eliminated due to construction activities at or near the 220 South Dawson Street property

Ecology believes this Alternative #7 remedy is likely to meet the minimum cleanup requirements found in WAC 173-340-360(2), as explained in the attached documents. If GE can move forward quickly with the revisions to the FFS detailed in the attachments, Ecology and GE can work to finalize the FFS report per the AO, and then move forward to draft the Cleanup Action Plan as quickly as is reasonably possible. Ecology's "comments" are divided into two categories: Attachment A: Description and Rationale for Additional Analyses and Requirements in the Draft FFS Report and Attachment B: Specific Comments. Attachment B's specific comments are additional Ecology comments, required by the AO, that describe the revisions GE must make to specific sections of the draft FFS in order for Ecology to approve those sections of the report (subject to public notice and comment).

In accordance with Agreed Order, DE-5477, GE is required to re-submit a revised FFS report within 45-calendar days of GE's receipt of this certified letter. Ecology is available to discuss its comments with the GE Team prior to the submittal deadline, and encourages GE to make use of this opportunity. Ecology looks forward to working with GE to finalize the FFS so that preparation of the Draft Cleanup Action Plan can begin.

Please feel free to call me at (425) 649-7264 if you have any questions regarding this letter.

Sincerely,

Dean Yasuda, P.E.
Environmental Engineer
Hazardous Waste and Toxics Reduction Program

DY:SA

cc: Julie Sellick, HWTR/NWRO
Ed Jones, Ecology HWTR/NWRO
Melisssa Rourke, Ecology AAG
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[1] Ecology agrees that groundwater monitoring is an essential part of the final site remedy, however, the fine details of this monitoring plan will be included in a draft plan for Ecology review as part of the cleanup action plan. Revisions to this plan are anticipated as the cleanup progresses through major phases of work.

Attachment A: Description and Rationale for Additional Analyses and Requirements in the Draft FFS Report: [2]

GE's proposed final site remedy (alternative #5) consists of the following: (1) in-situ chemical oxidation (ISCO) at the on-site and offsite areas[3]; (2) continued operation of the vapor intrusion mitigation system, (3) groundwater monitoring, and (4) institutional controls. Active pumping and discharging of groundwater for on-site hydraulic control using groundwater extraction wells (existing RW-2 and RW-3 or relocated extraction wells) during the on-site ISCO injections is not part of GE's proposal.

Ecology agrees with GE that ISCO should be implemented as part of the preferred remedy. Ecology also agrees that it is prudent and appropriate to continue operation of the vapor intrusion mitigation system until the potential threat of unacceptable chlorinated volatile organic contaminants (CVOC) vapor intrusion no longer exists. In addition, Ecology agrees that institutional controls are needed as long as environmental media (soil, indoor air, and groundwater) exceed unrestricted-use cleanup levels, as required under the Model Toxics Control Act (MTCA).

However, GE's Alternative #5 does not appear to meet the minimum requirements of WAC 173-340-360(2) without some modifications, for the reasons that follow. If, in consideration of Ecology's comments, GE still believes Alternative #5 meets the minimum requirements for a cleanup action, GE's revised report needs to further explain GE's rationale and response to the concerns raised below. Both alternatives #5 and #7 should incorporate the following additional technical and regulatory considerations of I.a, b, d and II through VI below. Alternative #7 should also incorporate the additional technical consideration of I.c. For the purposes of the revised FFS report, and as discussed in Attachment B, Ecology agrees with GE that Alternatives #1, #2, #3, #4, and #6 will not be considered further in the remedy alternative analysis for the primary final remedy, with the assumption that ISCO will be implemented as part of the final remedy.

I. Additional Analysis Required: The revised FFS should re-evaluate Alternative #5 and add evaluation of the additional Alternative #7 (as described in the cover letter) against the requirements of WAC 173-340-360(2).

a. **Optimized on-site hydraulic control of groundwater at the 220 South Dawson Street property.** For the reasons stated below, Ecology believes that optimized hydraulic control is necessary to meet the threshold requirements of WAC 173-340-360(2)(a)(i) and (ii): *protect human health and the environment* AND *comply with cleanup standards.* Ecology also believes that optimized hydraulic control is also necessary in order to provide for a reasonable restoration timeframe under WAC 173-340-360(2)(b)(ii). Therefore, alternative #7 includes that optimized hydraulic control of the on-site shallow CVOC groundwater plume be maintained until the ISCO treatment (or other contingency treatment, if required) is completed, and performance and confirmational groundwater monitoring shows that groundwater cleanup levels

[2] Note that the public has not yet been formally asked to comment on the GE FFS report, and thus Ecology's comments on the FS may be revised based on public comments.

[3] For purposes of convenience since the FS report refers to onsite and offsite areas, Ecology has also used these terms. Onsite refers to the 220 South Dawson Street property. Offsite refers to the areas of the MTCA site or facility that are located off the 220 South Dawson Street property. However, please note that the MTCA "site" or "facility" is not synonymous with either of these terms, and instead refers to the entire area where hazardous substances have come to be located. *See* RCW 70.105D.020(5) and WAC 173-340-200.

protective of surface water and indoor air have been attained at the point of compliance. Under this alternative, Ecology is willing to agree to turn off one or more groundwater extraction wells after the performance metric has been met, but not before.

GE's report should reflect the following concerns:

i. The ISCO treatment process may require a protracted period to meet its performance goals. Ecology and GE agree that multiple injections of ISCO oxidant will be required for the on-site final remedy. Between each injection, groundwater monitoring is required to evaluate how far the oxidant has moved from the injection point before dissipating, and to observe decreases and later increases (rebound) of TCE and other CVOCs in groundwater. It is also likely that some design modifications will be required for the ISCO injections after analyzing the initial round of post-injection groundwater data. GE's revised FFS report should reflect the time required for these multiple injections, any design changes (which require Ecology approval), and that adequate post-injection groundwater monitoring could take several years. Without optimized hydraulic control during this ISCO treatment implementation timeframe, CVOC contaminated groundwater would be allowed to flow offsite to downgradient areas. In addition, increased time requirements may result if alley access is reduced or eliminated as a result of the tenant-occupied atrium that McKinstry is planning to construct in the alley. Without optimized hydraulic control, all of the above will result in a longer restoration timeframe and more expensive and difficult cleanup, which needs to be considered in the FFS analysis.

ii. Given that the overall success of the ISCO implementation is uncertain because of the many difficult to control variables (such as how effectively oxidant can be delivered to the CVOC source areas, future access to these CVOC source areas, subsurface and aquifer conditions that could result in preferential groundwater flow paths around CVOC source areas, injection well fouling due to geochemical condition changes, etc), GE's FFS analysis should reflect that turning the groundwater extraction wells off for what could be an extended period of time constitutes a gamble that could result in higher concentrations of CVOCs migrating offsite. But by the time increased levels of offsite CVOC groundwater concentrations were observed, it would be too late to turn the system back on and hope to "pull back" the CVOC groundwater plume before it left the 220 South Dawson Street property.

While Ecology hopes that the ISCO technology is successful, there is no certainty that it will completely and swiftly remediate all on-site area groundwater contamination to cleanup levels with one, two, or more injections. Incomplete ISCO treatment without optimized hydraulic control results in increases in CVOC mass flux to offsite areas.

In addition, even if the ISCO treatment successfully treats the groundwater it contacts, liquid injections may push the CVOC groundwater plume downgradient ahead of the injectant front (or treatment zone). This poses the threat of spreading contaminated groundwater in front of the treatment zone before effectively oxidizing the contamination.

GE's FFS report should reflect that increases in CVOC mass flux to offsite areas are likely to result in longer remediation timeframes and a more difficult and expensive cleanup of the offsite CVOC groundwater plume[4]. Please revise the analysis of Alternative 5 to account for these considerations.

iii. GE's groundwater extraction wells have been operating in their current configuration for approximately 5 years (RW-2 and RW-3). Prior to that time, groundwater extraction wells RW-1 and RW-2 were operating. By shutting off the extraction wells during ISCO implementation, the equilibrium partitioning between the residual CVOC sources in the aquifer matrix and groundwater will adjust such that the on-site aquifer will go through a "CVOC rebound". That rebound will result in elevated CVOC groundwater concentrations on-site and additional CVOC migration offsite which would lead to higher downgradient concentrations, a longer remediation timeframe, and a more difficult and expensive cleanup of the offsite CVOC groundwater plume. Please revise the analysis of Alternative 5 to account for these considerations.

b. Increased Vapor Intrusion (VI) Risk. GE's report should be revised to take into account the increased vapor intrusion risk that may result without optimized hydraulic control. In-situ treatment without optimized hydraulic control has the potential to result in increased concentrations of CVOCs in the shallow zone of the on-site and offsite aquifer. The lack of optimized hydraulic control during ISCO treatment has the potential to result in an increased threat of vapor intrusion in buildings at, downgradient and cross-gradient of the 220 South Dawson Street property. At this time, with the RW-2 and RW-3 operational, we have VI assessments at downgradient buildings where, based on current data, Ecology is confident further indoor air and sub-slab vapor sampling is not required. But those assessments are based on current conditions. Assessments would need to be re-performed if TCE or other CVOC levels began increasing downgradient of the 220 South Dawson Street building. Neither Ecology or GE want to perform such new assessments (or install vapor intrusion mitigation systems) at downgradient or cross-gradient buildings if we can help it.

In addition, operation of groundwater extraction well RW-3 serves three functions: (a) it aides CVOC source area hydraulic control under the 220 South Dawson Street building, (b) it helps mitigate CVOC vapor intrusion in the 220 South Dawson St. building and (c) it minimizes the impact of CVOC vapor intrusion into the adjacent McKinstry building. The 220 South Dawson St building vapor intrusion mitigation system was designed based on the results of indoor air and sub-slab vapor data collected while RW-2 and RW-3 were operational (extracting contaminated groundwater and minimizing the footprint of the underlying CVOC groundwater plume). Shutting off optimized hydraulic control during ISCO implementation could potentially result in additional CVOC vapor intrusion into the 220 South Dawson

[4] It also becomes more difficult for GE and Ecology to understand the spatial and temporal distribution of TCE and other CVOCs in the offsite groundwater plume.

Street building since that building's current vapor intrusion mitigation system was not designed for an expanding CVOC groundwater plume underlying the building.

Among other reasons, Ecology required the installation of RW-3 to shrink the footprint of the CVOC groundwater source plume and reduce the portion of the plume below the McKinstry building[5]. Prematurely terminating optimized hydraulic control (during the ISCO injection phase) could potentially result in expansion of the CVOC groundwater plume under the McKinstry building and a heightened threat of vapor intrusion.

c. **Relocation of the groundwater extraction wells and pumping rates.** As part of the hydraulic control optimization for alternative #7 alone, GE should analyze relocating both extraction wells, RW-2 and RW-3 to the east side of 2nd Avenue South. The phasing of the on-site ISCO injections with the timing of moving both groundwater extraction wells should be analyzed in order to (1) maximally optimize the effectiveness of on-site hydraulic control and (2) minimize or eliminate any possible interferences between ISCO contact with subsurface CVOCs AND the operation of the groundwater extraction wells. Ecology believes the interferences would be minimal since the ISCO oxidant front is expected to travel no farther than 25-30 feet from the injection point.

RW-4 (relocated RW-3) should not be placed to the north of well MW-13 to keep CVOC contaminated groundwater away from MW-13 and the McKinstry building. The analysis should assume that RW-4 is located to the immediate north side of MW-6 so that it can intercept groundwater flow from upgradient MW-1 and MW-4. Under this RW-4 configuration, MW-6 becomes a monitoring point (hydraulically and chemically) at the center of the RW-4 capture zone and can also be used to directly measure the drawdown around RW-4. Ecology also believes it is important to intercept the "rebound" of CVOC groundwater contamination near MW-6 once RW-3 is shut off. CVOC groundwater concentrations were at least 2 orders of magnitude higher than current levels, prior to the operation of extraction wells RW-1 and RW-2.

To further improve hydraulic control over the 220 South Dawson Street property, Ecology also prefers to relocate RW-2 to the east side of 2nd Ave South (next to MW-8). In general, in order to maximize the groundwater capture zone, two extraction wells should be located to form a line that is perpendicular to the groundwater flow direction. Under this configuration, MW-8S an also be used to directly measure the drawdown around relocated RW-2[6].

Ecology understands that GE has obtained a discharge authorization for a maximum discharge rate of 17 gpm. But we do not understand the need to otherwise limit the total pumping rate to 17 gallons per minute (gpm) if a new discharge authorization or permit would allow a higher total pumping rate. Although Ecology does not expect to advocate any pump rate increases significantly above 17 gpm, GE should state that it will keep this option available while designing the optimized hydraulic control system. Page 5-3, Paragraph 2 of this section mentioned the need to increase

[5] Note that 2002 EPA VI guidance recommends screening buildings for unacceptable VI that are 100 feet from the edge of the groundwater plume.

[6] The measured drawdown at MW-8S is highly preferred over drawdown measured at the recovery well (which includes well head losses).

pumping rates for RW-2 and RW-4 which would result in a combined discharge rate greater than 17 gpm. Ecology will review and approve the location of new extraction well RW-4 (and relocated RW-2) after further discussions with GE/ENSR on optimum location, screen interval, and pump rate.

d. **Offsite ISCO Injections.** GE's proposed offsite injection points near MW-15D/M will not be deep enough to treat the CVOCs at the maximum known depth of 55' bgs. Since monitored natural attenuation is not proposed as part of the final remedy, the injection wells near MW-15D/M should therefore extend down to at least 55' bgs. In addition, injections have not been (but should be) proposed within the shallow aquifer zone east of the Western Cartage building to treat the low CVOC concentrations underneath this building. The objective of the offsite injections is to treat the entire offsite CVOC plume.

II. **Additional institutional control requirements:** To compliment the additional analysis required in paragraph 1 above, the institutional controls for alternatives #5 and #7 should prevent the withdrawal and use of ground water for drinking water purposes. WAC 173-340-720(6)(c)(iii)(B). The institutional controls must also address the residual contaminated soil (above cleanup levels protective of groundwater and indoor air cleanup levels) on the 220 South Dawson Street Property. GE must make a good faith effort to secure an Environmental (Restrictive) Covenant[7] on the 220 South Dawson Street property and all required downgradient properties before using other legal or administrative mechanisms (see WAC 173-340-440(8)(c)).

III. **Contingent Remedy.** Ecology and GE believe that ISCO may successfully meet our cleanup performance objectives. But Ecology also believes there is a good chance that the technology will only be partially successful. Consequently, the remedy should allow us to be prepared for such a scenario.

GE's FFS report should be revised to evaluate a contingent remedy that could be implemented quickly after a determination that ISCO did not appear to be effectively meeting cleanup objectives. Please evaluate the *reserve* remedy of enhanced in-situ biodegradation.[8] Ecology expects that "evaluation" to include a brief description of the technology that would be used and a general conceptual description of how it would be implemented. By "reserve remedy", Ecology means the remedy would only be required if Ecology determines:

a) the on-site or offsite ISCO treatment did not meet surface water cleanup levels at the standard groundwater point of compliance within an acceptable restoration timeframe, OR
b) on-site or offsite ISCO treatment does not appear to be adequately attaining cleanup milestones[9], OR
c) future access constraints to the alley or to other CVOC contaminated groundwater areas prevent further ISCO injections from being effective in treating the CVOC contaminated zones.

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[7] A restrictive covenant must meet the requirements of WAC 173-340-440(9).

[8] Injected substrate and/or bacteria at accessible locations on the upgradient side of the CVOC source zones (east part of the property) will have longer travel distances under the building (compared to ISCO oxidants). Injected substrate and/or bacteria is more likely to reach CVOC groundwater zones on the west side of the building.

[9] i.e., milestones established to monitor the effectiveness of the remedy as it is progressing.

IV. **Performance and Confirmational Groundwater Sampling Plans.** Note that the Cleanup Action Plan must include the requirement for performance and confirmational groundwater sampling plans. To compliment the additional analysis in paragraph 1 above, for alternatives #5 and #7, the Plans shall be submitted to Ecology for review and approval prior to implementation of ISCO. Monitoring wells within the performance-monitoring network should be located to measure both the advection/dispersion of oxidant and the effectiveness of the treatment in three dimensions. The monitoring points are expected to be located close to, but not necessarily exactly at, the proposed spots in alternative #5's description.[10] Each ISCO injection phase may require a separate performance and confirmational groundwater monitoring plan.

As part of the performance and confirmational groundwater sampling and analysis plan, GE will need to provide more explanation of how permanganate will be measured colorimetrically. In addition, the plan(s) should include:[11]

a. Lower limits of detection and associated accuracy of this colorimetric method.
b. Concentrations of permanganate used to establish the "edge" of the effective permanganate treatment plume?
c. Use of an Ecology-accredited laboratory for confirmation of field analysis.
d. An explanation for how it determines whether collected groundwater samples contain both permanganate and TCE (or other chlorinated compounds). If oxidant is present in the sample it may interfere with the CVOC analysis or continue to react with chlorinated compounds and interfere with data interpretation.
e. The proposed timing for the collection of baseline data.
f. A hydraulic monitoring discussion describing how (and how frequent, during and after injections) GE will measure water table elevations and, from these measurements, estimate the degree of mounding resulting from the ISCO injection(s).
g. Describe how GE will assess CVOC groundwater rebound. Ecology believes that dissolved CVOC groundwater concentrations will initially decrease within the treatment zone, but may later increase as equilibrium is reestablished between residual CVOC in the source area and dissolved phase CVOC. It may take months for this equilibrium to re-establish itself.
h. An explanation for how GE will differentiate between decreases in CVOC resulting from dilution/displacement (by injecting an aqueous permanganate solution) versus those attributable to actual CVOC oxidative destruction.
j. Proposed groundwater analytes. These should include Table 5-3 constituents, as well as chromium, cadmium, nickel, selenium and trans-1,2-DCE. Chromium and cadmium are sometimes contaminants in the permanganate feed. Chromium, nickel and selenium mobilization is sometimes observed.
k. An explanation of how GE intends to assess the issue of an induced increase in groundwater manganese concentrations, however temporary. The Plan should also discuss whether these concentrations are likely to exceed regulatory levels. If concentrations are likely to exceed regulatory levels, GE must explain how the exceedances will be monitored and addressed during the final remedy.

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[10] After consulting with ENSR on July 17, 2008, Ecology understands (and agrees that) the injection and monitoring point locations were proposed for the FFS conceptual design and selected primarily for alternative comparison purposes and not as final points for final remedy implementation.

[11] Ecology made a similar request in response to GE's November 9, 2007 ISCO pilot study proposal.

V. Vapor Intrusion Monitoring. During cleanup implementation, Ecology will require that GE continue indoor air monitoring, and possibly sub-slab vapor sampling, in conjunction with measurements of CVOC groundwater concentrations, to assess whether the potential for unacceptable vapor intrusion exists[12]. This monitoring will also be used to determine when to initially shut off the 220 South Dawson Street vapor intrusion mitigation system. The draft cleanup action plan will need to contain plans for performing this work. Ecology will allow GE to keep the vapor intrusion mitigation (VIM) system off when sustained (post VIM system shut off) confirmation indoor air sampling data indicate that vapor intrusion is not leading to unacceptable CVOC concentrations in indoor air.

VI. ISCO Implementation. Ecology believes that GE should first perform a focused bench-scale study to determine the appropriate oxidant volume and concentration that will overcome the natural oxidant demand of contaminated aquifer media and effectively oxidize the range of CVOCs likely encountered. GE may choose to include a revised conceptual ISCO implementation strategy for alternatives #5 and #7 based on the reanalysis and additional requirements listed in considerations I through V above, OR specify these details in the draft cleanup action plan. At this time Ecology is not approving the location of phased ISCO injections. Ecology believes it is premature to approve these details now because it anticipates that work plans for phased ISCO injections will be based on the results of previous ISCO injections and/or newly discovered access restrictions. Ecology expects that these details will be determined in the draft cleanup action plan. Ecology anticipates that it will recommend ISCO injections in a phased approach and likely in similar locations proposed in Alternative #5.

[12] Ecology is willing to accept future sub-slab depressurization testing in lieu of indoor air and/or sub-slab vapor sampling, however, the newly constructed raised floor may not allow for such testing on the north side of the building (nearest VIM-1 and VIM-5A).

Attachment B: Specific Comments on the Draft FFS Report:

In addition to the changes described in Attachment A, below are additional specific requested revisions Ecology is looking to see in the FFS Report. Note that generally, Ecology is looking for sufficient information to be presented and evaluated in the FFS in order to be able to move on to selecting a remedy and putting together the draft Cleanup Action Plan. *See* 173-340-350(8)(a). While Ecology has made an attempt to highlight points of disagreement with the current draft FFS, Ecology's comments are focused on revisions that are necessary to moving on to selection of a remedy. Thus, Ecology's silence as to a statement in GE's report does not necessarily indicate full agreement with any such statement.

Section 1.0 Introduction:

1. Page 1-2, Section 1.3: Please clarify in the text that Ecology did not approve all independent work before the work was conducted.

Section 2.0 Site Conceptual Model:

2. GE should include a figure showing the facility (including onsite and offsite monitoring wells) and its proximity to the Duwamish River and Slip 1. This figure is important for visually understanding the site conceptual model in this Section and Section 3.0, where cleanup levels are discussed.

3. Page 2-3, Section 2.1.2.3 Groundwater Characteristics, Paragraph 1: Include Section 4.4, Paragraph #3, here to acknowledge Ecology's disagreement on the effectiveness of the current groundwater hydraulic control system.

4. Page 2-7, Section 2.2.2.1, Paragraph 3: Ecology agrees that current TCE groundwater concentrations are the primary risk driver at the site. However, changing geochemical conditions (due to natural processes or as a result of cleanup actions) have the potential to result in more biodegradation of TCE and the formation of toxic daughter products such as vinyl chloride. Revise GE statements to include this comment.

5. Table 2-2: Consistent with the Ecology March 4, 2008, letter to GE, include the 1,4-dioxane surface water cleanup level (79 ug/L).

6. Contaminant Groundwater Contour Figures 2-12 through 2-27: The concentration contour figures here were prepared by GE/ENSR based on their interpretation of the groundwater data. Ecology does not agree with this interpretation of the groundwater data or with the contouring approach used in these figures[13]. Ecology will expect the final remedy design in the Cleanup Action Plan to reflect the assumption that the downgradient CVOC groundwater plume is continuous, as Ecology believes this point will be key to successful implementation of ISCO at the site.

[13] One such important disagreement is GE/ENSR's contouring of isolated downgradient "islands" of TCE contaminated groundwater around monitoring wells versus contouring smooth TCE iso-concentration lines extending upgradient and downgradient. Ecology does not believe that these isolated "islands" of TCE contaminated groundwater exist as drawn and this is not consistent with groundwater flow and TCE concentrations consistently found in those wells.

7. Page 2-10, Section 2.2.2.2 Arsenic, Paragraph 2: Ecology does not agree that the elevated arsenic groundwater concentrations at EPI- MW-4S (23 ppb on April 2008) are due to a localized source area of arsenic. It is very likely that reducing conditions resulted in the dissolution of arsenic in this area. For the purpose of revising this report, GE should state that this interpretation will be identified as GE's opinion not shared by Ecology.

8. Page 2-10, Section 2.2.2.2 Arsenic, Paragraph 3: Arsenic is a COC under the Agreed Order Section IV.B[14] and FFS. Arsenic is still of concern at the Site and needs to remain a COC.

9. Page 2-11, Section 2.2.2.3 1,4-Dioxane, Paragraph 1: Consistent with the Ecology March 4, 2008, letter to GE, the 1,4-dioxane surface water cleanup level is 79 ug/L. Revise the statement in the draft FFS to include this cleanup level.

10. Page 2-11, Section 2.2.2.3 1,4-Dioxane, Paragraph 3: 1,4-dioxane is a COC under the Agreed Order Section IV.B and FFS[15]. 1,4-dioxane is still of concern at the Site and needs to remain a COC.

11. Page 2-11, Section 2.2.2.4 Groundwater CVOC Fate and Transport, Paragraphs 2 and 3: Ecology agrees that Figures 2-30 and 2-31 depict reductions of 1,1,1 trichloroethane (1,1,1-TCA) and TCE over time. However, Ecology believes that the reduction of 1,1,1-TCA and TCE in groundwater over time is due to the groundwater extraction system operation, advection/dispersion/sorption mechanisms, and mass loss due to abiotic and biotic degradation. There is insufficient data at this time to be able to determine if one of these processes is more effective than the other two[16]. The text should therefore either be revised to include the points expressed in the two sentences above, or qualified so that it is clear that GE is positing an opinion, not shared by Ecology, that you believe explains site observations.

12. Page 2-12, Section 2.2.2.4 Groundwater CVOC Fate and Transport, Paragraph 3: Ecology disagrees with the statement that *"The lack of any detected CVOCs in the furthest downgradient monitoring wells indicates that complete degradation is occurring at the western most edge of the plume"*. Natural attenuation of CVOC groundwater plumes includes advection/dispersion/sorption in addition to degradation. Ecology does not agree that one can conclude groundwater plume stability is due to degradation only, particularly in a relatively conductive aquifer. In addition, the final compounds for complete degradation of CVOC are ethane and ethene, which have not been detected at or downgradient of the site.
As the next section (Section 2.2.2.5) of the report concludes, current aquifer geochemical conditions may not allow the reductive dechlorination process to proceed to completion (production of ethane and ethane as final products). Ecology believes we can proceed with remedy selection while agreeing to disagree on these matters. For the purpose of revising this report, the text should indicate that this is an opinion of GE not shared by Ecology.

[14] Per the Agreed Order, Section IV.B, the COCs are those dangerous constituents released to the subsurface soils and groundwater from past GE operational practices at the former GE 220 S. Dawson Street facility or released from the aquifer as a result of changes in geochemical conditions resulting from those releases in concentrations exceeding applicable cleanup levels. Based on the investigations conducted at this Site, the COCs are trichloroethylene (TCE), 1,1,1-trichloroethane (TCA), perchloroethylene (PCE), 1,1-dichloroethene (DCE), cis 1,2-dichloroethylene, trans 1,2 dichloroethylene, 1,4 dioxane, arsenic and vinyl chloride. Other substances may be identified as COCs as a result of work.

[15] Although concentrations of 1,4-dioxane are currently below MTCA Method B surface water cleanup levels throughout the site, there is an exceedance above the MTCA Method B groundwater cleanup level. Under the scenario, where groundwater cleanup standards are based on the protection of surface water receptors, institutional controls over groundwater areas with elevated 1,4-dioxane concentrations (above MTCA Method B groundwater cleanup levels) would be required as part of the final remedy.

[16] In addition, an increase in 1,1-DCE in MW-4 cannot be clearly identified to accompany 1,1,1-TCA decreases based on the data shown in Figure 30.

13. Page 2-15, Section 2.2.2.6 Summary of Groundwater Contaminants of Concern: This list should reflect the identical list of COCs included in the Agreed Order, Section IV.B because Ecology is not convinced that any of these contaminants are no longer of concern at the Site. To be clear, however, some COCs will require active treatment (such as by ISCO); other COCs will require only monitoring to verify no unexpected increases.

14. Page 2-15, Section 2.2.3 Indoor Air, Paragraph 1: Ecology did not agree with several statements in the draft interim action completion report. Since the revised FFS report references this draft report, then GE should also include a statement clarifying that Ecology did not approve this report.

15. Page 2-18, Section 2.2.3.3: If the intent of this paragraph is to state that an unacceptable amount of CVOC vapor intrusion is not occurring, then Ecology disagrees. For the purpose of revising this report, GE should include a statement to the effect that Ecology disagrees with GE's interpretation of these data (please see Ecology's March 10, 2006, letter to GE).

16. Page 2-18, Section 2.2.3.4: This list should reflect the identical list of COCs in the Agreed Order, Section IV.B. Since arsenic and 1,4-dioxane are obviously not volatile substances, Ecology has no objection to them being excluded from those COCs identified for the indoor air pathway.

Section 3.0 Cleanup Standards:

17. Page 3-2, Section 3.1: This list should reflect the identical list of COCs included in the Agreed Order, Section IV.B. Since arsenic and 1,4-dioxane are obviously not volatile substances, Ecology has no objection to them being excluded from those COCs identified for the indoor air pathway.

18. Page 3-3, Section 3.1.1.2, Table 3-1: The soil CULs in Table 3-1 are not protective of groundwater cleanup levels (based on surface water cleanup levels). Soil cleanup levels must be protective of surface water quality (cleanup levels) and cannot result in shallow groundwater contamination that would pose a threat to indoor air quality via vapor intrusion. The establishment of this soil cleanup level is a requirement of the Agreed Order, Task 1.3.

The amounts of CVOC and TPH in the vadose zone are expected to be small based on available data. However, as part of a complete cleanup standard analysis, GE should propose and justify soil cleanup levels that meet the following requirements: (1) protective of groundwater quality, such that soil contamination cannot lead to exceedances of surface water cleanup levels in groundwater; (2) protective of groundwater quality, such that soil contamination cannot lead to contamination in shallow groundwater that poses a potentially unacceptable VI threat. It is very possible that existing residual subsurface CVOC and TPH soil concentrations will already meet such soil cleanup levels. If not, GE should explain how the company intends to (eventually) meet the cleanup levels or otherwise contain the potential threat to receptors.

19. Section 3.1.2 Groundwater: This list should reflect the identical list of COCs included in the Agreed Order, Section IV.B because Ecology is not convinced that any of these contaminants are no longer of concern at the Site. To be clear, however, some COCs will require active treatment (such as by ISCO); other COCs will require only monitoring to verify no unexpected increases.

20. Page 3-7, Section 3.1.2.2 Evaluation of Groundwater Potability, fourth bulleted response, last sentence: Ecology has reviewed GE/ENSR's capture zone analysis results (ENSR 2007) and disagreed with a number of its conclusions. Ecology's own capture zone analysis report, dated October 31, 2007, describes the technical basis for Ecology's conclusions regarding incomplete capture and our basis for stating that optimized hydraulic control of contaminated groundwater at the 220 South Dawson Street property needs to be evaluated as part of Alternative #7. For the purpose of revising this report, the text should therefore either be revised to include Ecology's capture zone conclusions, or qualified so that it is clear that the statements only reflect GE's opinion, not shared by Ecology.

21. Page 3-8, GE response to (d)(iv): Although currently there are no plans to use the shallow aquifer for drinking water purposes, neither Ecology or GE can predict what the area's future drinking water demands will be and whether treatment of extracted groundwater would prove to be economically feasible based on future increased drinking water demands and the price of City-supplied water. Regarding the use of the shallow aquifer for future drinking water purposes, per WAC 173-340-720(2)(d), Ecology agrees that currently this "probability is low" but not zero. These statements should be included in the revised FFS report.

22. Page 3-8, Section 3.1.2.3, Paragraph 1: GE should add another bullet: *Groundwater cleanup levels must also consider unacceptable vapor intrusion into overlying buildings.* Ecology expects that achieving MTCA Method B surface water cleanup levels throughout the groundwater plume (standard point of compliance) will achieve this result for a commercial/industrial site.

23. Page 3-8, Section 3.1.2.3, Paragraph 2, Worker Direct Exposure to Groundwater: Without knowing the specific work activities, Ecology does not agree that a utility maintenance worker can be assumed to be less exposed than a construction worker (i.e. monitoring and maintaining the dewatering system). Utility workers in an excavation (above the water table) would still be exposed to CVOC vapors from the groundwater. The text should be revised to include these statements.

24. Page 3-9, Worker Direct Exposure to Groundwater: Ecology agrees that the cleanup levels based on the protection of a trencher exposed to groundwater are not likely to drive the cleanup at the site. This is based on the site's groundwater COC concentrations and the low MTCA Method B groundwater cleanup levels based on the protective of surface water.

However, Ecology does not have enough information to adequately evaluate how GE's "trencher" cleanup levels were calculated. GE should include the actual equations used from the EPA Risk Assessment Guidance for Superfund (RAGS), Part B, and discuss the assumptions that are inherent in the use of the equation(s), as compared to actual GE site conditions[17]. The exposure pathway assumptions for the site and applicability to the equations should be explained in the text. All input parameters to the equation(s) should be listed and site assumptions explained in Table 3-3 (if not done so already). In addition, the revised cleanup levels must adhere to the requirements of WAC 173-340-708(10)(b)(i), and use MTCA default parameters.

25. Page 3-10, Table 3-2 and Page 3-11, Table 3-6: Arsenic, cis-1,2 dichloroethylene, trans-1,2-dichloroethylene, and 1,4-dioxane cleanup levels should be included in Table 3-2. This list

[17] Note that the trench air cleanup levels could be calculated based on MTCA Method C indoor air cleanup levels divided by an appropriate constituent groundwater to trench volatilization factor.

should reflect the identical list of COCs in the Agreed Order, Section IV.B because Ecology is not convinced that any of these contaminants are no longer of concern at the Site. Ecology recommends that GE use the background value of 5 ug/L established under MTCA Method A, which is greater than the range of background values in groundwater samples collected at MW-5 and MW-2.

26. Table 3-8, Table 3-9 and Discussion under Section 3.1.3.2: Although at this time TCE is the only constituent that exceeds the MTCA Method C indoor air cleanup level, the degradation products of TCE and 1,1,1-TCA should be included as COCs and monitored for compliance with applicable cleanup levels. Subsurface conditions may naturally (or artificially, as a result of cleanup engineered design) change and result in higher concentrations of CVOC degradation products.

In addition, although Ecology proposed sub-slab vapor concentrations of 100 times the MTCA Method C air cleanup level as screening levels for evaluating the need for immediate interim actions, these concentrations are not defined as cleanup levels under the MTCA. The future slab integrity (presence or absence of cracking or man-made perforations) will have a significant role in determining the sub-slab vapor to indoor air attenuation factor, and whether an assumed cross-slab attenuation factor of 100 will continue to be protective, years into the future[18]. Sub-slab vapor data in combination with indoor air data, however, is a useful line of evidence for confirming vapor intrusion[19]. During cleanup implementation, Ecology will require that GE continue indoor air monitoring, and possibly sub-slab vapor sampling, in conjunction with measurements of CVOC groundwater concentrations, to assess whether the potential for unacceptable vapor intrusion exists and when to initially shut off the 220 South Dawson Street vapor intrusion mitigation system.

27. Page 3-14, Table 3.3: This list should reflect the identical list of COCs in the Agreed Order, Section IV.B because Ecology is not convinced that any of these contaminants are no longer of concern at the Site. Since arsenic and 1,4-dioxane are obviously not volatile substances, Ecology has no objection to them being excluded from those COCs identified for the indoor air pathway.

Section 4.0 Technology Screening:

28. Section 4.1: Ecology recognizes that GE has defined the offsite treatment area in this FFS report as that part of the contaminated aquifer that extends from 2nd Avenue South to Utah Street, as defined by groundwater chemical data. Ecology is not requiring any revisions to this statement. However, as a clarification, the "Site" defined by the Agreed Order is identical to the definition of Facility under RCW 70.105D.020(5), and includes the area where hazardous substances have come to be located. See footnote 3 above.

29. Section 4.2 Institutional Controls and Monitoring: Refer to the Ecology requirements for institutional controls and monitoring in Attachment A, paragraph II.

[18] Since the time when we began evaluating VI at the GE site there have also been studies published that question the conservativeness of an assumed cross-slab alpha of 0.01. Were we beginning the VI assessment today, it is likely that Ecology would choose an assumed attenuation closer to 50 times (or less).

[19] For example, high TCE sub-slab vapor concentrations coupled with lower indoor air TCE concentrations would indicate TCE vapor intrusion across the floor slab.

30. Page 4-2, Section 4.3, Paragraphs 2, 3 and 4: Ecology agrees in general with GE that "[t]he On-Site and Off-Site Area plumes are behaving in different ways". However, Ecology believes that the decreasing trend observed in the on-site area groundwater plume is mainly caused by the extraction well operation, not by natural attenuation. Ecology believes we can proceed with final remedy selection while agreeing to disagree on these matters. For the purpose of revising this report, the text should indicate that this is an opinion of GE not shared by Ecology.

The last sentence of the page states, "[t]he degradation at the Off-Site Area appears to be occurring at a rapid, consistent rate." Ecology believes this is a stable offsite groundwater plume where rate of contaminant entering the Off-Site Area equals the same dissipation rate with the Off-Site Area. For the purpose of revising this report, the text should be revised to include Ecology's technical position or the text should indicate that this is an opinion of GE not shared by Ecology.

31. Page 4-3, Section 4.4, Paragraph 3: Refer to comment #20.

Section 5.0 Detailed Evaluation of Remedial Alternatives:

32. Ecology appreciates the summary sections of 5.1, 5.1.1, 5.1.2, and 5.1.3. In a few cases the text in these summary paragraphs are not exact quotes from the MTCA. But Ecology sees no reason to provide comment on these sections since they reference the correct remedy selection sections in WAC 173-340-360. However, in the event of any conflict between the summary of MTCA or its regulations in GE's report and the actual provisions of MTCA, the language of MTCA and its implementing regulations will govern.

Ecology has some concerns with the way GE's disproportionate cost analysis was performed in the draft FFS. (See paragraph 41 for additional discussion of GE's overall ranking of alternatives). GE did not rank the six alternatives from most to least permanent, compared against the most practicable permanent solution, per WAC 173-340-360(3)(e)(ii). However, in the interest of streamlining this process, Ecology is only asking for further detailed analysis of Alternatives #5 and #7.

Further, as explained above, even before getting to the analysis of whether Alternative #5 is permanent to the maximum extent practicable, Ecology has concerns about whether Alternative #5 meets threshold criteria of WAC 173-340-360(2)(a). Ecology also has concerns about whether alternative #5 provides for a reasonable restoration timeframe under WAC 173-340-360(2)(b). Thus, Ecology does not feel that a detailed disproportionate cost analysis is central to selecting between Alternatives #5 and #7. In the interest of efficiency, if GE reviews Ecology's concerns and decides that Alternative #7 is the preferred alternative, further detailed disproportionate cost analysis in the FFS is not necessary. However, if after consideration of Ecology's concerns about Alternative #5, GE continues to believe that Alternative #5 is the preferred alternative, again in the interest of efficiency, GE need not redo the entire disproportionate cost analysis found in the draft FFS. GE need only revise the disproportionate cost analysis to include a comparison of Alternative #5 (with the revisions listed in this letter) with Alternative #7, using Alternative #7 as the baseline alternative, in accordance with WAC 173-340-360(3)(e)(ii).

Section 5.2 Alternative 1-Optimized Hydraulic Control, Soil Vapor Extraction/Air Sparging and Vapor Intrusion Mitigation: At this time Ecology is not looking for further evaluation of soil vapor extraction/air sparging as part of the final remedy. Therefore, we see no reason to comment on all parts of this section that we take issue with. Ecology's comments on alternative #1 are made only because alternative #5 indirectly references many portions of the alternative #1 discussion.

33. Page 5-3, Section 5.2, Optimized hydraulic control, Paragraph 2, third through fifth sentence: The text should state that the cone of depression around newly installed groundwater extraction well RW-4, and the combination of RW-2 (relocated) and RW-4, will need to be verified by field water elevation measurements[20]. If GE is referring to modeling results from its capture zone analysis report, Ecology has already stated that it does not agree with those results. (refer to comment #20). In addition, the discussion of any predicted effectiveness of relocated extraction wells should incorporate the "capture zone" instead of "cone of depression" or "cone of influence". This is because the capture zone describes the radial area from which contaminated groundwater would flow into and not around the extraction well. Capture zone is the more precise and proper parameter for extraction well operation, and is generally smaller than the cone of influence/depression.

34. Soil Vapor Extraction/Air Sparging System, Vapor Intrusion, Institutional Controls, 5.2.1 Threshold Requirements, 5.2.2 Restoration Timeframe, 5.2.3 MTCA Evaluation Criteria: Ecology agrees with GE that this technology has the potential to result in slightly longer restoration timeframes than ISCO or enhanced anaerobic bioremediation. However, the restoration timeframe would not be so much longer as to immediately eliminate the technology from consideration. Ecology believes we can proceed with final remedy selection while agreeing to disagree on these matters.

35. Page 5-8, Section 5.2.3, Consideration of Public Concerns: The Mason Supply business communicated to Ecology its concerns regarding CVOC vapor intrusion into its offices and they supported the installation of the vapor intrusion mitigation system. The Western Cartage building owner (as represented by its environmental consultant, Environmental Partners, Inc) has also communicated to Ecology that it is interested in the progress of the cleanup and received a copy of the draft FFS report, which is under their review. These comments were made outside any formal public comment period associated with either the vapor intrusion mitigation interim action or feasibility study agreed orders; however, Ecology believes their inclusion in this report is important. GE should make this revision to this section of the report as well as the corresponding sections in the re-analysis of alternatives #5 and #7.

36. Page 5-8, Section 5.2.4 MTCA Specific Requirements Regarding Containment: Refer to comment #20.

Section 5.3 Alternative 2 – Optimized Hydraulic Control, In-Situ Chemical Oxidation, Vapor Intrusion Mitigation: At this time, Ecology is not asking GE to re-evaluate alternative #2.

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[20] In addition, Ecology does not understand the statement, "… a cone of depression that influences groundwater up to 40 feet from the pumping well…" GE should be more specific in terms of "capture zone".

Section 5.4 Alternative 3 – Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation (EAB) and Vapor Intrusion Mitigation: At this time Ecology is not looking for further evaluation of EAB as part of the final remedy. Ecology disagrees with the comparative analysis between EAB and ISCO as well as the analysis with and without optimized hydraulic control. Ecology is not requesting these revisions to Section 5.4 of the draft FFS, however, Ecology believes that EAB is an acceptable contingent remedy (refer to Attachment A, consideration III).

Section 5.5 Alternative 4 – Soil Vapor Extraction/Air Sparging:

37. At this time, Ecology is not looking to further evaluate vapor extraction/air sparging as part of the final remedy. Therefore, we see no reason to comment on all parts of this section. Ecology agrees with GE that this technology has the "potential" to result in slightly longer restoration timeframe than ISCO or EAB. However, we do not believe that the timeframe will be so much longer that the technology's use should be immediately eliminated from consideration.

Ecology's comments on Section 5.2 and Attachment A are applicable to Section 5.5. Ecology is not requesting any revisions to this section of the FFS.

Section 5.6 Alternative 5 – In-Situ Chemical Oxidation and Vapor Intrusion:

38. GE should first re-evaluate this Alternative 5 against the threshold requirements (WAC 173-340-360(2)(a) given Ecology's comments herein and in Attachment A. Then, if GE believes this alternative meets the threshold requirements, GE should evaluate this alternative against Alternative #7 based on the Ecology statements in Attachment A, WAC 173-340-360(2)(b), and the following comments:

a. Vapor Intrusion Mitigation System: Refer to Attachment A, paragraph V.

b. Restoration Timeframe: Please revise this analysis to reflect Ecology's comments described in Attachment A, Paragraph I. Additionally, if down gradient CVOC groundwater concentrations remain elevated or rebound, the efficacy of the offsite treatment will also be evaluated.

c. Overall Protectiveness and Long Term Effectiveness: Ecology disagrees with GE that the groundwater extraction well system will negatively impact ISCO performance and effectiveness. So this potentiality should not result in a lower score/rank. Based on Attachment A, consideration I, Ecology believes optimized hydraulic control increases overall protectiveness and long term effectiveness. Please revise the analysis and compare Alternative # 5 to Alternative #7.

e. Short Term Risk: Ecology does not believe that short term risk to human health and the environment due to the maintenance of a groundwater extraction well system is significant or warrants a reduced score/rank. Maintenance of groundwater extraction well systems is a common practice for many cleanup sites, and the regulated community (and their environmental consultants) has considerable experience in this field. This activity will not pose additional or more hazards than injection of reactive oxidant. Moreover, any finite, theoretical additional risk can be minimized by system engineering design, management, planning, and communication. Please revise the analysis to account for these considerations.

f. Implementability: Ecology agrees that this alternative is practical and implementable. But Ecology does not believe that maintenance of the groundwater extraction well system will entail significant additional work, and we disagree that it should warrant a reduced score for implementability (compared to identical alternatives without groundwater extraction well systems). Maintenance of groundwater extraction well systems are common practice. It is probable that ISCO implementation may be much more difficult than maintaining the hydraulic control system, due to more severe injection and monitoring well clogging and fouling compared with the extraction/monitoring wells. Please revise the analysis to account for these considerations.

Section 5.7 Alternative 6 – Enhanced Anaerobic Bioremediation, Vapor Intrusion Mitigation and Institutional Controls with Recirculation:

39. Alternative 6 introduces "recirculation of the injection solution" in the On-Site Area. However, this section has insufficient information for Ecology to fully understand the technical principals/concepts and benefits/disadvantages associated with a recirculation system. It is unclear, for example, how and when existing extraction wells RW3 and RW-2 would be "retrofitted" into the recirculation operation.

40. Ecology is unable to fully evaluate the threshold criteria (WAC 173-340-360(2)(a)) and other requirements (WAC 173-340-360(2)(b)) for this alternative. Due to a lack of optimized hydraulic control (for the reasons stated in Attachment A), however, Ecology would not select this option as the final remedy anyway. GE, for different reasons, also eliminated alternative #6 from consideration.

Ecology sees no reason to provide further comment on this section and will eliminate this alternative from further consideration. Ecology is not asking for more detailed consideration of Alternative #6, and no response is needed for comments #39 and #40.

Section 5.8 Comparative Evaluation of Alternatives:

41. It is not clear to Ecology how GE/ENSR arrived at their final rankings (High, Medium, or Low) for each of the six alternatives analyzed in Section 5. However, Ecology is not asking GE to perform this re-ranking with further detailed explanation. Instead, GE should re-rank alternatives #5 and rank Alternative #7, calculate the cost estimate for Alternative #7, and re-calculate the revised cost estimate, as necessary, for alternative #5. Comparisons between alternative #5 and alternative #7 should use alternative #7 as the baseline alternative. Also refer to comment #32.

GE should describe how the "final" cumulative rankings for alternatives #5 and #7 were calculated. Any comparison of costs should be made on a net present value basis for a 2.0%[21] discount rate and a 7%[22] discount rate.

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[21] Long term T-bill rate minus the current inflation rate

[22] U.S. Environmental Protection Agency, July 2000, A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA540-R-00-002

42. Appendix B: Cost Estimates: Ecology recognizes that these cost estimate values carry a high level of uncertainty due to technology success, details (to be determined in the DCAP) of performance and confirmation monitoring, and other unanticipated events that may increase or shorten the restoration timeframe. Ecology expects that the approved cleanup action plan will include additional cleanup details that result in higher or lower costs than FS alternative costs generated for remedy comparison purposes only. To be clear, Ecology considers the Appendix B cost estimates to be effective for gross FS remedial alternative comparisons only. These cost estimates may need to be revised or altered before being used for purposes outside the FS process, such as for use in calculating financial assurances

ENSR | AECOM

General Electric
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Prepared for:
GE Aviation
Cincinnati, Ohio

Central Files

Focused Feasibility Study – Version 3
GE South Dawson Street
Seattle, Washington

October 2008
Document No.: 02978-415-735

Original hand signed letter sent after report submitted

General Electric
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October 17, 2008

Mr. Dean Yasuda
Washington Department of Ecology
Northwest Regional Office
3190- 160th Avenue S.E.
Bellevue, Washington 98008-5452

Dean Mr. Yasuda:

Attached please find the revised Focused Feasibility Study (FFS) for the former GE facility located at 220 South Dawson Street, Seattle. In submitting this FFS we followed Ecology's regulations for feasibility studies and the Scope of Work contained in Appendix B of Agreed Order DE 5477. We also carefully considered all communications with Ecology including the following;

- June 27, 2006 –Ecology Letter to GE with original request for a FFS
- February 21, 2008 –Ecology Letter to GE providing example feasibility studies under MTCA
- March 4, 2008 –Ecology Letter to GE providing comments on the draft FFS submitted June 18, 2007
- November 6-7, 2007 meetings with Ecology
- August 14, 2008 –Ecology FFS Comment Letter
- September 25, 2008 meeting with Ecology
- October 1, 2008 –Ecology Letter

For your convenience we have provided a table listing our responses to each of Ecology's comments in its August 14, 2008 and October 1, 2008 letters.

This revised FFS now expressly states GE's commitment to comply with Ecology regulations regarding restrictive covenants and institutional controls. The revised FFS now clearly presents ISCO as the preferred remediation technology as confirmed in the August 5, 2008 meeting between Ecology and GE.

As contemplated in the September 25, 2008 meetings and Ecology's October 1, 2008 letter, the revised FFS presents Alternative 5 as the preferred alternative. Alternative 5 employs ISCO as the preferred remediation technology with hydraulic containment readily available at any time as part of the contingent remedy. Use of the contingent remedy is dependent upon the results of a high frequency monitoring program outlined in the FFS and to be set forth in detail during remedial design. Indoor air cleanup standards are set forth as determined in the Agreed Order (number DE 4258) as MTCA Method C.

The FFS has also been revised to add information regarding Ecology's narrowed list of Alternatives, focusing on:

- Alternative 2: Optimized Hydraulic Control, *In situ* Chemical Oxidation, Subslab Depressurization System, and Institutional Controls
- Alternative 5: *In situ* Chemical Oxidation, Subslab Depressurization System, and Institutional Controls

For clarification, GE has modified Alternatives 2 & 5 (Sections 5.3 & 5.6 respectively), and added additional information regarding each alternative, in lieu of developing a new Alternative 7. As such these sections now stand alone from the other alternatives. Per Ecology's August 14, 2008 letter, no substantive revisions were made to Alternatives 1, 3, 4, or 6.

Finally, per Ecology's request, GE has added references throughout the FFS acknowledging where a stated viewpoint is held by GE or Ecology but the two parties are not necessarily in agreement.

In closing I wanted to thank Ecology for working with GE to finalize this FFS. We note especially Ecology's use of the facilitator in recent meetings and are thankful for Ecology's efforts in this regard.

We look forward to continuing the dialogue with Ecology about this site and working toward our mutual goal of a speedy and effective remediation. This includes our mutual year end goal of remedy selection. As we believe we have been fully responsive to all comments and requirement we ask that Ecology accept this FFS as final and that we mutually proceed to working on remedy selection and drafting the DCAP.

Should you have any questions or to schedule follow-up discussions please feel free to contact me at (513) 672-3986.

Sincerely,

James W. Sumner

Attachment – Focused Feasibility Study Version 3- 220 South Dawson St
Summary of Responses Matrix

cc: Julie Sellick – Ecology
Melissa Rourke – Attorney General's Office
Bill Chapman – K&L Gates, LLP
Tong Li – Groundwater Solutions
Bill Teplicky, McKinstry
Bill Joyce – Salter Joyce Ziker
Thom Morin – EPI
Elizabeth McManus – Ross & Associates w/o FFS
Jamie Stevens, Linda Baker – RETEC

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October 17, 2008

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In closing I wanted to thank Ecology for working with GE to finalize this FFS. We note especially Ecology's use of the facilitator in recent meetings and are thankful for Ecology's efforts in this regard.

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Should you have any questions or to schedule follow-up discussions please feel free to contact me at (513) 672-3986.

Sincerely,

James W. Sumner

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Jamie Stevens, Linda Baker – RETEC

Comment from Ecology	Response	Notes
General Comments (Attachment A- August 14, 2008 Letter)		
I.a.i - Without optimized hydraulic control during this ISCO treatment implementation timeframe, CVOC contaminated groundwater would be allowed to flow offsite to downgradient areas. In addition, increased time requirements may result if alley access is reduced or eliminated as a result of the tenant-occupied atrium that McKinstry is planning to construct in the alley. Without optimized hydraulic control, all of the above will result in a longer restoration timeframe and more expensive and difficult cleanup, which needs to be considered in the FFS analysis.	Addressed	Section 5.6.1 through 5.6.3 were added to address this comment.
I.a.ii- ....GE's FFS analysis should reflect that turning the groundwater extraction wells off for what could be an extended period of time constitutes a gamble that could result in higher concentrations of CVOCs migrating offsite. But by the time increased levels of offsite CVOC groundwater concentrations were observed, it would be too late to turn the system back on and hope to "pull back" the CVOC groundwater plume before it left the 220 South Dawson Street property....	Addressed	Section 5.6.1 through 5.6.3 were added to address this comment.
I.a.ii- GE's FFS report should reflect that increases in CVOC mass flux to offsite areas are likely to result in longer remediation timeframes and a more difficult and expensive cleanup of the offsite CVOC groundwater plume.	Addressed	Section 5.6.1 through 5.6.3 were added to address this comment.
I.a.iii - .....That rebound will result in elevated CVOC groundwater concentrations on-site and additional CVOC migration offsite which would lead to higher downgradient concentrations, a longer remediation timeframe, and a more difficult and expensive cleanup of the offsite CVOC groundwater plume. Please revise the analysis of Alternative 5 to account for these considerations.	Addressed	Section 5.6.1 through 5.6.3 were added to address this comment.
I.b. - Increased Vapor Intrusion (VI) Risk. GE's report should be revised to take into account the increased vapor intrusion risk that may result without optimized hydraulic control.	Addressed	Section 5.6.1.3 was added to address this comment.
I.c.- Relocation of the groundwater extraction wells and pumping rates. As part of the hydraulic control optimization for alternative #7 alone, GE should analyze relocating both extraction wells, RW-2 and RW-3 to the east side of 2nd Avenue South.	Addressed	Section 5.3 updated to reflect Ecology's comments related to Alternative 2, Figure 5-3 was also updated.
I.d.- Offsite ISCO Injections. GE's proposed offsite injection points near MW-15D/M will not be deep enough to treat the CVOCs at the maximum known depth of 55' bgs. Since monitored natural attenuation is not proposed as part of the final remedy, the injection wells near MW-15D/M should therefore extend down to at least 55' bgs.	Addressed	Section 5.3 was updated to include an additional observation well set screened at the deeper portion of the aquifer is included in Alternatives 2 and 5 (under Phases 2 and 5). Figures 5-3 and 5-6 were updated.
II - Additional institutional control requirements: To compliment the additional analysis required in paragraph I above, the institutional controls for alternatives #5 and #7 should prevent the withdrawal and use of ground water for drinking water purposes. WAC 173¬340-720(6)(c)(iii)(B). The institutional controls must also address the residual contaminated soil (above cleanup levels protective of groundwater and indoor air cleanup levels) on the 220 South Dawson Street Property. GE must make a good faith effort to secure an Environmental (Restrictive) Covenant7 on the 220 South Dawson Street property and all required downgradient properties before using other legal or administrative mechanisms (see WAC 173-340-440(8)(c)).	Addressed	Sections 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 pertaining to institutional controls were updated in sections Alternatives 1 through 6, per Ecology's comments.
III - GE's FFS report should be revised to evaluate a contingent remedy that could be implemented quickly after a determination that ISCO did not appear to be effectively meeting cleanup objectives.	Addressed	Section 6.2 was added to discuss a contingent remedy.
IV - Note that the Cleanup Action Plan must include the requirement for performance and conformational groundwater sampling plans. To compliment the additional analysis in paragraph 1 above, for alternatives #5 and #7, the Plans shall be submitted to Ecology for review and approval prior to implementation of ISCO.	No Response Required	No changes were made to the text, GE acknowledges this will be part of the DCAP process.
V. During cleanup implementation Ecology will require that GE continue indoor air monitoring, and possibly sub-slab vapor sampling, in conjunction with measurements of CVOC groundwater concentrations, to assess whether the potential for unacceptable vapor intrusion exists	Addressed	Additional sampling was assumed in Alternatives 2 and 5 for indoor air sampling, the cost tables (Appendix B) were also updated to reflect this addition.
VI. Ecology believes that GE should first perform a focused bench-scale study to determine the appropriate oxidant volume and concentration that will overcome the natural oxidant demand of contaminated aquifer media and effectively oxidize the range of CVOCs likely encountered	Addressed	Section 5.3 was updated to include a bench scale test during Phase 1.
Specific Comments (Attachment B - August 14, 2008 Letter)		
1. Page 1-2. Section 1.3: Please clarify in the text that Ecology did not approve all independent work before the work was conducted.	Accepted	The following was added to the sentence in Section 1.3 : Subsequent investigations and interim actions have been performed independently with input and informal concurrence (but not formal approval) by Ecology.
2. GE should include a figure showing the facility (including onsite and offsite monitoring wells) and its proximity to the Duwamish River and Slip 1. This figure is important for visually understanding the site conceptual model in this Section and Section 3.0, where cleanup levels are discussed.	Accepted	Figure 1-1 - Site Vicinity Map was added. The view includes Slip 1 and the Duwamish River.
3. Page 2-3, Section 2.1.2.3 Groundwater Characteristics, Paragraph 1: Include Section 4.4, Paragraph #3, here to acknowledge Ecology's disagreement on the effectiveness of the current groundwater hydraulic control system.	Accepted	A footnote was added stating to the following: See Section 4.4 for Ecology's opinion on the effectiveness of the current groundwater hydraulic control system.

4. Page 2-7. Section 2.2.2.1, Paragraph 3: Ecology agrees that current TCE groundwater concentrations are the primary risk driver at the site. However, changing geochemical conditions (due to natural processes or as a result of cleanup actions) have the potential to result in more biodegradation of TCE and the formation of toxic daughter products such as vinyl chloride. Revise GE statements to include this comment.	Accepted	Section 2.1.2.3: The following was added to the paragraph to clarify the intent: If geochemical conditions change, due to natural processes or as a results of future cleanup actions, there is potential for the degradation of TCE and the formation of toxic daughter products, through incomplete degradation. This section presents a site conceptual model based on historic and current site conditions, a full evaluation of the potential for the formation of daughter products will be included in the remedial design phase of the FFS (Section 5).
5. Table 2-2: Consistent with the Ecology March 4,2008, letter to GE, include the 1,4-dioxane surface water cleanup level (79 ug/L).	Accepted	Table 2-2 was updated.
6. Contaminant Groundwater Contour Figures 2-12 through 2-27: The concentration contour figures here were prepared by GE/ENSR based on their interpretation of the groundwater data. Ecology does not agree with this interpretation of the groundwater data or with the contouring approach used in these figures. Ecology will expect the final remedy design in the Cleanup Action Plan to reflect the assumption that the downgradient CHOC groundwater plume is continuous, as Ecology believes this point will be key to successful implementation of ISCO at the site.	Accepted	Comment noted, no changes were made to the figures at this time. ENSR used all available data to develop contours, dashed lines are used to show areas which are inferred. All of the proposed remedial alternatives address both on and off site areas.
7. Page 2-10, section 2.2.2.2 Arsenic, Paragraph 2: Ecology does not agree that the elevated arsenic groundwater concentrations at EPI-MW-4 (23 ppb on April 2008) are due to a localized source area of arsenic. It is very likely that reducing conditions resulted in the dissolution of arsenic in this area. For the purpose of revising this report GE should state that this interpretation will be identified as GE's opinion not shared by Ecology.	Accepted	The following footnote was added to the sentence clarifying Ecology's position: Ecology does not agree that the elevated arsenic groundwater concentrations at EPI-MW-4 (23 ppb on April 2008) are due to a localized source area of arsenic. Ecology states that It is very likely that reducing conditions resulted in the dissolution of arsenic in this area.
8. Page 2-10, Section 2.2.2.2 Arsenic, Paragraph 3: Arsenic is a COC under the Agreed Order Section IV.B 14 and FFS. Arsenic is still of concern at the Site and needs to remain a COC.	Accepted	Section 2.2.2.2 was updated to include Arsenic as a COC.
9. Page 2-11, Section 2.2.2.3 1,2-Dioxane, Paragraph I: Consistent with the Ecology March 4, 2008, letter to GE, the I,4-dioxane surface water cleanup level is 79 ug/L. Revise the statement in the draft FFS to include this cleanup level.	Accepted	Section 2.2.2.3 was updated to include the revised cleanup level for 1,4-dioxane.
10. Page 2-11, Section 2.2.2.3 1,4-Dioxane, Paragraph 3: 1,4-dioxane is a COC under the Agreed Order Section IV.B and FFS 15. 1,4-dioxane is still of concern at the Site and needs to remain a COC.	Accepted	Section 2.2.2.3 was updated with the following sentence: Though no concentrations of 1,4-dioxane are detected above the surface water screening value, 1,4-dioxane will be monitored during the remediation activities.
11. Page 2-11. Section 2.2.2.4 Groundwater CHOC Fate and Transport, Paragraphs 2 and 3: Ecology agrees that Figures 2-30 and 2-31 depict reductions of 1,1,1 trichloroethane (1,1,1-TCA) and TCE over time. However, Ecology believes that the reduction of 1,1,1-TCA and TCE in groundwater over time is due to the groundwater extraction system operation, advection/dispersion/sorption mechanisms, and mass loss due to abiotic and biotic degradation. There is insufficient data at this time to be able to determine if one of these processes is more effective than the other two. The text should therefore either be revised to include the points expressed in the two sentences above, or qualified so that it is clear that GE is positing an opinion, not shared by Ecology, that you believe explains site observations.	Accepted	This paragraph was clarified by the addition of the following sentences: It is unclear whether degradation or operation of the groundwater extraction system has more effectively reduced concentrations in the groundwater. However, data suggest that both processes are contributing to the reduction of CVOC concentrations.
12. Page 2-12, Section 2.2.2.4 Groundwater CVOC Fate and Transport, Paragraph 3: Ecology disagrees with the statement that *"The lack of any detected CVOCs in the furthest downgradient monitoring wells indicates that complete degradation* is *occurring at the we tern most edge of the plume"*. Natural attenuation of CVOC groundwater plumes includes advection/dispersion/sorption in addition to degradation. Ecology does not agree that one can conclude groundwater plume stability is due to degradation only, particularly in a relatively conductive aquifer. In addition, the final compounds for complete degradation of CVOC are ethane and ethene, which have not been detected at or downgradient of the site. As the next section (Section 2.2.2.5) of the report concludes, current aquifer geochemical conditions may not allow the reductive dechlorination process to proceed to completion (production of ethane and ethane as final products). Ecology believes we can proceed with remedy selection while agreeing to disagree on these matters. For the purpose of revising this report, the text should indicate that this is an opinion of GE not shared by Ecology.	Accepted	GE and ENSR agree with Ecology, 'complete degradation' was changed to 'attenuation' to more accurately describe the conditions at the site.
13. Page 2-15, Section 2.2.2.6 Summary of Groundwater Contaminants of Concern: This list should reflect the identical list of COCs included in the Agreed Order, Section IV.B because Ecology is not convinced that any of these contaminants are no longer of concern at the Site. To be clear, however, some COCs will require active treatment (such as by ISCO); other COCs will require only monitoring to verify no unexpected increases.	Accepted	Section 2.2.2.6 was updated to include: As discussed above, the 2008 Agreed Order listed the COCs for the site to include: TCE, 1,1,1-TCA, PCE, DCE, cis 1,2-dichloroethylene, trans 1,2 dichloroethylene, 1,4 dioxane, arsenic and VC
14. Page 2-15, Section 2.2.3 Indoor Air, Paragraph 1: Ecology did not agree with several statements in the draft interim action completion report. Since the revised FF report references this draft report, then GE should also include a statement clarifying that Ecology did not approve this report.	Accepted	A footnote was added stating the following: It should be noted that Ecology, while agreeing no further action was required, did not approve and disagreed with several statements in the IAWP Completion Report.
15. Page 2-18, Section 2.2.3.3: If the intent of this paragraph is to state that an unacceptable amount of CHOC vapor intrusion is not occurring, then Ecology disagrees. For the purpose of revising this report, GE should include a statement to the effect that Ecology disagrees with GE's interpretation of these data (please see Ecology's March 10, 2006, letter to GE).	Accepted	This paragraph was revised to reference only the work conducted in December 2005, all conclusions were deleted. It was revised to state the following: During the December 2005 sampling event, a cross-slab pressure differential was monitored at two locations in the building for 24 hours to assess the potential for sub-surface vapor intrusion. As described in the Evaluation of the Potential for Subsurface Vapor Intrusion report, pressure differential data from the test period showed a neutral gradient between the building and the subsurface (RETEC 2006A).

16. Page 2-18, Section 2.2.3.4: This list should reflect the identical list of COCs in the Agreed Order, Section IV.B. Since arsenic and lA-dioxane are obviously not volatile substances, Ecology has no objection to them being excluded from those COCs identified for the indoor air pathway.	Accepted	The COC list was updated to reflect the Agreed Order.
17. Page 3-2, Section 3.1: This list should reflect the identical list of COCs included in the Agreed Order, Section IV.B. Since arsenic and 1A-dioxane are obviously not volatile substances, Ecology has no objection to them being excluded from those COCs identified for the indoor air pathway.	Accepted	The COC list was updated to reflect the Agreed Order.
18. Page 3-3, Section 3.1.1.2, Table 3-1: The soil CULs in Table 3-l are not protective of groundwater cleanup levels (based on surface water cleanup levels). Soil cleanup levels must be protective of surface water quality (cleanup levels) and cannot result in shallow groundwater contamination that would pose a threat to indoor air quality via vapor intrusion. The establishment of this soil cleanup level is a requirement of the Agreed Order, Task 1.3. The amounts of CVOC and TPH in the vadose zone are expected to be small based on available data. However, as part of a complete cleanup standard analysis, GE should propose and justify soil cleanup levels that meet the following requirements: (l) protective of groundwater quality, such that soil contamination cannot lead to exceedances of surface water cleanup levels in groundwater; (2) protective of groundwater quality, such that soil contamination cannot lead to contamination in shallow groundwater that poses a potentially unacceptable VI threat. It is very possible that existing residual subsurface CVOC and TPH soil concentrations will already meet such soil cleanup levels. If not, GE should explain how the company intends to (eventually) meet the cleanup levels or otherwise contain the potential threat to receptors.	Accepted	GE and ENSR believe that the proposed cleanup levels are protective of groundwater, further clarification was added to Section 3.1.1.2 to clarify this assumption.
19. Section 3.1.2 Groundwater: This list should reflect the identical list of COCs included in the Agreed Order, section IV.B because Ecology is not convinced that any of these contaminants are no longer of concern at the Site. To be clear, however some COCs will require active treatment (such as by ISCO); other COCs will require only monitoring to verify no unexpected increases.	Accepted	The COC list was updated to reflect the Agreed Order.
20. Page 3-7, Section 3.1.2.2 Evaluation of Groundwater Potability, fourth bulleted response, last sentence: Ecology has reviewed GE/ENSR's capture zone analysis results (ENSR 2007) and disagreed with a number of its conclusions. Ecology's own capture zone analysis report, dated October 31,2007 describes the technical basis for Ecology's conclusions regarding incomplete capture and our basis for stating that optimized hydraulic control of contaminated groundwater at the 220 South Dawson Street property needs to be evaluated as part of Alternative #7. For the purpose of revising this report, the text should therefore either be revised to include Ecology's capture zone conclusions, or qualified so that it is clear that the statements *only* reflect GE's opinion, not shared by Ecology.	Accepted	In Section 3.1.2.2, the bulleted response was clarified to indicate Ecology's opinion on the Capture Zone Report.
21. Page 3-8, GE response to (d)(iv): Although currently there *are* no plans to use the shallow aquifer for drinking water purposes, neither Ecology or GE can predict what the area's *future* drinking water demands will be and whether treatment of extracted groundwater would prove to be economically feasible based on future increased drinking water demands and the price of City-supplied water. Regarding the use of the shallow aquifer for future drinking water purposes, per WAC 173-340-720(2)(d), Ecology agrees that currently this "probability is low" but not zero. These statements should be included in the revised FF report.	Accepted	The sentence was restated to reflect the following change: Domestic water supply production wells in the area would probably not be allowed in the foreseeable future under County ordinances and State regulations. In addition, a footnote was added stating the following: Ecology's Response to Comments stated that: use of the shallow aquifer for future drinking water purposes, per WAC 173-340-720(2)(d), Ecology agrees that currently this "probability is low" but not zero.
22. Page 3-8, Section 3.1.2.3, Paragraph 1: GE should add another bullet: *Groundwater cleanup levels must also consider unacceptable vapor intrusion into overlying buildings.* Ecology expects that achieving MTCA Method B surface water cleanup levels throughout the groundwater plume (standard point of compliance) will achieve this result for a commercial/industrial site.	Accepted	An additional bullet was added evaluating the groundwater surface cleanup levels and vapor intrusion into overlying buildings.
23. Page 3-8, Section 3.1.2.3, Paragraph 2, Worker Direct Exposure to Groundwater: Without knowing the specific work activities, Ecology does not agree that a utility maintenance worker can be assumed to be less exposed than a construction worker (i.e. monitoring and maintaining the dewatering system). Utility workers in an excavation (above the water table) would still be exposed to CHOC vapors from the groundwater. The text should be revised to include these statements.	Accepted	The differentiation between a utility worker and construction worker does not provided added value to this exposure scenario evaluation. Therefore, the text was modified to delete statements that one may be exposed more than the other.
24. Page 3-9, Worker Direct Exposure to Groundwater: Ecology agrees that the cleanup levels based on the protection of a trencher exposed to groundwater are not likely to drive the cleanup at the site. This is based on the site's groundwater COC concentrations and the low MTCA Method B groundwater cleanup levels based on the protective of surface water. However, Ecology does not have enough information to adequately evaluate how GE's 'trencher' cleanup levels were calculated. GE should include the actual equations used from the EPA Risk Assessment Guidance for Superfund (RAGS), Part B, and discuss the assumptions that are inherent in the use of the equation(s), as compared to actual GE site conditions. The exposure pathway assumptions for the site and applicability to the equations should be explained in the text. All input parameters to the equation(s) should be listed and site assumptions explained in Table 3-3 (if not done so already). In addition, the revised cleanup levels must adhere to the requirements of WAC 173-340-708(1 O)(b)(i), and use MTCA default parameters.	Accepted	Additional clarification was added to this section to address the comments raised by Ecology. Appendix D was added which contains the back equations/assumptions used for this section.

25. Page 3-10, Table 3-2 and Page 3-11, Table 3-6: Arsenic, cis-l,2 dichloroethylene, trans-1,2-dichJoroethylene, and l,4-dioxane cleanup levels should be included in Table 3-2. This list should reflect the identical list of COCs in the Agreed Order, Section IV.B because Ecology is not convinced that any of these contaminants are no longer of concern at the Site. Ecology recommends that GE use the background value of 5 ug/L established under MTCA Method A which is greater than the range of background values in groundwater samples collected at MW-5 and MW-2.	Accepted	Table 3-2 was updated to include the additional COCs, and the arsenic cleanup value was updated with the MTCA Method A background value.
26. Table 3-8, Table 3-9 and Discussion under Section 3.1.3.2: Although at this time TCE is the only constituent that exceeds the MTCA Method C indoor air cleanup level, the degradation products of TCE and 1,1,1-TCA should be included as COCs and monitored for compliance with applicable cleanup levels. Subsurface conditions may naturally (or artificially, as a result of cleanup engineered design) change and result in higher concentrations of CVOC degradation products. In addition, although Ecology proposed sub-slab vapor concentrations of 100 times the MTCA Method C air cleanup level as screening levels for evaluating the need for immediate interim actions, these concentrations are not defined as cleanup levels under the MTCA. The future slab integrity (presence or absence of cracking or man-made perforations) will have a significant role in determining the sub-slab vapor to indoor air attenuation factor, and whether an assumed cross-slab attenuation factor of 100 will continue to be protective, years into the future. Sub-slab vapor data in combination with indoor air data however, is a useful line of evidence for conforming vapor intrusion. During cleanup implementation, Ecology will require that GE continue indoor air monitoring, and possibly sub-slab vapor sampling, in conjunction with measurements of CVOC groundwater concentrations, to assess whether the potential for unacceptable vapor intrusion exists and when to initially shut off th 220 South Dawson Street vapor intrusion mitigation system.	Accepted	The additional degradation products were added to the tables. Text was added to clarify that the slab attenuation factor will be used as a screening value, and not cleanup level.
27. Page 3-14, Table 3.3: This list should reflect the identical list of COCs in the Agreed Order, Section N.B because Ecology is not convinced that any of these contaminants are no longer of concern at the Site. Since arsenic and 1,4-dioxane are obviously not volatile substances, Ecology has no objection to them being excluded from those COCs identified for the indoor air pathway.	Accepted	The list was updated to reflect the Agreed Order.
28. Section 4.1: Ecology recognizes that GE has defined the offsite treatment area in this FFS report as that part of the contaminated aquifer that extends from 2nd Avenue south to Utah Street, as defined by groundwater chemical data. Ecology is not requiring any revisions to this statement. However, as a clarification, the "Site" defined by the Agreed Order is identical to the definition of Facility under RCW 70.1050.020(5), and includes the area where hazardous substances have come to be located. See footnote 3 above.	No Response Required	No changes were made to the text.
29. Section 4.2 Institutional Controls and Monitoring: Refer to the Ecology requirements for institutional controls and monitoring in Attachment A, paragraph II.	Accepted	Text was added to reflect the requirements listed in Attachment A.
30. Page 4-2, Section 4.3, Paragraphs 2, 3 and 4: Ecology agrees in general with GE that "[t]he On-Site and Off-Site Area plumes are behaving in different ways". However Ecology believes that the decreasing trend observed in the on-site area groundwater plume is mainly caused by the extraction well operation, not by natural attenuation. Ecology believes we can proceed with final remedy selection while agreeing to disagree on these matters. For the purpose of revising this report, the text should indicate that this is an opinion of GE not shared by Ecology. The last sentence of the page states, "[t]he degradation at the Off-Site Area appears to be occurring at a rapid consistent rate.' Ecology believes this is a stable offsite groundwater plume where rate of contaminant entering the Off-Site Area equals the same dissipation rate with the Off-Site Area. For the purpose of revising this report, the text should be revised to include Ecology's technical position or the text should indicate that this is an opinion of GE not shared by Ecology.	Accepted	In response to the first part of this comment - the text was clarified to reflect that the decreasing trend observed could be due to the groundwater extraction well or by natural attenuation factors. In response to the second part of this comment, a footnote was added to the last sentence stating the following: Ecology believes this is a stable offsite groundwater plume where rate of contaminant entering the Off-Site Area equals the same dissipation rate with the Off-Site Area.
31. Page 4-3, Section 4.4, Paragraph 3: Refer to comment #20.	No Response Required	The text currently states the following: Ecology and GE disagree on the performance of the current recovery system - GE believe that this is sufficient to address the comments raised in Comment 31 (and Comment 20).

32. Ecology appreciates the summary sections of 5.1, 5.1.1, 5.1.2, and 5.1.3. In a few cases the text in these summary paragraphs are not exact quotes from the MTCA. But Ecology sees no reason to provide comment on these sections since they reference the correct remedy selection sections in WAC 173-340-360. However, in the event of any conflict between the summary of MTCA or its regulations in GE's report and the actual provisions of MTCA, the language of MTCA and its implementing regulations will govern.	No Response Required	Comment noted.
Ecology has some concerns with the way GE's disproportionate cost analysis was performed in the draft FFS. (See paragraph 41 for additional discussion of GE's overall ranking of alternatives). GE did not rank the six alternatives from most to least permanent, compared against the most practicable permanent solution, per WAC I73-340-360(3)(e)(ii). However, in the interest of streamlining this process, Ecology is only asking for further detailed analysis of Alternatives #5 and #7.	Accepted	Section 5.9 includes a DCA of Alternative 2 and 5, Alternative 2 is the baseline alternative.
Further, as explained above, even before getting to the analysis of whether Alternative #5 is permanent to the maximum extent practicable, Ecology has concerns about whether Alternative #5 meets threshold criteria of WAC 173-340-360(2)(a). Ecology also has concerns about whether alternative #5 provides for a reasonable restoration timeframe under WAC 173-340¬360(2)(b). Thus, Ecology does not feel that a detailed disproportionate cost analysis is central to selecting between Alternatives #5 and #7. In the interest of efficiency, if GE reviews Ecology s concerns and decides that Alternative #7 is the preferred alternative, further detailed disproportionate cost analysis in the FFS is not necessary. However, if after consideration of Ecology's concerns about Alternative #5, GE continues to believe that Alternative #5 is the preferred alternative, again in the interest of efficiency, GE need not redo the entire disproportionate cost analysis found in the draft FFS. GE need only revise the disproportionate cost analysis to include a comparison of Alternative #5 (with the revisions listed in this letter) with Alternative #7,	Accepted	Section 5.9 includes a DCA of Alternative 2 and 5, Alternative 2 is the baseline alternative.
Section 5.2 Alternative I-Optimized Hydraulic Control, Soil Vapor Extraction/Air Sparging and Vapor Intrusion Mitigation: At this time Ecology is not looking for further evaluation of soil vapor extraction/air sparging as part of the final remedy. Therefore, we see no reason to comment on all parts of this section that we take issue with. Ecology's comments on alternative # I are made only because alternative #5 indirectly references many portions of the alternative #1 discussion.	No Response Required	Comment noted.
33. Page 5-3, Section 5.2, Optimized hydraulic control, Paragraph 2, third through fifth sentence: The text should state that the cone of depression around newly installed groundwater extraction well RW-4 and the combination of RW-2 (relocated) and RW-4, will need to be verified by field water elevation mea urements20. If GE is referring to modeling results from its capture zone analysis report, Ecology has already stated that it does not agree with those results. (refer to comment #20). In addition, the discussion of any predicted effectiveness of relocated extraction wells should incorporate the "capture zone" instead of "cone of depression" or "cone of influence". This is because the capture zone describes the radial area from which contaminated groundwater would flow into and not around the extraction well. Capture zone is the more precise and proper parameter for extraction well operation, and is generally smaller than the cone of influence/depression.	Accepted	This section was updated to reflect Ecology's well location. All other reference to ENSR's justification for the original well locations was removed.
34. Soil Vapor Extraction/Air Sparging System, Vapor Intrusion, Institutional Controls, 5.2.1 Threshold Requirements, 5.2.2 Restoration Timeframe, 5.2.3 MTCA Evaluation Criteria: Ecology agrees with GE that this technology has the potential to result in slightly longer restoration timeframes than ISCO or enhanced anaerobic bioremediation. However, the restoration timeframe would not be so much longer as to immediately eliminate the technology from consideration. Ecology believes we can proceed with final remedy selection while agreeing to disagree on these matters.	No Response Required	Comment noted.
35. Page 5-8, Section 5.2.3, Consideration of Public Concerns: The Mason apply business communicated to Ecology its concerns regarding CVOC vapor intrusion into its offices and they supported the installation of the vapor intrusion mitigation system. The Western Cartage building owner (as represented by its environmental consultant Environmental Partners, Inc) has also communicated to Ecology that it is interested in the progress of the cleanup and received a copy of the draft FFS report, which is under their review. These comments were made outside any formal public comment period associated with either the vapor intrusion mitigation interim action or feasibility study agreed orders; however, Ecology believes their inclusion in this report is important. GE should make this revision to this section of the report as well as the corresponding sections in the re-analysis of alternatives #5 and #7.	Accepted	Section 5.8.6 was updated to include the following sentence: During review of the Draft FFS, Ecology received comments from Environmental Partners, on behalf of Gary Merlino, indicating that they recommend SVE/AS, or Alternative 1 (EPI, 2008). The following sentence from Section 5.2.3 was deleted: No previous public concerns have been received ahead of the submittal of this FFS.
36. Page 5-8, section 5.2.4 MTCA Specific Requirements Regarding Containment: Refer to comment #20. **Section 5.3 Alternative 2 -Optimized Hydraulic Control, In-Situ Chemical Oxidation, Vapor Intrusion Mitigation:** At this time, Ecology is not asking GE to re-evaluate alternative #2. **Section 5.4 Alternative 3 -Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation (EAB) and Vapor Intrusion Mitigation:** At this time Ecology is not looking for further evaluation of EAB as part of the final remedy. Ecology disagrees with the comparative analysis between EAB and ISCO as well as the analysis with and without optimized hydraulic control. Ecology is not requesting these revisions to Section 5.4 of the draft FFS, however, Ecology believes that EAB is an acceptable contingent remedy (refer to Attachment A, consideration UI).	See No. 20 - No Response Required	Comment noted.

37. **Section 5.5 Alternative 4 -Soil Vapor Extraction/Air Sparging:** At this time, Ecology is not looking to further evaluate vapor extraction/air sparging as part of the final remedy. Therefore, we see no reason to comment on all parts of this section. Ecology agrees with GE that this technology has the 'potential" to result in slightly longer restoration timeframe than ISCO or EAB. However, we do not believe that the timeframe will be so much longer that the technology's use should be immediately eliminated from consideration. Ecology's comments on Section 5.2 and Attachment A are applicable to Section 5.5. Ecology is not requesting any revisions to this section of the FFS.	No Response Required	Comment noted.
38. **Section 5.6 Alternative 5 -In-Situ Chemical Oxidation and Vapor Intrusion:** GE should first re-evaluate this Alternative 5 against the threshold requirements (WAC 173-340-360(2)(a) given Ecology's comments herein and in Attachment A. Then, if GE believes this alternative meets the threshold requirements, GE should evaluate this alternative against Alternative #7 based on the Ecology statements in Attachment A, WAC I73-340-360(2)(b), and the following comments:	Accepted	Alternative 5 was evaluated against the threshold requirements, and then Alternatives 2 and 5 were compared.
a Vapor Intrusion Mitigation System: Refer to Attachment A, paragraph V.	No Response Required	GE agrees with Ecology, and the current proposal includes monitoring. The frequency and timing will be included in the site wide monitoring plan, prepared in subsequent documents.
b Restoration Timeframe: Please revise this analysis to reflect Ecology's comments described in Attachment A, Paragraph 1. Additionally, if down gradient CVOC groundwater concentrations remain elevated or rebound, the efficacy of the offsite treatment will also be evaluated.	Disagree	GE and Ecology disagree on the effects of turning off the recovery system. This section was updated based on the discussions provided in Section 5.6.1.
c Overall Protectiveness and Long Term Effectiveness: Ecology disagrees with GE that the groundwater extraction well system will negatively impact ISCO performance and effectiveness. So this potentiality should not result in a lower score/rank. Based on Attachment A, consideration I, Ecology believes optimized hydraulic control increases overall protectiveness and long term effectiveness. Please revise the analysis and compare Alternative # 5 to Alternative #7.	Disagree	GE and Ecology disagree on the effects of turning off the recovery system. This section was updated based on the discussions provided in Section 5.6.1.
d Short Term Risk: Ecology does not believe that short term risk to human health and the environment due to the maintenance of a groundwater extraction well system is significant or warrants a reduced score/rank. Maintenance of groundwater extraction well systems is a common practice for many cleanup sites, and the regulated community (and their environmental consultants) has considerable experience in this field. This activity will not pose additional or more hazards than injection of reactive oxidant. Moreover, any finite, theoretical additional risk can be minimized by system engineering design, management, planning, and communication. Please revise the analysis to account for these considerations.	Disagree	GE and Ecology disagree on the effects of turning off the recovery system. This section was updated based on the discussions provided in Section 5.6.1.
f. Implementability: Ecology agrees that this alternative is practical and implementable. But Ecology does not believe that maintenance of the groundwater extraction well system will entail significant additional work, and we disagree that it should warrant a reduced score for implementability (compared to identical alternatives without groundwater extraction well systems). Maintenance of groundwater extraction well systems are common practice. It is probable that ISCO implementation may be much more difficult than maintaining the hydraulic control system, due to more severe injection and monitoring well clogging and fouling compared with the extraction/monitoring wells. Please revise the analysis to account for these considerations.	Disagree	Both Alternative 2 and 5 are implementable. Alternative 2 includes the optimization of the recovery system, this requires significant planning, design, verification, and extensive site activities (that include large equipment and subsurface work associated with abandoning and re installing 2 4 inch recovery wells). GE believes that the additional work does cause Alternative 2 to be more difficult to implement than Alternative 5 and prepared the rankings accordingly.
Section 5.7 Alternative 6 -Enhanced Anaerobic Bioremediation, Vapor Intrusion Mitigation and Institutional Controls with Recirculation: 39. Alternative 6 introduces "recirculation of the injection solution" in the On-Site Area. However, this section has insufficient information for Ecology to fully understand the technical principals/concepts and benefits/disadvantages associated with a recirculation system. It is unclear, for example how and when existing extraction wells RW3 and RW-2 would be "retrofitted' into the recirculation operation.	No Response Required	Comment noted.
40. Ecology is unable to fully evaluate the threshold criteria (WAC I73-340-360(2)(a)) and other requirements (WAC I73-340-360(2)(b)) for this alternative. Due to a lack of optimized hydraulic control (for the reasons stated in Attachment A), however, Ecology would not select this option as the final remedy anyway. GE for different reasons, also eliminated alternative #6 from consideration. Ecology sees no reason to provide further comment on this section and will eliminate this alternative from further consideration. Ecology is not asking for more detailed consideration of Alternative #6, and no response is needed for comments #39 and #40.	No Response Required	Comment noted.
Section 5.8 Comparative Evaluation of Alternatives: 41. It is not clear to Ecology how GE/ENSR arrived at their final rankings (High, Medium, or Low) for each of the six alternatives analyzed in Section 5. However, Ecology is not asking GE to perform this re-ranking with further detailed explanation. Instead, GE should re-rank alternatives #5 and rank Alternative #7, calculate the cost estimate for Alternative #7, and recalculate the revised cost estimate, as necessary, for alternative #5. Comparisons between alternative #5 and alternative #7 should use alternative #7 as the baseline alternative. Also refer to comment #32. GE should describe how the "final" cumulative rankings for alternatives #5 and #7 were calculated. Any comparison of costs should be made on a net present value basis for a 2.0% discount rate and a 7% discount rate.	Accepted	Table 5-1 has been updated and Appendix B has been revised to reflect both discount rates.

42. Appendix B: Cost Estimates: Ecology recognizes that these cost estimate values carry a high level of uncertainty due to technology success, details (to be determined in the DCAP) of performance and confirmation monitoring, and other unanticipated events that may increase or shorten the restoration timeframe. Ecology expects that the approved cleanup action plan will include additional cleanup details that result in higher or lower costs than FS alternative costs generated for remedy comparison purposes only. To be clear, Ecology considers the Appendix B cost estimates to be effective for gross FS remedial alternative comparisons only. These cost estimates may need to be revised or altered before being used for purposes outside the FS process, such as for use in calculating financial assurances	No Response Required	Comment noted.
General Comments - October 1, 2008 Letter		
If GE proposes this monitoring/re-start element as part of a remedial alternative in the revised FFS report, the proposal must include sufficient details so that Ecology can understand how the proposal will be implemented and how it will effectively meet the goal of preventing exacerbation of off-property conditions. This includes: a) a detailed discussion of the number, location and screened intervals of all monitoring wells (both existing and any additional wells) that would be used for this purpose;	Accepted	GE believes that these details should be included in the subsequent monitoring plan for the site. GE has prepared an example frequency to be used for discussion and the development of the final site sampling plan. GE would like to work with Ecology to develop the final site sampling plan to address all comments. Appendix C, Table C-1 provides an example of potential monitoring well information. Table C-2 and Figure 5-6 provides the well screen information.
b) sampling frequency;	Accepted	Appendix C, Table C-1 provides an example of monitoring frequency.
c) decision timing and criteria ("trigger" observations);	Disagree	Triggers, such as changes in CVOC concentrations or field measurements of changing aquifer conditions, will be used to determine if the pump and discharge system should be turn back on. The actual values of these triggers will be included in the subsequent design documents.
d) proposed groundwater recovery well extraction rates, in the event the wells were needed to capture the CVOC plume (and the rationale for choosing those rates);	Accepted	Pumping rates would be determined in subsequent design documents. For planning purposes, it is assumed that current pumping rates would be used, achieving at a minimum the current level of capture.
and e) proposed groundwater recovery well locations, if GE believes that the wells should be re-located or increased in number.	No Action Required	GE does not feel that the recovery wells should be relocated. Alternative 5 assumes that the recovery wells will remain at there current locations, maintaining the current level of capture.
You should also provide estimated costs for this monitoring, as well as anticipated costs of having to re-start the hydraulic control system.	Part 1 - Accepted; Part 2 - Disagree	Table C-1 was used to develop cost projections for monitoring, which have been updated in Table B-5. The analysis conducted by GE indicates that pumping is not required under Alternative 5, thus pumping is not included in the cost alternatives.
Lastly, based on GE's meeting statements, Ecology now understands that GE will provide an analysis as part of the revised FFS report to quantify the amount of CVOC contaminated groundwater that migrates offsite and cross-gradient if the groundwater recovery wells are shut off. Ecology does not know what model(s) GE may have used or how those models were used to make this demonstration, but GE should, at a minimum: (a) provide a clear explanation of why any model(s) used are appropriate for the site;	Accepted	Appendix C contains a memo, and supporting documents, detailing the simply hydraulic simulation which was used to verify the discussion presented in Section 5.6.1. GE believes. GE does want to be clear that the purpose of the hydraulic simulation is to verify the empirical data presented in the report.
b) justify all input parameters used and assumptions applied (which should include an explanation for why you believe your inputs and assumptions are reasonably conservative);	Accepted	Appendix C contains a memo detailing the simply hydraulic simulation which was ran to verify GE believes.
and, (c) include a sensitivity analysis that shows how uncertainty in input parameters impacts the results of the model.	Accepted	Appendix C contains a memo detailing the simply hydraulic simulation which was ran to verify GE believes.
In addition, if pre-recovery well data are used as part of the analysis, GE should be clear about which data were used, and what you feel these data represent.	Accepted	Appendix C contains a memo detailing the simply hydraulic simulation which was ran to verify GE believes.

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Prepared for:
GE Aviation
Cincinnati, Ohio

Focused Feasibility Study – Version 3

GE South Dawson Street
Seattle, Washington

October 2008
Document No.: 02978-415-735

Prepared for:
GE Aviation
Cincinnati, Ohio

Focused Feasibility Study – Version 3
GE South Dawson Street
Seattle, Washington

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Reviewed by Linda Baker, R.G., Sr. Project Hydrogeologist

October 2008
Document No.: 02978-415-735

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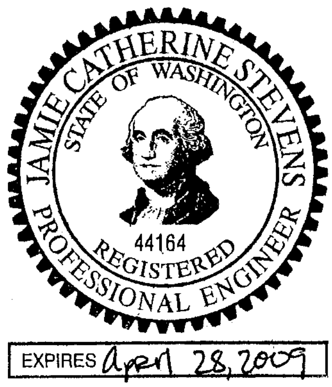
Engineer's Certification

I certify that the Draft Focused Feasibility Study for the 220 South Dawson Site was completed by me or by a person under my direct supervision.

Work for this project was performed in accordance with generally accepted professional practices for the nature and condition of work completed in the same or similar localities, at the time the work was performed.

No other warranty, express or implied, is made.



Jamie C. Stevens P.E., Project Engineer
Washington State PE Number: 44164
Expiration Date: April 28, 2009

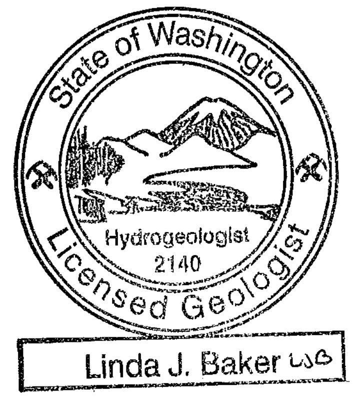
Hydrogeologist's Certification

I certify that the Draft Focused Feasibility Study for the 220 South Dawson Site was completed by me or by a person under my direct supervision.

Work for this project was performed in accordance with generally accepted professional practices for the nature and condition of work completed in the same or similar localities, at the time the work was performed.

No other warranty, express or implied, is made.

Linda Baker R.G., Sr. Project Hydrogeologist
Washington State RG Number: 2140
Expiration Date: 8-11-09



Executive Summary

This report presents a revised Focused Feasibility Study (FFS) – Version 3 for General Electric's (GE) Former Facility located at 220 South Dawson Street, Seattle, Washington (site). Figures 1-1 and 1-2 are vicinity and detailed site maps, respectively. This is being submitted in accordance with Washington State Department of Ecology (Ecology) Model Toxics Control Act (MTCA) regulations (WAC 173-340) and the 2008 Agreed Order DE-5477 Scope of Work, prepared by Ecology. Additionally, this FFS takes into account Ecology August 14, 2008 and October 1, 2008 comment letters regarding the June 17, 2008 version of the FFS. This FFS incorporates work conducted under the 2002 Agreed Order (DE02HWTRNR-4686), the 2007 Agreed Order (DE-4258) and historical work conducted prior to the 2002 Agreed Order. This FFS presents and evaluates site cleanup alternatives and enables a cleanup action to be selected for the site under WAC 173-340-360 through 173-340-390. GE's goal it to complete the remedy selection process before the end of the year such that clean up could begin in early 2009.

Physical and Geotechnical Findings and Results

The site lies in a depositional basin referred to as the Duwamish Trough. This basin holds approximately 200 feet of sediments deposited by the Duwamish River (deltaic, estuarine, and riverine) and volcanic mudflows. In the late 1800s and early 1900s, the tide flats present in the vicinity of the site were filled (by mechanical methods), predominantly with dredge material. Site investigation work has extended to a maximum depth of 65 feet, approximately one-third to one-quarter of the total depth of the alluvial valley fill (which includes the fill placed with dredge material). In the vicinity of the site, the stratigraphic sequence consists dominantly of sand and silty sand. Gravel has not been encountered and silt beds within the native alluvium are limited and generally not continuous

Nature and Extent

Chemical data and other characterization information collected during the site investigations have delineated the extent of chemically-affected groundwater, soil, and air at the site. Findings include:

- **Soil:** in 1995 and 1996 a voluntary interim action for soil was conducted on site that included source removal of chemically-affected soil. GE excavated over 3,000 tons of soil. All soil above the water table with concentrations above MTCA Method B cleanup levels was excavated to the maximum extent practicable and sent to an approved offsite disposal facility. It is estimated that less than 100 cubic yards of chemically-affected soil remain in the inaccessible areas beneath the building and electrical poles located adjacent to the building.
- **Groundwater**: temporary monitoring points and permanent monitoring wells have been sampled on a regular frequency since 1996. In general, chlorinated volatile organic compound (CVOC) concentrations have decreased or remained stable since implementation of the interim action groundwater recovery system in August of 1996. CVOCs sampled during the routine events include trichloroethylene (TCE), tetrachloroethylene (also called perchloroethylene; PCE), cis-1,2- dichloroethene (cis-1,2 DCE), 1,1-dichloroethene (DCE), 1,1- dichloroethane (DCA), 1,1,1-trichloroethane (1,1,1-TCA), and vinyl chloride (VC). TCE has been detected at the highest concentrations across the site in both on site and off site wells. PCE has the lowest cleanup level and occurs in 2 wells above the cleanup standards. Groundwater monitoring wells were sampled for total and dissolved metals in 2003, 2004, and 2008. Detected concentrations were all below MTCA Method A groundwater cleanup levels, with the exception of dissolved arsenic, in selected wells. Monitoring wells located in the On-Site and Off-Site areas were sampled for 1,4-dioxane between August 2004 and May 2008. During the most recent sampling event, May 2008, detected concentrations of 1,4-dioxane were below the MTCA Method B Cleanup Level for groundwater in all wells except one Off-Site Area downgradient well (MW-17D).

- **Subslab Vapor:** CVOC samples in the subslab vapor zone beneath the former GE building were collected in December 2005. Both 1,1,1-TCA and TCE were consistently detected in subslab samples. TCE concentrations were detected above the applicable cleanup level. No other compounds were detected.
- **Indoor Air:** Between 2000 and 2007 conditions at the former GE facility and at the two buildings downgradient were evaluated for the potential for sub-surface vapor intrusion. Indoor air samples collected from the former GE facility resulted in TCE detections above the applicable cleanup levels and the site-specific remediation levels in isolated locations. At the two downgradient buildings located above the off-site groundwater plume, indoor air engineering controls were estimated and modeling was conducted to predict concentrations of indoor air. Modeling showed concentrations below applicable screening levels. Additionally, indoor and ambient air samples collected from the furthest downgradient building, confirmed the model results; no CVOCs were detected above the applicable clean up levels.

Based on the investigation to date, the primary chemical of concern at this site (detected in soil, groundwater, and indoor air) is TCE. Additional chemicals evaluated in this FFS include PCE, 1,1,1-TCA, DCE, vinyl chloride (byproducts associated with the anaerobic degradation of TCE and PCE), 1,4-dioxane, and arsenic (dissolved). Total petroleum hydrocarbon (TPH) remains in the soil (inaccessible soil beneath the building foundations in isolated areas).

Potential Pathways of Exposure

Potential exposure routes include the following:

- **Contact with chemically-affected soil** – The potential exposure pathway is limited to construction worker contact with the soils during future construction or maintenance activities. Exposure routes could include dermal contact, incidental ingestion, and inhalation.
- **Contact with chemically-affected groundwater** – Exposure routes could include dermal contact (through construction activities, sampling, or activities associated with the current containment system by construction/utility workers), incidental ingestion (through construction activities, sampling, or activities associated with the current containment system by construction/utility workers), or inhalation of chemicals volatilizing when the groundwater comes into contact with air.
- **Contact with indoor air** – In this exposure pathway, CVOCs would volatilize from soil and groundwater, could migrate through the unsaturated zone via vapor gas and enter indoor ambient air. Exposure pathways include human inhalation of indoor air.
- **Consumption of fish and aquatic ecological exposure** – The groundwater at the site would ultimately discharge to the Duwamish River. Exposure pathways could include human exposure based on human consumption of fish and ecological exposure in the river. This pathway is currently incomplete as the plume currently diminishes to below detection approximately 690 feet from the Duwamish Waterway. In addition, it is unlikely that this pathway will ever be complete; the plume is not expected to increase significantly as chemical use has ceased and remedial actions have been implemented. While unlikely, this pathway is carried forward as it is the primary potential groundwater exposure pathway at the site.

Remedial Objectives and Cleanup Levels

Objectives developed for the remedial alternatives are based on compliance with MTCA requirements for remedy development and selection. Cleanup standards for chemically-affected media include:

- **Soil** – MTCA Method C Soil Cleanup Level for Industrial Properties and MTCA Method A Soil Cleanup Levels (for compounds that do not have a MTCA Method C Soil Cleanup Level) for unrestricted land uses

- **Groundwater** – MTCA Method B Surface Water Cleanup Level
- **Indoor Air and Subslab Vapor** – MTCA Method C Cleanup Levels for Subslab and Indoor Air.

Remedial Alternative Development and Analysis

Based on the screening of technologies, six proposed alternatives are evaluated under WAC 173-340-360. They include:

- **Alternative 1** – Optimized Hydraulic Control, Soil Vapor Extraction combined with Air Sparge (SVE/AS), Subslab Depressurization System, and Institutional Controls
- **Alternative 2** – Optimized Hydraulic Control, *In situ* Chemical Oxidation, Subslab Depressurization System, and Institutional Controls
- **Alternative 3** – Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls
- **Alternative 4** – Soil Vapor Extraction combined with Air Sparge, and Institutional Controls
- **Alternative 5** – *In situ* Chemical Oxidation, Subslab Depressurization System, and Institutional Controls
- **Alternative 6** – Enhanced Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls.

Preferred Remedial Alternative

Based on the results of the evaluation the preferred alternative for the 220 South Dawson Street site is Alternative 5. This alternative has the highest probability of achieving cleanup standards in a reasonable timeframe, addresses the remaining requirements under MTCA, addresses the On-Site Area, the Off-Site Area, and targets groundwater, soil, and vapor.

1.0 Introduction

This report documents the Focused Feasibility Study – Version 3 (FFS) for General Electric's (GE) former facility located at 220 South Dawson Street, Seattle, Washington (site), Figures 1-1 and 1-2 are vicinity and detailed site maps, respectively. In 2008, GE entered into an Agreed Order (DE 5477; 2008 Agreed Order) with the Washington State Department of Ecology (Ecology) to prepare a FFS based on the remedial investigation results collected under the November 14 2002 Agreed Order (DE02HWTRNR-4686; 2002 Agreed Order) and historical work conducted prior to the 2002 Agreed Order. Revision 1 of this FFS addresses comments provided by Ecology in the August 14, 2008 comment letter on the June 17, 2008 version of the FFS report (Ecology's Response to Comments) and the October 1, 2008 letter granting a two week extension on the FFS due date (Ecology 2008c/2008d). This FFS summarizes site conditions and evaluates potential remedial actions for the site. The FFS concludes with the proposed preferred alternative that best meets regulatory requirements under WAC 173-340-360 through 173-340-390. In additional, this FFS has also carefully considered all communications with the Ecology including the following:

- June 27, 2006 – Dept of Ecology Letter to GE with original request for a FFS
- November 6-7, 2007 – meetings with Ecology
- February 21, 2008 – Dept of Ecology Letter to GE providing example feasibility studies under MTCA
- March 4, 2008 – Dept of Ecology Letter to GE providing comments on the draft FFS submitted June 18, 2007.

The FFS provides background information on the site and a conceptual site model based on previous investigation work. Potential cleanup standards were reviewed and standards to be used during the cleanup action are proposed. The FFS develops remedial alternatives and evaluates these alternatives using the criteria specified in Model Toxics Control Act Cleanup (MTCA) regulations. The evaluation of the remedial technologies considers a number of factors: 1) the ability of technologies to achieve the numeric remediation goals and cleanup standards; 2) nature of the chemicals of concern: 3) local site conditions including geology, hydrogeology and existing site land use; 4) potential effects to human health and the local environment that could result from remedial construction and implementation; and 5) regulations and criteria applicable to or relevant and appropriate to the implementation of each technology at the GE site.

Figure 1 -3 presents a general flow diagram of the MTCA process. This diagram shows that the FFS is one of several sequential requirements leading to site cleanup under MTCA. The FFS uses data collected during the Remedial Investigation (RI) and additional data collected for the FFS to develop and evaluate cleanup action alternatives. The FFS is intended to provide information to allow Ecology to select a cleanup action. The procedures for conducting a feasibility study are set forth in WAC 173-340-350(8). After the FFS is complete, a Cleanup Action Plan will be prepared (WAC 173-340-380); this plan will present the selected cleanup action(s) that will be used to address site contamination.

Key definitions and concepts used in this report include:

- **Contaminants of Concern (COCs).** COCs are the subset of hazardous contaminants determined to contribute the majority of the overall threat to human health and the environment at a particular site. These are used to define site cleanup requirements and are defined in the FFS. The 2008 Agreed Order listed COCs for the site to include trichloroethylene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), perchloroethylene (PCE), 1,1-dichloroethene (DCE), cis-1,2-DCE, trans 1,2 dichloroethylene, 1,4 dioxane, arsenic and vinyl chloride. COCs are further defined for soil, groundwater, and vapor.

- **Conceptual Site Model (CSM).** The CSM provides potential exposure pathways from chemical source areas to potential receptors. The components of the CSM include the nature and extent of chemical source areas, the fate and transport characteristics of the chemicals, current and potential chemical migration pathways and potential receptors of site chemicals. Regarding the potential receptors the CSM also addresses current and potential land use and resources. The CSM is intended to refine and illustrate the definition of risk posed by site chemicals and assist with the definition of cleanup requirements.
- **Cleanup Standards.** Cleanup standards are defined in an FFS for all chemically-affected media, such as soil and groundwater, which could pose a potential risk to human health or the environment. Cleanup standards consist of chemical concentrations and the location where these cleanup levels must be met (i.e. point(s) of compliance).
- **Cleanup Action Alternatives.** Cleanup action alternatives consist of technologies (or combinations of technologies) that are intended to result in achieving the cleanup standards by reuse or recycling, destruction or detoxification, immobilization or solidification, disposal, containment with engineering controls or institutional controls and monitoring. These cleanup action alternatives must meet the following MTCA requirements (WAC 173-340-360):

    (1) protect human health and the environment

    (2) comply with cleanup standards and applicable federal and state laws

    (3) provide for compliance monitoring, use permanent solutions to the maximum extent practicable

    (4) provide for a reasonable restoration time frame, and

    (5) consider public concerns.

1.1 Site Location and Use History

The project site is located within the Northwest Quarter of Section 20, Range 4 East, Township 24 North, of the U.S. Geological Survey, Seattle South, Washington, 7.5-minute quadrangle (Figure 1 -2). The site is situated on the north side of S. Dawson Street between 2nd Avenue S. and 3rd Avenue S. The ground surface is approximately 15 feet above mean sea level (MSL) and generally slopes to the west at a gradient of 1 to 3 feet per mile. There is no apparent topographic relief across the site.

The site is occupied by a building that was originally constructed in 1949. The building is surrounded by asphalt pavement. GE occupied the premises in 1949 and began the manufacture and repair of equipment used in aircraft in 1959. Manufacturing operations ceased in 1994, and GE continued to use the property for office and warehouse space until it sold the property to new owners in 1996. Between 1996 and present, the building has been used for various warehousing operations by the new owners and/or their tenants.

Petroleum products and chlorinated solvents were used at the GE facility during manufacture and repair operations (1959 to 1994). The chlorinated solvents TCE, 1,1,1-TCA, and PCE were used primarily for cleaning parts.

1.2 Surrounding Land Use

The site, which lies within the Duwamish industrial corridor, is zoned General Industrial 2 (IG2) and is within the Urban designation of the Shoreline District Overlay (U/85) (City of Seattle 2008 zoning maps: (review of current zoning map: http://www.seattle.gov/dpd/Research/Zoning_Maps/default.asp). Land uses in the Duwamish industrial corridor are predominantly light industrial (e.g., manufacturing and warehousing) with some commercial businesses, occasional residences, and vacant lots. The adjacent properties and properties between the site and the Slip one of the Duwamish Waterway (Slip 1 is approximately 1600 feet from the former GE building, Figure 1-1) are currently used or zoned for industrial purposes. Immediately south of the site (crossgradient), two residences are located between industrial facilities. At the time of this report, one of the residences appeared to be abandoned.

The Duwamish Valley is an area known to be the subject of multiple historic releases. As of June 2006, there were 76 MTCA or Resource Conservation and Recovery Act (RCRA) sites, 8 Voluntary Cleanup Program (VCP) sites, 15 leaking underground storage tank sites, 18 sites with registered USTs, and one active Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site in the vicinity of the former GE facility. Most of these sites have chemically-affected groundwater. At many of these sites, groundwater remediation has not begun. In addition, the King County Department of Health reports that numerous landfills were historically located in the Duwamish industrial area, including at least one within 1,500 feet of the former GE facility. The locations and boundaries of some of the landfills in the Duwamish area, as well as the years of operation and the types of wastes accepted, are not known.

1.3 Regulatory History and Frame Work

Investigative and cleanup work at the site has been ongoing since 1987. Initial work at the site was completed as a RCRA Closure of the Dangerous Waste Management Unit. Subsequent investigations and interim actions have been performed independently with input and informal concurrence by Ecology. RCRA 3008(h) requires certain facilities that formerly operated under interim status to perform corrective action to address releases. Ecology accepted clean closure of the former GE site's storage unit by letter dated April 13 1995. GE agreed to conduct the additional work as part of the RCRA corrective action requirements for former dangerous waste storage facilities. In Ecology's Response to Comments, Ecology asked that GE clarify that the independent work was conducted independent of Ecology review and thus neither approved nor disapproved.

GE independently performed investigative and interim action cleanup work at the site in cooperation with Ecology, and submitted a draft Cleanup Action Plan (CAP) in 1997 to support Consent Decree negotiations. Ecology required additional work prior to continuing with the Consent Decree for site cleanup. GE and Ecology agreed to perform this additional work under the 2002 Agreed Order (Ecology 2002A). The *Interim Action Work Plan Completion Report* detailed the activities completed under the 2002 Agreed Order (RETEC 2007A). In 2007 an additional agreed order was issued specific to the subslab vapor and indoor air pathway (2007 Agreed Order DE 4258).

This FFS uses site data and associated information from the IAWP investigation and previous activities to identify a preferred site remedy. Upon completion of the FFS GE and Ecology will prepare a draft CAP, finalize Consent Decree negotiations, and implement the selected remedy.

1.4 Investigative and Remedial History

Chlorinated volatile organic compounds (CVOCs) were detected in soil and shallow groundwater at the former GE facility. The primary CVOCs found at the site include PCE, TCE, 1,1,1-TCA, DCE, and vinyl chloride (VC). Numerous historic investigations have been performed to delineate the extent of chemically affected soil, groundwater, and indoor air. Independent interim actions for groundwater, soil, and indoor air have been implemented to address the CVOC-affected areas.

In 1995 and 1996 an independent interim action for soil was conducted on site which included CVOC-affected soil removal. GE excavated over 3,000 tons of soil from the areas shown on Figure 1-4. Substantially all soil above the water table with concentrations above MTCA residential criteria and the 1995/1996 criteria for protection of groundwater was removed. Small volumes remain in inaccessible areas beneath the building's structural footings, near a transformer and beneath a utility pole (Area 1, Area 7, and Area 9, as defined in Dames & Moore 1996). The soil removal action was implemented between December 1995 and August 1996. A comprehensive account of the soil removal is provided in

Independent Interim Remedial Action of Soils (Dames & Moore 1996), and should be referred to for specific details on areas and depths of excavation, analytical data, and other pertinent information.

In addition to pre-1998 investigations of site conditions, GE has completed several geoprobe investigations between 1998 and 2005 (Figure 1-4). Grab groundwater samples were collected in the source area, downgradient, along 1st Avenue South, and in the western plume area. The investigations further defined the base of impacts at 2nd Avenue South, identified CVOCs in the intermediate depth zone near 1st Avenue South, and delineated the downgradient boundaries of the CVOC groundwater plume.

The groundwater interim action (groundwater extraction) was designed and constructed in 1996 and began operating in August 1996. Groundwater was recovered from two wells (RW-1 and RW-2, shown on Figure 1-4) on the downgradient side of the 220 South Dawson Street property with the objective of containing and recovering groundwater beneath the property. In August 2003 the groundwater extraction system was modified as required in the 2002 Agreed Order. A new recovery well was added and pumping locations were modified, with recovery from RW-2 and the new well, RW-3. The objective of this modified groundwater extraction system was to contain and recover groundwater, focusing on the source area in the northern portion of the property. Both the RW-1/RW-2 and RW-2/RW-3 recovery systems operated essentially continuously at a combined rate generally ranging from 12 to 17 gallons per minute (gpm) with discharge to the King County sewer under permit. GE continues to operate the RW-2/RW-3 groundwater extraction system. Over the past 12 years, over 113,873,000 gallons[1] of water have been extracted by the groundwater recovery system.

The predicted capture zone was evaluated prior to implementation of the original RW-1/RW-2 system and again prior to system modification to include RW-2/RW-3. In addition, a capture zone analysis was conducted at the completion of the interim action scope of work (RETEC 2007B). The capture zone analysis included an analysis of the extent of capture based on water levels, chemical trends, and hydrogeological modeling.

Quarterly groundwater monitoring has been performed since implementation of this interim action in 1996. The monitoring includes monitoring wells located upgradient, crossgradient, and downgradient of chemically-affected groundwater areas. Over 40 quarterly sampling events[2] have been completed at the site with collection of over 847 ground-water monitoring well samples. Samples have been analyzed for CVOCs, and for metals, 1,4-dioxane, and MNA parameters.

In 2001, Environmental Partners, Inc. (EPI), conducted investigations at the adjacent property downgradient of the former GE building (Liberty Ridge, formerly Western Cartage) to characterize soil and groundwater quality (EPI 2001). EPI designed their investigation to focus on the most probable source areas beneath the building and no on-site TCE sources were identified. Results of the investigation generally confirmed the groundwater quality data collected during the GE investigations, showing low levels of CVOCs in groundwater. GE began sampling several of the EPI wells as part of its quarterly monitoring program in February 2004.

An initial evaluation of the indoor air was conducted in 2004 using models to predict the expected concentrations inside the former GE building based on assumed concentrations in the subslab. In December of 2005, GE collected subslab, indoor air, and ambient air samples to evaluate the conditions within the former building (RETEC 2006A). Three additional rounds of indoor and ambient air sampling were conducted in 2006 and 2007 (RETEC 2006B 2007C/2007D). Pursuant to the 2007 Agreed Order between Ecology and GE, a

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[1] Total readings from system installation through May 2008. Based on monthly discharge reports submitted to King County.

[2] Quarterly sampling of monitoring wells started on in April 1997; prior to this event, 10 sampling events (of installed monitoring wells) were conducted between May 1992 and November 1996. These previous 10 sampling events are not included in the total stated for quarterly sampling events.

subslab depressurization system was installed in June of 2007 and an additional round of indoor, ambient, and stack gas sampling was conducted in November 2007 (ENSR 2007)

Results from an additional evaluation of the indoor air that was performed at the two buildings downgradient of the 220 South Dawson Street site indicated no unacceptable exposure risk (RETEC 2006D).

2.0 Site Conceptual Model

Site conditions in the vicinity of the GE facility were presented in the *Site Conceptual Model* (SCM) in 2004 (RETEC 2004). The information presented below provides an update to the 2004 SCM and includes all data collected prior to and under the Agreed Order (November 14, 2002, DE02HWTRNR-4686). Ecology did not require further revision but did not formally accept the SCM.

Figure 1 -2 provides a site location map. This figure shows the 220 S Dawson Street property and extends two blocks to the west to include the farthest downgradient monitoring wells. For discussion purposes in this FFS report the site is broken into two areas: the On-Site Area and the Off-Site Area. The On-Site Area includes the 220 S Dawson Street property, which contains the former GE facility. The Off-Site Area includes the downgradient investigation area of the 220 S. Dawson Street property extending to monitoring wells MW-16M/D.

The 2008 Agreed Order listed the COCs for the site to include TCE, 1,1,1-TCA, PCE, (DCE, cis-1,2 DCE, trans 1,2 dichloroethylene, 1,4 dioxane, arsenic and VC. This section focuses on the site COCs, but also includes discussion on additional compounds investigated at the site. Section 2.3 provides an updated list of COCs based on additional data collected in the spring of 2008.

2.1 Geology and Hydrogeology

Regional geologic and hydrogeologic conditions in the area of the site are discussed in the *Duwamish Basin Groundwater Pathways Conceptual Model Report* prepared for the City of Seattle Office of Economic Development and the King Country Office of Budget and Strategic Planning in April 1998 (*Duwamish Study*, April 1998). Geologic and hydrogeologic conditions at the site itself were characterized during the various field investigations conducted from 1995 to 2007. A brief summary of subsurface characteristics is provided here, and geological cross sections are presented in Figures 2-1 to 2-4.

2.1.1 Geology

The site lies in a depositional basin referred to as the Duwamish Trough. The basin holds up to 200 feet of sediments deposited by the Duwamish River (deltaic, estuarine, and riverine) and volcanic lahar deposits. The Duwamish Trough is bounded and floored by bedrock consisting of sedimentary rock and limited volcanic intrusive rocks. The recent alluvium filling the trough includes sands and silts deposited by the Duwamish River and its tributaries. In the vicinity of the site, the mudflows have not been encountered and the lower alluvial deposits consist typically of fine sands and silts with shells. This alluvial sequence grades upward from estuarine to a more river-dominated depositional sequence, with complexly interbedded sand, silt, and gravel (Fabritz, Massman and Booth 1998). In the late 1800's and early 1900s, during development of Seattle, the tide flat and flood plain were reclaimed for development through channelization of the Duwamish River and placement of fill. In many cases, the contact between fill and native soils is difficult to discern as the fill used is similar to the native soil.

Site investigation work has extended to a maximum depth of 65 feet, approximately one-quarter to one-third of the total depth of the alluvial valley fill. This upper 65 feet of the approximately 200-foot valley fill is interpreted to be equivalent to the river-dominated sequence of interbedded sand, silt and gravel described in the Duwamish Study (Fabritz, Massman and Booth 1998). However, in the vicinity of the site, the stratigraphic sequence consists predominantly of sand and silty sand. Gravel has not been encountered and silt beds within the native alluvium are limited and generally not continuous.

Figures 2-1 through 2-4 show soil stratigraphy at the site. Surface asphalt and concrete are underlain by approximately 1 foot of medium-dense to dense gravel fill. The texture of soil beneath the fill ranges from sandy silt to silty fine-grained sand to fine- to medium-grained sand with trace silts. The boring logs completed by Dames and Moore generally show a fining upwards beginning with interbedded silt and silty sand to depths of 6 to 11.5 feet and underlain by fine to medium sands. Subsequent borings completed by

EPI. (Liberty Ridge wells) and RETEC (RETEC merged with ENSR in February 2008) do not show this consistent grain size variation. Boring logs for the Liberty Ridge property show a generally fining downward sequence with fine sands with some silts to 9.5 feet below ground surface (bgs underlain by silty sands and fine sands with silt to 30 feet (total boring depth). Site boring logs show relatively uniform silty sand with thin silt beds extending to a depth of 57 feet. Deeper borings suggest that the interval between the 30- to 50-foot depths contains some thin silt beds. One silt bed may extend laterally approximately 200 feet, but other silt beds do not appear to be continuous.

2.1.2 Hydrogeology

According to the Duwamish Study, regionally the Duwamish River Valley is considered "a single, large aquifer system" due to the "singular nature of its geologic origin and its location within a valley bounded both laterally and vertically by walls comprised of bedrock, silts, and dense glacially overridden strata" (Fabritz, Massman and Booth 1998). Investigations associated with the former GE facility have focused on the uppermost 60 feet of this approximately 200-foot thick aquifer. Terms used in this report such as "shallow" and "deep" groundwater refer only to the portion of the aquifer studied and are not meant to imply that it is the "deep" portion of the whole aquifer in the greater Duwamish Valley.

2.1.2.1 Water Table Elevations

Groundwater occurs under unconfined conditions in the soils beneath the site. The saturated portion of the silty sandy soils beneath the site is considered the upper groundwater unit. Groundwater is generally encountered between 7 and 11 feet bgs. Figures 2-5 and 2-6 are site hydrographs showing water levels over time in selected On-Site and Off-Site Area wells[3]. Water levels varied seasonally by between 1.0 and 1.5 feet, with highest water levels measured in February and lower levels measured in August. For reference, monthly precipitation data obtained from the National Oceanographic and Atmospheric Association[4] is plotted with the water level data. As expected, the water table rises in wetter months and falls in drier months. Figure 2-7 shows the average groundwater elevations from quarterly gauging data collected from August 2003 through August 2006.

Regionally, according to the Duwamish Study,

> *"(t)he Duwamish Valley, by nature of its low elevation and surface water outlet, is a regional discharge area. The surrounding uplands, by virtue of their higher elevation, are recharge areas. A recharge area is indicated where there is a downward component to the groundwater flow evidenced by a downward vertical gradient in water levels in adjacent wells completed at different depths. Conversely, upward gradients with depth are indicative of a discharge area."*

The GE site is situated in an area with limited surface recharge where groundwater flows laterally from the surrounding uplands toward the discharge point at the Duwamish River. The Duwamish Study (AUTHOR DATE) includes a discussion of brackish groundwater occurrence in the valley that is due to the "current tidal mixing of water from the Duwamish River system, as well as the original depositional environment of the valley fill." Maps included in the report indicate that slightly brackish water conditions may exist in the vicinity of the GE project area, as defined by areas having greater than 1,000 micromhos per centimeter (µmhos/cm). Conductivity measurements from sampling of the deeper wells at the site (MW-14D, MW-15D and MW-16D) over the last year range from 493 to 988 µmhos/cm, with an average of 679 µmhos/cm. In the shallow wells (MW-14M, MW-15M, and MW-16D), conductivity ranged from 138 to 965 µmhos/cm, with an average of 536 µmhos/cm. These conductivity values below 1,000 µmhos/cm suggest that this

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[3] Note that an anomalous data point from MW-11 in August 2000 was omitted from the hydrographs and gradient evaluations.

[4] http://lwf.ncdc.noaa.gov/ oa/climate/research/cag3/Z7.html

area is not affected by tidal mixing from the Duwamish. The GE site is an area where recharging groundwater from the eastern portion of the Duwamish Valley and the surrounding uplands flows west towards the river.

Based on the largely industrial land use, and overall paved areas, the Duwamish Study estimates that recharge on the eastern side of the Duwamish Valley is limited to less than 10 inches per year. In the area surrounding the GE site, the ground surface is predominantly capped with buildings, asphalt, and concrete limiting infiltration. Very small landscaped areas currently exist as the only potential areas for recharge due to infiltration of precipitation. Prior to 2003, the alleyway between the 220 South Dawson Street property and the Liberty Ridge property was covered with degraded asphalt and patches of gravel. Based on the limited surface area of these landscaped areas and degraded asphalt, these areas are not expected to contribute to substantial recharge near the facility.

While the area immediately surrounding the GE site is essentially capped with buildings, asphalt and concrete, a relatively large area of recharge within the Duwamish Valley exists upgradient of the site. The Union Pacific Rail yard is located approximately 500 feet upgradient of the site and is largely open ground.

2.1.2.2 Horizontal and Vertical Gradients

Overall groundwater flow is from the east to the west and slightly southwest as illustrated on Figure 2-7. Flow directions in the vicinity of pumping wells MW-8S and MW-8M vary, as these are influenced by the ongoing groundwater recovery. The overall flow direction is consistent with the measured groundwater flow direction prior to the installation of the recovery system. Horizontal gradients generally range from 0.0003 to 0.002 ft/ft. Vertical gradients are low at the site as illustrated on Figure 2-8 and 2-9. Vertical gradients in the On-Site Area range from +0.015 to -0.003 ft/ft, indicating both slight upward and slight downward gradients. Vertical gradients in the Off-Site Area range from +0.01 to -0.005 ft/ft, indicating both slight upward and slight downward gradients. Note that the actual difference in water levels between the shallow and deep Off-Site Area wells is slight, generally less than 0.05 feet difference. This difference is close to the tolerance of both surveying (generally +/-0.01 ft) and water level measurement using a tape (also +/-0.01 ft). Therefore, these vertical gradients are considered minimal, and do not represent a significant hydrogeologic influence on the system.

2.1.2.3 Groundwater Characteristics

Pumping tests were performed in May 1996 and August 2003. A detailed description and summary of the pumping test data are included in the *Capture Zone Analysis* (RETEC 2007B). Ecology did not require further revision but did not formally accept the Capture Zone Analysis[5].

Hydraulic conductivity (K) values and variation have been investigated with two pumping tests. The results from the various pumping tests define a range of transmissivity values all of which are within a factor of two. The results of the pumping test analysis demonstrate that the shallow groundwater unit is generally homogeneous. Transmissivity estimates range from 2,700 square feet per day (ft^2/day) to 7,344 ft^2/day (RETEC 2007B). Additional analysis from Ecology resulted in a range of transmissivity estimates ranging from 2,780 to 14,050 ft^2/day (Ecology 2008). Given an aquifer thickness of 30 feet, this would correlate to a hydraulic conductivity in the range of 90 ft/day to 468 ft/day.

Horizontal groundwater seepage velocities (v) can be estimated using the average horizontal gradient (i), the hydraulic conductivity (k) and the effective porosity (n) as follows:

$$v = ki/n$$

Given a range of hydraulic conductivity of 90 to 468 ft/day, an average horizontal gradient of 0.001 ft/ft, and an effective porosity for silty sand of 0.3 (Freeze and Cherry 1979), the calculated groundwater velocity is 0.3 to 1.53 ft/day, or 108 to 562 ft/year.

[5] See Section 4.4 for Ecology's opinion on the effectiveness of the current groundwater hydraulic control system.

2.2 Nature and Extent of Chemically-Affected Media

This sub section defines the nature and extent of the chemically-affected soil, groundwater, and vapor at the site. This section presents preliminary screening values that are used to evaluate the extent of the chemically-affected media. The preliminary screening values are not intended to be site clean up levels or remediation levels, which are presented in Section 3.

2.2.1 Soil

Soil at the subject property has been investigated and remediated since 1996. In those investigations, elevated concentrations of TPH and CVOCs were identified. To minimize risk due to direct exposure and reduce the risk of releases from soil to groundwater and ambient, a removal action was performed in 1996. The following section summarizes the nature and extent of residual chemicals in the soil.

For purposes of defining the nature and extent of chemically-affected soil at the site, the following preliminary screening values have been applied:

Table 2-1 Soil Preliminary Screening Values

Compound	Value	Source
TPH	2,000 mg/kg	MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses (heavy oils)
PCE	0.05 mg/kg	MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses (protection of groundwater as a drinking water source)
TCE	0.03 mg/kg	MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses (protection of groundwater as a drinking water source)
Inorganics – Arsenic	20 mg/kg	MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses
Inorganics – Cadmium	2 mg/kg	MTCA Method A Unrestricted Land Uses Soil Table Value
Inorganics – Lead	250 mg/kg	MTCA Method A Unrestricted Land Uses Soil Table Value

2.2.1.1 1996 Soil Removal Action

In 1995 and 1996 an independent interim soil removal action was conducted on site. During this removal action, GE excavated over 3,000 tons of soil from the 12 areas shown on Figure 1-4. Substantially all soil above the water table with chemical concentrations above MTCA Method B cleanup levels was removed. Exceptions where soils with chemical exceedances were left in place are described in the following subsections.

The soil removal action was implemented between December 1995 and August 1996. A comprehensive account of the soil removal is provided in *Independent Interim Remedial Action of Soils* (Dames & Moore 1996), and should be referred to for specific details on areas and depths of excavation, analytical results, and other related information. Summaries are provided as they relate to the individual analytes in the following subsections. Soil removal areas are shown on Figure 1-4. The following bullets summarize the depth of excavation in each area, based on the 1996 Dames and Moore report:

- Area 1: Excavated to 3 to 4 feet bgs, 240 cubic yards of soil removed
- Area 2: Excavated to 4 to 6 feet bgs, 520 cubic yards of soil removed

- Area 3: Excavated to 10 feet bgs, 10 cubic yards of soil removed
- Area 4: Excavated to 4 feet bgs, 4 cubic yards of soil removed
- Area 5: Excavated to 5 feet bgs, 55 cubic yards of soil removed
- Area 6: Excavated to 4 to 7 feet bgs, 11 cubic yards of soil removed
- Area 7: Excavated to 5 to 8 feet bgs, 1,385 cubic yards of soil removed
- Area 8: Excavated to 5 to 7 feet bgs, 400 cubic yards of soil removed
- Area 9: Excavated to 4 feet bgs, 20 cubic yards of soil removed
- Area 10: Excavated to 3 to 6 feet bgs, 100 cubic yards of soil removed
- Area 11: Excavated to 3 feet bgs, 12 cubic yards of soil removed
- Area 12: Excavated to 4 feet bgs, 21 cubic yards of soil removed.

2.2.1.2 Total Petroleum Hydrocarbons

The Method A Cleanup Level for TPH-gasoline applied to the soil interim action was 100 mg/kg, although the TPH detected at the site was in the heavy oil range (with a current MTCA Method A Cleanup Level of 2,000 mg/kg). All post-excavation samples were below 100 mg/kg with the exception of Area 1 and Area 9. Post-excavation samples collected in Areas 11 and 12 were reported with TPH concentrations below 100 mg/kg.

A limited amount of inaccessible soil with TPH concentrations exceeding 100 mg/kg was left in place along the north and west side-walls at the northwestern corner of Area 1 (concentrations ranged from 167 to 356 mg/kg). The building foundations prohibited further excavation in Area 1. Soil with TPH concentrations exceeding 100 mg/kg was also left in place in Area 9 along the east and south side-walls (the maximum concentration detected was 10,900 mg/kg). Soil was inaccessible in this area because of an active transformer and an adjacent power pole.

The current MTCA Method A Soil Cleanup Level for industrial proprieties for heavy oils is 2,000 mg/kg. Based on the results presented above, a small amount of inaccessible soil remains above the current MTCA Method A soil cleanup levels in Area 9 only.

2.2.1.3 Volatile Organic Compounds

VOC concentrations measured in conformational soil samples indicated that all areas, with the exception of Areas 2, 7, and 8, were below the applicable cleanup level.

TCE above the screening level applicable at the time of the removal (0.398 mg/kg), was left in place beneath the footing of a load-bearing exterior wall and in the north-central side wall (maximum values of TCE detected at 1.16 mg/kg) and the northeastern side wall (maximum values of TCE detected a 0.67 mg/kg in Area 7. All post-excavation samples in Area 7 were below PCE cleanup levels that were applicable at the time of sampling (0.086 mg/kg).

The current MTCA Method A (unrestricted land use) Soil Cleanup Level for PCE is 0.05 mg/kg. The basis for this screening value is protection of groundwater for drinking water use (WAC 173-340-747(4)). The sample detection limit for the 1996 excavation for PCE was 0.05 mg/kg. Of all the post excavation soils sampled for PCE, only one sample was slightly above the detection limit. One floor soil sample from Area 7 at 10 ft bgs, reported a value of 0.06 mg/kg (sample ID S-7-34). All other samples were reported to be at or below the laboratory detection limit. Based on the above data soil concentrations of PCE are not present across the site above the current Method A Soil cleanup levels.

The current Method A Soil Cleanup Level for industrial proprieties for TCE is 0.03 mg/kg, and is based on protection of groundwater for drinking water use, using the procedures described in WAC 173-340-747(4). The 1996 excavation removed soils impacted below 0.398 mg/kg. The sample detection limit for the 1996 excavation for TCE was 0.05 mg/kg. The detection limit used during the 1996 excavation is above the current MTCA Method A Soil Cleanup Value. Soils with detected TCE concentrations above 0.03 mg/kg were left in place in Areas 7 and 8.

2.2.1.4 Inorganics

Confirmation sampling of Areas 1 through 12 produced inorganics concentrations consistently below the applicable cleanup level for soil. The cleanup levels for arsenic, cadmium, and lead were at or below the current MTCA Method A standards for unrestricted land use. Barium was excavated to a cleanup level of 112 mg/kg. Barium does not have a MTCA Method A soil cleanup level; the MTCA Method B standard for barium is 16,000 mg/kg. Based on the 1996 reports, soil in the excavated areas does not contain inorganics above the current MTCA Method A soil cleanup levels.

2.2.1.5 Summary of Soil Contaminants of Concern

As discussed above, the 2008 Agreed Order listed the COCs for the site to include: TCE, 1,1,1-TCA, PCE, DCE, cis 1,2-dichloroethylene, trans 1,2 dichloroethylene, 1,4 dioxane, arsenic and vinyl chloride. Based on the data presented above, the COCs for soil include TCE, PCE, and TPH (heavy oil range).

2.2.2 Groundwater

Figure 1 -2 shows the monitoring well network. Monitoring wells are located within the vicinity of the former GE building, and locations extending downgradient (west) of the property for approximately two blocks. Monitoring wells are screened at various depths within the upper groundwater unit beneath the site. To facilitate groundwater quality discussions, the wells have been grouped into three depth zones as follows:

- **Shallow (Water Table) Wells** – MW-1 through MW-13, MW-21S and EPI-MW-1S, -2S, -3S and
  -4S, are all screened across the water table, to a total depth of 15 to 20 feet bgs
- **Intermediate Wells** – MW-8M, -14M, -15M, -16M, -17M, -18M, -19M, and -20M are all screened from approximately 20 to 30 feet bgs. EPI-MW-1D, -2D, -3D and -4D are all screened 25 to 30 feet bgs
- **Deep Wells** – MW-14D, -15D -16D, -17D, and -18D are all screened from 45 to 55 feet bgs.

For purposes of defining the nature and extent of chemical-affected groundwater at the site, the following preliminary screening values have been applied to the site groundwater COCs (Table 2-2).

Table 2-2 Groundwater Preliminary Screening Values

Compound	Value	Source	Notes
Trichloroethylene (TCE)	1.5 and 0.11 µg/L	MTCA Method B Surface Water and Drinking Water Level (µg/L)	
1,1,1-Trichloroethane (1,1,1-TCA)	417,000 and 7,200 µg/L	MTCA Method B Surface Water and Drinking Water Level (µg/L)	
Perchloroethylene (PCE)	0.39 and 0.081 µg/L	MTCA Method B Surface Water and Drinking Water Level (µg/L)	
1,1-Dichloroethylene	4,167 and 400 µg/L	MTCA Method B Surface Water and Drinking Water Level (µg/L)	
Vinyl Chloride	3.69 and 0.029 µg/L	MTCA Method B Surface Water and Drinking Water Level (µg/L)	
cis 1,2-dichloroethylene	80 µg/L	MTCA Method B Drinking Water Level (µg/L)	No value is available for the MTCA Method B Surface Water Level
trans 1,2 dichloroethylene	33,000 and 160 µg/L	MTCA Method B Surface Water and Drinking Water Level (µg/L)	
Inorganics - Arsenic	0.005 and 0.01 mg/L	MTCA Method A Protection (mg/L)/Washington State MCL	The MTCA Method A value takes into account background, or non anthropogenic sources of arsenic
SVOC – 1,4 Dioxane	79 µg/L	Revised MTCA Method B Surface Water Level (µg/L)	

2.2.2.1 Groundwater CVOCs

In general, CVOC concentrations have decreased or remained stable since implementation of the IAWP, summarized on Figure 2-10 (RETEC 2007A). In wells located near new recovery well RW-3, with the exception of MW-1, concentrations have decreased significantly since wells were first installed. Groundwater is routinely analyzed for CVOCs including: TCE, PCE, DCE, 1,1-Dichlororethane, 1,1-DCA,1,1,1-TCA, cis-1,2-DCE and VC. The last annual groundwater sampling event, which included all site wells, was conducted in February 2008. This section includes historic groundwater sampling through February 2008.

Figures 2-11 through 2-27 present analytical cross-sections for TCE, 1,2-DCE, 1,1-DCE, 1,1,1-TCA for 1994 (prior to system start up), 2002-2003, (after modification of the extraction system), and February 2008 (12 years after the operation of site extraction wells). One analytical cross section for vinyl chloride and PCE is included for the February 2008 sampling event only. Appendix A summarizes the analytical data collected between 1992 and February 2008. A discussion of the CVOC distribution is provided in the following sub sections

Of the CVOCs, TCE has been, and is the most prevalent and is present at the highest concentrations in the groundwater at and downgradient of the site. Concentrations of other CVOCs are co-located with elevated TCE. Because of the prevalence of TCE across the site and the co-location with other CVOCs detected above cleanup standards, TCE drives the site investigation and is expected to drive the remedial recommendations. This section presents a site conceptual model based on historic and current site conditions. It is possible that geochemical conditions could change (e.g., as a result of a future cleanup action, discussed in Section 5). It is also possible that current TCE degradation processes could change, and incomplete degradation of TCE could lead to the formation of unwanted daughter products (e.g., vinyl chloride). Discussion on future conditions is included in the remedial design discussion (Section 5).

TCE is present at concentrations above MTCA Method B cleanup levels in the alley between the former GE building and the McKinstry building in the shallow wells (MW-1 and MW-4). TCE is also present in the shallow to medium depths below the west side of the Liberty Ridge property (MW-11, MW-14M, MW-14D and EPI MW-2D) and at deeper depths farther west (MW-15D). Figure 2-37 shows the vertical extent of the TCE plume based on the results of the February 2008 sampling event.

Trichloroethylene

Figure 2-12 shows the concentrations of TCE before the groundwater extraction system was installed. Figure 2-17 shows the TCE concentration after the groundwater extraction system was reconfigured to include RW-2 and RW-3[6]and Figure 2-22 shows TCE concentrations after 12 years of operation of the groundwater extraction system. Appendix A summarizes the analytical data collected between 1992 and February 2008.

Groundwater concentrations at MW-1, located in the alley of the former GE building, increased significantly during February and May of 2006, 2004, and 2002, and February 2000, corresponding with unusually heavy rain events during those periods. Figure 2-28 plots the TCE concentration in MW-1 versus rainfall, and Figure 2-28 shows that concentrations of TCE in MW-1 have increased after significant rain events. It is believed that the correlation between the increased precipitation and increase in TCE concentration was due to the higher water table coming into contact with residual TCE sorbed to soil in the "smear zone" (the zone of water table fluctuation) or from seepage water leaching TCE from the unsaturated to the saturated zone. In either case, the water interaction may have dissolved TCE from the soil into the groundwater and caused the increase in TCE concentration. In wells located farther downgradient, in the Off-Site Area, concentrations have remained stable since wells were first installed.

During the last annual groundwater sampling (February 2008), TCE was detected above the preliminary screening levels in the following wells:

TCE Surface Water Cleanup Level of 1.5 µg/L:	MW-1; MW-2; MW-4; MW-7; MW-8S; MW-11; MW-14M; MW-15M, MW-15D; MW-21S; EPI-MW-2D; EPI-MW-3S; EPI-MW-3D; and EPI-MW-4S
TCE Drinking Water Cleanup Level of 0.11 µg/L:	MW-1; MW-2; MW-4; MW-6; MW-7; MW-8S; MW-11; MW-14M; MW-14D, MW-15M, MW-15D; MW-20M; MW-21S; EPI-MW-2D; EPI-MW-3S; EPI-MW-3D; and EPI-MW-4S

cis1,2-Dichloroethylene

There is no MTCA Surface Water Cleanup Standard for cis-1,2 DCE; the MTCA Method B Drinking Water Standard is 80 µg/L.

Historically, cis-1,2 DCE has been detected above the drinking water standards in monitoring wells MW-7, MW-8S, MW-EPI-2D, MW-EPI-3S, MW-14M, MW-14D and MW-15D. Detections in MW-7 have been below drinking water levels since August 1998, and levels at MW-8S have been below drinking water levels since May 2000. EPI well EPI-MW-3S had detection above the drinking water level during the first

[6] RW-2 and RW-3 were brought on line in August 2003; RW-3 was installed in the alley to the north of the building to target the highest detections of TCE on the former GE site. After the system was modified to include RW-2 and RW-3, the pumping well RW-1 was turned off.

quarterly sampling event (February 2003); all other detections have been below the drinking water standards. EPI well EPI-MW-2D had detections above the drinking water level during the 2003 annual sampling event and during the 2008 annual sampling event; all other detections have been below the drinking water standards.

During the February 2008 annual groundwater sampling event cis-1,2-DCE was detected above the preliminary screening levels in the following wells:

cis-1,2-DCE Groundwater Cleanup Level of 80 µg/L: MW-14M, MW-15D, EPI-MW-2D

Figure 2-13 shows the concentrations of cis-1,2-DCE before the groundwater extraction system was installed, Figure 2-18 shows the TCE concentration after the groundwater extraction system was reconfigured to include RW-2 and RW-3[7]and Figure 2-23 shows cis-1,2-DCE concentrations after 12 years of operation of the groundwater extraction system. Appendix A summarizes the analytical data collected between 1992 and February 2008

1,1,1-Trichloroethane, 1,1-Dichlororethane, and 1,1-Dichloroethene

Detections of 1,1,1-TCA and its degradation byproduct (see Section 2.2.2.4) have been detected below the MTCA Method B Surface Water and Drinking Water Cleanup Levels for all monitoring wells sampled.

Figure 2-15 shows the concentrations of 1,1,1-TCA before the groundwater extraction system was installed, Figure 2-20 shows the TCE concentration after the groundwater extraction system was reconfigured to include RW-2 and RW-3, and Figure 2-25 shows 1,1,1-TCA concentrations after 12 years of operation of the groundwater extraction system. Appendix A summarizes the analytical data collected between 1992 and February 2008 for both 1,1-DCA, and 1,1,1-TCA .

Detections of DCE s are below the MTCA Method B Surface Water (23,000 µg/L) and MTCA Method B Groundwater (400 µg/L) Cleanup Levels since system startup. DCE is a byproduct of the abiotic degradation of 1,1,1-TCA ; therefore, the low concentrations of DCE that have been detected are likely the result of abiotic transformation of 1,1,1-TCA (see section 2.2.2.4).

Figure 2-14 shows the concentrations of DCE before the groundwater extraction system was installed,, Figure 2-19 shows the TCE concentration after the groundwater extraction system was reconfigured to include RW-2 and RW-3[8]and Figure 2-24 shows DCE concentrations after 12 years of operation of the groundwater extraction system. Appendix A summarizes the analytical data collected between 1992 and February 2008.

Vinyl Chloride

VC has not been detected above the MTCA Method B surface water cleanup level of 3.69 µg/L in On-site or Off-Site Area wells since the installation of the groundwater extraction system.

VC has previously been detected across the site in shallow and intermediate wells, and one deep well above the MTCA Method B Groundwater Cleanup level of 0.029 µg/L. The maximum detection of VC in shallow monitoring wells since system start up is in EPI-MW-3S, with a detection of 0.62 µg/L (February

[7] RW-2 and RW-3 were brought on line in August 2003; RW-3 was installed in the alley to the north of the building to target the highest detections of TCE on the former GE site. After the system was modified to include RW-2 and RW-3, the pumping well RW-1 was turned off.

[8] RW-2 and RW-3 were brought on line in August 2003; RW-3 was installed in the alley to the north of the building to target the highest detections of TCE on the former GE site. After the system was modified to include RW-2 and RW-3, the pumping well RW-1 was turned off.

2004). The maximum detection in intermediate wells is at EPI-MW-2D, detected at 1.6 µg/L (November 2004) and deep wells is MW-15D, with a maximum detected concentration of 0.48 µg/L (November 2004).

Figure 2-26 shows vinyl chloride concentrations after 12 years of operation of the groundwater extraction system. Appendix A summarizes the analytical data collected between 1992 and February 2008.

Tetrachloroethylene

Figure 2-28 shows the current extent of PCE at the site. This compound has historically been detected at very low levels, and has not persisted across the site (Appendix A). Detections of PCE above cleanup levels have been limited to the On-Site Area.

During the last annual groundwater sampling (February 2008) PCE was detected above the preliminary screening levels in the following wells:

PCE Surface Water Cleanup Level of 0.39 µg/L:	MW-1 and MW-4
PCE Groundwater Cleanup Level of 0.081 µg/L:	MW-1 MW-2, MW-4, and MW-6.

trans 1,2-Dichloroethylene

The trans 1,2-Dichloroethylene MTCA Method B surface water cleanup level is 33,000 µg/L and the MTCA Method B groundwater cleanup level is 160 µg/L Level. The highest detected value of this compound is 32 µg/L (detected at EPI-MW-2D during the February 2008 sampling event), which is below the cleanup level of 33,000 µg/L or 160 µg/L.

2.2.2.2 Arsenic

Arsenic analyses were performed on samples collected from all On- and Off-Site Area wells in May and August 2008 and from select monitoring wells in February and August 2004 (Table 2-3). Dissolved arsenic concentrations ranged from below the laboratory detection limit of 0.001 mg/L to 0.023 mg/L (EPI-MW-4S). Arsenic was detected in MW-6 (a maximum detection of 0.008 mg/L), MW-13 (a maximum detection of 0.006 mg/L), and EPI-MW-4S (a maximum detection of 0.026 mg/L) above the MTCA Method A Cleanup Level of 0.005 mg/L. Groundwater from all wells, with the expectation of EPI-MW-4S, is below the Washington State maximum contaminant level (MCL) concentration of 0.01 mg/L. The detections in the Off-site Area monitoring well, EPI-MW-4S, appears to be an isolated area of arsenic[9]. Monitoring wells in the immediate vicinity (including the shallow well, and wells located immediately upgradient and downgradient) have concentrations just above the detection limit.

Arsenic has not been detected above MTCA Method A cleanup levels in the source area (MW-1 and MW-4 concentrations detected at 0.001 mg/L). Detections in the upgradient wells MW-2 and MW-5, are similar to the detections in the source area (0.002 and 0.001 mg/L, respectively), suggestive of native sources of arsenic, and not anthropogenic sources.

Because dissolved arsenic is only detected in one well above the screening well, and because this well is off site, downgradient of the source area, and because it is not detected in the source area; it is not believed to be associated with site activities.

[9] Ecology does not agree that the elevated arsenic groundwater concentrations at EPI-MW-4 (23 ppb on April 2008) are due to a localized source area of arsenic. Ecology states that It is very likely that reducing conditions resulted in the dissolution of arsenic in this area.

Arsenic will be monitored during the remediation activities (Section 5), as remediation activities potentially could cause the mobilization of arsenic from soil to groundwater. This is unlikely at this site, based on the low detections of arsenic in the soil (Section 2.2.1) and the low native concentration in groundwater.

2.2.2.3 1,4-Dioxane

On- and Off-Site Area monitoring wells were sampled for 1,4-dioxane between August 2004 and August 2008. During the May 2008 groundwater sampling event, 1,4-dioxane was sampled in all site wells (Table 2-4). During this sampling event, 1,4-dioxane was detected above laboratory reporting limits in two monitoring wells, and detected above the MTCA Method B cleanup level for protection of drinking water level (4.0 µg/L) in one monitoring well. All detections are below the revised MTCA surface water standard, determined by Ecology, of 79 µg/L.

Samples were also collected between August 2004 and 2005, during these sampling events 1,4-dioxane was detected[10] in six monitoring wells of these, three monitoring wells were above the MTCA Method B cleanup level for protection of drinking water. To date, 116 groundwater samples have been collected for the analysis of 1,4-dioxane. Of these 147 samples, 7 samples (Table 2-4\ or 4.8 percent, resulted in detections above the MTCA Method B cleanup level for the protection of drinking water.

1,4-dioxane was primarily used in solvent application (predominantly in 1,1,1-TCA), in manufacturing, but is also commonly found in automotive coolant (EPA 1995). As stated above, 1,1,1-TCA concentrations historically have been below the preliminary screening levels, indicating that 1,1,1-TCA was not present in abundance at the site, or that concentrations have completely attenuated overtime. 1,4-dioxane has not been detected in the On-Site Area. It is possible that 1,4-dioxane has also attenuated and that the low level detections in the Off-Site Area are from residual concentrations. This seems unlikely since concentrations of 1,1,1-TCA are below screening levels downgradient. Regardless of the source of 1,4-dioxane, concentrations are very limited and remain relatively low, compared to other Ecology sites in the Georgetown neighborhood (Geomatrix 2007).

Though no concentrations of 1,4-dioxane are detected above the surface water screening value, 1,4-dioxane, Ecology requires that it be carried forward as a COC in groundwater.

2.2.2.4 Groundwater CVOC Fate and Transport

Groundwater data, collected during quarterly sampling events, suggest that natural biologic and abiotic degradation of CVOCs has occurred and may be occurring at the site and that source removal and the groundwater extraction system has effectively reduced concentrations in the former source area. CVOC degradation processes are illustrated in Figure 2-29. Reductive dechlorination of PCE and TCE has apparently occurred in portions of the site, as evidenced by the presence of the biodegradation byproducts cis-1,2-DCE and occasional detections of VC. Biological degradation of TCE almost always results in greater quantities of cis-1,2-DCE over trans-1,2-DCE. It is unclear whether degradation or operation of the groundwater extraction system has more effectively reduced concentrations in the groundwater. However, data suggest that both processes are contributing to the reduction of CVOC concentrations.

In addition to biological degradation processes, non-biological (abiotic) degradation is evidenced by the presence of 1,1-DCE, a potential byproduct of the abiotic degradation of 1,1,1-TCA. Degradation of 1,1,1-TCA is illustrated graphically in Figure 2-30. This graph shows 1,1,1-TCA in MW-1, initially at very high concentrations, and then decreasing with time. This decrease is accompanied by an increase in 1,1-DCE in MW-4, immediately downgradient from MW-1. This is evidence that 1,1,1-TCA degradation occurred, resulting in an increase in the breakdown product 1,1-DCE. MW-1 and MW-4 were selected for this

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[10] It should be noted that the laboratory reporting limit during the February and August 2005 event was slightly above the MTCA Method B Cleanup Level for protection of drinking water; however, results from the May 2008 confirmed that the non detections were below the cleanup level.

illustration because the historically high concentrations observed in the source area allow for visualization of trends; low concentrations are difficult to plot due to the "noise" that occurs when concentrations are at or below the detection limit (including undetected concentrations).

Similarly, TCE degradation is illustrated in Figure 2-31, Figure 2-32 shows the TCE concentrations overtime in On-Site Area wells and Figure 2-33 shows the TCE concentrations overtime in Off-site Area wells. Figure 2-30 shows that prior to initiation of pumping at the site in 1996, TCE concentrations in MW-1 were decreasing, with an accompanying increase in cis-1,2-DCE concentrations. TCE tends to decrease between MW-1 and MW-4, while cis-DCE tends to increase in these same wells. Groundwater flows towards MW-4, in the vicinity of the recovery system. Additionally, PCE, one of the primary sources at the site, has not migrated, and remains at low concentrations in a very localized area near the original source of impacts. Degradation processes serve to limit the migration of PCE. Figures 2-31 and 2-32 show that over the entire site TCE concentrations have decreased over time at all wells with the exception of MW-1.

Increasing concentrations of VC can indicate incomplete degradation of TCE and PCE. Figures 2-34 and 2-35 show the concentration of VC in On- and Off-Site Area wells over time. Detections of VC in On-Site Area wells have decreased over time. Concentrations in the Off-Site Area have shown both slight increases and slight decreases over time; none of the Off-Site Area wells show significant increases over time.

These observations indicate that some degradation is occurring at the site and degradation may differ throughout slightly between the On-Site and Off-Site Area. The lack of any detected CVOCs in the furthest downgradient monitoring wells indicates that attenuation is occurring at the western most edge of the plume. The Off-Site Area plume has remained stable or shown slight decreases and concentrations of TCE and its daughter products in the further downgradient wells are significantly lower or non-detect (Figure 2-33). The data also indicates that while TCE, PCE and 1,1,1-TCA have been associated with releases to groundwater at the 220 South Dawson Street property, TCE is the principle chemical of concern for the site (based on concentrations) and persistence in the dissolved phase.

2.2.2.5 Natural Attenuation Parameters

Groundwater samples were collected during two sampling events (February and August 2004) and analyzed for parameters to assess natural attenuation. Samples were collected from all groundwater monitoring wells (Table 2-5). This assessment was conducted to document geochemical evidence of natural CVOC biodegradation processes at the site and to evaluate the extent to which natural attenuation may constitute an effective remedial alternative for controlling dissolved chemical migration and reducing concentrations over time.

The site has no assigned background wells, but shallow upgradient wells, which have significantly lower TCE concentrations, include MW-2 and MW-5. MNA results will be compared against the MW-2 and MW-5 in this discussion and in Table 2-5, which includes a summary of all results.

Ethane/Ethene

Ethane and ethene are the final daughter products in the biological reductive dechlorination of chloroethene (PCE and TCE) and chloroethane (1,1,1-TCA) solvents. Sample results summarized in Table 2-5 indicate no detection of ethane or ethene in any groundwater samples collected. The absence of these constituents does not indicate that biodegradation of CVOCs is not occurring. Rather, it indicates that aquifer geochemical conditions have not yet allowed for the complete reductive dechlorination process to proceed to ethane and ethane as final products.

Chloride

Chloride is a product of chlorinated solvent reduction, and concentrations above background may indicate the degradation of chlorinated solvents. Chloride was detected in all samples, with concentrations ranging from 3.5 mg/L (MW-1) to 50 mg/L (MW-14M). Concentration trends were higher in the intermediate and deeper wells.

The average concentration in shallow wells is 12.15 mg/L, in intermediate wells is 29 mg/L, and in deep wells is 23.0 mg/L (Table 2-5). The average upgradient well concentration for chloride is 5.6 mg/L (measured at upgradient wells MW-2 and MW-5). All of the average concentrations at the remaining site wells are higher than the average upgradient well value, indicating the possibility of degradation.

Dissolved Oxygen

Dissolved oxygen (DO) concentrations less than 1 mg/L (Air Force 1996) or 0.5 mg/L (USEPA 1998) generally indicate anaerobic conditions. Field measurements of DO collected during sampling events indicates that DO values in the shallow wells average 1.2 mg/L and decrease with water depth to 0.5 mg/L (Table 2-5). These DO concentrations indicate that conditions may be marginally anaerobic in the shallow groundwater unit, allowing reductive dechlorination to occur. DO concentrations decreased with depth, indicating that anaerobic conditions are more likely associated with the intermediate and deeper groundwater unit.

Oxidation/Reduction Potential (ORP), Alkalinity, and Carbon Dioxide

Oxidation/reduction potential (ORP) is occasionally used as indicators of microbial activity. These parameters are not a direct measure of natural attenuation but may provide information regarding the occurrence of microbial activity at a site. In aquifers where increased microbial activity (associated with the biodegradation of organic constituents) has depleted DO concentrations, ORP values are typically lower than in areas where biodegradable organics are scarce. ORP values of -100 mV or lower are indicative of reducing geochemical conditions. Higher ORP values indicate that ORP may be inhibiting biological reductive dechlorination. The field measurements of ORP at the site indicate relatively high positive values (upgradient well average concentrations of 74.5 mV, shallow well average concentrations of 57 mV, intermediate well average concentrations of 58 mV, and deep well average concentrations of 28 mV), indicating that biological reductive dechlorination is inhibited (Table 2-5).

As part of the IAWP, Ecology required the inclusion of arsenic, iron, and manganese in the groundwater monitoring program to evaluate whether these metals are released into the aquifer as a result of redox conditions. Iron and manganese analyses were performed on samples collected from wells located in the CVOC-affected area, as well as MW-5, which was used to assess upgradient well concentrations of these metals. Table 2-2 summarizes the sampling results, for samples collected from 24 wells in August 2003, and February and August 2004. Concentrations of iron and manganese were all well below MTCA Method A groundwater standards (Method A standards take into account natural occurring concentrations), Table 2-2. As stated above, arsenic analyses were performed on samples collected from all On- and Off-site Area wells in May 2008 and from select monitoring wells in February and August 2004. Dissolved arsenic was detected at concentrations in the range of slightly above the MTCA Method A concentration of 0.005 mg/L in three shallow monitoring wells (Table 2-2).

The inorganic concentrations are generally consistent across the site and are relatively low, indicating that the possibility of mobilization of naturally-occurring metals is very low at this site and is not a significant risk.

Some geochemical assessments of intrinsic biodegradation have shown a positive relationship between zones of increased microbial activity and increased alkalinity. Increases in alkalinity may result from the dissolution of carbonate minerals due to acid produced through microbial metabolism. It should be noted that carbon dioxide production does not directly affect measured alkalinity. Consequently, alkalinity is affected by microbial activity, the mineralogy of the aquifer solids, and the buffering capacity within the aquifer matrix. Due to the complex interrelationship between these variables, alkalinity typically is not a reliable parameter for indicating increased intrinsic biodegradation activity. Alkalinity across the site was similar, with a slight increase towards the Off-Site Area wells MW-14, MW-15, and MW-16 (slight increase observed in both wells associated with these locations).

At the GE site, average measured concentrations of carbon dioxide in upgradient wells, and shallow, intermediate, and deep wells are similar across the site.

Electron Acceptors

Under anoxic conditions, nitrate (NO_3) can serve as an electron acceptor to support the biodegradation of certain organic contaminants. Non-chlorinated hydrocarbons (VOCs and semivolatile organic compounds [SVOCs]) have been shown to be susceptible to anaerobic biodegradation under nitrate-reducing conditions; however, the biological reductive dechlorination of highly chlorinated solvents, such as PCE and TCE, typically require more highly reducing geochemical conditions than are associated with nitrate reduction.

At the GE site, upgradient wells (MW-2, MW-5) generally exhibit nitrate concentrations ranging from 1 to 5 mg/L, and downgradient wells (MW-10, MW-11, MW-12) exhibit nitrate concentrations ranging from about 3 to 7 mg/L. Source area wells MW-1 and MW-4 have shown nitrate concentrations that are similar to the range of values reflected by the upgradient wells, while wells immediately downgradient of the source area (MW-7 and MW-8) generally exhibit nitrate concentrations less than 1 mg/L (Table 2-5). Consequently, the data do not exhibit a consistent pattern that is indicative of CVOC biodegradation via a nitrate reduction pathway.

Under highly reducing conditions, sulfate (SO_4^{2-}) can also serve as a terminal electron acceptor to support organic constituent biodegradation, with the production of sulfide as a reduced byproduct. Sulfate concentrations reported for upgradient, source area, and downgradient wells are all comparable and no pattern in concentrations was observed that could be attributable to CVOC biodegradation through a sulfate reduction pathway. Sulfide was not detected in any wells, with the exception of a single sample from MW-16D at a concentration slightly above the detection limit. The absence of detectable sulfide does not exclude the possibility that sulfate reduction could be occurring, since sulfide can readily react with ferrous iron and precipitate as insoluble iron sulfide (pyrite). Nevertheless, the sulfate and sulfide data do not provide geochemical evidence that sulfate reduction is a significant biodegradation pathway at the site.

Methane

When all other electron acceptors have been consumed and highly reducing conditions exist, carbon dioxide and/or simple organic acids can serve as electron acceptors to support the continued biodegradation of organic chemicals, resulting in the production of methane as a reduced byproduct. This process is typically referred to as methanogenesis. Methane was detected in all monitoring wells at the site; however, concentrations were generally very low and were only slightly above the analytical detection limit. The highest methane concentrations were detected in MW-16M (720 to 4,000 µg/L) and MW-16D (170 to 180 µg/L). These wells also exhibit the highest concentrations of total organic carbon (TOC), ranging from about 9 to 12 mg/L (Table 2-5). MW-16M and MW-16D have historically had non–detectable concentrations of CVOC. These two wells are also directly downgradient of MW-14M/D and MW-15M/D, which have the highest detectable CVOC concentrations in the Off-Site Area. The higher methane concentrations combined with the low detections of CVOCs at MW-16M/D (historical all samples have been below the laboratory detection limit for all compounds detected) indicate strong evidence of CVOC biodegradation via a methanogenic pathway.

Conductivity and pH

Conductivity (specific conductance) indicates the total dissolved ionic constituents in a water sample and is a measure of how well water can conduct an electrical current. For example, distilled water has a conductivity near 0 µmhos/cm. By comparison, sea water exhibits a conductivity value on the order of 50,000 µS/cm. Conductivity is not used as an indication of natural attenuation processes; rather, it is typically used in environmental assessments as a general water quality indicator to identify when groundwater produced during monitoring well purging has chemically stabilized. Conductivity can also be used to characterize water quality from separate hydrogeologic units (i.e., a shallow groundwater unit may exhibit a relatively high conductivity due to dissolved mineral constituents, while a deep sand and gravel aquifer may exhibit a lower conductivity.

At the 220 South Dawson site, conductivity values were generally consistent in all site wells, ranging from 497 to 726 µmhos/cm. Conductivity values were observed to increase somewhat as a function of depth. These values, in association with the known aquifer chemical data, indicate that all of the site monitoring wells are completed in a single hydrogeologic unit. The low conductivity readings further confirm that the groundwater is not affected by the influence of the estuarine portion of the Duwamish River.

Biodegradation processes are pH-dependant and optimally occur at a pH between 5 and 8 standard units (SU). The pH for all site wells ranged from 5.89 to 6.63, within the optimal range for CVOC reductive dechlorination

MNA Assessment Conclusions

CVOC concentrations in groundwater exhibit a pattern of biological reductive dechlorination, in which PCE and TCE are the predominant CVOCs in suspected source areas; less-chlorinated CVOCs (primarily cis-1,2-DCE), predominate in downgradient locations. The data suggest that further biological reductive dechlorination to VC is not occurring to a significant degree, possibly due to the absence of sufficient easily biodegradable primary substrate (as indicated by the relatively low TOC concentrations). In addition, there is little evidence that dissolved CVOCs are migrating in the Off-Site Area, which suggests that natural attenuation processes are limiting plume migration. However, secondary geochemical evidence of intrinsic biodegradation processes (i.e., relationships between contaminant source areas, electron acceptors, reduced byproducts, and groundwater flow direction), is inconsistent especially in regards to the On-Site Area. Intrinsic biodegradation may inhibit the dissolved migration of some CVOCs and reduce CVOC concentrations over time at both the On-Site and Off-Site Areas. Data collected from the MW-16 wells clearly indicated that methanogenesis is occurring at this downgradient area.

2.2.2.6 Summary of Groundwater Contaminants of Concern

As discussed above, the 2008 Agreed Order listed the COCs for the site to include: TCE, 1,1,1-TCA, PCE, DCE, cis 1,2-dichloroethylene, trans 1,2 dichloroethylene, 1,4 dioxane, arsenic and VC.

2.2.3 Indoor Air

Between 2000 and 2006, an indoor air evaluation at the former GE facility and at the two buildings downgradient was conducted. The following sections briefly outline the indoor air sampling at the former GE facility. Samples have been collected at the former GE building in December 2005, August 2006, November 2006, and February 2007. For a more detailed description of conditions at the former GE facility and the two downgradient buildings (the Liberty Ridge building and the Interior Environments building) please see the IAWP Completion Report (RETEC 2007A)[11].

A subslab depressurization system was installed in August 2006 as an interim measure to prevent the migration of subslab vapors into the indoor air at the former GE facility.

For purposes of defining the nature and extent of chemical-affected vapor at the site, Table 2-6 shows the preliminary screening values that have been applied to the site vapor COCs.

[11] Ecology agreed that no further action was required, but did not approve and disagreed with several statements in the IAWP Completion Report.

Table 2-6 Vapor Preliminary Screening Values

Compound	Value (µg/m^3)	Source
Subslab		
Trichloroethylene (TCE)	22	MTCA Method C Industrial Value
1,1,1-Trichloroethane (1,1,1-TCA)	1,100,000	MTCA Method C Industrial Value
Tetrachloroethylene (PCE)	420	MTCA Method C Industrial Value
1,1-Dichloroethylene	50	MTCA Method C Industrial Value
Vinyl Chloride	280	MTCA Method C Industrial Value
Indoor Air		
Trichloroethylene (TCE)	0.22 and 0.96	MTCA Method C Indoor Air Industrial Value and Site Specific Remediation Level
1,1,1-Trichloroethane (1,1,1-TCA)	11,000	MTCA Method C Indoor Air Industrial Value
Tetrachloroethylene (PCE)	4.2	MTCA Method C Indoor Air Industrial Value
1,1-Dichloroethylene	0.5	MTCA Method C Indoor Air Industrial Value
Vinyl Chloride	2.8	MTCA Method C Indoor Air Industrial Value

2.2.3.1 Subslab Samples Results

Subslab samples were collected in the December 2005 sampling event (Table 2-7). Both 1,1,1-TCA and TCE were consistently detected in subslab samples. 1,1,1-TCA concentrations ranged from 15 to 6,900 µg/m^3, but were well below the screening level of 220,500 µg/m^3. TCE concentrations ranged from 44 to 3,700 µg/m^3, exceeding the screening level of 22 µg/m^3. Table 2-7 summaries the results of this sampling and Figure 2-36 summarizes the sample locations.

2.2.3.2 Ambient and Indoor Air Sample Results

Five rounds of indoor air samples were collected at the site (December 2005, August 2006, November 2006, February 2007, and November 2007). One additional modified sampling event was conducted in March 2007. The November 2007 sampling event was conducted after the installation of a subslab vapor mitigation system. The following discussion is organized prior to the installation of the subslab vapor mitigation system, and after the installation. Table 2-8 summaries the results of this sampling and Figure 2-36 summarizes the sample locations.

<u>Prior to the Installation of the Subslab Vapor Mitigation System</u>

During the December 2005 sampling event 3 locations exhibited detected concentrations above the MTCA Method C indoor air exposure value of 0.22 µg/m^3. These were IA-6 (0.245 µg/m^3), IA-4 (0.355 µg/m^3), and IA-5 (0.515 µg/m^3). A site specific interim remediation level of 0.96 µg/m^3 was calculated; this value provides an acceptable risk of 10^{-5} under a realistic worker scenario. This number takes into account actual exposure frequencies and durations for the workers in the building, rather than assuming 24-hour a day exposures as the MTCA Method C value assumes. During the December 2005, none of the indoor air samples contained TCE at concentrations greater than this level.

GE completed three additional rounds of indoor and ambient air sampling on August 21, 2006, November 9, 2006, and February 19, 2007. Results of the indoor air samples from these three events varied. TCE, PCE, 1,1,1-TCA, and chloroform were detected during at least one of these events.

- Samples collected at IA-1, IA-3, IA-4 and IA-5 resulted in values above the MTCA Method C concentration for TCE (values detected above the reporting limit ranged from 0.24 μg/m^3 (IA-3) to 5.2 μg/m^3 (IA-4)). Sample locations with detected concentration above the site-specific remediation level of 0.96 included IA-1, IA-4, and IA-5 (values ranged from 0.99 μg/m^3 [IA-5] to 5.2 μg/m^3 [IA-4]).
- PCE detections were all below the MTCA Method C Cleanup level of 4.2 μg/m^3. Sample detections above the reporting limit ranged from 0.01 μg/m^3 (IA-4) to 0.67 μg/m^3 (IA-3)[12].
- 1,1,1-TCA detections were all below the MTCA Method C Cleanup level of 2,205 μg/m^3. Sample detections above the reporting limit ranged from 0.18 μg/m^3 (IA-1) to 0.37 μg/m^3 (IA-5).
- Chloroform was detected in two samples during the August sampling events. Detections were at the reporting limit of 0.16 μg/m^3, below the MTCA Method C Cleanup level of 1.1 μg/m^3. Chloroform is a common laboratory contaminant and these detected concentrations may not be related to the site.

During these sampling events PCE was the only CVOC detected in ambient air. PCE was detected during the August and February sampling events. PCE detections ranged from 0.26 μg/m^3 (AA-4) to 0.27 μg/m3 (in AA-3), below the MTCA Method C Indoor Air Screening Level of 4.2 μg/m^3. No other CVOC was detected at a concentration above the detection limit in ambient air samples.

After the Installation of the Subslab Vapor Mitigation System

Ambient air, indoor air, and a stack sample were collected on Friday, November 2 and Monday, November 5, 2007. 1,1,1-TCA, PCE, and chloroform were detected below the MTCA Method C screening level in all indoor air samples. TCE was detected in all indoor samples with the exception of IA-3. Corrected TCE detections ranged from 0.04 μg/m^3 (IA-5) to 0.46 μg/m^3 (IA-4)[13], TCE detected at IA-4 is greater than the MTCA Method C screening level of 0.22 μg/m^3. All detections are below the TCE site remediation level of 0.96 μg/m^3.

In addition to the ambient and indoor air samples, one analytical sample was collected directly from the exhaust stack on the downstream side of the exhaust fan. Prior to sampling, the exit velocity was measured from the sampling port using a hot wire anemometer. Table 2-9 provides a summary of the average flow, detected concentrations, and the total mass released based on the air flow and detected concentrations.

Table 2-9 VIMS Exhaust Sample Discharge

Summary of Velocity Recordings

Stack velocity range (ft/min):	1750-2305
Average stack velocity (ft/min):	1990
Pipe area (ft^2):	0.0899
Flow at exhaust (ft^3/min):	178.82

[12] Indoor air samples were corrected, to account for the influence of PCE from the ambient air

[13] TCE concentrations detected in indoor air are estimates due to lack of upwind ambient air TCE concentrations data for the sampling period.

Summary of Analytical Results

Location [a]	EX-1					
COC Detected [a]	1,1-DCA	cis-1,2-DCE	PCE	TCE	TCA	
µg/M^{3} [a]	8.2	7	6.2	140	44	
Kg/M^3	8.20E-09	7.00E-09	6.20E-09	1.40E-07	4.40E-08	
lbs/ft^3	5.12E-10	4.37E-10	3.87E-10	8.74E-09	2.75E-09	
					total lbs/ft^3	**1.28E-08**

[a] Results from November 5, 2007 sampling event

Summary of Mass Emitted

Flow (at sample location)		1,1-DCA	cis-1,2-DCE	PCE	TCE	TCA
cfm	**ft^3/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**	**lbs/yr**
175.82	9.24E+07	0.05	0.04	0.04	0.81	0.25
					total lbs/year	**1.18**

Exempt from Air Permit: Soil and groundwater remediation projects involving <15 pounds per year of benzene or vinyl chloride, <500 pounds per year of perchloroethylene, and <1,000 pounds per year of toxic air contaminants.

2.2.3.3 Cross-Slab Pressure Differential

During the December 2005 sampling event, a cross-slab pressure differential was monitored at two locations in the building for 24 hours to assess the potential for sub-surface vapor intrusion. As described in the *Evaluation of the Potential for Subsurface Vapor Intrusion* report, pressure differential data from the test period showed a neutral gradient between the building and the subsurface (RETEC 2006A).

2.2.3.4 Summary of Vapor Contaminants of Concern

As discussed above, the 2008 Agreed Order listed the COCs for the site to include: TCE, 1,1,1-TCA, PCE, DCE, cis-1,2 DCE, trans 1,2 dichloroethylene, and VC. Because arsenic and 1,4-dioxane are not volatile substances, these are not considered potential vapor contaminants of concern.

2.3 Exposure Assessment

This section identifies potential human and ecological exposures to chemically affected media at the site. Consistent with the purpose of the RI/FFS (WAC 173-340-350(1)), the goal of this section is to identify exposure scenarios to assist in the selection of a cleanup action. Cleanup actions developed in this FFS must "protect human health and the environment (including, as appropriate, aquatic and terrestrial ecological receptors)" (WAC 173-340-350(8)(c)(i)(A)). To evaluate cleanup actions, the cleanup standards must be established. As outlined in WAC 173-340-700(5), to set the cleanup standards applicable to cleanup actions, the following issues must be determined:

- **Nature of the Contamination:** The nature of chemically affected media was described in detail in Section 2.2. This section determines current and potential receptors and pathways of exposure, based on current and potential land and resource uses.
- **Potentially Chemically Affected Media:** Impacted media at the site include soil, groundwater, and indoor air.
- **Potentially Complete Current and Future Exposure Pathways:**
  - ▶ **Direct contact with soil** – In this exposure pathway, a receptor could come in direct contact with soil containing COCs. COCs exceeding screening criteria in soil at the former GE site is limited to soil that remained in place after a site-wide excavation (described in the introduction of Section 2.2). This remaining soil was not accessible to equipment during the excavation process; the majority of the soil is located under building foundations or building walls. Additionally, the former GE site is completely paved with asphalt or concrete. Therefore, the potential exposure scenario is limited to construction worker contact with the soils during

future construction or maintenance activities. Exposure routes include dermal contact, incidental ingestion, and inhalation.

- **Direct contact with groundwater** – In this exposure pathway, a receptor could come in direct contact with groundwater (e.g., if an excavation is extended below the water table). Direct contact with CVOC-affected groundwater is a potentially plausible exposure scenario. The potential exposure scenario would be a construction worker in direct contact with groundwater within and excavation. Exposure routes would include dermal contact and incidental ingestion.
- **Groundwater as a drinking water source** – In this exposure pathway, CVOCs would migrate from the source via groundwater to a drinking water well, where it would be used for residential consumption and cleaning. This pathway is not complete because the City of Seattle has an ordinance restricting use of groundwater as a drinking water source in this industrial area of Seattle. However, as required by Ecology, this FFS conservatively includes the potable use of groundwater pathway as potentially complete. Exposure routes would include dermal contact, ingestion, inhalation.
- **Vapor intrusion to indoor air** – In this exposure pathway, CVOCs would volatilize from soil and groundwater, would migrate through the unsaturated zone via vapor gas and would enter the indoor ambient air. A potential receptor would then inhale the CVOC-affected air. Concentrations measured in selected indoor air samples at the former GE building are higher than the MTCA screening concentrations established for the site. Based on these detected concentrations, this is a complete exposure pathway and will be addressed in the screening of alternatives. The exposure route includes inhalation.
- **Consumption of fish and aquatic ecological exposure** – In this exposure pathway, CVOCs that have partitioned to groundwater would migrate via groundwater the 690 feet to Slip 1 of the Duwamish Waterway (measured from the furthest downgradient portion of the plume), where they would be released to the surface water environment. Potential receptors are the ecological organisms in the waterway and human receptors that may catch and consume CVOC-affected fish. Current sampling data shows that the CVOC-affected groundwater does not extend to the waterway. The westernmost detected concentrations (demonstrated by the results from MW-16M and MW-16D) are 690 feet from Slip 1 of the waterway. In addition, the Duwamish Waterway is listed as a U.S. Environmental Protection Agency (EPA) Superfund Site and has restrictions on fish consumption. Furthermore, over 10 years of monitoring the On-Site Area and Off-Site Area have shown stable or decreasing concentrations. Given the substantial distance of the groundwater plume from the waterway, the fact that source concentrations are stable or decreasing, and the nature of the waterway (Superfund Site, fishing restrictions); this exposure pathway is not expected to be complete. While unlikely, this pathway is carried forward as it is the primary groundwater exposure pathway at the site.

- **Current and Potential Receptors:** Based on the impacted nature of the contamination, impacted medial, and the potential exposure pathways described above, the current and potential receptors include:
  - Construction worker (soil or groundwater)
  - Site worker (indoor air)
  - Recreational fishers (consumption of fish)
  - Aquatic ecological receptors
  - Potential receptors expected to be the same as current receptors.
- **Current and Potential Land and Resource Uses:** The site is located in a heavily industrial area of Seattle (Figure 1-4). Historically (over the past 100+ years), this area of Seattle has included heavy industrial land use. The Duwamish Valley was regraded and backfilled in the late 1800s and early 1900s to permit the construction of the currently established terminals and

rail yards. This area has never been subject to cultivation, or heavy residential use. Areas to the south of the site include a mixed use of residential and industrial land use. Based on the historic and current uses it is not anticipated that uses will change significantly in the future.

3.0 Cleanup Standards

While screening concentrations were used in Section 2 to identify chemicals of potential concern, cleanup standards are used to determine when a remedial action is complete. The cleanup standard comprises two components: cleanup concentration (or level) and point of compliance (the physical location(s) where the cleanup level needs to be achieved. MTCA provides the framework for evaluating and selecting cleanup actions. Within this framework are threshold requirements that need to be met by all cleanup actions. The threshold requirements for cleanup actions (WAC 173-340-360(2)(a)) are to:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal law
- Provide for compliance monitoring.

Other MTCA requirements for cleanup actions (WAC 173-340-360(2)(b)) are to use permanent solutions to the maximum extent practicable, provide for a reasonable restoration time frame, and consider public concerns raised on the draft Cleanup Action Plan during the public comment period.

The potential for human health and ecological exposures to the COCs at the site were evaluated in Section 2. Specific exposure pathways are summarized in Section 2.3. This section develops cleanup standards for the site that protect these human and ecological receptors. The section also identifies the state and federal laws that are applicable to the site and cleanup actions at the site. As stated in MTCA, cleanup standards consist of the following:

- The concentration of a hazardous substance that protects potential human and ecological receptors (cleanup level)
- The location(s) on or downgradient of the subject property where the cleanup level must be attained (point of compliance)
- Other regulatory requirements that apply to a cleanup action because of the type of action and/or the location of the site.

WAC 173-340-700(3) controls currently existing or being installed at the site minimize the potential for exposure to these chemicals. However, should conditions change in the future, additional potential exposure is possible. This section summarizes potential exposure pathways and COCs, applicable cleanup levels for each pathway and COC, and points of compliance.

3.1 Discussion of Cleanup Levels for Exposure Pathways and COCs

MTCA (WAC 173-340-705(2) and 706(2)) requires that cleanup levels be at least as stringent as:

- Concentrations of individual hazardous substances established under applicable state and federal laws;
- Concentrations that are estimated to result in no adverse effects on the protection and propagation of aquatic life, and no significant adverse effects on terrestrial ecological receptors using the procedures specified in WAC 173-340-7490 through 173-340-7494
- For hazardous substances for which sufficiently protective, health-based criteria or standards have not been established under applicable state and federal laws, those concentrations which protect human health as determined by risk assessment methods.

In addition, MTCA provides three methods for developing cleanup levels for soil, groundwater, and air:

- Method A defines cleanup levels for 25 common site chemicals and is generally designated for routine cleanups and considers background conditions and analytical quantification limitations
- Method B determines cleanup levels at sites with unrestricted use using a site-specific risk assessment with cancer risk levels established at 10^{-6} for individual carcinogens and 10^{-5} for total site risk, and non-cancer risk at or below a hazard index of 1
- Method C determines cleanup levels for specific site uses (i.e., industrial) using site-specific risk assessment when practicable methods of treatment are used and/or industrial use under WAC 173-340-745 can be demonstrated.

The COCs for the site to include:

- Soil: TCE, PCE, and TPH (heavy oil range)
- GW: TCE, 1,1,1-TCA, PCE, DCE, cis-1,2 DCE, trans 1,2 dichloroethylene, 1,4 dioxane, arsenic and VC
- Vapor: TCE, 1,1,1-TCA, PCE, DCE, cis-1,2 DCE, trans 1,2 dichloroethylene and VC.

3.1.1 Soil

COCs identified in site soil include TCE, PCE, and TPH-heavy oil. All three of these COCs were compared to MTCA Method A concentrations (unrestricted land use). For TCE and PCE the MTCA Method A concentrations of 0.03 mg/kg and 0.05 mg/kg (respectively) are based on soil concentrations that are protective of drinking water. With only a few exceptions (where soil was inaccessible), a 1996 soil removal action resulted in TCE and PCE concentrations at or below these concentrations (see discussion in Section 2). Therefore, soil concentrations are considered to be protective of both direct exposure and protection of groundwater.

Although they were not detected at concentrations that exceed screening concentrations, VC, 1,1,1-TCA and 1,1-DCE are also retained as chemicals of interest (COIs) because they are degradation products of TCE and PCE and, therefore, could increase in concentration during remediation.

3.1.1.1 Evaluation of Potential Exposure Pathways

As described in Section 2.3, potential exposure pathways and subsequent points of contact associated with the chemicals in soil are limited to direct contact by a construction worker during excavation, and the areas of concern would be limited to a few discrete areas that were inaccessible during the 1996 removal action.

The site is located in an urban, industrialized area and the potential for ecological exposure to soil is not considered significant. COC concentrations in the unsaturated zone are generally below MTCA Method A concentrations, which are protective of both direct contact and drinking water. CVOC remaining in the smear zone or saturated zone will be addressed by the groundwater remedy. A potential for soil to leach to groundwater exists only in small inaccessible areas of the remaining soil, specifically in Area 9 (TPH) and Area 7 (PCE).

No evaluation of risk to terrestrial ecological receptors is required because of the industrial nature of the area; specifically, the area is covered by buildings, paved roads, parking lots, and other barriers that prevent plants and wildlife from being exposed to the soil contamination[14] (WAC 173-340-7491 (1)(b). Therefore, ecologically-based cleanup levels will focus on human health and the environment.

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[14] Constructed landscape planters are present in a few areas on site and downgradient of the site. None of these planters are located in the former source area (the alley between the former GE and McKinstry building), all other remaining soil left on site is under building foundations and not accessible by wildlife or plants.

The only possible remaining pathway for exposure to contaminated soils is direct contact by a worker in an excavation of the limited volumes of soils with CVOC or TPH remain in inaccessible locations adjacent to building footings. These soils are currently capped, which prevents direct exposure and minimize infiltration. However, if the site is redeveloped in the future, direct contact with COC-affected soil could occur.

As a result, direct contact by a worker in an excavation is assumed to be a complete pathway, and is the sole exposure pathway that will be evaluated for determination of cleanup levels.

In Ecology's Response to Comments, they indicated that the proposed soil cleanup levels are protective of groundwater cleanup levels. They went on further to request that GE propose and justify why the above proposed cleanup levels are (1) protective of groundwater quality, such that soil contamination cannot lead to exceedances of surface water cleanup levels in groundwater; (2) protective of groundwater quality such that soil contamination cannot lead to contamination in shallow groundwater that poses a potentially unacceptable vapor intrusion threat. The following provides justification for the above items:

Protective of groundwater quality, such that soil contamination cannot lead to exceedances of surface water cleanup levels in groundwater: The MTCA Method A concentration for TCE (0.03 mg/kg) and PCE (0.05 mg/kg) is based on protection of groundwater as a drinking water source[15]. In section 2.2.1.3, it is stated that confirmational sampling conducted after the 1996 soil removal action verified that TCE concentrations left in place were generally at or below the detection limit (0.05 mg/kg). For the most part, TCE was not detected in the confirmational samples, which indicated that, if present, concentrations were below 0.05 mg/kg. There are two exceptions where TCE-affected soil was left in place. These are Areas 7 and 8, because soil was not accessible for excavation. Therefore, it was concluded that, in most areas, the residual TCE in soil is at or near a concentration that is protective of drinking water.

Although the cleanup standards described are selected based on direct exposure to soil, TCE and PCE leaching from soil to groundwater is also addressed via the remedial recommendations by empirical methods. By including long-term groundwater monitoring, it will be verified that, after groundwater cleanup standards are met, the groundwater concentrations will not become recontaminated from TCE in insitu soil.

The TPH-oil cleanup level from Table 3-1 is the MTCA A standard based on preventing accumulation on the groundwater of free product (i.e., protection of groundwater for beneficial use; WAC 173-340-900, table 740-1, footnote s), which is the appropriate cleanup standard for this site. Individual chemical constituents associated with TPH (e.g., BETX) were addressed separately if they were detected.

Protective of groundwater quality such that soil contamination cannot lead to contamination in shallow groundwater that poses a potentially unacceptable vapor intrusion threat: WAC 173-340-740 (3)(b)(iii)(C)(III) states the following:

- (C) **Soil vapors.** The soil to vapor pathway shall be evaluated for volatile organic compounds whenever any of the following conditions exist:

  (III) For other volatile organic compounds, including petroleum components, whenever the concentration is significantly higher than a concentration derived for protection of ground water for drinking water beneficial use under WAC 173-340-747(4).

Based on the data presented in Section 2.2.1.3 the remaining soil concentrations of PCE and TCE are not significantly higher than the MTCA standards, thus the soil vapor pathway does not need to be considered.

[15] MTCA Table 740-1, footnote u

3.1.1.2 Soil Cleanup Level and Applicable Soil Cleanup Levels

Although they are expected to overestimate risk for a construction worker temporarily working in an excavation (the most plausible scenario for future direct contact with soil), MTCA Method C default worker exposure assumptions and resulting soil concentrations will be used for the direct contact exposure pathway, and subsequently the cleanup levels for soil. MTCA Method C concentrations, however, are not available for TPH-heavy oil and, therefore, Method A (industrial) concentrations from WAC 173-340-900, Table 740-1 are established as the TPH-heavy oil cleanup levels. Soil cleanup levels for the site are listed in Table 3-1.

Table 3-1 Soil Cleanup Levels

Constituent	MTCA Method C Direct Contact (mg/kg)	MTCA Method A Unrestricted Land Use (mg/kg)	Cleanup Level (mg/kg)
Tetrachloroethylene (PCE)	240	0.05	0.05
Trichloroethylene (TCE)	330	0.03	0.03
TPH – heavy oils	Not Researched	2,000	2,000

Not Researched means research has not been conducted and no value exists in the database for this parameter
Source: CLARC Database September, 2008, WAC 173-340-900, Table 740-1

3.1.2 Groundwater

As described in Section 2.2.2, COCs identified in site groundwater include TCE, 1,1,1-TCA, PCE, DCE, cis-1,2 DCE, trans 1,2 dichloroethylene, 1,4 dioxane, arsenic and VC. Although they were not detected at concentrations that exceed screening concentrations, 1,1,1-TCA, DCE, trans 1,2-DCE are also retained because they are degradation products of TCE and PCE and, therefore, could increase in concentration during remediation. Remediation activities could potentially alter aquifer conditions in the vicinity of the activity and cause the mobilization of arsenic. This is unlikely, based on the low detections of arsenic and the existing aquifer characteristics; however, to be conservative, arsenic in groundwater will also be monitored.

3.1.2.1 Evaluation of Potential Exposure Pathways

As described in Section 2.3, potential exposure pathways and subsequent points of contact associated with the chemicals in groundwater include (1) incidental contact with the groundwater, (2) use of groundwater as a drinking water source, (3) migration of the chemicals in groundwater to a surface water source where a human receptor could come in contact via (a) use of the surface water as drinking water, (b) direct contact or (c) fish consumption, and (4) exposure of ecological receptors to surface water impacted by contaminated groundwater. For clarity of discussion, the viability and relative risk of each of these points of contact is described below.

(1) Incidental Contact

- Incidental direct contact with groundwater is a potentially plausible exposure scenario. The potential exposure scenario would be a construction worker in direct contact with exposed groundwater while working in an excavation trench over 5 to 7 feet deep; however, this trenching scenario is not unlikely due to current site conditions (i.e., none of the sewer invert elevations at or near the site are at depths that would be below the water table). Exposure routes would include dermal contact and incidental ingestion.
- **Conclusion:** Although this is a potentially plausible future-case point of contact, it is unlikely that it would be significant since the frequency and duration of contact would be brief and sporadic. However, it is retained in the evaluation of cleanup levels.

(2) Groundwater as Drinking Water

- Groundwater is not likely to be used as a drinking water source because the site is in an industrial area and City ordnance prohibits its use. Also, by city ordinance, land owners, residents and developers are required to use the best available potable water source. Since municipal water is readily available in this area, it would therefore be required that it was used rather than groundwater.
- Groundwater is also not considered potable per WAC-173-340-720(2). See the subsection "Evaluation of Groundwater Potability" (below) for a detailed evaluation of groundwater's suitability as a drinking water source.
- **Conclusion:** Groundwater is not considered suitable as a domestic or drinking water source and this exposure scenario is not used in the evaluation of cleanup levels.

(3) Surface Water – General

- The COC plume in groundwater terminates 690 feet from the nearest surface water body. The source of COCs and COIs has been effectively removed and the plume is attenuating, in addition to active treatment. Therefore, it is expected that the plume will not migrate further west from its current terminus (690 feet from surface water); therefore, it is not considered likely that COCs will reach the surface water via groundwater migration.
- **Conclusion:** Although this is not considered a complete pathway, surface water-based cleanup levels will be evaluated for completeness.

(a) Surface Water Ingestion

- ► The downgradient surface water body, the Duwamish Waterway, is brackish. Therefore, it is not suitable for ingestion.
- ► **Conclusion:** This is not considered a complete pathway and this exposure scenario is not used in the evaluation of cleanup levels.

(b) Surface Water Direct Contact

- ► The Duwamish Waterway is an industrial shipping corridor and would be a physical hazard for recreational use. It is also part of a Superfund site. While swimming is not considered a likely scenario, incidental contact with surface water is possible while recreating.
- ► **Conclusion:** This is considered a relatively insignificant pathway. Since fish consumption is considered to be more relevant and the cleanup levels via fish consumption would be more restrictive than via incidental contact, the direct contact exposure scenario is not considered in the cleanup level development.

(c) Human Consumption of Fish

- ► Fishing occurs in the Duwamish Waterway and there is no restriction to tribal fishing. In addition, clamming is allowed on the publicly accessible beaches.
- ► Conclusion: Fish consumption is considered a complete pathway and is the most likely surface water scenario. Both Ecology and EPA have developed surface water cleanup levels based on the fish consumption scenario.

(4) Ecological Receptors in Surface Water

- ► Although ecological exposure at the waterway is possible, ecological surface water standards are not available for the CVOCs or TPH.
- ► **Conclusion:** Cleanup levels for ecological receptors are not considered further.

Therefore, the following exposure pathways will be considered in developing cleanup levels:

- Construction worker direct contact with contaminated and exposed groundwater in a trenching scenario.
- Consumption of fish resident in surface water impacted by contaminated groundwater.

3.1.2.2 Evaluation of Groundwater Potability

As discussed in the April 5, 2002 Ecology letter, consideration of surface water cleanup criteria for establishing the groundwater cleanup level at this site is appropriate (Ecology 2002B). Use of non-potable groundwater levels based on surface water is allowed under MTCA provided the site meets requirements of WAC-173-340-720(1)a, WAC-173-340-720(2)d, and WAC-173-340-720(6). Text in WAC 173-340-720(1) documents Ecology's preference that groundwater cleanup levels be based on the highest beneficial use and reasonable maximum exposure. A site with groundwater that qualifies as non-potable under WAC 173-340-720(2) establishes cleanup levels under WAC 173-340-720(6). The following summarizes how the former GE site meets the requirements of WAC 173-340-720(2).

- "WAC-173-340-720(2) *Potable ground water defined. Ground water shall be classified as potable to protect drinking water beneficial uses unless the following can be demonstrated:* *(a) The ground water does not serve as a current source of drinking water;"*
  - ► Groundwater in the vicinity of the former GE facility is not a current source of drinking water. There are no drinking water wells within a one-quarter mile of the site and no drinking water wells downgradient of the site. The nearest potable well is a class A (municipal well) located approximately 6 miles south of the site in the city of Seatac[16]. The Beacon Hill Reservoir is located approximately 1.5 miles North-East and upgradient of the site. Institutional controls (city/county ordinances and requirements of the State Health Department) prohibit ground-water use in the vicinity of the site. The former GE facility lies in a highly developed portion of Seattle where city water is readily accessible. The State Health Department and King County Board of Health, Title 12, Section 12.24.010A state that a drinking water supply must come from the highest quality source feasible. The highest quality source available at the former GE facility is from the City of Seattle water supply. Therefore, connection to the City of Seattle water supply is mandatory for businesses or residences in this area. In addition, WAC 173-160-205(2) specifies certain setback distances for water supply wells. The code stipulates that wells be set back at least 100 feet from storm or sanitary sewers, public rights of way and buildings. Therefore, buildings, rights of ways and sewers/storm drains in the vicinity of the subject property prevent the installation of water supply wells.
- *"(b) The ground water is not a potential future source of drinking water for any of the following reasons:*

  (i) The ground water is present in insufficient quantity to yield greater than 0.5 gallon per minute on a sustainable basis to a well constructed in compliance with chapter 173-160 WAC and in accordance with normal domestic water well construction practices for the area in which the site is located;

  (ii) The ground water contains natural background concentrations of organic or inorganic constituents that make use of the water as a drinking water source not practicable. Ground water containing total dissolved solids at concentrations greater than 10,000 mg/L shall normally be considered to have fulfilled this requirement; (NOTE: The total dissolved solids

[16] Data confirmed by King County, Department of Public Health – well ID GrpA_77050_04. (http://www5.metrokc.gov/groundwater/Details.aspx?Equis_ID=GrpA_77050_04).

concentration provided here is an example. There may be other situations where high natural background levels also met this requirement.); *or*

(iii) The ground water is situated at a great depth or location that makes recovery of water for drinking water purposes technically impossible; and"

- ► Groundwater at the former GE facility is not a potential future source of drinking water. The rationale for unlikely future use of groundwater as drinking water does not clearly relate to the technical requirements in i, ii, or iii, above. However, the provision under WAC-173-340-720 (2)(d) recognizes that even if a site does not meet the conditions of this subsection (WAC-173-340-720 (2)(c) at some sites there is an extremely low probability that the groundwater will be used for a source of drinking water because of the site's proximity to a surface water that is not suitable as a domestic water supply. Under WAC-173-340-720 (2)(d) at these sites groundwater can be classified as nonpotable. WAC-173-340-720 (2)(d) is discussed below.

- *"(c) The department determines it is unlikely that hazardous substances will be transported from the contaminated ground water to ground water that is a current or potential future source of drinking water, as defined in (a) and (b) of this subsection, at concentrations which exceed ground water quality criteria published in chapter WAC 173-340-200. In making a determination under this provision, the department shall consider site-specific factors including:*

  (i) The extent of affected ground water;"

- ► The extent of affected groundwater at the site is known and is discussed in Section 2 of this report. Groundwater concentrations exceed drinking and surface water standards under the former GE facility to a depth of approximately 30 feet bgs, downgradient of the former facility to a depth of 55 feet bgs (Figure 2-29). Chemically-affected groundwater has been defined in the horizontal direction and is limited to the area west of 3rd Ave South (eastern extent) and Utah Street (western extent) as shown on Figure 2-37. The distal end of the affected groundwater is 690 feet upgradient of the Duwamish River.

  "(ii) The distance to existing water supply wells;"

- ► The nearest water supply well is 1.0 miles to the south of the affected site groundwater.

  "(iii) The likelihood of interconnection between the contaminated ground water and ground water that is a current or potential future source of drinking water due to well construction practices in the area of the state where the site is located;"

- ► As discussed above, water well installation and construction is not permitted in the industrial area of Seattle, where the site is located, and groundwater in the vicinity of the site is not a current or potential future source of drinking water. The lower Duwamish Valley is an important urban industrial and commercial area and future production of shallow groundwater in this densely developed area is highly unlikely. Connection to the city water supply is mandatory for businesses or residences in this area. WAC 173-160-205(2) specifies certain setback distances for water supply wells that also prevent well installation in the vicinity of the site.

  "(iv) The physical and chemical characteristics of the hazardous substance;"

- ► The physical and chemical characteristics of chlorinated solvents are well understood (Wypych 2001), and the distribution of these chemicals in affected groundwater has been characterized and is discussed in Section 2.

  "(v) *The hydrogeologic characteristics of the site;"*

- ► The hydrogeologic characteristics of the site are known through installation of 36 monitoring permanent wells, extensive site-wide geoprobes, and completion of two pumping tests.

Section 2.1 of this report discusses site the geology and hydrogeology. The regional geology and hydrogeology are discussed in the Duwamish Study (Fabritz, Massman and Booth 1998).

"(vi) The presence of discontinuities in the affected geologic stratum; and"

- Section 2.1.1 of this reports provided a detailed analysis of the geology. Figures 2-1 through 2-4 provide stratigraphic cross sections across the site. These figures show that the site consists predominantly of fine to medium grained sands and silty sands and the sand fill within the lower valley is relatively homogeneous. Substantial clay layers that are laterally continuous and could cause discontinuities have not been encountered at this site.

"(vii) The degree of confidence in any predictive modeling performed. "

- The nature and extent of affected groundwater has been evaluated based on site data rather than modeling. The information presented in Section 2 of this FFS report are based on field observation and data collection. Soil borings have been collected across the site and have included locations upgradient, downgradient, and cross gradient of the impacted areas. A site-wide soil investigation and resulting soil excavation was conducted in 1995 and 1996. Groundwater quality data has been collected quarterly starting in 1998 and is ongoing. The information presented above is based on these observations and site specific data and not modeling. Though the above evaluation is based on empirical data, modeling is available, both GE (Capture Zone Report, RETEC, 2007B) and Ecology (subsequent evaluation Ecology, 2007D).

"(d) Even if ground water is classified as a potential future source of drinking water under (b) of this subsection, the department recognizes that there may be sites where there is an extremely low probability that the ground water will be used for that purpose because of the site's proximity to surface water that is not suitable as a domestic water supply. An example of this situation would be shallow ground waters in close proximity to marine waters such as on Harbor Island in Seattle. At such sites, the department may allow ground water to be classified as non-potable for the purposes of this section if each of the following conditions can be demonstrated. These determinations must be for reasons other than that the ground water or surface water has been contaminated by a release of a hazardous substance at the site.

(i) The conditions specified in (a) and (c) of this subsection are met;"

- As stated above (a) and (c) are met.

"(ii) There are known or projected points of entry of the ground water into the surface water;"

- The groundwater in this area discharges in the lower Duwamish River located approximately 690 feet west of furthest downgradient point on the groundwater plume.

"(iii) The surface water is not classified as a suitable domestic water supply source under chapter 173-201A WAC; and"

- The lower Duwamish River is not classified as a suitable domestic water supply under chapter 173-201A WAC. The portion of the river where groundwater discharges lies within the EPA Lower Duwamish River Superfund Site and has been studied in some detail. The river is considered marine (saline) from the mouth to River Mile 2. The salt water wedge in the river extends farther upriver, depending on the tidal influence and river discharge. Groundwater from the former GE facility area discharges in the general area of River Mile 1, within the marine area.

"(iv) The ground water is sufficiently hydraulically connected to the surface water that the ground water is not practicable to use as a drinking water source."

The groundwater is hydraulically connected to the surface water, as the Duwamish Basin aquifer is continuous across the area and with the river bank and bed (Fabritz, Massman and Booth 1998). Domestic water supply production wells in the area would probably[17] not be allowed in the foreseeable future under County ordinances and State regulations. If the unforeseen were to happen, and installation of a municipal or large domestic water supply well/well field were considered for the area, analysis prior to installation would show that potable groundwater production is not feasible (Fabritz, Massman and Booth 1998) and modified slightly for the site capture zone analysis (RETEC 2007) to provide a rough estimate of the effects of groundwater recovery for water supply. Using chloride as a conservative tracer and pumping at a rate of 500 gallons per minute, the aquifer will yield unacceptable groundwater (saline conditions) in ten years. Higher pumping rates commonly used for municipal water supplies (1,000 to 2,000 gpm), would draw unacceptable groundwater to the well in a shorter time period. Requirements prohibit installation of individual potable groundwater wells and require connection to municipal groundwater supply. Given the urban and industrial land use history in the area and the proximity to a major city, it is not foreseeable that the site could transition from urban use to other uses where groundwater use would be feasible. The groundwater is sufficiently hydraulically connected to surface water that it is not practicable to use as a municipal water supply, even for a small municipality.

3.1.2.3 Development of Groundwater Cleanup Levels

Since the groundwater is considered non-potable and there is a city ordinance prohibiting its use as a drinking water source, the remaining potential exposure scenarios were each evaluated to calculate the respective cleanup levels. The most conservative of the resulting cleanup levels was selected as the level that would be applied to the subject property groundwater. The exposure scenarios evaluated included:

- Construction worker direct contact with exposed, contaminated groundwater while working in a trench;
- Consumption of fish resident in surface water impacted by contaminated groundwater;
- Worker exposure to unacceptable air concentrations associated with volatilization from groundwater and vapor intrusion.

The following discussion details the evaluation of these two potential risk scenarios.

Worker Direct Exposure to Groundwater. This section evaluates the groundwater cleanup levels that would be protective of future workers that could come into direct contact with contaminated groundwater at the site. Potential future workers temporarily exposed to groundwater include trench workers who could contact groundwater during utility installation/repair work, and construction workers who could contact groundwater through dewatering system installation, operation and maintenance associated with a future building renovation. This exposure could occur only if excavations extended relatively deep into the groundwater table (deeper than 7 to 11 feet bgs)[18]. At this site, utilities are largely located above the water table, and therefore, trench/utility worker contact with groundwater is plausible, but unlikely. The groundwater exposure potential (i.e., frequency, duration, and intensity) for trench/utility maintenance workers and construction workers installing, operating and maintaining a dewatering system is significantly lower than construction worker exposure potential. Therefore, the construction worker is considered the maximally exposed receptor for evaluation of groundwater cleanup levels below MTCA Methods for calculating groundwater cleanup levels (A,

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[17] Ecology's Response to Comments stated that: use of the shallow aquifer for future drinking water purposes, per WAC 173-340-720(2)(d), Ecology agrees that currently this "probability is low" but not zero.

[18] While engaged in excavation activities, there is a potential for construction workers to come in contact with chemically-affected groundwater via incidental ingestion, dermal contact, and inhalation of volatiles. It should be noted that, while plausible, this scenario is not currently supported by site conditions. None of the sewer invert elevations at or near the site are at depths that would be below the water table.

B, or C) do not consider construction/trench worker exposure to exposed groundwater where water is not considered potable. Therefore, a site-specific calculation based on standard worker exposure path to groundwater was developed using EPA default values and exposure frequency values used by the Oregon Department of Environmental Quality (ODEQ).

The ODEQ guidance was included because it has specific guidance for an excavation/trench worker, which neither MTCA nor EPA evaluate. Note, non-MTCA exposure parameters for the trench worker are appropriate under WAC 173-340-7081 (10)(b)(ii), which states "that default values for Exposure Frequency, Exposure Duration, and Exposure Time may be changed when there is adequate scientific data to demonstrate that use of an alternative or additional value would be more appropriate for the conditions present at the site. Examples of exposure parameters for which the default values may be changed under this provision include: frequency of soil contact, duration of soil exposure, duration of air exposure." Based on this statement, frequency of groundwater contact and duration of groundwater exposure could be appropriately extrapolated based on potential trenching conditions present at the site.

Due to the limited contact with exposed groundwater that a trench worker may encounter, exposure assumptions developed for the trench worker scenario are presented in Table 3-3 and are conservatively based on standard EPA construction worker default values, as well as ODEQ trench worker default values. Again, these exposure assumptions assume that a trench extends into the water table, which is unlikely, as most utilities occur above the water table. To be conservative, however, EPA construction worker and ODEQ trench worker assumptions were assumed and most appropriately represent any trenching activities at the Site. Specifically, the exposure duration (ED) recommended for construction workers is one year, based on conducting relatively short-term projects located in specific portions of a site (EPA 2002). The exposure frequency (EF) of nine days per year is based on the ODEQ's default value for excavation workers and accounts for the time that construction workers may spend working in a trench (ODEQ 2000), regardless of whether the trench extends to the water table. The exposure time (ET) spent in the trench (or maintaining a dewatering system) is conservatively assumed to be eight hours per day (or the typical workday) (EPA 1989), it is likely that the typical workday would not apply to a trench situation because of working restrictions and limits resulting from working in a potential confined space.

Toxicity values for groundwater COCs are presented in Table 3-4 and were obtained from EPA's October 2004 Region 9 PRG Table (EPA 2004), which reflects the hierarchy for sources. Permeability constants are applied for dermal contact with water and are used to estimate the potential dose of an analyte that is absorbed through the skin. Permeability constants are based on those recommended in EPA Risk Assessment Guidance for Superfund Part E (EPA 2004b). In addition, a volatilization factor (VF) is necessary to determine the concentration of a volatile analyte emanating from groundwater into ambient air where it may be inhaled by potential receptors. The default VF of 0.5 L/m^3 is discussed and utilized in derivation of EPA Region 9 preliminary remediation goals (PRGs) and was selected for evaluating COPCs at this Site (EPA 2004). However, this VF is conservative for use at this site as it accounts for residential household uses.

Cleanup levels are then calculated in accordance with equations and methodology presented in EPA's Risk Assessment Guidance for Superfund Part B (EPA 1991) by combining exposure assumptions with the toxicity values and modeling factors. A carcinogenic target risk level (TRL) of 10^{-6} and a noncancer HI of 1 were applied. The resulting cleanup levels for construction workers are summarized in Table 3-5.

As indicated, the cleanup level for each COC is greater than the MTCA Method B Cleanup Level for surface water (with the exception of 1,1,1-TCA, 1,1-DCE , and trans-1,2-DCE), indicating that overall use of surface water criteria is considered protective of other receptors and groundwater exposure pathways at the site. Note, cis1,2-DCE does not have a MTCA Method B Cleanup Level for surface water and therefore, the calculated cleanup level would apply. For 1,1-TCA, 1,1-DCE , and trans-1,2-DCE, the construction worker risk-based levels exceed the MTCA Method B Cleanup Levels for surface water. However, the maximum site concentrations of these COC are two to three orders-of-magnitude below the surface water cleanup levels and are one to two orders of magnitude below the construction worker risk-based cleanup level. Therefore1,1-TCA, 1,1-DCE , and trans-1,2-DCE are not considered an issue for the construction worker receptor. A cleanup of site groundwater to the MTCA Method B surface water standards listed in Table 3-2 will be protective of the construction worker as follows:

- No significant acute or chronic toxic effects on human health exists as demonstrated by not exceeding a hazard quotient of one for individual hazardous substances
- An upper bound on the estimated excess cancer risk that is less than or equal to one in one million of individual hazardous substances and the total excess cancer risk is less than one in one hundred thousand for multiple compounds. Concentrations of 1,1,1-TCA, 1,1-DCE , and trans-1,2-DCE are not expected to increase to above to value high enough to pose risk to construction workers.

Overall, no unacceptable risk exists to construction workers (or utility workers) potentially exposed to site groundwater during installation, monitoring or maintenance of the dewatering system will occur with site groundwater concentrations below the MTCA Surface Water Cleanup Levels.

Exposure through Consumption of Fish. This section evaluates the groundwater cleanup levels that would be protective of a potential receptor that consumes fish resident in the unlikely event that surface water became impacted by contaminated groundwater from the site. This section allows cleanup levels to be established using a site-specific risk assessment as provided for under (c) of this subsection for protection of other ground water beneficial uses. Section WAC 173-340-720(6)(c)(i)(E) indicates that any cleanup levels developed through risk assessment will not exceed surface water cleanup levels derived under WAC 173-340-730 at the groundwater point of compliance or exceed the surface water or sediment quality standards at any point downstream, unless it can be demonstrated that the hazardous substances are not likely to reach surface water.

As discussed previously, the Slip 1 of the lower Duwamish Waterway is downgradient of the subject property and lies approximately 690 feet west of the site (measured from the furthers downgradient detection above screening values). The former GE facility is located directly east and upgradient of Slip 1 in the Duwamish Waterway (at approximately River Mile 1). The lower Duwamish, between river miles 0 and 2, is considered a marine environment. Based on its salinity, the lower Duwamish is not a suitable source of drinking water, but it could be a source of food.[19]

The Washington State surface water standards (WAC 173-201A) established for protection of aquatic life are not available for TCE or PCE or their degradation products. However, criteria have been published by EPA to assist states in establishing surface water standards. These criteria include values to protect humans who might ingest fish or other aquatic organisms. MTCA Method B standard values for surface water are also protective of the consumption of fish. MTCA Method A surface water values are not available for the COCs. Since there is a potential for tribal fishing, MTCA Method C was not considered. MTCA Method C assumes a lower fish consumption rates, applicable for small scale fishing such as recreational.

The EPA surface water quality criteria to protect human health from consumption of food and MTCA Method B protection of surface water levels are:

[19] Based on a review of the Water Quality Assessment of the Duwamish Estuary (Harper-Owes 1982)

Table 3-2 EPA and MTCA Surface Water Quality Levels

Compound	EPA Ambient water Quality Criteria [1] – Food (µg/L)	MTCA Method B (µg/L) [2]
Trichloroethylene (TCE)	30	1.5
1,1,1-Trichloroethane (TCA)	No Value	417,000
Tetrachloroethylene (PCE)	3.3	0.39
1,1-Dichloroethylene	7,100	23,000
Vinyl Chloride	2.4	3.69
trans 1,2 dichloroethylene	10,000	33,000
cis-1,2 dichloroethylene	Not Listed	Not Researched
1,4-dioxane	Not Listed	79 [3]
Arsenic	0.14	5 [4]

Source: 1. http://www.epa.gov/waterscience/criteria/wqcriteria.html
2. CLARC Database September 2008
3. Ecology revised surface water standard
4. MTCA Method A background value

As the EPA surface water quality criteria are recommendations to States and not specified cleanup levels, the cleanup levels to protect fish consumption receptors will be the MTCA Method B cleanup levels for surface water.

Vapor intrusion into overlying buildings from Groundwater. This section evaluates the groundwater cleanup levels that would be protective of a potential receptor that works in a building overlying the groundwater plume. To evaluate if the groundwater cleanup value is protective of indoor air, the EPA Johnson-Ettinger model (JEM) could be used as a screening tool. In 2005 GE and Ecology discussed the input parameters for this screening tool, and both GE and Ecology disagreed on the results of the screening tool. In an effort to move forward, and since the JEM is used as a screening tool with many default parameters which may/or may not be appropriate for this site, GE believes the most appropriate approach currently available would rely upon empirical data. During the correspondences in 2005, Ecology indicated that the Puget Sound Energy Georgetown Site was using a TCE concentration of 9 µg/L as a trigger for determining the need for indoor air sampling at commercial properties (Ecology, 2005). TCE is appropriate to use as a screening VOC because very low concentrations of other VOCs in the groundwater and the absence of other VOCs from the sampling in the 220 S Dawson building and the Interior Environments building. The 9 µg/L screening value will be carried forward to confirm that no unacceptable risk exists to workers inside the buildings overlaying the groundwater plume at concentrations below this trigger. The proposed MTCA Surface Water Cleanup Level for TCE is below 9 µg/L.

3.1.2.4 Other Requirements for Non-potable Cleanup Levels

As required under WAC 173-340-720(6)(c)(iii) all potentially affected property owners, local governments, tribes and water purveyors with jurisdiction in the area potentially affected by the chemically-affected ground water will be mailed a notice of the proposed use of surface water standards and provided an opportunity to comment. These regulations also require that GE make a good faith effort to provide institutional controls preventing the use of contaminated groundwater for drinking water purposes in area potentially affected. Some institutional controls exist in this area as County Ordinances preventing the use of groundwater in the vicinity of the site. The remedy will include a periodic confirmation that the County Ordinance preventing groundwater use is maintained for areas where site groundwater exceeds potable water cleanup levels under MTCA.

3.1.2.5 Summary of Applicable Groundwater Cleanup Levels

Groundwater cleanup levels were evaluated for potentially complete exposure pathways (construction worker exposure to groundwater and human consumption of resident fish. As indicated, the cleanup levels calculated for the construction worker scenario are less than the MTCA Method B Cleanup Level surface water (with the exception of 1,1,1-TCA) that is protective of humans consuming resident fish. As 1,1,1-TCA concentrations onsite are one to two orders of magnitude below construction worker-based cleanup levels, the use of surface water criteria is considered protective of other receptors and groundwater exposure pathways at the site. A cleanup of site groundwater to the MTCA Method B surface water standards listed in Table 3-2 will be protective of the construction worker as follows:

- No significant acute or chronic toxic effects on human health exists as demonstrated by not exceeding a hazard quotient of one for individual hazardous substances
- An upper bound on the estimated excess cancer risk that is less than or equal to one in one million of individual hazardous substances and the total excess cancer risk is less than one in one hundred thousand for multiple compounds.

Overall, no unacceptable risk exists to construction workers (or utility workers) potentially exposed to site groundwater during installation, monitoring or maintenance of the dewatering system will occur with site groundwater concentrations below the MTCA Surface Water Cleanup Levels.

Table 3-6 summarizes the cleanup levels that will be applied to the subject property under the exposures listed above, which includes worker direct exposure to groundwater and fish consumption.

Table 3-6 Site Cleanup Levels for Groundwater

Compound	MTCA Method B (µg/L) Surface Water
Trichloroethylene (TCE)	1.5 [1]
1,1,1-Trichloroethane (TCA)	417,000 [1]
Tetrachloroethylene (PCE)	0.39 [1]
1,1-Dichloroethylene	23,000 [1]
Vinyl Chloride (VC)	3.69 [1]
trans 1,2 dichloroethylene	33,000 [1]
cis-1,2 dichloroethylene	Not Researched [1]
1,4-dioxane	79 [2]
arsenic	5 [3]

Source: 1. CLARC Database September 2008
2. Ecology revised surface water standard
3. MTCA Method A background value

3.1.3 Indoor Air

GE installed an interim action mitigation system to address intermittent detections of TCE above cleanup levels in indoor air at the former GE building. Analyses completed during site investigations have shown that indoor air risks are not present at other buildings in the area. Cleanup standards will be developed to address this pathway as part of the long-term remedy for the site. The results of the investigation of indoor air quality at the former GE building, and the two buildings located downgradient over the Off-Site Area plume, demonstrate that the only CVOC that exceeds MTCA Method C ambient air concentrations is TCE.

The COCS for indoor air include: TCE, 1,1,1-TCA, PCE, DCE, cis-1,2 DCE, trans 1,2 dichloroethylene and VC.

3.1.3.1 Evaluation of Potential Exposure Pathways

As described in Section 2.3, potential exposure pathways and subsequent points of contact associated with the chemicals in indoor air are limited to vapor intrusion to indoor air. –Indoor air concentrations measured in selected indoor air samples at the former GE building are higher than the screening concentrations established for the site. Based on these detected concentrations this is a complete exposure pathway and will be addressed in the screening of alternatives. The exposure route includes inhalation and is a complete pathway for which indoor air cleanup values will be evaluated.

3.1.3.2 Development of Cleanup Levels

Ambient air standards established under the Washington Clean Air Act (70.94 RCW) include acceptable source impact levels for CVOCs identified at the site as follows:

Table 3-7 Ambient Air Standards (WA Clean Air Act (70.94 RCW))

Compound	EPA and Ecology Air Standard – Annual Average (µg/m^3)
Trichloroethylene (TCE)	0.22
1,1,1-trichloroethane (TCA)	—
Tetrachloroethylene (PCE)	4.20
1,1-dichloroethylene	200
Vinyl chloride	2.8
trans 1,2 dichloroethylene	Not Listed
cis-1,2 dichloroethylene	Not Listed

Source: WAC 173-460-150

In addition, Washington State MTCA regulations provide air cleanup levels in WAC 173-340-750. Because the property is an industrial property, the relevant cleanup level is the MTCA Method C value. WAC 173-340-706(1)(c).

For evaluation of subslab soil vapor, Ecology has assumed a hundred-fold default dilution between the soil vapor and indoor air, resulting in a screening level equal to 100 times the MTCA Method C formula value. The indoor air will continue to be monitored before the subslab depressurization system is decommissioned (see Section 5). This monitoring will evaluate any potential additional contribution of groundwater concentrations to subslab soil vapor, and consequently indoor air.

The following table summaries the MTCA Method C Cleanup value for indoor air and the Ecology recommended screening value for subslab vapor.

Table 3-8 MTCA Method C Cleanup Value for Indoor Air and Subslab Vapor

Compound	Indoor Air MTCA Method C (µg/m³)	Subslab Screening Value (µg/m³)
Trichloroethylene (TCE)	0.22	22
1,1,1-Trichloroethane (TCA)	11,000	1,100,000
Tetrachloroethylene (PCE)	4.2	420
1,1-Dichloroethylene	200	20,000
Vinyl Chloride	2.8	280
cis-1,2 dichloroethylene	35	350
trans 1,2 dichloroethylene	70	70

Source: CLARC Database June, 2008

3.1.3.3 Summary of Applicable Air Cleanup Levels

The applicable air cleanup level for this site is MTCA Method C Cleanup Level for indoor air are summarized below. The subslab screening value presented in Table 3-8 will not be carried forward as a site cleanup level because of the uncertainty associated with the attenuation factor (an attenuation factor of 100 is assumed to develop the subslab screening value).

Table 3-9 Applicable Air Cleanup Levels for the Site

Compound	Indoor Air MTCA Method C (µg/m³)
Trichloroethylene (TCE)	0.22
1,1,1-Trichloroethane (TCA)	11,000
Tetrachloroethylene (PCE)	4.2
1,1-Dichloroethylene	200
Vinyl Chloride	2.8
cis-1,2 dichloroethylene	35
trans 1,2 dichloroethylene	70

Source: CLARC Database June, 2008

3.2 Points of Compliance

The points of compliance define the locations where the cleanup levels must be attained. The term includes both standard and conditional points of compliance. Points of compliance are established for each environmental medium in accordance with the requirements and procedures in WAC 173-340-720 through 173-340-760. A conditional point of compliance is only available under certain conditions.

For the subject property, points of compliance have been established for soil, groundwater and ambient air. Establishment of both standard and conditional points of compliance is summarized below.

3.2.1 Soil

Soil cleanup levels are based on direct contact. Based on this exposure scenario, the point of compliance has been established as soil from ground surface to a depth of 15 feet, or the groundwater table, whichever is shallower. Since the chemically-affected soils that have been identified at the site are currently inaccessible, this point of compliance is intended to be protective in the event that the site is redeveloped in the future.

3.2.2 Groundwater

The standard point of compliance for ground water is throughout the site, from the uppermost level of the saturated zone, taking into consideration the seasonal groundwater fluctuations, and extending vertically to the lowest-most depth that could potentially be affected by the site (WAC 173-340-720(8)(b)).

A conditional point of compliance may also be set for groundwater where it can be demonstrated that it is not practicable to meet the cleanup levels throughout the site within a reasonable restoration timeframe (WAC 173-340-720(8)(c)). Conditional points of compliance may either be set on the property or off the property that is the source of the contamination, subject to several conditions. The on-property conditional point of compliance must be set as close as practicable to the source of the hazardous substances, but may not exceed the property boundary. The use of an on-property point of compliance is conditioned on the use of all practicable methods of treatment at the site (WAC 173-340-720(8)(c)).

The definition of and the requirements for the off-property conditional point of compliance are discussed in WAC 173-340-720(8)(d). An off-property conditional point of compliance is appropriate when considering groundwater protection of surface water and the surface water cleanup levels. In this case, the 220 South Dawson Street property is located upgradient of, but does not abut, surface water. Consequently, the off-property conditional point of compliance has been set as close as practicable to the source of the releases. The establishment of such an off-property conditional point of compliance is conditioned on meeting several requirements, including, but not limited to, the following (WAC 173-340-720(8)(d)(ii))

- Groundwater discharges must be provided with all known available and reasonable treatment methods before being released into the Duwamish
- Groundwater discharges must not result in violations of sediment quality values
- The affected property owners between the 220 South Dawson Street property boundary and the Duwamish River must agree in writing to setting such a conditional point of compliance.

Based on the requirement to develop cleanup levels based on surface water standards the point of compliance for all the alternatives discussed in the FFS is a standard point of compliance.

3.2.3 Air

Indoor air point of compliance is the indoor air throughout the site.

3.3 Summary of Selected Site Cleanup Levels and Points of Compliance

Table 3-10 Summary of Applicable Cleanup Levels and Points of Compliance for the Site

Compound	Soil	Groundwater	Indoor Air
	MTCA Method C (mg/kg)	MTCA Method B Surface Water Level (µg/L)	MTCA Method C (µg/m^3)
Trichloroethylene (TCE)	330	1.5	0.22
Tetrachloroethylene (PCE)	240	0.39	4.2
1,1,1-Trichloroethane (TCA)	NA	420,000	11,000
1,1-Dichloroethylene	NA	23,000	200
Vinyl Chloride	NA	3.7	2.8
cis-1,2 dichloroethylene	NA	Not researched	35
trans 1,2 dichloroethylene	NA	33,000	70
Arsenic	NA	5	NA
1,4-Dioxane	NA	79	NA
TPH -diesel Range	2,000	NA	NA
Point of Compliance	Groundwater Table	Standard Point of compliance	Indoor Air throughout the site

Notes:

MTCA Method C concentrations are not available for TPH-heavy oil, therefore, Method A soil cleanup levels for unrestricted land use is assumed.

NA – Not applicable

Source: CLARC Database September, 2008

3.4 Other Potentially Applicable Requirements

MTCA requires that all cleanup actions comply with applicable state and federal laws (WAC 173-340-360(2)). MTCA defines applicable state and federal laws to include “legally applicable requirements” and “relevant and appropriate requirements.” Laws related to cleanup levels were presented above. This section of the FFS identifies laws and regulations that pertain to treatment and disposal activities and laws that could affect planning or place restrictions on how cleanup actions may be performed.

Cleanup actions at the site may result in the generation of waste materials that require appropriate handling. Such materials could include excavated soils, extracted groundwater, and/or extracted vapors. Although MTCA cleanup actions are exempt from permits, they must meet the substantive requirements of the applicable law.

Because the GE facility had interim status under RCRA, both RCRA and the Washington State Dangerous Waste Regulations (WAC 173-303) are applicable to the cleanup action. Any waste that is generated as part of cleanup will need to be evaluated to determine if it is hazardous and managed accordingly. The Dangerous Waste Regulations (or the Solid Waste regulations at WAC 173-313) provide the requirements for design and use of on-site or off-site treatment, storage, and/or disposal facilities.

The groundwater treatment system that is in operation at the site discharges groundwater to the Metro sewer. GE has a permit for that discharge, which established limits on both the quality and quantity of water that can be discharged. The conditions of that permit must be met under future actions or a new permit must be obtained. Discharges from upland areas to surface waters require permits under restrictions of the National Pollutant Discharge Elimination System (NPDES) program. Discharges to the sanitary sewer are subject to pretreatment standards and local discharge standards and permitting.

Actions that could release hazardous chemicals to air will need to be examined to ensure compliance with ambient air standards (WAC 173-460-150) and with performance standards for new discharges.

Table 3-11 presents the potential applicable laws for the cleanup.

Table 3-11 Potential Applicable Laws

Law/Regulation	Requirements
Federal Water Pollution Control Act Clean Water Act (CWA) 40 CFR 100-149 Washington State Water Quality Standards for Surface Waters WAC 173-201A	Establishes the basic structure for regulating discharges of pollutants into the waters of the United States and establishes standards for the protection of surface water quality. The cleanup action will comply with these regulations through the implementation of best management practices and a water quality monitoring program.
National Pretreatment Standards (40 CFR 403) Metro District Wastewater Discharge Ordinance	Establishes pretreatment requirements for discharge to a municipal sewer. May be applicable if the selected remedy involves continued discharges to the Metro sanitary or combined sewer system
Resource Conservation and Recovery Act (RCRA) 40 CFR 260 – 268 Washington Dangerous Waste Regulations WAC 173-303	Establishes requirements for identification of Dangerous Wastes based on whether or not the waste contains a listed waste, or if it displays a dangerous waste characteristic, for example by the Toxicity Characteristic Leaching Procedure (TCLP). These regulations may be applicable for the storage, treatment, and disposal of the excavated/extracted material.
Solid Waste Handling Standards (RCW 70.95; WAC 173-350)	Establishes the requirements for solid waste management and disposal. May be applicable.
Clean Air Act, National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61) State Emission Standards for Hazardous Air Pollutants (WAC 173-400-075)	Establishes emission standards as well as ambient air quality standards. These requirements may be applicable to releases of hazardous air pollutants from remedial actions.

4.0 Technology Screening

4.1 Treatment Areas

For purposes of discussing the technologies screened as part of the FFS, the former GE site has been broken into two areas, the On-Site Area and the Off-Site Area. Figure 1 -2 shows these two areas. The On-Site Area includes the former GE building and essentially extends from 3rd Avenue South to 2nd Avenue South. The Off-Site Area includes all the area to the west of 2nd Avenue South to Utah Street. These two areas are defined by the higher concentrations detected in the groundwater plume. Concentrations of TCE are highest at MW-4 (On-Site Area); then concentrations drop and increase again at MW-14M (Off-Site Area).

4.2 Institutional Controls and Monitoring

Institutional controls are legal or administrative measures designed to limit or control activities that could result in exposures to contamination before, during, and after a cleanup action, particularly if contaminant residues are likely to remain above cleanup levels for an extended period of time. For the former GE site cleanup, institutional controls would be designed to:

- Ensure access by GE or Ecology to remedial systems (e.g., cleanup or monitoring equipment) before, during, and after active cleanup operations
- Protect occupants and construction workers from exposure to hazardous substances on site during and after active cleanup operations.

A common form of institutional control is a local ordinance or a state rule or regulation. Local government, using its general land use authority, can limit the installation of groundwater wells and can require permits before excavation or drilling occurs in contaminated or urban areas. WAC 173-160-171 prohibits installation of a well within 100 ft of known or potential areas of contamination. The State Department of Health reviews permit applications for public drinking water sources and requires that the applicant should only use drinking water from the highest quality source feasible.

To the extent required by WAC 173-340-440 (11), GE will establish financial assurance for cleanup actions that include engineered and/or institutional controls. Financial assurance is intended to demonstrate that GE has sufficient resources to pay for costs associated with the operation and maintenance of the cleanup action, including institutional controls, compliance monitoring and corrective measures. GE currently provides financial assurance for other cleanup sites using a corporate financial test consistent with EPA requirements (40 CFR Part 264, Subpart F) and comparable state requirements.

At the 220 South Dawson Street property institutional controls already exist in the form of local ordinances restricting the use of the groundwater for drinking water, and prohibiting the installation of groundwater monitoring or extraction wells without proper permitting and controls. These controls will remain in place unless the City of Seattle changes it regulations. The entire area around 220 South Dawson Street is and has historically been used by industry (Section 1). Institutional controls restricting the use of groundwater are carried forward and incorporated in all alternatives.

Based on historic documents detailing the removal of chemically-affected soil, a small amount of TPH affected soil remains in place under the building foundations. The volume of this soil is estimated to be approximately 95 cubic yards[20] (Dames &Moore 1996). Based on the small amount of TPH remaining, and lack of access to

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[20] Area 1 – Extent assumed along the North corner of the building; limited to the North and West side-wall, assumed to extend 3 feet in the vertical and horizontal directions. Area 9 – Extent assumed along the East and South side-walls,

the building foundations, institutional controls are applied to all soil beneath the building foundations. Currently the physical building limits human contact with the TPH soil. Groundwater results indicate that TPH is not in the groundwater (Dames & Moore 1996). Because the building is currently limiting the exposure, and because plans are uncertain as to remodeling, removal, or reconstruction, institutional controls will be put into place until the soil beneath the building is accessible. When the soil beneath the building becomes accessible, controls will be put into place to ensure that the soil is properly managed and disposed of in accordance with all local, state, and federal laws. GE will work with the current or future building owner(s) to ensure that they understand this responsibility and will negotiate any terms or conditions as needed. GE will make a good faith effort to secure an environmental restrictive covenant on the 220 S Dawson street property or on any required downgradient properties if residual contaminated soil or vapors remain above MTCA Method C cleanup levels, before using other legal or administrative mechanisms.

4.3 Monitored Natural Attenuation

MNA refers to physical, chemical, or biological processes, which can lead to the reduction of mass, toxicity, mobility, volume, or concentration of organic contaminants in soil and/or groundwater. These processes include biodegradation, dispersion, mixing, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of COCs. Primary and secondary lines of evidence are evaluated along with the requirements presented in WAC 173-340-370.

The data presented in Section 2 indicate that the On-Site and Off-Site Area plumes are behaving in different ways. The On-Site Area plume is decreasing as concentrations in all wells have decreased over time. The Off-Site Area plume is stable and concentrations have remained constant since wells were installed and sampled.

Monitoring data of CVOC concentrations exhibits a pattern of biological reductive dechlorination, in which PCE and TCE are the predominant CVOCs in the suspected source area, while less chlorinated CVOCs (primarily cis-1,2-DCE), predominate in downgradient locations. The data suggest that ultimate biological reductive dechlorination to VC is not occurring to a significant degree, possibly due to the absence of sufficient easily biodegradable primary substrate (as indicated by the relatively low TOC concentrations). In addition, there is little evidence that dissolved CVOCs are migrating in the Off-Site Area, which suggests that natural attenuation processes are limiting plume migration. However, secondary geochemical evidence of intrinsic biodegradation processes (i.e., relationships between contaminant source area, electron acceptors, reduced byproducts, and groundwater flow direction) is inconsistent, especially in regards to the On-Site Area. This may be due to the relatively low contaminant concentrations which lead to relatively low rates of biodegradation. Consequently, residual concentrations of electron acceptors persist throughout much of the site. Its also not clear what extent the reduction in CVOC concentrations can be attributed to natural attenuation or the groundwater extraction system. Nevertheless, intrinsic biodegradation is likely to be an important attenuation process that will limit dissolved CVOC migration and reduce CVOC concentrations over time at both the On-Site and Off-Site Areas. Data collected from the MW-16 wells indicates that methanogenesis is occurring at this downgradient area.

Based on the results of the MNA analysis, MNA is occurring at the Off-Site Area and may be occurring at the On-Site Area. The degradation at the Off-Site Area appears to be occurring at a rapid, consistent rate[21]. MNA is not being carried forward as a technology at this site, but if conditions change during the post remediation, the application of MNA will be reevaluated.

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assumed to extent 3 feet in the vertical and horizontal direction. Area 7 – Extent assumed along the north central side-wall, and the North Eastern side-wall, assumed to extend 3 feet in the vertical and 7 feet in the horizontal direction.

[21] Ecology believes this is a stable offsite groundwater plume where rate of contaminant entering the Off-Site Area equals the same dissipation rate with the Off-Site Area.

With regards to the use of MNA, MTCA WAC 173-340-370(7)(a) states the following:

> (a) Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable

Source removal at the site has included the excavation of accessible soils and extraction of chemically-affected groundwater, to the maximum extent practicable. However, source material remains in place at some soil locations and remains in the dissolved phase detected in groundwater. The restoration time frame of MNA, observed at similar sites, to reduce TCE and PCE concentrations to cleanup levels is not reasonable considering current and future site uses (which is an industrial/commercial setting). MNA is not carried forward at this time because of the restoration time frame. In the future, if conditions change, MNA may be considered for portions of the site. At that time, a full evaluation of the applicability of MNA will be conducted under the site conditions at that time.

4.4 Containment of Groundwater

Containment technology would include actively recovering part or all of the chemically-affected groundwater or preventing migration of groundwater by physical barriers. Physical barriers could include a barrier wall, slurry walls, or funnel and gates. Barrier walls work in aquifers that have an aquitard, or confining bottom layer, which permits the barrier wall to be tied into the existing aquifer. The aquifer is deep at the former GE site with no confining layers encountered to a depth of at least 55 feet bgs; at this depth a barrier wall is not feasible.

As discussed in Section 1.1.4, currently groundwater is recovered from two wells (RW-2 and RW-3, shown on Figure 1-4) located in the On-Site Area. The current recovery system has operated essentially continuously at a combined rate generally ranging from 12 to 17 gpm with discharged to the King County sewer under permit. TCE concentrations in the On-Site Area well MW-4 have decreased from a high of 260 µg/L (November 1996) to 51 µg/L (February 2008) and in monitoring well MW-1 have decreased from a high of 560 µg/L (April 1997) to 50 µg/L (February 2008). Based on previous operation, it is expected that concentrations in the On-Site Area will continue to decline, although data collected to date indicates that groundwater extraction alone will not remediate the groundwater in both the On-Site and Off-Site Area sufficient to meet Ecology's standards. Additionally, the recovery system has reduced dissolved concentrations. Over the past 12 years of operation, TCE concentrations have been reduced in MW-4 by 80%; however, concentrations currently remain 34% higher than the MTCA Method B Surface Water Cleanup Level. TCE concentrations in the Off-Site Area have not shown a significant decline or increase over time (Section 2.2.2.1). The continued operation of the recovery system would not meet the cleanup goals in the On-Site or Off-Site Areas. Containment, without the combined effects of another technology, is not carried forward in this FFS.

A detailed study of the effectiveness of the current containment system was presented in the *Capture Zone Analysis* and *Scope of Work* (RETEC 2007B). Ecology and GE disagree on the performance of the current recovery system. In an effort to move the site towards closure, GE has agreed to optimize the current hydraulic system. In this FFS, groundwater extraction will be carried forward, but the current recovery system will be optimized and will be paired with an additional remediation technology, discussed below. Containment is being carried forward as a method to control the groundwater unit in the On-Site Area, and potentially to be used as a method to enhance delivery of potential injection approaches. The full effect of containment is discussed under each selected Alternative in Section 5.

4.5 Vapor Barriers for the Containment of Subslab Vapor

Technologies that would provide containment of the Subslab vapor include the installation of a liner or modifications to the interior of the building to physically prevent potential migration of CVOCs from the subslab to the inside of the building. Vapor barriers, such as liners, are commonly installed in new constructions to prevent existing concentrations from migration or as a precautionary step to prohibit concentrations in the future from migrating into the building. Physically sealing the building is a technology that works by physically cutting off the migration pathway. Buildings tend to shift and crack with age and new cracks could occur after sealing, or sealing could result in a preferred pathway for vapor and could potentially increase the concentrations of vapors inside the building.

To implement a vapor barrier, such as a liner, the subslab would have to be removed and a vapor barrier would have to be installed. After the barrier was installed the slab would be restored or replaced. This alternative is not feasible at the former GE site because the building is currently completely constructed and occupied. For this Alternative to be implemented the building would need be to shored and all of the interior concrete slab would need to be removed. The concrete slab is estimated to be 8 to 11 inches thick throughout the building. This technology does not reduce CVOC concentration in the subslab.

Physical sealing of the building is more feasible than installing a vapor barrier; however, the building is filled with cracks and holes and is subject to potential earthquakes that could cause small, structurally insignificant cracks or open sealed cracks. This technology would involve considerable monitoring and repairs to identify new cracks and seal them. Furthermore, this technology does not reduce CVOC concentrations in the subslab.

Containment of subslab vapor is not carried forward as a technology applicable for the former GE site.

4.6 Additional Source Area Treatment/Removal

4.6.1 Air Sparging/Soil Vapor Extraction

Air sparging (AS) is a potential option for additional source area remediation. AS is an *in situ* technology in which air is bubbled into the aquifer to enhance volatilization and/or aerobic biodegradation, as appropriate for the chemicals of concern. Air is dispersed radially from the injection points to create a subsurface "air stripper" which removes volatile contaminants and/or a bioactive zone where aerobic biodegradation is enhanced. The air is injected into the groundwater either in wells or trenches. Air sparging also provides a degree of physical stripping, especially for volatile compounds. In these cases, the soil vapor and air quality may need to be monitored carefully or controlled with soil vapor extraction (SVE) to prevent release of potentially harmful concentrations of volatilized compounds. If necessary, off-gas treatment would be performed, typically by use of thermal or catalytic oxidation following by scrubbing to remove hydrochloric acid. SVE would have the additional benefit of reducing the potential for vapor intrusion from the subsurface into overlying buildings.

AS is effective at delivering oxygen in coarse-grained lithologies. Significant pressures are required to deliver oxygen in fine-grained lithologies and the penetration into fine-grained lithologies may result in short-circuiting and poor oxygen delivery. Use of trenches with coarse backfill will allow more uniform injection of oxygen into groundwater in fine-grained lithologies, but are dependent upon groundwater flow to circulate the oxygenated groundwater. The finer-grained lithologies at the site may make air sparging less effective than other technologies for delivering oxygen to the groundwater and, based on performance of the groundwater extraction system, significant fowling of the screen is expected. AS is generally more effective on volatile compounds than semivolatile compounds. Costs for AS are relatively low as compared to other means of delivering oxygen, though costs are increased considerably if vapor collection and treatment are required.

A combined SVE/AS system combines unsaturated zone treatment and saturated treatment. SVE/AS sparge systems have been installed at similar sites and have reduced the COC concentrations in groundwater and in the vapor zone. Geological conditions such as confining layers or dense compacted soil can reduce the capacity of the system to extract vapors from the sub surface, affecting the performance of a SVE/AS system. Based on the geology presented in the above sections, these conditions do not exists at this site

The target areas for treatment are located in accessible areas which makes the installation of a combined SVE/AS system possible.

A combination of SVE/AS will be carried forward as a selected technology for the site.

4.6.2 In-Well Air Stripping

In-well air stripping technology is a type of physical treatment in which pressurized air is injected into a vertical well that has been screened at two depths. The lower screen is set below the groundwater table, and the upper screen is in the unsaturated zone. Pressurized air is injected into the lower well screen, aerating the groundwater within the radius of influence. The air spreads outward and rises towards the water surface and flows out of the system at the upper screen. CVOCs vaporize within the well at the top of the water table, as the air bubbles out of the water. The vapors are drawn off by an SVE system (described above).

Modifications to the in-well stripping process may involve additives injected into the stripping well to enhance biodegradation (e.g., nutrients, electron acceptors, etc.). Typically, the target contaminant groups for successful implementation of this technology include halogenated VOCs, SVOCs, and hydrocarbons. In-well air stripping systems are most effective at treating sites with volatile contaminants with relatively high aqueous solubility and strong biodegradation potential, sites with high concentrations of dissolved contaminants, and in sites with deep water tables.

Limitations to in-well air stripping include fouling of the system from infiltrating precipitation containing oxidized constituents, or naturally-occurring metals oxidizing in the well. In addition, shallow aquifers may limit process effectiveness. At this site recovery wells routinely are clogged and fouled and significant fouling is observed at MW-8. The fouling of the injection screens could limit the performance and cause a greater number of injection wells to be installed at the site to obtain the required radius of influence. For these reasons in-well air stripping is not carried forward as a technology for this site.

4.6.3 Additional Excavation

As discussed above, over 3,000 tons of chemically-affected soil were already removed from the source area. The source area is located primarily in a narrow alley between two buildings, and likely extends beneath and adjacent to the foundation of the 220 South Dawson Street building foundation.

Based on site conditions, excavation is not practicable due to the existing buildings and paved areas. Based on the historic excavation and concentrations trends, the highest chemically-affected soils remain beneath the building foundations. Excavation beneath the building foundations is not practicable, particularly when the building is occupied. If conditions change significantly prior to development of a draft cleanup action plan (DCAP), this remedy may be furthered evaluated.

4.6.4 Depressurization and Vapor Extraction Systems

Depressurization and vapor extraction systems depressurize the ground immediately below buildings, generating sufficient pressure to prevent chemically-affected vapor intrusion from the soil, through the building foundation, and into the building. Fans pull the gases from the subsurface and vent them to ambient air. This system decreases the pressure below the building foundation so that pressure inside the building is higher. Thus any flow of air and any gases between the building and the slab will be forced downward out of the building and into the foundation slab.

This type of system has been designed for a wide variety of VOCs that migrate through soil, largely through diffusion. The default pressure differential from the subsurface to indoor air typically assigned for vapor intrusion assessments is 4 pascals (Pa), which equals about 0.015 in-H_2O. The pressure differential that will be necessary to maintain a negative pressure will be determined during the installation and diagnostic testing specific to the former GE facility.

As stated above, GE installed a subslab depressurization system inside the 220 South Dawson Street building in the summer of 2007 (RETEC 2007E). This technology will be carried forward as a selected technology because currently a system is installed and operating at the site; this technology will be included in combination with other technologies, and not as a standalone technology.

4.7 *In situ* Treatment

4.7.1 Chemical Oxidation

In situ chemical oxidation (ISCO) technology promotes reduction/oxidation (redox) reactions that chemically convert constituents of concern to less toxic compounds that are more stable, less mobile, or inert. Redox reactions involve the transfer of electrons from one compound to another. Specifically, one reactant is oxidized (loses electrons) and one is reduced (gains electrons). ISCO involves the introduction of a strong oxidant, typically potassium permanganate or Fenton's reagent (catalyzed hydrogen peroxide that creates a hydroxyl free radical as an oxidizing agent), using wells for direct injection. Permanganate, for example, reacts with carbon-carbon double bonds to convert these chemicals into smaller molecules, and ultimately to carbon dioxide, water, and/or chloride. Permanganate oxidation is typically very effective in the treating of chlorinated ethenes, such as PCE and TCE. Fenton's reagent has been shown to achieve considerably greater reduction of contaminant concentration and mass than permanganate when aromatic compounds are the principal constituents of concern. At the former GE site, aromatic compounds are not present. Using Fenton's reagent there is a potential for gas generation.

These technologies (ISCO) require subsurface transport (or delivery) through pressurized injection and mixing of the chemical oxidant. Since the native soil material typically consumes a large fraction of the added oxidant, the efficiency of this process is greatest in areas that have little oxygen demand. Naturally occurring organic matter and reduced forms of metals in groundwater can reduce the effectiveness of ISCO technologies by preferentially "scavenging" the oxidant, and by creating a plugging or fouling situation in the aquifer. Testing indicates little naturally occurring organic matter is present at this site.

Permanganate has been applied to similar sites and has reduced TCE concentrations under similar conditions (Interstate Technology & Regulator Council 2005). There are two common forms of permanganate – potassium permanganate ($KMnO_4$) and sodium permanganate ($NaMnO_4$). Potassium permanganate is supplied as a solid from which an aqueous solution can be prepared. The aqueous solution is usually limited to a 4% solution. Sodium permanganate is generally supplied as a liquid and can be diluted on site to a wider range of concentrations. Both forms of permanganate are strong oxidizing agents and are non-selective.

4.7.2 Enhanced Aerobic Biodegradation

Enhanced Aerobic Biodegradation introduces additional oxygen into a system to provide an alternative or additional oxygen source. Oxygen Release Compound™ is a solid compound which releases oxygen into groundwater over time. The compound can be directly injected into the groundwater as a slurry, using a direct-push coring rig or drill rig. It can also be placed repeatedly in wells using contained "socks." The compound releases oxygen slowly and provides a moderate duration (up to several months) for an oxygen source.

This process is effective at delivering oxygen to the groundwater, but it is reliant on diffusion and groundwater advection and dispersion to distribute the oxygen over larger areas. In areas where the oxygen demand is high or groundwater migration is relatively slow, the oxygen distribution is slow, limiting the effectiveness and rate of aerobic biodegradation. The process is implementable at the site.

Naturally occurring degradation of TCE occurs under anaerobic conditions. Aerobic conditions may be needed if VC concentration exceeds standards. TCE is the driver at this site and VC concentrations are currently below cleanup standards. Enhanced aerobic degradation is not carried forward as a potential technology applied to this site.

4.7.3 Enhanced Anaerobic Biodegradation

Enhanced Anaerobic Biodegradation is a process where compounds that stimulate naturally-occurring reductive dechlorination are added to the subsurface to increase breakdown of the target compounds. Under anaerobic conditions, chlorinated solvents typically undergo a process called reductive dechlorination.

Research has shown that chlorinated solvents can be utilized as electron acceptors by certain anaerobic microorganisms for energy generation. Thus, the chlorinated solvents are used in the same way as the more conventional microbial electron acceptors: oxygen, nitrate, and sulfate. Different organic growth substrates (carbon and electron donor sources) are consumed at different rates anaerobically.

Scientific publications have reported that a number of growth substrates can stimulate anaerobic dechlorination by applying electron donor amendment. The substrates that tend to be less readily consumed may be more effective at stimulating dechlorination. Some preferential additives include butyric acid (Fennel et al. 1997, Fennel et al. 1995), propionic acid (Fennel et al. 1997, Yang et al. 1998), lactic acid (Fennel et al. 1997, Fennel et al. 1995), and ethanol (Cirpka et al 1998, Fennel et al. 1997, Fennel et al. 1995). Based on the activity of lactic acid, a commercial product, designated HRC™ (Hydrogen Release Compound), was recently developed by Regenesis in San Juan Capistrano, California. This product is a poly-lactate ester which provides a timed release of lactate, thus potentially providing a slow, steady source of electron donor that may support dechlorination of chlorinated contaminants.

At present, there is no one preferential material that has been identified for stimulating anaerobic dechlorination. Depending on the nature of the microbial populations at each site, the effectiveness of a specific substrate varies. Three likely candidates for further consideration include ethanol, propionic acid, and HRC™. These three substrates were selected based on potential effectiveness, costs, and delivery options. All can potentially stimulate dechlorination. HRC™ may prove very effective and may be relatively easy to deliver over an extended period of time, but it is the highest in cost on a per pound basis. Recent studies (Fennel et al. 1997; Yang et al. 1998) indicate propionic acid may be one of the most effective of the traditional substrates and it is moderate in cost. Ethanol may be somewhat less effective than the others, but it is the lowest in cost.

Based on the analytical data presented in Section 2, enhanced degradation is a viable technology for this site and will be carried forward.

4.8 Selection of Remedial Technologies

Based on the initial screening presented in the above section the selected technologies for this site include:

- Institutional controls
- Containment, including groundwater recovery
- Additional source area treatment/removal, including air sparging/soil vapor extraction, and depressurization and vapor extraction systems
- *In situ* treatment, including chemical oxidation and enhanced bioremediation.

Based on these selected remedial technologies, six proposed alternatives are identified in the following section. These technologies and the proposed alternatives are evaluated in further detailed as required by WAC 173-340-360(2).

WAC 173-340-360(2) (Minimum Requirements for Cleanup Actions) states that, "because cleanup actions will often involve the use of several cleanup technologies or methods at a single site, the overall cleanup action shall meet the requirements of this section." Based on the screening discussion presented in Section 4, proposed alternatives are evaluated in the following sections under WAC 173-340-360(2). The six proposed alternatives include:

- **Alternative 1** – Optimized Hydraulic Control , Soil Vapor Extraction combined with Air Sparge (SVE/AS), Subslab Depressurization System, and Institutional Controls
- **Alternative 2** – Optimized Hydraulic Control, Chemical Oxidation with Potassium Permanganate, Subslab Depressurization System, and Institutional Controls

- **Alternative 3** – Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls
- **Alternative 4** – Soil Vapor Extraction combined with Air Sparge, and Institutional Controls
- **Alternative 5** – Chemical Oxidation with Potassium Permanganate, Subslab Depressurization System, and Institutional Controls
- **Alternative 6** – Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls.

5.0 Detailed Evaluation of Remedial Alternatives

5.1 MTCA Evaluation Criteria

The MTCA regulations contain explicit criteria for the evaluation and selection of cleanup alternatives. This section provides an overview of these regulatory criteria. The consistency of each alternative with these criteria is then discussed in the subsequent sections.

5.1.1 MTCA Threshold Requirements

Cleanup actions selected under MTCA must comply with several basic requirements. Alternatives that do not comply with these criteria cannot be considered valid cleanup actions under MTCA. WAC 173-340-360(2)(a) lists four threshold requirements for cleanup actions. All cleanup actions must:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable laws
- Provide for compliance monitoring.

The project alternatives contained in this FFS are designed to meet these threshold requirements.

5.1.2 Other MTCA Requirements

Under MTCA, when selecting from alternatives that meet the threshold requirements, the selected action must also address the following three criteria:

- **Provide a reasonable restoration time frame** (WAC 173-340-360(2)(b)(ii)): MTCA places a preference on those alternatives that, while equivalent in other respects, can be implemented in a shorter period of time. MTCA includes a summary of factors that can be considered in evaluating whether a cleanup action provides for a reasonable restoration time frame (WAC 173-340-360(4)).
- **Use permanent solutions to the maximum extent practicable** (WAC 173-340-360(2)(b)(i)): MTCA specifies that when selecting a cleanup action, preference shall be given to actions that are "permanent solutions to the maximum extent practicable" (WAC 173-340-360(2)(b)(i)). The regulations specify the manner in which this analysis of permanence is to be conducted (WAC 173-340-360(3). The permanence analysis also requires that the costs and benefits of each of the project alternatives be balanced using a "disproportionate cost analysis" (WAC 173-340-360(3)(e)). The criteria for conducting this analysis are described below.
- **Consider Public Concerns** (WAC 173-340-360(2)(b)(iii)): Ecology will address public comments during draft Cleanup Action Plan public review process.

5.1.3 MTCA Disproportionate Cost Analysis

The MTCA analysis of disproportionate costs is used to compare the relative benefits and costs of cleanup alternatives (WAC 173-340-360(3)(e)). Seven criteria are used in the disproportionate cost analysis as specified in WAC 173-340-360(3)(f):

- **Protectiveness** – Overall protectiveness is a parameter that considers many factors. First, it considers the extent to which human health and the environment are protected and the degree to which overall risks at a site are reduced. Both On-Site and Off-Site risks resulting from implementing the alternative are considered. The parameter also expresses the degree to which the cleanup action may perform to a higher level than specific standards in MTCA. Finally, it measures the improvement of the overall environmental quality at the site.

- **Permanence** – The permanence of remedies under MTCA is measured by the relative reduction in toxicity, mobility, or volume of hazardous substances, including both the original contaminated media and the residuals generated by the cleanup action.
- **Costs** – The analysis of costs under MTCA includes all costs associated with implementing the alternative, including design, construction, long-term monitoring, and institutional controls. Costs analyses are intended to be comparable among different project alternatives to assist in the overall analysis of relative costs and benefits of different alternatives. Costs are evaluated against remedy benefits in order to assess cost-effectiveness and remedy practicability.
- **Long-Term Effectiveness** – The degree of certainty that the alternative will be successful in maintaining compliance with cleanup standards over the long-term performance of the remedy. The MTCA regulations contain a specific preference ranking for different types of technologies that is considered as part of the comparative analysis. The preference ranking places the highest preference on technologies such as reuse/recycling, treatment, immobilization/ solidification, and disposal in an engineered, lined, and monitored facility. Lower preference rankings are applied for technologies such as On-Site isolation/ containment with attendant engineering controls, and institutional controls and monitoring. The regulations recognize that in most cases the cleanup alternatives will combine multiple technologies to accomplish remedial objectives. The preference ranking must be considered along with other site-specific factors in the ranking of long-term effectiveness. Table 5-1 illustrates the range of technologies used with each of the alternatives, in order of the long-term effectiveness rankings under MTCA.
- **Short-Term Risk Management** – Short-term risk management is a parameter that measures the relative magnitude and complexity of actions required to maintain protection of human health and the environment during implementation of the cleanup action. Cleanup actions carry short-term risks such as potential mobilization of contaminants during construction, or safety risks typical to large construction projects. Some short-term risks can be managed through the use of best practices during project design and construction, and other risks are inherent to project alternatives and can offset the long-term benefits of an alternative.
- **Implementability** – Implementability is an overall measurement expressing the relative difficulty and uncertainty of implementing the project. It includes technical factors such as whether the alternative is technically possible, the availability of mature technologies, the right to site access and experienced contractors to accomplish the cleanup work. It also includes administrative factors associated with permitting, integration with existing facility operations and completing the cleanup.
- **Considerations of Public Concerns** – The public involvement process under MTCA is used to identify public concerns regarding alternatives, and the extent to which an alternative addresses those concerns is considered as part of the remedy selection process. This includes concerns raised by individuals, community groups, local governments, tribes, federal and state agencies, and other organizations that may have an interest in or knowledge of the site.

The analysis compares the relative environmental benefits of each alternative against those provided by the most permanent alternative. These benefits can be qualitative as well as quantitative. The costs of a more costly alternative are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost but overall effective alternative exceed the incremental decree of benefits achieved by the more costly alternative relative to that of the lower cost alternative (WAC 173-340-360(e)(i)). Where the quantitative and qualitative benefits of two alternatives are equivalent, the department shall select the less costly alternative (WAC 173-340-360(e)(ii)(C)).

5.2 Alternative 1 – Optimized Hydraulic Control, Soil Vapor Extraction/Air Sparging and Vapor Intrusion Mitigation

The technologies included in Alternative 1 are hydraulic control (containment), groundwater extraction, SVE/AS, the continued operation of the existing subslab depressurization system, and institutional controls.

An alternative that includes SVE/AS was selected because it is proven to be an effective technology for the treatment of TCE at other sites with similar contaminants. Alternative 1 includes:

- Optimizing the existing pump and discharge system
- Installation of a SVE/AS system (at the On-Site and Off-Site Areas)
- The continued operation of the Vapor Intrusion System
- A revised groundwater monitoring program
- Institutional controls.

Optimized Hydraulic Control

As discussed in Section 1.1.4 and Section 4.4, currently groundwater is recovered from two extraction wells (RW-2 and RW-3, shown on Figure 1-4) and extracted water is discharged to the City of Seattle. The objective of the current recovery network is to contain and recover groundwater, focusing on areas in the northern portion of the property. The current recovery system has operated continuously[22] at a combined rate generally ranging from 12 to 17 gpm. Over the past 12 years, over 113,874,000 gallons[23] of groundwater has been extracted and discharged. TCE concentrations in the On-Site Area well MW-4 have decreased from a high of 260 µg/L (November 1996) to 51 µg/L (February 2008), and concentrations in On-Site Area well MW-1 have decreased from a high of 560 µg/L (April 1997) to 50 µg/L (February 2008).

In an effort to increase the performance of the current recovery system, RW-3 will be abandoned and RW-4 will be installed downgradient, as shown on Figure 5-1. The location of RW-4 was selected based on a review of the potentiometric surface maps, the 1996 pump test, and the On-Site Area dissolved plume. A review of the potentiometric maps suggests a cone of depression that influences groundwater up to 40 feet from the pumping well during current average groundwater pumping rates. Groundwater modeling conducted to date confirms this result, but also suggests that the cone of influence could be expanded; however, in an effort to be conservative, the lower radius of influence will be carried forward (RETEC 2007B). By placing the two recovery wells within 70 feet of each other and increasing the discharge rates, the resulting cones of depression will overlap and result in a more robust design for the capture of the dissolved plume.

A review of the analytical data collected to date indicates that TCE concentrations in well MW-13 have been below the cleanup level (of 1.5 µg/L) since 2003. To continue this trend RW-4 should not be placed north of this well, which could potentially pull groundwater contamination into an area that is no longer affected. Monitoring well MW-6, the closest well to the proposed location, has previously had TCE levels above the cleanup level, but since August 2006 the TCE levels have decreased to below or just above the cleanup level for TCE. To continue this trend of low detections, the recovery well will be placed at least 10 feet south of MW-6. Groundwater will be pulled towards the recovery system, and away from MW-6.

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[22] Recovery system has been turned off only for operations and maintenance or repairs.

[23] Total readings from system installation through May 2008, based on monthly discharge reports.

The total pumping rate will remain a maximum value of 17 gpm. Based on the closest proximity of the two wells, best efforts will be maintained to split the total flow evenly between the two recovery wells. The recovery well will continue to operate continuously, and the current operations and maintenance (O&M) schedule will be assumed. Groundwater elevations will be monitored after the installation of RW-4 to verify the radius of influence observed in the field.

Soil Vapor Extraction/Air Sparging

Conceptually, Alternative 1 includes two areas of treatment during Phase 1 – On-Site and Off-Site Area – using 2 separate skid mounted catalytic oxidizers. For the On-Site Area, Alternative 1 includes a SVE system that consists of lateral wells installed in the alley (between MW-1 and MW-4). The lateral wells will be installed approximately 6 feet bgs and would run between MW-1 and MW-4 (approximately 50 feet), Figure 5-1 shows the proposed well network. Lateral wells are proposed to increase coverage in the shallow zone using a small above ground foot print. The SVE system will be plumed to a thermal catalytic oxidizer with a granular active carbon (GAC) or scrubbers to treat the extracted vapor before release into the atmosphere (as required by the permits). The current paved alley will remain as is; the pavement serves as a cover to minimize or control volatile emissions from escaping, minimizing short circulation within the SVE network, and to minimize the wet, or saturated, soil zone by minimizing surface infiltration. An additional AS system would be paired with the SVE system to remove COCs in the saturated zones, installed in close proximity to the SVE system, operating under the same electric power system and control devices. he space for the treatment unit would be rented from the current property owners. The On-Site Area system is expected to run for 36 months based on the potential chemically-affected soils under the building footings and based on data from similar sites. The exact duration of the SVE/AS system may change after initial monitoring data is collected after the system is installed.

Due to the extent of chemically-affected groundwater in the Off-Site Area, and based on the major roadway (1st Avenue South) separating the MW-14 and MW-15, two separate SVE/AS treatment systems are proposed. The first treatment system will occur at the same time as the On-Site Area, Phase 1 of this Alternative. Phase 1 includes treatment associated with MW-14; Phase 2 would include treatment of the MW-15 area. Similar to the On-Site Area, a skid-mounted treatment unit will be installed on the east side of 1st Avenue South and would target the MW-14 well cluster. Vertical SVE wells, which have been proven effective as deep as 300 feet, will be installed near and around MW-14. Vertical SVE wells are proposed extending to approximately 8 feet bgs; AS wells are proposed to extend to approximately 45 feet bgs. Six SVE wells will be placed along the center line of the plume, as shown on Figure 5-1. The placement of the treatment unit will be determined in final design, but mostly likely will require access negotiations to enable the rental of a portion of the parking lot. GE will work with local building owners and Ecology to balance the best possible location with the least amount of disturbances for local business.

Conceptually, Phase 2, which will start after the termination of Phase 1, will target the Off-Site Area on the west side of 1st Avenue South. The same SVE/AS oxidizer system will be installed in the vicinity of MW-15. The well network is similar to the wells proposed for the MW-14 treatment area, as shown on Figure 5-1. Phase 2 is expected to run for 36 months (the time frame is based on performance at similar sites). The exact duration of the system may change after initial monitoring data is collected after the system is installed.

Additional cost is added by having the system run off natural gas, but propane tanks were not considered appropriate because of the physical setting of the On- and Off-Site Areas. Propane tanks require a large footprint; renting the land for tank siting was not evaluated because of the heavily developed area and the current redevelopment construction. Furthermore, because of the traffic and the high density of industrial offices, a possible risk is associated with accidental collision; these risks were weighed higher than any potential cost saving.

Performance of the SVE/AS system will be monitored by the semiannual collection of vapor samples from the individual SVE wells and routine groundwater sampling. Phase 1 would include quarterly groundwater sampling of the On-Site Area monitoring wells and annual groundwater sampling of all site monitoring wells. Phase 2 would include quarterly groundwater sampling of the Off-Site Area monitoring wells and annual groundwater sampling of all site monitoring wells.

Vapor Mitigation System

Ecology has requested that the subslab depressurization system, which was installed in August 2006 to minimize vapor intrusion from the subslab into the former GE building, continue to operate during active remediation (at the same time as the operation of both the SVE/AS and pump and discharge). The combined operation of the subslab depressurization system and the SVE/AS could introduce potential interference and short circuiting, which may affect the performance of both technologies. Furthermore, while the SVE system would treat vapors in a more aggressive method than the current vapor mitigation system, essentially these two technologies act in the same way. Both pull vapors from the soil pores and vent them (SVE includes final treatment; the subslab depressurization system does not include final treatment). Based on the field work conducted in August 2006 and typical performance of SVE system in sandy soils, the radius of influences of the two system are expected to overlap in the northern portion of the building. During operation of the SVE system, it is possible that the preferred pathway could be the subslab depressurization riser pipe, which extends from the subslab of the building to the atmosphere. If this occurred, the efficiency of the SVE/AS to target the On-Site former source area would be significantly reduced. ENSR reviewed available site summaries on Ecology's and EPA's website and was not able to find a case which described a SVE/AS and subslab depressurization system overlapping. However, in an effort to move the site towards closure, GE has agreed to include the operation of the vapor mitigation system with this Alternative. Best efforts will be made during the design efforts to minimize the potential short circulation. During the implementation of Phase 1, periodically, the exit velocity of VIMS will be monitored; a reversal in direction or a significant decrease in flow suggests that the SVE system is pulling atmospheric air through one or more of the VIMS riser pipes. This will be evaluated during the performance monitoring conducted for the SVE/AS system.

A detailed description of the subslab depressurization system is included in the *Final Engineering Report - Sub-Surface Vapor Intrusion Interim Measure* (RETEC 2007F). The purpose of the VIMS is to prevent migration of vapors from below the building to inside the building, thereby reducing potential worker exposure. This is achieved by actively extracting air from five sumps constructed below the slab through a piping network connected to an inline centrifugal fan. Extracting the air not only removes VOC vapors, but also decreases the pressure under the slab so that it is lower than inside the building. This negative pressure gradient reduces air flow upward through the slab. The air extracted by the fan discharges to the atmosphere.

The VIMS consists of five separate pits, each connected to a 3-inch and 4-inch PVC pipe riser which extends up from the concrete slab to the roof. Two risers are located in the northwest portion of the building and three are located in the southwest portion of the building (Figure 5-2). These locations were determined by Ecology and corresponded to sampling locations where elevated concentrations of TCE were detected in the sub-slab and indoor air. Each riser is connected to piping routed to a single, roof-mounted centrifugal fan that extracts the air from under the building foundation. The extracted air is vented through a stack located on the southwest portion of the roof. As all potential concentrations are below permissible limits set by Puget Sound Clean Air Agency (PSCAA) no permitting or end of stack treatment is required.

One round of performance monitoring was collected in November 2007. A second round of performance monitoring will be conducted 2 months prior to field implementation of Alternative 1. The performance testing event will include indoor air sampling, ambient air sampling, exhaust sampling, and air flow measurements. If concentrations are above the MTCA Method C Cleanup Level for Indoor Air, additional sampling will occur on a yearly schedule. The vapor mitigation system will be terminated when concentrations inside the former GE building reach the MTCA Method C Cleanup Level for Indoor Air.

Institutional Controls

Institutional controls provide protection for human health and the environment by limiting the use of the groundwater and by securing the exposure routes to prevent exposure to chemically affected groundwater and soil. Institutional controls are currently provided by local regulations and laws which prohibit the extraction and use of groundwater for drinking water purposes in the area. GE will make a good faith effort to secure an environmental restrictive covenant on the 220 S Dawson street property or on any required downgradient properties if residual contaminated soil or vapors remain above MTCA Method C cleanup levels, before using other legal or administrative mechanisms.

Additional potential institutional controls, which add protection for human health and the environment, include providing fences or locks around operating treatment units and control boxes. Institutional controls are also included to protect human health and the environment from exposure to chemically-affected soil which is located beneath the building foundations. These current institutional controls are included in this alternative.

5.2.1 MTCA Threshold Requirements

A comparison of Alternative 1 against applicable MTCA criteria is provided below. This information is summarized in Table 5-1.

- **Protection of Human Health and the Environment**: Alternative 1 is expected to protect human health and the environment by preventing the migration of groundwater and to treat soil vapor. The use of institutional controls provides further protection by informing the current building owner of hazards and limiting uncontrolled activities. Institutional controls are difficult to implement at this site because GE does not own the building, but negotiations will be made with current and future building owner(s) to ensure that these are met.

- **Compliance with Cleanup Standards:** SVE/AS and groundwater recovery technologies have been proven to reduce CVOC concentrations. However, SVE/AS systems do not reliably achieve low potable cleanup levels in soil and groundwater. Treatment to the lowest TCE cleanup values (in groundwater, soil, or vapor) may require additional operation time and may not be achievable with this technology. Review of the operation of SVE/AS at other site proves that this technology can achieve the TCE MCL cleanup level, but it has not been reliable to treat groundwater, subslab vapor, or indoor air to the proposed cleanup standards. In addition, there are limitations at the site because the arrangement of building limits the ability to install SVE/AS wells in a robust design. The use of institutional controls is limited to management of potential chemically-affected soils which may be inaccessible to the SVE/AS treatment and control any remaining isolated locations which are above cleanup standards.

- **Compliance with Applicable State & Federal Laws:** This alternative could comply with applicable state and federal laws. Institutional controls will be addressed as part of the final Cleanup Action Plan, Consent Decree, and project implementation actions.

- **Provisions for Compliance Monitoring:** Alternative 1 provides for compliance groundwater and air monitoring.

5.2.2 Restoration Time frame

The restoration time frame for Alternative 1 is the longest of the proposed alternatives (Table 5-1). Alternative 1 includes one year for remedy selection and one year for design and permitting for both the optimized hydraulic system and the SVE/AS system. Six years is required for the implementation of both On-Site and Off-Site Areas, and three years of compliance monitoring is assumed. The total groundwater and indoor air restoration time frame for Alternative 1 is eleven years.

These time frames are based on similar sites; however, a site-specific restoration time frame will be determined after the systems are operating. Initial data will be collected to evaluated the performance of the system on groundwater and vapor concentrations and determine the final projected restoration time frame. The final restoration time frame may be longer than the current estimates. All of the restoration time frames presented in this FFS should be consider relative, and used for comparing the different alternatives. These time frames are based on the known fate and transport of the CVOCs under the respective treatment technologies, but do not represent an absolute time frame.

This restoration time frame assumes that the downgradient groundwater concentrations are related to the GE source concentrations. After completion of on-site treatment, if the downgradient groundwater concentrations rebound or remain elevated, the potential for a secondary source might need to be re-evaluated.

5.2.3 MTCA Evaluation Criteria

The MTCA disproportionate cost analysis includes comparative analysis of seven criteria. Issues relevant to the disproportionate costs analysis are discussed below and are listed in Table 5-1.

- **Overall Protectiveness:** The protectiveness of Alternative 1 is achieved primarily through containment of groundwater beneath the On-Site Area and the use of SVE/AS at the On-Site and Off-Site Areas. The use of institutional controls is limited to management of potential drinking water use and managing the current site use and any future site use to comply with all environmental regulations.
- **Permanence:** Alternative 1 provides reduction in the total volume of CVOC, both in the saturated and unsaturated zone. This Alternative would target CVOC concentrations in the groundwater, soil, and vapor.
- **Remedy Costs and Cost Effectiveness:** The probable cost of Alternative 1 ($4.6 Million) is the most costly of the evaluated alternatives (Appendix B). The most significant cost portion of the Alternative is the cost of operating the SVE/AS combined with the continued operation of the pump and discharge system.
- **Long-Term Effectiveness:** Alternative 1 uses an aggressive remediation strategy for the removal/degradation of CVOCs in groundwater. However, the ability to reach the lowest cleanup standard is the least likely with this Alternative. The long-term effectiveness of the alternative is therefore considered to be lowest, due to the increased risk of not effectively treating the chemically-affected media.
- **Short-Term Risk Management:** Alternative 1 involves the greatest amount of installation and on-site equipment (for the SVE/AS) and associated highest short-term risk as compared to the other alternatives. Management, planning, and communication are necessary during the implementation to minimize the short-term risk.
- **Implementability:** Compared to the other alternatives, this is the most difficult to implement. The required treatment equipment, large amount of excavation required for lateral wells, the coordination with the current building and land owners associated with storage of treatment equipment and the industrial, high profile setting are difficulties that need to be addressed. Additional work will be required to move the current recovery wells, and space constraints inhibit access to the source area. While significant, these are expected to be managed with proper planning before work starts. It should be noted that the building owner's preference is to minimize the amount of time workers spend on site. The operation of the pump and treat system requires routine O&M, weekly checks, and frequent cleanouts. The SVE/AS will also

require routine O&M and frequent site visits. Though this does not preclude the ability to implement an alternative which includes optimization and operation of the existing pump and treat system, it is a factor that should be consider in the final evaluation and selection of a site cleanup alternative (Section 5.8).

- **Consideration of Public Concerns:** Public review will be part of the review process for the Draft Cleanup Action Plan, as required under WAC 173-340-380.

5.2.4 MTCA Specific Requirements Regarding Containment

MTCA requirements listed in WAC 173-340-360(2)(ii)(B) state the following regarding containment:

> *(B) Ground water containment, including barriers or hydraulic control through ground water pumping, or both, shall be implemented to the maximum extent practicable to avoid lateral and vertical expansion of the ground water volume affected by the hazardous substance.*

The results of the Capture Zone Analysis demonstrate that the current configuration of the containment system has completely captured the chemically-affected groundwater area associated with the on site area (RETEC 2007B). Based on the data presented in the Capture Zone Analysis the current configuration complies with the WAC 173-340-360(2)(ii)(B) for the On-Site Area only. The current configuration does not affect the Off-Site Area; however, quarterly data collected since August 2003 indicates that the Off-Site Area plume is steady state and COCs are not migrating. This Alternative includes monitoring in the Off-Site Area to verify that site conditions do not change

5.3 Alternative 2 – Optimized Hydraulic Control, *In situ* Chemical Oxidation, Vapor Intrusion Mitigation, Institutional Controls

The technologies included in Alternative 2 are hydraulic control (containment), groundwater extraction, *in situ* chemical oxidation, continued operation of the existing subslab depressurization system, and institutional controls. Chemical oxidation does not require extensive excavation and disposal of contaminated soils and has proven to be effective at similar sites for chlorinated solvents, specifically TCE. The use of potassium permanganate was selected because of its rapid degradation of TCE, ease of application method, because it is not toxic to microbes which may be in the soil, and because site conditions are favorable for the degradation of TCE without accumulation of vinyl chloride (Ecology refers to this as Alternate 7 in the Response to Comments).

Alternative 2 includes:

- Optimizing the existing pump and discharge system;
- *In situ* Chemical Oxidation injection (at the On-Site and Off-Site Areas)
- The continued operation of the Vapor Intrusion System;
- A revised groundwater monitoring program; and
- Institutional Controls.

<u>**Optimized Hydraulic Control**</u>

As discussed in Section 1.1.4 and Section 4.4, currently groundwater is recovered from two extraction wells (RW-2 and RW-3, shown on Figure 1-4) and extracted water is discharged to the City of Seattle. The objective of the current recovery network is to contain and recover groundwater, focusing on areas in the northern portion of the property. The current recovery system has operated continuously[24] at a combined rate generally ranging from 12 to 17 gpm. Over the past 12 years, over 113,874,000 gallons[25] of groundwater has been extracted and discharged. TCE concentrations in the On-Site Area well MW-4 have decreased from a high of 260 µg/L (November 1996) to 51 µg/L (February 2008), and concentrations in On-Site Area well MW-1 have decreased from a high of 560 µg/L (April 1997) to 50 µg/L (February 2008).

In an effort to increase the performance of the current recovery system, RW-3 will be abandoned and RW-4 will be installed downgradient, as shown on Figure 5-1. Ecology has requested that RW-2 be replaced and that the new well (herein referred to as RW-5) be located to the east side of 2nd Avenue at a similar north-south location as RW-2 and that RW-4 be located on the east side of 2nd Avenue and north of MW-6 (Ecology, 2008C). The cone of depression around the newly installed groundwater extraction wells RW-4 and RW-5 will be evaluated by water elevation measurements collected after installation.

For costing estimates, the total pumping rate is assumed to remain at a maximum value of 17 gpm. The final pumping rate and exact well locations will be determined in subsequent final design documents. A range of pumping rates will be evaluated and may include a higher rate than the current design. Based on the closest proximity of the two wells, best efforts will be maintained to split the total flow evenly between the two recovery wells. The recovery well will continue to operate continuously, and the current operations and maintenance (O&M) schedule will be assumed.

***In Situ* Chemical Oxidation**

The following equations show the chemical equitation for the reaction of TCE and vinyl chloride with potassium permanganate:

- Where TCE = C_2HCl_3, Potassium Permanganate= $KMnO_4$ and Vinyl Chloride = C_2H_3Cl
- $2KMnO_4 + C_2HCl_3 \rightarrow 2CO_2 + 2MnO_2 + 3Cl^- + H^+ + 2K^+$
- $10KMnO_4 + 3C_2H_3Cl \rightarrow 6CO_2 + 10MnO_2 + 10K^+ 3Cl^- + 7OH^- + H_2O$

The required chemical concentrations needed for injection and the required injection network varies based on the oxidant demand for the site. The implementation of Alternative 2 would occur in a phased approach; Phase 1 would be include a bench scale test followed by a small scale injection for the purpose of evaluating the effectiveness of chemical oxidation including the estimation of the radius of influence based, destruction efficiency, based on site specific conditions. Phase 2 would include a full scale injection in the entire On-Site and Off-Site Areas, and Phase 3 would focus on any remaining areas that required additional treatment. The data collected during each phase of injection could alter the planned injection during the next phase.

Conceptually, Phase 1 will be limited to the vicinity around monitoring well MW-1, which is located in the eastern portion of the alley (Figure 5-3). It is assumed that access to this location will be limited by the planned building renovations; however, implementation of this alternative will work around all building owner requirements and fully restore any areas to existing conditions. Phase 1 would use a combination of conventional and temporary monitoring wells for injection and observation uses. Because of space constraints within the footprint of the alley, temporary injection and monitoring points are proposed within this location. In areas outside of the alley, conventional injection points will be installed, these conventional injection points will be used for future injections. Figure 5-3 shows the proposed injection and observation

[24] Recovery system has been turned off only for operations and maintenance or repairs.

[25] Total readings from system installation through May 2008, based on monthly discharge reports.

points. These locations are approximate, and may change based on site conditions, site activities, and site access (note that different phases of injections are shown on Figure 5-3). Separate injection wells will be screened at 9-13 and 16-20 ft bgs. Observation wells, used to evaluate the performance of the injection wells, would be screened at 9-13, 16-20, and 24 to 28 ft bgs. As discussed in for the MW-4 area, injection pressure is expected to remain within 1 psi per foot of depth. During injection, the $KMnO_4$ ROI will be estimated colorimetrically and using a multimeter water quality meter to identify distribution to the observation points. Phase 1 will include the most observation wells, to verify the radius of influence and enhance overall performance monitoring. Phase 1 also includes more frequent initial monitoring to track changes in the aquifer conditions or potential migration beyond the source area. Field data will be collected daily for the first five days after each injection. It is anticipated that after 5 days the $KMnO_4$ will be consumed. If $KMnO_4$ remains additional field data will be collected prior to collecting the analytical parameters.

During Phase 1, concentrations of KMnO4 are expected to range between 1.0% and 3.0%. Based on previous experience, this range of concentrations is expected to be sufficient to overcome oxidant demand of the aquifer media and the concentration of CVOC by several orders of magnitude. This concentration allows for a wide range of injection concentrations to be evaluated during Phase 1

Conceptually, Phase 2 will target 80% of the TCE for the On-Site Area and 60% of the TCE in the Off-Site Area. Chemical data will be collected from monitoring wells and evaluated to estimate the effectiveness of the injection by evaluating CVOC concentrations and field measurements. On-Site Area injection points will be screened across two intervals: the water table to 4 feet below the water table[26] and 12 to 16 feet bgs. Similarly, Off-Site Area injection points will be screened at 2 intervals: 20 to 24 feet bgs and 26 to 30 feet bgs. Injection at the Off-Site Area is concentrated around MW-14M/D and extends in the east and west direction towards EPI—MW-2D and MW-16M/D, respectively. Injection depths are based on the data presented in the site conceptual model (Section 2) and represent areas where soil beneath building foundations remain in place. Pairs of injection points would be located at each of the injection points. On-Site Area injections will include the area inside the alley and then extend to the east towards monitoring well MW-5. Injection points will also extend to the south of the former GE building (all injection is limited to the outside of the building). Based on the results of Phase 1 and Phase 2, the remaining TCE concentrations will be targeted in Phase 3 of injection. After Phase 3, it may be necessary to apply additional injection chemicals or adjust the treatment to target any potential byproducts that may be present as evidence of incomplete degradation.

The pump and discharge system will remain on during each round of injection. The continued operation of the pump and discharge system may benefit the chemical affected groundwater by drawing the injection fluid through the groundwater more quickly than in its absence. However; the continued operation of the pump and discharge system might instead impede the effectiveness of the *in situ* chemical oxidation alternative. The use of the pump and discharge system may cause the injection fluid to move too quickly, or cause it to migrate against the natural groundwater flow path, moving instead towards the recovery system. Impacted media may be out of this flow path, and could potentially not come into contact with the injection chemicals. Phase 1 will determine the potential influence of the recovery system on injection in the On-Site Area.

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[26] The water table depth will range based on the elevation of groundwater during the installation. Water table depths at MW-4 have ranged from 12.28 to 8.37 bgs and water depths at MW-11 have ranged from 9.97 to 7.28 bgs.

Prior to conducting Phase 1, a baseline data set will be generated. Groundwater will be collected from select observation points and nearby existing monitoring wells and analyzed for CVOCs, metals (potassium, iron, manganese, arsenic; (total and dissolved), chloride and general water quality parameters.

Following each injection, two additional rounds of analytical parameters (analyzed for the same list of parameters as the baseline) will be collected to assess changes in water quality and reduction of CVOC concentration (and therefore mass). In addition, samples will be pulled from downgradient wells to measure the arrival time of un-reacted $KMnO_4$ against predicted arrival time. Table 5-3 summarizes the proposed performance monitoring. Existing monitoring wells will be used to monitoring flow paths and trends during and after injection. Depending on the results of the monitoring additional injection may be needed to target any residual TCE concentration remaining above the cleanup values. As stated above, permanganate oxidizes TCE to carbon dioxide and water. Based on site chemistry, vinyl chloride is expected to completely degrade during the remediation and is not expected to accumulate.

Vapor Mitigation System

Alternative 2 includes the vapor mitigation systems elements and monitoring, presented in Alternative 1 The vapor mitigation system will continue to operate at the same time as the injections and would be terminated when concentrations inside the former GE building reach the MTCA Method C Cleanup Level for Indoor Air. Alternative 2 includes the option for additional air monitoring, as needed and required by Ecology.

Institutional controls

Institutional controls provide protection for human health and the environment by limiting the use of the chemically-affected groundwater, soil, and vapor by securing the exposure routes to prevent exposure. Institutional controls are currently provided by local regulations and laws which prohibit the extraction and use of groundwater for drinking water purposes in the area. GE will make a good faith effort to secure an environmental restrictive covenant on the 220 S Dawson street property or on any required downgradient properties if residual contaminated soil or vapors remain above MTCA Method C cleanup levels, before using other legal or administrative mechanisms.

Additional potential institutional controls that add protection for human health and the environment could include providing fences or locks around operating wells and control boxes. Institutional controls would also be included in order to protect human health and the environment from exposure to chemically-affected soil which is located beneath the building foundations.

5.3.1 MTCA Threshold Requirements

A comparison of Alternative 2 against applicable MTCA criteria is provided below. This information is summarized in Table 5-1. Alternative 2 complies with MTCA threshold criteria, as do the other alternatives evaluated in the FFS.

- **Protection of Human Health and the Environment**: Alternative 2 is expected to be protective of human health and the environment by complying with applicable federal and state cleanup standards.
- **Compliance with Cleanup Standards:** Alternative 2 addresses the cleanup levels described in Section 3 for groundwater and air, through the use of chemical and physical control measures. The use of institutional controls is limited to management of potentially chemically-affected soil under the building which may not be affected by the chemical injections. Remaining soil may be inaccessible due to structures, e.g. building, supporting building walls, telephone poles. Institutional controls will be implemented by restricting the current site use and any future site use.

- **Compliance with Applicable State & Federal Laws:** This alternative will comply with applicable state and federal laws. Institutional controls will be addressed as part of the final Cleanup Action Plan, Consent Decree, and project implementation actions.
- **Provisions for Compliance Monitoring:** Alternative 2 provides for compliance monitoring to demonstrate that concentrations are stable for both groundwater and air.

5.3.2 Restoration Time Frame

The groundwater restoration time-frame for Alternative 2 is relatively short due to the aggressive treatment of the CVOC concentrations. Alternative 2 includes two years for remedy selection, design, and permitting. Three years are planned for the implementation and three years of compliance monitoring is assumed. The total groundwater and indoor air restoration time frame for Alternative 2 is eight years.

The use of the hydraulic control system during injection could limit the ability for the injection chemicals to come into contact with the full extent of contamination. The GE facility operated using COC for approximately 40 years prior to operation of the groundwater recovery system (pre-1996) and COC became located in the subsurface based on pre-pumping flow paths. The groundwater recovery system alters flow pathways in the vicinity of recovery wells, including lowering the groundwater table. Flow paths during pumping will not address all flow paths that existed prior to initiation of pumping. Residual soil contamination likely remains above and in areas adjacent to the pumping wells that will not be addressed by remediation with the recovery system in operation. In this alternative, the recovery system operates until cleanup levels are met. When the system is shut down, COC concentrations will likely increase and additional treatment may be necessary to treat COC remaining in flow pathways not addressed under pumping conditions. Additionally, the use of the hydraulic control system reduces the contact time of the chemical injections and the groundwater. It is difficult to determine the effect these factors will have on the restoration time frame but it will most likely increase because potentially additional injections or monitoring will be required if groundwater concentrations increase above the cleanup levels.

The restoration time frame includes 2 years for additional treatment. This allows for potential monitored natural attenuation, isolated areas of further injection or another proven technology. These factors could result in additional time to remobilize to site and address isolated pockets of groundwater with CVOCs persisting above cleanup standards. Future treatments for isolated pockets of CVOCs may include MNA or other technologies. Treatment options will be discussed with Ecology prior to any mobilization.

The final restoration time-frame may be longer than the current estimates. All of the restoration time-frames presented in this FFS should be considered relative, and used primarily for comparing the different Alternatives. These time-frames are based on the known fate and transport of the CVOCs under the respective treatment technologies, but do not represent an absolute time frame

For purposes of this FFS the above restoration time frame is assumed. This restoration time-frame assumes that the downgradient groundwater concentrations are related to the GE source concentrations. After completion of On-Site treatment, if the downgradient groundwater concentrations rebound or remain elevated, the potential for a secondary source will need to be re-evaluated.

5.3.3 MTCA Evaluation Criteria

The MTCA disproportionate cost analysis includes comparative analysis of seven criteria. Issues relevant to the disproportionate costs analysis are discussed below, and are listed in Table 5-1.

- **Overall Protectiveness:** The protectiveness of Alternative 2 is achieved primarily through the aggressive use of removal by chemical oxidation. This remedy represents a moderate level of protectiveness. The risk associated with the not reaching all areas or pockets of contaminants (associated with the continued use of the extraction system, discussed above), decreases the overall protectiveness compared to other alternatives evaluated in the FFS. The use of institutional controls is also needed and proposed under this alternative.

- **Permanence:** Chemical oxidation is a permanent solution to eliminate the CVOCs present in the dissolved and un-dissolved phase. As dissolved CVOCs are diminished, sorbed CVOCs disassociate and become dissolved. Un-reacted permanganate reacts with the dissolved CVOCs to increase the reduction. Chemical oxidation with a permanganate solution is very rapid degradation process, as described above; additional applications may be needed to treat all residual concentrations of CVOCs.
- **Remedy Costs and Cost Effectiveness:** The probable costs of Alternative 2 ($3.7 million) are the second highest of the six evaluated alternatives (Appendix B). The most significant cost portion of the alternative is the combined use of *in situ* chemical injection and pump and discharge. The continued operation of the pump and treat system requires twice as much chemical injection as Alternative 5 (*in situ* chemical injection without pump and treat).
- **Long-Term Effectiveness:** Alternative 2 uses the most aggressive remediation strategy for the degradation of CVOCs in groundwater. The continued operation of the extraction system during injection may inhibit ability for the chemicals to come into contact with the full extent of the chemical affected media, introducing uncertainty associated with reaching the site cleanup levels. Due to this potential uncertainty, the long-term effectiveness of the alternative is therefore considered to be moderate, compared to Alternatives 5 and 6.
- **Short-Term Risk Management:** Alternative 2 involves the greatest chemical exposure risk because of the highly reactive permanganate solution and during the optimization of the existing pump and discharge system. Management, planning, and communication during the implementation of Alternative 2 will minimize the short term risk.
- **Implementability:** Alternative 2 is practicable and implementable. Difficulties related to implementability include access, chemical storage, and availability of contractors. All of these difficulties can be managed with proper project planning before work starts. It should be noted that the building owner's preference is to minimize the amount of time workers spend on site. The operation of the pump and treat system requires routine O&M, weekly checks, and frequent cleanouts. Though this does not preclude the ability to implement an alternative which includes optimization and operation of the existing pump and treat system, it is a factor that should be consider in the final evaluation and selection of a site cleanup alternative (Section 5.8).
- **Consideration of Public Concerns:** Public review will be part of the review process for the Draft Cleanup Action Plan, as required under WAC 173-340-380. No previous public concerns have been received ahead of the submittal of this FFS.

5.4 Alternative 3 – Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation and Vapor Intrusion Mitigation

The technologies included in Alternative 3 are hydraulic control (containment), groundwater extraction enhanced bioremediation, the continued operation of the existing subslab depressurization system, and institutional controls.

An alternative that includes bioremediation was selected because it is technically feasible, has been proven to be an effective technology for the treatment of TCE at similar sites and it can target a large area without disturbing aboveground structures. Alternative 3 includes:

- Optimizing the existing pump and discharge system
- Electron donor injection into the On-Site and Off-Site areas

- Installation of electron donor injection wells (at the On-Site and Off-Site Areas)
- The continued operation of the Vapor Intrusion System
- A revised groundwater monitoring program
- Institutional Controls.

Optimized Hydraulic Control

Alternative 3 includes the optimized hydraulic control elements presented in Alternative 1

Performance monitoring of the groundwater pump and discharge system will include bi-annual discharge samples submitted to King County (assumed for costing, the sampling frequency is subject to change based on the permit requirements determined by the King County). Groundwater samples will be collected in association with the Enhanced Anaerobic Bioremediation performance monitoring, which is described below.

Enhanced Anaerobic Bioremediation

The enhanced bioremediation portion of Alternative 3 includes the injection of a combination of soluble and slow-release (or insoluble) electron donors. This combination of electron donors allows for a larger treatment area. The soluble donors release high concentrations of hydrogen and intermediate volatile organic acids (which ferment to hydrogen) downgradient of the injection wells. Slow release electron donors ferment near the injection well, resulting in a continuous supply of hydrogen and intermediate volatile organic acids moving downgradient with groundwater flow. The proposed[27] soluble donor selected for Alternative 3 is sodium lactate and the proposed slow release electron donor selected is vegetable oil emulsion. A yeast extract will be added to the injection slurry to enhance bacterial growth.

The required injection slurry volume needed for injection and the required injection network varies with each site. The implementation of Alternative 3 would occur in a phased approach; Phase 1 includes a small scale injection to evaluate the natural bacteria conditions, evaluate the effectiveness of the selected donors, estimate the radius of influence, and evaluate the effects of the hydraulic recovery system. Injection and monitoring during Phase 1 is limited to the On-Site Area; the data collected during Phase 1 will be applied to both the On-Site and Off-Site Areas during Phase 2.

Conceptually, Phase 1 includes an initial evaluation of the microbial counts in the groundwater from the On-Site and Off-Site Area. This FFS assumes that natural bacteria is present in sufficient numbers and type, if results of the microbial counts dispute this assumption, the injection will include electron donors, yeast, and bacterial augmentation. After results are evaluated, Phase 1 will include the installation of additional of injection wells located in the On-Site Area. Five injection wells on 10 foot centers would be installed 30 feet upgradient of MW-1, as shown on Figure 5-4. All injection wells will be installed outside of the foot print of the existing buildings. On-Site Area injection points will be screened across two intervals: the water table to 4 feet below the water table[28] and 12 to 16 feet bgs. Injection depths are based on the data presented in the site conceptual model (Section 2) and represent areas where chemically-affected soil beneath building foundations remain in place (Dames and Moore, 1994). Chemical data would be collected from monitoring wells and used to determine the effectiveness of the injection by evaluating CVOC concentrations (a monitoring plan would be prepared with the final design). Based on the results of the Phase 2, the remaining TCE concentrations will be

[27] The final selected soluble and insoluble donors may change based on availability, the proposed donors presented in this FFS are used for costing purposes. Final selected donors will be similar (in-terms of donor properties) to these proposed.

[28] The water table depth will range based on the elevation of groundwater during the installation. Water table depths at MW-4 have ranged from 12.28 to 8.37 bgs and water depths at MW-11 have ranged from 9.97 to 7.28 bgs.

targeted in the third phase of injection. After Phase 3, it may be necessary to apply an additional injection compounds or adjust the treatment to target any potential byproducts that may be present as evidence of incomplete degradation. Additional treatment could target vinyl chloride, as this is a byproduct that can result from incomplete degradation. A monitoring schedule is included on Table 5-4.

Phase 1 will also include a tracer study to better understand groundwater movement within in the treatment area. Sodium bromide will be dissolved into the injection solution and delivered across the treatment area. Daily bromide samples will be collected in the nearest downgradient wells (MW-4 and MW-6, MW-8M, and MW-8S) until breakthrough of bromide is observed.

Phase 2 includes injection of electron donors on both the On-Site and Off-Site Areas. Injection in the On-Site Area includes the same network used in Phase 1, plus an additional 8 injection wells, on 10 foot centers located within the alley and upgradient of MW-1. All injection wells will be installed outside of the foot print of the existing buildings. Similar to Phase 1, On-Site Area injection points will be screened across two intervals: the water table to 4 feet below the water table and 12 to 16 feet bgs. Injection depths and total number of injection wells may be altered depending on the results of the Phase 1. Pairs of injection points would be located at each of the injection points.

The pump and discharge system will remain on during each round of injection. The continued operation of the pump and discharge system may benefit the chemical affected groundwater by drawing the injection fluid through the groundwater unit in a shorter timeframe. However; the continued operation of the pump and discharge system may also impede the effectiveness of the injection alternative. The use of the pump and discharge system may cause the injection fluid to move against the natural groundwater flow path, moving towards the recovery system. Shallow concentrations of chemical affected media may be out of this flow path, and could potentially not come into contact with the injection slurry. Phase 1 will determine the influence of the recovery system in the On-Site Area.

The Off-Site Area will include 10 injection wells on 10 foot centers located around monitoring wells MW-14M/D and MW-15M/D. Figure 5-4 shows the configuration of the Off-Site Area injection wells, which will include five injection wells located around well MW-14M/D and five wells located around MW-15M/D. Off-Site Area injection points will be screened at two intervals: 20 to 24 feet bgs and 26 to 30 feet bgs. Injection depths and total number of injection wells may be altered depending on the results of Phase 1. Pairs of injection points would be located at each of the injection points. All injection wells will be installed outside of the foot print of the existing buildings.

Phase 3 includes subsequent injections. The extent of Phase 3 will be dependent on the results of Phase 2. For the purpose of this FFS, a general cost estimate is included for Phase 3, assuming that the injection volume will be 30% of Phase 2, cover the same injection network, and not include any well construction.

Monitoring will be performed during and after injections (a full monitoring schedule will be developed as part of the final design). Temporary observation wells may be installed to monitor injection flow rates at the Off-Site Area. Existing monitoring wells will be used to monitoring flow paths and trends during and after injection. Table 5-4 summaries the proposed monitoring schedule.

Vapor Mitigation System

Alternative 3 includes the vapor mitigation systems elements, and monitoring, presented in Alternative 1 The vapor mitigation system will continue to operate at the same time as the injections and would be terminated when concentrations inside the former GE building reach the MTCA Method C Cleanup Level for Indoor Air.

Methane produced by methanogenic aquifer conditions (induced by electron donor amendment) has the potential to migrate to enclosed spaces located below ground and or adjacent to the treatment zone. No basements, tunnels or below grade location existing on site. In the event that locations of potential concern are identified by building owners/tenants, air monitoring will occur during the performance monitoring. If any location detects methane (at or near 20 % the LEL) the areas will be vented to prevent methane buildup and eliminate any potential explosive risk.

Institutional Controls

Institutional controls are also included to protect human health and the environment from exposure to chemically-affected soil which is located beneath the building foundations. These sort of institutional controls are included in this selected alternative to add an additional degree of protection for the On-Site Area and the Off-Site Area.

Institutional controls are currently provided by local regulations and laws that prohibit the extraction and use of groundwater for drinking water purposes in the area. GE will make a good faith effort to secure an environmental restrictive covenant on the 220 S Dawson street property or on any required downgradient properties if residual contaminated soil or vapors remain above MTCA Method C cleanup levels, before using other legal or administrative mechanisms. Additional potential institutional controls that add protection for human health and the environment could include providing fences or locks around operating wells and control boxes.

5.4.1 MTCA Threshold Requirements

A comparison of Alternative 3 against applicable MTCA criteria is provided below. This information is summarized in Table 5-1.

- **Protection of Human Health and the Environment**: Alternative 3 is expected to be protective of human health and the environment by complying with applicable federal and state cleanup standards.
- **Compliance with Cleanup Standards:** Alternative 3 addresses the cleanup levels described in Section 3 for groundwater and air, through the use of enhanced anaerobic bioremediation. Data collected to date suggest that anaerobic bioremediation can be effective at the site. However, bioremediation is very sensitive to site specific conditions and may result in the formation of new CVOCs above cleanup standards (from byproducts or mobilization of metals). The use of institutional controls is limited to management of potentially chemically-affected soil under the building which may not be affected by the electron donor injections. Remaining soil may be inaccessible due to impermeable structures, e.g. building walls, utilities. Institutional controls will be implemented by managing the current site use and any future site use to comply with all environmental regulations. Furthermore, continued operation of the pump and discharge system may inhibit the effectiveness of this Alternative in the On-Site Area.
- **Compliance with Applicable State & Federal Laws:** Assuming compliance with appropriate project design and permitting requirements this alternative will comply with applicable state and federal laws. Institutional controls will be addressed as part of the final Cleanup Action Plan, Consent Decree, and project implementation actions.
- **Provisions for Compliance Monitoring:** Alternative 3 provides for compliance monitoring to demonstrate that concentrations are stable for both groundwater and air.

5.4.2 Restoration Time-Frame

The groundwater restoration time-frame for Alternative 3 is moderate due to the aggressive treatment of the CVOC concentrations.

Alternative 3 includes two years for remedy selection, design, and permitting. Five years are required for the implementation of all phases of the proposed alternative. After final injection, three years of compliance monitoring is assumed. The total groundwater and indoor air restoration time frame for Alternative 3 is ten years.

Because of the potential for bioremediation to produce CVOCs byproducts or mobilization metals (this is unlikely given the concentration of metals at the site), additional time is assumed to treat isolated pockets of groundwater or vapor that could remain above the cleanup standards. Time is included for the analysis of the microbial study results. The final restoration time-frame may be longer than the current estimates. All of the restoration time-frames presented in this FFS should be consider relative, and used primarily for comparing the different Alternatives. These time-frames are based on the known fate and transport of the CVOCs under the respective treatment technologies, but do not represent an absolute time frame.

This restoration time-frame assumes that the downgradient groundwater concentrations are related to the GE source concentrations. After completion of On-Site treatment, if the downgradient groundwater concentrations rebound or remain elevated, the potential for an off-site source may need to be re-considered.

5.4.3 MTCA Evaluation Criteria

The MTCA disproportionate cost analysis includes comparative analysis of seven criteria. Issues relevant to the disproportionate costs analysis are discussed below, and are listed in Table 5-1.

- **Overall Protectiveness:** The protectiveness of Alternative 3 is achieved primarily through the use of CVOC removal by bioremediation. The natural biological process on site has been slow to reduce CVOC concentrations, Phase 1 will indicate if conditions across the site are favorable for bioremediation. Alternative 3 is ranked moderate compared to the other alternatives. The uncertainties associated with the effectiveness and potential generation of unwanted byproducts; decrease the overall protectiveness compared to the other alternatives. The use of institutional controls is still required under this alternative.
- **Permanence:** Biodegradation, similar to chemical oxidation, is a permanent solution to eliminate the CVOCs present in the dissolved and un-dissolved phase. As dissolved CVOCs are diminished, sorbed CVOCs disassociate and become dissolved. Natural bacteria, enhanced by the augmentation of groundwater unit, react with the newly dissolved CVOCs to increase the overall CVOC reduction. Alternative 3 ranks high for permanence compared to the other alternatives.
- **Remedy Costs and Cost Effectiveness:** The total probable cost of Alternative 3 (3.2 million) is lower than Alternatives 1 and 2 but more costly than the other evaluated alternatives (Appendix B). The most significant cost portion of the alternative is the electron donor slurry combined with the current operation of the pump and discharge system. The continued operation of the pump and treat system requires twice as much electron donor slurry than Alternative 6 (enhanced bioremediation injection without pump and treat).
- **Long-Term Effectiveness:** Alternative 3 uses enhancement of natural bacteria to degrade CVOC in the groundwater and in the smear zone (in the interface between the water and the soil). The continued operation of the pump and discharge system may inhibit ability for the electron donor slurry to come into contact with natural bacteria, inhibiting effectiveness of this Alternative in the On-Site Area. Results of Phase 1 will confirm the effectiveness. Due to this potential uncertainty, the long-term effectiveness of the alternative is therefore considered to be moderate, compared to Alternatives 5 and 6.
- **Short-Term Risk Management:** Alternative 3 involves minimal risk during installation of the enhanced bio remediation system. The injection slurry is essentially everyday household kitchen products and have little contact or exposure risk by workers. Risk associated with the optimization of the existing pump and discharge is moderate. Management, planning, and communication is necessary during the implementation to minimize the short term risk.

- **Implementability:** Alternative 3 is practicable and implementable. Difficulties related to implementability include access, product storage, injection design, timeframe of injection, and availability of contractors. All of these difficulties can be managed with proper planning before work starts. It should be noted that the building owner's preference is to minimize the amount of time workers spend on site. The operation of the pump and treat system requires routine O&M, weekly checks, and frequent cleanouts. Though this does not preclude the ability to implement an alternative which includes optimization and operation of the existing pump and treat system, it is a factor that should be consider in the final evaluation and selection of a site cleanup alternative (Section 5.8).
- **Consideration of Public Concerns:** Public review will be part of the review process for the Draft Cleanup Action Plan, as required under WAC 173-340-380. No previous public concerns have been received ahead of the submittal of this FFS.

5.5 Alternative 4 – Soil Vapor Extraction/ Air Sparging

The technologies included in Alternative 4 are SVE/AS, the continued operation of the existing subslab depressurization system, and institutional controls.

Alternative 4 includes:

- Installation of a SVE/AS system (at the On-Site and Off-Site Areas)
- The continued operation of the Vapor Intrusion System
- A revised groundwater monitoring program
- Institutional controls.

SVE/AS System

Alternative 4 includes the SVE/AS elements presented in Alternative 1.

Institutional Controls

Alternative 4 includes the institutional controls elements presented in Alternative 1.

5.5.1 MTCA Threshold Requirements

A comparison of Alternative 4 against applicable MTCA criteria is provided below. This information is summarized in Table 5-1. Alternative 4 complies with MTCA threshold criteria, as do the other alternatives evaluated in the Focused Feasibility Study.

- **Protection of Human Health and the Environment**: Alternative 4 is expected to be protective of human health and the environment by complying with applicable federal cleanup standards by preventing the migration of soil vapor and reducing groundwater concentrations in both On-Site and Off-Site Areas. The use of institutional controls provides further protection by informing the current building owner of hazards and limiting uncontrolled activities. Institutional controls are difficult to implement at this site because GE does not own the building, but negotiations will be made with current and future building owner(s) to ensure that these are met.
- **Compliance with Cleanup Standards:** SVE/AS and groundwater recovery technologies have been proven to reduce CVOC concentrations. SVE/AS systems do not reliably achieve low potable cleanup levels in soil and groundwater. Treatment to the lowest TCE cleanup values (in groundwater, soil, or vapor) may require additional operation time and may not be achievable with this technology. Review of the operation of SVE/AS at other site proves that this

technology can achieve the TCE MCL cleanup level, but it has not reliable to treat groundwater, subslab vapor, or indoor air to the proposed cleanup standards combined with the limitations of the site (the arrangement of building limits the ability to install SVE/AS wells across in a robust design to meet cleanup standards). The use of institutional controls is limited to management of potential chemically-affected soils which may be inaccessible to the SVE/AS treatment and control any remaining isolated locations which are above cleanup standards.

- **Compliance with Applicable State & Federal Laws:** Assuming compliance with appropriate project design and permitting requirements this alternative will comply with applicable state and federal laws. Institutional controls will be addressed as part of the final Cleanup Action Plan, Consent Decree, and project implementation actions.
- **Provisions for Compliance Monitoring:** Alternative 4 provides for compliance monitoring to demonstrate that concentrations are stable.

5.5.2 Restoration Time-Frame

The restoration time-frame for Alternative 4 is the same as Alternative 1, which are the longest of the proposed alternatives (Table 5-1). Alternative 4 includes one year for remedy selection and one year for design and permitting. Six years is required for the implementation of both On-Site and Off-Site Areas, and three years of compliance monitoring is assumed. The total groundwater and indoor air restoration time frame for Alternative 4 is 11 years.

These time frames are based on similar sites, however, a site-specific restoration time frame will be determined after the systems are operating, initial data will be collected to evaluated the performance of the system on groundwater and vapor concentrations and determine the final projected restoration time frame. The final restoration time-frame may be longer than the current estimates, all of the restoration time-frames presented in this FFS should be consider relative, and used for comparing the different alternatives. These time-frames are based on the known fate and transport of the CVOCs under the respective treatment technologies, but do not represent an absolute time frame.

This restoration time-frame assumes that the downgradient groundwater concentrations are related to the GE source concentrations. After completion of On-Site treatment, if the downgradient groundwater concentrations rebound or remain elevated, the potential for a secondary source will need to be re-evaluated.

5.5.3 MTCA Evaluation Criteria

The MTCA disproportionate cost analysis includes comparative analysis of seven criteria. Issues relevant to the disproportionate costs analysis are discussed below, and are listed in Table 5-1.

- **Overall Protectiveness:** The protectiveness of Alternative 4 is achieved primarily through the use of SVE/AS in the On-Site and Off-Site Areas. The use of institutional controls is limited to management of potential drinking water use and managing the current site use and any future site use to comply with all environmental regulations. The overall protectiveness of Alternative 4 is considered similar to that of Alternative 1.
- **Permanence:** Alternative 4 provides reduction in the total volume of CVOC, both in the saturated and unsaturated zone. This Alternative would target CVOC concentrations in the groundwater, soil, and vapor.
- **Remedy Costs and Cost Effectiveness:** The probable costs of Alternative 4 ($2.6 million); this cost is moderate compared to all six of the alternatives (Appendix A). The most significant cost portion of the alternative the cost of operation of the SVE/AS systems.
- **Long-Term Effectiveness:** Alternative 4 uses an aggressive remediation strategy for the removal/degradation of CVOCs in groundwater. However, the ability to reach the lowest

cleanup standard is the least likely with Alternative 4 (similar to Alternative 1). The long-term effectiveness of the alternative is therefore considered to be moderate or less, due to the increased use of higher-preference remediation technologies as defined under MTCA.

- **Short-Term Risk Management:** Alternative 4 requires significant installation and on-site equipment associated with the SVE/AS equipment. Management, planning, and communication are necessary during the implementation to minimize the short-term risk.
- **Implementability:** Compared to the other alternatives, Alternative 4 is the second most difficult to implement (Alternative 1 is the most difficult to implement). The required treatment equipment, large amount of excavation required for lateral wells, the coordination with the current building and land owners associated with storage of treatment equipment and the industrial, high profile setting are difficulties that need to be addressed. While significant, these are expected to be managed with proper planning before work starts. Additionally, it should be noted that the building owner's preference is to minimize the amount of time workers spend on site. The operation of the SVE/AS systems will require routine O&M and frequent site visits.
- **Consideration of Public Concerns:** Public review will be part of the review process for the Draft Cleanup Action Plan, as required under WAC 173-340-380. No previous public concerns have been received ahead of the submittal of this FFS.

5.6 Alternative 5 – *In Situ* Chemical Oxidation, Vapor Intrusion Mitigation and Institutional Controls

The technologies included in Alternative 5 are oxidation (using potassium permanganate), the continued operation of the existing subslab depressurization system, and institutional controls.

- *In situ* chemical oxidation injection (at the On-Site and Off-Site Areas)
- The continued operation of the Vapor Intrusion System
- A revised groundwater monitoring program
- Institutional controls.

***In Situ* Chemical Oxidation**

The following equations show the chemical equitation for the reaction of TCE and vinyl chloride with potassium permanganate:

- Where TCE = C_2HCl_3, Potassium Permanganate= $KMnO_4$ and Vinyl Chloride = C_2H_3Cl
- $2KMnO_4 + C_2HCl_3 \rightarrow 2CO_2 + 2MnO_2 + 3Cl^- + H^+ + 2K^+$
- $10KMnO_4 + 3C_2H_3Cl \rightarrow 6CO_2 + 10MnO_2 + 10K^+ 3Cl^- + 7OH^- + H_2O$

The required chemical concentrations needed for injection and the required injection network varies based on the oxidant demand for the site. The implementation of Alternative 2 would occur in a phased approach; Phase 1 would be include a bench scale test followed by a small scale injection for the purpose of evaluating the effectiveness of chemical oxidation including the estimation of the radius of influence based, destruction efficiency, based on site specific conditions. Phase 2 would include a full scale injection in the entire On-Site and Off-Site Areas, and Phase 3 would focus on any remaining areas that required additional treatment. The data collected during each phase of injection could alter the planned injection during the next phase.

Conceptually, Phase 1 will be limited to the vicinity around monitoring well MW-1, which is located in the eastern portion of the alley (Figure 5-6). It is assumed that access to this location will be limited by the planned building renovations; however, implementation of this alternative will work around all building owner requirements and fully restore any areas to existing conditions. Phase 1 would use a combination of conventional and temporary monitoring wells for injection and observation uses. Because of space constraints within the footprint of the alley, temporary injection and monitoring points are proposed within this location. In areas outside of the alley, conventional injection points will be installed, and these conventional injection points will be used for future injections. Figure 5-6 shows the proposed injection and observation points. These locations are approximate, and may change based on site conditions, site activities, and site access (note that different phases of injections are shown on Figure 5-6). Separate injection wells will be screened at 9-13 and 16-20 ft bgs. Observation wells, used to evaluate the performance of the injection wells, would be screened at 9-13, 16-20, and 24 to 28 ft bgs. As discussed in for the MW-4 area, injection pressure is expected to remain within 1 psi per foot of depth. During injection, the $KMnO_4$ ROI will be estimated colorimetrically and using a multi meter water quality meter to identify distribution to the observation points. Phase 1 will include the most observation wells, to verify the radius of influence and enhance overall performance monitoring. Phase 1 also includes more frequent initial monitoring to track changes in the aquifer conditions or potential migration beyond the source area. Field data will be collected daily for the first five days after each injection. It is anticipated that after 5 days the $KMnO_4$ will be consumed. If $KMnO_4$ remains additional field data will be collected prior to collecting the analytical parameters.

During Phase 1, concentrations of KMnO4 are expected to range between 1.0% and 3.0%. Based on previous experience, this range of concentrations is expected to be sufficient to overcome oxidant demand of the aquifer media and the concentration of CVOC by several orders of magnitude. This concentration allows for a wide range of injection concentrations to be evaluated during Phase 1

Conceptually, Phase 2 will target 80% of the TCE for the On-Site Area and 60% of the TCE in the Off-Site Area. Chemical data will be collected from monitoring wells and evaluated to estimate the effectiveness of the injection by evaluating CVOC concentrations and field measurements. On-Site Area injection points will be screened across two intervals: the water table to 4 feet below the water table and 12 to 16 feet bgs. Similarly, Off-Site Area injection points will be screened at 2 intervals: 20 to 24 feet bgs and 26 to 30 feet bgs. Injection at the Off-Site Area is concentrated around MW-14M/D and extends in the east and west direction towards EPI—MW-2D and MW-16M/D, respectively. Injection depths are based on the data presented in the site conceptual model (Section 2) and represent areas where soil beneath building foundations remain in place. Pairs of injection points would be located at each of the injection points. On-Site Area injections will include the area inside the alley and then extend to the east towards monitoring well MW-5. Injection points will also extend to the south of the former GE building (all injection is limited to the outside of the building). Based on the results of Phase 1 and Phase 2, the remaining TCE concentrations will be targeted in Phase 3 of injection. After Phase 3, it may be necessary to apply additional injection chemicals or adjust the treatment to target any potential byproducts that may be present as evidence of incomplete degradation.

Prior to conducting Phase 1, a baseline data set will be generated. Groundwater will be collected from select observation points and nearby existing monitoring wells and analyzed for CVOCs, metals (potassium, iron, manganese, arsenic; (total and dissolved), chloride and general water quality parameters.

The recovery wells will be turned off when injections are initiated. Recovery wells will remain and will be used, as necessary to facilitate chemical travel time during injection only (based on the results of Phase 1) or to prevent any unacceptable downgradient plume movement identified based on monitoring results. Recovery well locations will be evaluated during remedial design to assess whether one or both wells should be relocated to optimize locations for potential risk management. Injection and performance monitoring location and frequency will be finalized during remedial design. The injection and monitoring locations shown in Figure 5-6 and the monitoring frequency schedule shown on Table C-1 are preliminary, planning level scenarios and were used for costing this alternative.

Following each injection, two additional rounds of analytical parameters (analyzed for the same list of parameters as the baseline) will be collected to assess changes in water quality and reduction of CVOC concentration (and therefore mass). In addition, samples will be pulled from downgradient wells to measure the arrival time of un-reacted KMnO4 against predicted arrival time. Table 5-5 summarizes the proposed performance monitoring. Existing monitoring wells will be used to monitoring flow paths and trends during and after injection. Depending on the results of the monitoring additional injection may be needed to target any residual TCE concentration remaining above the cleanup values. As stated above, permanganate oxidizes TCE to carbon dioxide and water. Based on site chemistry, vinyl chloride is expected to completely degrade during the remediation and is not expected to accumulate.

Recent discussion with Ecology and Ecology's Response to Comments indicate that Ecology has some comments related to the risk of turning off the recovery wells during the remediation (Ecology, 2008C). Specifically:

- The possibility of expansion of the CVOC plume when the pumps are turned off. Plume expansion could result in additional area for treatment or migration of unacceptable vapors to indoor air in new areas
- The potential hydraulic effect of injecting fluids into the groundwater aquifer when the pumps are turned off.

The following additional sections provide further detail and explanation regarding these specific issues.

5.6.1 Potential Expansion of the CVOC plume

Ecology has expressed concerns that if the recovery system is turned off the CVOC plume will move in such a way that it will cause significant increase in CVOC concentrations downgradient or cross-gradient. If that were to occur, indoor air concentrations in downgradient and cross gradient buildings could potentially increase above the cleanup standards. In addition, if there was substantial plume expansion, treatment might be required over a broader area or a longer time interval than would otherwise be the case.

Unsaturated zone soils were removed in 1995 and 1996 (Section 2.2.1.1). An active recovery system was installed in August 1996 and has been operating for 12 years. The system was reconfigured in August of 2003 (RW-1 was shut off and pumping began at RW-3 – RW-2 continued pumping). The current configuration has been operating for over 5 years and both data and theory indicate that the system is in a steady-state with respect to contaminant migration (i.e. not expanding). CVOC concentrations may increase when the recovery well is turned off for the following reasons:

- Groundwater flowpaths will revert to pre-pumping which allows previously recovered molecules to migrate
- The recovery wells will no longer draw in uncontaminated water resulting in a rebound effect at the recovery wells.
- When the recovery system is turned off, dissolved concentrations could increase because flow paths will vary and CVOC particles sorbed to the soil might unsorb and dissolve into the groundwater.

To a limited extent, the released concentrations could cause groundwater concentrations of CVOC to increase. Based on the analysis presented below, ENSR believes changes in the CVOC concentrations after the recovery system is turned off would be minor and not significantly affect achievement of cleanup goals.

CVOC plume movement can be predicted and maximum potential CVOC concentration increase can be bounded by using empirical data, experience at other sites, and verified with a hydraulic simulation. The extent of the increase in CVOC concentrations (the exact concentration) can not be predicted, but it is possible to conservatively bound values to define a potential range. Active plume monitoring, particularly during the early phases of treatment will provide assurance that the plume is behaving as expected and not resulting in additional short-term risk. If monitoring indicates substantial CVOC plume expansion or significant CVOC increases (beyond what is expected), the recovery system will be turned on. When the recovery system is turned on, at current pumping rates, the system will achieve, at a minimum, the current level of capture observed today.

Historical site information (property use, groundwater quality data, and completed remedial actions) indicates that changes in the CVOC plume will be minor and can be monitored, and that if necessary, restarting the recovery system can contain any unacceptable migration. CVOC were used in manufacturing process from 1959 to 1994, with increasing controls on its use through time. Based on historic practices, releases were likely more significant in the earlier years of operation than at later dates (e.g., 1960s and 1970s). In 1994, CVOC were present at the property boundary downgradient of the source areas. We know that it is not possible to reach the maximum historical loading because of the extensive soil and groundwater source removal activities, starting in 1995.Based on groundwater concentrations measured in shallow wells prior to and during the past 12 years of operation of the groundwater extraction system, CVOC concentrations have reduced in the On-site Area. It is possible to monitor the plume movement, and to essentially stay ahead of any possible plume movement – meaning monitor any changes in the leading end of the plume. If necessary, the groundwater extraction system can be turned on well in advance of significant increase of the groundwater CVOC plume. In other words, it is possible to inhibit the groundwater CVOC plume from growing larger than it once had been. Site monitoring and experience shows that it is possible to turn the recovery wells back on if a significant increase in the CVOC plume is observed.

5.6.1.1 Empirical Data

Empirical data can be used to assess the volume of the potential chemically affected soil remaining in place. TCE[29] (as this is the main driver and the main CVOC of concern) concentrations measured prior to, during, and after the soil removal can be used to bound the likely potential contribution of TCE from remaining sources. Empirical data also provides information on the concentration and location of the TCE plume prior to the installation of the recovery system and the historic groundwater contours to understand groundwater flow before the recovery system was installed. When the recovery system is turned off, the groundwater flow will be similar to flow observed prior to the installation of the recovery system. Concentrations today (or in the future) are expected to be less due to mass removal by soil excavation, groundwater pumping, and contaminant degradation. Historic information (both TCE concentrations and groundwater contours) provide valuable bounding information on likely changes in aquifer conditions when the recovery system is turned off. Below is a summary of the empirical data:

- **Soil data**: Soil samples were collected in 1995 and 1996 by Dames and Moore (Dames and Moore, 1996). Soil was left in place in Areas 2, 7, and 8 above the current TCE Method A cleanup level (for the protection of groundwater) of 0.03 mg/kg. The concentration of TCE left in the unsaturated zone was conservatively approximated using the 95% upper confidence limit for detected TCE concentrations (or ½ the detection limit for concentrations below the detection limits) from the soil samples. The volume of soil left in place above the current cleanup levels was estimated based on the limits of excavation (reported by Dames and Moore) and the estimated water table elevation (based on the field notes during the soil removal activities). Using the TCE concentration and the volume, the mass of TCE remaining in place, in the unsaturated zone, was conservatively estimated. This mass provides an estimate of potential contributing residual concentrations which may desorb from the soil at, near and above the water table and become part of the dissolved concentrations. This value is conservative because it does not account for any attenuation or removal which likely occurred since the soil removal in 1996. Figure 5-8 includes a summary of the conservatively estimated TCE mass

[29] The following discussions focus on TCE, because TCE is the primary pollutant in the soil and groundwater and the behavior (movement in the groundwater) of the other CVOC will behave in manor similar to TCE.

remaining in the unsaturated zone. While some mass may remain in the unsaturated zone, site data (low concentrations at the base of the excavation) indicate this mass is also limited. Calculations used to estimate the remaining mass are detailed in Appendix C. The results of this analysis show that the amount of TCE remaining in the soil that could be a source to groundwater is limited.

- **TCE concentrations in groundwater**: Concentrations measured prior to the installation of the recovery system can be used to understand the groundwater conditions and plume flow before the recovery system was installed. Understanding the movement of the groundwater and plume flow is important to confirm that sufficient wells are available to track the plume when the recovery system is shut down, and to understand and bound the likely changes in groundwater concentrations. TCE groundwater data is available from 1992 to present day. This FFS looks at February 2008 (Figure 2-37), as this is the last site wide groundwater monitoring event (which includes all monitoring wells) collected as this report is going into production. Figure 5-9 shows the TCE concentration in shallow groundwater prior to the installation of the recovery system. Comparison of Figure 5-9 and Figure 2-37 show that: (1) the plume is not significantly wider than the current plume; (2) the groundwater flow was slightly more to the north, but still in the west direction; and (3) high concentrations remain localized around MW-1 and MW-4[30]. Future TCE concentrations should not increase above pre-pumping concentrations and prior to 12 years of mass removal through groundwater extraction. In short, the plume likely migrated for tens of years prior to the installation of the extraction system in 1996, but once the extraction system was turned on the extent of the plume in the north and south directions assumed its current shape. Unacceptable changes in the extent of the plume during a period without pumping could quickly be reversed by restarting the pumps.

5.6.1.2 Hydraulic Simulation

Knowledge of existing site conditions can be used with a hydraulic simulation to develop a conservative assessment of the rate of plume movement, confirm that significant lateral expansion is not expected and inform a monitoring program to assess conditions. The purpose of the hydraulic simulation is to verify what we expect, based on the empirical data, and to also present the most conservative, or worst case conditions. Appendix C contains a detailed description of the simulation.

The analysis takes what we know about groundwater flow and TCE at the site (based on the empirical data above), and then assumes the most conservative plausible limits for default parameters. In this way, the simulation bounds the maximum possible TCE movement and concentrations. The analysis uses a universally accepted analytical equation (below) that estimates the movement and spreading of TCE assuming that <u>there is a constant source added to the groundwater</u> (e.g., more TCE is added to the groundwater every day as it is released from the residual soil concentrations).

The governing equation for the simulation is:

$$R\frac{\partial C}{\partial t} = D_x\frac{\partial^2 C}{\partial x^2} + D_y\frac{\partial^2 C}{\partial y^2} - V\frac{\partial C}{\partial x} - \lambda RC \quad \text{(Wexler 1982)}$$

Where:

C = concentration

R = retardation factor

[30] MW-6 concentrations dropped several orders of magnitude with the initiation of pumping due to change in groundwater flow patterns in the area of this well. Groundwater monitoring during injection will track these concentrations.

D_x = longitudinal dispersivity

D_y = transverse dispersivity

λ = degradation (decay) constant

V = seepage velocity

This is a very conservative simulation because it only considers groundwater and plume movement due to advection (TCE transported by the movement of groundwater) and dispersion (the effect of TCE spreading out from its advective path). The simulation does not take account any loss of TCE, such as degradation due to natural attenuation or remedial action. We also assume that none of the mobilized TCE particles is sorbed (sticks) to the soil it is passing through (this is soil that is within the aquifer, soil that the aquifer flows through as it moves underground). In addition, the simulation assumes a continuous source of TCE released into the subsurface (0.006 kg/days). These assumptions are intended to overestimate the concentration and rate of TCE movement to conservatively bound the results, demonstrating the 'worst-case' scenario, and substantially overestimating downgradient concentrations, in an abundance of caution.

Figures 5-9 and 5-10 show the results after 60 and 90 days. After 60 days, with all of the conservative assumptions that were included in this analysis, the maximum increase in concentration at the property boundary is predicted to be less than 10 µg/L. Again, this does not assume that the TCE material would be reducing, because of the active remediation occurring at the same time.

This simulation demonstrates that even with the most conservative plausible assumptions, there would be sufficient timeframe to assure environmental safety via sufficient groundwater monitoring frequency. This simulation is used only as a tool to verify that monitoring is possible, to develop planning level monitoring (discussed below); not to predict possible increases in CVOC concentrations.

5.6.1.3 Indoor Air Concentrations

Indoor air concentrations are related to chemically affected groundwater and residual soil concentrations. If the pumps are turned off, and CVOC concentrations in groundwater increase, this could cause indoor air concentrations in downgradient and cross gradient buildings to increase. While unlikely, concentrations could increase to a concentration such that indoor air concentrations may potentially be exceeded. As discussed above, we do not believe that the CVOC concentrations will increase significantly when the pumps are turned off. We also know that *in situ* chemical oxidation will be occurring simultaneously; deceasing the groundwater and vadose zone soil concentration making any net change small

The 220 S Dawson Street building has an active system which inhibits sub slab vapor flow into the building. The sub slab vapor system is not dependent on concentration of sub slab vapors; it cuts off the pathway. The area around the extraction points is depressurized which prohibits the sub slab air flow upwards; into the building. The groundwater plume is not expected to change direction and flow south, in the direction of portions of the building without vapor extractions points. When the pumps are turned off, the groundwater is expected to move in a slightly more northern flow than the current flow, but remain predominantly to the west.

The McKinstry building is to the north of the 220 S Dawson Street Building. Concentrations are not expected to increase in this area because:

- Residual soil impacts remain under the 220 S Dawson Street building (not the McKinstry building)
- Active remediation will be occurring in the alley (which is between the 220 S Dawson Street building and the McKinstry building)
- The groundwater flow will not change direction significantly in the northern direction

- Concentrations are not expected to increase significantly based on the available data and verified by the hydraulic simulation. Changes in groundwater concentrations can be monitored during remediation activities, to verify this statement. Monitoring can be conducted at the current MW-13.

Downgradient buildings such as the Irrido and Interior Environmental buildings are beyond the influence of the pumps (RETEC 2007B). Any potential risk to these buildings, from turning the pumps off, will be evaluated through groundwater monitoring and if necessary, indoor air monitoring during the active remediation. As stated above, the pump and discharge system could be turned back on, achieving the currently acceptable level of protectiveness for these buildings. Alternatively, engineered controls could be installed to reduce any potential short term risk of exposure for people inside the buildings.

Additionally, when considering potential vapor intrusion risk, it's also reasonable to consider that treatment will be occurring onsite, the treatment will be actively removing TCE and associated daughter products, and that risk values are based on chronic exposures.

5.6.2 Effects of the Injection on the Aquifer

Ecology has noted a concern regarding the effects of the injection fluid on the aquifer, for example whether injecting oxidant could push the plume downgradient. This is an effect that is observed when the necessary conditions occur: (1) there is significant injection volumes of fluid relative to natural fluxes and the aquifer is not porous; or (2) confining conditions exist, which could block or limit the dispersion of the injecting liquid or (3) when there is a significant difference in density betweens the injection fluid and the groundwater.

We do not have these necessary conditions at this site. We know that potassium permanganate does not have a significantly different density than groundwater; therefore, we can assume that we are essentially injecting groundwater into groundwater. The injection will occur over several locations, spreading out the injection network and limiting any potential push down effects. We know, based on the lack of draw down observed at site, the rate of groundwater movement, and the geological information collected during monitoring installation that the aquifer is very porous and mounding will be small and plume movement associated with injections will be insignificant.

Though we can't determine the exact volume of injection fluid (this will be determined during Phase 1, as will the radius of influence), we know that we can measure for potential changes which should be observed instantaneously in the existing monitoring wells and the proposed additional observation wells.

5.6.3 Safety Measures and Monitoring

Based on the data presented above, site conditions can be sufficiently monitored to prevent unacceptable plume expansion and unacceptable vapor intrusion into buildings as the remediation is occurring. Active monitoring permits the pump and discharge system to be turned on if conditions in the groundwater aquifer change significantly. Once the pumps are turned back on, at a minimum, the current level of capture can be achieved. The ability to turn the pump and discharge system on and off is a contingency, in the unlikely event that the design does not perform as expected[31]. The pump and discharge system could act as containment in the On-Site Area, which could be used temporarily to control any potential changing groundwater conditions. Field measurements collected during injections will provide a real time picture of conditions and allow sufficient response time. Treatment downgradient in Phase 2 and any later phases will address any slight increases in concentration downgradient if they were to occur.

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[31] ENSR would maintain the current discharge permit - updating all necessary applications, as required by the discharge authority – during the active remediation.

Ecology has requested a monitoring program which includes sampling frequency, triggers for turning the system on, proposed groundwater well extraction rates, and proposed groundwater recovery well locations. The high-frequency monitoring program proposes weekly CVOC and field parameter monitoring during Phase 1, stepped down in subsequent phases to monthly monitoring (all as detailed in Table C-1). The reduction in monitoring during subsequent phases correlates with the expected reduction in CVOC groundwater concentrations in the on-site area. Appendix C, Table C-1, contains sampling program details at a planning level, including likely locations, analytes and frequency. Well screen intervals are also provided in Table C-2 and Figure 5-6. Extraction rates would be assumed as currently used. This planning level sampling program is provided for discussion. The sampling program would be proposed final as part of the compliance monitoring plan. Details, including triggers, will be included in the design documents and subject to Ecology approval, associated with the final selected remedy.

Existing monitoring wells and proposed observation wells are assumed, and no additional monitoring wells are required for sufficient special coverage. The current monitoring network, perhaps with one additional well downgradient of MW-6, is expected to be sufficient for monitoring during injections. Existing downgradient and cross gradient monitoring wells, which were installed prior to pumping and prior to the RW-2/RW-3 reconfiguration, can bound the behavior of the plume. We do not expect to see a dramatically different trend in the groundwater behavior today than we did in 1995 because changes in the site have been minimal. There has been no significant re-grading, no significant trenching or installation of underground sewers, no dewatering systems or other sub surface activities that would affect the movement of the groundwater flow.

Triggers, such as changes in CVOC concentrations or field measurements of changing aquifer conditions, will be used to determine if the pump and discharge system should be turn back on. The actual values of these triggers will be included in the subsequent design documents. Ecology has also asked for proposed pumping rates of the recovery wells, if they are required to be turned back on. Pumping rates would be determined in subsequent design documents. For planning purposes, it is assumed that current pumping rates would be used, achieving at a minimum the current level of capture.

Vapor Mitigation System

Alternative 5 includes the subslab depressurization system elements presented in Alternative 2.

Institutional Controls

Alternative 5 includes the institutional controls elements presented in Alternative 2.

5.6.4 MTCA Threshold Requirements

A comparison of Alternative 5 against applicable MTCA criteria is provided below. This information is summarized in Table 5-1.

- **Protection of Human Health and the Environment**: Alternative 5 is expected to be protective of human health and the environment and comply with applicable federal and state cleanup standards.
- **Compliance with Cleanup Standards:** Alternative 5 addresses the cleanup levels described in Section 3 for groundwater and air, through the use of chemical oxidation. Data collected to date, and a review of a similar site which utilized chemical oxidation suggest that this technology would be effective. The use of institutional controls is limited to management of potentially chemically-affected soil under the building which may not be affected by the chemical injections. Remaining soil may be inaccessible due to impermeable structures, e.g. building walls. Institutional controls will be implemented by managing the current site use and any future site use to comply with all environmental regulations.

- **Compliance with Applicable State & Federal Laws:** This alternative will comply with applicable state and federal laws. Institutional controls will be addressed as part of the final Cleanup Action Plan, Consent Decree, and project implementation actions.
- **Provisions for Compliance Monitoring:** Alternative 5 provides for compliance monitoring to demonstrate that concentrations are stable for both groundwater and air.

5.6.5 Restoration Time-Frame

The groundwater restoration time-frame for Alternative 5 is relatively short due to the aggressive treatment of the CVOC concentrations. Chemical oxidation is a permanent solution to eliminate the CVOCs present in the dissolved and un-dissolved phase. As dissolved CVOCs are diminished, sorbed CVOCs disassociate and become dissolved. Un-reacted permanganate reacts with the dissolved CVOCs to increase the reduction. Chemical oxidation with a permanganate solution is very rapid degradation process, as described above; additional applications may be needed to treat all residual concentrations of CVOCs.

Alternative 5 has a somewhat shorter restoration time frame than Alternative 2, even though Alternative 2 proposes a combination of *in situ* and continued operation of the pump and discharge system. The effect of the pump and discharge system observed in the relative short period associated with the *in situ* chemical oxidation restoration time frame is expected to be insignificant. TCE concentrations (TCE is used as an indicator of overall CVOC reduction) have decreased over 12 years of pumping (see Figure 2-32), however the rate of decrease has declined over time, which is expected based on the behavior of chlorinated solvents in groundwater. Concentrations in MW-4 observed over the last 2 years (February 2006 through February 2008) have been detected at a high of 51 µg/L (observed in November 2007) and a low of 17 µg/L (May 2007; Figure 2-32 and Table A-1 of Appendix A). Any small increases in concentrations, due to the termination of the recovery system, will be more efficiently managed during the active remediation, versus after cleanup standards have been achieved and the pumps are shut down[32]. As stated above in Section 5.3.2, Alternative 2 includes additional time due to the uncertainty associated with the minimal increases in CVOC concentrations that may result when the pump and discharge system is turned off.

Alternative 5 includes two year for remedy selection, design, and permitting. Three years are planned for the implementation and three years of compliance monitoring is assumed. The total groundwater and indoor restoration time frame for Alternative 5 is eight years.

For purposes of this FFS the above restoration time frame is assumed. This restoration time-frame assumes that the downgradient groundwater concentrations are related to the GE source concentrations. After completion of On-Site treatment, if the downgradient groundwater concentrations rebound or remain elevated, the potential for a secondary source will need to be re-evaluated.

5.6.6 MTCA Evaluation Criteria

The MTCA disproportionate cost analysis includes comparative analysis of seven criteria. Issues relevant to the disproportionate costs analysis are discussed below, and are listed in Table 5-1.

- **Overall Protectiveness:** The protectiveness of Alternative 5 is achieved primarily through the aggressive use of removal by chemical oxidation. This remedy represents the most protective remedy evaluated in the FFS under the shortest time frame. It's important to note that currently

[32] Ecology stated in the August 14, 2008 comment letter that the pump and discharge system can not be turned off till after the performance metric has been met, not before. This is assumed to be the cleanup standards, which are not expected to be met till after the injection of the *in situ* chemical oxidant.

installed groundwater recovery could be turned on if Alternative 5 does not perform as expected.

- **Permanence:** Alternative 5 ranks similar to Alternatives 2, 3, and 6 for permanence. Chemical oxidation is a permanent solution to eliminate the CVOCs present in the dissolved and un-dissolved phase. As dissolved CVOCs are diminished, sorbed CVOCs disassociate and become dissolved. Un-reacted permanganate reacts with the dissolved CVOCs to increase the reduction. Chemical oxidation with a permanganate solution is very rapid degradation process, as described above; additional applications may be needed to treat all residual concentrations of CVOCs.
- **Remedy Costs and Cost Effectiveness:** The probable costs of Alternative 5 ($2.7 million) are the second lowest of the evaluated alternatives and much lower than Alternatives 1 through 3. (Appendix B).
- **Long-Term Effectiveness:** Alternative 5 uses the most aggressive remediation strategy for the degradation of CVOCs in groundwater. The long-term effectiveness of the alternative is therefore considered to be high, due to the increased use of high-preference remediation technologies as defined under MTCA.
- **Short-Term Risk Management:** Alternative 5 involves a higher chemical exposure risk because of the highly reactive permanganate solution. Alternative 5 provides a small risk of direct contact with chemically-affected groundwater or soil due to the installation method and the temporary injection points. Management, planning, and communication are necessary during the implementation to minimize the short term risk. Additional short term risk is associated with potential downgradient plume expansion and related increases in indoor air exposure. These risks can be managed through active monitoring which allows for the option of the turning on the recovery system as a contingency or implementing vapor mitigation during the remedial phase of work.
- **Implementability:** Alternative 5 is practicable and implementable. Difficulties related to implementability include access, chemical storage, and availability of contractors. All of these difficulties can be managed with proper planning before work starts.
- **Consideration of Public Concerns:** Public review will be part of the review process for the Draft Cleanup Action Plan, as required under WAC 173-340-380. No previous public concerns have been received ahead of the submittal of this FFS.

5.7 Alternative 6 – Enhanced Anaerobic Bioremediation, Vapor Intrusion Mitigation and Institutional Controls

The technologies included in Alternative 6 are enhanced anaerobic bioremediation, the continued operation of the existing subslab depressurization system, and institutional controls.

- Electron donor injection into the On-Site and Off-Site Areas
- Installation of electron donor injection wells (at the On-Site and Off-Site Areas) and recirculation
- The continued operation of the Vapor Intrusion System
- A revised groundwater monitoring program
- Institutional controls.

Enhanced Anaerobic Bioremediation

Alternative 6 includes the enhanced bioremediation elements presented in Alternative 3. This alternative does not include the optimization of the recovery wells, recovery wells RW-2 and RW-3 will remain in the current locations. Alternative 6 includes recirculation of the injection solution in the On-Site Area. The recirculation allows for longer contact time, increased hydraulic control during injection, and a more effective distribution of treatment solution. The recirculation will be implemented with a small scale mobile unit; using a small scale treatment trailer will minimize site disturbances, reduce risk (pre-assembled control panel with built-in safety features) and permit flexibility during injection. Injection rates and discharges can be controlled with the computer interface. The existing recovery well, RW-3, will be retrofitted for the recirculation process. RW-2 may also be used during Phase 2 depending on performance during Phase 1.

Similar to Alternative 5, this alternative also includes the flexibility to turn on the pump and discharge system for use as containment in the On-Site Area, if conditions in the groundwater unit change significantly. Changing aquifer conditions could include the mobilization of metals or the production of incomplete degradation byproducts. Field measurements collected during injections will provide a real time picture of conditions and allow a fast response time if needed.

Figure 5-7 provides a summary of the proposed locations, Table 5-6 summarizes the proposed monitoring schedule.

Vapor Mitigation System

Alternative 6 includes the subslab depressurization system elements presented in Alternative 3.

Institutional Controls

Alternative 6 includes the institutional controls elements presented in Alternative 3.

5.7.1 MTCA Threshold Requirements

The MTCA disproportionate cost analysis includes comparative analysis of seven criteria. Issues relevant to the disproportionate costs analysis are discussed below, and are listed in Table 5-1.

- **Overall Protectiveness:** The protectiveness of Alternative 6 is achieved primarily through the use of CVOC removal by bioremediation. The natural biological process on site has been slow to reduce CVOC concentrations, Phase 1 will indicate if conditions across the site are favorable for bioremediation. This remedy represents the second most protective remedy evaluated in the FFS; the time frame of Alternative 6 is the same as Alternative 3. The use of institutional controls is still required under this alternative to reach the drinking water standard. The overall protectiveness of Alternative 6 is considered similar to that of Alternative 5. It's important to note that currently installed groundwater recovery could be turned on if the Alternative does not perform as expected.
- **Permanence:** Biodegradation, similar to chemical oxidation, is a permanent solution to eliminate the CVOCs present in the dissolved and un-dissolved phase. As dissolved CVOCs are diminished, sorbed CVOCs disassociate and become dissolved. Natural bacteria, enhanced by the augmentation of groundwater unit, react with the newly dissolved CVOCs to increase the overall CVOC reduction. Alternative 6 ranks high for permanence compared to the other alternatives.
- **Remedy Costs and Cost Effectiveness:** The probable costs of Alternative 6 (1.8 million) are the lowest of the evaluated alternatives (Appendix B). The most significant cost portion of the alternative is the electron donor slurry.

- **Long-Term Effectiveness:** Alternative 6 uses natural bacteria to degrade CVOC in the groundwater and in the smear zone (in the interface between the water and the soil). The long-term effectiveness of the alternative is therefore considered to be high, due to the increased use of high-preference remediation technologies as defined under MTCA.
- **Short-Term Risk Management:** Alternative 6 involves minimal risk during installation and operation. The injection slurry is essentially everyday household kitchen products and have little contact or exposure risk by workers. Management, planning, and communication is necessary during the implementation to minimize the short term risk.
- **Implementability:** Alternative 6 is practicable and implementable. Difficulties related to implementability include access, product storage, injection design, timeframe of injection, and availability of contractors. All of these difficulties can be managed with proper planning before work starts.
- **Consideration of Public Concerns:** Public review will be part of the review process for the Draft Cleanup Action Plan, as required under WAC 173-340-380. No previous public concerns have been received ahead of the submittal of this FFS.

5.8 Comparative Evaluation of Alternatives

The evaluation of disproportionate cost is based on a comparative analysis of costs against six other criteria. Relative rankings of each alternative for these seven criteria are summarized in Table 5-1. In Ecology's Response to Comments, Ecology requested that this revised FFS include a comparison of Alternatives 2 and 5, as these have been down selected by Ecology (Ecology, 2008c). For completeness, Table 5-1 contains the detailed analysis of all of the alternatives (Alternatives 1 through 6). Table 5-2 provides a summary of the restoration time frames for each alternative.

5.8.1 Overall Protectiveness

Overall protectiveness is a parameter that considers many factors. First, it considers the extent to which human health and the environment are protected and the degree to which overall risks at a site are reduced. Both On-Site and Off-Site risks resulting from implementing the alternative are considered. The parameter also expresses the degree to which the cleanup action may perform to a higher level than specific standards in MTCA. Finally, it measures the improvement of the overall environmental quality at the site.

The overall protectiveness of Alternatives 5 and 6 are highest because they include aggressive technologies which reliably treat the affected media. Alternatives 5 and 6 provide a contingency for the use of the hydraulic containment, but only if conditions pose a significant risk. Alternatives 2 and 3, which are similar to 5 and 6 (respectively), both include the active use of hydraulic containment. As discussed above, the use of active containment during injection could interfere with the natural flow path of the injected compounds. This could possibly limit the treatment zone of the injected compounds, potentially leaving in place small pockets of chemically affected media in the On-Site Area. Because of this uncertainty, Alternatives 2 and 3 receive a lower over ranking for protectiveness compared to Alternatives 5 and 6. Alternatives 1 and 4 both receive a lowest ranking because of the uncertainty in obtaining state cleanup levels (discussed above).

The overall protectiveness of Alternatives 5 is higher than Alternative 2 because the use of active containment during injection could interfere with the natural flow path of the injected compounds. This could possibly limit the treatment zone of the injected compounds, potentially leaving in place small pockets of chemically affected media in the On-Site Area. Because of this uncertainty, Alternative 2 receives a lower over ranking for protectiveness compared to Alternatives 5.

5.8.2 Permanence

All of the proposed alternatives provide a reduction in the total volume of CVOC concentrations in the groundwater, soil, and vapor. Alternatives 3 and 6 have a small degree of risk associated with the potential formation of other CVOCs during the degradation process or the mobilization of metals. The risk associated with this is considered low in this application because each phase of the injections will be tailored to the site-specific conditions at the time of the injections; all injection compounds will be altered based on the measured CVOCs.

Alternatives 2 and 5 provide a reduction in the total volume of CVOC concentrations in the groundwater, soil, and vapor. Alternative 2 has risk associated with increases in groundwater concentrations when the recovery system is terminated. However, this risk is considered low in this application because additional phases of injections can be triggered to treat any remaining areas of contamination.

5.8.3 Long-Term Effectiveness

Long-term effectiveness is a parameter that expresses the degree of certainty that the alternative will be successful in maintaining compliance with cleanup standards over the long-term performance of the remedy. The MTCA regulations contain a specific preference ranking for different types of technologies that is considered as part of the comparative analysis. The preference ranking places the highest preference on technologies such as reuse/recycling, treatment, immobilization/solidification, and disposal in an engineered, lined, and monitored facility. Lower preference rankings are applied for technologies such as On-Site isolation/containment with attendant engineering controls, and institutional controls and monitoring. The regulations recognize that in most cases the cleanup alternatives will combine multiple technologies to accomplish remedial objectives. The preference ranking must be considered along with other site-specific factors in the ranking of long-term effectiveness.

Alternatives 2 and 5 include the use of technologies that actively remove and destroy contamination. In both alternatives residual chemically-affected soils beneath the building foundation may remain in place. Alternative 2 receives a moderate ranking because of the longer restoration time frame and the uncertainty associated with how the continued operation of the pump and discharge system will affect the ability of the injections to reach the full extent of chemically affected media. As discussed above, the affect of the pump and discharge system will be evaluated during Phase 1 of each Alternative, and the results may show that this is not a concern.

Alternative 5 receives a higher ranking for long-term effectiveness because of this alternative has a greater ability to accommodate changing groundwater unit conditions. Though these alternatives are similar, because Alternative 5 does not include the recovery system, any increases in CVOC concentrations can be actively managed during the injection phase, reducing the additional injections associated with the potential increase in CVOC concentrations associated with Alternative 2. Alternative 5 includes a contingency plan to turn the recovery system back on if conditions change to a degree that requires containment (discussed above).

Alternatives 1 and 4 receive a low ranking for long-term effectiveness because of the uncertainty in achieving the lowest cleanup standard. Alternative 3 receive a moderate ranking because of the uncertainty associated with how the continued operation of the pump and discharge system will affect the ability of the injections to reach the full extent of chemically affected media. Alternative 6 receives a high ranking for long-term effectiveness because of the use of an aggressive treatment technology, the ability to accommodate changing groundwater unit conditions (this alternative does not include operation of the pump and discharge system, but does allow for the system to be turned on if conditions warrant during injections), and cleanup standards are expected to be achieved in a shorter time frame (compared to the other alternatives).

5.8.4 Short-Term Risk Management

Short-term risk management is a parameter that measures the relative magnitude and complexity of actions required to maintain protection of human health and the environment during implementation of the cleanup action. Cleanup actions carry risks associated with mobilization of contaminants and also safety risks typical to large construction projects. Other short-term risks associated with construction activities must be controlled through the use of best practices during project design and construction.

A higher ranking for short-term risk management is given to Alternative 2 because of the active use of the recovery system during injection, limiting the potential for any changes in the downgradient plume from changing conditions at the on site plume. A slightly lower ranking is giving to Alternative 5 because it does not include the use of the recovery system. As discussed above, short term risks associated with Alternative 5 can be actively managed through high-frequency monitoring, and if conditions indicate adverse conditions, actions can be taken to manage short-term risk (e.g., the recovery system can be turned on or vapor mitigation implemented).

Similarly, a higher ranking is given to Alternative 3 compared to Alternative 6, because it does not include the use of the recovery system. Alternatives 1 and 4 receive a lower ranking because both of these alternatives require significant below ground delivery equipment and above ground treatment/operational units. These treatment systems carry the highest risk associated with vapors (from the treatment units), electricity (potentially required for operation), and possible explosive safety concerns (potentially required for operation).

5.8.5 Implementability

Implementability is an overall measurement expressing the relative difficulty and uncertainty of implementing the project. It includes technical factors such as the availability of nature technologies and experienced contractors to accomplish the cleanup work. It also includes administrative factors associated with permitting, funding, and completing the cleanup. All of the alternatives are complex and require significant actions during design, permitting, and construction to achieve a successful project. All Alternatives are sufficiently implementable to pass the threshold criteria under MTCA.

Alternatives 2 and 3 receive a moderate ranking for overall implementability because of the additional work required with the optimization of the existing pump and treat system. The optimization activities require large equipment to be on site during decommissioning and reconfiguration of the recovery system. Access will be restricted (including a reduction in the number of parking spaces and portions of the alley) and drums with soil cuttings and decontamination fluids will be stored on site during the field activities. After installation long term equipment will continue to operate at the site requiring frequent visits from workers and frequent O&M activities to maintain system performance. These additional elements lower the overall implementability of Alternative 2.

Though Alternatives 5 and 6 are similar to Alternatives 2 and 3, the absences of the additional work associated with optimization and continued operation of the pump and treat system result in a higher rank when compared to the other alternatives.

The implementability of Alternative 1 and 4 is low, because these alternatives require the greatest amount of construction, design, and permitting. Alternatives 1 and 4 require substantial investment in additional on-site equipment, which conflicts with current planning and land use. Currently building operations are expected to expand into the alley, which could interfere in the future with the SVE/AS wells or the treatment unit. Space for the all of the required treatment equipment required for SVE/AS is a premium because of needed parking space for all of the industries in this area.

5.8.6 Consideration of Public Concerns

Public review comments have been invited several times previously (for example, on the Agreed Orders) and will be invited again as part of the review process for the Draft Cleanup Action Plan, as required under WAC 173-340-380. During review of the Draft FFS, Ecology received comments from Environmental Partners, on behalf of Gary Merlino, indicating that they recommend SVE/AS, or Alternative 1 (EPI, 2008).

5.8.7 MTCA Disproportionate Cost Analysis (DCA) – Alternatives 2 and 5

Consistent with MTCA requirements for remedy selection, the costs and benefits associated with the evaluated remedial alternatives are compared using a disproportionate cost analysis. The costs of a more costly alternative are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost but overall effective alternative exceed the incremental decree of benefits achieved by the more costly alternative relative to that of the lower cost alternative. (WAC 173-340-360(e)(i)). Where the quantitative and qualitative benefits of two alternatives are equivalent, MTCA specifies that Ecology shall select the less costly alternative (WAC 173-340-360(3)(e) (ii)(C)).

Table 5-1 summarizes the remedy cost for each alternative, as well as the remedy benefits discussed in Section 5 above. Appendix A contains a detailed cost breakdown for each alternative. Costs are expressed in 2008 dollars without adjustments for future cost inflation and without present value discounting of future costs. These costs are expected to vary within a range of +/- 30% around estimates required for costing at a preliminary level.

As noted above, Alternatives 2 and 5 are similar, the differences are that Alternatives 2 includes optimized hydraulic containment and Alternative 5 does not; the hydraulic containment is left in place, with pumping to resume contingent upon the results of high-frequency monitoring. Alternative 5, according to Ecology, has a slightly higher short term risk than Alternative 2. The additional risk can be managed through active monitoring and if conditions change which could adversely affect downgradient conditions, a contingency plan is in place.

The cost difference between the use of hydraulic containment (Alternative 2) and the alternative not using hydraulic containment (Alternatives 5) is approximately 1.0 million dollars. The overall ranking of Alternative 2 is moderate and the overall ranking of Alternative 5 is high. Considering that the overall ranking of Alternative 5 is higher than Alternative 2, and the cost of Alternative 5 is less than Alternative 2, the cost increment of 1.0 million dollars is disproportionate to any incremental benefits that might be expected.

6.0 Conclusions

6.1 Selection and Description of the Preferred Alternatives

Based on the information presented in Section 5 and summarized in Table 5-1, the preferred alternative for the 220 South Dawson Street site is Alternative 5. This alternative addresses all of the requirements under MTCA and addresses the On-Site Area, the Off-Site Area, and targets groundwater, soil, and vapor.

- **Compliance with MTCA Threshold Criteria**: Alternative 5 complies with MTCA threshold criteria and receives a high ranking under all criteria.
- **Use of a reasonable restoration time frame:** Of the evaluated alternatives, the predicted restoration time frame for Alternative 5 is the shortest (eight years), including the time required for final selection, design, permitting, construction, and compliance monitoring.
- **Use of Permanent Solutions to the Maximum Extent Practicable:** Through the use of *in situ* chemical injection, Alternative 5 uses a permanent solution to remove TCE and PCE chemically affected media at the site. Alternative 5 includes both On-Site and Off-Site Areas. Alternative 5 targets shallow, intermediate, and deep zones of the groundwater unit, to the maximum extent practicable.
- **Implementability and overall Protectiveness:** Alternative 5 is practicable, implementable, and the protective of human health and the environment. This alternative uses a proven technology with effectively reduce concentrations of CVOCs in soil, groundwater, and vapor. Alternative 5 requires a small foot print for implementation and include short durations of intensive onsite activities followed by less intensive monitoring.
- **Remedial Technologies:** Contaminated groundwater, vapor, and soil are remediated using both active and passive remedial technologies including chemical oxidation and the subslab depressurization system. Institutional controls are proposed to mange site restriction site and groundwater use. This alternative uses more aggressive treatment technologies than the lowest cost alternative.
- **Benefit Cost Analysis:** Alternative 5 has a low cost, with the highest benefit. A similar alternative that includes continued operation of the recovery system is proportionally much more costly than the selected alternative. Alternative 3 provides potential benefits, but there is a higher risk of incomplete treatment to achieve standards at all On-Site and Off-Site locations, and the cost is disproportionately higher than benefits achieved.
- **On-Site Area:** The On-Site Area will be remediated by removing CVOC in groundwater and sorbed to the soil by chemical degradation. Vapor under the former GE building will be contained and removed by the installation of the subslab depressurization system. Institutional controls will be put in place for the limited TPH soil above cleanup standards.
- **Off-Site Area:** The Off-Site Area will be remediated by removing CVOC in groundwater and sorbed to the soil by chemical degradation.

6.2 Contingent Remedy

Alternative 5 includes the option for turning on the discharge system (discussed in Section 5.6.3). The addition or resumption of the pump-and-discharge system acts as the first contingent remedy for the site.

Ecology has requested that an additional contingent remedy be included in the event that the ISCO alternative fails to perform as designed. Ecology would require a contingent remedy if they determine the following (as stated in the August 14, 2008 comment letter, Item III):

- The on-site or offsite ISCO treatment did not meet surface water cleanup levels at the standard groundwater point of compliance within an acceptable restoration timeframe, OR
- On-site or offsite ISCO treatment does not appear to be adequately attaining cleanup milestones, OR
- Future access constraints to the alley or to other CVOC contaminated groundwater areas prevent further ISCO injections from being effective in treating the CVOC contaminated zones.

Ecology has requested that the contingent remedy be enhanced in-situ bioremediation. Alternatives 3 and 6 provide a conceptual design for such a future contingent remedy. The final contingent remedy design will be developed jointly with Ecology, utilizing an updated data set collected during the implementation of the proposed remedy (Alternative 5). Data collected in the future (or technologies developed in the future) may alter the selection of enhanced in-situ bioremediation or may otherwise inform the selection of remediation technology to completely address site conditions.

6.3 Implementation of Site Cleanup

This FFS will inform Ecology's preliminary selection of a cleanup alternative for the 220 South Dawson Street site. The preliminary selected alternative will be articulated for public review in a DCAP. Following public review of the DCAP, the cleanup will move forward into design, permitting, construction, and long-term monitoring.

7.0 References

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Table 2-3 Inorganic Groundwater Parameters

Sample Location	Sample Number	Sample Date	Arsenic - Total	Arsenic - Dissolved	Iron - Total	Iron - Dissolved	Manganese - Total	Manganese - Dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			EPA 7060A	EPA 7060A	EPA 6010B	EPA 6010B	EPA 6010B	EPA 6010B
MW-1	MW-1-0803	8/20/2003	< 0.001	< 0.001	< 0.05	< 0.05	0.031	0.037
	MW-1-0204	2/23/2004	< 0.001	0.001	< 0.05	< 0.05	0.016	0.017
	MW-1-0408	4/30/2008	0.001	0.001	—	—	—	—
	MW-1-0808	8/6/2008	0.001	0.001	—	—	—	—
	MW-100-0808 (Dup)	8/6/2008	0.001	< 0.001	—	—	—	—
MW-2	MW-2-0803	8/20/2003	NA	NA	0.13	0.12	0.045	0.046
	MW-2-0204	2/24/2004	0.001	0.001	0.11	< 0.05	0.023	0.030
	MW-2-0508	5/6/2008	0.001	0.002	—	—	—	—
	MW-2-0808	8/7/2008	0.001	0.002	—	—	—	—
MW-3	MW-3-0803	8/20/2003	0.005	0.004	11	11	0.87	0.96
	MW-3-0204	2/24/2004	0.003	0.003 J	4.8	5.1	0.53	0.64
	MW-25-0204 (Dup)	2/24/2004	0.003	0.002 J	5.0	5.1	0.57	0.64
	MW-3-0408	4/30/2008	0.003	0.003	—	—	—	—
	MW-3-0808	8/6/2008	0.004	0.003	—	—	—	—
MW-4	MW-4-0803	8/20/2003	< 0.001	< 0.001	0.09	0.11	0.38	0.39
	MW-4-0204	2/24/2004	0.002	0.001	0.62	0.51	0.22	0.25
	MW-4-0508	5/6/2008	0.001	< 0.001	—	—	—	—
	MW-4-0808	8/7/2008	0.001	< 0.001	—	—	—	—
MW-5	MW-5-0803	8/20/2003	< 0.001	< 0.001	0.39	0.42	0.38	0.42
	MW-5-0204	2/24/2004	0.001	0.001	0.14	< 0.05	0.30	0.34
	MW-5-0508	5/6/2008	0.001	0.001	—	—	—	—
	MW-5-0808	8/6/2008	0.001	< 0.001	—	—	—	—
MW-6	MW-6-0803	8/21/2003	0.006	0.005	26	28	1.12	1.22
	MW-25-0803 (Dup)	8/21/2003	0.007	0.006	26	28	1.10	1.19
	MW-6-0204	2/25/2004	0.006	0.005	29	33	1.09	1.28
	MW-6-0508	5/2/2008	0.009	0.008	—	—	—	—
	MW-6-0808	8/7/2008	0.008	0.007	—	—	—	—
MW-7	MW-7-0803	8/20/2003	0.004	0.002	12	13	0.38	0.47
	MW-7-0204	2/24/2004	0.001	0.001	11	11	0.37	0.41
	MW-7-0508	5/5/2008	0.001	0.001	—	—	—	—
	MW-7-0808	8/7/2008	0.002	0.002	—	—	—	—
MW-8S	MW-8-0803	8/20/2003	0.12	0.001	161	1.92	2.25	1.06
	MW-8-0204	2/24/2004	0.019	0.001	28	0.51	0.27	0.09
	MW-8S-0508	5/2/2008	0.016	0.002	—	—	—	—
	MW-8S-0808	8/6/2008	0.035	0.001	—	—	—	—
MW-8M	MW-8M-0508	5/2/2008	< 0.001	< 0.001	—	—	—	—
	MW-8M-0808	8/6/2008	< 0.001	< 0.001	—	—	—	—

Table 2-3 Inorganic Groundwater Parameters

Sample Location	Sample Number	Sample Date	Arsenic - Total	Arsenic - Dissolved	Iron - Total	Iron - Dissolved	Manganese - Total	Manganese - Dissolved
			mg/L EPA 7060A	mg/L EPA 7060A	mg/L EPA 6010B	mg/L EPA 6010B	mg/L EPA 6010B	mg/L EPA 6010B
MW-9	MW-9-0803	8/20/2003	NA	NA	0.14	0.08	0.39	0.33
	MW-9-0204	2/24/2004	0.001	0.001	0.07	< 0.05	0.28	0.23
	MW-9-0408	4/30/2008	0.002	0.001	—	—	—	—
	MW-9-0808	8/7/2008	< 0.001	< 0.001	—	—	—	—
MW-10	MW-10-0803	8/21/2003	NA	NA	0.32	< 0.05	0.014	0.013
	MW-10-0204	2/25/2004	< 0.001	0.001	0.08	< 0.05	0.007	0.008
	MW-10-0505	5/5/2008	< 0.001	0.001	—	—	—	—
	MW-10-0808	8/6/2008	0.001	< 0.001	—	—	—	—
MW-11	MW-11-0803	8/21/2003	0.001	< 0.001	0.18	0.13	0.72	0.75
	MW-11-0204	2/23/2004	0.001	< 0.001	0.19	0.06	0.52	0.50
	MW-11-0508	5/5/2008	0.002	0.002	—	—	—	—
	MW-11-0808	8/7/2008	0.001	0.001	—	—	—	—
MW-12	MW-12-0803	8/21/2003	NA	NA	0.31	< 0.05	0.033	0.037
	MW-12-0204	2/25/2004	< 0.001	0.001	0.23	< 0.05	0.011	0.011
	MW-12-0508	5/2/2008	0.001	0.001	—	—	—	—
	MW-12-0808	8/6/2008	0.001	< 0.001	—	—	—	—
	MW-120-0808 (Dup)	8/6/2008	< 0.001	< 0.001	—	—	—	—
MW-13	MW-13-0803	8/20/2003	0.008	0.005	31	29	1.04	1.04
	MW-13-0204	2/24/2004	0.008	0.005	25	28	0.85	1.03
	MW-30-0204 (Dup)	2/24/2004	0.007	0.004	27	29	0.93	1.03
	MW-13-0508	5/5/2008	0.006	0.006	—	—	—	—
	MW-13-0808	8/7/2008	0.006	0.006	—	—	—	—
MW-14M	MW-14S-0803	8/21/2003	0.001	< 0.001	12	13	0.36	0.41
	MW-20-0803 (Dup)	8/21/2003	0.001	< 0.001	13	13	0.37	0.41
	MW-14S-0204	2/23/2004	< 0.001	< 0.001	13	12	0.29	0.33
	MW-20-0204 (Dup)	2/23/2004	< 0.001	< 0.001	14	12	0.32	0.34
	MW-14M-0508	5/5/2008	< 0.001	< 0.001	—	—	—	—
	MW-14M-0808	8/7/2008	< 0.001	< 0.001	—	—	—	—
MW-14D	MW-14D-0803	8/21/2003	0.006	0.004	4.32	0.75	0.17	0.15
	MW-14D-0204	2/23/2004	0.003	0.002	3.57	1.51	0.13	0.13
	MW-14D-0508	5/5/2008	0.001	< 0.001	—	—	—	—
	MW-14D-0808	8/7/2008	< 0.001	< 0.001	—	—	—	—
	MW-140D-0808 (Dup)	8/7/2008	< 0.001	< 0.001	—	—	—	—
MW-15M	MW-15S-0803	8/21/2003	0.003	< 0.001	11	1.56	0.15	0.085
	MW-15S-0204	2/25/2004	< 0.001	< 0.001	2.00	1.63	0.05	0.065
	MW-15M-0408	4/29/2008	< 0.001	< 0.001	—	—	—	—
	MW-15S-0808	8/8/2008	< 0.001	< 0.001	—	—	—	—

Table 2-3 Inorganic Groundwater Parameters

Sample Location	Sample Number	Sample Date	Arsenic - Total mg/L EPA 7060A	Arsenic - Dissolved mg/L EPA 7060A	Iron - Total mg/L EPA 6010B	Iron - Dissolved mg/L EPA 6010B	Manganese - Total mg/L EPA 6010B	Manganese - Dissolved mg/L EPA 6010B
MW-15D	MW-15D-0803	8/21/2003	0.003	0.002	5.97	5.16	0.34	0.35
	MW-15D-0204	2/25/2004	0.002	0.001	10	7.10	0.16	0.15
	MW-15D-0408	4/28/2008	< 0.001	< 0.001	—	—	—	—
	MW-15D-0808	8/8/2008	< 0.001	< 0.001	—	—	—	—
MW-16M	MW-16S-0803	8/21/2003	0.001	< 0.001	2.24	1.06	0.14	0.13
	MW-16S-0204	2/25/2004	0.001	< 0.001	3.09	1.17	0.11	0.12
	MW-16M-0508	5/1/2008	< 0.001	< 0.001	—	—	—	—
	MW-16M-0808	8/7/2008	< 0.001	< 0.001	—	—	—	—
MW-16D	MW-16D-0803	8/21/2003	0.005	0.002	20	1.84	0.32	0.11
	MW-16D-0204	2/25/2004	0.002	0.001	5.8	1.89	0.12	0.11
	MW-16D-0408	5/1/2008	< 0.001	< 0.001	—	—	—	—
	MW-16D-0808	8/7/2008	< 0.001	< 0.001	—	—	—	—
MW-17D	MW-17D-0508	5/1/2008	< 0.001	< 0.001	—	—	—	—
	MW-17D-0808	8/8/2008	< 0.001	< 0.001	—	—	—	—
MW-17M	MW-17M-0508	5/1/2008	< 0.001	< 0.001	—	—	—	—
	MW-17M-0808	8/8/2008	< 0.001	< 0.001	—	—	—	—
MW-18D	MW-18D-0508	5/1/2008	< 0.001	< 0.001	—	—	—	—
	MW-18D-0808	8/8/2008	< 0.001	< 0.001	—	—	—	—
MW-18M	MW-18M-0508	5/1/2008	< 0.001	< 0.001	—	—	—	—
	MW-18M-0808	8/8/2008	< 0.001	< 0.001	—	—	—	—
MW-19M	MW-19M-0508	5/2/2008	< 0.001	< 0.001	—	—	—	—
	MW-19M-0808	8/6/2008	< 0.001	< 0.001	—	—	—	—
MW-20M	MW-20M-0508	5/5/2008	0.001	0.001	—	—	—	—
	MW-20M-0808	8/6/2008	< 0.001	< 0.001	—	—	—	—
MW-21S	MW-21S-0408	4/30/2008	0.002	0.002	—	—	—	—
	MW-21S-0808	8/8/2008	0.002	0.001	—	—	—	—
EPI-MW-2D	EPI-MW-2D-0204	2/25/2004	< 0.001	< 0.001	12	13	0.41	0.45
	EPI-MW-2D-0804	8/27/2004	< 0.001	< 0.001	NA	NA	NA	NA
	MW-20-0804 (Dup)	8/27/2004	< 0.001	< 0.001	NA	NA	NA	NA
	EPI-2D-0508	5/6/2008	< 0.001	< 0.001	—	—	—	—
	EPI-MW-2D-0808	8/5/2008	< 0.001	< 0.001	—	—	—	—
EPI-MW-3S	EPI-MW-3S-0204	2/25/2004	0.003	0.002	26	29.50	0.74	0.88
	EPI-MW-3S-0804	8/27/2004	0.005	0.003	NA	NA	NA	NA
	EPI-3S-0408	4/30/2008	0.002	0.002	—	—	—	—
	EPI-MW-3S-0808	8/5/2008	0.004	0.004	—	—	—	—

Table 2-3 Inorganic Groundwater Parameters

Sample Location	Sample Number	Sample Date	Arsenic - Total mg/L EPA 7060A	Arsenic - Dissolved mg/L EPA 7060A	Iron - Total mg/L EPA 6010B	Iron - Dissolved mg/L EPA 6010B	Manganese - Total mg/L EPA 6010B	Manganese - Dissolved mg/L EPA 6010B
EPI-MW-3D	EPI-MW-3D-0204	2/25/2004	< 0.001	0.001	10	13.80	0.33	0.45
	EPI-MW-3D-0804	8/27/2004	< 0.001	< 0.001	NA	NA	NA	NA
	EPI-3D-0408	4/30/2008	< 0.001	< 0.001	—	—	—	—
	EPI-MW-3D-0808	8/5/2008	< 0.001	< 0.001	—	—	—	—
EPI-MW-4S	EPI-MW-4S-0204	2/25/2004	0.023	0.023	56	56.30	0.55	0.57
	EPI-MW-4S-0804	8/27/2004	0.027	0.021	NA	NA	NA	NA
	EPI-4S-0408	4/30/2008	0.024	0.023	—	—	—	—
	EPI-MW-4S-0808	8/5/2008	0.028	0.026	—	—	—	—
EPI-MW-4D	EPI-MW-4D-0204	2/25/2004	< 0.001	0.001	13	13.30	0.44	0.49
	EPI-MW-4D-0804	8/27/2004	< 0.001	< 0.001	NA	NA	NA	NA
	EPI-4D-0408	4/30/2008	< 0.001	< 0.001	—	—	—	—
	EPI-MW-4D-0808	8/5/2008	0.001	< 0.001	—	—	—	—
MTCA Method A Cleanup Levels for Groundwater (mg/L)			0.005		NR		NR	
MTCA Method B Cleanup Levels for Surface Water (mg/L)			Not Applicable		NR		NR	
MTCA Method B Cleanup Levels for Groundwater (mg/L)			Not Applicable		NR		2.2	

NOTES:

All results in mg/L.

NA or — - Not Analyzed

NR - Not researched, no cleanup level is available for this compound under

Shading indicates an exceedance of air/vapor screening levels.

Table 2-4 Results of 1,4-Dioxane Groundwater Sampling

Sample Location	1,4-Dioxane (µg/l)					
	Aug-2004	Nov-2004	Feb-2005	Aug-2005	April/May-2008	Aug-2008
MW-1	< 1.0	NA	NA	NA	< 2.0	< 2.0
MW-1 (Dup)	NA	NA	NA	NA	NA	< 2.0
MW-2	< 1.1	NA	NA	NA	< 2.0	< 2.0
MW-3	< 1.0	NA	NA	NA	< 2.0	< 2.0
MW-3 (Dup)	< 1.1	NA	NA	NA	NA	NA
MW-4	< 1.1	< 1.0	< 6.0 UJ	< 5.0	< 2.0	< 2.0
MW-5	< 1.1	NA	NA	NA	< 2.0	< 2.0
MW-6	< 1.0	< 1.0	< 5.8 UJ	< 5.0	< 2.0	< 2.0
MW-7	< 1.0	< 1.0	< 5	< 5.0	< 2.0	< 2.0
MW-8S	< 1.1	< 1.0	< 5.6 UJ	< 5.0	< 2.0	< 2.0
MW-8M	NA	NA	NA	NA	< 2.0	< 2.0
MW-8M (Dup)	NA	NA	NA	NA	< 2.0	NA
MW-9	< 1.1	NA	NA	NA	< 2.0	< 2.0
MW-10	< 1.2	NA	NA	NA	< 2.0	< 2.0
MW-11	< 1.1	< 1.0	< 5.2	< 5.0 UJ	< 2.0	< 2.0
MW-11 (Dup)	NA	< 1.1	NA	NA	NA	NA
MW-12	< 1.2	NA	NA	NA	< 2.0	< 2.0
MW-12 (Dup)	NA	NA	NA	NA	NA	< 2.0
MW-13	< 1.2	NA	NA	NA	< 2.0	< 2.0
MW-14M	**4.7**	< 2.4	< 5.0	< 5.0 UJ	< 2.0	< 2.0
MW-14D	**1.4**	< 1.0	< 5.0	< 5.0 UJ	< 2.0	**2.1**
MW-14D (Dup)	NA	NA	NA	NA	< 2.0	< 2.0
MW-15M	< 1.0	< 1.0	< 5.0	< 5.0 UJ	< 2.0	< 2.0
MW-15D	< 1.1	< 1.6	< 5.0	< 5.0 UJ	< 2.0	< 2.0
MW-16M	< 1.0	< 1.0	< 5.0	< 5.0 UJ	< 2.0	< 2.0
MW-16D	**1.6**	< 1.0	< 5.0	< 5.0 UJ	**3.0**	**3.5**
MW-17M	NA	NA	< 5.0	< 5.0 UJ	< 2.0	< 2.0
MW-17M (Dup)	NA	NA	NA	< 5.0 UJ	NA	NA
MW-17D	NA	NA	**27**	**21**	**16**	**15**
MW-18M	NA	NA	< 5.2	< 5.0 UJ	< 2.0	< 2.0
MW-18D	NA	NA	< 5.0	< 5.0 UJ	< 2.0	< 2.0
MW-19M	NA	NA	< 5.2 UJ	< 5.0 UJ	< 2.0	< 2.0
MW-19M (resample)	NA	NA	< 5.0	NA	NA	NA
MW-20M	NA	NA	< 5.0	< 5.0 UJ	< 2.0	< 2.0
MW-20M (Dup)	NA	NA	< 5.0	NA	NA	NA
MW-21S	NA	NA	NA	NA	< 2.0	< 2.0
EPI-MW-2D	**4.0**	**4.9 J**	< 5.3	< 5.0	< 2.0	< 2.0
EPI-MW-2D (Dup)	< 1.9	< 4.0	< 5.0	< 5.0	NA	NA
EPI-MW-3S	< 1.2	< 1.0	< 5.1	< 5.0	< 2.0	< 2.0
EPI-MW-3D	2.5	< 1.0	< 5.3	< 5.0	< 2.0	< 2.0
EPI-MW-4S	< 1.1	< 1.0	< 6.1	< 5.0	< 2.0	< 2.0
EPI-MW-4D	< 1.0	< 1.6	< 5.9	< 5.0	< 2.0	< 2.0
				MTCA Method B GW	4	4
				MTCA Method C Surface Water	No Value	No Value

Notes:
EPA Analytical Method SW8270C was used
Shading indicates values above the MTCA Method B Screening level

Table 2-5 Summary of Groundwater Natural Attenuation Parameters

Sample Location	Sample Number	Sample Date	Cond	pH	DO	ORP	Alkalinity SM2320 mg/L	Ferrous Iron SM3500 FeD mg/L	Chloride EPA 325.2 mg/L	N-Ammonia EPA 350.1M mg/L	N-Nitrate Calculated mg/L
Shallow Upgradient Well Concentrations											
MW-2	MW-2-0803	8/20/2003	322	5.97	0.69	63	100	0.17	6.3	0.013	3.8
	MW-2-0204	2/24/2004	470	5.83	1.58	99	110	< 0.040	6.4	< 0.010	1.8
MW-5	MW-5-0803	8/20/2003	439	5.99	0.25	50	180	0.45	6.0	0.026	1.6
	MW-5-0204	2/24/2004	759	5.80	1.22	86	220	< 0.040	3.6	< 0.010	3.1
	Min Concentration		322	5.8	0.25	50	100	0.04	3.6	0.01	1.6
	Max Concentration		759	5.99	1.58	99	220	0.45	6.4	0.026	3.8
		Average	497.5	5.8975	0.935	74.5	152.5	0.1755	5.575	0.01475	2.575
Shallow Wells											
MW-1	MW-1-0803	8/20/2003	417	5.91	0.99	62	170	0.059	3.5	< 0.010	4.9
	MW-1-0204	2/23/2004	718	5.96	3.07	37.8	170	< 0.040	3.8	< 0.010	5.3
MW-3	MW-3-0803	8/20/2003	325	5.94	0.44	47	95	11	9.8	0.19	0.12
	MW-3-0204	2/24/2004	448	5.56	1.04	60.8	90	4.8	5.8	0.12	0.14
	MW-25-0204 (Dup)	2/24/2004	448	5.56	1.04	60.8	89	4.7	6.0	0.13	0.13
MW-4	MW-4-0803	8/20/2003	419	5.96	0.47	53	140	0.15	6.6	0.031	3.9
	MW-4-0204	2/24/2004	719	5.61	0.59	63	150	0.44	8.3	0.036	3.4
MW-6	MW-6-0803	8/21/2003	425	5.93	0.25	59	170	27	14	0.28	< 0.010
	MW-25-0803 (Dup)	8/21/2003	425	5.93	0.25	59	170	27	12	0.28	< 0.010
	MW-6-0204	2/25/2004	569	5.81	0.44	113	190	73	13	0.24	0.022 J
MW-7	MW-7-0803	8/20/2003	437	5.94	0.40	48	150	14	8.2	0.19	0.10
	MW-7-0204	2/24/2004	579	5.79	0.57	25	130	10	7.9	0.14	0.03
MW-8	MW-8-0803	8/20/2003	413	5.80	0.28	52	150	1.4	7.9	0.42	0.061
	MW-8-0204	2/24/2004	682	5.57	5.67	99	130	0.34	9.8	0.04	2.9
MW-9	MW-9-0803	8/20/2003	432	6.03	0.41	65	160	0.11	6.7	0.012	4.1
	MW-9-0204	2/24/2004	725	5.70	1.38	68	170	< 0.040	8.4	< 0.010	4.5
MW-10	MW-10-0803	8/21/2003	261	6.18	1.72	48	56	0.054	9.4	0.022	6.6
	MW-10-0204	2/25/2004	446	6.02	2.41	119	99	< 0.040	11	< 0.010	7.2 J
MW-11	MW-11-0803	8/21/2003	624	6.17	0.43	116	180	0.13	36	0.42	3.3
	MW-11-0204	2/23/2004	789	5.94	1.86	70	110	0.056	20	0.33	3.2
MW-12	MW-12-0803	8/21/2003	273	5.84	1.59	65	32	< 0.040	11	0.064	7.0
	MW-12-0204	2/25/2004	378	5.49	2.90	131	28	0.042	16	0.015	6.9 J
MW-13	MW-13-0803	8/20/2003	475	5.86	0.39	61	200	32	12	0.13	< 0.010
	MW-13-0204	2/24/2004	767	5.99	0.54	20	220	27	23	0.17	0.032
	MW-30-0204 (Dup)	2/24/2004	767	5.99	0.54	20	210	27	24	0.20	0.031
EPI-MW-3S	EPI-MW-3S-0204	2/23/2004	763	6.35	0.97	-28	120	28	20	1.40	0.015
EPI-MW-4S	EPI-MW-4S-0204	2/23/2004	788	6.11	0.58	-41	120	52	14	0.52	< 0.010
	Min Concentration		261	5.49	0.25	-41	28	< 0.04	3.5	< 0.01	< 0.01
	Max Concentration		789	6.35	5.67	131	220	72.6	36	1.4	7.2
		Average	537.48148	5.8866667	1.1562963	57.533333	137	12.6042	12.15185	0.200752	2.367444
Intermediate Wells											
MW-14S	MW-14S-0803	8/21/2003	565	6.04	0.36	90	160	12	50	0.43	0.012
	MW-20-0803 (Dup)	8/21/2003	565	6.04	0.36	90	160	13	48	0.40	0.011
	MW-14S-0204	2/23/2004	799	6.15	0.84	23	150	11	20	0.45	0.010
	MW-20-0204 (Dup)	2/23/2004	799	6.15	0.84	23	140	11	21	0.42	0.017
MW-15S	MW-15S-0803	8/21/2003	142	6.33	0.28	28	37	1.6	5.3	0.083	< 0.010
	MW-15S-0204	2/25/2004	182	5.98	0.22	90	35	1.4	5.5	0.056	< 0.010 R
MW-16S	MW-16S-0803	8/21/2003	744	6.93	0.21	19	360	1.1	34	5.0	< 0.010
	MW-16S-0204	2/25/2004	965	6.72	0.12	94	360	1.1	30	4.5	< 0.010 R
EPI-MW-2D	EPI-MW-2D-0204	2/23/2004	875	6.15	0.82	-8.9	140	13	43	0.24	0.021
EPI-MW-3D	EPI-MW-3D-0204	2/25/2004	611	6.04	0.53	101	180	13	33	0.15	< 0.010
EPI-MW-4D	EPI-MW-4D-0204	2/25/2004	618	5.98	0.56	95	190	12	30	0.16	< 0.010
	Min Concentration		142	5.98	0.12	-8.9	35	1.12	5.3	0.056	< 0.01
	Max Concentration		965	6.93	0.84	101	360	12.9	50	5	0.021
		Average	624.09091	6.2281818	0.4672727	58.554545	173.8	8.22182	29.07273	1.080818	0.011909
Deep Wells											
MW-14D	MW-14D-0803	8/21/2003	665	6.70	0.56	56	300	0.79	26	0.34	< 0.010
	MW-14D-0204	2/23/2004	988	6.82	0.55	-40	290	1.45	25	0.39	< 0.010
MW-15D	MW-15D-0803	8/21/2003	583	6.46	0.26	17.9	240	4.8	18	0.23	< 0.010
	MW-15D-0204	2/25/2004	701	6.15	0.55	84	220	6.8	17	0.27	< 0.010 R
MW-16D	MW-16D-0803	8/21/2003	613	7.06	0.22	-8.5	290	1.8	25	0.42	< 0.010
	MW-16D-0204	2/25/2004	811	6.63	0.74	62	280	1.8	27	0.33	< 0.010 R
	Min Concentration		583	6.15	0.22	-40	220	0.787	17	0.23	NA
	Max Concentration		988	7.06	0.74	84	300	6.8	27	0.42	NA
		Average	726.83333	6.6366667	0.48	28.566667	270	2.90283	23	0.33	NA

NOTES:
J - Estimated: quantification below detection limit
UJ - Estimated detection limit.
R - Result not valid based on data validation.

Table 2-5 Summary of Groundwater Natural Attenuation Parameters

Sample Location	Sample Number	Sample Date	Cond	pH	DO	ORP	N-Nitrite EPA 353.2 mg/L	Nitrate + Nitrite EPA 353.2 mg/L	Sulfate EPA 375.2 mg/L	Sulfide EPA 376.2 mg/L	TOC EPA 415.1 mg/L
Shallow Upgradient Well Concentrations											
MW-2	MW-2-0803	8/20/2003	322	5.97	0.69	63	0.026	3.9	28	< 0.05	2.8
	MW-2-0204	2/24/2004	470	5.83	1.58	99	0.012	1.8	26	< 0.05	2.8
MW-5	MW-5-0803	8/20/2003	439	5.99	0.25	50	0.025	1.6	37	< 0.05	5.1
	MW-5-0204	2/24/2004	759	5.80	1.22	86	0.025	3.1	33	< 0.05	5.3
	Min Concentration		322	5.8	0.25	50	0.012	1.6	26	0.05	2.8
	Max Concentration		759	5.99	1.58	99	0.026	3.9	37	0.05	5.3
	Average		497.5	5.8975	0.935	74.5	0.022	2.6	31	0.05	4
Shallow Wells											
MW-1	MW-1-0803	8/20/2003	417	5.91	0.99	62	0.031	4.9	30	< 0.05	3.7
	MW-1-0204	2/23/2004	718	5.96	3.07	37.8	0.033	5.3	55	< 0.05	4.7
MW-3	MW-3-0803	8/20/2003	325	5.94	0.44	47	< 0.010	0.12	74	< 0.05	2.4
	MW-3-0204	2/24/2004	448	5.56	1.04	60.8	< 0.010	0.14	37	< 0.05	2.4
	MW-25-0204 (Dup)	2/24/2004	448	5.56	1.04	60.8	< 0.010	0.13	37	< 0.05	2.2
MW-4	MW-4-0803	8/20/2003	419	5.96	0.47	53	0.028	3.9	56	< 0.05	3.6
	MW-4-0204	2/24/2004	719	5.61	0.59	63	0.021	3.4	69	< 0.05	4.2
MW-6	MW-6-0803	8/21/2003	425	5.93	0.25	59	0.030	< 0.010	52	< 0.05	4.1
	MW-25-0803 (Dup)	8/21/2003	425	5.93	0.25	59	0.021	0.017	52	< 0.05	4.1
	MW-6-0204	2/25/2004	569	5.81	0.44	113	< 0.010 UJ	0.022 J	32	< 0.05	5.5
MW-7	MW-7-0803	8/20/2003	437	5.94	0.40	48	0.010	0.11	88	< 0.05	3.5
	MW-7-0204	2/24/2004	579	5.79	0.57	25	< 0.010	0.03	44	< 0.05	3.5
MW-8	MW-8-0803	8/20/2003	413	5.80	0.28	52	< 0.010	0.061	65	< 0.05	13
	MW-8-0204	2/24/2004	682	5.57	5.67	99	0.012	2.9	58	< 0.05	6.2
MW-9	MW-9-0803	8/20/2003	432	6.03	0.41	65	0.034	4.1	39	< 0.05	3.7
	MW-9-0204	2/24/2004	725	5.70	1.38	68	0.027	4.5	51	< 0.05	3.8
MW-10	MW-10-0803	8/21/2003	261	6.18	1.72	48	0.033	6.7	23	< 0.05	1.8
	MW-10-0204	2/25/2004	446	6.02	2.41	119	0.036 J	7.2 J	27	< 0.05	2.5
MW-11	MW-11-0803	8/21/2003	624	6.17	0.43	116	0.022	3.4	70	< 0.05	6.2
	MW-11-0204	2/23/2004	789	5.94	1.86	70	0.015	3.2	99	< 0.05	5.3
MW-12	MW-12-0803	8/21/2003	273	5.84	1.59	65	0.033	7.0	39	< 0.05	3.1
	MW-12-0204	2/25/2004	378	5.49	2.90	131	0.027 J	7.0 J	40	< 0.05	3.4
MW-13	MW-13-0803	8/20/2003	475	5.86	0.39	61	0.043	< 0.010	36	< 0.05	4.9
	MW-13-0204	2/24/2004	767	5.99	0.54	20	< 0.010	0.032	36	< 0.05	6.8
	MW-30-0204 (Dup)	2/24/2004	767	5.99	0.54	20	< 0.010	0.031	32	< 0.05	6.5
EPI-MW-3S	EPI-MW-3S-0204	2/23/2004	763	6.35	0.97	-28	< 0.010	0.015	80	< 0.05	8.5
EPI-MW-4S	EPI-MW-4S-0204	2/23/2004	788	6.11	0.58	-41	0.039	0.032	100	< 0.05	5.3
	Min Concentration		261	5.49	0.25	-41	< 0.01	< 0.01	23	NA	1.8
	Max Concentration		789	6.35	5.67	131	0.043	7.2	100	NA	13
	Average		537.48148	5.8866667	1.1562963	57.533333	0.02167	2.38	52.6296	NA	4.6259
Intermediate Wells											
MW-14S	MW-14S-0803	8/21/2003	565	6.04	0.36	90	< 0.010	0.012	73	< 0.05	5.0
	MW-20-0803 (Dup)	8/21/2003	565	6.04	0.36	90	< 0.010	0.011	73	< 0.05	5.1
	MW-14S-0204	2/23/2004	799	6.15	0.84	23	< 0.010	0.010	71	< 0.05	4.5
	MW-20-0204 (Dup)	2/23/2004	799	6.15	0.84	23	< 0.010	0.017	71	< 0.05	4.4
MW-15S	MW-15S-0803	8/21/2003	142	6.33	0.28	28	< 0.010	< 0.010	20	< 0.05	4.8
	MW-15S-0204	2/25/2004	182	5.98	0.22	90	< 0.010 UJ	< 0.010 R	14	< 0.05	4.5
MW-16S	MW-16S-0803	8/21/2003	744	6.93	0.21	19	< 0.010	< 0.010	9.8	< 0.05	10.6
	MW-16S-0204	2/25/2004	965	6.72	0.12	94	< 0.010 UJ	< 0.010 R	7.8	< 0.05	11.0
EPI-MW-2D	EPI-MW-2D-0204	2/23/2004	875	6.15	0.82	-8.9	< 0.010	0.021	61	< 0.05	5.1
EPI-MW-3D	EPI-MW-3D-0204	2/25/2004	611	6.04	0.53	101	0.017	< 0.010	35	< 0.05	4.3
EPI-MW-4D	EPI-MW-4D-0204	2/25/2004	618	5.98	0.56	95	0.019	< 0.010	19	< 0.05	4.8
	Min Concentration		142	5.98	0.12	-8.9	< 0.01	< 0.01	7.8	NA	4.3
	Max Concentration		965	6.93	0.84	101	0.019	0.021	73	NA	11
	Average		624.09091	6.2281818	0.4672727	58.554545	0.01145	0.0119091	41.3273	NA	5.8273
Deep Wells											
MW-14D	MW-14D-0803	8/21/2003	665	6.70	0.56	56	< 0.010	< 0.010	23	< 0.05	7.5
	MW-14D-0204	2/23/2004	988	6.82	0.55	-40	< 0.010	< 0.010	10	< 0.05	6.7
MW-15D	MW-15D-0803	8/21/2003	583	6.46	0.26	17.9	< 0.010	< 0.010	47	< 0.05	4.4
	MW-15D-0204	2/25/2004	701	6.15	0.55	84	< 0.010 UJ	< 0.010 R	43	< 0.05	4.5
MW-16D	MW-16D-0803	8/21/2003	613	7.06	0.22	-8.5	< 0.010	< 0.010	14	< 0.05	12.4
	MW-16D-0204	2/25/2004	811	6.63	0.74	62	< 0.010 UJ	< 0.010 R	9.0	0.06	9.2
	Min Concentration		583	6.15	0.22	-40	NA	NA	9	< 0.05	4.4
	Max Concentration		988	7.06	0.74	84	NA	NA	47	0.06	12.4
	Average		726.83333	6.6366667	0.48	28.566667	NA	NA	24.2667	0.0517	7.45

NOTES:
J - Estimated: quantification below detection limit
UJ - Estimated detection limit.
R - Result not valid based on data validation.

Table 2-5 Summary of Groundwater Natural Attenuation Parameters

Sample Location	Sample Number	Sample Date	Cond	pH	DO	ORP	Methane EPA 8015 Mod µg/L	Ethane EPA 8015 Mod µg/L	Ethene EPA 8015 Mod µg/L	CO2 TCD mg/L	TOX EPA 9020 mg/L
Shallow Upgradient Well Concentrations											
MW-2	MW-2-0803	8/20/2003	322	5.97	0.69	63	1.1	< 0.50	< 0.50	810	< 0.01
	MW-2-0204	2/24/2004	470	5.83	1.58	99	< 0.50	< 0.50	< 0.50	61	< 0.01
MW-5	MW-5-0803	8/20/2003	439	5.99	0.25	50	0.97	< 0.50	< 0.50	1,200	0.02
	MW-5-0204	2/24/2004	759	5.80	1.22	86	< 0.50	< 0.50	< 0.50	190	0.012
	Min Concentration		322	5.8	0.25	50	0.5	0.5	0.5	61	0.01
	Max Concentration		759	5.99	1.58	99	1.1	0.5	0.5	1200	0.015
	Average		497.5	5.8975	0.935	74.5	0.7675	0.5	0.5	565.25	0.0118
Shallow Wells											
MW-1	MW-1-0803	8/20/2003	417	5.91	0.99	62	0.93	< 0.50	< 0.50	1,400	< 0.01
	MW-1-0204	2/23/2004	718	5.96	3.07	37.8	< 0.50	< 0.50	< 0.50	120	0.084
MW-3	MW-3-0803	8/20/2003	325	5.94	0.44	47	1.2	< 0.50	< 0.50	720	< 0.01
	MW-3-0204	2/24/2004	448	5.56	1.04	60.8	< 0.50	< 0.50	< 0.50	70	< 0.01
	MW-25-0204 (Dup)	2/24/2004	448	5.56	1.04	60.8	< 0.50	< 0.50	< 0.50	71	< 0.01
MW-4	MW-4-0803	8/20/2003	419	5.96	0.47	53	0.55	< 0.50	< 0.50	970	0.01
	MW-4-0204	2/24/2004	719	5.61	0.59	63	0.54	< 0.50	< 0.50	120	0.080
MW-6	MW-6-0803	8/21/2003	425	5.93	0.25	59	11	< 0.50	< 0.50	1,600	< 0.01
	MW-25-0803 (Dup)	8/21/2003	425	5.93	0.25	59	23	< 0.50	< 0.50	1,300	< 0.01
	MW-6-0204	2/25/2004	569	5.81	0.44	113	18	< 0.50	< 0.50	160	< 0.01
MW-7	MW-7-0803	8/20/2003	437	5.94	0.40	48	5.5	< 0.50	< 0.50	1,100	0.01
	MW-7-0204	2/24/2004	579	5.79	0.57	25	1.2	< 0.50	< 0.50	88	0.013
MW-8	MW-8-0803	8/20/2003	413	5.80	0.28	52	1.3	< 0.50	< 0.50	1,200	< 0.01
	MW-8-0204	2/24/2004	682	5.57	5.67	99	< 0.50	< 0.50	< 0.50	94	0.060
MW-9	MW-9-0803	8/20/2003	432	6.03	0.41	65	1.6	< 0.50	< 0.50	900	< 0.01
	MW-9-0204	2/24/2004	725	5.70	1.38	68	< 0.50	< 0.50	< 0.50	120	< 0.01
MW-10	MW-10-0803	8/21/2003	261	6.18	1.72	48	1.2	< 0.50	< 0.50	240	< 0.01
	MW-10-0204	2/25/2004	446	6.02	2.41	119	< 0.50	< 0.50	< 0.50	31	< 0.01
MW-11	MW-11-0803	8/21/2003	624	6.17	0.43	116	4.8	< 0.50	< 0.50	700	< 0.01
	MW-11-0204	2/23/2004	789	5.94	1.86	70	< 0.50	< 0.50	< 0.50	72	0.029
MW-12	MW-12-0803	8/21/2003	273	5.84	1.59	65	2.2	< 0.50	< 0.50	260	< 0.01
	MW-12-0204	2/25/2004	378	5.49	2.90	131	0.60	< 0.50	< 0.50	28	< 0.01
MW-13	MW-13-0803	8/20/2003	475	5.86	0.39	61	6.1	< 0.50	< 0.50	1,500	< 0.01
	MW-13-0204	2/24/2004	767	5.99	0.54	20	19.0	< 0.50	< 0.50	150	< 0.01
	MW-30-0204 (Dup)	2/24/2004	767	5.99	0.54	20	34.0	< 0.50	< 0.50	180	< 0.01
EPI-MW-3S	EPI-MW-3S-0204	2/23/2004	763	6.35	0.97	-28	8.3	< 0.50	< 0.50	74	0.095
EPI-MW-4S	EPI-MW-4S-0204	2/23/2004	788	6.11	0.58	-41	0.85	< 0.50	< 0.50	130	0.027
	Min Concentration		261	5.49	0.25	-41	< 0.5	NA	NA	28	< 0.01
	Max Concentration		789	6.35	5.67	131	34	NA	NA	1600	0.095
	Average		537.48148	5.8866667	1.1562963	57.533333	5.384074	NA	NA	496.2222	0.0218
Intermediate Wells											
MW-14S	MW-14S-0803	8/21/2003	565	6.04	0.36	90	46	< 0.50	< 0.50	920	< 0.01
	MW-20-0803 (Dup)	8/21/2003	565	6.04	0.36	90	76	< 0.50	< 0.50	880	< 0.01
	MW-14S-0204	2/23/2004	799	6.15	0.84	23	5.9	< 0.50	< 0.50	83	0.110
	MW-20-0204 (Dup)	2/23/2004	799	6.15	0.84	23	1.2	< 0.50	< 0.50	78	0.113
MW-15S	MW-15S-0803	8/21/2003	142	6.33	0.28	28	22	< 0.50	< 0.50	63 J	0.01
	MW-15S-0204	2/25/2004	182	5.98	0.22	90	0.60	< 0.50	< 0.50	8.6	0.115
MW-16S	MW-16S-0803	8/21/2003	744	6.93	0.21	19	4,000	< 0.50	< 0.50	320	< 0.01
	MW-16S-0204	2/25/2004	965	6.72	0.12	94	720	< 0.50	< 0.50	19	< 0.01
EPI-MW-2D	EPI-MW-2D-0204	2/23/2004	875	6.15	0.82	-8.9	5.3	< 0.50	< 0.50	82	0.150
EPI-MW-3D	EPI-MW-3D-0204	2/25/2004	611	6.04	0.53	101	24	< 0.50	< 0.50	70	0.074
EPI-MW-4D	EPI-MW-4D-0204	2/25/2004	618	5.98	0.56	95	180	< 0.50	< 0.50	59	0.038
	Min Concentration		142	5.98	0.12	-8.9	0.6	NA	NA	8.6	< 0.01
	Max Concentration		965	6.93	0.84	101	4000	NA	NA	920	0.15
	Average		624.09091	6.2281818	0.4672727	58.554545	461.9091	NA	NA	234.7818	0.0591
Deep Wells											
MW-14D	MW-14D-0803	8/21/2003	665	6.70	0.56	56	1.1	< 0.50	< 0.50	290	< 0.01
	MW-14D-0204	2/23/2004	988	6.82	0.55	-40	88	< 0.50	< 0.50	28	< 0.01
MW-15D	MW-15D-0803	8/21/2003	583	6.46	0.26	17.9	19	< 0.50	< 0.50	540	< 0.01
	MW-15D-0204	2/25/2004	701	6.15	0.55	84	21	< 0.50	< 0.50	49	0.039
MW-16D	MW-16D-0803	8/21/2003	613	7.06	0.22	-8.5	170	< 0.50	< 0.50	220	< 0.01
	MW-16D-0204	2/25/2004	811	6.63	0.74	62	180	< 0.50	< 0.50	24	< 0.01
	Min Concentration		583	6.15	0.22	-40	1.1	NA	NA	24	< 0.01
	Max Concentration		988	7.06	0.74	84	180	NA	NA	540	0.039
	Average		726.83333	6.6366667	0.48	28.566667	79.85	NA	NA	191.8333	0.0148

NOTES:
J - Estimated: quantification below detection limit
UJ - Estimated detection limit.
R - Result not valid based on data validation.

Table 2-7 Vapor Intrusion Study Sub Slab Sample Results – Former GE Building

		Chemical Name	1,1,1-TCA	1,1-DCA	1,1-DCE	Chloroform	cis-1,2-DCE	PCE	TCE	Vinyl Chloride
Location ID	Sample Date	Sample ID								
Indoor Air Samples (μg/m^3)										
IA-1	12/5/2005	IA-1-1205	**0.18**	< 0.13	< 0.063	< 0.15	< 0.12	**0.38**	**0.28**	< 0.04
IA-2	12/5/2005	IA-2-1205	< 0.19	< 0.14	< 0.068	< 0.17	< 0.14	**0.38**	**0.27**	< 0.044
IA-2 (dup)	12/5/2005	IA-20-1205	< 0.18	< 0.13	< 0.064	< 0.16	< 0.13	**0.38**	**0.28**	< 0.041
IA-3	12/5/2005	IA-3-1205	< 0.18	< 0.14	< 0.067	< 0.16	< 0.13	**0.43**	**0.34**	< 0.043
IA-4	12/5/2005	IA-4-1205	< 0.18	< 0.13	< 0.064	< 0.16	< 0.13	**0.42**	**0.55**	< 0.041
IA-5	12/5/2005	IA-5-1205	**0.38**	< 0.14	< 0.068	< 0.17	< 0.14	**0.45**	**0.71**	< 0.044
IA-6	12/5/2005	IA-6-1205	< 0.18	< 0.13	< 0.064	< 0.16	< 0.13	**0.46**	**0.44**	< 0.041
Upwind Ambient Samples (μg/m^3)										
AA-1	12/5/2005	AA-1-1205	< 0.18	< 0.14	< 0.067	< 0.16	< 0.13	**0.46**	**0.2**	< 0.043
AA-5	12/5/2005	AA-5-1205	< 0.17	< 0.13	< 0.063	< 0.15	< 0.12	**0.4**	**0.19**	< 0.04
Average Upwind for Indoor Air Correction			*0*	*0*	*0*	*0*	*0*	***0.43***	***0.195***	*0*
Down/Crosswind Ambient Samples (μg/m^3)										
AA-2	12/5/2005	AA-2-1205	< 0.17	< 0.13	< 0.063	< 0.15	< 0.12	**0.38**	**0.18**	< 0.04
AA-3	12/5/2005	AA-3-1205	< 0.17	< 0.13	< 0.063	< 0.15	< 0.12	**0.37**	**0.18**	< 0.04
AA-4	12/5/2005	AA-4-1205	< 0.17	< 0.13	< 0.063	< 0.15	< 0.12	**0.34**	< 0.17	< 0.04
Corrected Indoor Air Results (Indoor Air minus Ambient) (μg/m^3)										
IA-1	12/5/2005	IA-1-1205	**0.18**	< 0.13	< 0.063	< 0.15	< 0.12	**-0.05**	**0.085**	< 0.04
IA-2	12/5/2005	IA-2-1205	< 0.19	< 0.14	< 0.068	< 0.17	< 0.14	**-0.05**	**0.075**	< 0.044
IA-2 (dup)	12/5/2005	IA-20-1205	< 0.18	< 0.13	< 0.064	< 0.16	< 0.13	**-0.05**	**0.085**	< 0.041
IA-3	12/5/2005	IA-3-1205	< 0.18	< 0.14	< 0.067	< 0.16	< 0.13	**0**	**0.145**	< 0.043
IA-4	12/5/2005	IA-4-1205	< 0.18	< 0.13	< 0.064	< 0.16	< 0.13	**-0.01**	**0.355**	< 0.041
IA-5	12/5/2005	IA-5-1205	**0.38**	< 0.14	< 0.068	< 0.17	< 0.14	**0.02**	**0.515**	< 0.044
IA-6	12/5/2005	IA-6-1205	< 0.18	< 0.13	< 0.064	< 0.16	< 0.13	**0.03**	**0.245**	< 0.041
Indoor Air Screening Level			*2,205*	*350*	*200*	*1.1*	*35*	*4.2*	*0.22*	*2.82*

Table 2-7 Vapor Intrusion Study Sub Slab Sample Results – Former GE Building

Location ID	Sample Date	Sample ID / Chemical Name	1,1,1-TCA	1,1-DCA	1,1-DCE	Chloroform	cis-1,2-DCE	PCE	TCE	Vinyl Chloride
Sub-slab Vapor Samples (µg/m³)										
V-1	12/6/2005	V-1-1205	**6,900**	**23**	< 15	< 18	< 15	< 25	**1,600**	< 9.5
V-1 (resamp	12/7/2005	V-10-1205	**6,900**	**24**	< 14	< 18	< 14	< 24	**1,600**	< 9.2
V-2	12/6/2005	V-2-1205	**1,600**	< 3.5	< 3.4	< 4.2	< 3.4	< 5.8	**44**	< 2.2
V-3	12/7/2005	V-3-1205	**15**	< 3	< 2.9	< 3.6	< 2.9	< 5	**240**	< 1.9
V-4	12/7/2005	V-4-1205	**270**	< 2.9	< 2.8	< 3.5	< 2.8	**19**	**350**	< 1.8
V-5	12/6/2005	V-5-1205	**700**	**250**	< 11	**19**	**480**	< 19	**3,700**	< 7.1
Sub-slab Screening Level			*220,500*	*35,000*	*20,000*	*110*	*3,500*	*420*	*22*	*282*
Alpha Factor (Indoor/Sub-slab)										
IA-1/V-1			*0.00003*	*0.00283*	*NA*	*NA*	*NA*	*NA*	*0.00005*	*NA*
IA-1/V-1 (resample)			*0.00003*	*0.00271*	*NA*	*NA*	*NA*	*NA*	*0.00005*	*NA*
IA-2/V-2			*0.00006*	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00170*	*NA*
IA-2 (dup)/V-2			*0.00006*	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00193*	*NA*
IA-3/V-3			*0.00600*	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00060*	*NA*
IA-4/V-4			*0.00033*	*NA*	*NA*	*NA*	*NA*	*-0.00053*	*0.00101*	*NA*
IA-5/V-5			*0.00054*	*0.00028*	*NA*	*0.00447*	*0.00015*	*NA*	*0.00014*	*NA*
Groundwater Samples (µg/L)										
MW-1	11/17/2005	MW-1-1105	**11**	< 0.6	**0.12**	< 0.6	< 0.6	**1.8**	**24**	< 0.02
MW-4	11/14/2005	MW-4-1105	**12**	**7.2**	**3.4**	< 0.6	< 0.6	**2.3**	**40**	**0.032**
MW-6	11/17/2005	MW-6-1105	< 0.2	**0.4**	**0.12**	< 0.2	< 0.2	**0.026**	**2.1**	< 0.02
MW-6 (dup)	11/17/2005	MW-6A-1105 (dup)	< 0.2	**0.5**	**0.13**	< 0.2	< 0.2	**0.025**	**2.0**	< 0.02
MW-7	11/17/2005	MW-7-1105	< 0.2	**0.4**	**0.3**	< 0.2	**0.5**	< 0.020	**3.8**	< 0.02
MW-8	11/14/2005	MW-8S-1105	< 0.2	**2.0**	**0.7**	< 0.2	**12**	< 0.020	**12**	**0.04**

Notes:

Sub-slab vapor samples analyzed by Method TO-15 SIM
Indoor and ambient air samples analyzed by Method TO-15
Groundwater samples analyzed by Method 8260 and Method 8260 SIM
Shading indicates an exceedance of air/vapor screening levels.
Alpha factors calculated using 1/2 detection limit for non-detects in indoor air.

Table 2-8 Summary of Vapor Intrusion Confirmation Results – Former GE Building

1,1,1-TCA

Location ID	12/5/2005	8/21/2006	11/9/2006	2/19/2007	3/13/2007	11/2/2007	11/5/2007
Indoor Air Samples (µg/m^3)							
IA-1	**0.18**	**0.21**	< 0.18	< 0.18	NS	**0.19**	NS
IA-2	< 0.19	NS	NS	NS	NS	NS	NS
IA-2 (duplicate)	< 0.18	NS	NS	NS	NS	NS	NS
IA-3	< 0.18	**0.17**	< 0.18	< 0.18	NS	NS	< 0.18
IA-4	< 0.18	**0.21**	< 0.17	< 0.18	NS	NS	< 0.17
IA-4 (duplicate)	NS	NS	< 0.18	< 0.2	NS	NS	< 0.14
IA-5	**0.38**	**0.21**	**0.32**	**0.37**	NS	**0.19**	NS
IA-5 (duplicate)	NS	**0.18**	NS	NS	NS	NS	NS
IA-6	< 0.18	NS	NS	NS	NS	NS	NS
IA-7		NS	NS	NS	< 0.19	NS	< 0.16
Alley Trailer	NS	NS	NS	NS	NS	NS	< 0.16
Ambient Samples (µg/m^3)							
AA-1	< 0.18	< 0.18	< 0.17	< 0.18	NS	NS	< 0.15
AA-3	< 0.17	< 0.18	< 0.16	< 0.18	< 0.17	NS	< 0.15
AA-5	< 0.17	NS	NS	NS	NS	NS	NS
AA-2	< 0.17	< 0.18	< 0.16	< 0.18	NS	**0.19**	NS
AA-4	< 0.17	< 0.18	< 0.17	< 0.16	NS	**0.22**	< 0.14
Average Upwind for Indoor Air Correction	*0*	*0*	*0*	*0*	0	*0*	*0*
Corrected Indoor Air Results (Indoor Air minus Ambient) (µg/m^3)							
IA-1	**0.18**	**0.21**	< 0.18	< 0.18	NS	**0.19**	NS
IA-2	< 0.19	NS	NS	NS	NS	NS	NS
IA-3	< 0.18	**0.17**	< 0.18	< 0.18	NS	NS	< 0.18
IA-4	< 0.18	**0.21**	< 0.17	< 0.18	NS	NS	< 0.17
IA-5	**0.38**	**0.21**	< 0.32	**0.37**	NS	**0.19**	NS
IA-6	< 0.18	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	< 0.19	NS	< 0.16
MTCA Method C Indoor Air Screening Level	*2,205*						

Chloroform

Location ID	12/5/2005	8/21/2006	11/9/2006	2/19/2007	3/13/2007	11/2/2007	11/5/2007
Indoor Air Samples (µg/m^3)							
IA-1	< 0.15	< 0.16	< 0.16	< 0.16	NS	< 0.15	NS
IA-2	< 0.17	NS	NS	NS	NS	NS	NS
IA-2 (duplicate)	< 0.16	NS	NS	NS	NS	NS	NS
IA-3	< 0.16	0.16	< 0.16	< 0.16	NS	NS	< 0.16
IA-4	< 0.16	0.16	< 0.15	< 0.16	NS	NS	< 0.15
IA-4 (duplicate)	NS	NS	< 0.16	< 0.16	NS	NS	**0.14**
IA-5	< 0.17	< 0.16	< 0.13	< 0.18	NS	< 0.16	NS
IA-5 (duplicate)	NS	< 0.16	NS	NS	NS	NS	NS
IA-6	< 0.16	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	< 0.17	NS	**0.16**
Alley Trailer	NS	NS	NS	NS	NS	NS	< 0.15
Ambient Samples (µg/m^3)							
AA-1	< 0.16	< 0.16	< 0.15	0.16	NS	NS	< 0.13
AA-3	< 0.15	< 0.16	< 0.15	0.16	< 0.15	NS	< 0.12
AA-5	< 0.15	NS	NS	NS	NS	NS	NS
AA-2	< 0.15	< 0.16	< 0.14	*0.16*	NS	< 0.15	NS
AA-4	< 0.15	< 0.16	< 0.15	**0.15**	NS	**0.14**	< 0.12
Average Upwind for Indoor Air Correction	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Corrected Indoor Air Results (Indoor Air minus Ambient) (µg/m^3)							
IA-1	< 0.15	< 0.16	< 0.16	< 0.16	< 0.18	< 0.15	NS
IA-2	< 0.17	NS	NS	NS	NS	NS	NS
IA-3	< 0.16	0.16	< 0.16	< 0.16	0 0	NS	< 0.16
IA-4	< 0.16	0.16	< 0.15	< 0.16	0 0	NS	< 0.15
IA-5	< 0.17	< 0.16	< 0.13	< 0.18	0 0	< 0.16	NS
IA-6	NS	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	< 0.17	NS	**0.16**
MTCA Method C Indoor Air Screening Level	*1.1*						

cis-1,2-DCE

Location ID	12/5/2005	8/21/2006	11/9/2006	2/19/2007	3/13/2007	11/2/2007	11/5/2007
Indoor Air Samples (µg/m^3)							
IA-1	< 0.12	< 0.13	< 0.13	< 0.13		< 0.12	NS
IA-2	< 0.14	NS	NS	NS	NS	NS	NS
IA-2 (duplicate)	< 0.13	NS	NS	NS	NS	NS	NS
IA-3	< 0.13	< 0.12	< 0.13	< 0.13	NS	NS	< 0.13
IA-4	< 0.13	< 0.13	< 0.12	< 0.13	NS	NS	< 0.12
IA-4 (duplicate)	NS	NS	< 0.13	< 0.13	NS	NS	< 0.1
IA-5	< 0.14	< 0.13	< 0.11	< 0.14	NS	< 0.13	NS
IA-5 (duplicate)	NS	< 0.13	NS	NS	NS	NS	NS
IA-6	< 0.13	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	< 0.14	NS	< 0.12
Alley Trailer	NS	NS	NS	NS	NS	NS	< 0.12
Ambient Samples (µg/m^3)							
AA-1	< 0.13	< 0.13	< 0.12	< 0.13	NS	NS	< 0.11
AA-3	< 0.12	< 0.13	< 0.12	< 0.13	< 0.12	NS	< 0.1
AA-5	< 0.12	NS	NS	NS	NS	NS	NS
AA-2	< 0.12	< 0.13	< 0.12	< 0.13	NS	< 0.12	NS
AA-4	< 0.12	< 0.13	< 0.12	< 0.16	NS	< 0.1	< 0.1
Average Upwind for Indoor Air Correction	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Corrected Indoor Air Results (Indoor Air minus Ambient) (µg/m^3)							
IA-1	< 0.12	< 0.13	< 0.13	< 0.13	NS	< 0.12	NS
IA-2	< 0.14	NS	NS	NS	NS	NS	NS
IA-3	< 0.13	< 0.12	< 0.13	< 0.13	NS	NS	< 0.13
IA-4	< 0.13	< 0.13	< 0.12	< 0.13	NS	NS	< 0.12
IA-5	< 0.14	< 0.13	< 0.11	< 0.14	NS	< 0.13	NS
IA-6	NS	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	< 0.14	NS	< 0.12
MTCA Method C Indoor Air Screening Level	*35*						

Vinyl Chloride

Location ID	12/5/2005	8/21/2006	11/9/2006	2/19/2007	3/13/2007	11/2/2007	11/5/2007
Indoor Air Samples (µg/m^3)							
IA-1	< 0.04	< 0.041	< 0.043	< 0.043	< 0.13	< 0.04	NS
IA-2	< 0.044	NS	NS	NS	NS	NS	NS
IA-2 (duplicate)	< 0.041	NS	NS	NS	NS	NS	NS
IA-3	< 0.043	< 0.039	< 0.043	< 0.043	< 0.13	NS	< 0.04
IA-4	< 0.041	< 0.041	< 0.04	< 0.041	< 0.12	NS	< 0.04
IA-4 (duplicate)	NS	NS	< 0.041	< 0.041	< 0.13	NS	< 0.03
IA-5	< 0.044	< 0.041	< 0.034	< 0.047	NS	< 0.042	NS
IA-5 (duplicate)	NS	< 0.041	NS	NS	NS	NS	NS
IA-6	< 0.041	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	< 0.045	NS	< 0.04
Alley Trailer	NS	NS	NS	NS	NS	NS	< 0.04
Ambient Samples (µg/m^3)							
AA-1	< 0.043	< 0.043	< 0.04	< 0.041	NS	NS	< 0.03
AA-3	< 0.04	< 0.042	0.039	< 0.041	NS	NS	< 0.03
AA-5	< 0.04	NS	NS	NS	< 0.04	NS	NS
AA-2	< 0.04	< 0.043	< 0.038	< 0.041	NS	< 0.04	NS
AA-4	< 0.04	< 0.043	< 0.04	< 0.039	NS	< 0.033	< 0.03
Average Upwind for Indoor Air Correction	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Corrected Indoor Air Results (Indoor Air minus Ambient) (µg/m^3)							
IA-1	< 0.04	< 0.041	< 0.043	< 0.043	NS	< 0.04	NS
IA-2	< 0.044	NS	NS	NS	NS	NS	NS
IA-3	< 0.043	< 0.039	< 0.043	< 0.043	NS	NS	< 0.04
IA-4	< 0.041	< 0.041	< 0.04	< 0.041	NS	NS	< 0.04
IA-5	< 0.044	< 0.041	< 0.034	< 0.047	NS	< 0.04	NS
IA-6	< 0.041	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	< 0.045	NS	< 0.04
MTCA Method C Indoor Air Screening Level	*2.82*						

PCE

Location ID	12/5/2005	8/21/2006	11/9/2006	2/19/2007	3/13/2007	11/2/2007	11/5/2007
Indoor Air Samples (µg/m^3)							
IA-1	**0.38**	**0.22**	< 0.23	< 0.22	NS	**0.74**	NS
IA-2	**0.38**	NS	NS	NS	NS	NS	NS
IA-2 (duplicate)	**0.38**	NS	NS	NS	NS	NS	NS
IA-3	**0.43**	**0.29**	**0.67**	< 0.23	NS	NS	< 0.22
IA-4	**0.42**	**0.22**	< 0.21	< 0.22	NS	NS	**0.22**
IA-4 (duplicate)	NS	NS	< 0.22	< 0.22	NS	NS	< 0.17
IA-5	**0.45**	**0.22**	**0.28**	**0.25**	NS	0.71	NS
IA-5 (duplicate)	NS	**0.22**	NS	NS	NS	NS	NS
IA-6	**0.46**	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	**0.57**	NS	< 0.2
Alley Trailer	NS	NS	NS	NS	NS	NS	< 0.21
Ambient Samples (µg/m^3)							
AA-1	**0.46**	< 0.23	< 0.21	< 0.22	NS	NS	0.2
AA-3	**0.37**	**0.27**	< 0.21	< 0.22	1.8	NS	< 0.18
AA-5	**0.4**	NS	NS	NS	NS	NS	NS
AA-2	**0.38**	< 0.23	< 0.2	< 0.22	NS	0.7	NS
AA-4	**0.34**	< 0.23	< 0.21	**0.26**	NS	0.9	< 0.18
Average Upwind for Indoor Air Correction	***0.41***	***0.12*** [1]	*0.00*	*0.00*			*0.00*
Corrected Indoor Air Results (Indoor Air minus Ambient) (µg/m^3)							
IA-1	**-0.03**	**0.03**	< 0.23	< 0.22	NS	0.74	NS
IA-2	**-0.03**	NS	NS	NS	NS	NS	NS
IA-3	**0.02**	**0.10**	**0.67**	< 0.23	NS	NS	< 0.22
IA-4	**0.01**	**0.03**	< 0.21	< 0.22	NS	NS	**0.22**
IA-5	**0.04**	**0.03**	**0.28**	**0.25**	NS	0.71	NS
IA-6	**0.05**	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS		NS	< 0.20
MTCA Method C Indoor Air Screening Level	*4.2*						

TCE

Location ID	12/5/2005	8/21/2006	11/9/2006	2/19/2007	3/13/2007	11/2/2007	11/5/2007
Indoor Air Samples (µg/m^3)							
IA-1	**0.28**	**1.3**	**0.2**	< 0.17	NS	**0.5**	NS
IA-2	**0.27**	NS	NS	NS	NS	NS	NS
IA-2 (duplicate)	**0.28**	NS	NS	NS	NS	NS	NS
IA-3	**0.34**	**0.29**	< 0.18	**0.24**	NS	NS	< 0.17
IA-4	**0.55**	**5.2**	**1.7**	**0.35**	NS	NS	**0.6**
IA-4 (duplicate)	NS	NS	**1.7**	**0.37**	NS	NS	**0.54**
IA-5	**0.71**	**1.2**	**1**	**0.99**	NS	**0.45**	NS
IA-5 (duplicate)	NS	**0.96**	NS	NS	NS	NS	NS
IA-6	**0.44**	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS	**0.26**	NS	**0.33**
Alley Trailer	NS	NS	NS	NS	NS	NS	**0.16**
Ambient Samples (µg/m^3)							
AA-1	**0.2**	< 0.18	< 0.17	< 0.17	NS	NS	**0.14**
AA-3	**0.18**	< 0.18	< 0.16	< 0.17	< 0.17	NS	< 0.14
AA-5	**0.19**	NS	NS	NS	NS	NS	NS
AA-2	**0.18**	< 0.18	< 0.16	< 0.17	NS	**0.41**	NS
AA-4	< 0.17	< 0.18	< 0.17	< 0.16	NS	**0.67**	**0.14**
Average Upwind for Indoor Air Correction	***0.19***	*0.00*	*0.00*	*0.00*		*0.41*	*0.14*
Corrected Indoor Air Results (Indoor Air minus Ambient) (µg/m^3)							
IA-1	**0.09**	**1.3**	**0.2**	**0.17**	NS	**0.09** [3]	NS
IA-2	**0.08**	NS	NS	NS	NS	NS	NS
IA-3	**0.15**	**0.29**	< 0.18	**0.24**	NS	NS	< 0.03
IA-4	**0.36**	**5.2**	**1.7**	**0.35**	NS	NS	**0.46**
IA-5	**0.52**	**1.2**	**1**	**0.99**	NS	**0.04** [3]	NS
IA-6	NS	NS	NS	NS	NS	NS	NS
IA-7	NS	NS	NS	NS		NS	**0.19**
MTCA Method C Indoor Air Screening Level	*0.22/0.96*						

Notes:

1. Average PCE concentration in ambient air calculated using 1/2 detection limit for non-detect result.
2. TCE has two screening levels, the MTCA Method C screening level (0.22 ug/m3)and the site specific remediation level (0.96 ug/m^3)
3. Sample results are estimate due to a lack of upwind ambient air TCE concentrations data for the sampling peroid.

NS - Location was not sampled

Shading indicates values above the MTCA Method C Screening level

Shading indicates values above the Site Specific Remediation Level

During the November 2006 Sampling event no COCs were detected in the Ambient air.

1,1,1-TCA- 1,1,1-Trichloroethane

1,1-DCA- 1,1-Dichloroethane - all detections ND, not included in this table

1,1-DCE- 1,1-Dichloroethylene all detections ND, not included in this table

1,2-DCE- cis 1,2-Dichloroethylene

PCE- Tetrachloroethylene

TCE- Trichloroethylene

Table 3-3 Exposure Assumptions for the Current/Future On-Site Construction Worker [a]

General Assumptions	Site-Specific	Reference
BW (body weight)	70 kg	standard default exposure factor [EPA, 1991; ODEQ, 2000]
AT (averaging times):		
Carcinogenic effects	70 years	life expectancy; recommended exposure factor [EPA, 1993; EPA, 2001; Exhibit 5-1; ODEQ, 2000]
Chronic effects (noncarc.)	1 year	duration of a single construction project (typically a year or less) [EPA, 2002; ODEQ, 2000]
Groundwater/Seep Exposure Assumptions		
ED (exposure duration)	1 year	duration of a single construction project (typically a year or less) [EPA, 2002; ODEQ, 2000]
EF (exposure frequency)	9 days/yr	default value for excavation/trench worker [ODEQ, 2000] - considered conservative as this scenario is not currently supported by site conditions (e.g., none of the site utilities are at depths that would be below the water table)
Incidental Ingestion		
IR (ingestion rate) - adult	50 mL/day	standard default for ingestion of surface water while swimming; conservative assumption [EPA, 1989] - incidental ingestion of groundwater would occur if trench worker was directly contacting groundwater.
FI (fraction ingested)	100%	worst-case assumption that all water ingested is absorbed and is impacted
Dermal Contact		
EV (event frequency)	1 event/day	recommended value for a construction worker [EPA, 2002; Exhibit 5-1]
BSAE (body surface area exposed)	3,300 cm^2	recommended value for a construction worker [EPA, 2002; Exhibit 5-1]
ET (exposure time)	8 hr/day	standard default exposure factor based on typical workday [EPA, 1989] - this value is conservative given the confined space of a trench
PC (chemical permeability factor)	chemical-specific	value varies according to chemical [EPA, 2004]
Inhalation of Volatiles in Ambient Air		
IR (inhalation rate)	3.3 m^3/hr	recommended inhalation rate for outdoor workers involved in heavy activities [EPA, 1997;T5-23]
ET (exposure time)	8 hr/day	standard default exposure factor based on typical workday [EPA, 1989] - this value is conservative given the confined space of a trench

Notes:

[a] Construction/trench worker only contacts exposed groundwater during excavation (trenching) activities and, while plausible, this trenching scenario is not currently supported by site conditions (i.e., none of the sewer invert elevations at or near the site are at depths that would be below the water table).

References:

EPA, 1989. Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

EPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.6-03. March 25, 1991.

EPA, 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure, Draft, dated November 4, 1993.

EPA, 1997. Exposure Factors Handbook. Vols I-III. Office of Research and Development, Washington, D.C. EPA/600/P-95/002Fa. August.

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER 9355.4-24. December.

EPA, 2004. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment). Final. Office of Emergency and Remedial Response, Washington D.C. EPA/540/R/99/005. July 2004.

ODEQ, 2000. Risk-Based Decision Making for the Remediation of Petroleum Contaminated Sites. Oregon Department of Environmental Quality. Land Quality Division, Environmental Cleanup and Tanks Program. Portland, OR. September 27, 2000. Table H-1.

Table 3-4 Toxicity Data for Chemicals of Potential Concern

COPC	CAS Number	Volatile Organic Compound	Reference Dose (mg/kg/d) (Oral)	Source	Reference Dose (mg/kg/d) (Dermal)	Source	Reference Concentration (mg/m^3) (Inhalation)	Source	Cancer Slope Factor (mg/kg/d)$^{-1}$ (Oral)	Source	Cancer Slope Factor (mg/kg/d)$^{-1}$ (Dermal)	Source	Unit Risk (µg/m^3)$^{-1}$ (Inhalation)	Source	Perm-eability Constant (K_p) cm/hr	Reference	Volatil-ization Factor L/m^3	Reference
1,1,1-Trichloroethane	71-55-6	y	2.80E-01	N	2.80E-01	R	2.21E+00	P	NA		NA		NA		1.30E-02	2	0.5	1
1,1-Dichloroethene	75-35-4	y	5.00E-02	I	5.00E-02	R	2.00E-01	I	NA		NA		NA		1.20E-02	2	0.5	1
Tetrachloroethene	127-18-4	y	1.00E-02	I	1.00E-02	R	3.50E-02	C	5.40E-01	C	5.40E-01	R	6.00E-06	C	3.30E-02	2	0.5	1
trans-1,2-dichloroethene	156-60-5	y	2.00E-02	I	2.00E-02	R	5.95E-02	P	NA		NA		NA		7.70E-03	2	0.5	1
Trichloroethene	79-01-6	y	3.00E-04	N	3.00E-04	R	3.50E-02	N	4.00E-01	N	4.00E-01	R	1.14E-04	N	1.20E-02	2	0.5	1
Vinyl chloride	75-01-4	y	3.00E-03	I	3.00E-03	R	1.02E-01	I	1.50E+00	I	1.50E+00	R	8.86E-06	I	5.60E-03	2	0.5	1

Notes:
[a] = calculated
y = yes
n = no
NA= Not applicable or Not Available
Oral toxicity values were used as dermal toxicity values

RfD inhalation and CSF inhalation values available in U.S. EPA Region IX Preliminary Remediation Goal (PRG) Table (October 2004) were converted to reference concentration and unit risk by the following equations:
RfC (mg/m^3)=RfDinh mg/kg/day* (70kg/20 m^3/day), Unit Risk (ug/m^3)$^{-1}$=CSFinh (mg/kg/day) $^{-1}$ * 1mg/1000 ug *20m^3/1day * 1/70kg

Abbreviations for Sources:
I = IRIS
P =PPRTV
C =California EPA
N= NCEA
R= Route-to-route extrapolation

References:

1) USEPA, 2004. USEPA Region IX Preliminary Remediation Goal (PRG) Table. October 2004. (Note, Region IX has incorporated the latest hierarchy into their toxicity data table; this was used as the source of values listed).

2) USEPA, 2004. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Exhibit B-3. Final. July 2004. EPA/540/R/99/005.

Table 3-5 Cleanup Levels for Chemicals of Potential Concern in Groundwater

					EF = 25 days/yr		EF = 50 days/yr		EF = 100 days/yr	
COPC	CAS Number	MTCA Method B Surface Water Standard (µg/L)	MTCA Method B Construction Worker Cleanup Level (µg/L)	Is Surface Water Standard Protective of Cleanup Level?	MTCA Method B Construction Worker Cleanup Level (µg/L)	Is Surface Water Standard Protective of Cleanup Level?	MTCA Method B Construction Worker Cleanup Level (µg/L)	Is Surface Water Standard Protective of Cleanup Level?	MTCA Method B Construction Worker Cleanup Level (µg/L)	Is Surface Water Standard Protective of Cleanup Level?
1,1,1-Trichloroethane	71-55-6	420,000	126,982	NO	45,713	NO	22,857	NO	11,428	NO
1,1-Dichloroethene	75-35-4	23,000	11,882	NO	4,278	NO	2,139	NO	1,069	NO
Tetrachloroethene	127-18-4	0.39	257	YES	92	YES	46	YES	23	YES
trans-1,2-Dichloroethene	156-60-5	33,000	3,597	NO	1,295	NO	648	NO	324	NO
Trichloroethene	79-01-6	1.5	37	YES	13	YES	7	YES	3	YES
Vinyl chloride	75-01-4	3.7	281	YES	101	YES	51	YES	25	YES

Notes:
y = yes
n = no
COPC = chemical of potential concern
µg/L = micrograms per liter
EF = exposure frequency
yr = years
carcinogenic target risk level (TRL) = 10^{-6}
noncancer HI = 1

Table 5-1 Detailed MTCA Evaluation of Alternatives

Alternative Number	Alt. 1	Alt. 2	Alt. 3
Probable Cost	$4,598,772	$3,703,694	$3,386,675
Alternative Description	Optimized Hydraulic Control, Soil Vapor Extraction combined with Air Sparge (SVE/AS), Subslab Depressurization System, and Institutional Controls	Optimized Hydraulic Control, Chemical Oxidation with Potassium Permanganate, Subslab Depressurization System, and Institutional Controls	Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls
Overall Ranking	Low	Moderate	Moderate
Basis for Alternative Ranking Under MTCA			
1 Compliance with MTCA Threshold Criteria *(WAC 173-340-360(2)(a))*			
Protection of Human Health & Environment	**Moderate:** Alternative 1 protects human health and the environment by complying with applicable federal and state cleanup standards. AS/SVE removes potential impacts and vapors are controlled by permits and regulations. The lowest state cleanup levels may not be met under this alternative.	**High:** Alternative 2 protects human health and the environment by complying with applicable federal and state cleanup standards.	**High:** Alternative 3 protects human health and the environment by complying with applicable federal and state cleanup standards.
Compliance with Cleanup Standards	**Low:** SVE/AS technical has been proven to reduce CVOC concentrations; however, treatment to the lowest TCE cleanup values may require additional operation time and may not be achievable with this technology.	**High:** This alternative complies with the cleanup standards through the use of chemical degradation. This alternative treats both On-Site and Off-Site Areas, clean up standards are expected to be achieved at both areas. Where cleanup levels cannot be obtained, appropriate institutional controls will be implemented	**Moderate:** This alternative complies with the cleanup standards through the use of enhanced biodegradation. This receives a moderate ranking because of the chance of producing CVOC byproducts or the potential for mobilization of metals. The use of institutional controls is limited to management of potential drinking water use and managing the current site use and any future site use to comply with all environmental regulations. This alternative treats both On-Site and Off-Site Areas, clean up standards are expected to be achieved at both areas.
Compliance with Applicable State & Federal Laws	**High:** This alternative complies with all applicable state and federal laws.	**High:** This alternative complies with all applicable state and federal laws.	**High:** This alternative complies with all applicable state and federal laws.
Provision for Compliance Monitoring	**High:** This alternative provides for compliance monitoring to demonstrate that concentrations are stable, this allows for all types of compliance monitoring.	**High:** This alternative provides for compliance monitoring to demonstrate that concentrations are stable, this allows for all types of compliance monitoring.	**High:** This alternative provides for compliance monitoring to demonstrate that concentrations are stable, this allows for all types of compliance monitoring.
2 Restoration Time-Frame *(WAC 173-340-360(2)(b)(ii))*	**Low:** This alternative has one of the longest restoration time frames - 11 years.	**Moderate:** This alternative has a moderate restoration time frames - 10 years.	**Moderate:** This alternative has a moderate restoration time frames - 10 years.
3 Evaluation of Permanence Using MTCA Disproportionate Cost Analysis *(WAC 173-340-360(2)(b)(i) & WAC 173-340-360(3)(f))*			
Overall Protectiveness	**Low:** Alternative 1 protects human health and the environment by complying with applicable federal and state cleanup standards. The lowest state cleanup levels may not met under this alternative, which is why this alternative receives a lower rank than Alternatives 2 and 3.	**Moderate:** This alternative permanently removes impacts from the soil, vapor, and groundwater. This alternative may not treat all On-Site Area residual contamination (because of the combined use of pump and treat and injection), and receives a moderate ranking.	**Moderate:** This alternative permanently removes impacts from the soil, vapor, and groundwater. This alternative may not treat all On-Site Area residual contamination (because of the combined use of pump and treat and injection), and receives a moderate ranking.
Permanence	**High:** Provides reduction in the total volume of TCE concentrations in the groundwater, soil, and vapor.	**High:** Provides reduction in the total volume of TCE concentrations in the groundwater, soil, and vapor.	**High:** Provides reduction in the total volume of TCE concentrations in the groundwater, soil, and vapor.
Long-Term Effectiveness	**Low:** This alternative has an increased use of higher-preference remediation technologies as defined under MTCA, however this is comparative to all other alternatives. The rank is lower than then Alternatives 2, 3, 5 and 6 because of the uncertainty of achieving the clean up standards.	**Moderate:** This alternative an aggressive remediation strategy for the degradation of CVOCs in groundwater. However, uncertainty exists with the combined use of the pump and discharge system with injection. The combined use of these 2 technologies may affect the ability for the injection chemicals to reach the full extent of impacted media. Due to this potential uncertainty, the long-term effectiveness of the alternative is therefore considered to be moderate, compared to Alternatives 5 and 6.	**Moderate:** This alternative an aggressive remediation strategy for the degradation of CVOCs in groundwater. However, uncertainty exists with the combined use of the pump and discharge system with injection. The combined use of these 2 technologies may affect the ability for the injection slurry to reach the full extent of impacted media. Due to this potential uncertainty, the long-term effectiveness of the alternative is therefore considered to be moderate, compared to Alternatives 5 and 6.
Short-Term Risk Management	**Low:** Alternative 1 involves the greatest amount of installation and On-Site equipment and associated highest short-term risk as compared to the other alternatives. Because of the high risk, this alternatives receives a low ranking for management of short term risk.	**Low:** Alternative 2 involves less equipment than Alternative 1, but additional short term risk management is required with the use of chemicals. This alternative includes optimization of the pump and discharge, which will require additional planning and considerations to minimize exposure	**Moderate:** Alternative 3 involves less equipment than Alternative 1 and 2, and the minimal risk is associated with the selected injection products. This alternative includes optimization of the pump and discharge, which will require additional planning and considerations to minimize exposure
Implementability	**Low:** Alternative 1 is practicable and implementable; however, compared to the two other alternatives, this is the most difficult to implement. The required treatment equipment, large amount of excavation required for lateral wells, the coordination with the current building and land owners associated with storage of treatment equipment and the industrial, high profile setting are difficulties that need to be addressed. While significant, these are expected to be managed with proper planning before work starts.	**Moderate:** Compared to Alternative 5 , additional difficulties are associated with Alternative 2's need for optimization and continued operation of the pump and treat system. Alternatives 2 and 5 both include difficulties related to overall site access, chemical storage, and availability of contractors; however, the fact that the site is no longer owned by the PLP always makes it more difficult to operate and maintain the hydraulic control system. Because these difficulties can be minimized with proper planning before work starts, however, Alternative 2 is implementable.	**Moderate:** Alternative 3 is implementable, however, compared to Alternative 6 additional difficulties are associated with the optimization and continued operation of the pump and treat system. Alternatives 3 and 6 include difficulties related to overall site access, chemical storage, and availability of contractors. All of these difficulties can be managed with proper planning before work starts.
Consideration of Public Concerns	**Low:** This alternative has the longest restoration time frame compared to the other alternatives. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.	**High:** This alternative has the shortest restoration time frame. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.	**Moderate:** This alternative had a medium restoration time frame. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.

Table 5-1 Detailed MTCA Evaluation of Alternatives

Alternative Number	Alt. 4	Alt. 5	Alt. 6
Probable Cost	$2,632,083	$2,747,069	$1,928,792
Alternative Description	Soil Vapor Extraction combined with Air Sparge (SVE/AS) and Institutional Controls	Chemical Oxidation, Institutional Controls, and Subslab Depressurization System	Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls
Overall Ranking	Low	High	Moderate
Basis for Alternative Ranking Ur			
1 Compliance with MTCA Thresholc *(WAC 173-340-360(2)(a))*			
Protection of Human Health & Environment	**Moderate:** Alternative 4 protects human health and the environment by complying with applicable federal and state cleanup standards. AS/SVE removes potential impacts and vapors are controlled by permits and regulations. The lowest state cleanup levels may not be met under this alternative.	**High:** Alternative 5 protects human health and the environment by complying with applicable federal and state cleanup standards.	**High:** Alternative 6 protects human health and the environment by complying with applicable federal and state cleanup standards.
Compliance with Cleanup Standards	**Low:** SVE/AS technical has been proven to reduce CVOC concentrations; however, treatment to the lowest TCE cleanup values may require additional operation time and may not be achievable with this technology.	**High:** This alternative complies with the cleanup standards through the use of chemical degradation. This alternative treats both On-Site and Off-Site Areas, clean up standards are expected to be achieved at both areas. Where cleanup levels cannot be obtained, appropriate institutional controls will be implemented	**Moderate:** This alternative complies with the cleanup standards through the use of enhanced biodegradation. This receives a moderate ranking because of the chance of producing CVOC byproducts or the potential for mobilization of metals. The use of institutional controls is limited to management of potential drinking water use and managing the current site use and any future site use to comply with all environmental regulations. This alternative treats both On-Site and Off-Site Areas, clean up standards are expected to be achieved at both areas.
Compliance with Applicable State & Federal Laws	**High:** This alternative complies with all applicable state and federal laws.	**High:** This alternative complies with all applicable state and federal laws.	**High:** This alternative complies with all applicable state and federal laws.
Provision for Compliance Monitoring	**High:** This alternative provides for compliance monitoring to demonstrate that concentrations are stable, this allows for all types of compliance monitoring.	**High:** This alternative provides for compliance monitoring to demonstrate that concentrations are stable, this allows for all types of compliance monitoring.	**High:** This alternative provides for compliance monitoring to demonstrate that concentrations are stable, this allows for all types of compliance monitoring.
2 Restoration Time-Frame *(WAC 173-340-360(2)(b)(ii))*	**Low:** This alternative has one of the longest restoration time frames - 11 years.	**High:** This alternative has a short restoration time frames - 8 years.	**Moderate:** This alternative has a moderate restoration time frames - 10 years.
3 Evaluation of Permanence Using *(WAC 173-340-360(2)(b)(i) & WAC*			
Overall Protectiveness	**Low:** Alternative 4 is similar to Alternative 1 except it does not include hydraulic contanment. Because this alternative does not include an additional layer of protectiveness, it receives a lower ranking compared to Alternatives 1, 2, and 3.	**High:** Similar to Alternative 2, this alternative permanently removes impacts from the soil, vapor, and groundwater. Because this alternative does not include the uncertainness associated with the continued pump and discharge system, this alternatives ranking higher than Alternative 2.	**High:** Similar to Alternative 3, this alternative permanently removes impacts from the soil, vapor, and groundwater. Because this alternative does not include the uncertainness associated with the continued pump and discharge system, this alternatives ranking higher than Alternative 3.
Permanence	**High:** Provides reduction in the total volume of TCE concentrations in the groundwater, soil, and vapor.	**High:** Provides the greatest reduction in the total volume of TCE concentrations in the groundwater, soil, and vapor.	**High:** Provides reduction in the total volume of TCE concentrations in the groundwater, soil, and vapor.
Long-Term Effectiveness	**Low:** This alternative has an increased use of higher-preference remediation technologies as defined under MTCA, however this is comparative to all other alternatives. The rank is lower than then Alternatives 2, 3, 5 and 6 because of the uncertainty of achieving the clean up standards.	**High:** This alternative utilizes an aggressive remediation strategy for the degradation of CVOCs in groundwater. The long-term effectiveness of the alternative is therefore considered to be high, due to the increased use of high-preference remediation technologies as defined under MTCA.	**High:** This alternative utilizes an aggressive remediation strategy for the degradation of CVOCs in groundwater. The long-term effectiveness of the alternative is therefore considered to be high, due to the increased use of high-preference remediation technologies as defined under MTCA.
Short-Term Risk Management	**Moderate:** Alternative 4 requires significant above ground equipment and work required with the instillation process. This alternative ranks slightly higher than Alternative 1 because it does not include optimization of the current hydraulic recovery system.	**Moderate:** Alternative 5 involves less equipment than the previous alternatives, but additional short term risk management is required for the use of injection chemicals.	**High:** Alternative 6 involves generally the same amount of equipment as alternative 5, however, less risk is associated with the selected injection chemicals.
Implementability	**Low:** Alternative 1 is practicable and implementable; however, compared to the two other alternatives, this is the most difficult to implement. The required treatment equipment, large amount of excavation required for lateral wells, the coordination with the current building and land owners associated with storage of treatment equipment and the industrial, high profile setting are difficulties that need to be addressed. While significant, these are expected to be managed with proper planning before work starts.	**High:** This is practicable and implementable. Alternatives 2 and 5 both include difficulties related to overall site access, chemical storage, and availability of contractors; however, the fact that the site is no longer owned by the PLP always makes it more difficult to operate and maintain the hydraulic control system. Because these difficulties can be minimized with proper planning before work starts. All of these difficulties can be managed with proper planning before work starts.	**High:** This is practicable and implementable. Difficulties related to implementability include access, chemical storage, and availability of contractors. All of these difficulties can be managed with proper planning before work starts.
Consideration of Public Concerns	**Low:** This alternative has the longest restoration time frame compared to the other alternatives. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.	**High:** This alternative has the shortest restoration time frame. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.	**Moderate:** This alternative had a medium restoration time frame. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.

Table 5-1 Detailed MTCA Evaluation of Alternatives

Alternative Number	Alt. 1	Alt. 2	Alt. 3
Probable Cost	$4,598,772	$3,703,694	$3,386,675
Alternative Description	Optimized Hydraulic Control, Soil Vapor Extraction combined with Air Sparge (SVE/AS), Subslab Depressurization System, and Institutional Controls	Optimized Hydraulic Control, Chemical Oxidation with Potassium Permanganate, Subslab Depressurization System, and Institutional Controls	Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls
Overall Ranking	Low	Moderate	Moderate

Basis for Alternative Ranking Under MTCA

1 Compliance with MTCA Threshold Criteria
(WAC 173-340-360(2)(a))

	Alt. 1	Alt. 2	Alt. 3
Protection of Human Health & Environment	**Moderate:** Alternative 1 protects human health and the environment by complying with applicable federal and state cleanup standards. AS/SVE removes potential impacts and vapors are land owners associated with storage of treatment equipment and the industrial, high profile setting are difficulties that need to be addressed. While significant, these are expected to be managed with proper planning before work starts.	**High:** Alternative 2 protects human health and the environment by complying with applicable federal and state cleanup standards. however, the fact that the site is no longer owned by the PLP always makes it more difficult to operate and maintain the hydraulic control system. Because these difficulties can be minimized with proper planning before work starts, however, Alternative 2 is implementable.	**High:** Alternative 3 protects human health and the environment by complying with applicable federal and state cleanup standards. availability of contractors. All of these difficulties can be managed with proper planning before work starts.
Consideration of Public Concerns	**Low:** This alternative has the longest restoration time frame compared to the other alternatives. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.	**High:** This alternative has the shortest restoration time frame. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.	**Moderate:** This alternative had a medium restoration time frame. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.

Table 5-1 Detailed MTCA Evaluation of Alternatives

Alternative Number	Alt. 4	Alt. 5	Alt. 6
Probable Cost	$2,632,083	$2,747,069	$1,928,792
Alternative Description	Soil Vapor Extraction combined with Air Sparge (SVE/AS) and Institutional Controls	Chemical Oxidation, Institutional Controls, and Subslab Depressurization System	Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls
Overall Ranking	Low	High	Moderate
Basis for Alternative Ranking Ur			
1 Compliance with MTCA Thresholc *(WAC 173-340-360(2)(a))*			
Protection of Human Health & Environment	**Moderate:** Alternative 4 protects human health and the environment by complying with applicable federal and state cleanup standards. AS/SVE removes potential impacts and vapors are land owners associated with storage of treatment equipment and the industrial, high profile setting are difficulties that need to be addressed. While significant, these are expected to be managed with proper planning before work starts.	**High:** Alternative 5 protects human health and the environment by complying with applicable federal and state cleanup standards. control system. Because these difficulties can be minimized with proper planning before work starts. All of these difficulties can be managed with proper planning before work starts.	**High:** Alternative 6 protects human health and the environment by complying with applicable federal and state cleanup standards.
Consideration of Public Concerns	**Low:** This alternative has the longest restoration time frame compared to the other alternatives. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.	**High:** This alternative has the shortest restoration time frame. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.	**Moderate:** This alternative had a medium restoration time frame. Based on the current views of the building owners an expedited remedy is preferred for this site. Additional public comments will be addressed as part of the DCAP review process.

Table 5-2 Restoration Time Frame

Alternative	Remedy Selection, Design, and Permitting	Implementation & Performance Monitoring	Compliance Monitoring	Total Time Frame (years)	Overall MTCA Ranking (See Table 5-1)	Probable Cost (see Appendix B)
Alt. 1 - Optimized Hydraulic Control , Soil Vapor Extraction combined with Air Sparge (SVE/AS), Sub Slab Depressurization System, and Institutional Controls	2	6	3	11	Low	$4,598,772
Alt. 2 -Optimized Hydraulic Control, Chemical Oxidation with Potassium Permanganate, Sub Slab Depressurization System, and Institutional Controls	2	5	3	10	Moderate	$3,703,694
Alt. 3 - Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation, Sub Slab Depressurization System, and Institutional Controls	2	5	3	10	Moderate	$3,386,675
Alt. 4 -Air Sparging/Soil Vapor Extraction and Institutional Controls	2	6	3	11	Low	$2,632,083
Alt. 5 - Chemical Oxidation, Institutional Controls, and Sub Slab Depressurization System	2	3	3	8	High	$2,747,069
Alt. 6 - Anaerobic Bioremediation, Sub Slab Depressurization System, and Institutional Controls	2	5	3	10	Moderate	$1,928,792

Note:

Restoration time frames are estimated from available data to date and similar sites

Table 5-3 Summary of Performance Monitoring - Alternative 2

Location	Field Measurements[1]	$KMnO_4$	Total Organic Carbon	CVOC[2] and Metals[3]
Phase 1				
Observation Wells	X			
Select Observation Wells	X	X	X	X
On-Site Area: MW-1, MW-4, MW-6, MW-7,MW-8S, MW-8M, MW-13	X	X	X	X
On-Site Area: MW-5, RW-4 and RW-2	X			
Off-Site Area: EPI-MW-1S/1D	X			
Phase 2 and Phase 3				
Observation Wells	X			
Select Observation Wells	X	X	X	X
On-Site Area: MW-1, MW-4, MW-6, MW-7, MW-13, MW-8S, MW-8M	X	X	X	X
On-Site Area: MW-5, RW-4 and RW-2	X			
Off-Site Area: MW-11, MW-14M/D, MW-15M/D, MW-21S, MW-16M/D	X	X	X	X
EPI-MW-2D, EPI-MW-4S/4D			X	X
Off-Site Area: MW-17D/M and EPI-MW-1S/1D	X			

Notes:

1. Field measurements include specific conductivity, pH, oxidation/ reduction potential, temperature, dissolved oxygen, turbidity, and visual observation of color ($KMnO_4$)

2. CVOC list includes 1,1-Dichloro-ethylene, cis 1,2-Dichloro-ethylene, Tetrachloro-ethylene, Trichloro-ethylene, 1,1,1-Trichloro-ethane, Vinyl Chloride. Locations which are pink or purple in color, indicating $KMnO_4$ is present, will not be sampled. Field Measurements will be collected during sampling. Low flow sampling procedures consistent with previous sampling events will be used.

3. Metals include potassium, iron, manganese, arsenic; (total and dissolved)

Table 5-4 Summary of Performance Monitoring - Alternative 3

Location	Field Measurements[1]	Ethene/Ethane, Methane	Total Organic Carbon	Sulfate	Bromide	CVOC[2] and Metals[3]
Phase 1						
Observation Wells	X	—		—	—	—
Select Observation Wells	X	X	X	X	—	X
On-Site Area: MW-1, MW-4 MW-6, MW-7,MW-8S, MW-8M, MW-13	X	X	X	X	—	X
On-Site Area: MW-5, RW-4 and RW-2	X	—	—	—	—	—
Off-Site Area: EPI-MW-1S/1D	X	—	—	—	—	—
Tracer Study - MW-4, MW-6, MW-8M, and MW-8S	—	—	—	—	X	—
Phase 2 and Phase 3						
Observation Wells	X	—	—	—	—	—
Select Observation Wells	X	X	X	X	—	X
On-Site Area: MW-1, MW-4 MW-6, MW-7, MW-13,MW-8S, MW-8M	X	X	X	X	—	X
On-Site Area: MW-5, RW-4 and RW-2	X	—	—	—	—	—
Off-Site Area: MW-11, MW-14M/D, MW-15M/D, MW-21S, MW-16M/D	X	X	X	—	—	X
EPI-MW-2D, EPI-MW-4S/4D	—	—	X	—	—	X
Off-Site Area: MW-17D/M and EPI-MW-1S/1D	X	—	—	—	—	—

Notes:

1. Field measurements include specific conductivity, pH, oxidation/reduction potential, temperature, dissolved oxygen, turbidity, and visual observation of color ($KMnO_4$)

2. CVOC list includes 1,1-Dichloro-ethylene, cis-1,2-Dichloro-ethylene, Tetrachloro-ethylene, Trichloro-ethylene, 1,1,1-Trichloro-ethane, Vinyl Chloride. Locations which are pink or purple in color, indicating $KMnO_4$ is present, will not be sampled.

3. Metals include potassium, iron, manganese, arsenic; (total and dissolved)

Table 5-5 Summary of Performance Monitoring - Alternative 5

Location	Field Measurements[1]	$KMnO_4$	Total Organic Carbon	CVOC[2] and Metals[3]
Phase 1				
Observation Wells	X			
Select Observation Wells	X	X	X	X
On-Site Area: MW-1, MW-4 MW-6, MW-7,MW-8S, MW-8M,MW-13	X	X	X	X
On-Site Area: MW-5, RW-4 and RW-2	X			
Off-Site Area: EPI-MW-1S/1D	X			
Phase 2 and Phase 3				
Observation Wells	X			
Select Observation Wells	X	X	X	X
On-Site Area: MW-1, MW-4 MW-6, MW-7, MW-13,MW-8S, MW-8M	X	X	X	X
On-Site Area: MW-5, RW-4 and RW-2	X			
Off-Site Area: MW-11, MW-14M/D, MW-15M/D, MW-21S, MW-16M/D	X	X	X	X
EPI-MW-2D, EPI-MW-			X	X
Off-Site Area: MW-17D/M and EPI-MW-1S/1D	X			

Notes:

1. Field measurements include specific conductivity, pH, oxidation/ reduction potential, temperature, dissolved oxygen, turbidity, and visual observation of color ($KMnO_4$)

2. CVOC list includes 1,1-Dichloro-ethylene, cis-1,2-Dichloro-ethylene, Tetrachloro-ethylene, Trichloro-ethylene, 1,1,1-Trichloro-ethane, Vinyl Chloride. Locations which are pink or purple in color, indicating $KMnO_4$ is present, will not be sampled. Field Measurements will be collected during sampling. Low flow sampling procedures consistent with previous sampling events will be used.

3. Metals include potassium, iron, manganese, arsenic; (total and dissolved)

Table 5-6 Summary of Performance Monitoring - Alternative 6

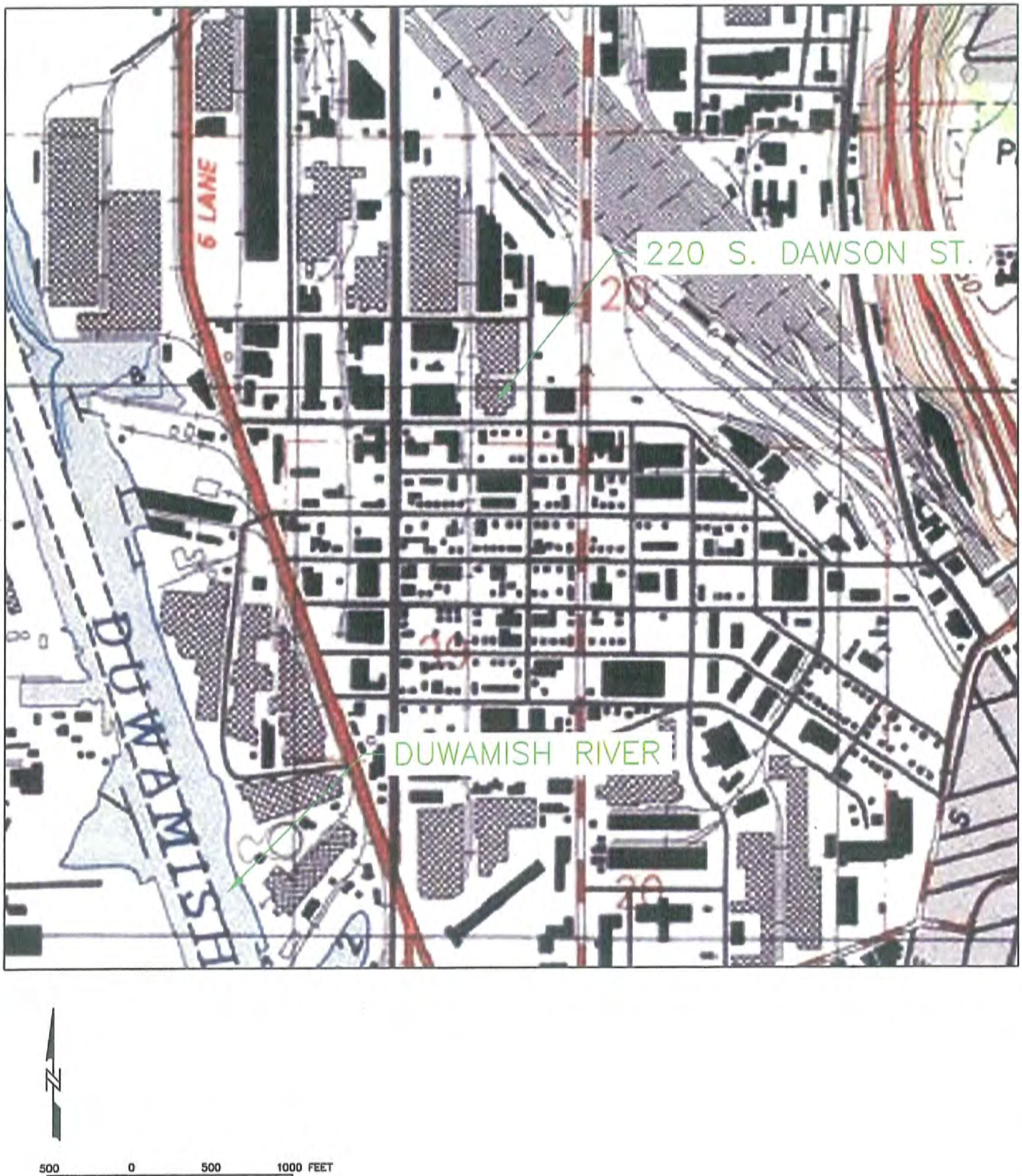
Location	Field Measurements[1]	Ethene/Ethane, Methane	Total Organic Carbon	Sulfate	Bromide	CVOC[2] and Metals[3]
Phase 1						
Observation Wells	X	—		—	—	—
Select Observation Wells	X	X	X	X	—	X
On-Site Area: MW-1, MW-4 MW-6, MW-7,MW-8S, MW-8M,MW-13	X	X	X	X	—	X
On-Site Area: MW-5, RW-4 and RW-2	X	—	—	—	—	—
Off-Site Area: EPI-MW-1S/1D	X	—	—	—	—	—
Tracer Study - MW-4, MW-6, MW-8M, and MW-8S	—	—	—	—	X	—
Phase 2 and Phase 3						
Observation Wells	X	—	—	—	—	—
Select Observation Wells	X	X	X	X	—	X
On-Site Area: MW-1, MW-4 MW-6, MW-7, MW-13,MW-8S, MW-8M	X	X	X	X	—	X
On-Site Area: MW-5, RW-4 and RW-2	X	—	—	—	—	—
Off-Site Area: MW-11, MW-14M/D, MW-15M/D, MW-21S, MW-16M/D	X	X	X	—	—	X
EPI-MW-2D, EPI-MW-4S/4D	—	—	X	—	—	X
Off-Site Area: MW-17D/M and EPI-MW-1S/1D	X	—	—	—	—	—

Notes:

1. Field measurements include specific conductivity, pH, oxidation/ reduction potential, temperature, dissolved oxygen, turbidity, and visual observation of color ($KMnO_4$)

2. CVOC list includes 1,1-Dichloro-ethylene, cis-1,2-Dichloro-ethylene, Tetrachloro-ethylene, Trichloro-ethylene, 1,1,1-Trichloro-ethane, Vinyl Chloride. Locations which are pink or purple in color, indicating $KMnO_4$ is present, will not be sampled.

3. Metals include potassium, iron, manganese, arsenic; (total and dissolved)



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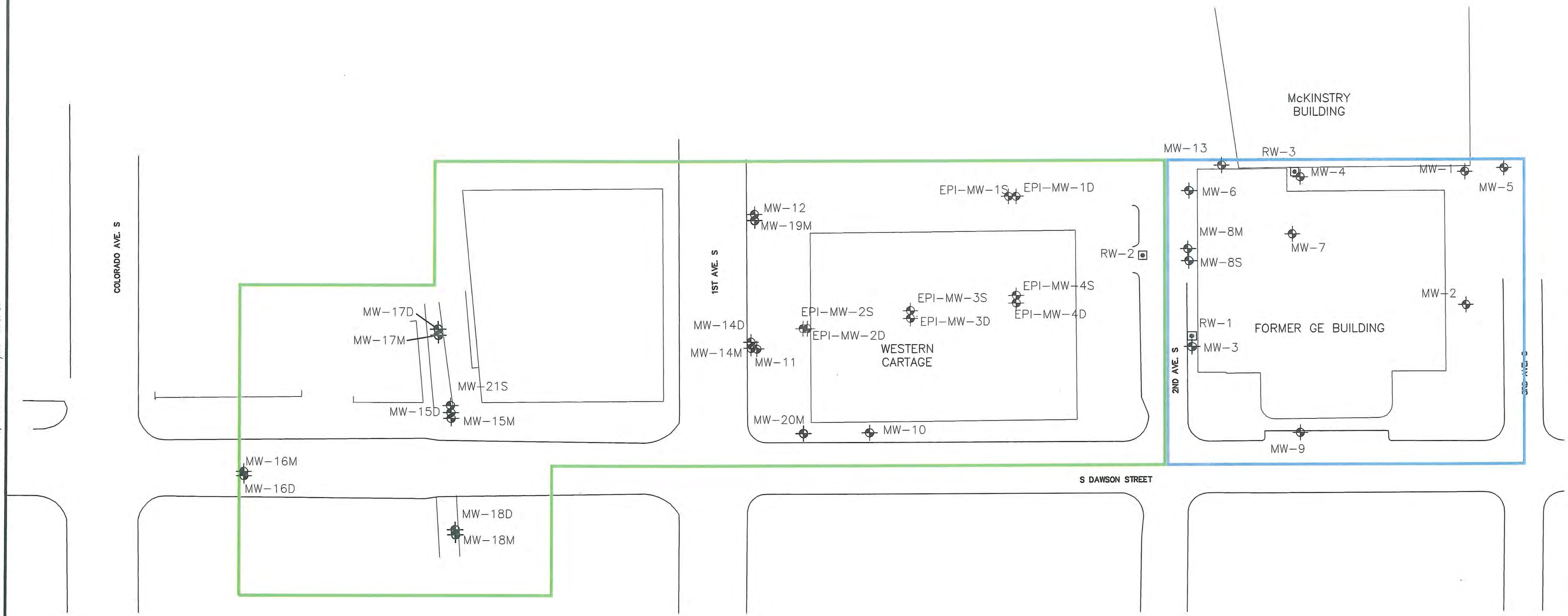
GE - S. DAWSON STREET
02978-415-735

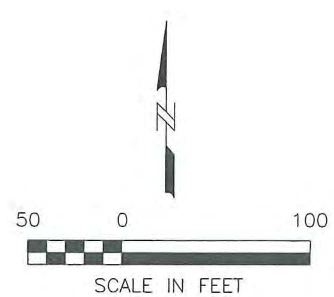
DATE: 2/28/08 DRWN: S.MEXIA

VICINITY MAP

FIGURE 1-1

File: L:\GE-S.Dawson\VICINITY.dwg Layout: ANSI_AVI-LJ User: MarshallE Plotted: Oct 13, 2008 - 12:42pm Xref's:





NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. ON-SITE AND OFF-SITE AREAS WERE DETERMINED BASED ON TCE CONCENTRATIONS IN THE GW PLUME. THESE AREAS HAVE ONLY BEEN ASSIGNED TO ASSIST WITH THE SELECTION OF A FINAL REMEDY AS PART OF THE DRAFT FOCUSED FEASIBILITY STUDY.

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- ON-SITE AREA
- OFF-SITE AREA

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GE - S. DAWSON STREET
02978-415-735

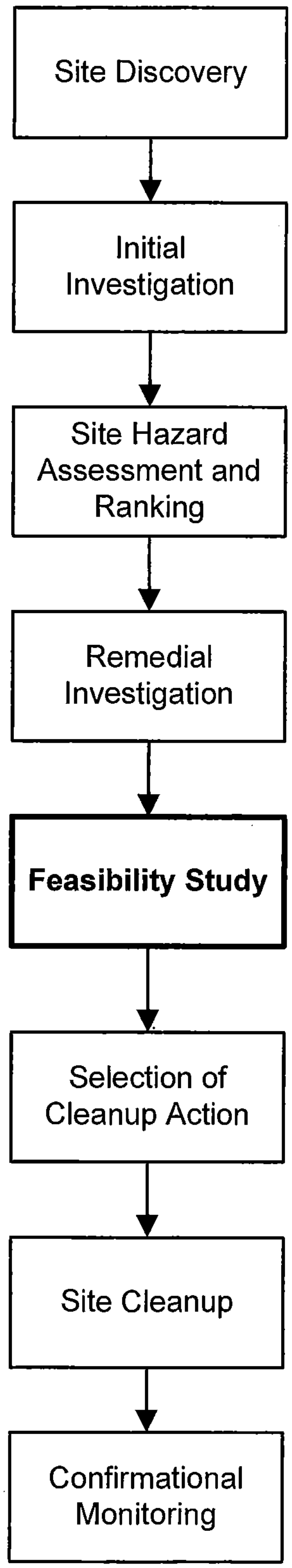
DATE: 06/12/08 DRWN: E.M./SEA

SITE LOCATION MAP

FIGURE 1-2

File: L:\GE-S.Dawson\02978_site-location.dwg Layout: figure 1-2 User: MarshallE Plotted: Oct 10, 2008 - 3:07pm Xref's:

Figure 1-3 Steps to Site Cleanup Under the Model Toxics Control Act Cleanup Regulations (WAC 173-340)



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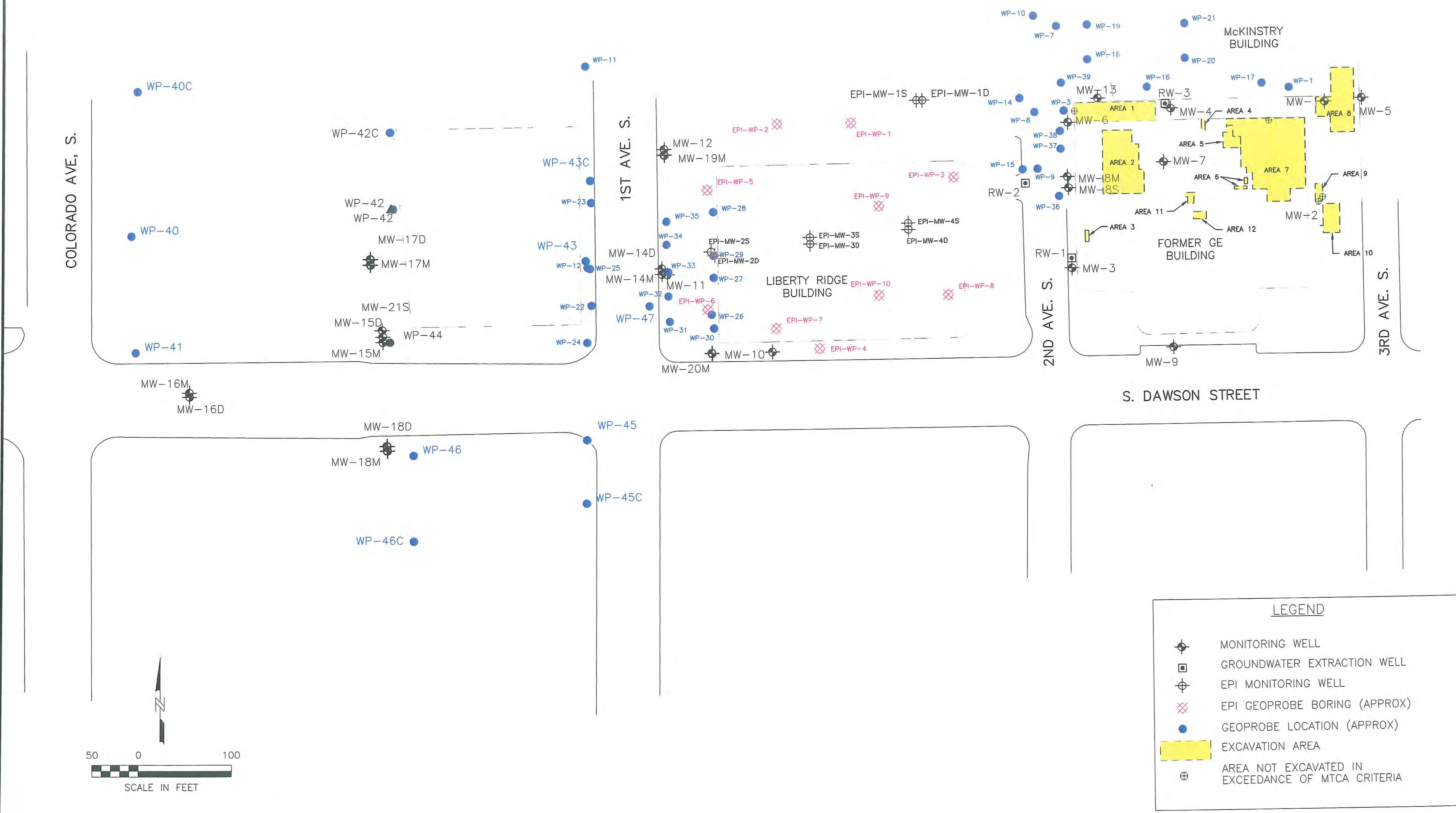

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02978-415-735

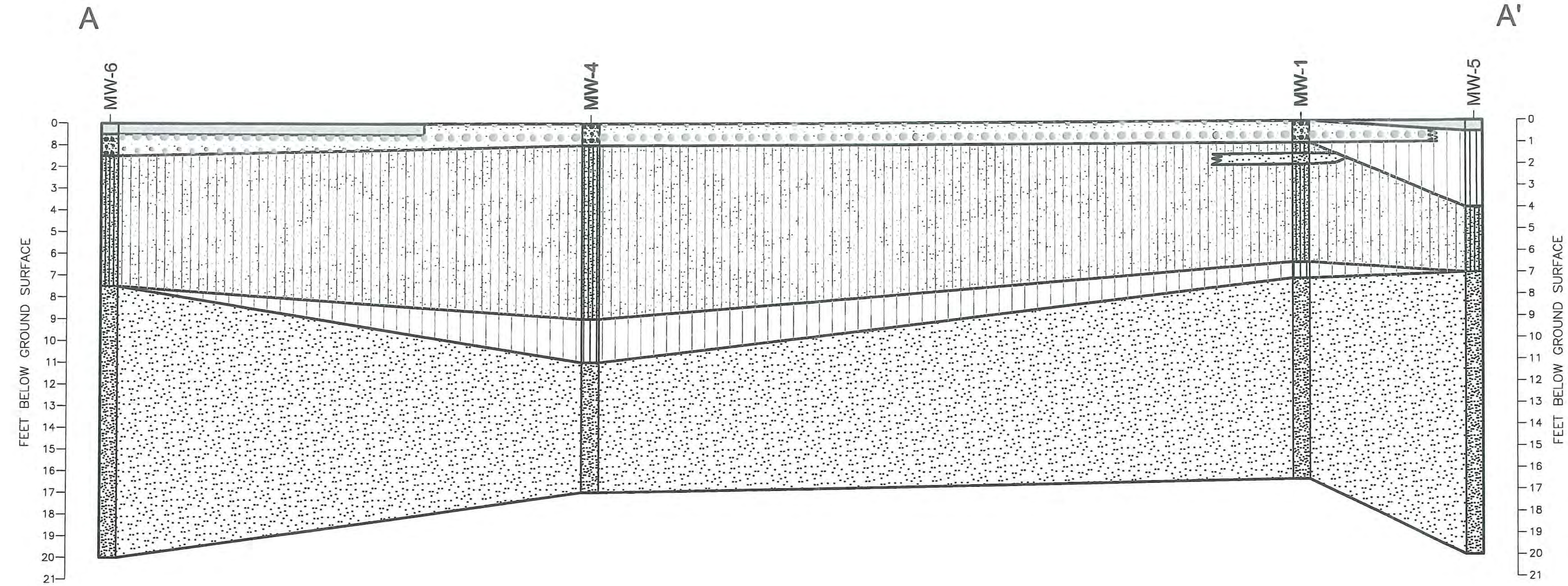
DATE: 06/06/08

DRWN: E.M./SEA

PREVIOUS INVESTIGATIONS LOCATION MAP

FIGURE 1-4

File: L:\GE-S.Dawson\02978_actions-activities.dwg Layout: FIGURE 1-4 User: MarshallE Plotted: Oct 10, 2008 - 3:08pm Xref's:

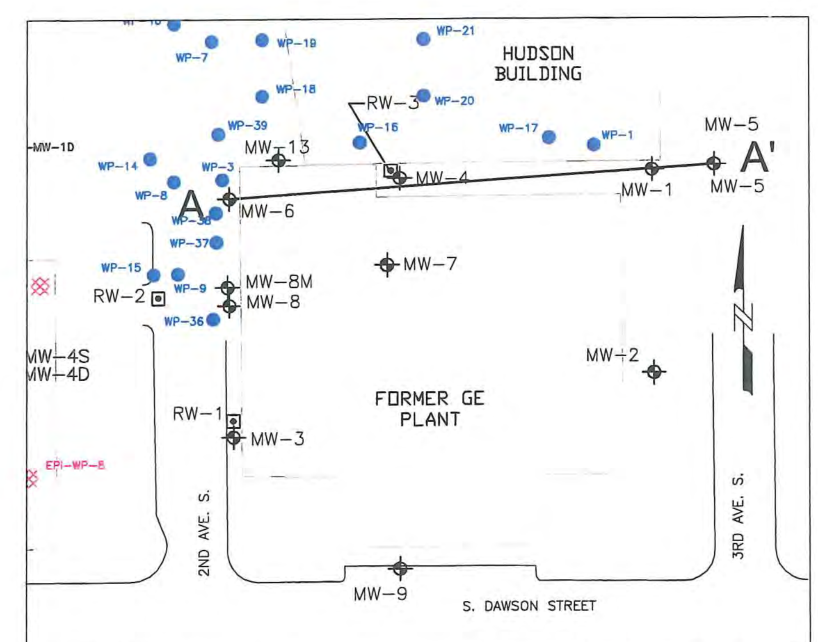


15 0 30

SCALE IN FEET
VERTICAL EXAGGERATION= 5:1

LEGEND

- GRAVEL or SANDY GRAVEL
- FINE TO MEDIUM GRAINED SAND
- SILTY SAND
- SILT or SANDY SILT
- ASPHALTIC CONCRETE



PLAN VIEW

60 0 120

SCALE IN FEET

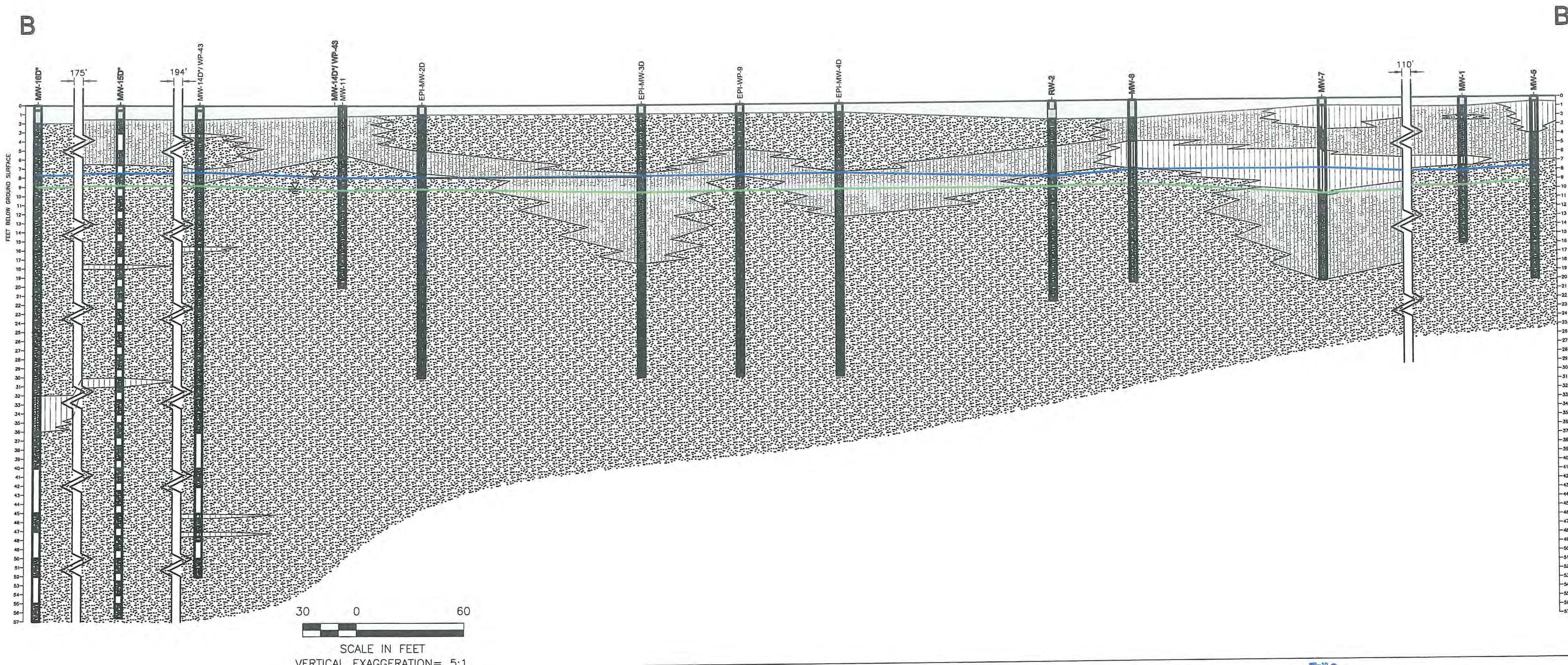
ENSR | AECOM

GE - S. DAWSON STREET
02978-415-735

DATE: 06/06/08 | DRWN: E.M./UKN

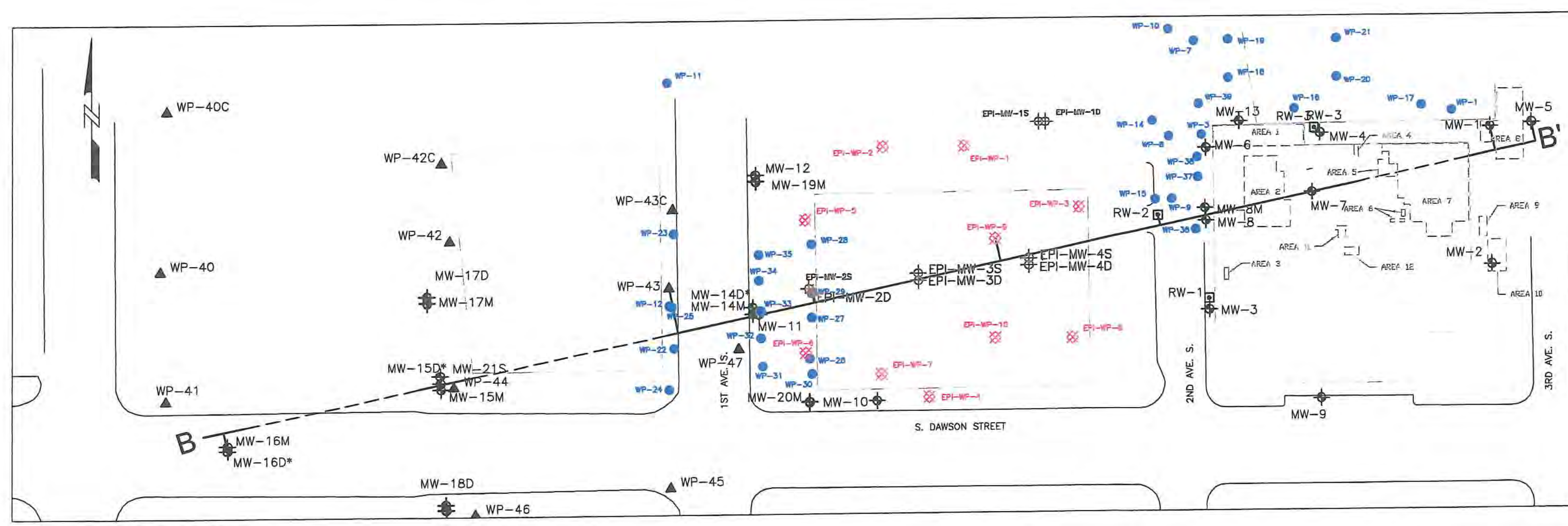
STRATIGRAPHIC CROSS-SECTION A-A'

FIGURE 2-1



LEGEND

- GRAVEL or SANDY GRAVEL
- FINE TO MEDIUM GRAINED SAND
- SILTY SAND TO SAND
- SILTY SAND
- SILT or SANDY SILT
- ASPHALTIC CONCRETE
- HIGH GROUNDWATER TABLE
- LOW GROUNDWATER TABLE



PLAN VIEW

75 0 150
SCALE IN FEET

NOTES:

THE HIGH WATER TABLE VALUE IS BASED ON THE FEBRUARY 2004 EVENT,
THE LOW WATER TABLE VALUE IS BASED ON THE AUGUST 2003 EVENT.
MW-14 LOG COLLECTED AT WP-43

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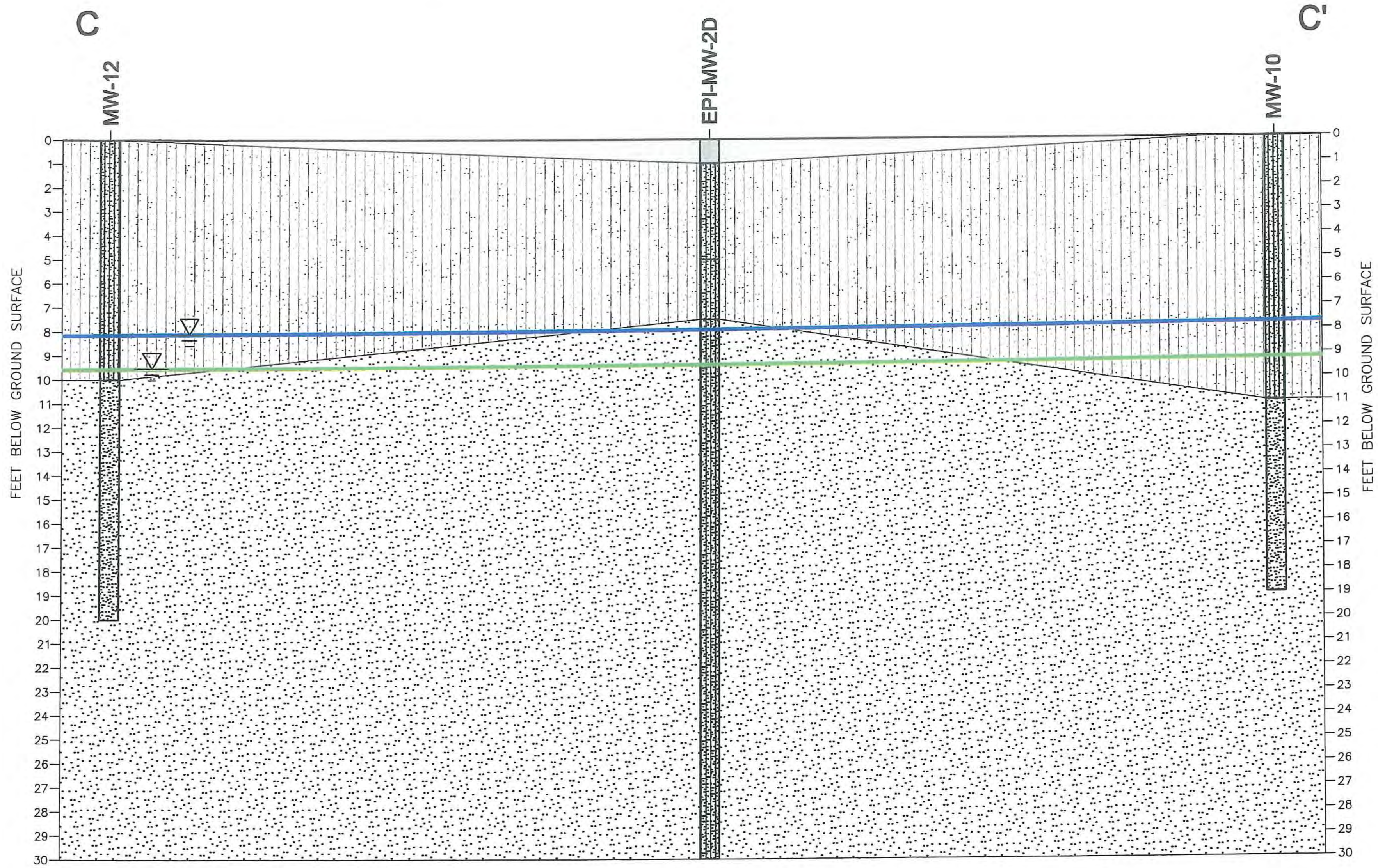
02978-415-735

STRATIGRAPHIC CROSS-SECTION B-B'

DATE: 06/06/08 | DRWN: E.M./SEA

FIGURE 2-2

File: L:\GE-S.Dawson\02978_G002.dwg Layout: FIG 2-2 User: emarshall Plotted: Jun 06, 2008 - 2:31pm Xref's:



15 0 30

SCALE IN FEET

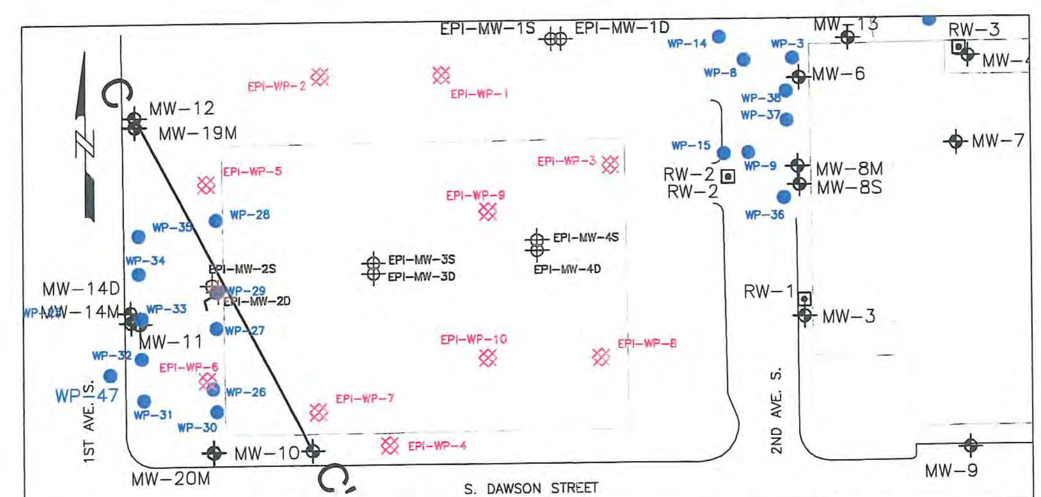
VERTICAL EXAGGERATION= 5:1

LEGEND

- GRAVEL or SANDY GRAVEL
- FINE TO MEDIUM GRAINED SAND
- SILTY SAND
- SILT or SANDY SILT
- ASPHALTIC CONCRETE
- HIGH GROUNDWATER TABLE
- LOW GROUNDWATER TABLE

NOTE:

THE HIGH WATER TABLE VALUE IS BASED ON THE FEBRUARY 2004 EVENT.
THE LOW WATER TABLE VALUE IS BASED ON THE AUGUST 2003 EVENT.



PLAN VIEW

60 0 120

SCALE IN FEET

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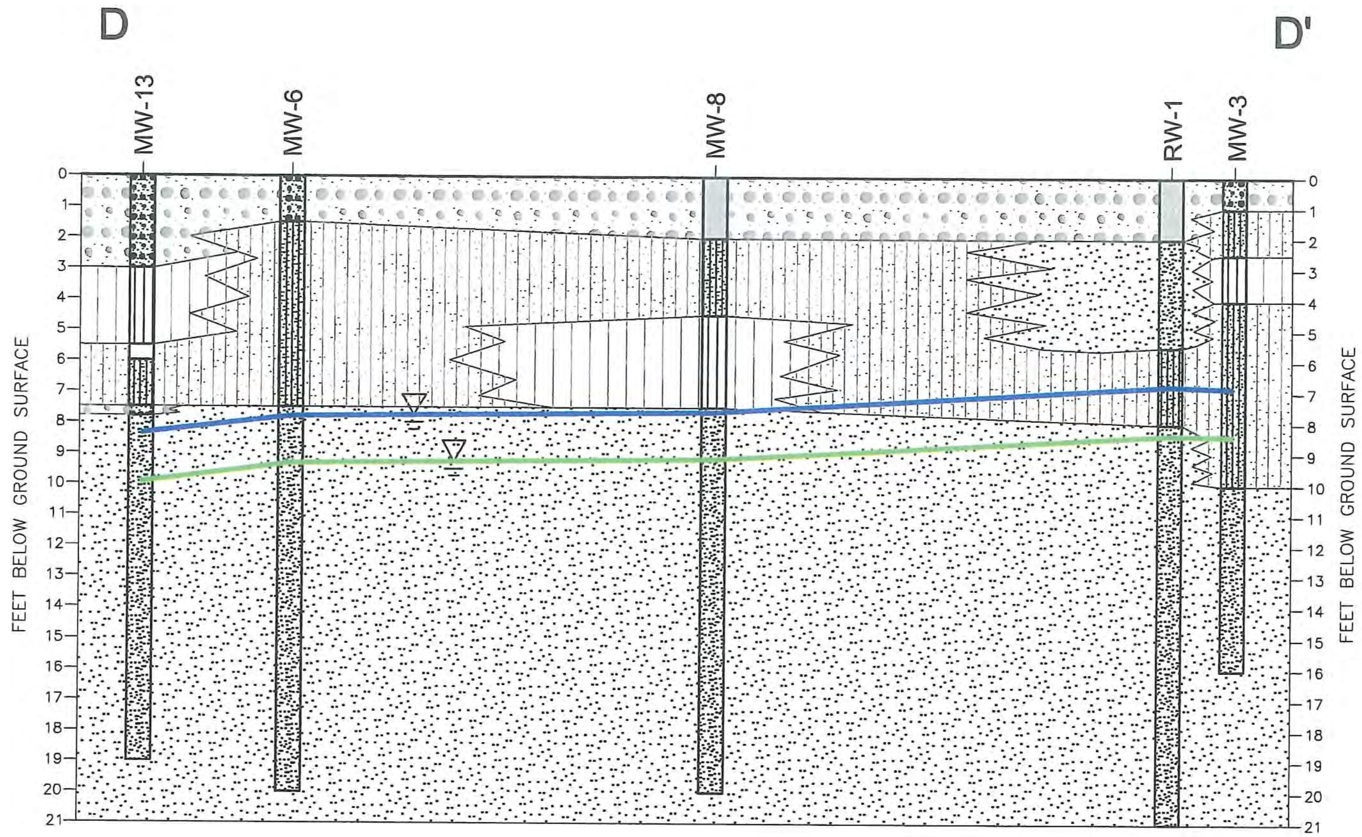
GE - S. DAWSON STREET 02978-415-735	STRATIGRAPHIC CROSS-SECTION C-C'
DATE: 06/09/08 DRWN: E.M./SEA	FIGURE 2-3

File: L:\GE-S.Dawson\02978_G003.dwg Layout: FIG 2-3 User: emarshall Plotted: Jun 09, 2008 - 8:50am Xref's:



15 0 30

SCALE IN FEET

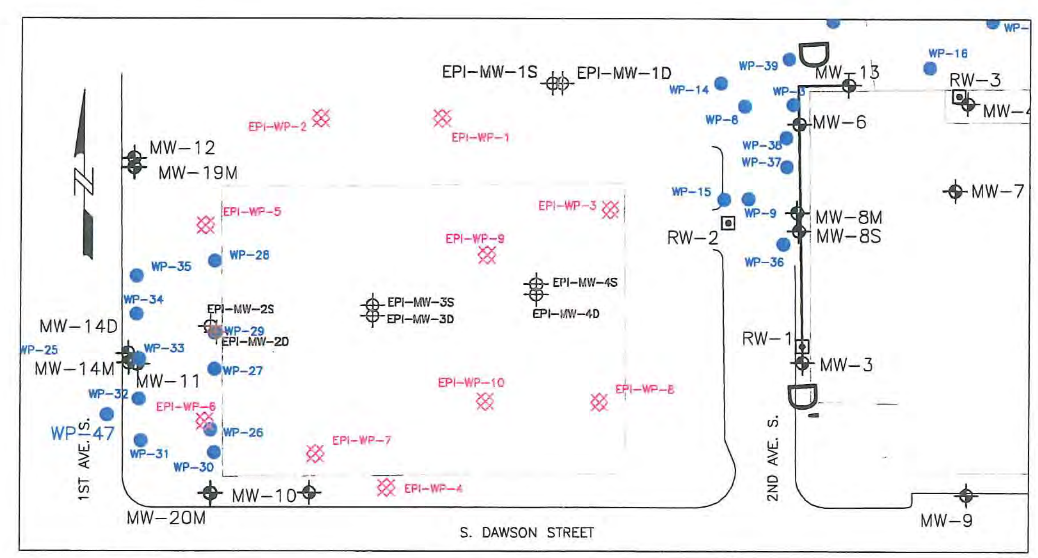
VERTICAL EXAGGERATION= 5:1

LEGEND

- GRAVEL or SANDY GRAVEL
- FINE TO MEDIUM GRAINED SAND
- SILTY SAND
- SILT or SANDY SILT
- ASPHALTIC CONCRETE
- HIGH GROUNDWATER TABLE
- LOW GROUNDWATER TABLE

NOTE:

THE HIGH WATER TABLE VALUE IS BASED ON THE FEBRUARY 2004 EVENT,
THE LOW WATER TABLE VALUE IS BASED ON THE AUGUST 2003 EVENT.



PLAN VIEW

60 0 120

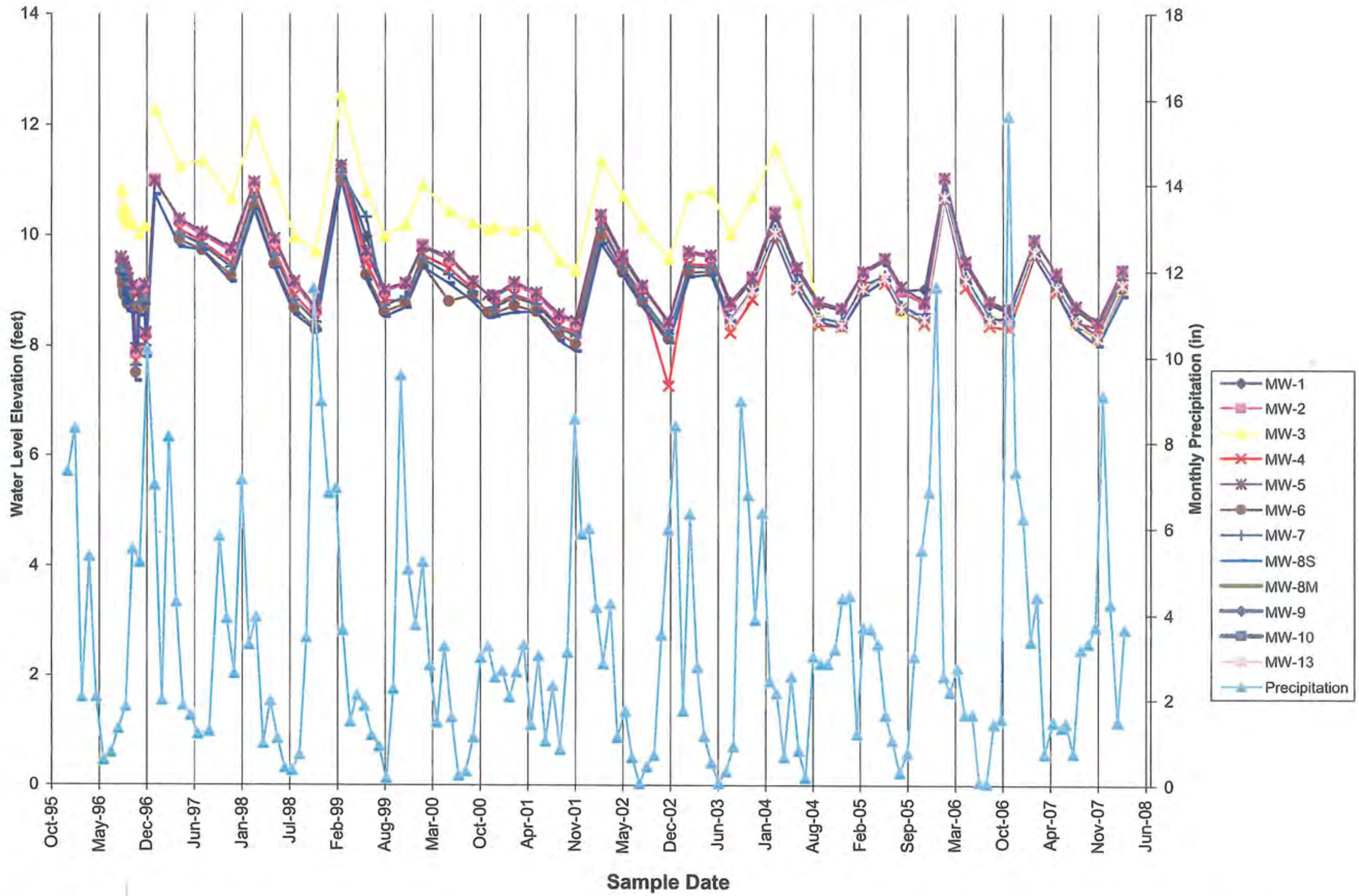
SCALE IN FEET

ENSR | AECOM

GE - S. DAWSON STREET 02978-415-735	STRATIGRAPHIC CROSS-SECTION D-D'
DATE: 06/09/08 DRWN: E.M./SEA	FIGURE 2-4

File: L:\GE-S.Dawson\18002G004.dwg Layout: FIG 2-4 User: emarshall Plotted: Jun 09, 2008 - 8:55am Xref's:

Figure 2-5 Site Hydrograph – On-Site Area Wells



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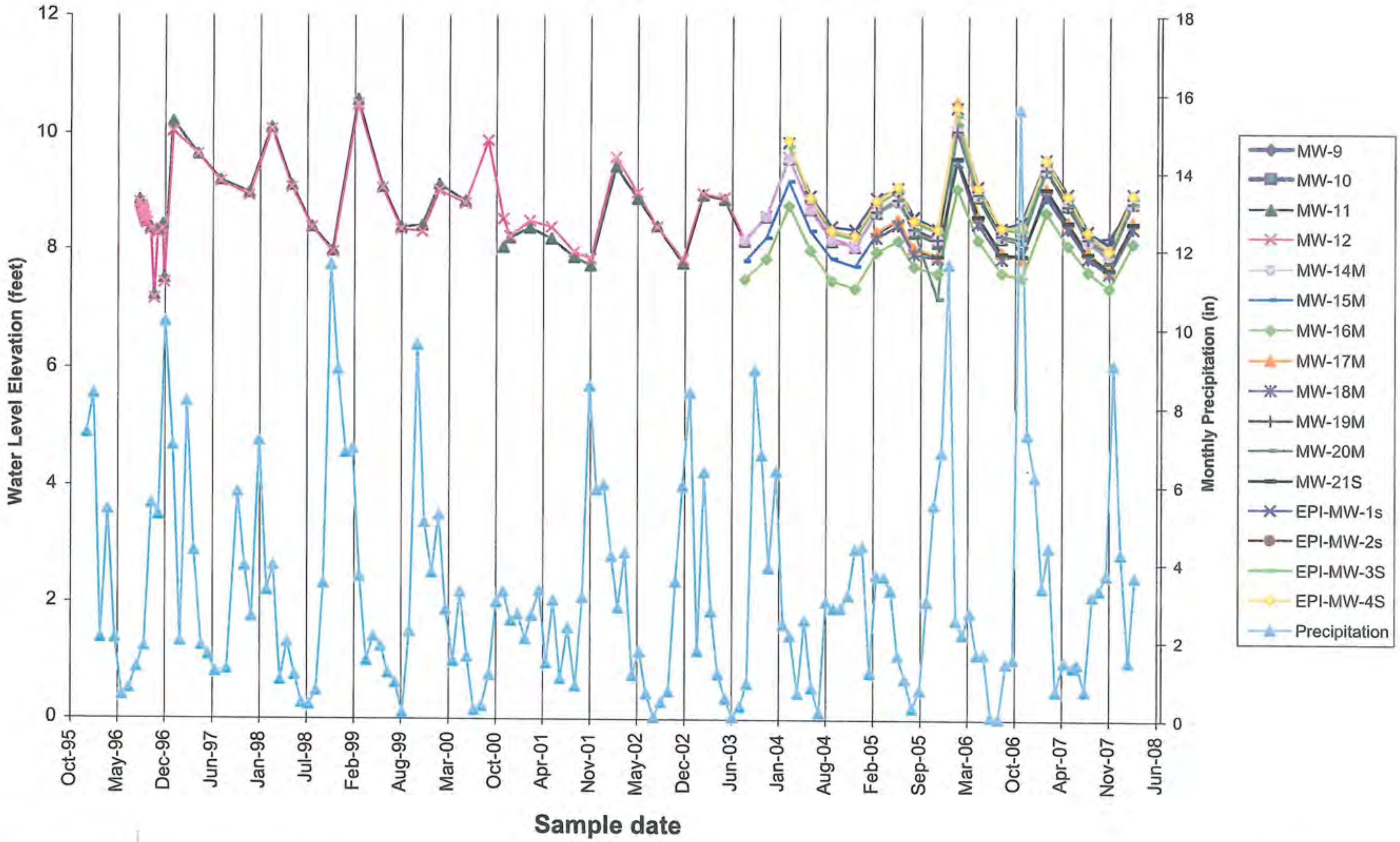
Notes: MW -11 August 2000 anomalous data point omitted. Deep wells are not shown.

Figure 2-6 Site Hydrograph – Off-Site Area Wells



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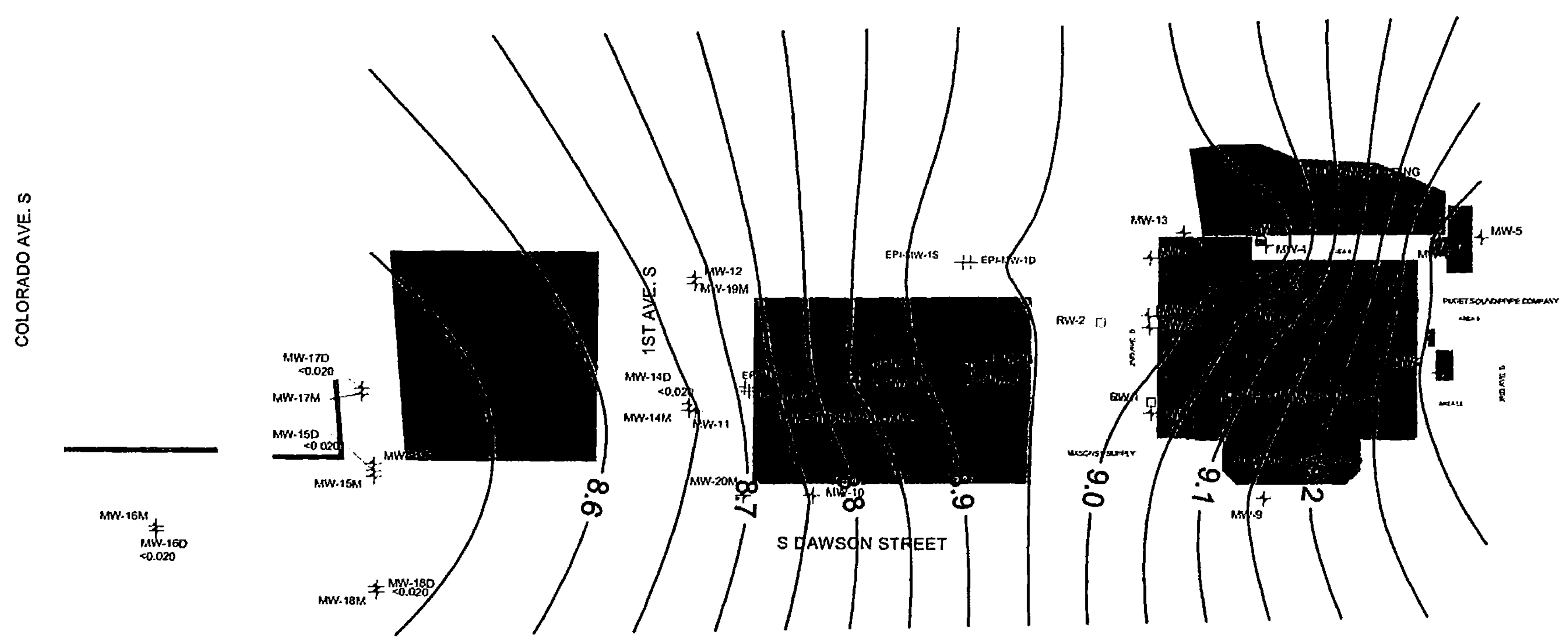
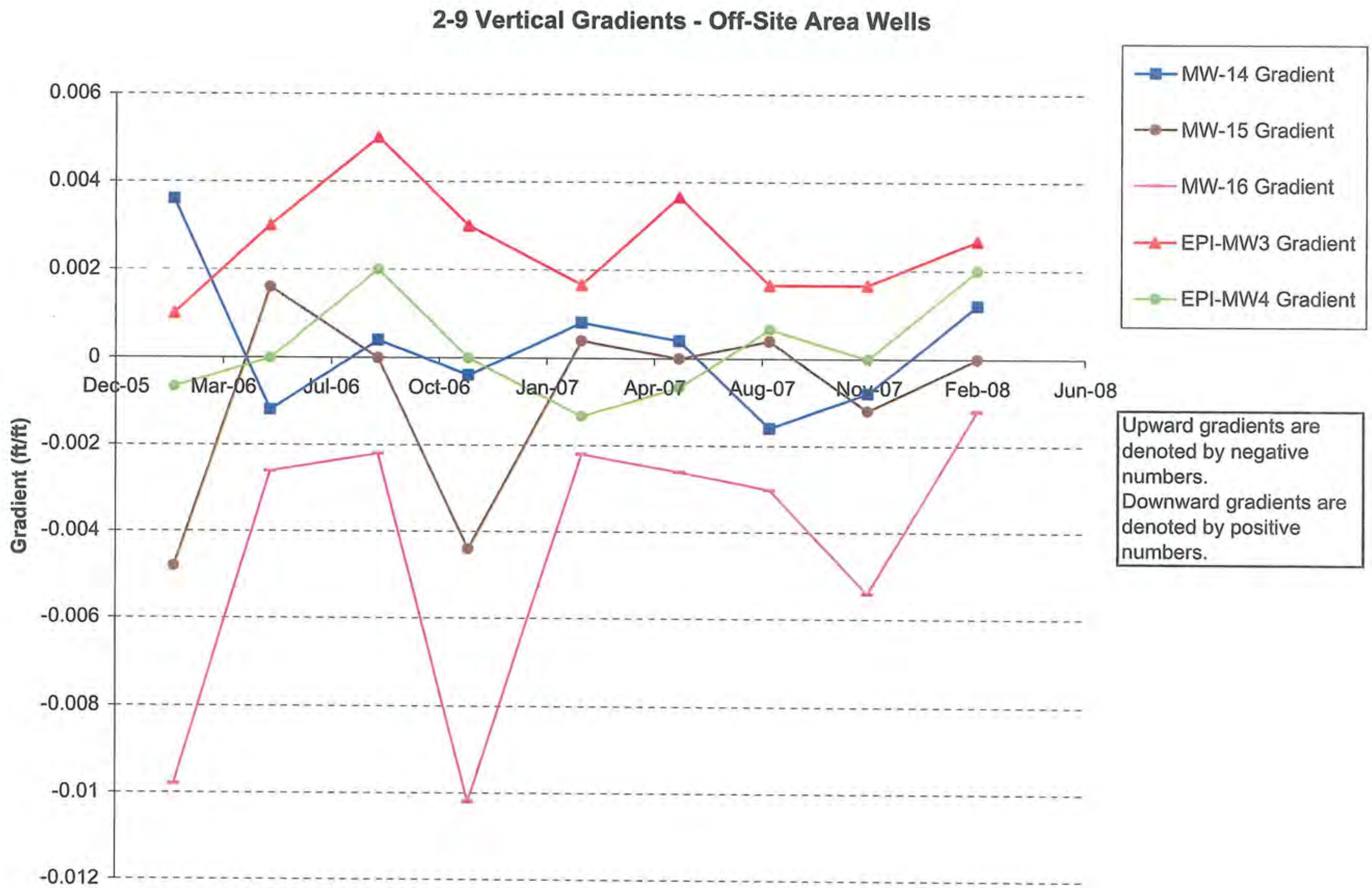
Notes: MW-11 August 2000 anomalous data point omitted. Deep wells are not shown

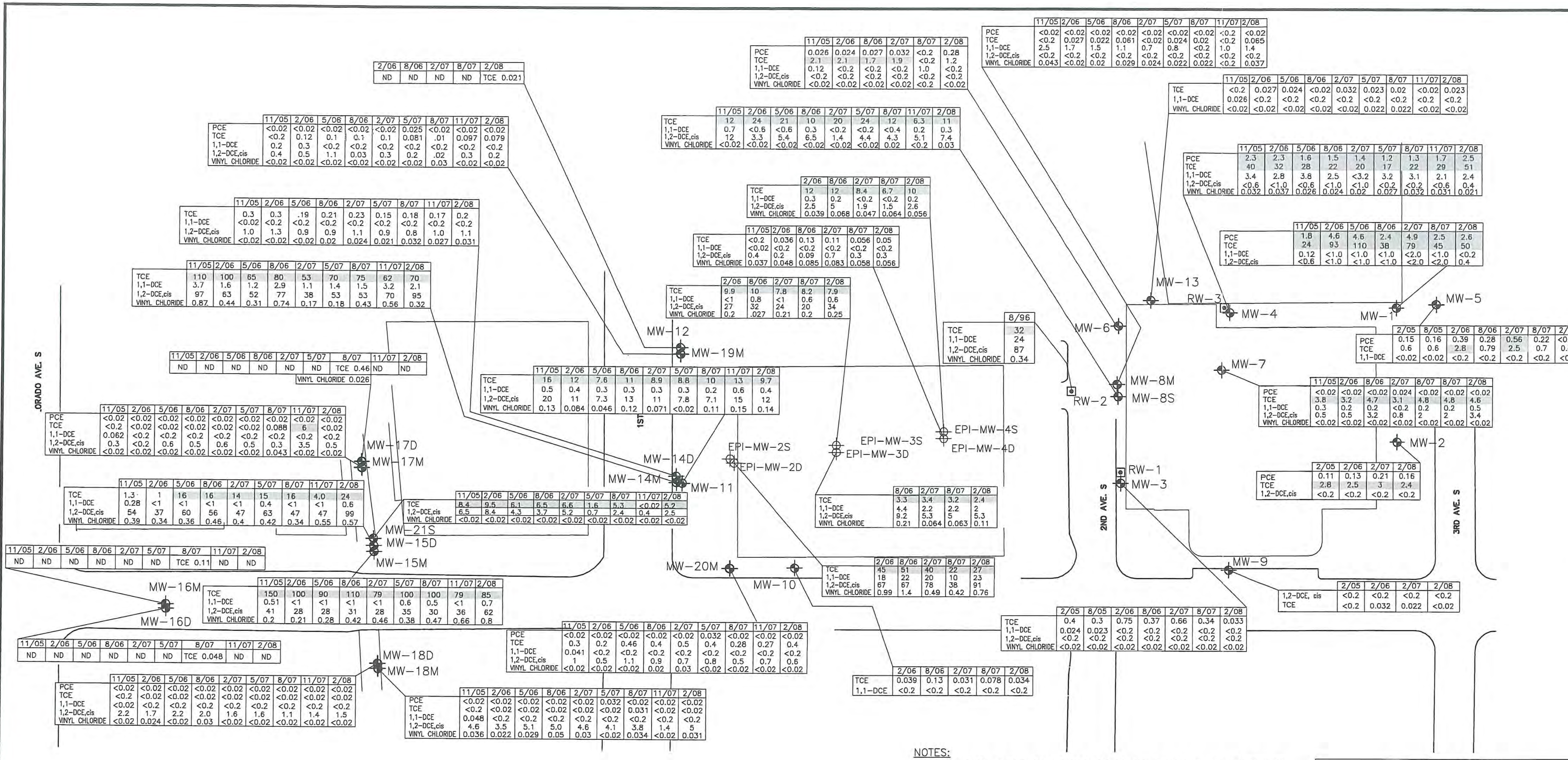
Figure 2-7 Shallow Groundwater Level Data Averaged from August 2003 to August 2006 (Elevation in MLLW)



2-8 Vertical Gradients - On-Site Area Wells



2-9 Vertical Gradients - Off-Site Area Wells
Gradient (ft/ft)
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
-0.012
Dec-05
Mar-06
Jul-06
Oct-06
Jan-07
Apr-07
Aug-07
Nov-07
Feb-08
Jun-08
MW-14 Gradient
MW-15 Gradient
MW-16 Gradient
EPI-MW3 Gradient
EPI-MW4 Gradient
Upward gradients are denoted by negative numbers.
Downward gradients are denoted by positive numbers.



2/06	8/06	2/07	8/07	2/08
ND	ND	ND	ND	TCE 0.021

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
PCE	<0.02	<0.02	<0.02	<0.02	<0.02	0.025	<0.02	<0.02	<0.02
TCE	<0.2	0.12	0.1	0.1	0.1	0.081	.01	0.097	0.079
1,1-DCE	0.2	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-DCE,cis	0.4	0.5	1.1	0.03	0.3	0.2	.02	0.3	0.2
VINYL CHLORIDE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
TCE	0.3	0.3	.19	0.21	0.23	0.15	0.18	0.17	0.2
1,1-DCE	<0.02	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-DCE,cis	1.0	1.3	0.9	0.9	1.1	0.9	0.8	1.0	1.1
VINYL CHLORIDE	<0.02	<0.02	<0.02	0.02	0.024	0.021	0.032	0.027	0.031

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
TCE	110	100	65	80	53	70	75	62	70
1,1-DCE	3.7	1.6	1.2	2.9	1.1	1.4	1.5	3.2	2.1
1,2-DCE,cis	97	63	52	77	38	53	53	70	95
VINYL CHLORIDE	0.87	0.44	0.31	0.74	0.17	0.18	0.43	0.56	0.32

	11/05	2/06	8/06	2/07	8/07	2/08
PCE	0.026	0.024	0.027	0.032	<0.2	0.28
TCE	2.1	2.1	1.7	1.9	<0.2	1.2
1,1-DCE	0.12	<0.2	<0.2	<0.2	1.0	<0.2
1,2-DCE,cis	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
VINYL CHLORIDE	<0.02	<0.02	<0.02	<0.02	<0.2	<0.02

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
TCE	12	24	21	10	20	24	12	6.3	11
1,1-DCE	0.7	<0.6	<0.6	0.3	<0.2	<0.2	<0.4	0.2	0.3
1,2-DCE,cis	12	3.3	5.4	6.5	1.4	4.4	4.3	5.1	7.4
VINYL CHLORIDE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.2	0.03

	2/06	8/06	2/07	8/07	2/08
TCE	12	12	8.4	6.7	10
1,1-DCE	0.3	0.2	<0.2	<0.2	0.2
1,2-DCE,cis	2.5	5	1.9	1.5	2.6
VINYL CHLORIDE	0.039	0.068	0.047	0.064	0.056

	11/05	2/06	8/06	2/07	8/07	2/08
TCE	<0.2	0.036	0.13	0.11	0.056	0.05
1,1-DCE	<0.02	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-DCE,cis	0.4	0.2	0.09	0.7	0.3	0.3
VINYL CHLORIDE	0.037	0.048	0.085	0.083	0.058	0.056

	2/06	8/06	2/07	8/07	2/08
TCE	9.9	10	7.8	8.2	7.9
1,1-DCE	<1	0.8	<1	0.6	0.6
1,2-DCE,cis	27	32	24	20	34
VINYL CHLORIDE	0.2	.027	0.21	0.2	0.25

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
PCE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.2	<0.02
TCE	<0.2	0.027	0.022	0.061	<0.02	0.024	0.02	<0.2	0.065
1,1-DCE	2.5	1.7	1.5	1.1	0.7	0.8	<0.2	1.0	1.4
1,2-DCE,cis	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
VINYL CHLORIDE	0.043	<0.02	0.02	0.029	0.024	0.022	0.022	<0.2	0.037

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
TCE	<0.2	0.027	0.024	<0.02	0.032	0.023	0.02	<0.02	0.023
1,1-DCE	0.026	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
VINYL CHLORIDE	<0.02	<0.02	<0.02	<0.02	<0.02	0.022	0.022	<0.02	<0.02

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
PCE	2.3	2.3	1.6	1.5	1.4	1.2	1.3	1.7	2.5
TCE	40	32	28	22	20	17	22	29	51
1,1-DCE	3.4	2.8	3.8	2.5	<3.2	3.2	3.1	2.1	2.4
1,2-DCE,cis	<0.6	<1.0	<0.6	<1.0	<1.0	<0.2	<0.2	<0.6	0.4
VINYL CHLORIDE	0.032	0.037	0.026	0.024	0.02	0.027	0.032	0.031	0.021

	11/05	2/06	5/06	8/06	2/07	8/07	2/08
PCE	1.8	4.6	4.6	2.4	4.9	2.5	2.6
TCE	24	93	110	38	79	45	50
1,1-DCE	0.12	<1.0	<1.0	<1.0	<2.0	<1.0	<0.2
1,2-DCE,cis	<0.6	<1.0	<1.0	<1.0	<2.0	<2.0	0.4

	8/96
TCE	32
1,1-DCE	24
1,2-DCE,cis	87
VINYL CHLORIDE	0.34

	2/05	8/05	2/06	8/06	2/07	8/07	2/08
PCE	0.15	0.16	0.39	0.28	0.56	0.22	<0.02
TCE	0.6	0.6	2.8	0.79	2.5	0.7	0.41
1,1-DCE	<0.02	<0.02	<0.2	<0.2	<0.2	<0.2	<0.2

11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
ND	ND	ND	ND	ND	ND	TCE 0.46 VINYL CHLORIDE 0.026	ND	ND

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
TCE	16	12	7.6	11	8.9	8.8	10	13	9.7
1,1-DCE	0.5	0.4	0.3	0.3	0.3	0.3	0.2	0.6	0.4
1,2-DCE,cis	20	11	7.3	13	11	7.8	7.1	15	12
VINYL CHLORIDE	0.13	0.084	0.046	0.12	0.071	<0.02	0.11	0.15	0.14

	11/05	2/06	8/06	2/07	8/07	8/07	2/08
PCE	<0.02	<0.02	<0.02	0.024	<0.02	<0.02	<0.02
TCE	3.8	3.2	4.7	3.1	4.8	4.8	4.6
1,1-DCE	0.3	0.2	0.2	<0.2	0.2	0.2	0.5
1,2-DCE,cis	0.5	0.5	3.2	0.8	2	2	3.4
VINYL CHLORIDE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
PCE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
TCE	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	0.088	6	<0.02
1,1-DCE	0.062	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-DCE,cis	0.3	<0.2	0.6	0.5	0.6	0.5	0.3	3.5	0.5
VINYL CHLORIDE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.043	<0.02	<0.02

	2/05	2/06	2/07	2/08
PCE	0.11	0.13	0.21	0.16
TCE	2.8	2.5	3	2.4
1,2-DCE,cis	<0.2	<0.2	<0.2	<0.2

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
TCE	1.3	1	16	16	14	15	16	4.0	24
1,1-DCE	0.28	<1	<1	<1	<1	0.4	<1	<1	0.6
1,2-DCE,cis	54	37	60	56	47	63	47	47	99
VINYL CHLORIDE	0.39	0.34	0.36	0.46	0.4	0.42	0.34	0.55	0.57

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
TCE	8.4	9.5	6.1	6.5	6.6	1.6	5.3	<0.02	5.2
1,2-DCE,cis	6.5	8.4	4.3	3.7	5.2	0.7	2.4	0.4	2.5
VINYL CHLORIDE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

	8/06	2/07	8/07	2/08
TCE	3.3	3.4	3.2	2.4
1,1-DCE	4.4	2.2	2.2	2
1,2-DCE,cis	9.2	5.3	5	5.3
VINYL CHLORIDE	0.21	0.064	0.063	0.11

11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
ND	ND	ND	ND	ND	ND	TCE 0.11	ND	ND

	2/06	8/06	2/07	8/07	2/08
TCE	45	51	40	22	27
1,1-DCE	18	22	20	10	23
1,2-DCE,cis	67	67	78	38	91
VINYL CHLORIDE	0.99	1.4	0.49	0.42	0.76

	2/05	2/06	2/07	2/08
1,2-DCE, cis	<0.2	<0.2	<0.2	<0.2
TCE	<0.2	0.032	0.022	<0.02

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
TCE	150	100	90	110	79	100	100	79	85
1,1-DCE	0.51	<1	<1	<1	<1	0.6	0.5	<1	0.7
1,2-DCE,cis	41	28	28	31	28	35	30	36	62
VINYL CHLORIDE	0.2	0.21	0.28	0.42	0.46	0.38	0.47	0.66	0.8

	2/05	8/05	2/06	8/06	2/07	8/07	2/08
TCE	0.4	0.3	0.75	0.37	0.66	0.34	0.033
1,1-DCE	0.024	0.023	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-DCE,cis	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
VINYL CHLORIDE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
ND	ND	ND	ND	ND	ND	TCE 0.048	ND	ND

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
PCE	<0.02	<0.02	<0.02	<0.02	<0.02	0.032	<0.02	<0.02	<0.02
TCE	0.3	0.2	0.46	0.4	0.5	0.4	0.28	0.27	0.4
1,1-DCE	0.041	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-DCE,cis	1	0.5	1.1	0.9	0.7	0.8	0.5	0.7	0.6
VINYL CHLORIDE	<0.02	<0.02	<0.02	0.02	0.03	<0.02	<0.02	<0.02	<0.02

	2/06	8/06	2/07	8/07	2/08
TCE	0.039	0.13	0.031	0.078	0.034
1,1-DCE	<0.2	<0.2	<0.2	<0.2	<0.2

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
PCE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
TCE	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-DCE	<0.02	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-DCE,cis	2.2	1.7	2.2	2.0	1.6	1.6	1.1	1.4	1.5
VINYL CHLORIDE	<0.02	0.024	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02

	11/05	2/06	5/06	8/06	2/07	5/07	8/07	11/07	2/08
PCE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
TCE	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	0.031	<0.02	<0.02
1,1-DCE	0.048	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-DCE,cis	4.6	3.5	5.1	5.0	4.6	4.1	3.8	1.4	5
VINYL CHLORIDE	0.036	0.022	0.029	0.05	0.03	<0.02	0.034	<0.02	0.031

NOTES:

1. 8/96 DATA WERE COLLECTED PRIOR TO INITIATION OF RECOVERY. THE REMAINING DATA WERE COLLECTED DURING SYSTEM OPERATION.
2. FROM 9/96 TO 8/03 THE GROUNDWATER RECOVERY SYSTEM CONSISTED OF PUMPING WELLS RW-1 AND RW-2. IN 8/03, THE SYSTEM WAS MODIFIED. RW-1 WAS SHUT DOWN AND PUMPING BEGAN AT RW-3.
3. WHERE PCE, TCE, 1,1-DCE, 1,2-DCE (CIS) OR VINYL CHLORIDE HAVE CONSISTENTLY NOT BEEN DETECTED, THESE COMPOUNDS ARE NOT INCLUDED ON INSET TABLES.
4. RW-2 HAS NOT BEEN SAMPLED SINCE 8/96.
5. TCE METHOD B SURFACE WATER CLEANUP VALUE WAS LOWERED FROM 55.6μg/L TO 1.5μg/L. THIS FIGURE HAS BEEN UPDATED TO REFLECT THE LOWER TCE CLEANUP VALUE.

LEGEND

(symbol)	EXISTING WELL
(symbol)	GROUNDWATER EXTRACTION WELL
12	ANALYTICAL RESULTS, μg/L
J	ESTIMATED CONCENTRATION
ND	NO COMPOUNDS DETECTED
(shading)	CONCENTRATION EXCEEDS MTCA METHOD B SURFACE WATER CLEANUP LEVEL

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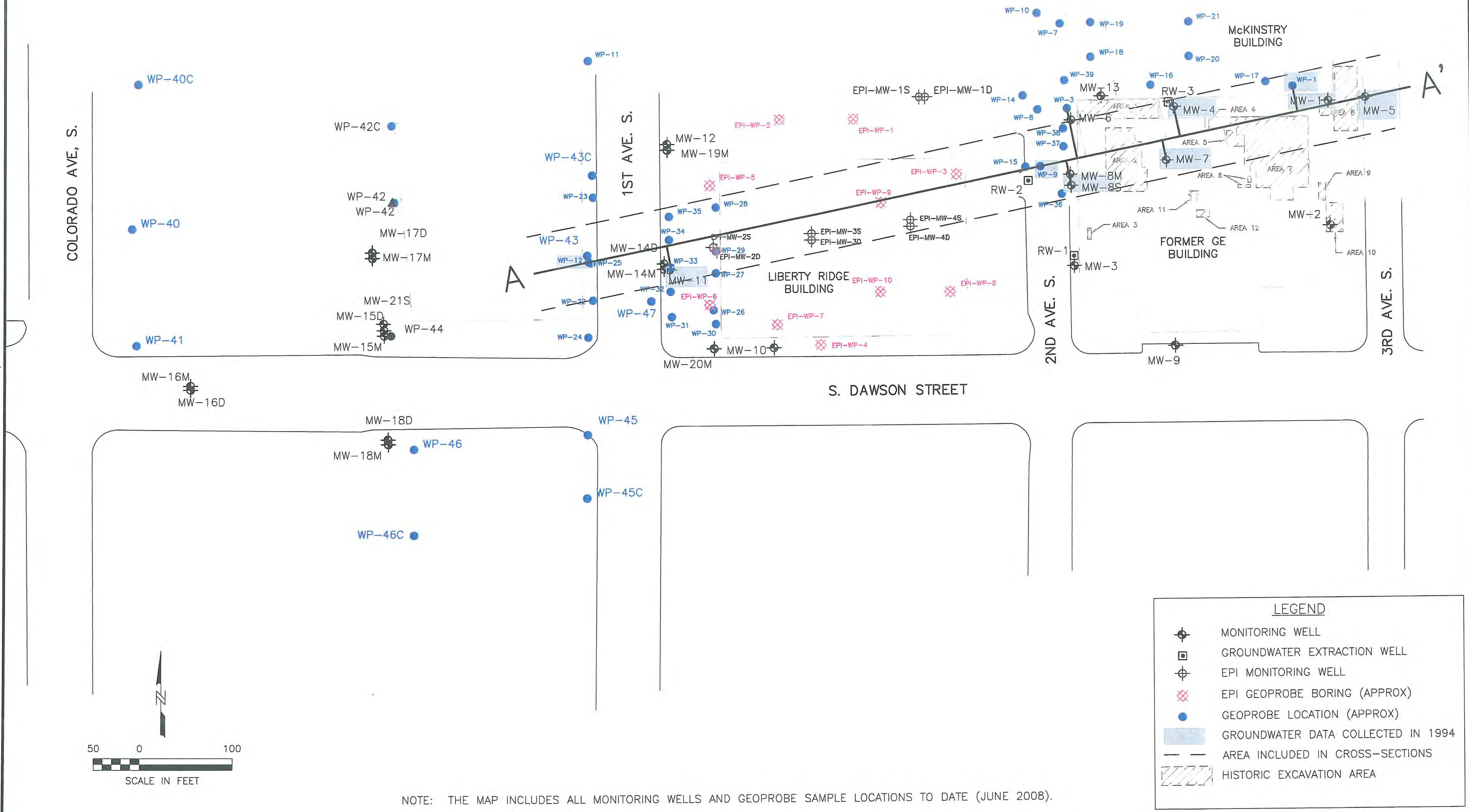
GE - S. DAWSON STREET

02978-415

VOC CONCENTRATIONS IN GROUNDWATER FOLLOWING SYSTEM STARTUP

DATE: 03/25/08 DRWN: E.M./SEA

FIGURE 2-10



NOTE: THE MAP INCLUDES ALL MONITORING WELLS AND GEOPROBE SAMPLE LOCATIONS TO DATE (JUNE 2008).

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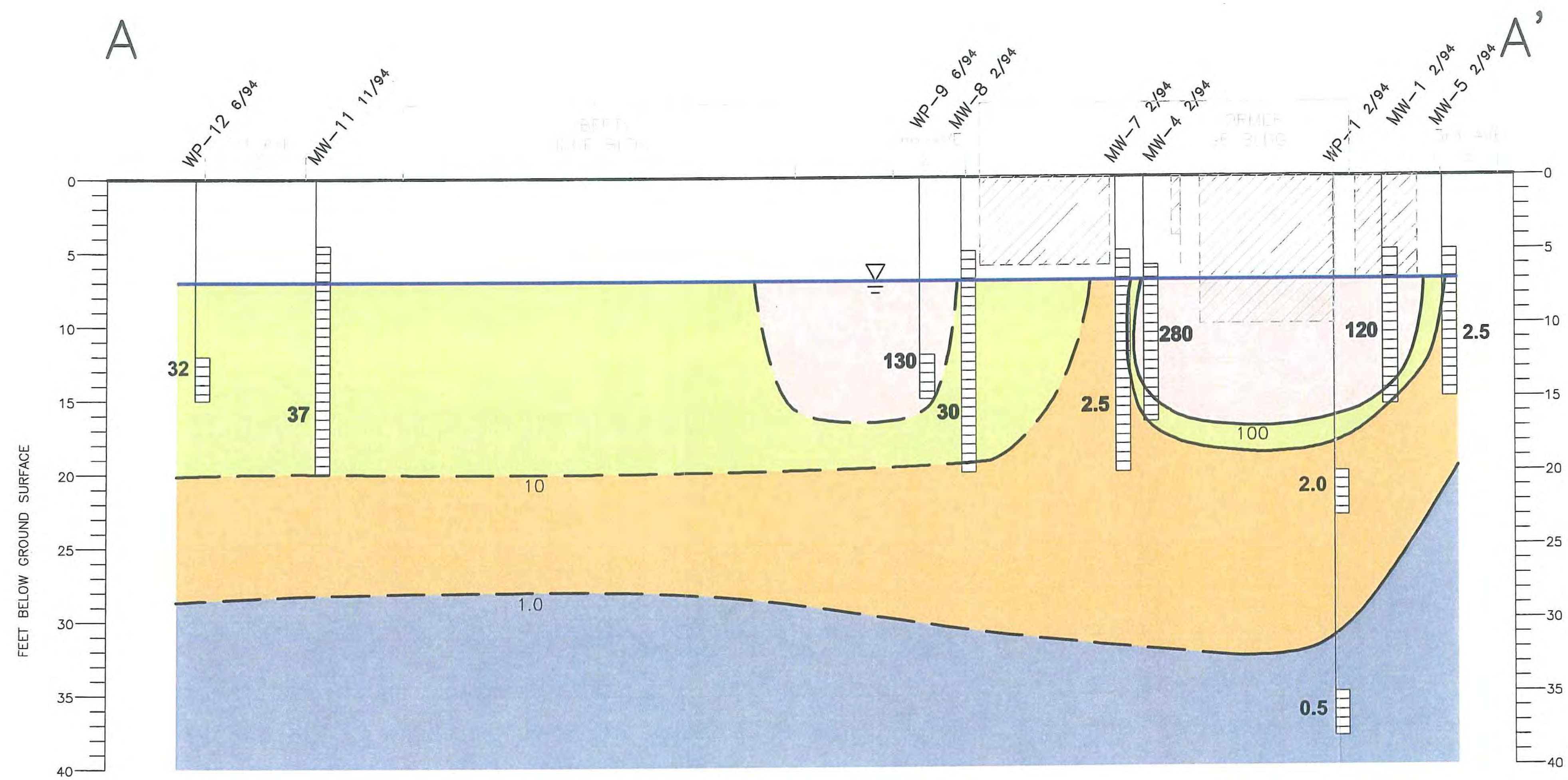
GE - S. DAWSON STREET 02978-415-735	1994 CROSS SECTION LOCATION MAP
DATE: 06/06/08 DRWN: E.M./SEA	FIGURE 2-11

File: L:\GE-S.Dawson\02978_1994-x-sect.dwg Layout: FIGURE 2-11 User: emarshall Plotted: Jun 12, 2008 - 3:17pm Xref's:



NOTES:

FOR RESULTS BELOW THE LAB DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

SAMPLE DEPTH FOR ALL WELLS ARE TOP OF SCREEN – BOTTOM OF WELL.

WATER TABLE ELEVATION BASED ON JAN. 1997 GAUGING EVENT. NO GAUGING DATA AVAILABLE FROM FEB. 1994.

TCE CONCENTRATION (ug/L)

- <1
- 1–10
- 10–100
- >100

LEGEND

- WELL SCREEN
- **2.5** CONCENTRATION (ug/L)
- MW-1 2/94 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100

HORIZONTAL SCALE IN FEET

VERTICAL EXAGGERATION 1:10

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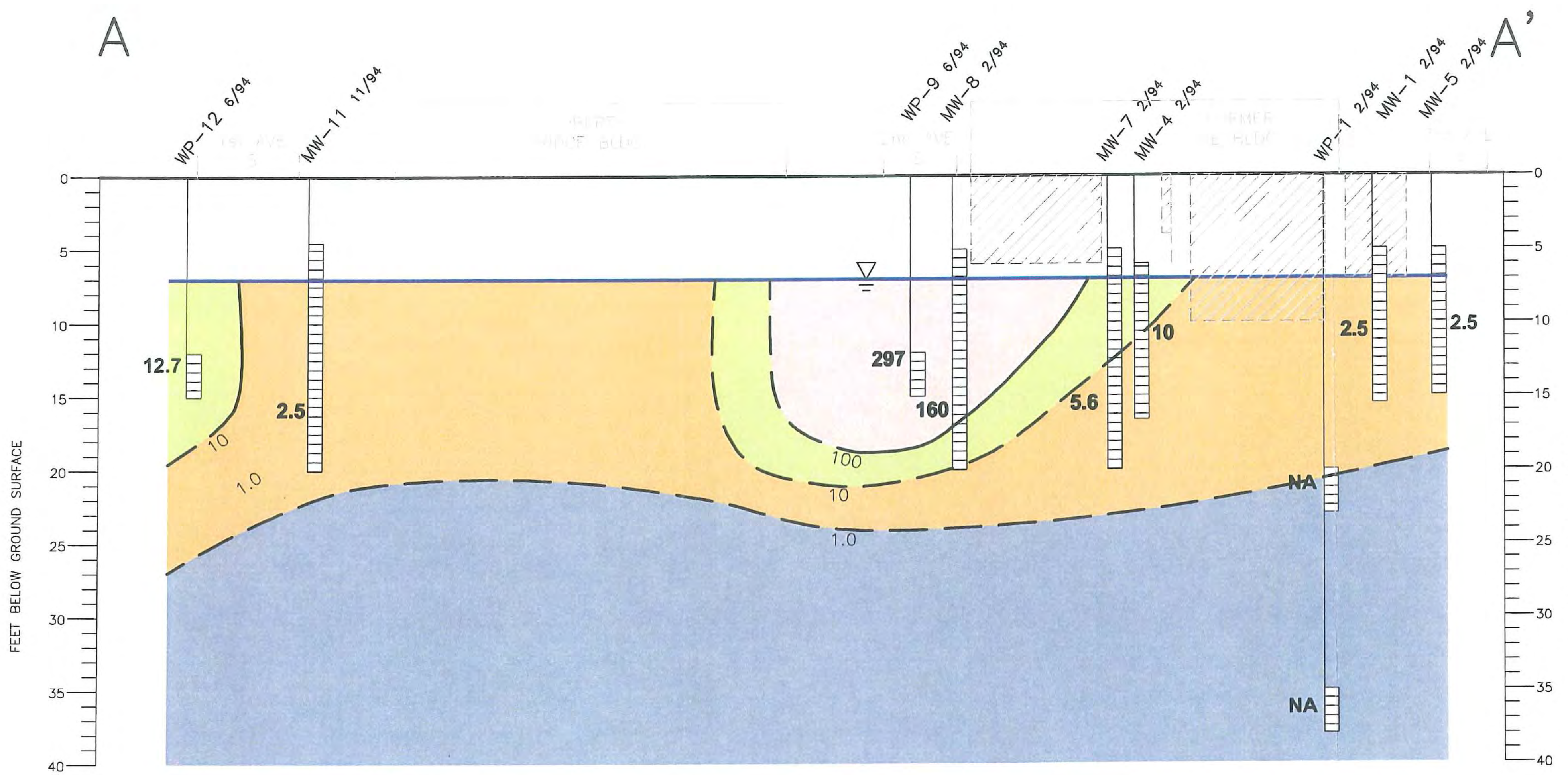
GE - S. DAWSON STREET 02978-415-735	1994 CROSS SECTION TRICHLOROETHENE
DATE: 06/06/08 DRWN: E.M./SEA	FIGURE 2-12

File: L:\GE-S.Dawson\02978_1994-x-sect.dwg Layout: FIGURE 2-12 User: emarshall Plotted: Jun 09, 2008 - 8:56am Xref's:



NOTES:

FOR RESULTS BELOW THE LAB DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

SAMPLE DEPTH FOR ALL WELLS ARE TOP OF SCREEN – BOTTOM OF WELL.

WATER TABLE ELEVATION BASED ON JAN. 1997 GAUGING EVENT. NO GAUGING DATA AVAILABLE FROM FEB. 1994.

NA – CIS 1,2-DCE WAS NOT ANALYZED IN THIS ROUND OF SAMPLING.

CIS 1,2-DICHLOROETHANE CONCENTRATION (ug/L)

- <1
- 1–10
- 10–100
- >100

LEGEND

- WELL SCREEN
- **2.5** CONCENTRATION (ug/L)
- MW-1 2/94 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

ENSR | AECOM

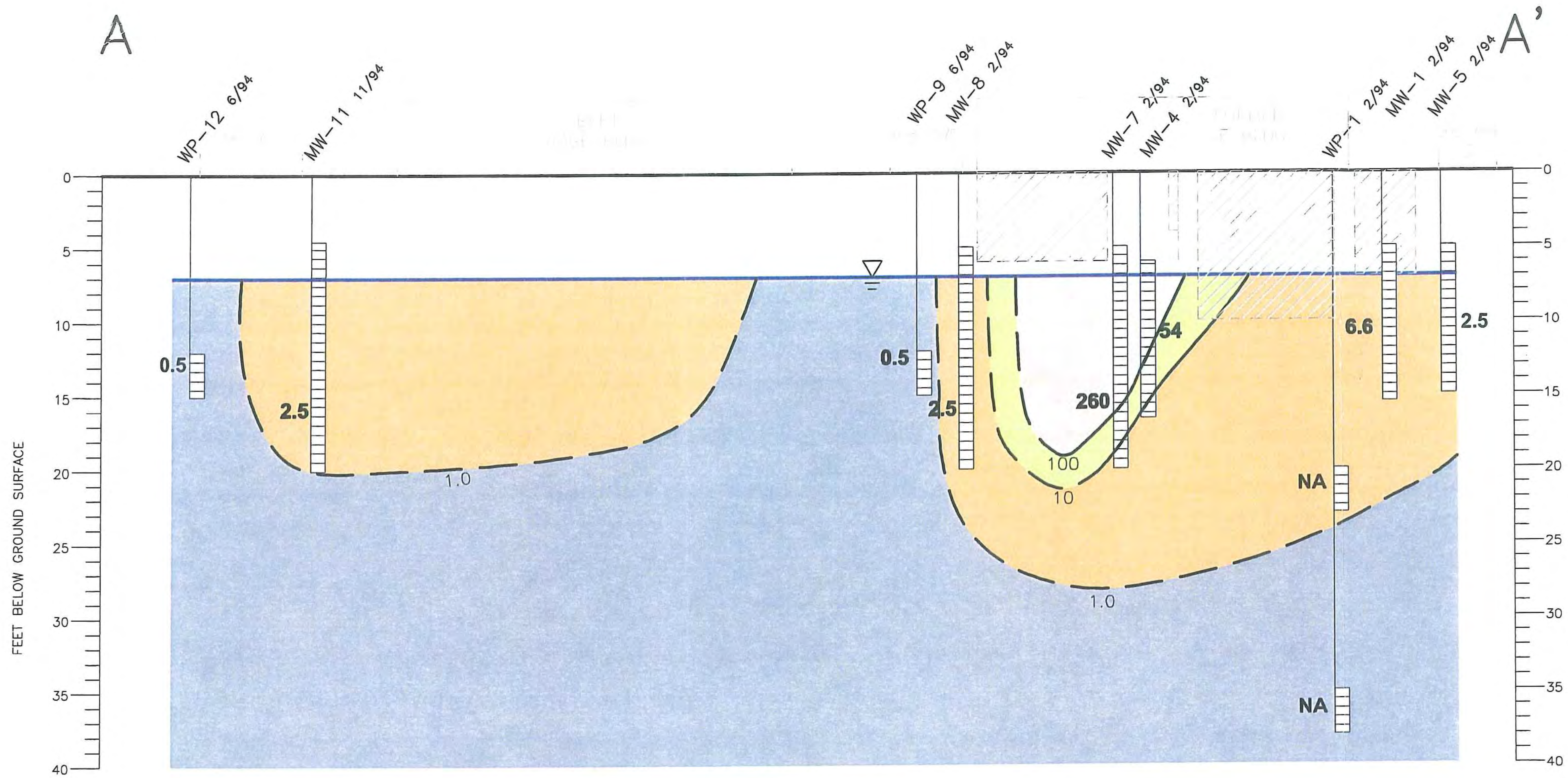
GE - S. DAWSON STREET
02978-415-735

DATE: 06/06/08 DRWN: E.M./SEA

1994 CROSS SECTION CIS 1,2-DICHLOROETHENE

FIGURE 2-13

File: L:\GE-S.Dawson\02978_1994-x-sect.dwg Layout: FIGURE 2-13 User: emarshall Plotted: Jun 12, 2008 – 3:18pm Xref's:



NOTES:

FOR RESULTS BELOW THE LAB DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

SAMPLE DEPTH FOR ALL WELLS ARE TOP OF SCREEN – BOTTOM OF WELL.

WATER TABLE ELEVATION BASED ON JAN. 1997 GAUGING EVENT. NO GAUGING DATA AVAILABLE FROM FEB. 1994.

NA – 1,1 DICHLOROETHANE WAS NOT ANALYZED FOR IN THIS ROUND OF SAMPLING.

1,1-DICHLOROETHANE CONCENTRATION (ug/L)

- <1
- 1–10
- 10–100
- >100

LEGEND

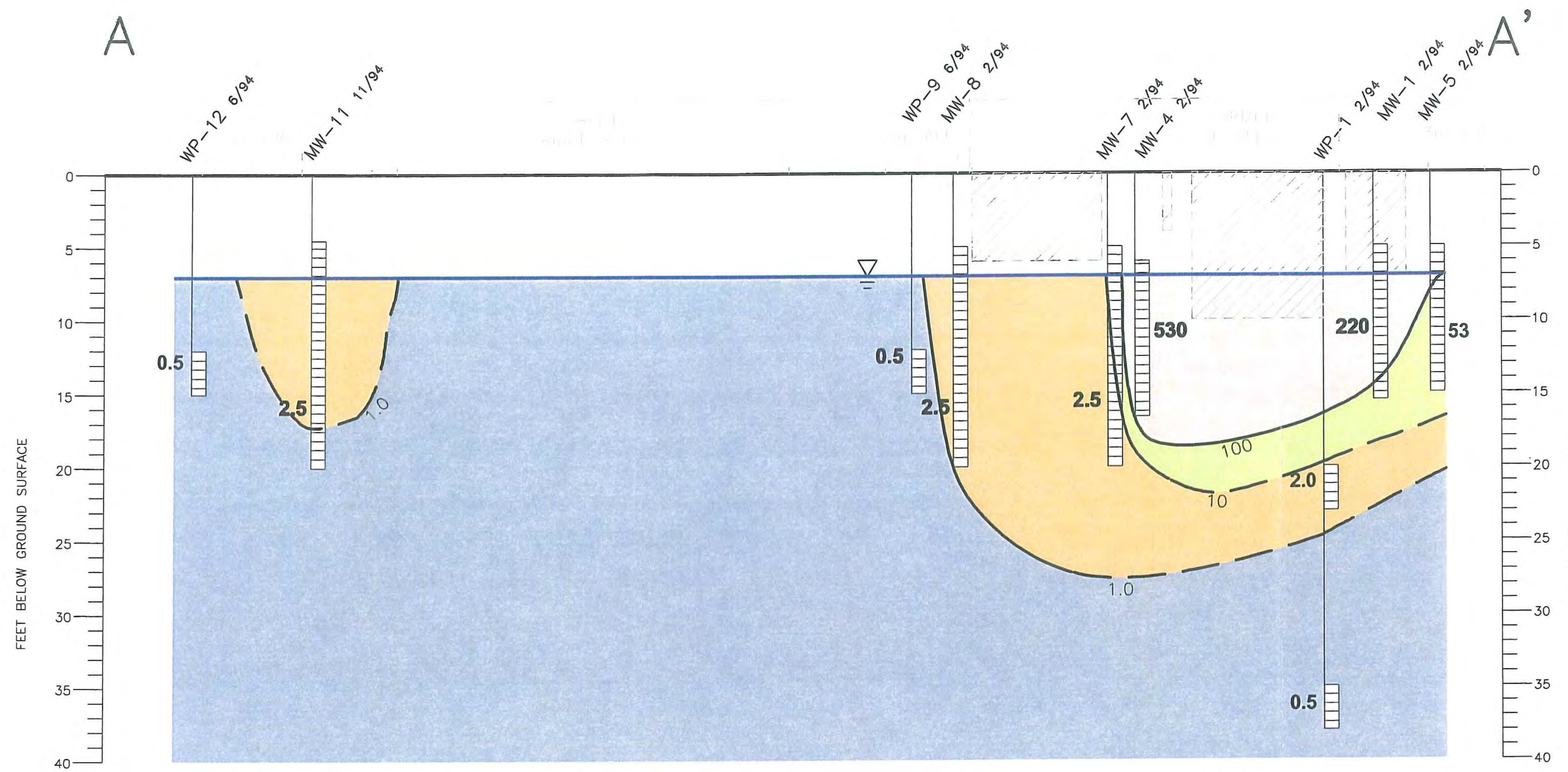
- WELL SCREEN
- 2.5 CONCENTRATION (ug/L)
- MW-1 2/94 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET 02978-415-735	1994 CROSS SECTION 1,1-DICHLOROETHENE
DATE: 06/06/08 DRWN: E.M./SEA	FIGURE 2-14

File: L:\GE-S.Dawson\02978_1994-x-sect.dwg Layout: FIGURE 2-14 User: emarshall Plotted: Jun 09, 2008 - 8:58am Xref's:



NOTES:

FOR RESULTS BELOW THE LAB DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

SAMPLE DEPTH FOR ALL WELLS ARE TOP OF SCREEN – BOTTOM OF WELL.

WATER TABLE ELEVATION BASED ON JAN. 1997 GAUGING EVENT. NO GAUGING DATA AVAILABLE FROM FEB. 1994.

1,1,1-TRICHLORETHANE CONCENTRATION (ug/L)

- <1
- 1–10
- 10–100
- >100

LEGEND

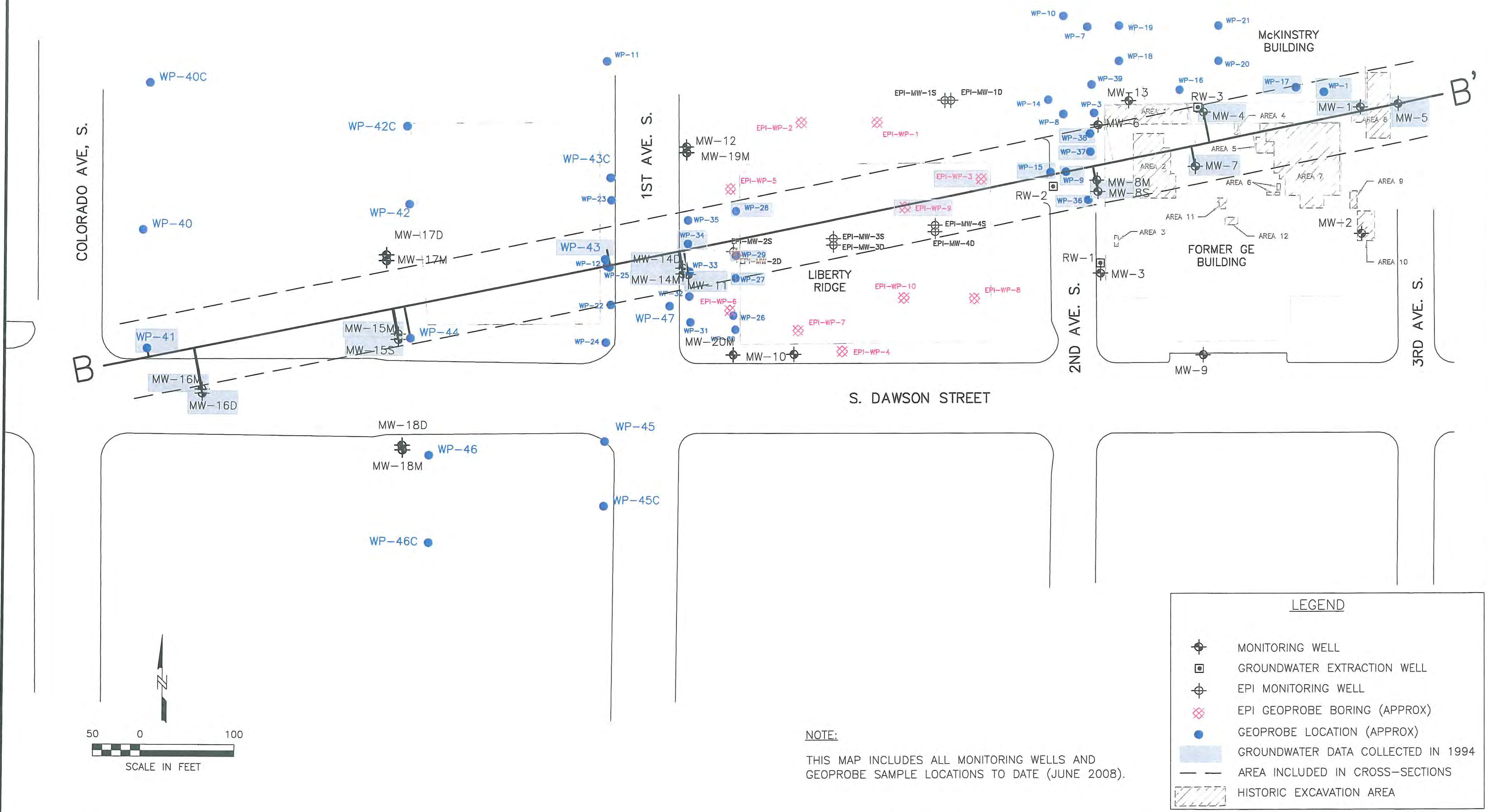
- WELL SCREEN
- 2.5 CONCENTRATION (ug/L)
- MW-1 2/94 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET 02978-415-735	1994 CROSS SECTION 1,1,1-TRICHLOROETHANE
DATE: 06/06/08 DRWN: E.M./SEA	FIGURE 2-15

File: L:\GE-S.Dawson\02978_1994-x-sect.dwg Layout: FIGURE 2-15 User: emarshall Plotted: Jun 09, 2008 - 8:59am Xref's:



NOTE:

THIS MAP INCLUDES ALL MONITORING WELLS AND GEOPROBE SAMPLE LOCATIONS TO DATE (JUNE 2008).

ENSR | AECOM

GE - S. DAWSON STREET

02978-415-735

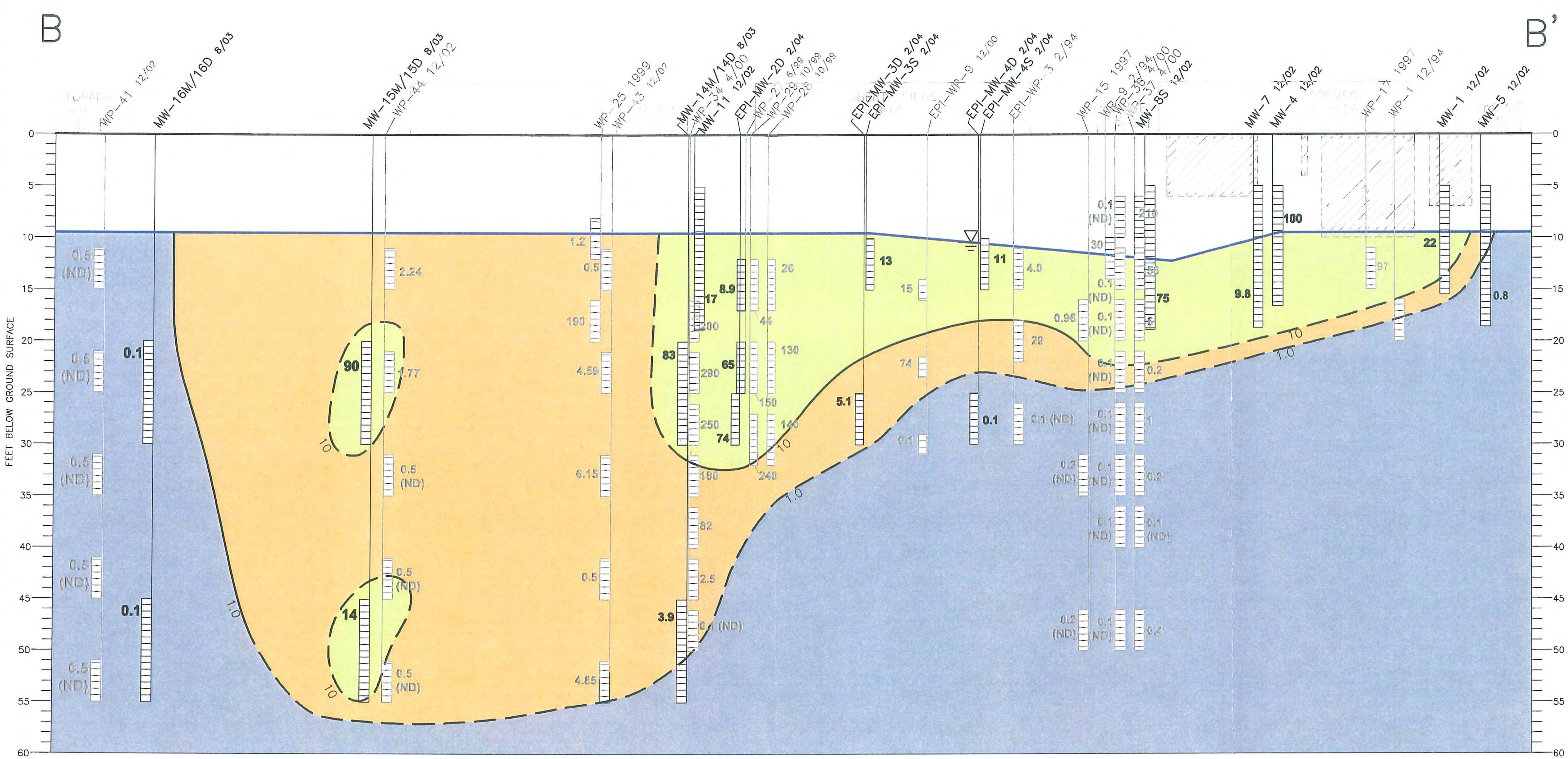
DATE: 6/8/08

DRWN: E.M./SEA

2002-2003 CROSS SECTION LOCATION MAP

FIGURE 2-16

File: L:\GE-S.Dawson\02978_x003 (2002-03).dwg Layout: FIGURE 2-16 User: emarshall Plotted: Jun 12, 2008 - 9:45am Xref's:



File: L:\GE-S.Dawson\02978_x003 (2002-03).dwg Layout: FIGURE 2-17 User: MarshallE Plotted: Oct 13, 2008 - 1:19pm Xref's:

NOTES:

FOR RESULTS BELOW THE LAB DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON DEC. 2002 GUAGING EVENT.

DATA USED FOR MW-14M/14D, MW-15M/15D, MW-16M/16D IS FROM AUG. 2003, THIS WAS THE FIRST GROUNDWATER SAMPLING EVENT IN THESE WELLS.

TCE CONCENTRATION (ug/L)

- <1
- 1-10
- 10-100
- >100

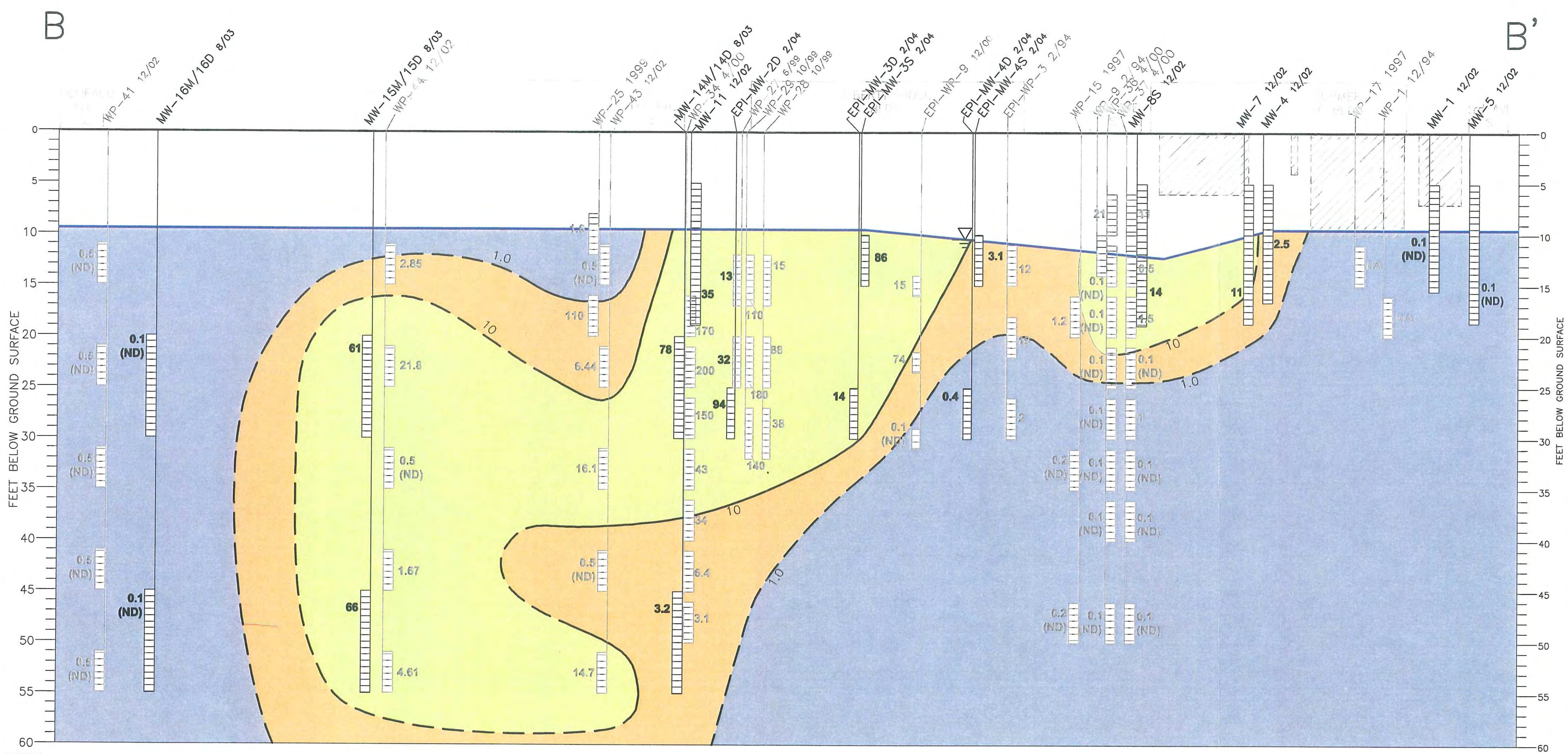
LEGEND

- WELL SCREEN
- **2.5** CONCENTRATION (ug/L)
- MW-1 2/08 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET 02978-415-735	2002-2003 CROSS SECTION TRICHLOROETHENE
DATE: 6/9/08 DRWN: E.M./SEA	FIGURE 2-17



NOTES:

FOR RESULTS BELOW THE LAB DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON DEC. 2002 GUAGING EVENT.

DATA USED FOR MW-14M/14D, MW-15M/15D, MW-16M/16D IS FROM AUG. 2003, THIS WAS THE FIRST GROUNDWATER SAMPLING EVENT IN THESE WELLS.

1,2-DICHLOROETHANE CONCENTRATION (ug/L)

- <1
- 1–10
- 10–100
- >100

LEGEND

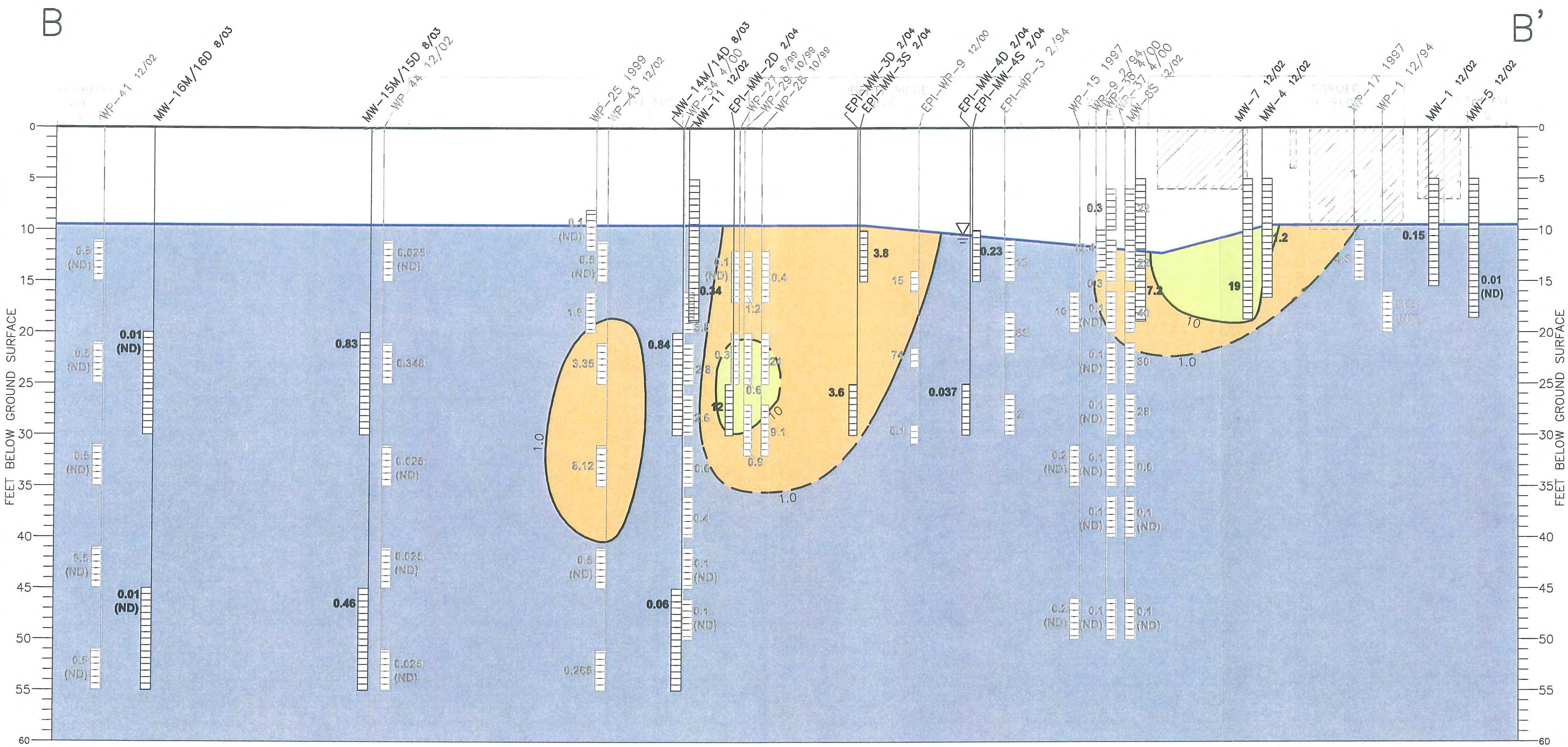
- WELL SCREEN
- **2.5** CONCENTRATION (ug/L)
- MW-1 2/08 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET 02978-415-735	2002-2003 CROSS SECTION CIS 1,2-DICHLOROETHENE
DATE: 6/9/08 DRWN: E.M./SEA	FIGURE 2-18

File: L:\GE-S.Dawson\02978_x003 (2002-03).dwg Layout: FIGURE 2-18 User: emarshall Plotted: Jun 12, 2008 - 9:55am Xref's:



NOTES:

FOR RESULTS BELOW THE LAB DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON DEC. 2002 GUAGING EVENT.

DATA USED FOR MW-14M/14D, MW-15M/15D, MW-16M/16D IS FROM AUG. 2003, THIS WAS THE FIRST GROUNDWATER SAMPLING EVENT IN THESE WELLS.

1,1-DICHLOROETHANE CONCENTRATION (ug/L)

- <1
- 1-10
- 10-100
- >100

LEGEND

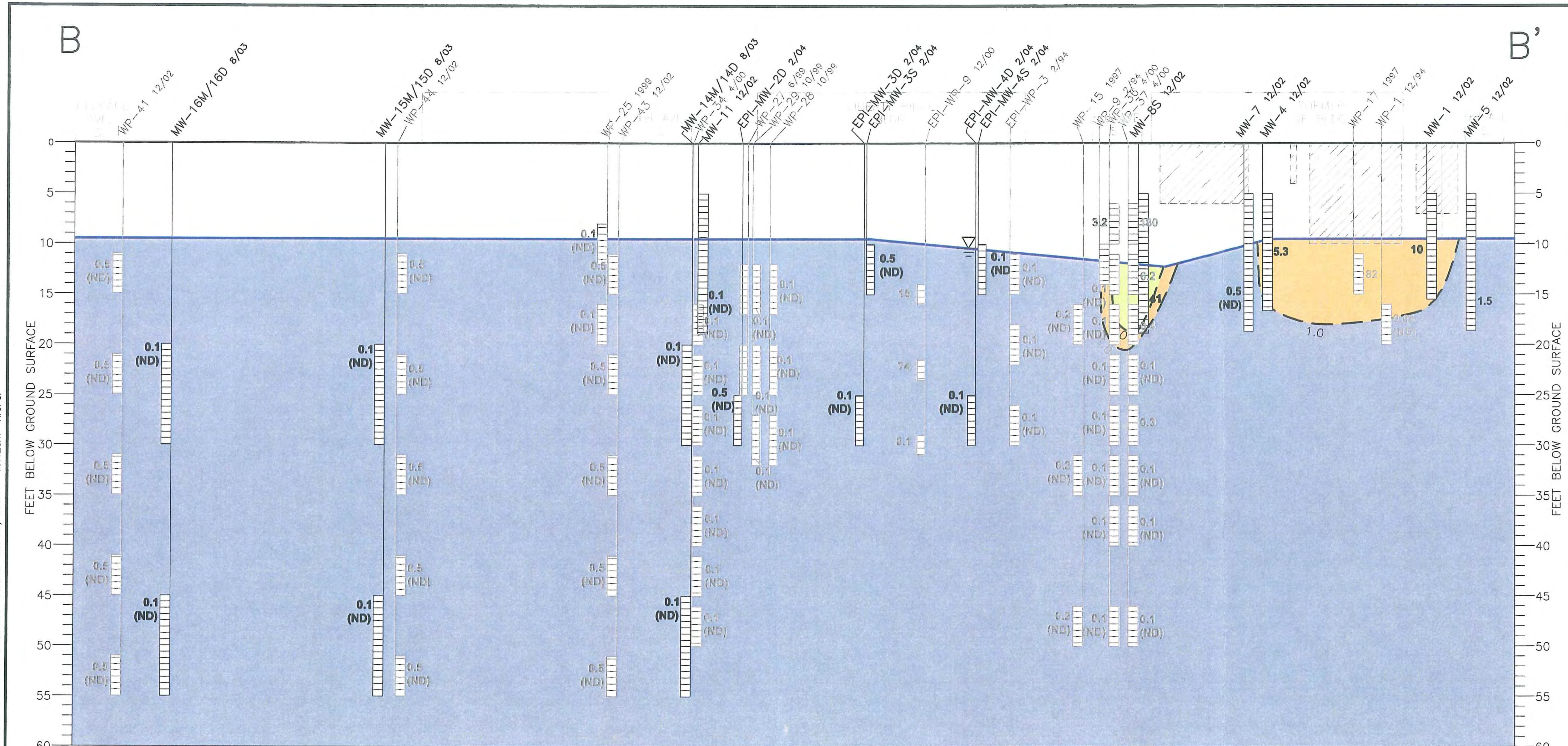
- WELL SCREEN
- **2.5** CONCENTRATION (ug/L)
- MW-1 2/08 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET 02978-415-735	2002-2003 CROSS SECTION 1,1-DICHLOROETHENE
DATE: 6/9/08 DRWN: E.M./SEA	FIGURE 2-19

File: L:\GE-S.Dawson\02978_x003 (2002-03).dwg Layout: FIGURE 2-19 User: emarshall Plotted: Jun 12, 2008 - 10:03am Xref's:



NOTES:

FOR RESULTS BELOW THE LAB DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON DEC. 2002 GUAGING EVENT.

DATA USED FOR MW-14M/14D, MW-15M/15D, MW-16M/16D IS FROM AUG. 2003, THIS WAS THE FIRST GROUNDWATER SAMPLING EVENT IN THESE WELLS.

1,1,1-TRICHLOROETHANE CONCENTRATION (ug/L)

- <1
- 1–10
- 10–100
- >100

LEGEND

- WELL SCREEN
- **2.5** CONCENTRATION (ug/L)
- MW-1 2/08 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

ENSR | AECOM

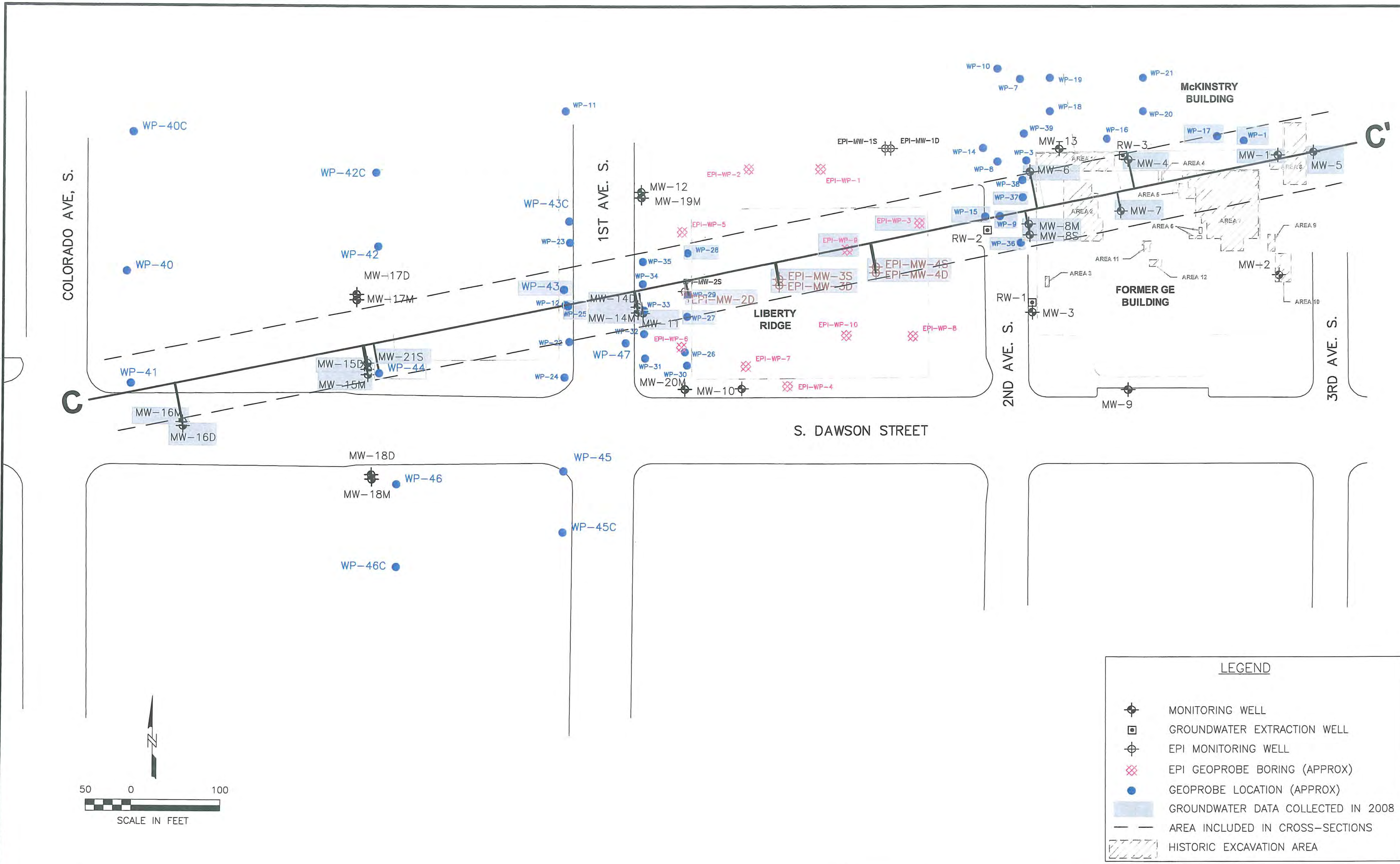
GE - S. DAWSON STREET
02978-415-735

DATE: 6/9/08 | DRWN: E.M./SEA

2002-2003 CROSS SECTION
1,1,1-TRICHLOROETHANE

FIGURE 2-20

File: L:\GE-S.Dawson\02978_x003 (2002-03).dwg Layout: FIGURE 2-20 User: emarshall Plotted: Jun 12, 2008 - 10:12am Xref's:



ENSR | AECOM

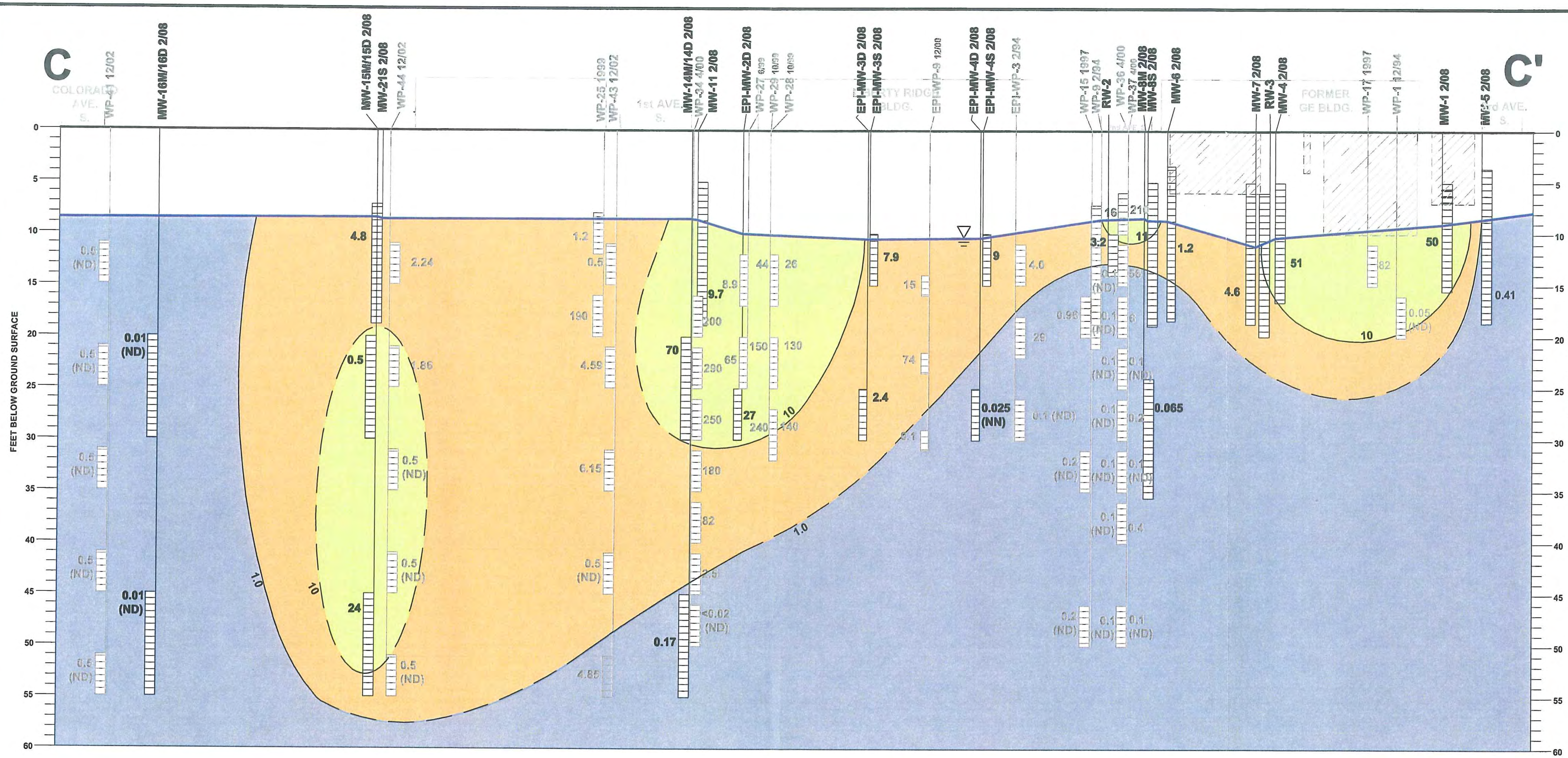
GE-S. DAWSON STREET
02978-415-735

DATE: 6/9/08 | DRWN: E.M./SEA

2008 CROSS SECTION LOCATION MAP

FIGURE 2-21

File: L:\GE-S.Dawson\02978_x005_(feb_2008).dwg Layout: FIG 2-21 User: emarshall Plotted: Jun 13, 2008 - 8:59am Xref's:



NOTES:

FOR RESULTS BELOW THE LABORATORY DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON FEB. 2008 GAUGING EVENT.

VERTICAL EXTENT OF CONCENTRATION IS BASED ON HISTORIC CONCENTRATIONS BELOW THE LABORATORY DETECTION LIMIT.

MTCA METHOD B SURFACE WATER CLEANUP LEVEL = 1.5 μg/L.

MTCA METHOD B GROUNDWATER CLEANUP LEVEL = 0.11 μg/L.

TCE CONCENTRATION (ug/L)

- <1
- 1-10
- 10-100
- >100

LEGEND

- WELL SCREEN
- 4.7 — CONCENTRATION (ug/L)
- MW-1 8/06 — MONITORING WELL, SAMPLE DATE
- WATER TABLE
- 100 — ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100

HORIZONTAL SCALE IN FEET

VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET

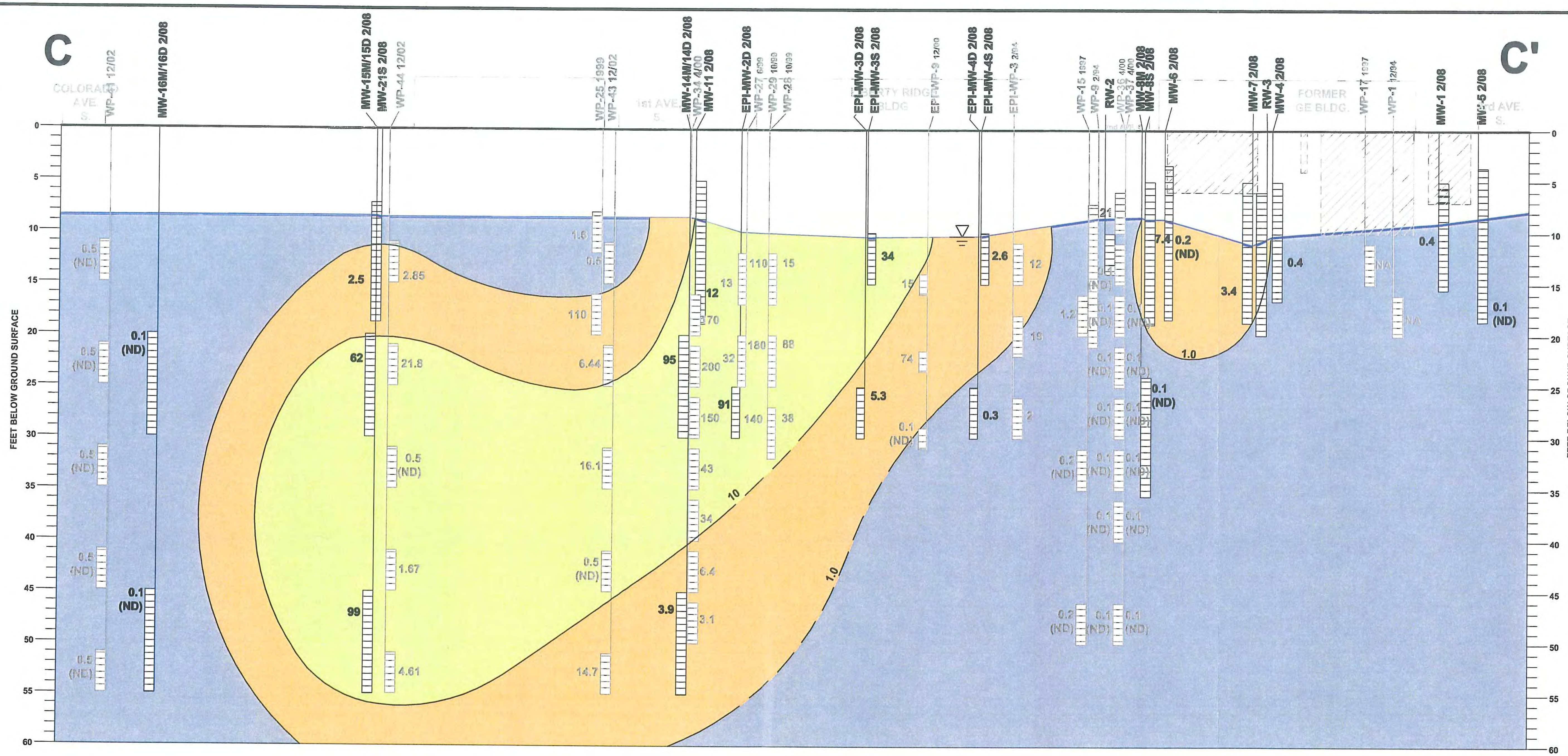
02978-415-735

DATE: 6/9/08 DRWN: E.M./SEA

FEBRUARY 2008 CROSS SECTION TRICHLOROETHENE

FIGURE 2-22

File: L:\GE-S.Dawson\02978_x005_(feb_2008).dwg Layout: FIG 2-22 User: MarshallE Plotted: Oct 13, 2008 - 1:16pm Xref's:



NOTES:

FOR RESULTS BELOW THE LABORATORY DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON FEB. 2008 GAUGING EVENT.

VERTICAL EXTENT OF CONCENTRATION IS BASED ON HISTORIC CONCENTRATIONS BELOW THE LABORATORY DETECTION LIMIT.

MTCA METHOD B SURFACE WATER CLEANUP LEVEL = NO STANDARD.

MTCA METHOD B GROUNDWATER CLEANUP LEVEL = 80 µg/L.

CIS 1,2-DCE CONCENTRATION (ug/L)

- <1
- 1-10
- 10-100
- >100

LEGEND

- WELL SCREEN
- 4.7 — CONCENTRATION (ug/L)
- MW-1 8/06 — MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 — ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

File: L:\GE-S.Dawson\02978_x005_(feb_2008).dwg Layout: FIG 2-23 User: emarshall Plotted: Jun 13, 2008 - 8:51am Xref's:

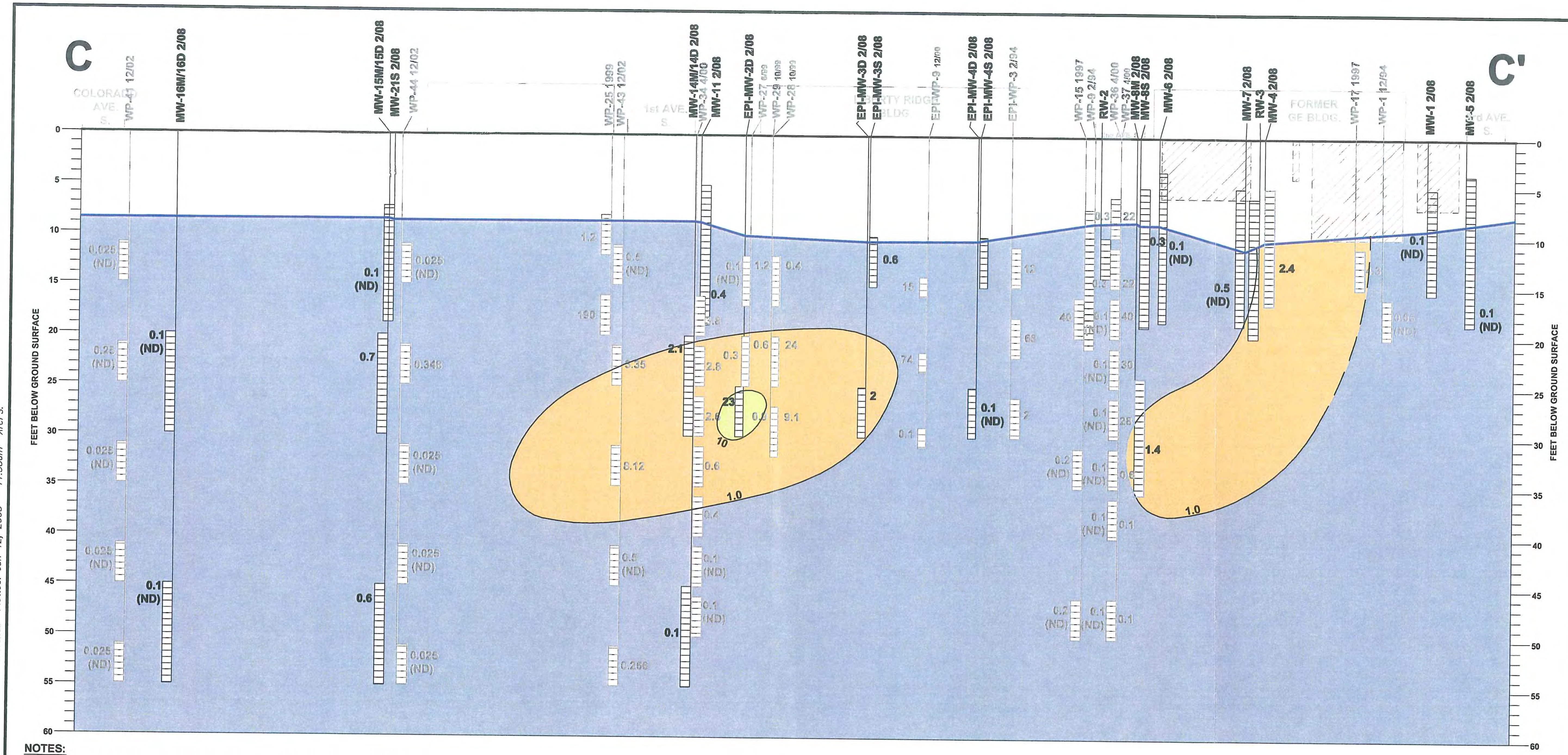
ENSR | AECOM

GE - S. DAWSON STREET
02978-415-735

DATE: 6/9/08 DRWN: E.M./SEA

FEBRUARY 2008 CROSS SECTION
CIS 1,2-DICHLOROETHENE

FIGURE 2-23



NOTES:

FOR RESULTS BELOW THE LABORATORY DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON FEB. 2008 GAUGING EVENT.

VERTICAL EXTENT OF CONCENTRATION IS BASED ON HISTORIC CONCENTRATIONS BELOW THE LABORATORY DETECTION LIMIT.

MTCA METHOD B SURFACE WATER CLEANUP LEVEL = 4,167 μg/L.

MTCA METHOD B GROUNDWATER CLEANUP LEVEL = 72 μg/L.

1,1-DCE CONCENTRATION (ug/L)

- <1
- 1-10
- 10-100
- >100

LEGEND

- WELL SCREEN
- 4.7 — CONCENTRATION (ug/L)
- MW-1 8/06 — MONITORING WELL, SAMPLE DATE
- WATER TABLE
- 100 — ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

ENSR | AECOM

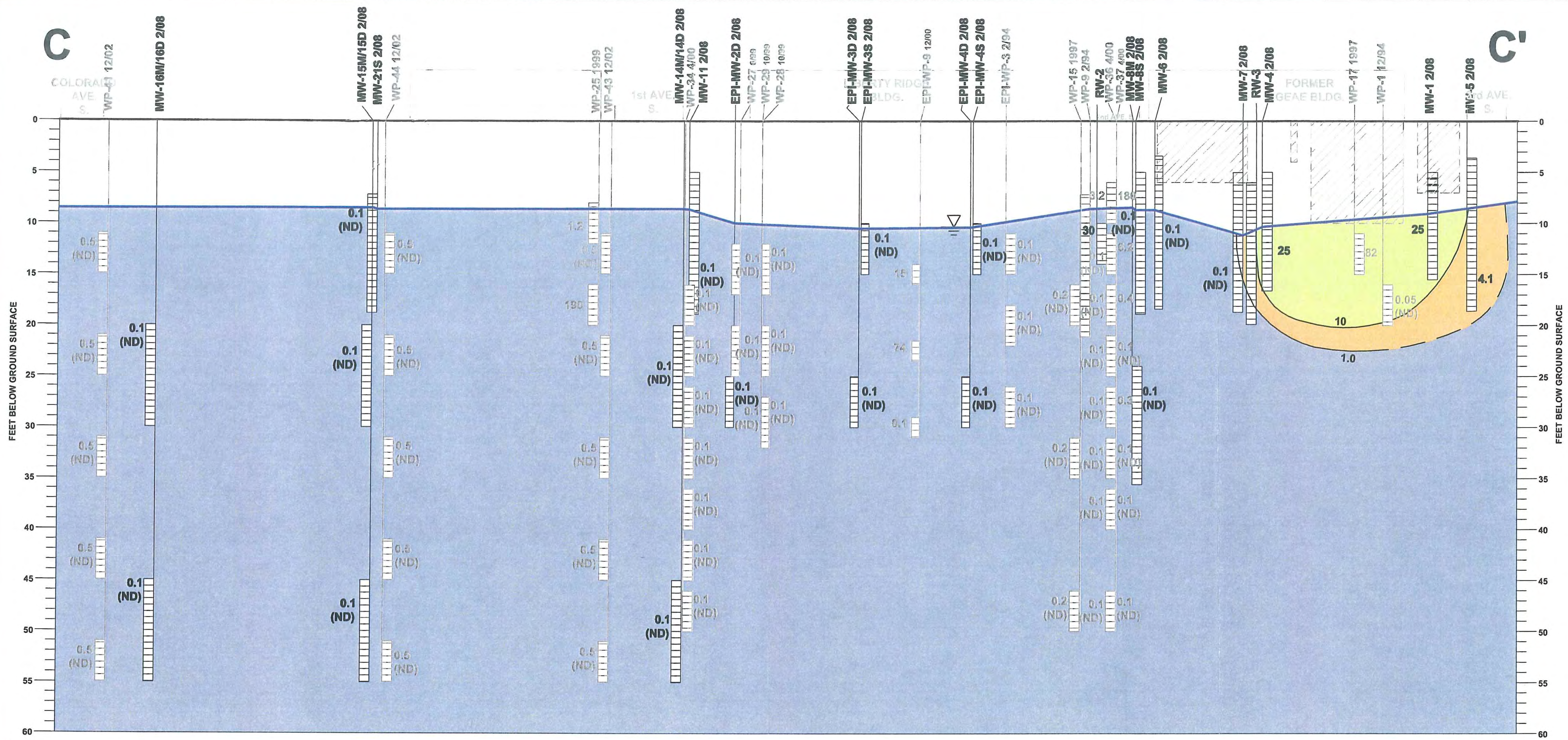
GE - S. DAWSON STREET
02978-415-735

DATE: 6/9/08 | DRWN: E.M./SEA

FEBRUARY 2008 CROSS SECTION
1,1-DICHLOROETHENE

FIGURE 2-24

File: L:\GE-S.Dawson\02978_x005_(feb_2008).dwg Layout: FIG 2-24 User: emarshall Plotted: Jun 12, 2008 - 11:58am Xref's:



NOTES:

FOR RESULTS BELOW THE LABORATORY DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON FEB. 2008 GAUGING EVENT.

VERTICAL EXTENT OF CONCENTRATION IS BASED ON HISTORIC CONCENTRATIONS BELOW THE LABORATORY DETECTION LIMIT.

MTCA METHOD B SURFACE WATER CLEANUP LEVEL = 417,000 µg/L.

MTCA METHOD B GROUNDWATER CLEANUP LEVEL = 7,200 µg/L.

1,1,1-TCA CONCENTRATION (ug/L)

- <1
- 1-10
- 10-100
- >100

LEGEND

- WELL SCREEN
- 4.7 — CONCENTRATION (ug/L)
- MW-1 8/06 — MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 — ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100

HORIZONTAL SCALE IN FEET

VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET

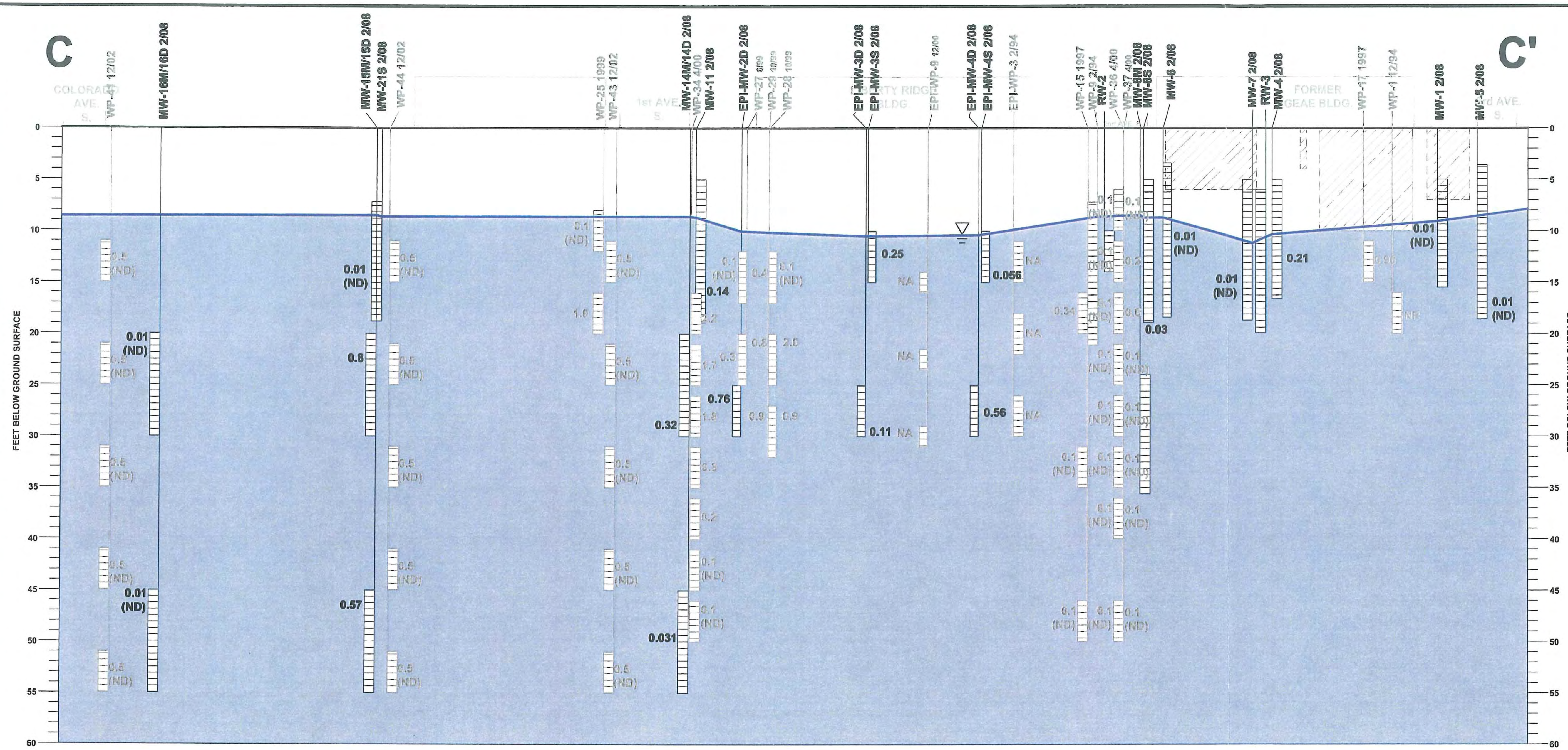
02978-415-735

DATE: 6/9/08 DRWN: E.M./SEA

FEBRUARY 2008 CROSS SECTION 1,1,1-TRICHLOROETHANE

FIGURE 2-25

File: L:\GE-S.Dawson\02978_x005_(feb_2008).dwg Layout: FIG 2-25 User: emarshall Plotted: Jun 12, 2008 - 11:58am Xref's:



NOTES:

FOR RESULTS BELOW THE LABORATORY DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON FEB. 2008 GAUGING EVENT.

VERTICAL EXTENT OF CONCENTRATION IS BASED ON HISTORIC CONCENTRATIONS BELOW THE LABORATORY DETECTION LIMIT.

EPI HISTORIC GEOPROBES WERE NOT INCLUDED ON THIS ANALYSIS, VALUES FOR VINYL CHLORIDE WERE NOT REPORTED

MTCA METHOD B SURFACE WATER CLEANUP LEVEL = 3.69 µg/L.

MTCA METHOD B GROUNDWATER CLEANUP LEVEL = 0.029 µg/L.

VC CONCENTRATION (ug/L)

- <1
- 1-10
- 10-100
- >100

LEGEND

- WELL SCREEN
- 4.7 — CONCENTRATION (ug/L)
- MW-1 8/06 — MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 — ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100

HORIZONTAL SCALE IN FEET

VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET

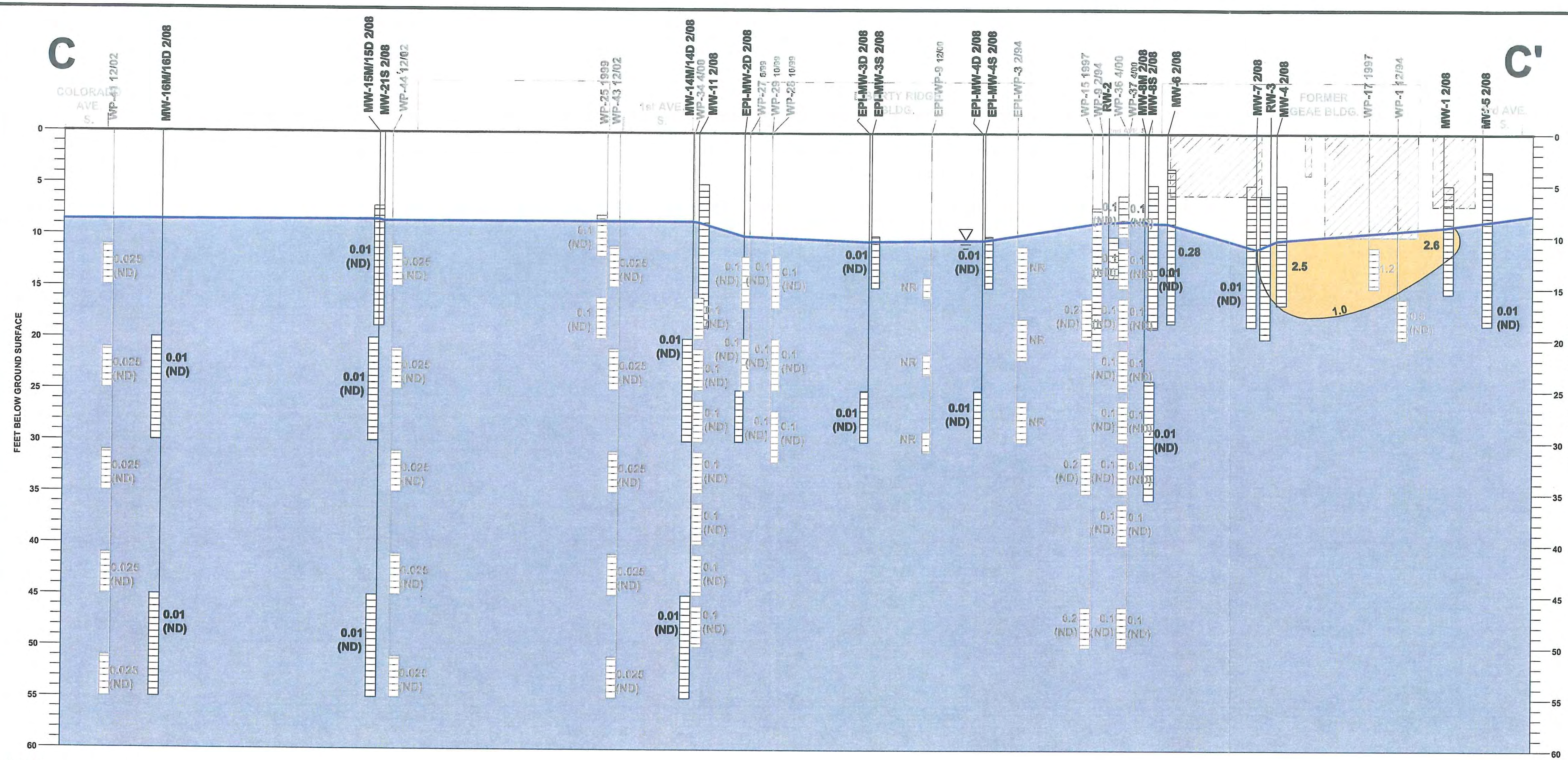
02978-415-735

DATE: 6/9/08 | DRWN: E.M./SEA

FEBRUARY 2008 CROSS SECTION VINYL CHLORIDE

FIGURE 2-26

File: L:\GE-S.Dawson\02978_x005_(feb_2008).dwg Layout: FIG 2-26 User: emarshall Plotted: Jun 12, 2008 - 12:00pm Xref's:



NOTES:

FOR RESULTS BELOW THE LABORATORY DETECTION LIMIT, 1/2 OF THE LABORATORY DETECTION LIMIT WAS USED.

WATER TABLE ELEVATION BASED ON FEB. 2008 GAUGING EVENT.

VERTICAL EXTENT OF CONCENTRATION IS BASED ON HISTORIC CONCENTRATIONS BELOW THE LABORATORY DETECTION LIMIT.

MTCA METHOD B SURFACE WATER CLEANUP LEVEL = 0.39 µg/L.

MTCA METHOD B GROUNDWATER CLEANUP LEVEL = 0.081 µg/L.

VC CONCENTRATION (ug/L)

- <1
- 1-10
- 10-100
- >100

LEGEND

- WELL SCREEN
- 4.7 CONCENTRATION (ug/L)
- MW-1 8/06 MONITORING WELL SAMPLE DATE
- WATER TABLE
- 100 ISOPLETH LINE OF EQUAL CONCENTRATION (DASHED WHERE INFERRED)
- HISTORIC EXCAVATION

50 0 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 1:10

ENSR | AECOM

GE - S. DAWSON STREET
02978-415-735

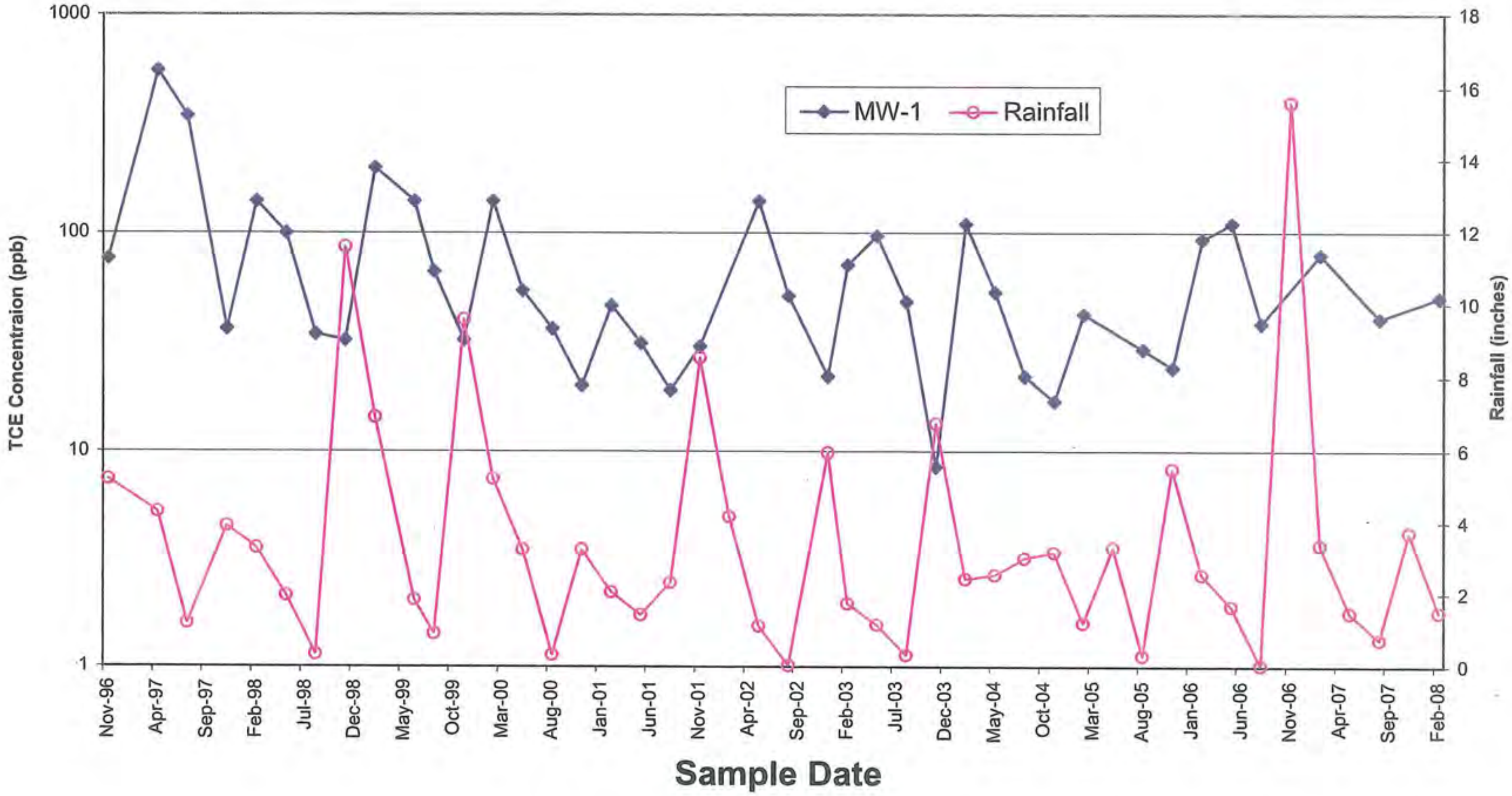
DATE: 6/9/08 | DRWN: E.M./SEA

FEBRUARY 2008 CROSS SECTION TETRACHLOROETHENE

FIGURE 2-27

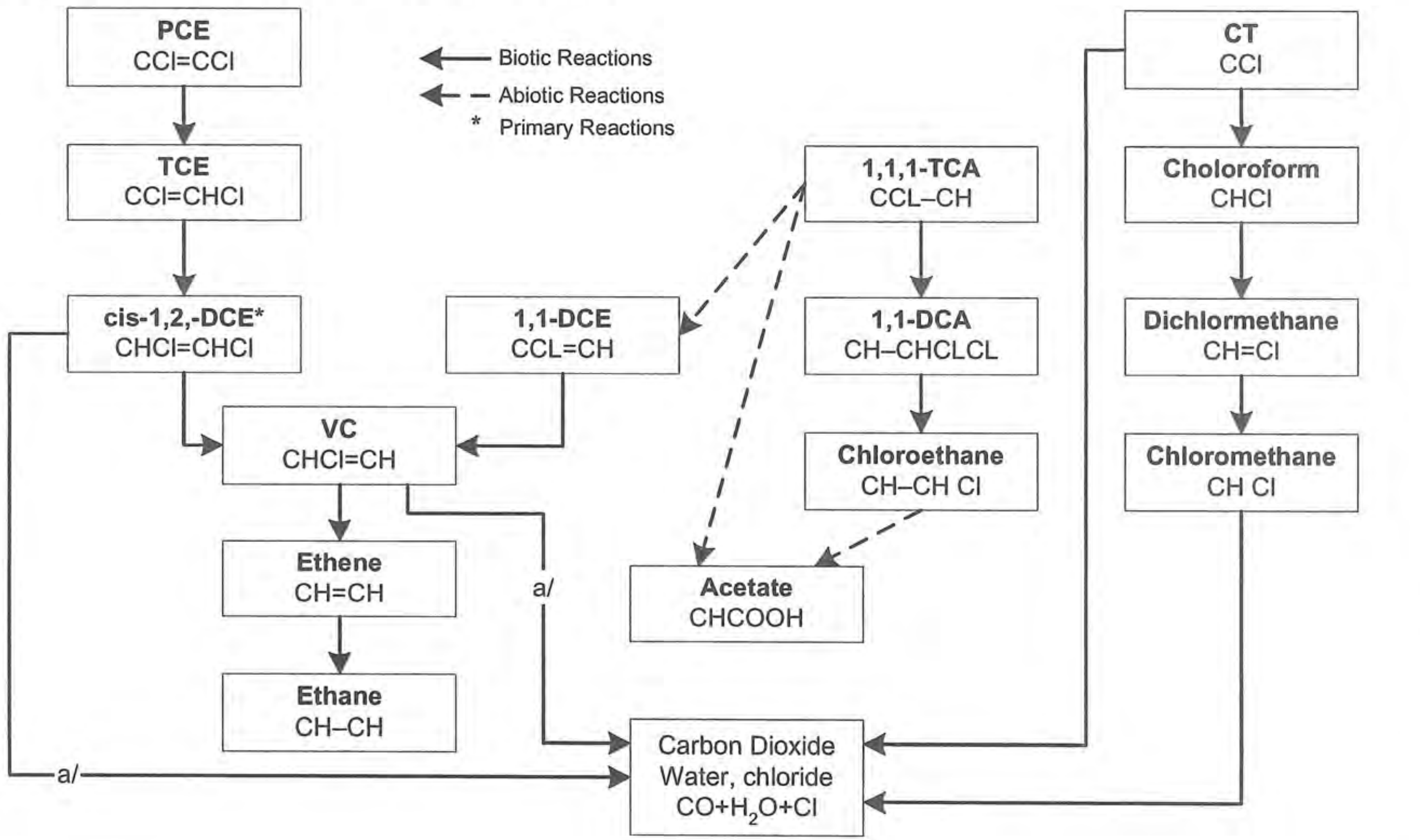
File: L:\GE-S.Dawson\02978_x005_(feb_2008).dwg Layout: FIG 2-27 User: emarshall Plotted: Jun 12, 2008 - 12:03pm Xref's:

Figure 2-28: Effects of Precipitation on On-Site Area Well MW-1



ENSR | AECOM

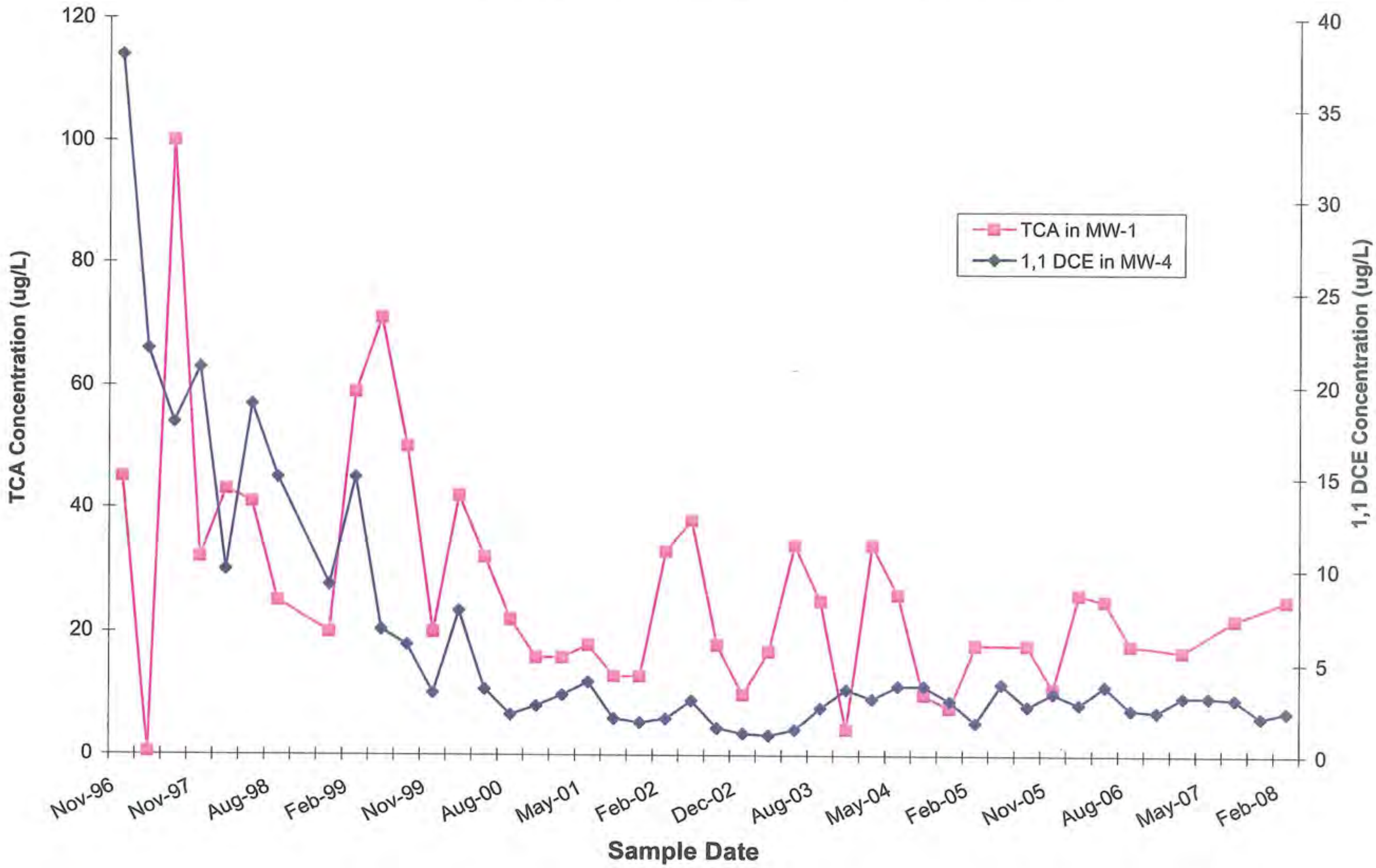
Figure 2-29 CVOC Degradation Process



ENSR | AECOM

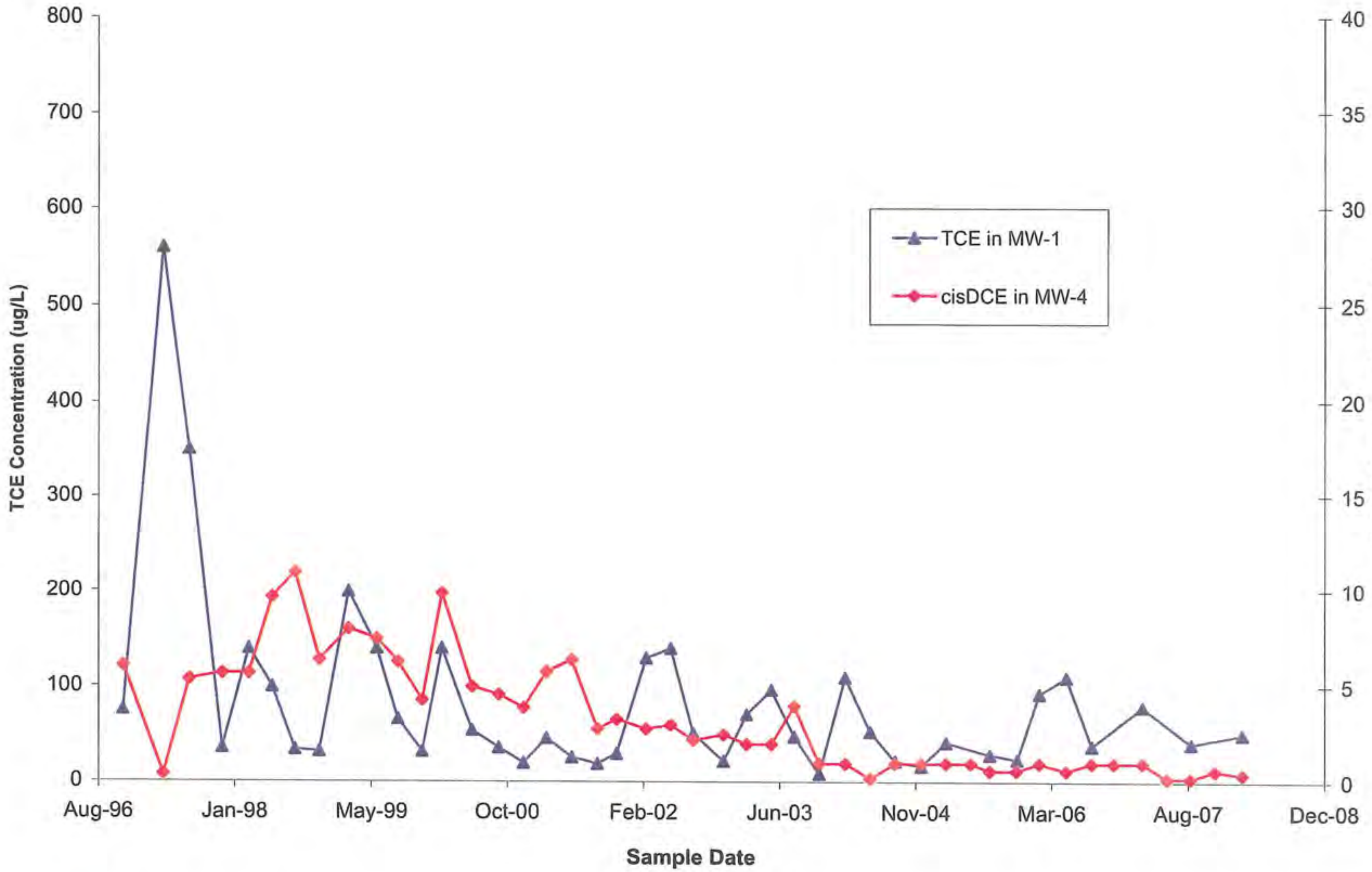
a/ – oxidative biological pathway; all other biological pathways are reductive

Figure 2-30 TCA Degradation in Select On-Site Area Wells



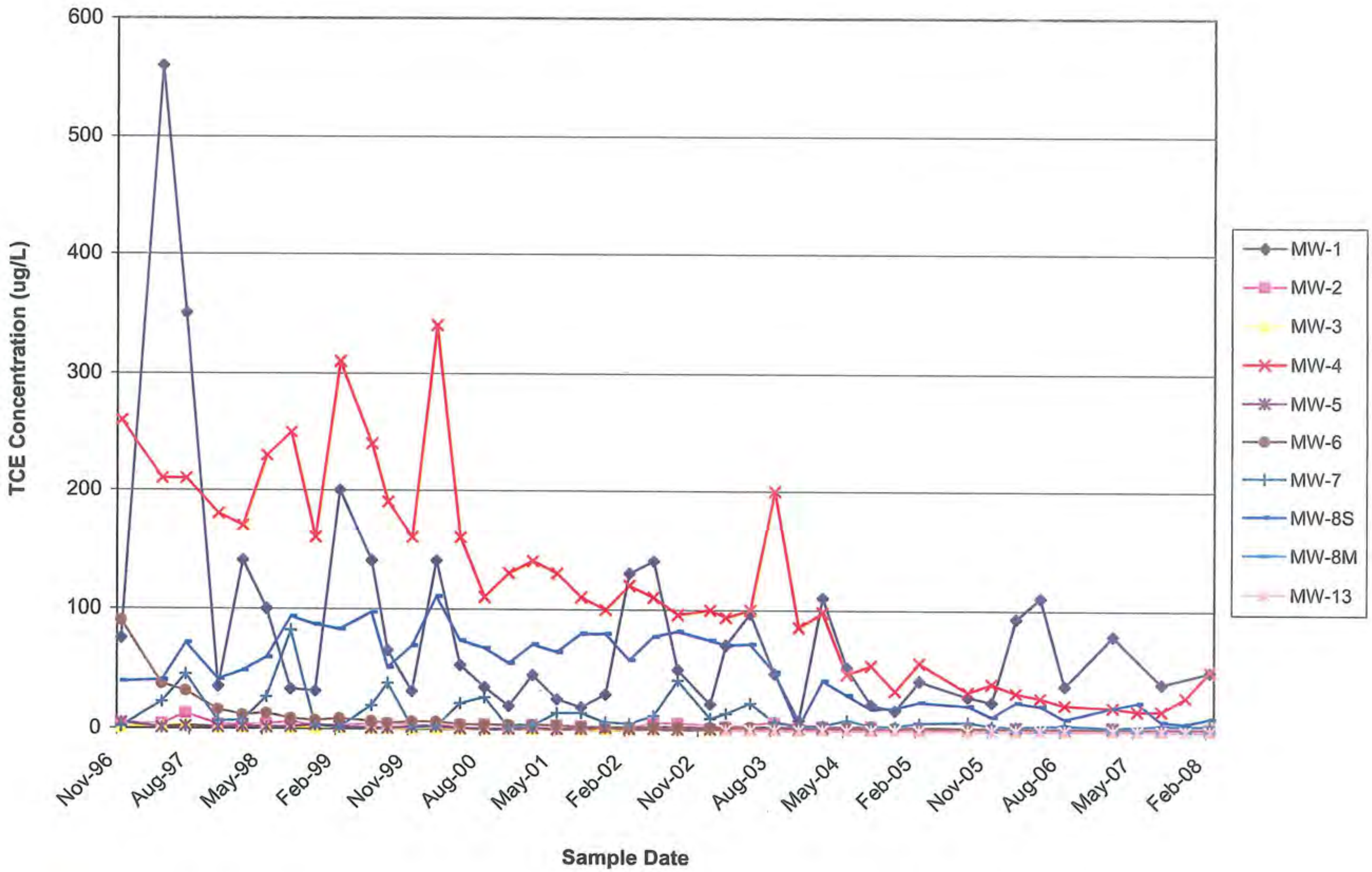
ENSR | AECOM

Figure 2-31 TCE Degradation in Select On-Site Area Wells



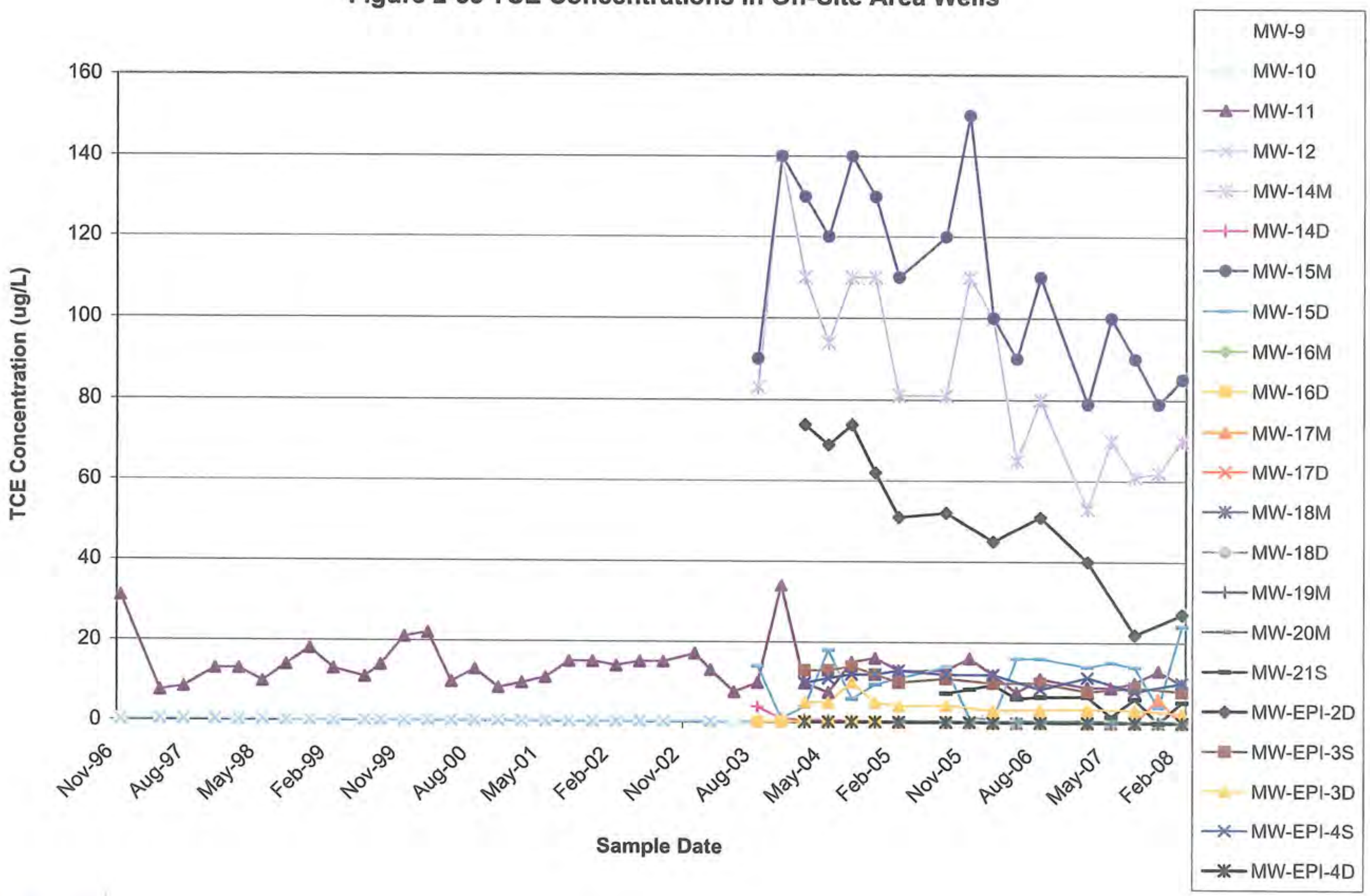
ENSR | AECOM

Figure 2-32 TCE Concentrations in On-Site Area Wells



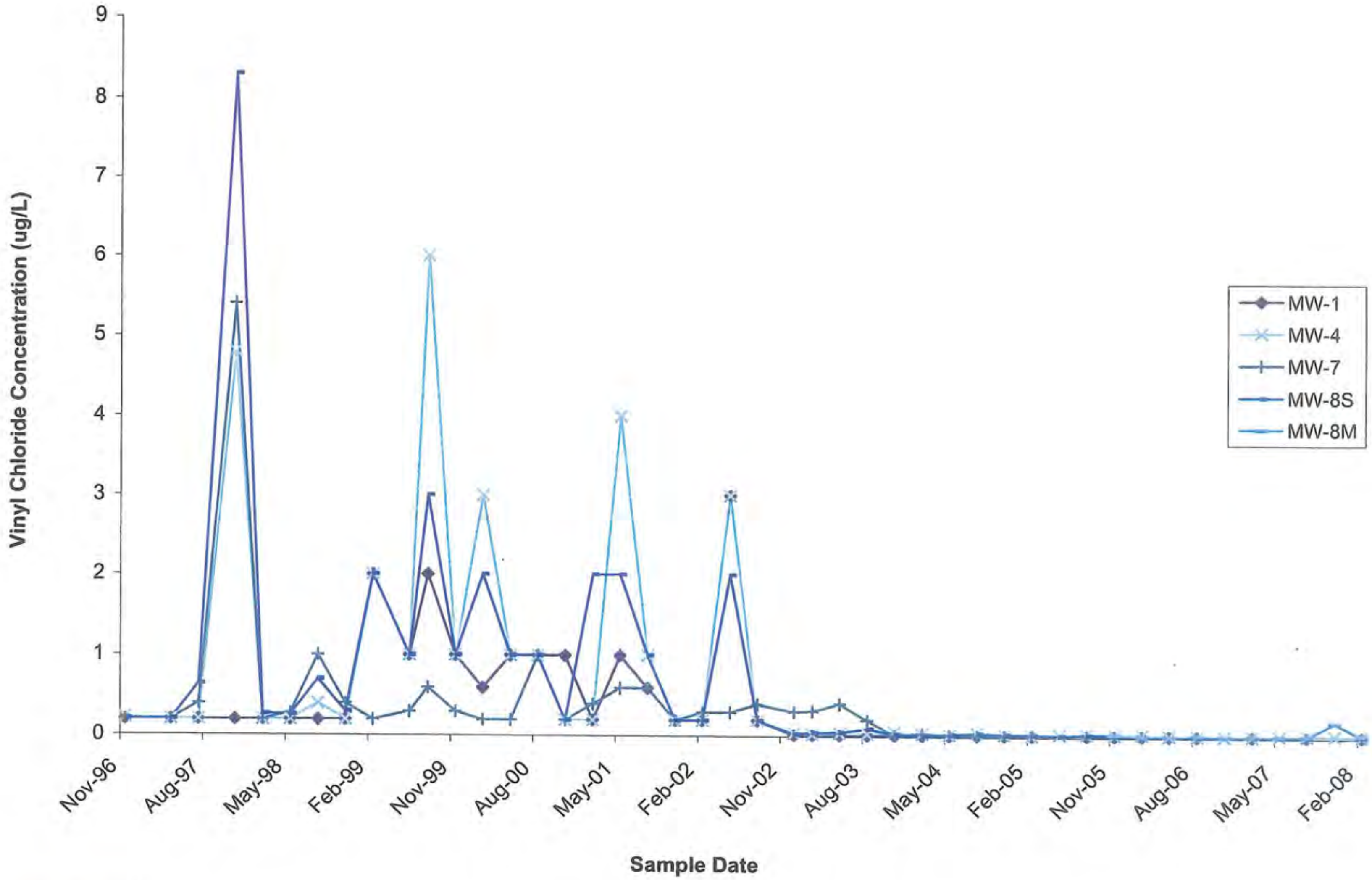
ENSR | AECOM

Figure 2-33 TCE Concentrations in Off-Site Area Wells



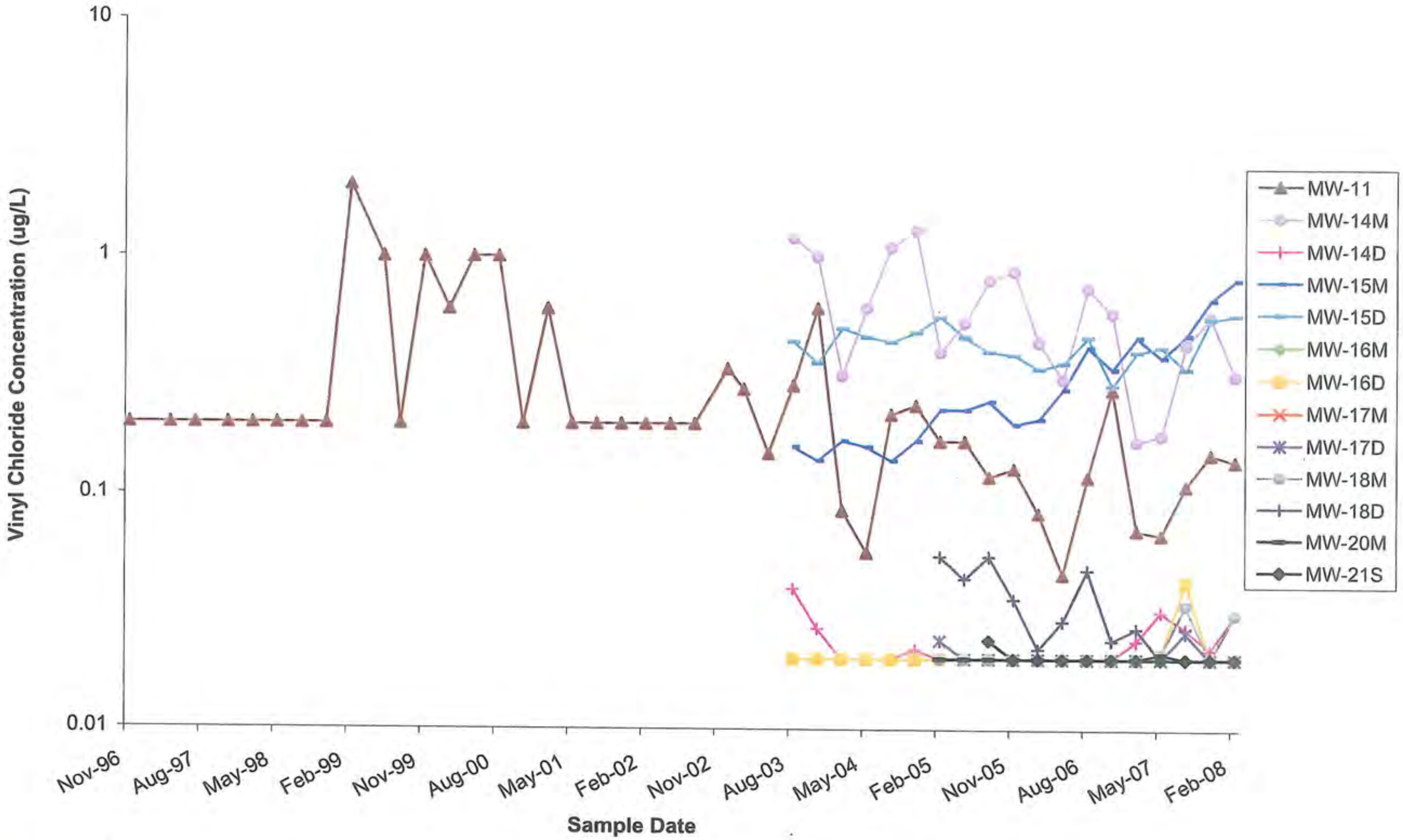
ENSR | AECOM

Figure 2-34 Vinyl Chloride Concentration in On-Site Area Wells

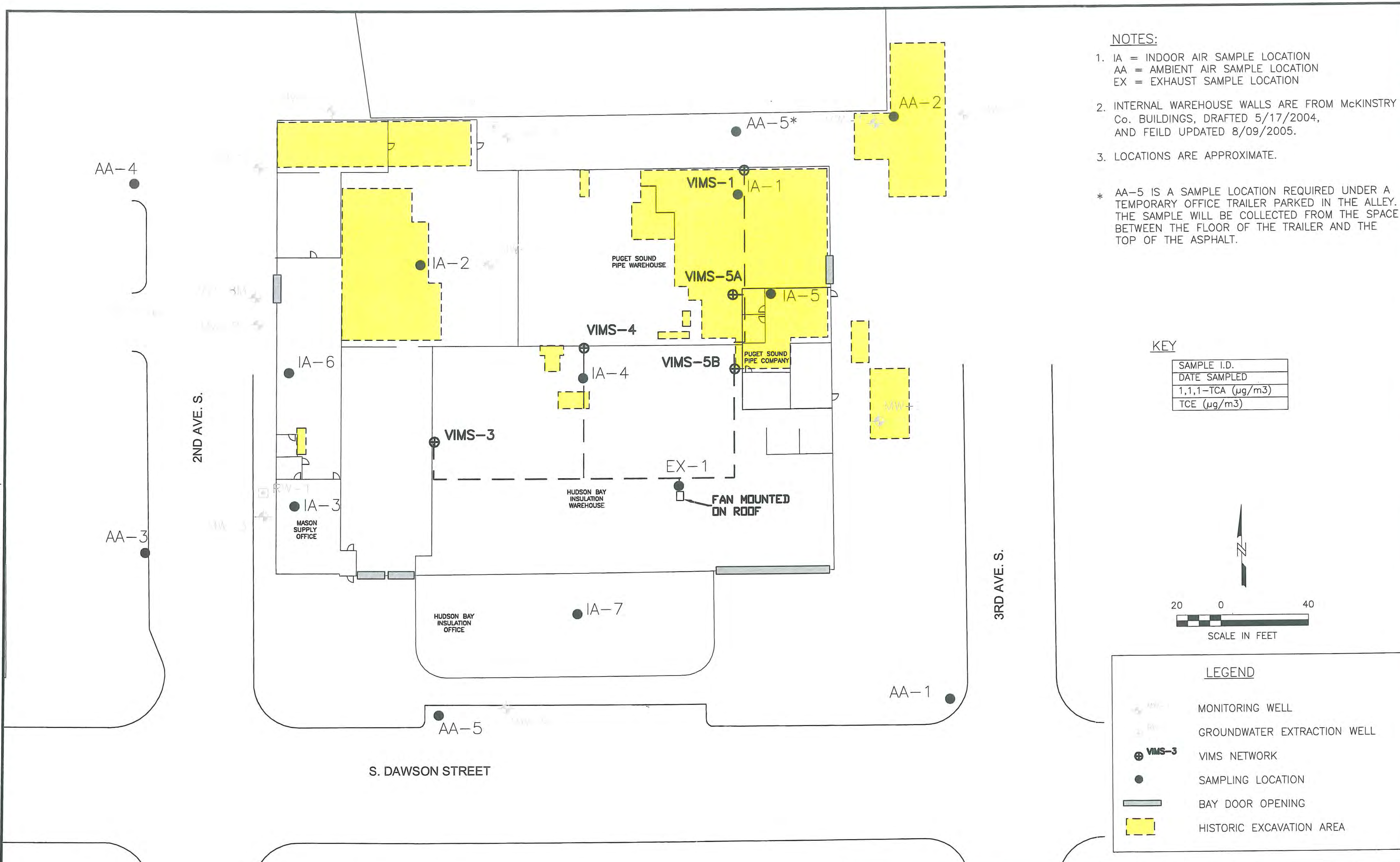


ENSR | AECOM

Figure 2-35 Vinyl Chloride Concentration Off-Site Area Wells



ENSR | AECOM



ENSR | AECOM

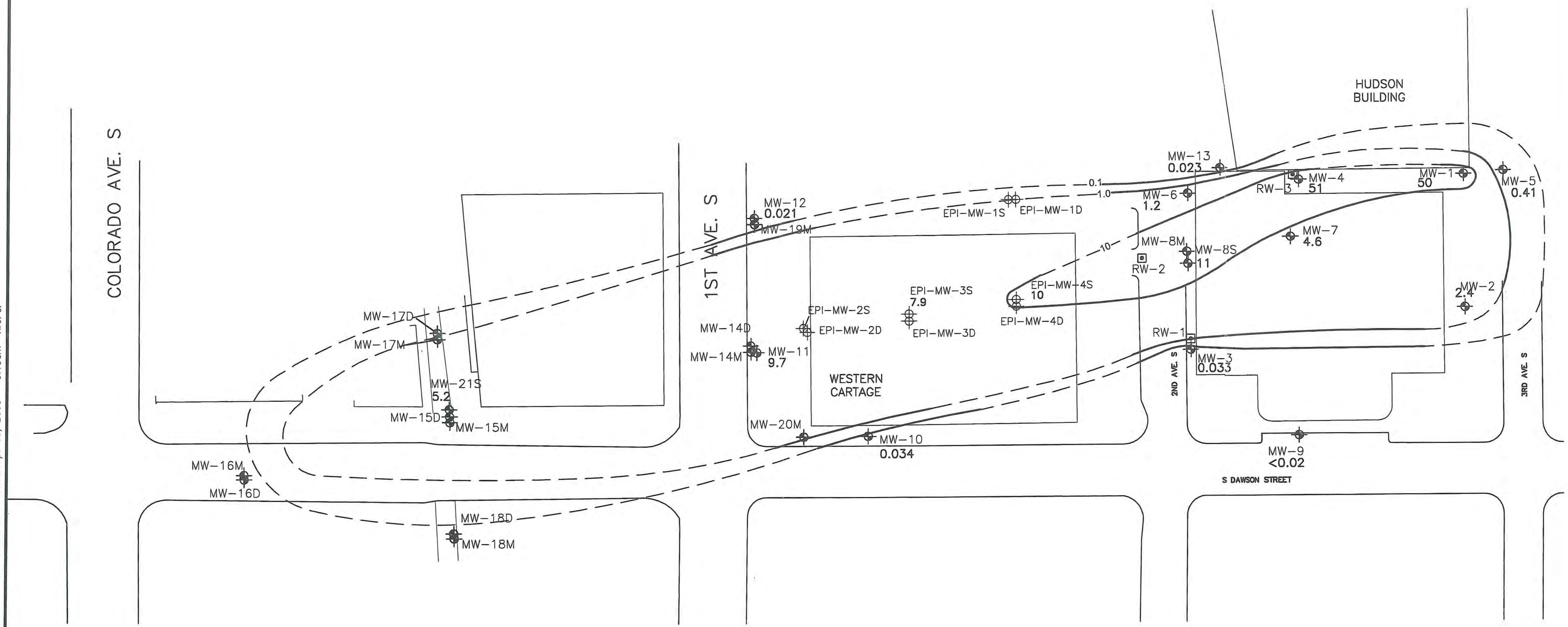
GE - S. DAWSON STREET
02978-415-750

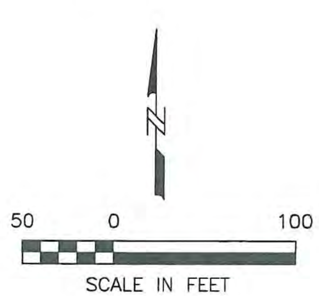
DATE: 06/13/08 | DRWN: E.M./SEA

VAPOR INTRUSION STUDY OF FORMER GE BUILDING

FIGURE 2-36

File: L:\GE-S.Dawson\19314S085.dwg Layout: FIGURE 1 User: emarshall Plotted: Jun 13, 2008 - 4:06pm Xref's:





NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. LOCATIONS ARE APPROXIMATE.

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- 12 — GROUNDWATER CONCENTRATION (μg/L)
- —10— GROUNDWATER CONCENTRATION CONTOUR (DASHED WHERE INFERRED)

File: L:\GE-S.Dawson\02978_gw_2-08_S04.dwg Layout: FIGURE 4 User: emarshall Plotted: Apr 09, 2008 - 9:13am Xref's:

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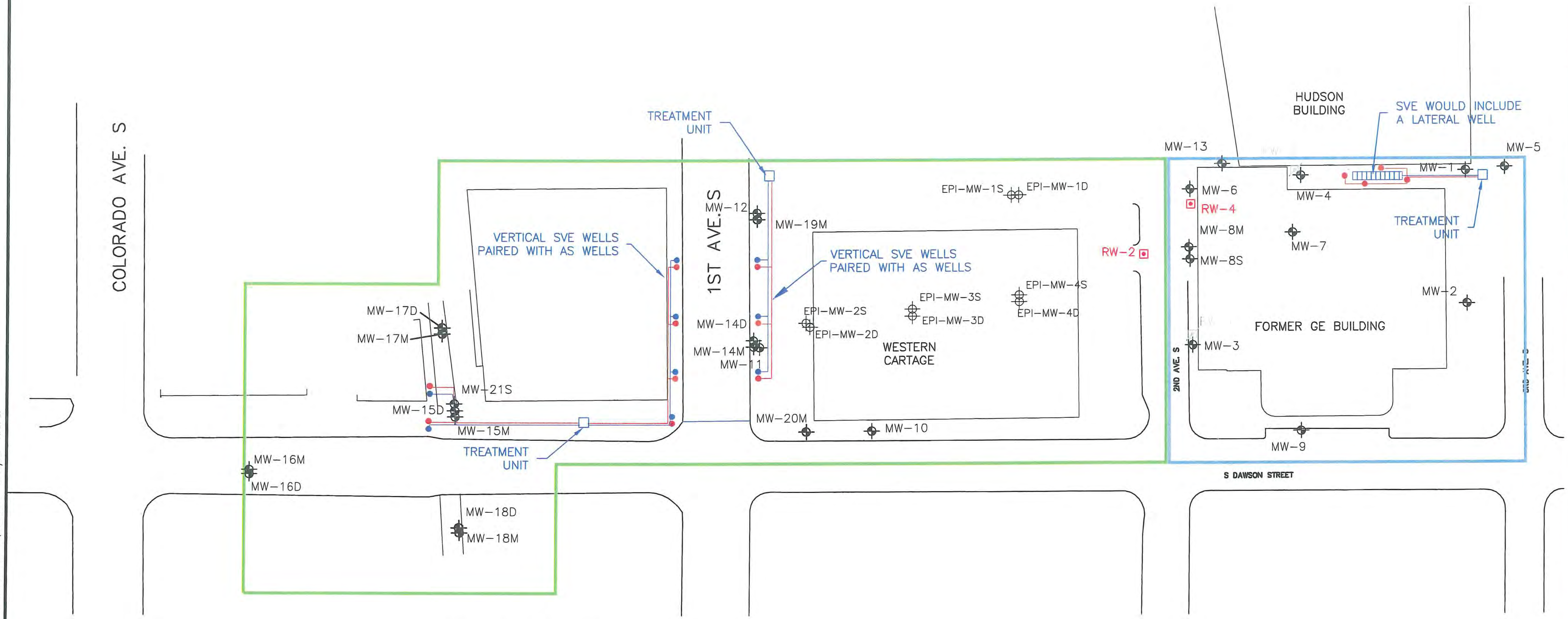
GE - S. DAWSON STREET

02978-415

DATE: 03/25/08 DRWN: E.M./SEA

TCE CONCENTRATION IN GROUNDWATER FEBRUARY 2008 (SHALLOW WELLS)

FIGURE 2-37



ALTERNATIVE DETAILS:

1. RECOVERY SYSTEM WILL BE OPTIMIZED, RW-3 AND RW-1 WILL BE ABANDONED AND REPLACED WITH RW-4.
2. COMBINED SVE AND AS SYSTEM WOULD BE INSTALLED.
3. SVE WELLS INSTALLED APPROX. 6 FEET BGS, AS WELLS IN ON-SITE AREA INSTALLED 15 FEET BGS, AS WELLS IN OFF-SITE AREA INSTALLED 25 FEET BGS.
4. OPERATION IS EXPECTED FOR 3 YEARS IN THE ON-SITE AREA (PHASE 1) AND 3 YEARS IN THE OFF-SITE AREA (PHASE 2).
5. INCLUDES SUB SLAB DEPRESSURIZATION SYSTEM – SEE FIGURE 5-2.
6. PERFORMANCE MONITORING WILL INCLUDE VAPOR (INDOOR AIR AND SVS) AND GROUNDWATER SAMPLES FOR 3 YEARS.

NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. LOCATIONS ARE APPROXIMATE

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- ABANDONED GROUNDWATER EXTRACTION WELL
- SOIL VAPOR EXTRACTION WELL
- AIR SPARGE WELL
- ON-SITE AREA
- OFF-SITE AREA

N

50 0 100

SCALE IN FEET

ENSR | AECOM

GE - S. DAWSON STREET

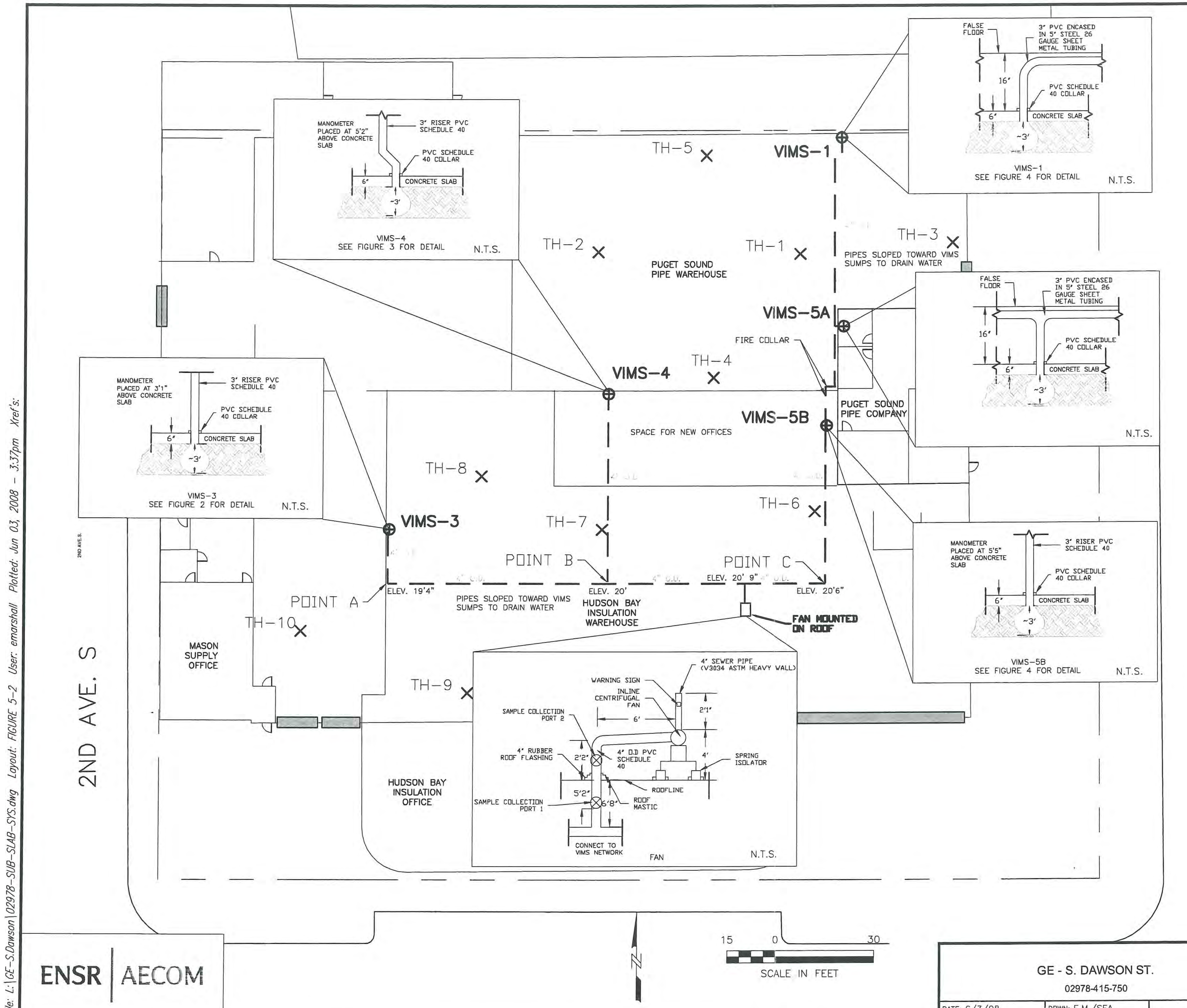
02978-415-735

DATE: 06/03/08 DRWN: E.M./SEA

ALTERNATIVE 1

FIGURE 5-1

File: L:\GE-S.Dawson\02978_ALT_1.dwg Layout: FIGURE 5-1 User: emarshall Plotted: Jun 03, 2008 - 2:49pm Xref's:



NOTES:

1. ALL 4" SEWER PIPE IS V3034 ASTM HEAVY WALL WITH THE EXCEPTION OF THE EXTERNAL FAN PIPING. PLEASE SEE INSERT FOR DETAILS.
2. ALL PIPING ELEVATIONS ARE MEASURED FROM THE TOP OF THE CONCRETE FLOOR.
3. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
4. LOCATIONS ARE APPROXIMATE.
5. N.T.S. = NOT TO SCALE
6. ELECTRICAL BOX IS LOCATED ON THE SOUTHERN INTERIOR HUDSON BAY WAREHOUSE WALL.

LEGEND

- PROPERTY LINE
- INTERIOR DUCT WORK
- SUMP LOCATION
- BAY DOOR OPENING
- APPROXIMATE TEST HOLE LOCATION

File: L:\GE-S.Dawson\02978-SUB-SLAB-SYS.dwg Layout: FIGURE 5-2 User: emarshall Plotted: Jun 03, 2008 - 3:37pm Xref's:

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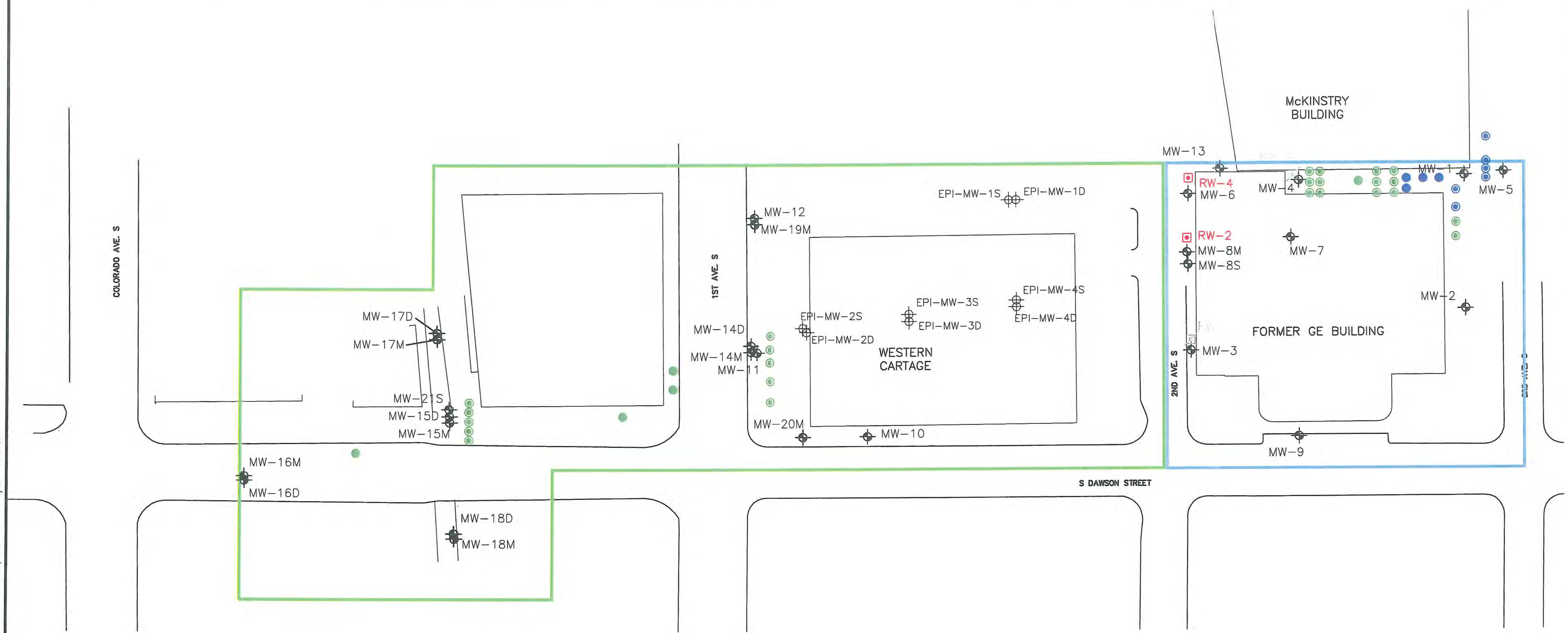
GE - S. DAWSON ST.
02978-415-750

DATE: 6/3/08 | DRWN: E.M./SEA

SUB-SLAB DEPRESSURIZATION SYSTEM

FIGURE 5-2



50 0 100

SCALE IN FEET

ALTERNATIVE DETAILS:

1. RECOVERY SYSTEM WILL BE OPTIMIZED, RW-3 AND RW-1 WILL BE ABANDONED AND REPLACED WITH RW-4.
2. 1 TO 4% POTASSIUM PERMANGANATE INJECTED IN ON-SITE AND OFF-SITE INJECTION POINTS.
3. ON-SITE AREA INJECTION POINTS ARE SCREENED AT 4 FEET BELOW WATER TABLE AND 12 TO 16 FEET BGS.
4. OFF-SITE AREA INJECTION POINTS ARE SCREENED AT 20 TO 24, 26 TO 30, AND 51 TO 55 FEET BGS.
5. OPERATION IS EXPECTED TO BE 2 PHASES, 6 MONTHS APART, FOR A TOTAL OF 3 YEARS.
6. INCLUDES SUB SLAB DEPRESSURIZATION SYSTEM – SEE FIGURE 5-2
7. PERFORMANCE MONITORING WILL INCLUDE VAPOR (INDOOR AIR) AND GROUNDWATER SAMPLES FOR 3 YEARS.

NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. LOCATIONS ARE APPROXIMATE.

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- ABANDONED GROUNDWATER EXTRACTION WELL
- PHASE 1 INJECTION POINT
- PHASE 1 OBSERVATION POINT
- PHASE 2 AND 3 INJECTION POINT
- PHASE 2 AND 3 OBSERVATION POINT
- ON-SITE AREA
- OFF-SITE AREA

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GE - S. DAWSON STREET

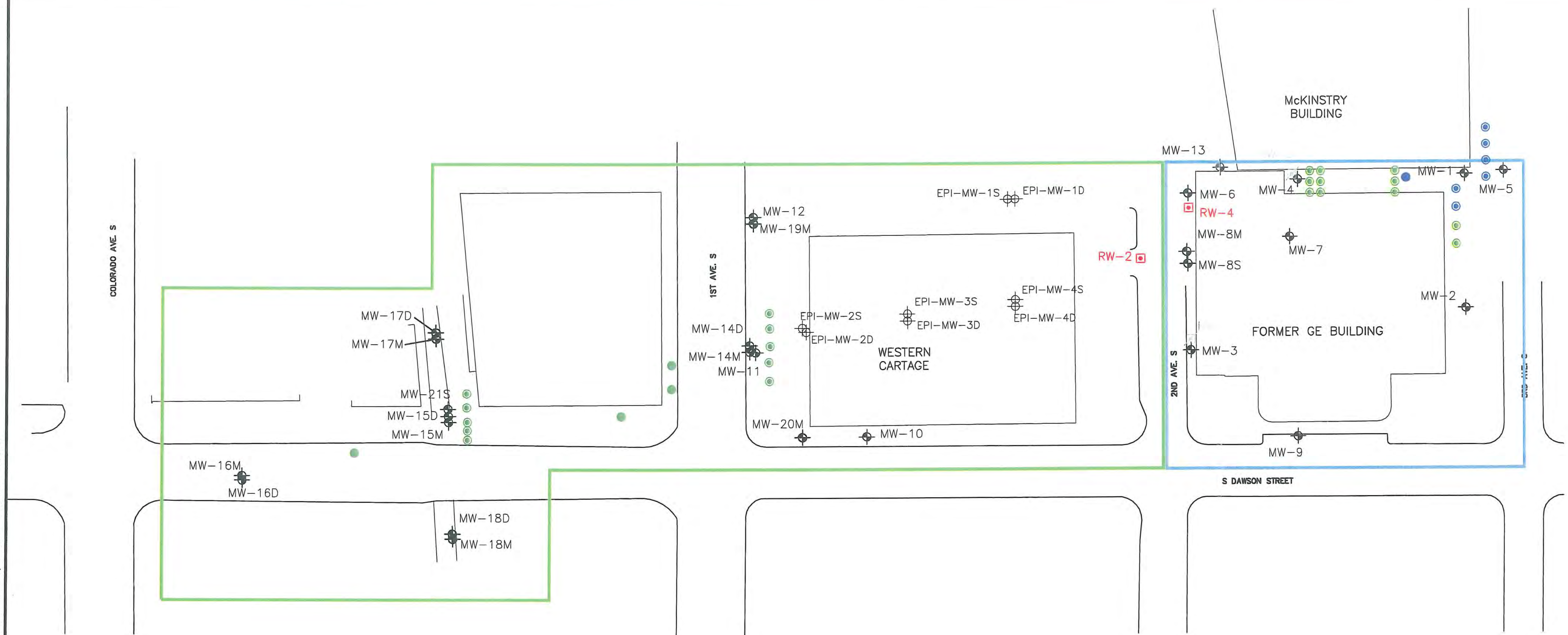
02978-415-735

DATE: 06/09/08 DRWN: E.M./SEA

ALTERNATIVE 2

FIGURE 5-3

File: L:\GE-S.Dawson\02978_ALT_2.dwg Layout: FIGURE 5-3 User: MarshallE Plotted: Oct 10, 2008 - 3:12pm Xref's:



ALTERNATIVE DETAILS:

1. RECOVERY SYSTEM WILL BE OPTIMIZED. RW-3 AND RW-1 WILL BE ABANDONED AND REPLACED WITH RW-4.
2. SOLUBLE AND INSOLUBLE ELECTRON DONORS INJECTED IN THE ON-SITE AND OFF-SITE INJECTION POINTS.
3. ON-SITE AREA INJECTION POINTS ARE SCREENED AT 4 FEET BELOW WATER TABLE AND 12 TO 16 FEET BGS.
4. OFF-SITE INJECTION POINTS ARE SCREENED AT 20 TO 24 AND 26 TO 30 FEET BGS.
5. INCLUDES SUB SLAB DEPRESSURIZATION SYSTEM – SEE FIGURE 5-2.
6. PERFORMANCE MONITORING WILL INCLUDE VAPOR (INDOOR AIR) AND GROUNDWATER SAMPLES FOR 3 YEARS.

50 0 100

SCALE IN FEET

NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. LOCATIONS ARE APPROXIMATE.

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- ABANDONED GROUNDWATER EXTRACTION WELL
- PHASE 1 INJECTION POINT
- PHASE 1 OBSERVATION POINT
- PHASE 2 AND 3 INJECTION POINT
- PHASE 2 AND 3 OBSERVATION POINT
- ON-SITE AREA
- OFF-SITE AREA

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GE - S. DAWSON STREET

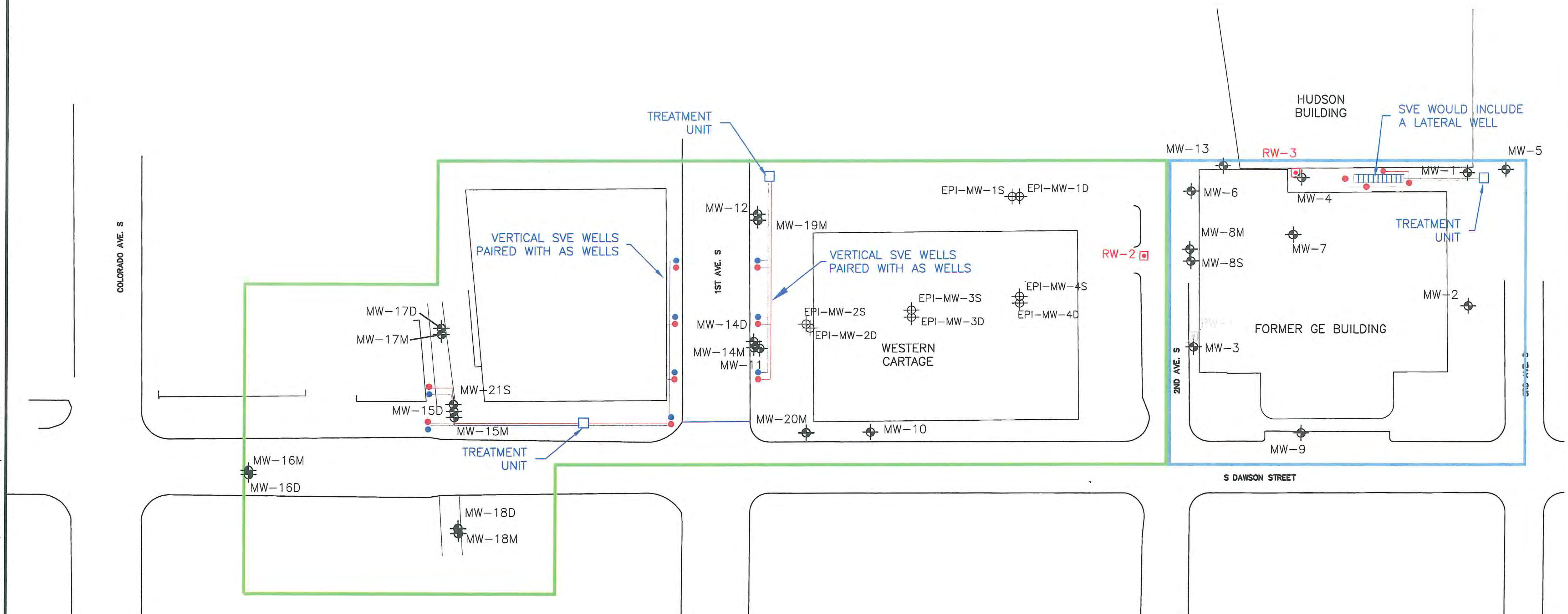
02978-415-735

DATE: 06/03/08 | DRWN: E.M./SEA

ALTERNATIVE 3

FIGURE 5-4

File: L:\GE-S.Dawson\02978_ALT_3.dwg Layout: FIGURE 5-4 User: emarshall Plotted: Jun 13, 2008 - 10:21am Xref's:



ALTERNATIVE DETAILS:

1. COMBINED SVE AND AS SYSTEM WOULD BE INSTALLED.
2. SVE WELLS INSTALLED APPROX. 6 FEET BGS, AS WELLS IN ON-SITE AREA INSTALLED 15 FEET BGS, AS WELLS IN OFF-SITE AREA INSTALLED 25 FEET BGS.
3. OPERATION IS EXPECTED FOR 3 YEARS IN THE ON-SITE AREA (PHASE 1) AND 3 YEARS IN THE OFF-SITE AREA (PHASE 2).
4. INCLUDES SUB SLAB DEPRESSURIZATION SYSTEM – SEE FIGURE 5-2.
5. PERFORMANCE MONITORING WILL INCLUDE VAPOR (INDOOR AIR AND SVS) AND GROUNDWATER SAMPLES FOR 3 YEARS.

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- SOIL VAPOR EXTRACTION WELL
- AIR SPARGE WELL
- ON-SITE AREA
- OFF-SITE AREA

50 0 100
SCALE IN FEET

NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. LOCATIONS ARE APPROXIMATE

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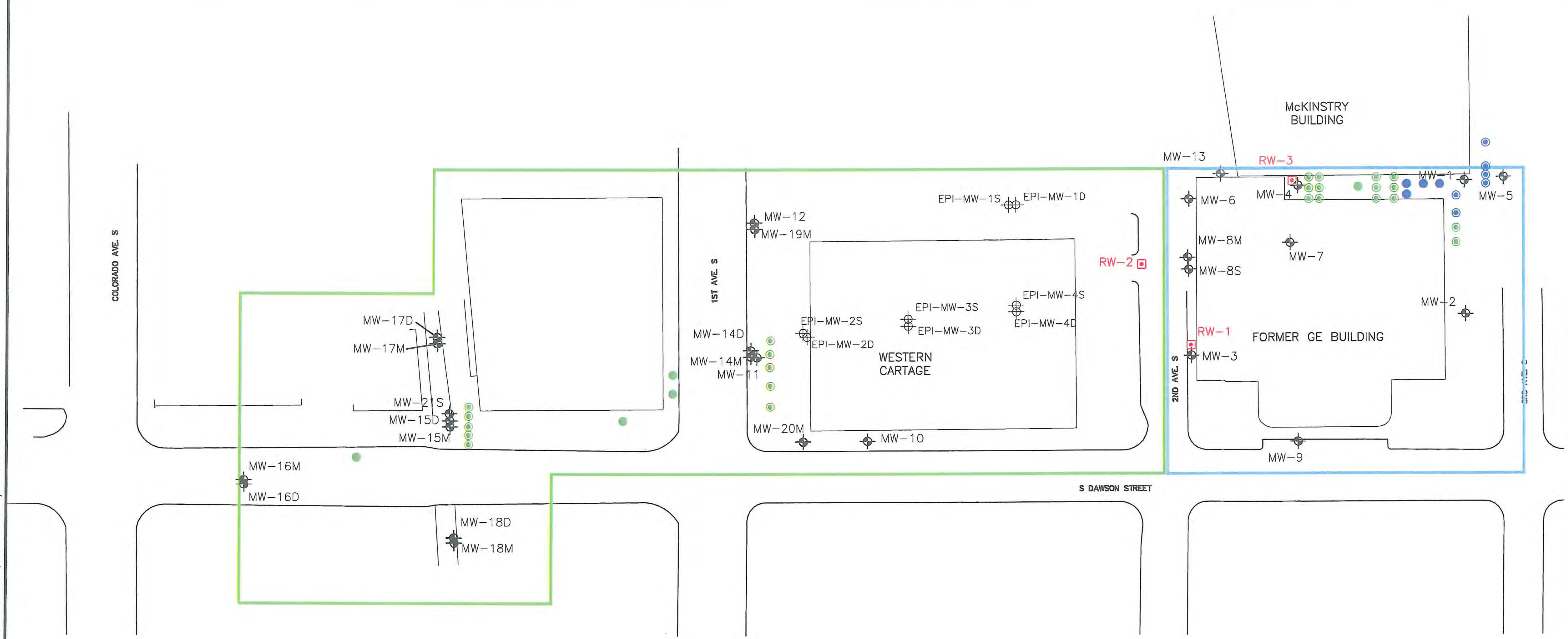
GE - S. DAWSON STREET 02978-415-735	ALTERNATIVE 4
DATE: 06/03/08 DRWN: E.M./SEA	FIGURE 5-5

File: L:\GE-S.Dawson\02978_ALT_4.dwg Layout: FIGURE 5-5 User: emarshall Plotted: Jun 16, 2008 - 12:46pm Xref's:



ALTERNATIVE DETAILS:

1. RECOVERY SYSTEM WILL BE ABANDONED AFTER PHASE 3 OF INJECTION. THE RECOVERY SYSTEM WILL NOT OPERATE BETWEEN INJECTIONS.
2. 1 TO 4% POTASSIUM PERMANGANATE INJECTED IN ON-SITE AND OFF-SITE INJECTION POINTS.
3. ON-SITE AREA INJECTION POINTS ARE SCREENED AT 4 FEET BELOW WATER TABLE AND 12 TO 16 FEET BGS.
4. OFF-SITE AREA INJECTION POINTS ARE SCREENED AT 20 TO 24, 26 TO 30, AND 51 TO 55 FEET BGS.
5. OPERATION IS EXPECTED TO BE 2 PHASES, 6 MONTHS APART, FOR A TOTAL OF 3 YEARS.
6. INCLUDES SUB SLAB DEPRESSURIZATION SYSTEM – SEE FIGURE 5-2
7. PERFORMANCE MONITORING WILL INCLUDE VAPOR (INDOOR AIR) AND GROUNDWATER SAMPLES FOR 3 YEARS.

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- PHASE 1 INJECTION POINT
- PHASE 1 OBSERVATION POINT
- PHASE 2 AND 3 INJECTION POINT
- PHASE 2 AND 3 OBSERVATION POINT
- ON-SITE AREA
- OFF-SITE AREA

50 0 100

SCALE IN FEET

NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. LOCATIONS ARE APPROXIMATE.

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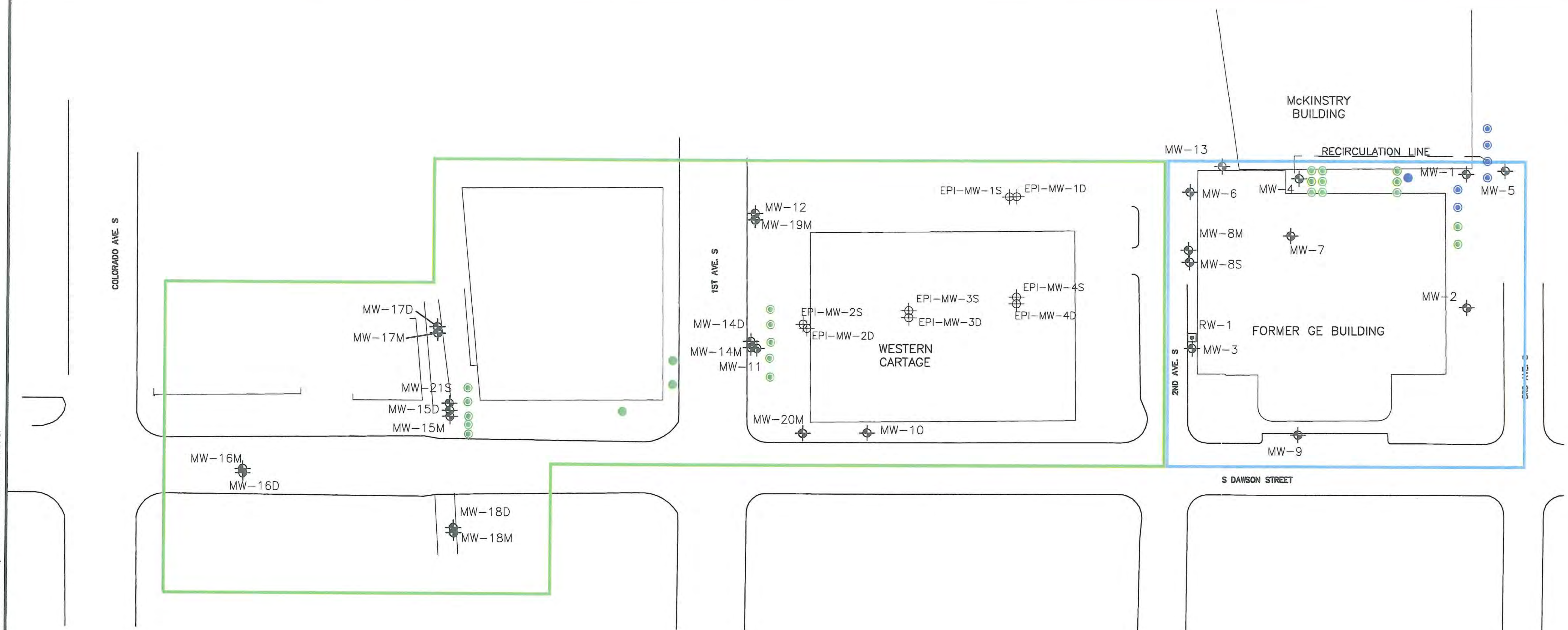
GE - S. DAWSON STREET 02978-415-735	ALTERNATIVE 5
DATE: 6/9/08 DRWN: E.M./SEA	FIGURE 5-6

File: L:\GE-S.Dawson\02978_ALT_5.dwg Layout: FIGURE 5-6 User: MarshallE Plotted: Oct 10, 2008 - 3:10pm Xref's:



ALTERNATIVE DETAILS:

1. RECOVERY SYSTEM WILL BE ABANDONED AFTER PHASE 3 OF INJECTION. THE RECOVERY SYSTEM WILL NOT OPERATE BETWEEN INJECTIONS. IN THE ON-SITE AREA GROUNDWATER WILL BE RECIRCULATED DURING INJECTIONS.
2. SOLUBLE AND INSOLUBLE ELECTRON DONORS INJECTED IN THE ON-SITE AND OFF-SITE INJECTION POINTS.
3. ON-SITE AREA INJECTION POINTS ARE SCREENED AT 4 FEET BELOW WATER TABLE AND 12 TO 16 FEET BGS.
4. OFF-SITE INJECTION POINTS ARE SCREENED AT 20 TO 24 AND 26 TO 30 FEET BGS.
5. INCLUDES SUB SLAB DEPRESSURIZATION SYSTEM - SEE FIGURE 5-2.
6. PERFORMANCE MONITORING WILL INCLUDE VAPOR (INDOOR AIR) AND GROUNDWATER SAMPLES FOR 3 YEARS.

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- PHASE 1 INJECTION POINT
- PHASE 1 OBSERVATION POINT
- PHASE 2 AND 3 INJECTION POINT
- PHASE 2 AND 3 OBSERVATION POINT
- ON-SITE AREA
- OFF-SITE AREA

NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. LOCATIONS ARE APPROXIMATE.

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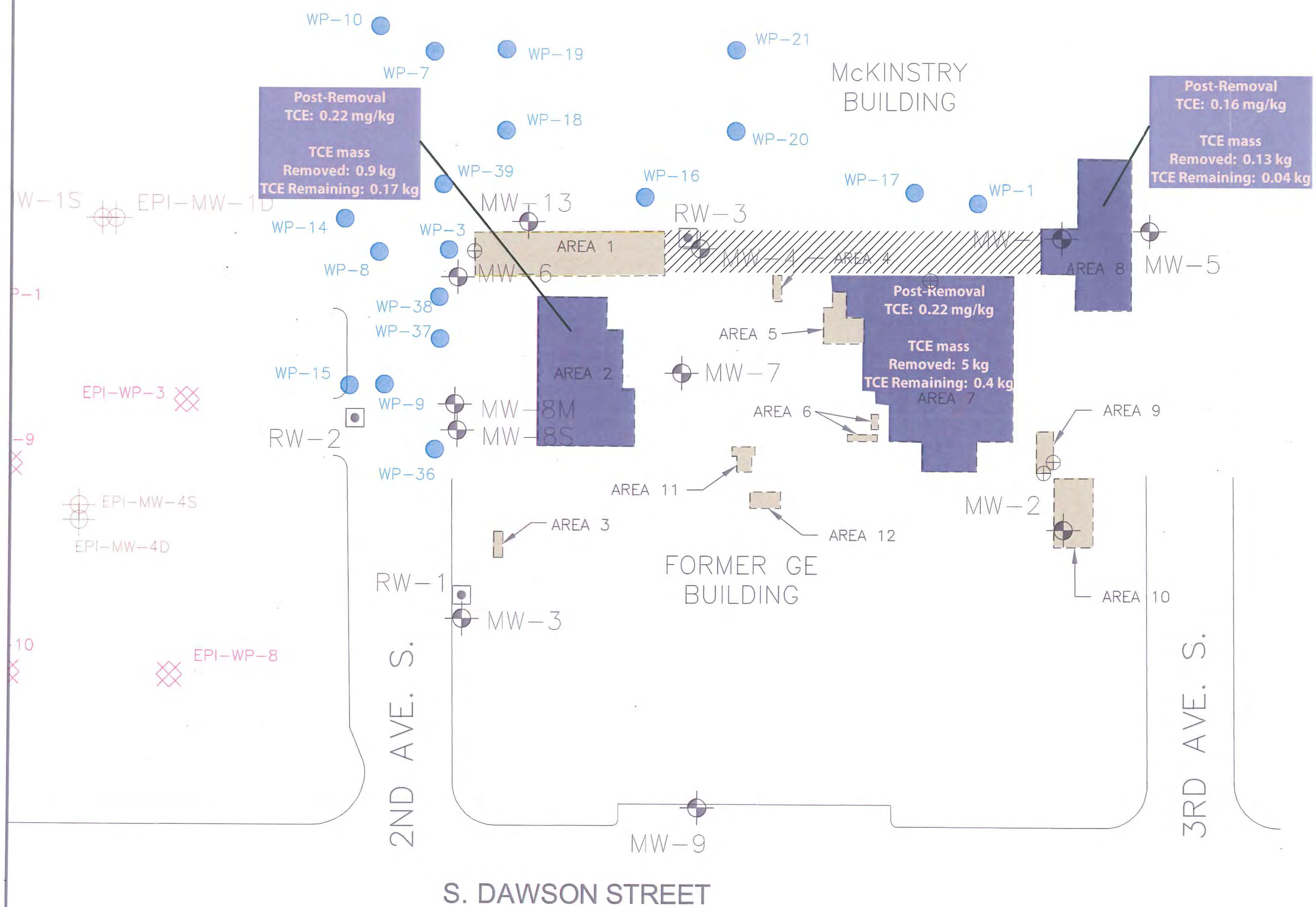
GE - S. DAWSON STREET 02978-415-735	ALTERNATIVE 6
DATE: 6/9/08 DRWN: E.M./SEA	FIGURE 5-7

File: L:\GE-S.Dawson\02978_ALT_6.dwg Layout: FIGURE 5-7 User: emarshall Plotted: Jun 13, 2008 - 10:29am Xref's:



NOTES:

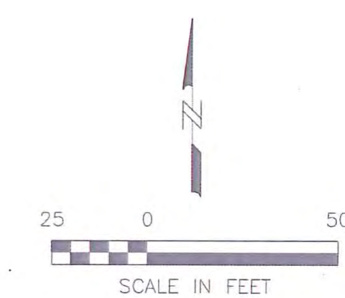
1. Explanation of information provided for Areas 2, 7, and 8:

a. "Post-Removal TCE: xx mg/kg" is the 95% upper confidence limit (UCL) for detected TCE Concentrations (1/2 detection limits were used for non-detected concentrations)

b. "TCE Mass - Removed:" is an estimate of the mass of TCE that was removed from the vadose zone in each of the three removal areas. "TCE Mass - Remaining:" is an estimate of the mass of TCE that remained in place at the end of the removal action.

c. Removal Volumes were estimated from information provided in the removal action report (Dames & Moore 1996). Removed and remaining TCE mass was estimated by comparing total volume of remaining (left inplace) soil to 95% UCL concentrations for each specified area.

2. Hatched Area was the site of a RCRA Clean Closure.



LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- EPI MONITORING WELL
- EPI GEOPROBE BORING (APPROX)
- GEOPROBE LOCATION (APPROX)
- Left in Place Conc. and Mass Shown / Less than 0.03 mg/kg or ND — EXCAVATION AREA
- AREA NOT EXCAVATED IN EXCEEDANCE OF MTCA CRITERIA

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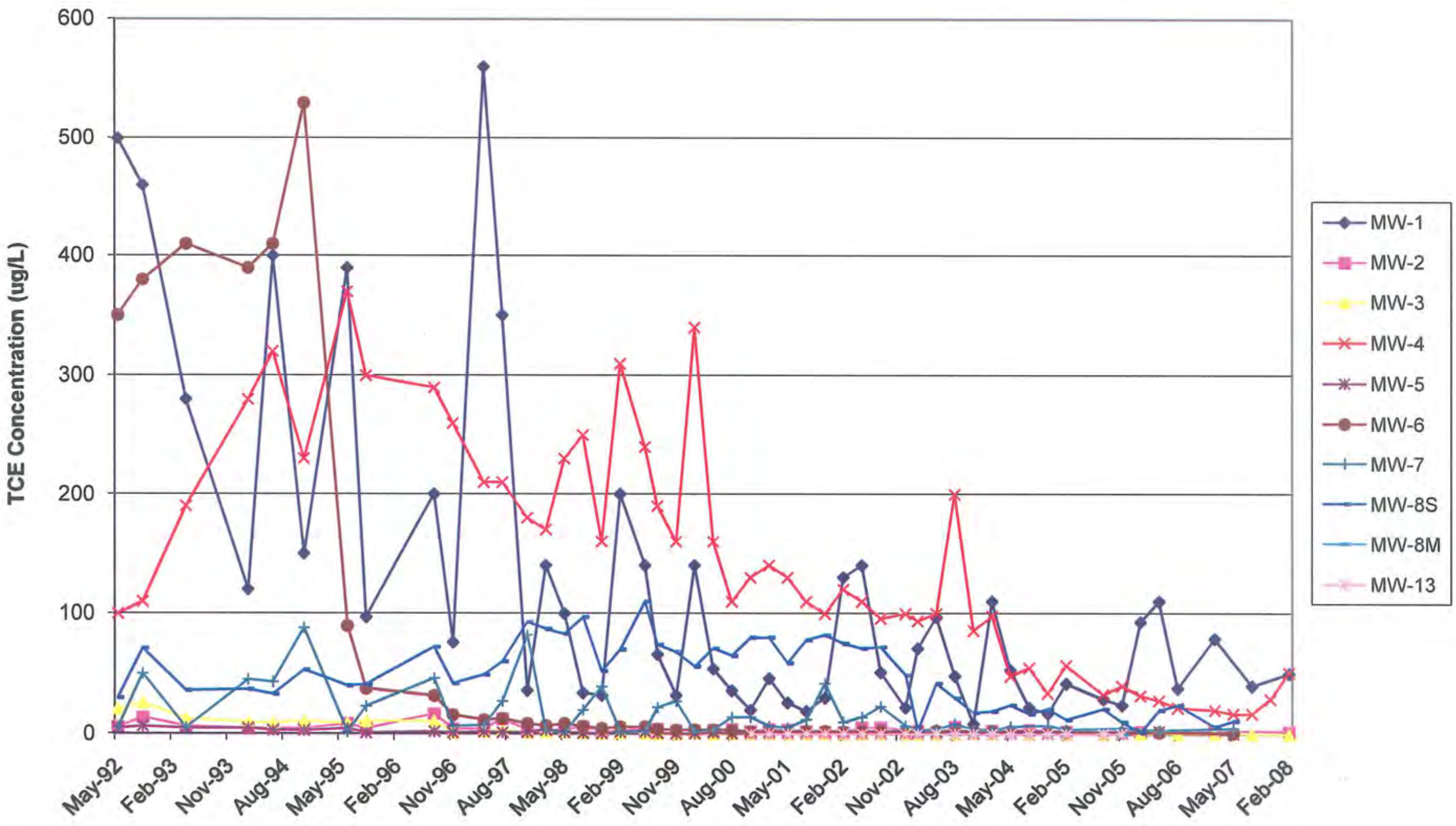
GE - S. DAWSON STREET 02978-415-735	Illustration of Soil Removal Areas and Concentrations Left In Place
DATE: 09/23/08 DRWN: TB/SEA	Figure 5-8

Figure 5-9 TCE Concentrations in On-Site Area Wells (1992 -2008)



Appendix A

Groundwater Analytical Data Results

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-1 (Shallow)	MW-1-10	11/20/1996	15	1.6	0.8	1.2	4.6	76	45	< 0.2
	MW-1-11	4/17/1997	17 E	< 0.4	2.5	< 0.4	< 0.4	560 D	< 0.4	< 0.2
	MW-1-12	7/21/1997	9.7	< 0.4	0.3 J	5.1	10	350 E,D	100 D	< 0.2
	MW-1-13	11/19/1997	28 B	0.88	2.4	0.4	2.4	36	32	< 0.2
	MW-1-14	2/24/1998	8.7	2.2	0.9	3.3	5.9	140 D	43 D	< 0.2
	MW-1-15	5/20/1998	14 D	0.95	0.6	1.4	4.2	100 D	41 D	< 0.2
	MW-1-16	8/12/1998	18 D	0.4	0.8	0.3	3.0	34 D	25 D	< 0.2
	MW-20-16	8/12/1998	19 D	0.4	0.6	0.3	3.0	33 D	24 D	< 0.2
	MW-1-17	11/9/1998	22 B,D	0.6	0.4	0.3	2.4	32 D	20 D	< 0.2
	MW-1-18	2/24/1999	15	0.9 J	2.1	2.2	7.2	200	59	< 2.0
	MW-20 (Dup)	2/24/1999	22 D	1.1	2.0	2.2	7.0	200 D	56 D	< 0.2
	MW-1-19	6/8/1999	12	1.1	< 1.0	1.1	6.1	140	71	< 1.0
	MW-1-20	8/25/1999	11	< 2.0	< 2.0	< 2.0	4.5	66	50	< 2.0
	MW-1-21	11/22/1999	4.7	< 1.0	< 1.0	< 1.0	2.5	32	20	< 1.0
	MW-20 (Dup)	11/22/1999	4.9	< 1.0	< 1.0	< 1.0	2.6	31	20	< 1.0
	MW-1-200	2/2/2000	9.3 B	1.4	0.6	1.0	6.8	140	42	< 0.6
	MW-1-0500	5/23/2000	< 1.0	< 1.0	< 1.0	< 1.0	3.2	54	32	< 1.0
	MW-1-0800	8/29/2000	4.8	< 1.0	< 1.0	< 1.0	3.0	36	22	< 1.0
	MW-1-1100	11/28/2000	2.9	< 1.0	< 1.0	< 1.0	2.3	20	16	< 1.0
	MW-1-0201	2/20/2001	2.9	0.5	0.3	0.3	3.2	46 D	16 D	< 0.2
	MW-1-0501	5/24/2001	2.4 D	< 1.0	< 1.0	< 1.0	2.2 D	26 D	18 D	< 1.0
	MW-20-0501 (Dup)	5/24/2001	2.0 D	0.5	0.2	0.2	2.4 D	31 D	18 D	< 0.2
	MW-1-0801	8/27/2001	1.8	< 0.6	< 0.6	< 0.6	1.5	19	13	< 0.6
	MW-1-1101	11/5/2001	1.7	0.4	0.2	< 0.2	1.8	30 D	13	< 0.2
	MW-1-0202	2/21/2002	1.9	1.7	0.7	1.1	4.5	130	33	< 0.2
	MW-20-0202 (Dup)	2/21/2002	1.9	1.8	0.7	1.2	4.0	140	37	< 0.2
	MW-1-0502	5/23/2002	2.1 J	< 3.0	< 3.0	< 3.0	4.5	140 D	38 D	< 3.0
	MW-1-0802	8/14/2002	1.2	0.4	< 0.2	< 0.2	3.4	51 D	18 D	< 0.2
	MW-20-0802 (Dup)	8/14/2002	1.2	0.4	< 0.2	< 0.2	3.5	51 D	18 D	< 0.2
	MW-1-1202	12/3/2002	0.8	0.2	0.15 b	< 0.2	2.5 b	22 D	10	< 0.02 b
	MW-1-0203	2/26/2003	1.0	1.2	0.33 b	0.6	3.2	71 D	17 D	< 0.02 b
	MW-1-0503	5/28/2003	< 2.0	< 2.0	0.35 b	< 2.0	3.7	97	34	< 0.02 b
	MW-1-0803	8/20/2003	< 2.0	< 2.0	0.17 b	< 2.0	2.5	48	25	< 0.02 b
	MW-1-1103	11/20/2003	0.3	< 0.2	0.057 b	< 0.2	1.1 b	8.5	4.3	< 0.02 b
	MW-1-0204	2/23/2004	1.4	< 1.0	0.39 b	< 1.0	4.3 b	110	34	< 0.02 b
	MW-1-0504	5/25/2004	0.7	0.2	0.20 b	< 0.2	3.7 b	53	26	< 0.02 b
	MW-1-0804	8/25/2004	< 0.6	< 0.6	0.13 b	< 0.6	1.9 b	22	10	< 0.02 b
	MW-1-1104	11/29/2004	< 0.6	< 0.6	0.089 b	< 0.6	1.7	17	7.8	< 0.02 b
	MW-1-0205	2/28/2005	< 1	< 1	0.17 b	< 1	2.4 b	42	18	< 0.02 b
	MW-1-0805	8/8/2005	< 1	< 1	0.14 b	< 1	2 b	29	18	< 0.02 b
	MW-1-1105	11/17/2005	< 0.6	< 0.6	0.12 b	< 0.6	1.8	24	11	< 0.02 b
	MW-1-0206	2/6/2006	1.4	< 1	< 1	< 1	4.6 b	93 x	26	< 0.02 b
	MW-1-0506	5/16/2006	1.7	< 1	< 1	< 1	4.6	110 x	25	< 0.02 b
	MW-1-0806	8/18/2006	1.2	< 1	< 1	< 1	2.4	38	18	< 0.02 b
	MW-1-0207	2/19/2007	< 2	< 2	< 2	< 2	4.9 b	79	17	< 0.02 b
	MW-1-0807	8/17/2007	1.5	< 1	< 1	< 1	2.5	40	22	< 0.02 b
	MW-1-0208	2/20/2008	1.2	0.6	< 0.2	0.4	2.6 b	50 bJ	25	< 0.02 b
	Rolling Average		1.5	1.1	1.0	1.1	3.60	43.3	22.2	0.02
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-2 (Shallow)	MW-2-10	11/20/1996	< 0.2	< 0.2	< 0.2	0.4	< 0.2	4.5	< 0.2	< 0.2
	MW-2-11	4/17/1997	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	4.4	< 0.4	< 0.2
	MW-2-12	7/21/1997	< 0.4	< 0.4	< 0.4	0.9	0.6	13 D	0.2 J	< 0.2
	MW-2-13	11/19/1997	< 0.4	< 0.4	< 0.4	0.6	< 0.4	3.8	< 0.4	< 0.2
	MW-2-14	2/24/1998	< 0.4	< 0.4	< 0.2	< 0.4	< 0.2	3.2	< 0.4	< 0.2
	MW-2-15	5/20/1998	< 0.4	< 0.4	< 0.4	0.4	< 0.4	4.2	< 0.4	< 0.2
	MW-2-16	8/12/1998	< 0.2	< 0.2	< 0.2	1.0	0.2	6.2	< 0.2	< 0.2
	MW-2-17	11/9/1998	< 0.2	< 0.2	< 0.2	0:4	< 0.2	2.4	< 0.2	< 0.2
	MW2-19	6/8/1999	< 0.2	< 0.2	< 0.2	0.2 J	0.2	4.2	< 0.2	< 0.2
	MW2-20	8/25/1999	< 0.2	< 0.2	< 0.2	0.3	0.2	4.5	< 0.2	< 0.2
	MW2-21	11/22/1999	< 0.2	< 0.2	< 0.2	0.3	< 0.2	3.5	< 0.2	< 0.2
	MW-2-200	2/2/2000	< 0.2	< 0.2	< 0.2	< 0.2	0.2	3.0	< 0.2	< 0.2
	MW-2-0500	5/23/2000	< 0.2	< 0.2	< 0.2	0.3	< 0.2	3.6	< 0.2	< 0.2
	MW-2-0800	8/29/2000	< 0.2	< 0.2	< 0.2	0.5	< 0.2	4.5	< 0.2	< 0.2
	MW-2-1100	11/28/2000	< 0.2	< 0.2	< 0.2	0.4	< 0.2	2.7	< 0.2	< 0.2
	MW-2-0201	2/20/2001	< 0.2	< 0.2	< 0.2	0.6	0.2	4.4	< 0.2	< 0.2
	MW-2-0501	5/24/2001	< 0.2	< 0.2	< 0.2	0.6	< 0.2	4.0	< 0.2	< 0.2
	MW-2-0801	8/27/2001	< 0.2	< 0.2	< 0.2	0.6	< 0.2	2.8	< 0.2	< 0.2
	MW-2-1101	11/5/2001	< 0.2	< 0.2	< 0.2	0.3	< 0.2	2.2	< 0.2	< 0.2
	MW-2-0202	2/21/2002	< 0.2	< 0.2	< 0.2	0.2	< 0.2	2.2	< 0.2	< 0.2
	MW-2-0502	5/23/2002	< 0.2	< 0.2	< 0.2	0.6	0.2	5.8	0.2	< 0.2
	MW-2-0802	8/14/2002	< 0.2	< 0.2	< 0.2	0.7	< 0.2	5.9	< 0.2	< 0.2
	MW-2-0203	2/26/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.19 bUB	3.1	< 0.2	< 0.02 b
	MW-2-0803	8/20/2003	< 0.2	< 0.2	< 0.02 b	0.8	0.21 b	6.8	< 0.2	< 0.02 b
	MW-2-0204	2/24/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	0.24 b	3.4	< 0.2	< 0.02 b
	MW-2-0804	8/27/2004	< 0.2	< 0.2	< 0.02 b	0.4	0.15 b	3.9	< 0.2	< 0.02 b
	MW-2-0205	2/28/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	0.11 b	2.8	< 0.2	< 0.02 b
	MW-2-0206	2/8/2006	< 0.2	< 0.2	< 0.2	< 0.2	0.13 b	2.5 b	< 0.2	< 0.02 b
	MW-2-0207	2/23/2007	< 0.2	< 0.2	< 0.2	< 0.2	0.21 b	3 b	< 0.2	< 0.02 b
	MW-2-0208	2/21/2008	< 0.2	< 0.2	< 0.2	< 0.2	0.16 b	2.4	< 0.2	< 0.02 b
	Rolling Average		0.2	0.2	0.1	0.2	0.17	3.00	0.2	0.02 b
RW-2	RW-2	*8/13/1996*	*0.6*	*37 D*	*24 D*	*87 D*	< *0.2*	*32 D*	*0.2*	*0.3*
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-3 (Shallow)	MW-3-10	11/20/1996	< 0.2	11	6.0	2.2	< 0.2	1.2	0.6	< 0.2
	MW-3-10D	11/20/1996	< 0.2	11	5.7	1.9	< 0.2	1.3	0.7	< 0.2
	MW-3-11	4/17/1997	< 0.4	11 D	6.6	3.2	< 0.4	2.3	< 0.4	< 0.2
	MW-3-12	7/21/1997	< 0.4	4.7	2.9	1.3	< 0.4	3.3	0.4	< 0.2
	MW-20 (Dup)	7/21/1997	< 0.4	4.4	2.7	1.1	< 0.4	3.1	0.4 J	< 0.2
	MW-3-13	11/19/1997	< 0.4	3.3	1.5	0.92	< 0.4	1.3	< 0.4	0.8
	MW-3-14	2/24/1998	0.28 J	2.5	1.2	0.70	< 0.2	1.9	< 0.4	< 0.2
	MW-3-15	5/20/1998	< 0.4	1.6	0.65	0.46	< 0.4	1.6	< 0.4	< 0.2
	MW-3-16	8/12/1998	< 0.2	2.0	1.0	0.70	< 0.2	1.2	< 0.2	< 0.2
	MW-3-17	11/9/1998	< 0.2	1.1	0.5	0.60	< 0.2	0.7	< 0.2	< 0.2
	MW-3-18	2/24/1999	< 0.2	0.9	1.6	0.6	< 0.2	1.1	< 0.2	< 0.2
	MW-3-19	6/8/1999	< 0.2	1.1	0.5	0.5	< 0.2	0.9	< 0.2	< 0.2
	MW-3-20	8/25/1999	< 0.2	0.5	0.3	0.3	< 0.2	0.5	< 0.2	< 0.2
	MW-20 (Dup)	8/25/1999	< 0.2	0.5	0.2	0.3	< 0.2	0.4	< 0.2	< 0.2
	MW-3-21	11/22/1999	< 0.2	0.2	< 0.2	0.3	< 0.2	0.3	< 0.2	< 0.2
	MW-3-200	2/2/2000	< 0.2	0.9	0.4	0.6	< 0.2	0.8	< 0.2	< 0.2
	MW-3-0500	5/23/2000	< 0.2	0.3	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2
	MW-3-0800	8/29/2000	< 0.2	0.7	0.4	0.5	< 0.2	0.6	< 0.2	< 0.2
	MW-20-0800 (Dup)	8/29/2000	< 0.2	0.6	0.4	0.5	< 0.2	0.5	< 0.2	< 0.2
	MW-3-1100	11/28/2000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.5	< 0.2	< 0.2
	MW-3-0201	2/20/2001	< 0.2	0.3	< 0.2	< 0.2	< 0.2	0.4	< 0.2	< 0.2
	MW-3-0501	5/24/2001	< 0.2	< 0.2	< 0.2	0.2	< 0.2	0.3	< 0.2	< 0.2
	MW-3-0801	8/27/2001	< 0.2	0.3	0.2	0.4	< 0.2	0.3	< 0.2	< 0.2
	MW-3-1101	11/5/2001	< 0.2	< 0.2	0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2
	MW-20-1101 (Dup)	11/5/2001	< 0.2	0.2	0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2
	MW-3-0202	2/21/2002	< 0.2	< 0.2	< 0.2	0.6	< 0.2	0.4	< 0.2	< 0.2
	MW-3-0502	5/23/2002	< 0.2	< 0.2	< 0.2	0.6	< 0.2	0.2	< 0.2	< 0.2
	MW-3-0802	8/14/2002	< 0.2	< 0.2	< 0.2	0.4	< 0.2	0.4	< 0.2	< 0.2
	MW-3-1202	12/3/2002	< 0.2	< 0.2	0.066 b	0.2	< 0.05 b	0.3	< 0.2	< 0.02 b
	MW-3-0203	2/26/2003	< 0.2	0.2	0.052 b	0.5	< 0.05 b	< 0.2	< 0.2	< 0.02 b
	MW-3-0503	5/28/2003	< 0.2	< 0.2	0.036 b	< 0.2	< 0.05 b	0.3	< 0.2	< 0.02 b
	MW-3-0803	8/20/2003	< 0.2	< 0.2	0.021 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-3-1103	11/21/2003	< 0.2	< 0.2	0.020 b	< 0.2	< 0.02 b	0.8	< 0.2	< 0.02 b
	MW-3-0204	2/24/2004	< 0.2	< 0.2	0.028 b	< 0.2	< 0.02 b	0.4	< 0.2	< 0.02 b
	MW-25-0204 (Dup)	2/24/2004	< 0.2	< 0.2	0.027 b	< 0.2	< 0.02 b	0.4	< 0.2	< 0.02 b
	MW-3-0804	8/25/2004	< 0.2	< 0.2	0.032 b	< 0.2	< 0.02 b	0.4	< 0.2	< 0.02 b
	MW-30-0804 (Dup)	8/25/2004	< 0.2	< 0.2	0.024 b	< 0.2	< 0.02 b	0.4	< 0.2	< 0.02 b
	MW-3-0205	3/2/2005	< 0.2	< 0.2	0.024 b	< 0.2	< 0.02 b	0.4	< 0.2	< 0.02 b
	MW-3-0805	8/9/2005	< 0.2	< 0.2	0.023 b	< 0.2	< 0.02 b	0.3	< 0.2	< 0.02 b
	MW-3-0206	2/7/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.75 b	< 0.2	< 0.02 b
	MW-3-0806	8/17/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.37 b	< 0.2	< 0.02 b
	MW-3-0207	2/19/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.66 b	< 0.2	< 0.02 b
	MW-3-0807	8/13/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02	0.34 b	< 0.2	< 0.02 b
	MW-3-0208	2/20/2008	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.033 b	< 0.2	< 0.02 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-4 (Shallow)	MW-4-10	11/21/1996	3.8	46	38	6.1	2.6	260	120	0.2
	MW-4-11	4/17/1997	< 0.4	< 0.4	22 E	< 0.4	2.7	210 D	< 0.4	< 0.2
	MW-4-12	7/21/1997	2.5	< 0.4	18 D	5.4	2.2	210 D	99 D	< 0.2
	MW-4-13	11/19/1997	1.1 B	41	21	5.7	1.2	180	78	4.8
	MW-4-14	2/24/1998	1.2	18 D	10	5.7	1.7	170 D	44	< 0.2
	MW-4-15	5/20/1998	1.1	32 D	19 D	9.7	1.5	230 D	40 D	< 0.2
	MW-20-15	5/20/1998	1.2	31 D	18 D	9.7	1.5	240 D	44 D	< 0.2
	MW-4-16	8/12/1998	1.5	24 D	15 D	11 D	2.0	250 D	59 D	0.4
	MW-4-17	11/9/1998	0.8 B	22 D	9.2	6.4	1.3	160 D	36 D	< 0.2
	MW-4-18	2/24/1999	1.8	6.5	15	8.0	2.4	310 D	49	< 2.0
	MW-4-19	6/8/1999	< 1.0	14	6.8	7.5	2.4	240	37	< 1.0
	MW-20-(Dup)	6/8/1999	< 1.0	14	6.9	7.6	2.5	240	33	< 1.0
	MW-4-20	8/25/1999	< 6.0	10	< 6.0	6.3	< 6.0	190	27	< 6.0
	MW-4-21	11/22/1999	< 1.0	7.2	3.4	4.3	1.4	160	18	< 1.0
	MW-4-200	2/2/2000	3.9 B	14	7.8	9.9	3.0	340	38	< 3.0
	MW-4-0500	5/23/2000	< 1.0	9.0	3.6	5.0	1.1	160	18	< 1.0
	MW-4-0800	8/29/2000	< 1.0	9.2	2.2	4.6	1.0	110	14	< 1.0
	MW-4-1100	11/28/2000	0.5	6.3	2.7	3.9	1.3	130	17	< 0.2
	MW-20-1100 (Dup)	11/28/2000	0.5	6.6	2.8	3.9	1.3	130	18	< 0.2
	MW-4-0201	2/20/2001	0.5	7.8	3.3	5.8	1.3	140 D	14 D	< 0.2
	MW-4-0501	5/24/2001	< 4.0	9.2 D	< 4.0	6.4 D	< 4.0	130 D	16 D	< 4.0
	MW-4-0801	8/27/2001	< 1.0	4.5	2.0	2.8	< 1.0	110	9.1	< 1.0
	MW-4-1101	11/5/2001	0.4	4.0	1.8	3.3	0.6	100 D	7.9	< 0.2
	MW-4-0202	2/21/2002	0.2	4.2	2.0	2.8	0.8	120	5.8	< 0.2
	MW-4-0502	5/23/2002	< 3.0	4.1 D	< 3.0	< 3.0	< 3.0	110 D	7.7 D	< 3.0
	MW-4-0802	8/14/2002	0.4	3.7	1.5	2.2	1.1	96 D	6.8	< 0.2
	MW-4-1202	12/3/2002	< 2.0	3.6 D	1.2 b	2.5 D	1.3 b	100 D	5.3 D	0.041 b
	MW-4-0203	2/26/2003	< 2.0	4.2	1.1 b	2.0	1.0 b	94	5.5	0.030 b
	MW-4-0503	5/28/2003	< 2.0	4.0	1.4 b	< 2.0	1.2 b	100	7.4	0.044 b
	MW-4-0803	8/20/2003	< 4.0	6.2	2.6 b	< 4.0	4.0 b	200	29	0.039 b
	MW-4-1103	11/20/2003	< 1.0	12	3.6 b	< 1.0	3.8 b	86	20	0.062 b
	MW-20-1103 (Dup)	11/20/2003	< 1.0	13	3.6 b	< 1.0	3.7 b	86	20	0.062 b
	MW-4-0204	2/24/2004	< 1.0	8.2	3.1 b	< 1.0	4.0 b	98	20	0.043 b
	MW-4-0504	5/25/2004	< 0.2	8.6	3.8 b	0.2	2.6 b	48	12	0.028 b
	MW-4-0804	8/25/2004	< 1.0	9.5	3.8 b	< 1.0	3.1 b	55	15	0.053 b
	MW-4-1104	11/29/2004	< 1.0	4.8	3 b	< 1.0	2.1	34	9	0.033 b
	MW-4-0205	2/28/2005	< 1.0	2.7	1.8 b	< 1.0	2.3 b	57	17	< 0.02 b
	MW-4-0505	5/31/2005	< 1	7.1	3.9 b	< 1	1.9 b	33	13	0.036 b
	MW-4-0805	8/8/2005	< 0.6	6	2.7 b	< 0.6	2 b	33	15	0.04 b
	MW-4-1105	11/14/2005	< 0.6	7.2	3.4	< 0.6	2.3	40	12	0.032 b
	MW-4-0206	2/6/2006	< 1	5.4	2.8	< 1	2.3 b	32	14	0.037 b
	MW-4-0506	5/16/2006	< 0.6	8.9	3.8	< 0.6	1.6 b	28	12	0.026 b
	MW-4-0806	8/18/2006	< 1	6.1	2.5	< 1	1.5 b	22	11	0.024 b
	MW-40-0806 (Dup)	8/18/2006	< 1	5.5	2.4	< 1	1.6 b	22	10	0.024 b
	MW-4-1106	11/7/2006	< 1	4.2	2.4	< 1	1.3 b	20	9	< 0.02 b
	MW-4-0207	2/20/2007	< 1	5.4	3.2	< 1	1.4 b	20	6.4	< 0.02 b
	MW-D4-0507	5/21/2007	< 0.2	4.4	3.2	< 0.2	1.2 b	17	5.4	0.027 b
	MW-4-0807	8/14/2007	< 0.2	6.6	3.1	< 0.2	1.3 J	17	9.1	0.032 J
	MW-4-1107	11/13/2007	< 0.6	4.9	2.1	< 0.6	1.7	29 b	15	0.031
	MW-4-0208	2/21/2008	0.2	4.3 J	2.4	0.4 J	2.5 b	51 bJ	25	0.021 b
	DUP-3-0208 (Dup)	2/21/2008	< 2	5.9 J	2.9	< 2 UJ	2.4 b	47 bJ	28	0.022 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-5 (Shallow)	MW-5-10	11/21/1996	7.6	0.6	0.4	< 0.2	1.1	4.9	20	< 0.2
	MW-5-11	4/17/1997	11	< 0.4	< 0.4	< 0.4	0.60	1.0	< 0.4	< 0.2
	MW-5-12	7/21/1997	26 D	0.3 J	0.5	< 0.4	1.2	2.2	16 D	< 0.2
	MW-5-13	11/19/1997	4.1 B	0.5	0.9	< 0.4	0.30 J	1.1	8.1	< 0.2
	MW-5-14	2/24/1998	8.2	< 0.4	< 0.2	< 0.4	0.88	1.9	9.2 D	< 0.2
	MW-5-15	5/20/1998	14 D	< 0.4	< 0.4	< 0.4	0.62	1.3	9.1	< 0.2
	MW-5-16	8/12/1998	17 D	0.2	0.3	< 0.2	0.60	1.6	13 D	< 0.2
	MW-5-17	11/9/1998	9 B	0.5	0.3	< 0.2	0.70	3.3	16 D	< 0.2
	MW-5-18	2/24/1999	12	< 1.0	< 1.0	< 1.0	0.9 J	1.6	9.2	< 2.0
	MW-5-19	6/8/1999	3.7	0.5	< 0.2	< 0.2	0.4	0.8	8.5	< 0.2
	MW-5-20	8/25/1999	0.8	< 0.2	< 0.2	< 0.2	0.3	0.7	3.5	< 0.2
	MW-5-21	11/22/1999	3.4	< 0.2	< 0.2	< 0.2	< 0.2	1.7	8.7	< 0.2
	MW-5-200	2/2/2000	5.2 B	0.3	< 0.2	< 0.2	0.6	2.0	13	< 0.2
	MW-20-200 (Dup)	2/2/2000	4.4 B	0.2	< 0.2	< 0.2	0.4	1.5	13	< 0.2
	MW-5-0500	5/23/2000	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.7	< 1.0
	MW-5-0800	8/29/2000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.5	1.1	< 0.2
	MW-5-1100	11/28/2000	< 0.2	< 0.2	< 0.2	< 0.2	0.2	0.6	0.9	< 0.2
	MW-5-0201	2/20/2001	0.4	< 0.2	< 0.2	< 0.2	0.2	1.4	3.0	< 0.2
	MW-5-0501	5/24/2001	< 0.2	< 0.2	< 0.2	< 0.2	0.2	0.6	1.5	< 0.2
	MW-5-0801	8/27/2001	0.2	< 0.2	< 0.2	< 0.2	0.2	1.0	2.3	< 0.2
	MW-5-1101	11/5/2001	0.2	< 0.2	< 0.2	< 0.2	0.3	1.6	2.4	< 0.2
	MW-5-0202	2/21/2002	0.2	< 0.2	< 0.2	< 0.2	0.2	1.0	2.3	< 0.2
	MW-5-0502	5/23/2002	< 0.2	< 0.2	< 0.2	< 0.2	0.2	0.8	1.6	< 0.2
	MW-5-0802	8/14/2002	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.4	0.9	< 0.2
	MW-5-1202	12/3/2002	< 0.2	< 0.2	< 0.02 b	< 0.2	0.32 b	0.8	1.5	< 0.02 b
	MW-5-0203	2/26/2003	< 0.2	< 0.2	0.022 b	< 0.2	< 0.30 bUB	1.0	2.5	< 0.02 b
	MW-5-0503	5/28/2003	< 0.2	< 0.2	0.024 b	< 0.2	0.24 b	0.7	2.5	< 0.02 b
	MW-5-0803	8/20/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	0.22 b	0.8	1.9	< 0.02 b
	MW-5-1103	11/20/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	0.23 b	0.9	1.0	< 0.02 b
	MW-5-0204	2/24/2004	0.2	< 0.2	0.042 b	< 0.2	0.45 b	2.0	8.0	< 0.02 b
	MW-5-0804	8/25/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	0.21 b	0.7	1.8	< 0.02 b
	MW-5-0205	2/28/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	0.15 b	0.6	2.3	< 0.02 b
	MW-5-0805	8/9/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	0.16 b	0.6	2.4	< 0.02 b
	MW-5-0206	2/7/2006	1.6	< 0.2	< 0.2	< 0.2	0.39 b	2.8 b	7.7	< 0.02 b
	MW-5-0806	8/18/2006	< 0.2	< 0.2	< 0.2	< 0.2	0.28 b	0.79 b	1.2	< 0.02 b
	MW-5-0207	2/23/2007	3.1	< 0.2	< 0.2	< 0.2	0.56 b	2.5 b	7.1	< 0.02 b
	MW-5-0807	8/17/2007	0.2	< 0.2	< 0.2	< 0.2	0.3 b	0.7 b	1.7	< 0.02 b
	MW-5-0208	2/20/2008	0.4	< 0.2	< 0.2	< 0.2	< 0.02 b	0.41 b	4.1	< 0.02 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-6 (Shallow)	MW-6-10	11/20/1996	0.2	23	15	3.1	0.5	90	17	< 0.2
	MW-6-11	4/17/1997	< 0.4	8.4 D	·10	2.5	< 0.4	38 D	< 0.4	< 0.2
	MW-20 (Dup)	4/17/1997	< 0.4	9.5 D	10	2.7	< 0.4	43 D	6.7	< 0.2
	MW-6-12	7/21/1997	< 0.4	10	5.8	1.0	0.2 J	32 D	7.3	< 0.2
	MW-6-13	11/19/1997	< 0.4	4.6	2.7	0.4	< 0.4	16 D	3.9	1.1
	MW-6-14	2/24/1998	< 0.4	3.6	1.7	0.37 J	< 0.2	12 D	2.6	< 0.2
	MW-20 (Dup)	2/24/1998	< 0.4	3.7	1.8	0.37 J	< 0.2	13 D	2.7	< 0.2
	MW-6-15	5/20/1998	0.21 J	5.4	1.9	0.60	< 0.4	13 D	9.4	< 0.2
	MW-6-16	8/12/1998	< 0.2	4.5	1.6	0.20	< 0.2	8.8 D	3.5	< 0.2
	MW-6-17	11/9/1998	< 0.2	2.3	0.8	< 0.2	< 0.2	7.1	1.1	< 0.2
	MW-6-18	2/24/1999	< 0.2	1.3	3.5	0.2	< 0.2	8.9	3.4	< 0.2
	MW-6-19	6/8/1999	< 0.2	3.0	0.9	0.2 J	< 0.2	6.7	1.7	< 0.2
	MW-6-20	8/25/1999	< 0.2	1.9	0.6	< 0.2	< 0.2	5.0	0.6	< 0.2
	MW-6-21	11/22/1999	< 0.2	1.8	0.6	< 0.2	< 0.2	6.2	0.4	< 0.2
	MW-6-200	2/2/2000	< 0.2	2.7	0.8	0.2	< 0.2	6.2	1.0	< 0.2
	MW-6-0500	5/23/2000	< 0.2	2.0	0.5	< 0.2	< 0.2	4.3	1.0	< 0.2
	MW-20-0500 (Dup)	5/23/2000	< 0.2	1.9	0.5	< 0.2	< 0.2	4.3	1.0	< 0.2
	MW-6-0800	8/29/2000	< 0.2	1.9	0.4	< 0.2	< 0.2	3.7	0.8	< 0.2
	MW-6-1100	11/28/2000	< 0.2	1.2	0.4	< 0.2	< 0.2	3.8	0.7	< 0.2
	MW-6-0201	2/20/2001	< 0.2	1.8	0.4	< 0.2	< 0.2	3.6	1.1	< 0.2
	MW-20-0201 (Dup)	2/20/2001	< 0.2	2.1	0.5	< 0.2	< 0.2	4.5	1.2	< 0.2
	MW-6-0501	5/24/2001	< 0.2	1.5	0.4	< 0.2	< 0.2	3.4	0.9	< 0.2
	MW-6-0801	8/27/2001	< 0.2	0.9	0.3	< 0.2	< 0.2	2.0	< 0.2	< 0.2
	MW-6-1101	11/5/2001	< 0.2	1.0	0.2	< 0.2	< 0.2	2.3	0.2	< 0.2
	MW-6-0202	2/21/2002	< 0.2	0.9	0.3	< 0.2	< 0.2	2.1	< 0.2	< 0.2
	MW-6-0502	5/23/2002	< 0.2	1.2	0.3	< 0.2	< 0.2	2.5	0.4	< 0.2
	MW-6-0802	8/14/2002	< 0.2	1.4	0.3	< 0.2	< 0.2	2.7	0.5	< 0.2
	MW-6-1202	12/3/2002	< 0.2	1.4	0.26 b	< 0.2	< 0.05 b	2.2	0.3	0.069 b
	MW-6-0203	2/26/2003	< 0.2	1.3	0.23 b	< 0.2	< 0.05 b	2.3	0.2	0.068 b
	MW-6-0503	5/28/2003	< 0.2	1.2	0.34 b	< 0.2	0.052 b	2.7	0.4	0.038 b
	MW-6-0803	8/21/2003	0.2	1.1	0.23 b	< 0.2	0.029 b	2.4	0.3	0.027 b
	MW-25-0803 (Dup)	8/21/2003	< 0.2	1.1	0.22 b	< 0.2	0.027 b	2.4	0.3	0.026 b
	MW-6-1103	11/21/2003	< 0.2	1.0	0.23 b	< 0.2	< 0.02 b	2.5	< 0.2	0.035 b
	MW-6-0204	2/25/2004	< 0.2	1.0	0.42 b	< 0.2	0.057 b	3.0	< 0.2	0.030 b
	MW-6-0504	5/25/2004	< 0.2	1.0	0.29 b	< 0.2	0.04 b	3.1	0.4	0.056 b
	MW-6-0804	8/25/2004	< 0.2	0.9	0.26 b	< 0.2	0.032 b	2.8	0.3	0.081 b
	MW-6-1104	11/30/2004	< 0.2	0.5	0.3	< 0.2	0.04 b	2.6	0.3	0.045 b
	MW-6-0205	2/28/2005	< 0.2	0.6	0.18 b	< 0.2	0.024 b	2.7	0.3	0.032 b
	MW-6-0805	8/9/2005	< 0.2	0.6	0.16 b	< 0.2	0.03 b	2.3	0.2	0.022 b
	MW-6-1105	11/17/2005	< 0.2	0.4	0.12 b	< 0.2	0.026 b	2.1	< 0.2	< 0.02 b
	MW-6A-1105 (dup)	11/17/2005	< 0.2	0.5	0.13 b	< 0.2	0.025 b	2	< 0.2	< 0.02 b
	MW-6-0206	2/7/2006	< 0.2	0.5	< 0.2	< 0.2	0.024 b	2.1 b	0.2	< 0.02 b
	MW-6-0806	8/17/2006	< 0.2	0.3	< 0.2	< 0.2	0.027 b	1.7 b	< 0.2	< 0.02 b
	MW-6-0207	2/20/2007	< 0.2	0.3	< 0.2	< 0.2	0.032 b	1.9 b	< 0.2	< 0.02 b
	MW-6-0807	8/16/2007	< 0.2	0.3	< 0.2	< 0.2	< 0.02	1.2 b	< 0.2	< 0.02 b
	MW-6-0208	2/20/2008	< 0.2	0.3	< 0.2	< 0.2	0.28 b	1.2	< 0.2	< 0.02 b
	Rolling Average		0.2	0.4	0.2	0.2	0.07	1.7	0.2	0.02
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-7 (Shallow)	MW-7-10	11/21/1996	< 0.2	28	40	5.6	< 0.2	1.5	0.3	< 0.2
	MW-7-11	4/17/1997	< 0.4	19 E	9.4	50 D	< 0.4	23 E	11	< 0.2
	MW-7-12	7/21/1997	0.4 J	36 D	21 D	130 D	0.3 J	46 D	25 D	0.4
	MW-7-13	11/19/1997	< 0.4	46 D	38 D	20 D	< 0.4	6.3	2.7	5.4
	MW-7-14	2/24/1998	< 0.4	8.7	9.2	19 D	< 0.2	7.2	2.3	< 0.2
	MW-7-15	5/20/1998	< 8	20 D	12 D	58 D	< 0.4	27 D	7.3	0.28
	MW-7-16	8/12/1998	0.4	32 D	10	150 D	0.6	82 D	26	1.0
	MW-7-17	11/9/1998	< 0.2	15 D	15 D	8.6	< 0.2	2.8	0.4	0.4
	MW-7-18	2/24/1999	< 0.2	7.9	5.2	2.7	< 0.2	1.1	< 0.2	< 0.2
	MW-7-19	6/8/1999	< 0.2	11 E	8.0	30 E	< 0.2	20 E	< 4.1	0.3
	MW-7-20	8/25/1999	< 0.6	16	9.4	51	< 0.6	39	7.7	< 0.6
	MW-7-21	11/22/1999	< 0.2	10	14	4.8	< 0.2	1.4	< 0.2	0.3
	MW-7-200	2/2/2000	< 0.2	54	11	9.6	< 0.2	2.1	< 0.2	< 0.2
	MW-7-0500	5/23/2000	< 0.2	16	8.7	43	0.2	22	4.6	0.2
	MW-7-0800	8/29/2000	< 1.0	21	10	45	< 1.0	27	8.2	< 1.0
	MW-7-1100	11/28/2000	< 0.2	13	13	2.9	< 0.2	1.9	< 0.2	< 0.2
	MW-7-0201	2/20/2001	< 0.2	12	13	7.6	< 0.2	3.4	0.3	0.4
	MW-7-0501	5/24/2001	< 0.6	15 D	12 D	22 D	< 0.6	14 D	2.6 D	< 0.6
	MW-7-0801	8/27/2001	< 0.6	19	14	16	< 0.6	14	3.9	< 0.6
	MW-20-0801 (Dup)	8/27/2001	< 0.6	21	14	17	< 0.6	14	4.0	< 0.6
	MW-7-1101	11/5/2001	< 0.2	21 D	16 D	6.6	< 0.2	6.5	0.9	0.2
	MW-7-0202	2/21/2002	< 0.2	15 D	16	5.0	< 0.2	5.1	0.5	0.3
	MW-7-0502	5/23/2002	< 0.4	17 D	13 D	11 D	< 0.2	12 D	2.1 D	0.3 J
	MW-7-0802	8/14/2002	< 0.2	30 D	11	35 D	0.5	42 D	12.0	0.4
	MW-7-1202	12/3/2002	< 1.0	30 D	19 D	11 D	0.056 b	9.8 D	< 1.0	0.31 b
	MW-20-1202 (Dup)	12/3/2002	< 1.0	31 D	18 D	11 D	0.057 b	11 D	1.2 D	0.31 b
	MW-7-0203	2/26/2003	< 0.2	23 D	14	13	< 0.10 bUB	14 D	2.1	0.32 b
	MW-7-0503	5/28/2003	< 0.2	19 D	11	24 D	0.25 b	23 D	5.5	0.41 b
	MW-20-0503 (Dup)	5/28/2003	< 0.2	18 D	11	22 D	0.26 b	22 D	5.4	0.4 b
	MW-7-0803	8/20/2003	< 0.2	8.4	8.2	11	0.031 b	6.9	0.4	0.21 b
	MW-7-1103	11/20/2003	< 0.2	1.3	0.75 b	1.5	< 0.020 b	2.8	< 0.2	< 0.02 b
	MW-7-0204	2/24/2004	< 0.2	1.7	1.1 b	4.4	< 0.020 b	3.9	< 0.2	0.046 b
	MW-7-0504	5/24/2004	< 0.2	1.4	0.59 b	7.5	0.046 b	8.4	0.4	0.030 b
	MW-7-0804	8/25/2004	< 0.2	0.7	0.49 b	1.2	< 0.020 b	4	< 0.2	< 0.020 b
	MW-7-1104	11/29/2004	< 0.2	0.3	0.40	0.8	< 0.020 b	3.2	< 0.2	< 0.020 b
	MW-7-0205	3/2/2005	< 0.2	1.1	0.63 b	5.2	< 0.020 b	6.2	< 0.2	0.025 b
	MW-7-0805	8/9/2005	< 0.2	1	0.44 b	5.7	0.023 b	7	0.2	0.020 b
	MW-7-1105	11/17/2005	< 0.2	0.4	0.30	0.5	< 0.020 b	3.8	< 0.2	< 0.020 b
	MW-7-0206	2/8/2006	< 0.2	0.4	0.20	0.5	< 0.020 b	3.2 b	< 0.2	< 0.020 b
	MW-7-0806	8/17/2006	< 0.2	0.4	0.20	3.2	< 0.020 b	4.7	< 0.2	< 0.020 b
	MW-7-0207	2/20/2007	< 0.2	0.2	< 0.20	0.8	0.024 b	3.1 b	< 0.2	< 0.020 b
	MW-7-0807	8/17/2007	< 0.2	0.4	0.20	2.0	< 0.020	4.8 b	< 0.2	< 0.020 b
	MW-7-0208	2/21/2008	< 0.2	0.7	0.5	3.4	< 0.02 b	4.6	< 0.2	< 0.02 b
	Rolling Average		0.2	0.4	0.3	1.7	0.02	4.0	0.2	0.02
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-8S* (Shallow)	MW-8-10	11/21/1996	0.2	16	5.4	100	< 0.2	40	7.8	< 0.2
	MW-8-11	4/17/1997	< 0.4	21 E	4.9	96 D	< 0.4	41 D	17 E	< 0.2
	MW-8-12	7/21/1997	< 0.4	66	30 D	180 D	< 0.4	72 D	32 D	0.6
	MW-8-13	11/19/1997	< 0.4	83 D	90 D	67 D	< 0.4	42 D	33 D	8.3
	MW-20-2 (Dup)	11/19/1997	< 0.4	82 D	85 D	66 D	< 0.4	40 D	31 D	8.6
	MW-8-14	2/24/1998	0.51	32 D	9.7 D	130 D	< 0.2	49 D	19 D	0.27
	MW-8-15	5/20/1998	0.44	37 D	8	170 D	< 0.4	60 D	22 D	0.26
	MW-8-16	8/12/1998	0.80	43 D	9.7	210 D	< 0.2	93 D	32 D	0.70
	MW-8-17	11/9/1998	0.90 B	72 D	24 D	170 D	< 0.2	87 D	65 D	0.30
	MW-20-17 (Dup)	11/9/1998	1.00 B	68 D	22 D	170 D	< 0.2	86 D	61 D	0.30
	MW-8-18	2/24/1999	0.9 J	12	60	260 D	< 1.0	83	51	< 2.0
	MW-8-19	6/8/1999	< 1.0	49	8.3	210	< 1.0	97	39	< 1.0
	MW-8-20	8/25/1999	< 3.0	20	4.5	97	< 3.0	52	14	< 3.0
	MW-8-21	11/22/1999	< 1.0	26	5.7	120	< 1.0	70	16	< 1.0
	MW-8-200	2/2/2000	2.8 B	54	10	260	< 2.0	110	39	< 2.0
	MW-8-0500	5/23/2000	< 1.0	33	27	40	< 1.0	74	28	< 1.0
	MW-8-0800	8/29/2000	< 1.0	25	22	16	< 1.0	68	62	< 1.0
	MW-8-1100	11/28/2000	0.4	27	18	34	< 0.2	56	30	< 0.2
	MW-8-0201	2/20/2001	< 2.0	35 D	16 D	73 D	< 2.0	71 D	32 D	< 2.0
	MW-8-0501	5/24/2001	< 2.0	34 D	14 D	69 D	< 2.0	65 D	33 D	< 2.0
	MW-8-0801	8/27/2001	< 1.0	23	13	27	< 1.0	80	43	< 1.0
	MW-8-1101	11/5/2001	0.6	20 D	12	18 D	< 0.2	80 D	54 D	< 0.2
	MW-8-0202	2/21/2002	0.6	16 D	5.7	32 D	< 0.2	59 D	30 D	< 0.2
	MW-8-0502	5/23/2002	< 2.0	17 D	10 D	21 D	< 2.0	78 D	42 D	< 2.0
	MW-20-0502 (Dup)	5/23/2002	< 3.0	16 D	9.9 D	20 D	< 3.0	74 D	40 D	< 3.0
	MW-8-0802	8/14/2002	0.7	17 D	12	10	0.2	82 D	37 D	< 0.2
	MW-8-1202	12/3/2002	< 2.0	19 D	9.0 D	14 D	0.099 b	75 D	41 D	0.031 b
	MW-8-0203	2/26/2003	< 2.0	20	5.9	28	< 0.120 bUB	71	28	0.047 b
	MW-8-0503	5/28/2003	< 2.0	19	4.6	27	0.130 b	72	30	0.056 b
	MW-8-0803	8/20/2003	< 2.0	13	4.8	24	0.061 b	49	17	0.100 b
	MW-8-1103	11/21/2003	< 0.2	2.0	2.0	6.5	< 0.020 b	3.1	< 0.2	0.034 b
	MW-8-0204	2/24/2004	< 1.0	8.1	0.88 b	27	0.11 b	42	5.4	0.020 b
	MW-8-0504	5/25/2004	< 0.2	4.2	1.20 b	20	0.068 b	30	2.7	0.031 b
	MW-8-0804	8/27/2004	< 0.4	2.5	0.92 b	14	0.027 b	18	0.9	0.049 b
	MW-8-1104	11/30/2004	< 0.4	1.9	1.1	12	0.031 b	19	0.5	0.035 b
	MW-8-0205	2/28/2005	< 0.4	2	0.58 b	12	0.037 b	24	0.9	0.033 b
	MW-8-0505	5/31/2005	< 0.4	1.2	0.4	6.5	0.037 b	17	0.6	< 0.02 b
	MW-8-0805	8/9/2005	< 0.4	2.1	0.5 b	12	0.042 b	21	0.6	0.033 b
	MW-8S-1105	11/14/2005	< 0.2	2	0.7	12	< 0.02 b	12	< 0.2	0.04 b
	MW-8S-0206	2/7/2006	< 0.6	0.9	< 0.6	3.3	0.056 b	24	1	< 0.02 b
	MW-8S-0506	5/16/2006	< 0.6	1.1	< 0.6	5.4	0.057 b	21	< 0.6	< 0.02 b
	MW-8S-0806	8/17/2006	< 0.2	0.8	0.3	6.5	< 0.02 b	10	< 0.2	< 0.02 b
	MW-8S-1106	11/7/2006	< 0.2	0.3	< 0.2	0.8	< 0.02 b	1.4 b	< 0.2	< 0.02 b
	MW-8S-0207	2/20/2007	< 0.2	0.3	< 0.2	1.4	0.084 b	20	0.6	< 0.02 b
	MW-8S-0507	5/21/2007	< 0.2	0.6	< 0.2	4.4	0.084 b	24	0.6	< 0.02 b
	MW-8S-0807	8/14/2007	< 0.4	0.6	< 0.4	4.3	< 0.02	7.9	< 0.4	0.02 b
	MW-8S-1107	11/12/2007	< 0.2	0.6	0.2	5.1	< 0.2 b	6.3 b	< 0.2	< 0.2 b
	MW-8S-0208	2/22/2008	< 0.2	0.9	0.3	7.4	0.024 b	11	< 0.2	0.03 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-8M (Intermediate)	MW-8M-1105	11/14/2005	< 0.2	1	2.5	< 0.2	< 0.02 b	< 0.2	< 0.2	0.043 b
	MW-8M-0206	2/7/2006	< 0.2	0.7	1.7	< 0.2	< 0.02 b	0.027 b	< 0.2	< 0.020 b
	Dup-1-0206	2/7/2006	< 0.2	0.7	1.7	< 0.2	< 0.02 b	0.027 b	< 0.2	< 0.020 b
	MW-8M-0506	5/16/2006	< 0.2	0.7	1.5	< 0.2	< 0.02 b	0.022 b	< 0.2	0.020 b
	MW-8M-0806	8/14/2006	< 0.2	0.6	1.1	< 0.2	< 0.02 b	0.061 b	< 0.2	0.029 b
	MW-8M-1106	11/7/2006	< 0.2 UJ	0.5 J	1.0 J	< 0.2 UJ	< 0.02 b	0.025 b	< 0.2 UJ	0.020 b
	MW-8M-0207	2/20/2007	< 0.2	0.4	0.7	< 0.2	< 0.02 b	< 0.020 bUJ	< 0.2	0.024 b
	DUP-1-0207 (dup)	2/20/2007	< 0.2	0.4	0.7	< 0.2	< 0.02 b	0.022 bJ	< 0.2	0.025 b
	MW-8M-0507	5/21/2007	< 0.2	0.5	0.8	< 0.2	< 0.02 b	0.024 b	< 0.2	0.022 b
	DUP-1-0807 (dup)	8/13/2007	< 0.2	0.5	0.8	< 0.2	< 0.02	0.025 b	< 0.2	0.036 b
	MW-8M-0807	8/13/2007	< 0.2	0.5	0.8	< 0.2	< 0.02	< 0.02 b	< 0.2	0.027 b
	MW-8M-1107	11/12/2007	< 0.2	0.7	1	< 0.2	< 0.2 b	< 0.2 b	< 0.2	< 0.2 b
	MW-8M-0208	2/20/2008	< 0.2	1	1.4	< 0.2	< 0.02 b	0.065 bJ	< 0.2	0.037 b
	DUP-1-0208 (Dup)	2/20/2008	< 0.2	1	1.3	< 0.2	< 0.02 b	< 0.02 bUJ	< 0.2	0.036 b
MW-9 (Shallow)	MW-9-10	11/20/1996	< 0.2	< 0.2	< 0.2	0.5	< 0.2	< 0.2	< 0.2	< 0.2
	MW-9-11	4/17/1997	< 0.4	< 0.4	< 0.4	0.6	< 0.4	< 0.4	< 0.4	< 0.2
	MW-9-12	7/21/1997	< 0.4	< 0.4	< 0.4	0.6	< 0.4	< 0.4	< 0.4	< 0.2
	MW-9-13	11/19/1997	< 0.4	< 0.4	< 0.4	0.2 J	< 0.4	< 0.4	< 0.4	< 0.2
	MW-9-14	2/24/1998	< 0.4	< 0.4	< 0.2	0.46	< 0.2	< 0.2	< 0.4	< 0.2
	MW-9-15	5/20/1998	< 0.4	< 0.4	< 0.4	0.52	< 0.4	< 0.4	< 0.4	< 0.2
	MW-9-16	8/12/1998	< 0.2	< 0.2	< 0.2	0.70	< 0.2	< 0.2	< 0.2	< 0.2
	MW-9-17	11/9/1998	< 0.2	< 0.2	< 0.2	0.80	0.2	< 0.2	< 0.2	< 0.2
	MW-9-18	2/24/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW9-19	6/8/1999	< 0.2	< 0.2	< 0.2	1.0	< 0.2	0.2	< 0.2	< 0.2
	MW9-20	8/25/1999	< 0.2	< 0.2	< 0.2	1.0	< 0.2	0.3	< 0.2	< 0.2
	MW9-21	11/22/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-9-200	2/2/2000	< 0.2	< 0.2	< 0.2	1.3	< 0.2	1.3	< 0.2	< 0.2
	MW-9-0500	5/23/2000	< 0.2	< 0.2	< 0.2	1.2	< 0.2	1.1	< 0.2	< 0.2
	MW-9-0800	8/29/2000	< 0.2	< 0.2	< 0.2	1.1	< 0.2	1.4	< 0.2	< 0.2
	MW-9-1100	11/28/2000	< 0.2	< 0.2	< 0.2	0.2	< 0.2	0.3	< 0.2	< 0.2
	MW-9-0201	2/20/2001	< 0.2	< 0.2	< 0.2	0.4	< 0.2	0.8	< 0.2	< 0.2
	MW-9-0501	5/24/2001	< 0.2	< 0.2	< 0.2	0.5	< 0.2	0.8	< 0.2	< 0.2
	MW-9-0801	8/27/2001	< 0.2	< 0.2	< 0.2	0.8	< 0.2	0.8	< 0.2	< 0.2
	MW-9-1101	11/5/2001	< 0.2	< 0.2	< 0.2	0.7	< 0.2	1.2	< 0.2	< 0.2
	MW-9-0202	2/21/2002	< 0.2	< 0.2	< 0.2	0.3	< 0.2	0.7	< 0.2	< 0.2
	MW-9-0502	5/23/2002	< 0.2	< 0.2	< 0.2	0.4	< 0.2	1.0	< 0.2	< 0.2
	MW-9-0802	8/14/2002	< 0.2	< 0.2	< 0.2	0.2	< 0.2	0.5	< 0.2	< 0.2
	MW-9-0203	2/26/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.05 b	0.3	< 0.2	< 0.02 b
	MW-9-0803	8/20/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	0.3	< 0.2	< 0.02 b
	MW-9-0204	2/24/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-9-0804	8/25/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	0.2	< 0.2	< 0.02 b
	MW-9-0205	2/28/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-9-0206	2/7/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.032 b	< 0.2	< 0.02 b
	MW-9-0207	2/20/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.022 b	< 0.2	< 0.02 b
	MW-9-0208	2/21/2008	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	0.037 b
	Rolling Average		0.2	0.2	0.1	0.2	0.02	0.1	0.2	0.02
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-10 (Shallow)	MW-10-10	11/20/1996	< 0.2	1.1	< 0.2	< 0.2	< 0.2	0.3	< 0.2	< 0.2
	MW-10-11	4/17/1997	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	MW-10-12	7/21/1997	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	MW-10-13	11/19/1997	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	MW-10-14	2/24/1998	< 0.4	< 0.4	< 0.2	< 0.4	< 0.2	< 0.2	< 0.4	< 0.2
	MW-10-15	5/20/1998	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	MW-10-16	8/12/1998	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-17	11/9/1998	< 0.2	0.3	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2
	MW-10-18	2/24/1999	0.3	< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-19	6/8/1999	0.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-20	8/25/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-21	11/22/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-200	2/2/2000	0.3 B	0.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-0500	5/23/2000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-0800	8/29/2000	< 0.2	0.9	< 0.2	< 0.2	< 0.2	0.3	< 0.2	< 0.2
	MW-10-1100	11/28/2000	< 0.2	0.6	< 0.2	3.9	< 0.2	0.5	< 0.2	< 0.2
	MW-10-0201	2/20/2001	< 0.2	0.9	< 0.2	2.1	< 0.2	0.4	< 0.2	< 0.2
	MW-10-0501	5/24/2001	< 0.2	0.8	< 0.2	1.3	< 0.2	0.3	< 0.2	< 0.2
	MW-10-0801	8/27/2001	< 0.2	0.7	< 0.2	0.8	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-1101	11/5/2001	< 0.2	0.8	< 0.2	0.7	< 0.2	0.2	< 0.2	< 0.2
	MW-10-0202	2/21/2002	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-0502	5/23/2002	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-10-0802	8/14/2002	< 0.2	0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2
	MW-10-0203	2/26/2003	< 0.2	0.4	0.031 b	< 0.2	< 0.05 b	< 0.2	< 0.2	< 0.02 b
	MW-10-0803	8/21/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-10-0204	2/25/2004	< 0.2	< 0.2	0.044 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-10-0804	8/27/2004	< 0.2	0.2	0.042 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-10-0205	2/28/2005	< 0.2	0.5	0.08 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-10-0805	8/10/2005	< 0.2	0.5	0.09 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-10-0206	2/8/2006	0.8	< 0.2	< 0.2	< 0.2	< 0.02 b	0.039 b	< 0.2	< 0.02 b
	MW-10-0806	8/17/2006	1.5	0.2	< 0.2	< 0.2	< 0.02 b	0.13 b	< 0.2	< 0.02 b
	MW-10-0207	2/23/2007	0.4	< 0.2	< 0.2	< 0.2	< 0.02 b	0.031 b	< 0.2	< 0.02 b
	MW-10-0807	8/17/2007	0.3	< 0.2	< 0.2	< 0.2	< 0.02	0.078 b	< 0.2	< 0.02 b
	MW-10-0208	2/20/2008	0.3	< 0.2	< 0.2	< 0.2	< 0.02 b	0.034 b	< 0.2	< 0.02 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-11 (Shallow)	MW-11-10	11/20/1996	< 0.2	0.36	< 0.2	8.8	< 0.2	31	< 0.2	< 0.2
	MW-11-11	4/17/1997	< 0.4	0.43	< 0.4	3.3	< 0.4	7.5	< 0.4	< 0.2
	MW-11-12	7/21/1997	0.39 J	< 0.4	< 0.4	3.7	< 0.4	8.4	< 0.4	< 0.2
	MW-11-13	11/19/1997	< 0.4	0.28 J	0.25 J	7.1	< 0.4	13 D	< 0.4	< 0.2
	MW-11-14	2/24/1998	< 0.4	0.75	0.27	5.4	< 0.2	13 D	< 0.4	< 0.2
	MW-11-15	5/20/1998	< 0.4	0.68	0.26	4.4	< 0.4	9.8	< 0.4	< 0.2
	MW-11-16	8/12/1998	< 0.2	0.80	0.30	6.7	< 0.2	14 D	< 0.2	< 0.2
	MW-11-17	11/9/1998	< 0.2	0.70	0.40	11 D	< 0.2	18 D	< 0.2	< 0.2
	MW-11-18	2/24/1999	< 1.0	< 1.0	0.90 J	8.6	< 1.0	13	< 1.0	< 2.0
	MW-11-19	6/8/1999	< 1.0	< 1.0	< 1.0	6.9	< 1.0	11	< 1.0	< 1.0
	MW-11-20	8/25/1999	< 0.2	0.70	0.40	8.2	< 0.2	14	< 0.2	< 0.2
	MW-11-21	11/22/1999	< 1.0	< 1.0	< 1.0	15	< 1.0	21	< 1.0	< 1.0
	MW-11-200	2/2/2000	< 0.6	1.6	0.80	9.8	< 0.6	22	< 0.6	< 0.6
	MW-11-0500	5/23/2000	< 1.0	< 1.0	< 1.0	3.8	< 1.0	9.8	< 1.0	< 1.0
	MW-11-0800	8/29/2000	28	< 1.0	< 1.0	4.1	< 1.0	13	< 1.0	< 1.0
	MW-11-1100	11/28/2000	23	< 0.2	< 0.2	1.9	< 0.2	8.4	< 0.2	< 0.2
	MW-11-0201	2/20/2001	4.4 D	< 0.6	< 0.6	2.7 D	< 0.6	9.6 D	< 0.6	< 0.6
	MW-11-0501	5/24/2001	2.8	< 0.2	< 0.2	4.2	< 0.2	11	< 0.2	< 0.2
	MW-11-0801	8/27/2001	1.2	0.3	< 0.2	6.8	< 0.2	15	< 0.2	< 0.2
	MW-11-1101	11/5/2001	0.5	0.5	< 0.2	10	< 0.2	15 D	< 0.2	< 0.2
	MW-11-0202	2/21/2002	0.3	0.8	0.3	12	< 0.2	14	< 0.2	< 0.2
	MW-11-0502	5/23/2002	0.4	1.0	0.2	13	< 0.2	15	< 0.2	< 0.2
	MW-11-0802	8/14/2002	0.4	1.4	0.2	17 D	< 0.2	15	< 0.2	< 0.2
	MW-11-1202	12/3/2002	0.3	2.5	0.34 b	35 D	< 0.05 b	17 D	< 0.2	0.34 b
	MW-11-0203	2/26/2003	< 1.0	2.4	0.33 b	29	< 0.05 b	13	< 1.0	0.28 b
	MW-11-0503	5/28/2003	2.0	2.2	0.19 b	19 D	< 0.05 b	7.6	< 0.2	0.15 b
	MW-11-0803	8/21/2003	< 1.0	5.4	0.40 b	40	< 0.02 b	9.9	< 1.0	0.29 b
	MW-11-1103	11/20/2003	< 1.0	5.4	0.59 b	63	< 0.02 b	34	< 1.0	0.61 b
	MW-11-0204	2/23/2004	< 0.4	1.3	0.32 b	16	< 0.02 b	9.8	< 0.4	0.09 b
	MW-11-0504	5/26/2004	< 0.2	1.0	0.19 b	12	< 0.02 b	7.5	< 0.2	0.057 b
	MW-11-0804	8/26/2004	< 0.2	1.9	0.47 b	21	< 0.02 b	15	< 0.2	0.22 b
	MW-11-1104	11/30/2004	< 0.6	1.4	0.60	22	< 0.02 b	16	< 0.6	0.24 b
	MW-30-1104 (dup)	11/30/2004	< 0.2	1.4	0.5	24	< 0.02 b	18	< 0.2	0.24 b
	MW-11-0205	3/1/2005	< 0.6	1.4	0.35 b	19	< 0.02 b	13	< 0.6	0.17 b
	MW-11-0505	6/1/2005	< 0.4	1.2	0.38 b	19	< 0.02 b	13	< 0.4	0.17 b
	MW-11-0805	8/12/2005	< 0.4	1.1	0.34 b	17	< 0.02 b	13	< 0.4	0.12 b
	MW-11-1105	11/15/2005	< 0.4	1.6	0.5	20	< 0.02 b	16	< 0.4	0.13 b
	MW-11-0206	2/9/2006	< 0.2	0.8	0.4	11	< 0.02 b	12	< 0.2	0.084 b
	DUP-2-0206 (dup)	2/9/2006	< 0.2	0.9	0.5	11	< 0.02 b	13	< 0.2	0.087 b
	MW-11-0506	5/17/2006	< 0.2	0.6	0.3	7.3	< 0.02 b	7.6	< 0.2	0.046 b
	MW-11-0806	8/16/2006	< 0.2	0.7	0.3	13	< 0.02 b	11 b	< 0.2	0.12 b
	MW-111-0806	8/16/2006	< 0.2	0.7	0.3	13	< 0.02 b	12	< 0.2	0.15 b
	MW-11-1106	11/8/2006	< 1	2.6	< 1	46	< 0.02 b	26	< 1	0.28 b
	MW-11-0207	2/21/2007	< 0.2	0.6	0.3	11	< 0.02 b	8.9	< 0.2	0.071 b
	DUP-2-0207 (Dup)	2/21/2007	< 0.2	0.6	0.3	11	< 0.02 b	9.1	< 0.2	0.086 b
	MW-11-0507	5/23/2007	< 0.2	0.5	0.3	7.8	< 0.02 b	8.8	< 0.2	0.068 b
	DUP-2-0807 (dup)	8/15/2007	< 0.2	0.6	0.3	8.2	< 0.02	10	< 0.2	0.073 J
	MW-11-0807	8/15/2007	< 0.2	0.4	0.2	7.1	< 0.02	10	< 0.2	0.11 J
	MW-11-1107	11/13/2007	< 0.2	1.2	0.6	15	< 0.2 b	13 b	< 0.2	0.15 J
	MW-11-0208	2/20/2008	< 0.2	0.7	0.4	12	< 0.02 b	9.7 bJ	< 0.2	0.14 b
	DUP-2-0208 (Dup)	2/20/2008	< 0.2	0.7	0.4	13	< 0.02 b	11	< 0.2	0.14 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-12 (Shallow)	MW-12-10	11/20/1996	< 0.2	1.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-11	4/17/1997	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	MW-12-12	7/21/1997	< 0.4	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	MW-12-13	11/19/1997	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	MW-12-14	2/24/1998	< 0.4	0.55	< 0.2	< 0.4	< 0.2	< 0.2	< 0.4	< 0.2
	MW-12-15	5/20/1998	< 0.4	0.29	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	MW-12-16	8/12/1998	< 0.2	0.30	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-17	11/9/1998	< 0.2	0.50	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-18	2/24/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-19	6/8/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-20	8/25/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-21	11/22/1999	< 0.2	0.7	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-200	2/2/2000	< 0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0500	5/23/2000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0800	8/29/2000	3.3	< 0.2	0.3	0.3	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-1100	11/28/2000	6.0	1.0	0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0201	2/20/2001	9.8	1.3	0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0501	5/24/2001	3.5	1.3	0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0801	8/27/2001	0.9	1.1	0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-1101	11/5/2001	0.4	0.9	< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0202	2/21/2002	< 0.2	0.8	0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0502	5/23/2002	0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0802	8/14/2002	0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	MW-12-0203	2/26/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.05 b	< 0.2	< 0.2	< 0.02 b
	MW-12-0803	8/21/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-12-0204	2/25/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	0.025 b	< 0.2	< 0.2	< 0.02 b
	MW-12-0804	8/27/2004	< 0.2	< 0.2	0.025 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-12-0205	2/28/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-12-0805	8/12/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-12-0206	2/8/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-12-0806	8/17/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-12-0207	2/21/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-12-0807	8/15/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.020	< 0.020 b	< 0.2	< 0.020 b
	MW-12-0208	2/20/2008	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.021 b	< 0.2	< 0.02 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-13 (Shallow)	MW-13-0203	2/26/2003	< 0.2	0.9	0.072 b	< 0.2	< 0.05 b	< 0.2	< 0.2	0.053 b
	MW-20-0203 (Dup)	2/26/2003	< 0.2	1.2	0.084 b	< 0.2	< 0.05 b	< 0.2	< 0.2	0.059 b
	MW-13-0503	5/28/2003	< 0.2	0.8	0.091 b	< 0.2	< 0.05 b	< 0.2	< 0.2	0.055 b
	MW-13-0803	8/20/2003	< 0.2	0.8	0.068 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.030 b
	MW-13-1103	11/20/2003	< 0.2	0.6	0.054 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.11 b
	MW-25-1103 (Dup)	11/20/2003	< 0.2	0.7	0.054 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.12 b
	MW-13-0204	2/24/2004	< 0.2	0.6	0.070 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.12 b
	MW-30-0204 (Dup)	2/24/2004	< 0.2	0.6	0.073 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.12 b
	MW-13-0504	5/25/2004	< 0.2	0.5	0.063 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.072 b
	MW-20-0504 (Dup)	5/25/2004	< 0.2	0.5	0.063 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.065 b
	MW-13-0804	8/25/2004	< 0.2	0.4	0.06 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.057 b
	MW-13-1104	11/30/2004	< 0.2	0.2	0.039 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.027 b
	MW-13-0205	3/2/2005	< 0.2	0.2	0.032 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.034 b
	MW-13-0505	5/31/2005	< 0.2	0.2	0.03 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.02 b
	MW-13-0805	8/9/2005	< 0.2	0.2	0.026 b	< 0.2	< 0.02 b	< 0.2	< 0.2	0.023 b
	MW-13-1105	11/16/2005	< 0.2	0.2	0.026 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-13-0206	2/8/2006	< 0.2	0.2	< 0.2	< 0.2	< 0.02 b	0.027 b	< 0.2	< 0.02 b
	MW-13-0506	5/17/2006	< 0.2	0.2	< 0.2	< 0.2	< 0.02 b	0.024 b	< 0.2	< 0.02 b
	MW-13-0806	8/17/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-13-1106	11/7/2006	< 0.2 UJ	< 0.2 UJ	< 0.2 UJ	< 0.2 UJ	< 0.02 b	< 0.02 b	< 0.2 UJ	< 0.02 b
	MW-13-0207	2/20/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.032 b	< 0.2	< 0.02 b
	MW-13-0507	5/21/2007	< 0.2	< 0.2	< 0.2	< 0.2	0.028 b	0.023 b	< 0.2	0.022 b
	MW-13-0807	8/16/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.020	0.020 b	< 0.2	0.022 b
	MW-13-1107	11/12/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02	< 0.02	< 0.2	< 0.02
	MW-13-0208	2/18/2008	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	0.023 b	< 0.2	< 0.02 b
MTCA Method B Groundwater Cleanup Level			7.17	800	.72	80	0.858	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.2	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-14M* (Intermediate)	MW-14S-0803	8/21/2003	< 0.2	21	0.84 b	78	< 0.02 b	83	< 0.2	1.2 b
	MW-20-0803 (Dup)	8/21/2003	< 1.0	21	0.88 b	98	< 0.02 b	110	< 1.0	1.2 b
	MW-14S-1103	11/20/2003	< 1.0	29	1.2 b	98	< 0.02 b	140	< 1.0	1.0 b
	MW-14S-0204	2/23/2004	< 1.0	9.3	0.62 b	83	< 0.02 b	110	< 1.0	0.32
	MW-20-0204 (Dup)	2/23/2004	< 1.0	9.3	0.60 b	82	< 0.02 b	110	< 1.0	0.31
	MW-14S-0504	5/26/2004	< 2.0	8.6	0.52 b	68	< 0.02 b	94	< 2.0	0.61
	MW-14S-0804	8/26/2004	< 1	28	1.2 b	91	< 0.02 b	110	< 1	1.1 b
	MW-14S-1104	11/30/2004	< 1	27	1.5 b	94	< 0.02 b	110	< 1	1.3 b
	MW-14S-0205	3/2/2005	< 1	8.9	0.74 b	68	< 0.02 b	81	< 1	0.4 b
	MW-14S-0505	6/1/2005	< 1	8	0.61 b	58	< 0.02 b	84	< 1	0.53 b
	MW-14S-0805	8/12/2005	< 1	17	1.1 b	71	< 0.02 b	81	< 1	0.8 b
	MW-14S-1105	11/15/2005	< 2	45	3.7 b	97	< 0.02 b	110	< 2	0.87 b
	MW-14M-0206	2/9/2006	< 1	22	1.6	63	< 0.02 b	100	< 1	0.44 b
	MW-14M-0506	5/17/2006	< 1	9.6	1.2	52	< 0.02 b	65	< 1	0.31 b
	MW-14M-0806	8/16/2006	< 1	22	2.9	77	< 0.02 b	80	< 1	0.74 b
	MW-14M-1106	11/8/2006	< 1	26	3.1	71	< 0.02 b	78 Jb	< 1	0.58 b
	MW-14M-0207	2/21/2007	< 1	4.5	1.1	38	< 0.02 b	53	< 1	0.17 b
	MW-14M-0507	5/23/2007	< 0.2	6.7	1.4	53	< 0.02 b	70	< 0.2	0.18 b
	MW-14M-0807	8/15/2007	< 1.0	11	1.5	53	< 0.020	61	< 1.0	0.43 b
	MW-14M-1107	11/13/2007	< 1	18	3.2	70	< 0.02	62 b	< 1	0.56
	MW-14M-0208	2/20/2008	< 0.2	14	2.1	95	< 0.02 b	70 bJ	< 0.2	0.32 b
MW-14D (Deep)	MW-14D-0803	8/21/2003	0.2	1	0.06 b	3.2	< 0.02 b	3.9	< 0.2	0.04 b
	MW-14D-1103	11/20/2003	< 0.2	< 0.2	< 0.020 b	0.7	< 0.02 b	1.0	< 0.2	0.027 b
	MW-14D-0204	2/23/2004	< 0.2	< 0.2	< 0.020 b	0.8	< 0.02 b	0.7	< 0.2	< 0.020 b
	MW-14D-0504	5/26/2004	< 0.2	< 0.2	< 0.020 b	0.9	< 0.02 b	0.6	< 0.2	< 0.020 b
	MW-14D-0804	8/26/2004	< 0.2	< 0.2	< 0.02 b	0.8	< 0.02 b	0.5	< 0.2	< 0.02 b
	MW-14D-1104	11/30/2004	< 0.2	< 0.2	< 0.02 b	0.7	< 0.02 b	0.4	< 0.2	0.022 b
	MW-14D-0205	3/2/2005	< 0.2	< 0.2	< 0.02 b	1	< 0.02 b	0.4	< 0.2	< 0.02 b
	MW-14D-0505	6/1/2005	< 0.2	< 0.2	< 0.02 b	1.1	< 0.02 b	0.4	< 0.2	< 0.02 b
	MW-14D-0805	8/12/2005	< 0.2	< 0.2	< 0.02 b	1	< 0.02 b	0.3	< 0.2	< 0.02 b
	MW-14D-1105	11/15/2005	< 0.2	< 0.2	< 0.02 b	1	< 0.02 b	0.3	< 0.2	< 0.02 b
	MW-14D-0206	2/9/2006	< 0.2	< 0.2	< 0.2	1.3	< 0.02 b	0.3 b	< 0.2	< 0.02 b
	MW-14D-0506	5/17/2006	< 0.2	< 0.2	< 0.2	0.9	< 0.02 b	0.19 b	< 0.2	< 0.02 b
	MW-14D-0806	8/16/2006	< 0.2	< 0.2	< 0.2	0.9	< 0.02 b	0.21 b	< 0.2	0.02 b
	MW-14D-1106	11/8/2006	< 0.2	< 0.2	< 0.2	0.7	< 0.02 b	0.16 b	< 0.2	< 0.02 b
	MW-14D-0207	2/21/2007	< 0.2	< 0.2	< 0.2	1.1	< 0.02 b	0.23 b	< 0.2	0.024 b
	MW-14D-0507	5/23/2007	< 0.2	< 0.2	< 0.2	0.9	0.02 b	0.15 b	< 0.2	0.021 b
	MW-14D-0807	8/15/2007	< 0.2	< 0.2	< 0.2	0.8	< 0.020	0.18 b	< 0.2	0.032 b
	MW-14D-1107	11/11/2007	< 0.2	< 0.2	< 0.2	1	< 0.02	0.17	< 0.2	0.027
	MW-14D-1107 (Dup)	11/13/2007	< 0.2	< 0.2	< 0.2	0.9	< 0.02	0.16	< 0.2	0.022
	MW-14D-0208	2/20/2008	< 0.2	< 0.2	< 0.2	1.1	< 0.02 b	0.2	< 0.2	0.031 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-15M* (Intermediate)	MW-15S-0803	8/21/2003	< 0.2	0.8	0.83 b	61	< 0.02 b	90	< 0.2	0.16 b
	MW-15S-1103	11/21/2003	< 1.0	< 1.0	0.62 b	50	< 0.02 b	140	< 1.0	0.14 b
	MW-15S-0204	2/25/2004	< 2.0	< 2.0	0.90 b	49	0.022 b	130	< 2.0	0.17 b
	MW-15S-0504	5/26/2004	< 3.0	< 3.0	0.74 b	41	0.02 b	120	< 3.0	0.16 b
	MW-15S-0804	8/27/2004	< 1.0	< 1.0	0.67 b	41	< 0.02 b	140	< 1.0	0.14 b
	MW-15S-1104	11/30/2004	< 1.0	< 1.0	0.6 b	38	< 0.02 b	130	< 1.0	0.17 b
	MW-15S-0205	3/3/2005	< 1.0	< 1.0	0.66 b	35	< 0.02 b	110	< 1.0	0.23 b
	MW-15S-0505	6/2/2005	< 1.0	< 1.0	0.64 b	35	< 0.02 b	110	< 1.0	0.23 b
	MW-15S-0805	8/11/2005	< 1.0	1.1	0.59 b	35	< 0.02 b	120	< 1.0	0.25 b
	MW-15S-1105	11/17/2005	< 2.0	< 2.0	0.51 b	41	< 0.02 b	150	< 2.0	0.2 b
	MW-15M-0206	2/9/2006	< 1.0	< 1.0	< 1	28	< 0.02 b	100	< 1.0	0.21 b
	MW-15M-0506	5/18/2006	< 1.0	1.6	< 1	28	< 0.02 b	90	< 1.0	0.28 b
	MW-15M-0806	8/16/2006	< 1.0	1.8	< 1	31	< 0.02 b	110	< 1.0	0.42 b
	MW-15M-1106	11/8/2006	< 1.0	2.1	< 1	32	< 0.02 b	95 Jb	< 1.0	0.34 b
	MW-15M-0207	2/21/2007	< 1.0	2.0	< 1	28	< 0.02 b	79	< 1.0	0.46 b
	MW-15M-0507	5/23/2007	< 0.2	3.2	0.6	35 J	< 0.02 b	100 J	< 0.2	0.38 b
	MW-15M-0807	8/16/2007	< 0.2	3.1	0.5	30	< 0.020	90	< 0.2	0.47 b
	MW-15M-1107	11/14/2007	< 1.0	4.3	< 1	36	< 0.02	79 b	< 1.0	0.66
	MW-15M-0208	2/19/2008	< 0.2	7.4	0.7	62	< 0.02 b	85 bJ	< 0.2	0.8 b
MW-15D (Deep)	MW-15D-0803	8/21/2003	< 0.2	1	0.46 b	66	< 0.02 b	14	< 0.2	0.44 b
	MW-15D-1103	11/21/2003	< 1.0	< 1.0	0.20 b	42	< 0.02 b	< 1.0	< 1.0	0.36 b
	MW-15D-0204	2/25/2004	< 2.0	< 2.0	0.43 b	53	< 0.02 b	3.9	< 2.0	0.50 b
	MW-15D-0504	5/26/2004	< 2.0	< 2.0	0.51 b	68	< 0.02 b	18.0	< 2.0	0.46 b
	MW-15D-0804	8/27/2004	< 1.0	< 1.0	0.39 b	54	< 0.02 b	5.9	< 1.0	0.44 b
	MW-15D-1104	11/30/2004	< 1.0	< 1.0	0.36 b	54	< 0.02 b	9.5	< 1.0	0.48 b
	MW-15D-0205	3/2/2005	< 1.0	< 1.0	0.44 b	53	< 0.02 b	11	< 1.0	0.56 b
	MW-15D-0505	6/2/2005	< 1.0	< 1.0	0.32 b	46	< 0.02 b	1.3	< 1	0.46 b
	MW-15D-0805	8/11/2005	< 1.0	< 1.0	0.45 b	56	< 0.02 b	14	< 1	0.4 b
	MW-15D-1105	11/17/2005	< 1.0	< 1.0	0.28 b	54	< 0.02 b	1.3	< 1	0.39 b
	MW-15D-0206	2/9/2006	< 1.0	< 1.0	< 1	37	< 0.02 b	1 b	< 1	0.34 b
	MW-15D-0506	5/18/2006	< 1.0	< 1.0	< 1	60	< 0.02 b	16	< 1	0.36 b
	MW-15D-0806	8/16/2006	< 1.0	< 1.0	< 1	56	< 0.02 b	16	< 1	0.46 b
	MW-15D-1106	11/8/2006	< 1.0	< 1.0	< 1	32	< 0.02 b	0.97 b	< 1	0.29 b
	MW-15D-0207	2/21/2007	< 1.0	< 1.0	< 1	47	< 0.02 b	14	< 1	0.4 b
	MW-15D-0507	5/23/2007	< 0.2	0.4	0.4	63	0.022 b	15	< 0.2	0.42 b
	MW-15D-0807	8/16/2007	< 1.0	< 1.0	< 1.0	47	< 0.020	14	< 1.0	0.34 b
	MW-15D-1107	11/14/2007	< 1.0	< 1.0	< 1	47	< 0.02	4	< 1	0.55
	MW-15D-0208	2/19/2008	< 0.2	1.0	0.6	99	< 0.02 b	24 bJ	< 0.2	0.57 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-16M* (Intermediate)	MW-16S-0803	8/21/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-1103	11/21/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-0204	2/25/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-0504	5/25/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-0804	8/26/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-1104	11/30/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-0205	3/3/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-0505	6/3/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-60S-0505 (dup)	6/3/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-0805	8/12/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16S-1105	11/17/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16M-0206	2/10/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16M-0506	5/18/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16M-0806	8/15/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16M-1106	11/10/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16M-0207	2/22/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16M-0507	5/22/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16M-0807	8/16/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.020	0.11 b	< 0.2	< 0.020 b
	MW-16M-1107	11/15/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02	< 0.02	< 0.2	< 0.02
	MW-16M-0208	2/19/2008	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
MW-16D (Deep)	MW-16D-0803	8/21/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-1103	11/21/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-0204	2/25/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-0504	5/25/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-0804	8/26/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-1104	11/30/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-0205	3/3/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-0505	6/3/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-0805	8/12/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-1105	11/17/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-16D-0206	2/10/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16D-0506	5/18/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16D-0806	8/15/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16D-1106	11/10/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16D-0207	2/22/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16D-0507	5/22/2007	< 0.2	< 0.2	< 0.2	< 0.2	0.023 b	< 0.02 b	< 0.2	< 0.02 b
	MW-16D-0807	8/16/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.020	0.048 b	< 0.2	< 0.020 b
	MW-16D-1107	11/15/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02	< 0.02	< 0.2	< 0.02
	MW-16D-0208	2/19/2008	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-17M (Intermediate)	MW-17M-0205	3/3/2005	< 0.2	1.5	0.1 b	0.5	< 0.02 b	< 0.2	< 0.2	0.02 b
	MW-17M-0505	6/2/2005	< 0.2	1.2	0.08 b	0.4	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-17M-0805	8/11/2005	< 0.2	1.3	0.1 b	0.5	< 0.020 b	< 0.2	< 0.2	< 0.020 b
	MW-17S-0805 (dup)	8/11/2005	< 0.2	1.3	0.1 b	0.4	< 0.020 b	< 0.2	< 0.2	< 0.020 b
	MW-17M-1105	11/16/2005	< 0.2	1.1	0.1 b	0.3	< 0.020 b	< 0.2	< 0.2	< 0.020 b
	MW-17M-0206	2/9/2006	< 0.2	0.6	< 0.2	< 0.2	< 0.020 b	< 0.02 b	< 0.2	< 0.020 b
	MW-17M-0506	5/18/2006	< 0.2	1.1	< 0.2	0.6	< 0.020 b	< 0.02 b	< 0.2	< 0.020 b
	MW-17M-0806	8/16/2006	< 0.2	0.8	< 0.2	0.5	< 0.020 b	< 0.02 b	< 0.2	< 0.020 b
	MW-17M-1106	11/10/2006	< 0.2	0.6	< 0.2	< 0.2	< 0.020 b	< 0.02 b	< 0.2	< 0.020 b
	MW-17M-0207	2/22/2007	< 0.2	0.8	< 0.2	0.6	< 0.020 b	< 0.02 b	< 0.2	< 0.020 b
	MW-17M-0507	5/23/2007	< 0.2	0.9	< 0.2	0.5	< 0.020 b	< 0.02 b	< 0.2	0.021 b
	MW-17M-0807	8/15/2007	< 0.2	0.7	< 0.2	0.3	< 0.020	0.088 b	< 0.2	0.043 b
	MW-17M-1107	11/14/2007	0.2	< 0.2	< 0.2	3.5	< 0.020	6.00 b	< 0.2	< 0.020
	MW-17M-0208	2/19/2008	< 0.2	1	< 0.2	0.5	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
MW-17D (Deep)	MW-17D-0205	3/3/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-17D-0505	6/2/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-17D-0805	8/11/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.020 b	< 0.2	< 0.2	< 0.02 b
	MW-17D-1105	11/15/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.020 b	< 0.2	< 0.2	< 0.02 b
	MW-17D-0206	2/9/2006	< 0.2	< 0.2	< 0.20	< 0.2	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-17D-0506	5/17/2006	< 0.2	< 0.2	< 0.20	< 0.2	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-17D-0806	8/16/2006	< 0.2	< 0.2	< 0.20	< 0.2	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-17D-1106	11/10/2006	< 0.2	< 0.2	< 0.20	< 0.2	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-17D-0207	2/22/2007	< 0.2	< 0.2	< 0.20	< 0.2	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-17D-0507	5/23/2007	< 0.2	< 0.2	< 0.20	< 0.2	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-17D-0807	8/15/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.020	0.46 b	< 0.2	0.026 b
	MW-17D-1107	11/14/2007	< 0.2	< 0.2	< 0.20	< 0.2	< 0.020	< 0.02	< 0.2	< 0.02
	MW-17D-0208	2/19/2008	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
MW-18M (Intermediate)	MW-18M-0205	3/3/2005	< 0.2	0.5	0.1 b	4.7	< 0.02 b	< 0.2	< 0.2	0.1 b
	MW-18M-0505	6/3/2005	< 0.2	0.4	0.049 b	4.3	< 0.02 b	< 0.2	< 0.2	0.044 b
	MW-18M-0805	8/12/2005	< 0.2	0.5	0.06 b	6.1	< 0.020 b	< 0.2	< 0.2	0.06 b
	MW-18M-1105	11/17/2005	< 0.2	0.4	0.05 b	4.6	< 0.020 b	< 0.2	< 0.2	0.04 b
	MW-18M-0206	2/10/2006	< 0.2	0.5	< 0.20	3.5	< 0.020 b	< 0.02 b	< 0.2	0.02 b
	MW-18M-0506	5/18/2006	< 0.2	0.4	< 0.20	5.1	< 0.020 b	< 0.02 b	< 0.2	0.03 b
	DUP-1-0506 (Dup)	5/18/2006	< 0.2	0.4	< 0.20	5.0	< 0.020 b	< 0.02 b	< 0.2	0.03 b
	MW-18M-0806	8/15/2006	< 0.2	0.4	< 0.20	5.0	< 0.020 b	< 0.02 b	< 0.2	0.05 b
	MW-18M-1106	11/10/2006	< 0.2	0.3	< 0.20	2.8	< 0.020 b	< 0.02 b	< 0.2	0.02 b
	MW-18M-0207	2/22/2007	< 0.2	0.3	< 0.20	4.6	< 0.020 b	< 0.02 b	< 0.2	0.03 b
	MW-18M-0507	5/22/2007	< 0.2	0.3	< 0.20	4.1	0.032 b	< 0.02 b	< 0.2	0.02 b
	MW-118M-0507 (Dup)	5/22/2007	< 0.2	0.3	< 0.20	4.2	0.027 b	< 0.02 b	< 0.2	0.03 b
	MW-18M-0807	8/17/2007	< 0.2	0.3	< 0.2	3.8	< 0.020	0.031 b	< 0.2	0.034 b
	MW-18M-1107	11/14/2007	< 0.2	< 0.2	< 0.20	1.4	< 0.020	< 0.02	< 0.2	< 0.02
	MW-18M-0208	2/19/2008	< 0.2	0.4	< 0.20	5.0	< 0.020 b	< 0.02 b	< 0.2	0.03 b
MW-18D (Deep)	MW-18D-0205	3/3/2005	< 0.2	< 0.2	< 0.02 b	2.2	< 0.02 b	< 0.2	< 0.2	0.029 b
	MW-18D-0505	6/9/2005	< 0.2	< 0.2	< 0.02 b	2	< 0.2	< 0.2	< 0.2	0.02 b
	MW-18D-0805	8/12/2005	< 0.2	< 0.2	< 0.02 b	2.5	< 0.020 b	< 0.2	< 0.2	0.02 b
	MW-18D-1105	11/17/2005	< 0.2	< 0.2	< 0.02 b	2.2	< 0.020 b	< 0.2	< 0.2	< 0.02 b
	MW-18D-0206	2/10/2006	< 0.2	< 0.2	< 0.20	1.7	< 0.020 b	< 0.02 b	< 0.2	0.02 b
	DUP-3-0206 (dup)	2/9/2006	< 0.2	< 0.2	< 0.20	1.6	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-18D-0506	5/18/2006	< 0.2	< 0.2	< 0.20	2.2	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-18D-0806	8/15/2006	< 0.2	< 0.2	< 0.20	2.0	< 0.020 b	< 0.02 b	< 0.2	0.03 b
	MW-18D-1106	11/10/2006	< 0.2	< 0.2	< 0.20	0.8	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-18D-0207	2/22/2007	< 0.2	< 0.2	< 0.20	1.6	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	DUP-3-0207 (dup)	2/22/2007	< 0.2	< 0.2	< 0.20	1.4	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	MW-18D-0507	5/22/2007	< 0.2	< 0.2	< 0.20	1.6	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
	DUP-3-0807 (dup)	8/17/2007	< 0.2	< 0.2	< 0.2	1.0	< 0.020	< 0.020 b	< 0.2	< 0.020 b
	MW-18D-0807	8/17/2007	< 0.2	< 0.2	< 0.2	1.1	< 0.020	< 0.020 b	< 0.2	< 0.020 b
	MW-18D-1107	11/14/2007	< 0.2	< 0.2	< 0.20	1.4	< 0.020	< 0.02	< 0.2	< 0.02
	MW-18D-0208	2/19/2008	< 0.2	< 0.2	< 0.20	1.5	< 0.020 b	< 0.02 b	< 0.2	< 0.02 b
MTCA Metbod B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-19M	MW-19M-0205	2/28/2005	< 0.2	1.0	0.3 b	0.6	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-19M-0505	5/31/2005	< 0.2	0.8	0.3	0.5	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	MW-19M-0805	8/11/2005	< 0.2	1.0	0.22 b	0.6	< 0.020 b	< 0.2	< 0.2	< 0.02 b
	MW-19M-1105	11/14/2005	< 0.2	0.8	0.20	0.4	< 0.020 b	< 0.2	< 0.2	< 0.02 b
	MW-19M-0206	2/8/2006	< 0.2	1.0	0.30	0.5	< 0.020 b	0.1 b	< 0.2	< 0.02 b
	MW-19M-0506	5/16/2006	< 0.2	0.7	< 0.20	0.4	< 0.020 b	0.1 b	< 0.2	< 0.02 b
	MW-19M-0806	8/17/2006	< 0.2	0.5	< 0.20	0.3	< 0.020 b	0.1 b	< 0.2	< 0.02 b
	MW-19M-1106	11/8/2006	< 0.2	0.5	< 0.20	0.3	< 0.020 b	0.1 b	< 0.2	< 0.02 b
	MW-19M-0207	2/21/2007	< 0.2	0.4	< 0.20	0.3	< 0.020 b	0.1 b	< 0.2	< 0.02 b
	MW-19M-0507	5/21/2007	< 0.2	0.5	< 0.20	0.2	0.025 b	0.1 b	< 0.2	< 0.02 b
	MW-19M-0807	8/15/2007	< 0.2	0.4	< 0.2	0.2	< 0.020	0.10 b	< 0.2	0.030 b
	MW-19M-1107	11/12/2007	< 0.2	0.5	< 0.20	0.3	< 0.020	0.1	< 0.2	< 0.02
	MW-19M-0208	2/20/2008	< 0.2	0.4	< 0.20	0.2	< 0.020 b	0.1 b	< 0.2	< 0.02 b
MW-20M (Intermediate)	MW-20M-0205	3/2/2005	< 0.2	1.2	0.1 b	1.3	< 0.02 b	0.4	< 0.2	< 0.02 b
	MW-200M-0205 (dup)	3/2/2005	< 0.2	1.2	0.1 b	1.3	< 0.02 b	0.4	< 0.2	0.02 b
	MW-20M-0505	6/1/2005	< 0.2	1	0.046 b	1	< 0.02 b	0.3	< 0.2	< 0.02 b
	MW-20M-0805	8/11/2005	< 0.2	1.4	0.05 b	1.5	< 0.020 b	0.4	< 0.2	< 0.02 b
	MW-20M-1105	11/15/2005	< 0.2	1.2	0.04 b	1.0	< 0.020 b	0.3	< 0.2	< 0.02 b
	MW-20M-0206	2/8/2006	< 0.2	1.2	< 0.20	0.5	< 0.020 b	0.2 b	< 0.2	< 0.02 b
	MW-20M-0506	5/16/2006	< 0.2	1.3	< 0.20	1.1	< 0.020 b	0.5 b	< 0.2	< 0.02 b
	MW-20M-0806	8/17/2006	< 0.2	1.1	< 0.20	0.9	< 0.020 b	0.4 b	< 0.2	0.02 b
	MW-20M-1106	11/7/2006	< 0.2	0.5	< 0.20	0.2	< 0.020 b	0.1 b	< 0.2	< 0.02 b
	MW-200M-1106 (dup)	11/7/2006	< 0.2	0.6	< 0.20	0.2	< 0.020 b	0.1 b	< 0.2	< 0.02 b
	MW-20M-0207	2/23/2007	< 0.2	1.1	< 0.20	0.7	< 0.020 b	0.5 b	< 0.2	0.03 b
	MW-20M-0507	5/22/2007	< 0.2	1.0	< 0.20	0.8	0.032 b	0.4 b	< 0.2	0.02 b
	MW-20M-0807	8/17/2007	< 0.2	0.8	< 0.2	0.5	< 0.020	0.28 b	< 0.2	< 0.020 b
	MW-20M-1107	11/13/2007	< 0.2	1.1	< 0.20	0.7	< 0.020	0.3	< 0.2	< 0.02
	MW-20M-0208	2/20/2008	< 0.2	1.2	< 0.20	0.6	< 0.020 b	0.4	< 0.2	< 0.02 b
MW-21S (Shallow)	MW-21S-0905	9/26/2005	1.2	< 0.2	0.10 b	6.3	< 0.02 b	7.3	< 0.2	0.024 b
	MW-20S-1105	11/16/2005	0.4	< 0.2	0.14 b	6.5	< 0.02 b	8.4	< 0.2	< 0.02 b
	MW-22S-1105 (dup)	11/16/2005	0.3	< 0.2	0.14 b	6.2	< 0.02 b	8.6	< 0.2	0.02 b
	MW-21S-0206	2/9/2006	0.4	0.2	.0.20	8.4	< 0.02 b	9.5	< 0.2	< 0.02 b
	MW-21S-0506	5/18/2006	0.7	< 0.2	< 0.20	4.3	< 0.02 b	6.1	< 0.2	< 0.02 b
	MW-21S-0806	8/16/2006	0.7	< 0.2	< 0.20	3.7	< 0.02 b	6.5	< 0.2	< 0.02 b
	MW-21S-1106	11/8/2006	0.9	< 0.2	< 0.20	1.2	< 0.02 b	1.8 b	< 0.2	< 0.02 b
	MW-21S-0207	2/22/2007	< 0.2	< 0.2	< 0.20	5.2	< 0.02 b	6.6	< 0.2	< 0.02 b
	MW-21S-0507	5/23/2007	< 0.2	< 0.2	< 0.20	0.7	< 0.02 b	1.6 b	< 0.2	< 0.02 b
	MW-21S-0807	8/16/2007	< 0.2	< 0.2	< 0.2	2.4	< 0.020	6.0	< 0.2	< 0.020 b
	MW-21S-1107	11/14/2007	< 0.2	0.7	< 0.20	0.4	< 0.02	< 0.0	< 0.2	< 0.02
	MW-21S-0208	2/22/2008	< 0.2	< 0.2	< 0.20	2.5	< 0.02 b	5.2	< 0.2	< 0.02 b
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
EPI-MW-2D (Intermediate)	EPI-MW-2D-0204	2/23/2004	< 1.0	83.0	12	94	0.021 b	74	< 1	1.1 b
	EPI-MW-2D-0504	5/26/2004	< 2.0	64.0	8.3 b	64	< 0.02 b	69	< 2	1.2 b
	EPI-MW-2D-0804	8/27/2004	< 1	96	15	69	< 0.02 b	74	< 1	1.4 b
	MW-20-0804 (DUP)	8/27/2004	< 0.2	95	14	67	< 0.02 b	73	< 0.2	1.3 b
	EPI-MW-2D-1104	11/30/2004	< 1	79	19 Jb	72	< 0.02 b	62	< 1	1.6 b
	MW-20-1104 (dup)	11/30/2004	< 1	79	19 Jb	72	< 0.02 b	64	< 1	1.6 b
	EPI-MW-2D-0205	3/1/2005	< 1	55	16 Jb	67	< 0.02 b	51	< 1	1.3 b
	EPI-MW-20D-0205 (dup)	3/1/2005	< 1	56	16 Jb	68	< 0.02 b	51	< 1	1.3 b
	EPI-MW-2D-0805	8/9/2005	< 1	71	22 Jb	72	< 0.02 b	52	< 1	1.2 b
	EPI-MW-5D-0805 (dup)	8/9/2005	< 0.2	72	21 Jb	72	< 0.02 b	53	< 0.2	1.2 b
	EPI-MW-2D-0206	2/7/2006	< 1	51	18	67	< 0.02 b	45	< 1	0.99 b
	EPI-MW-2D-0806	8/14/2006	< 2	63	22	67	< 0.02 b	51	< 2	1.4 b
	EP1-MW-2D-0207	2/19/2007	< 1	45	20	78	< 0.02 b	40	< 1	0.49 b
	EPI-MW-2D-0807	8/14/2007	< 1	27	10	38	< 0.02	22	< 1	0.42 b
	EPI-MW-2D-0208	2/21/2008	< 0.2	51	23	91	< 0.02 b	27 bJ	< 0.2	0.76 b
	Rolling Average		0.9	51.5	19.0	68.8	0.02	39.7	0.9	0.88
EPI-MW-3S (Shallow)	EPI-MW-3S-0204	2/23/2004	< 1.0	12.0 J	3.8 b	86	< 0.02 b	13	< 1	0.62 b
	EPI-MW-3S-0504	5/26/2004	< 2.0	5.8	2.9 b	61	< 0.02 b	13	2	0.39 b
	EPI-MW-3S-0804	8/27/2004	< 1	7	3.1 b	68	< 0.02 b	14	< 1	0.41 b
	EPI-MW-3S-1104	11/29/2004	< 1	4.5	2.3 b	51	< 0.02 b	12	< 1	0.37 b
	EPI-MW-3S-0205	3/1/2005	< 1	3.3	1.6 b	40	< 0.02 b	10	< 1	0.31 b
	EPI-MW-3S-0805	8/8/2005	< 1	2.6	1.5 b	39	< 0.02 b	11	< 1	0.27 b
	EPI-MW-3S-0206	2/6/2006	< 1	1.6	< 1	27	< 0.02 b	9.9	< 1	0.2 b
	EPI-MW-3S-0806	8/14/2006	< 0.6	1.6	0.8	32	< 0.02 b	10	< 0.6	0.27 b
	EP1-MW-3S-0207	2/19/2007	< 1	1.1	< 1	24	< 0.02 b	7.8	< 1	0.21 b
	EPI-3S-0807	8/13/2007	< 0.2	1.3	0.6	20	< 0.02	8.9	< 0.2	0.2 b
	EPI-MW-3S-0208	2/18/2008	< 0.2	1.5	0.6	34	< 0.02 b	7.9 bJ	< 0.2	0.25 b
	Rolling Average		0.7	1.6	0.9	29.3	0.02	9.3	0.7	0.23
EPI-MW-3D (Intermediate)	EPI-MW-3D-0204	2/25/2004	< 0.2	34	3.6 b	14	< 0.02 b	5.1	< 0.2	0.66 b
	EPI-MW-3D-0504	5/26/2004	< 0.6	31.0	3.9 b	12	< 0.02	5	< 0.6	0.45 b
	EPI-MW-3D-0804	8/26/2004	< 10	12	0.63 b	< 10	< 0.02 b	< 10	< 10	0.26 b
	EPI-MW-3D-1104	11/29/2004	< 0.4	27	5.5	13	< 0.02 b	5.1	< 0.4	0.47 b
	EPI-MW-3D-0205	3/1/2005	< 1	24	6.8 Jb	12	< 0.02 b	4.2	< 1	0.36 b
	EPI-MW-3D-0805	8/8/2005	< 0.6	20	7.1 Jb	13	< 0.02 b	4.4	< 0.6	0.22 b
	EPI-MW-3D-0206	2/6/2006	< 0.2	8.8	4.6	8.1	< 0.02 b	3.1 b	< 0.2	0.07 b
	EPI-MW-3D-0806	8/14/2006	< 0.2	11	4.4	9.2	< 0.02 b	3.3	< 0.2	0.21 b
	EP1-MW-3D-0207	2/19/2007	< 0.2	3.4	2.2	5.3	< 0.02 b	3.4 b	< 0.2	0.064 b
	EPI-MW-3D-0807	8/13/2007	< 0.2	4.4	2.2	5	< 0.02	3.2 b	< 0.2	0.063 b
	EPI-MW-3D-0208	2/18/2008	< 0.2	4	2	5.3	< 0.02 b	2.4 bJ	< 0.2	0.11 b
	Rolling Average		0.3	8.6	3.8	7.7	0.02	3.3	0.3	0.12
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
EPI-MW-4S (Shallow)	EPI-MW-4S-0204	2/23/2004	< 0.2	0.6	0.23 b	3.1	< 0.02 b	11	< 0.2	0.061 b
	EPI-MW-4S-0504	5/26/2004	< 0.2	0.8	0.2 b	3.4	< 0.02 b	9.8	< 0.2	0.051 b
	EPI-MW-4S (DUP)	5/26/2004	< 0.2	0.8	0.2 b	3.2	< 0.2 b	10	< 0.2	0.052 b
	EPI-MW-4S-0804	8/26/2004	< 0.2	0.7	0.21 b	3.7	< 0.02 b	11	< 0.2	0.051 b
	EPI-MW-4S-1104	11/29/2004	< 0.2	0.6	0.3	2.9	< 0.02 b	12	< 0.2	0.059 b
	EPI-MW-4S-0205	3/1/2005	< 0.2	0.8	0.21 b	3.4	< 0.02 b	12	< 0.2	0.061 b
	EPI-MW-4S-0805	8/8/2005	< 0.2	0.9	0.21 b	5.4	< 0.02 b	13	< 0.2	0.054 b
	EPI-MW-4S-0206	2/6/2006	< 0.2	0.8	0.3	2.5	< 0.02 b	12	< 0.2	0.039 b
	EPI-MW-4S-0806	8/14/2006	< 0.2	0.5	0.2	5	< 0.02 b	12	< 0.2	0.068 b
	EPI-MW-4S-0207	2/19/2007	< 0.2	0.5	< 0.2	1.9	< 0.02 b	8.4	< 0.2	0.047 b
	EPI-4S-0807	8/13/2007	< 0.2	0.5	< 0.2	1.5	< 0.02	7.9	< 0.2	0.064 b
	EPI-MW-4S-0208	2/18/2008	< 0.2	0.5	0.2	2.6	< 0.02 b	10	< 0.2	0.056 b
	Rolling Average		0.2	0.6	0.2	3.2	0.02	10.6	0.2	0.05
EPI-MW-4D (Intermediate)	EPI-MW-4D-0204	2/25/2004	< 0.2	0.3	0.037 b	0.4	< 0.02	< 0.2	< 0.2	0.022 b
	EPI-MW-4D-0504	5/26/2004	< 0.2	0.2	0.028 b	0.6	< 0.2 b	0.2	< 0.2	0.024 b
	EPI-MW-4D-0804	8/27/2004	< 0.2	0.3	0.031 b	0.7	< 0.02 b	0.2	< 0.2	0.025 b
	EPI-MW-4D-1104	11/29/2004	< 0.2	< 0.2	< 0.02 b	0.4	< 0.02 b	< 0.2	< 0.2	0.031 b
	EPI-MW-4D-0205	3/1/2005	< 0.2	< 0.2	< 0.02 b	0.6	< 0.02 b	< 0.2	< 0.2	0.053 b
	EPI-MW-4D-0505	5/31/2005	< 0.2	< 0.2	< 0.02 b	0.7	< 0.02 b	< 0.2	< 0.2	0.059 b
	EPI-MW-4D-0805	8/8/2005	< 0.2	< 0.2	< 0.02 b	0.8	< 0.02 b	< 0.2	< 0.2	0.052 b
	EPI-MW-4D-1105	11/16/2005	< 0.2	< 0.2	< 0.02 b	0.4	< 0.02 b	< 0.2	< 0.2	0.037 b
	EPI-MW-4D-0206	2/6/2006	< 0.2	< 0.2	< 0.2	0.2	< 0.02 b	0.036 b	< 0.2	0.048 b
	EPI-MW-4D-0806	8/15/2006	< 0.2	< 0.2	< 0.2	0.9	< 0.02 b	0.13 b	< 0.2	0.085 b
	EPI-MW-14D-0806 (Dup)	8/15/2006	< 0.2	< 0.2	< 0.2	1	< 0.02 b	0.13 b	< 0.2	0.082 b
	EPI-MW-4D-0207	2/19/2007	< 0.2	< 0.2	< 0.2	0.7	< 0.02 b	0.11 b	< 0.2	0.083 b
	EPI-MW-4D-0807	8/13/2007	< 0.2	< 0.2	< 0.2	0.3	< 0.02	0.056 b	< 0.2	0.058 b
	EPI-MW-4D-0208	2/19/2008	< 0.2	< 0.2	< 0.2	0.3	< 0.02 b	0.05 b	< 0.2	0.056 b
	Rolling Average		0.2	0.2	0.2	0.6	0.02	0.1	0.2	0.07
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.86/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.15/0.39 f	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
OTHER	Trip Blank	11/21/1996	0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	4/17/1997	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	Trip Blank	7/21/1997	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	Trip Blank	7/21/1997	0.23 JB	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	Trip Blank	2/24/1998	< 0.4	< 0.4	< 0.2	< 0.4	< 0.2	< 0.2	< 0.4	< 0.2
	Trip Blank	5/20/1998	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2
	Trip Blank	8/12/1998	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Field Blank	11/9/1998	5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	11/9/1998	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	2/24/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	6/8/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	8/25/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	11/22/1999	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	2/2/2000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	5/23/2000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	8/29/2000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	11/28/2000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	2/20/2001	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	5/24/2001	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	8/27/2001	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	11/5/2001	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	2/21/2002	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	5/23/2002	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	8/14/2002	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Trip Blank	12/3/2002	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.05 b	< 0.2	< 0.2	< 0.02 b
	Trip Blank	2/26/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	0.073 b	< 0.2	< 0.2	< 0.02 b
	Trip Blank	5/28/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.05 b	< 0.2	< 0.2	< 0.02 b
	Trip Blank	8/20-21/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.05 b	< 0.2	< 0.2	< 0.02 b
	Trip Blank	11/20-21/2003	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	Trip Blank	2/23-25/2004	0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	Trip Blank	5/25-26/2004	0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	Field Blank	5/26/2004	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	Trip Blank	8/27/2004	0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	Trip Blank	11/30/2004	0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	TB-0205	2/7/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	TRIP BLANK-0505	5/17/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	TripBlank-0805	8/3/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	TripBlank2-0805	8/3/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	TRIP BLANK-1-1105	11/7/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	TRIP BLANK-2-1105	11/7/2005	< 0.2	< 0.2	< 0.02 b	< 0.2	< 0.02 b	< 0.2	< 0.2	< 0.02 b
	TRIP BLANK-1105	11/11/2005	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
	Trip Blank-1-0206	1/30/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TRIP BLANK-2-0206	1/30/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TRIP BLANK-0506	5/16/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TRIP BLANK_0806	8/8/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TRIP BLANK_0806B	8/8/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TRIP BLANK-1106	11/7/2006	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TRIP BLANK-1-0207	2/19/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TRIP BLANK-2-0207	2/22/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TRIP BLANK-0507	5/17/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02 b	< 0.02 b	< 0.2	< 0.02 b
	TB-0807	8/13/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02	< 0.02 b	< 0.2	< 0.02 b
	TB-1107	11/12/2007	< 0.2	< 0.2	< 0.2	< 0.2	< 0.02	< 0.02	< 0.2	< 0.02
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.858	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.2	55.6/1.5 d	417,000	3.69

Table A-1 Groundwater Groundwater Quality: Volatile Organic Compounds (Continued)
November 1996 Data to Present

NOTES:

All results in µg/L. 1992 to 1995 analyses by EPA Method 8240; 1996 to present analyses by EPA Method 8260.
Italicized data were collected prior to startup of the hydraulic-containment and groundwater-recovery system.
December 2002 results for vinyl chloride, 1,1-DCE and PCE are by EPA Method 8260 SIM.
a - Federal Register 1990 as cited in IRIS, 1994.
b - Analysis by SIM method.
c- TCE Method B groundwater cleanup value was lowered from 3.98 ug/L to 0.11 ug/L - both values are shown for reference.
d- TCE Method B surface water cleanup value was lowered from 55.6 ug/L to 1.5 ug/L - both values are shown for reference.
e-PCE Method B groundwater cleanup value was lowered from 0.858 ug/L to 0.081 - both values are shown for reference.
f- PCE Method B surface water cleanup value was lowered from 4.2 ug/L to 0.39 ug/L - both values are shown for reference.
B - This compound also detected in associated blank.
D - The reported result for this analyte is calculated based on a secondary dilution factor (i.e., results were derived from a laboratory-diluted sample).
E - The concentration of this analyte exceeded the instrument calibration range.
J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UB - Analyte was detected in the associated trip blank. Based on data validation, sample result was reclassified as not detected.
NA - Not Applicable
* - Well renamed with "S" or "M" suffix to denote shallow or intermediate well, as appropriate
** - Average does not include previous triggering values.
x - Because average returned to the levels prior to triggering, future averages will not include data marked with an "x".

Table A-2 Historic Groundwater Quality: Volatile Organic Compounds (Continued)

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-1	MW-1	5/11/1992	11 J	11 J	71	< 20	12 J	500	2,400	< 2.0
(Shallow)	MWX-1	5/11/1992	< 20	< 20	72	< 20	8.7 J	460	2,200	< 2.0
	MW-1-2	9/17/1992	11	10	31	6.2	15	460	1,800	NA
	MW-1-2D	9/17/1992	10	15	54	12	22	720	2,600	NA
	MW-1-3	4/8/1993	14	9.5	35	6.6	13	280	1,500	< 10
	MW-1-4	2/25/1994	7.6	6.2	6.6	< 5.0	< 5.0	120	220	< 10
	MW-1-5	6/21/1994	11	12	15	5.5	9.6	400	840	< 10
	MW-1-6	11/3/1994	24	< 5.0	< 5.0	< 5.0	5.7	150	270	< 10
	MW-1-7	6/16/1995	9.7	< 5.0	6.1	5.6	11	390	430	< 10
	MW-1-8	9/27/1995	18	1.0	1.6	0.8	4.6	97	110	< 0.5
	MW-1-9	8/13/1996	11 D	1.8	2.1	3.5	9.1 D	200 D	160 D	< 0.2
MW-2	MW-2	5/11/1992	< 1.0	< 1.0	< 1.0	0.7 J	< 1.0	6.0	< 1.0	< 2.0
(Shallow)	MW-2-2	9/17/1992	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	14	37	NA
	MW-2-3	4/8/1993	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.7	< 5.0	< 10
	MW-2-4	2/25/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-2-5	6/21/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-2-6	11/3/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-2-7	6/14/1995	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	8.8	< 5.0	< 10
	MW-2-8	9/27/1995	< 0.5	< 0.5	< 0.5	0.6	< 0.5	4.8	< 0.5	< 0.5
	MW-2-9	8/13/1996	< 0.2	< 0.2	< 0.2	1.8	0.6	17 D	0.2	< 0.2
RW-2	RW-2	8/13/1996	0.6	37 D	24 D	87 D	< 0.2	32 D	0.2	0.3
MW-3	MW-3	5/11/1992	< 1.0	1.9	< 1.0	4.3	< 1.0	21	< 1.0	< 2.0
(Shallow)	MW-3-2	9/17/1992	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	26	< 5.0	NA
	MW-3-3	4/8/1993	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	13	< 5.0	< 10
	MW-3-4	2/25/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	9.9	< 5.0	< 10
	MW-3-5	6/21/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	9.4	< 5.0	< 10
	MW-3-6	11/3/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	11	< 5.0	< 10
	MW-3-7	6/15/1995	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	8.9	< 5.0	< 10
	MW-3-8	9/27/1995	< 0.5	< 0.5	< 0.5	1.2	< 0.5	11	< 0.5	< 0.5
	MW-3-9	8/13/1996	< 0.2	0.4	< 0.2	1.1	< 0.2	11 D	< 0.2	< 0.2
MW-4	MW-4	5/11/1992	< 4.2	12	7.1	1.4	1.1	100	75	< 2.0
(Shallow)	MW-4-2	9/17/1992	< 5.0	13	6.7	< 5.0	< 5.0	110	99	NA
	MW-4-3	4/8/1993	6.7	12	15	6.3	< 5.0	190	230	< 10
	MW-4-4	2/25/1994	6.6	36	54	10	< 5.0	280	530	< 10
	MW-4-5	6/21/1994	6.8	100	80	14	< 5.0	320	490	< 10
	MW-4-6	11/3/1994	< 5.0	81	57	8.6	< 5.0	230	240	< 10
	MW-4-7	6/16/1995	6.8	74	66	11	< 5.0	370	470	< 10
	MW-4-8	9/27/1995	4.3	71	63	9.1	2.6	300	240	< 0.5
	MW-4-9	8/13/1996	7.0 D	38 D	37 D	8.8 D	4.8	290 D	250 D	< 0.2
MW-5	MW-5-4	2/25/1994	14	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	53	< 10
(Shallow)	MW-5-5	6/21/1994	25	< 5.0	< 5.0	< 5.0	< 5.0	6.6	45	< 10
	MW-5-6	11/3/1994	17	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	98	< 10
	MW-5-7	6/16/1995	14	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	20	< 10
	MW-5-7-DUP	6/16/1995	15	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	17	< 10
	MW-5-8	9/27/1995	11	1.4	0.8	< 0.5	< 0.5	3.2	23	< 0.5
	MW-5-9	8/13/1996	20 D	0.4	0.3	< 0.2	1.4	3.1	16 D	< 0.2

Table A-2 Historic Groundwater Quality: Volatile Organic Compounds (Continued)

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
MW-6 (Shallow)	MW-6-4	2/25/1994	< 5.0	82	150	15	< 5.0	350	830	< 10
	MW-6X-4	2/25/1994	< 5.0	84	160	16	< 5.0	330	630	< 10
	MW-6-5	6/21/1994	< 5.0	120	200	19	< 5.0	380	990	< 10
	MW-6X-5	6/21/1994	< 5.0	140	310	21	< 5.0	460	1,800	< 10
	MW-6-6	11/3/1994	< 5.0	73	290	17	< 5.0	410	2,500	< 10
	MW-6X-5	11/3/1994	< 5.0	79	250	17	< 5.0	390	1,900	< 10
	MW-6-7	6/16/1995	< 5.0	380	360	25	< 5.0	390	420	< 10
	MW-6-8	9/27/1995	< 12	170	300	18	< 12	410	1,000	< 10
	MW-6-9	8/13/1996	1.2	180 D	260 D	20 D	3.7	530 D	420 D	< 0.56
MW-7 (Shallow)	MW-7-4	2/25/1994	< 5	210	260	5.6	< 5.0	< 5.0	< 5.0	< 10
	MW-7-5	6/21/1994	< 5	200	180	170	< 5.0	50	30	< 10
	MW-7-6	11/3/1994	< 5	200	220	11	< 5.0	< 5.0	< 5.0	< 10
	MW-7-7	6/16/1995	< 5	75	53	160	< 5.0	45	26	< 10
	MW-7-8	9/27/1995	< 0.5	71	62	140	< 0.5	43	22	0.9
	MW-7-9	8/13/1996	0.4	75 D	54 D	240 D	0.2	88 D	30 D	0.6
MW-8S* (Shallow)	MW-8-4	2/25/1994	< 5.0	16	< 5.0	160	< 5.0	30	< 5.0	< 10
	MW-8-5	6/21/1994	< 5.0	19	< 5.0	370	< 5.0	71	< 5.0	< 10
	MW-8-6	11/3/1994	< 5.0	26	< 5.0	230	< 5.0	36	< 5.0	< 10
	MW-8-7	6/15/1995	< 5.0	8.1	< 5.0	130	< 5.0	37	< 5.0	< 10
	MW-8-8	9/27/1995	< 0.5	9.1	1.0	140	< 0.5	33	< 0.5	< 0.5
	MW-8-9	8/13/1996	< 0.2	10 D	2.3	97 D	< 0.2	53 D	3.2	< 0.2
	MW-20 (Dup)	8/13/1996	< 0.2	6.7 D	2.3	77 D	< 0.2	29 D	3.0	< 0.2
MW-8M (Intermediate)	MW-8M-1105	11/14/2005	< 0.2	1	2.5	< 0.2	< 0.02 b	< 0.2	< 0.2	0.043 b
	MW-8M-0206	2/7/2006	< 0.2	0.7	1.7	< 0.2	< 0.02 b	0.027 b	< 0.2	< 0.020 b
	Dup-1-0206	2/7/2006	< 0.2	0.7	1.7	< 0.2	< 0.02 b	0.027 b	< 0.2	< 0.020 b
MW-9 (Shallow)	MW-9-4	2/25/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-9-5	6/21/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-9-6	11/3/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-9-7	6/15/1995	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-9-8	9/27/1995	< 0.5	< 0.5	0.5	< 0.6	< 0.5	< 0.5	< 0.5	< 0.5
	MW-9-9	8/13/1996	< 0.2	< 0.2	< 0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2
MW-10 (Shallow)	MW-10-6	11/3/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-10-7	6/15/1995	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-10-8	9/27/1995	< 0.5	1.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
	MW-10-9	8/13/1996	< 0.2	0.6	< 0.2	< 0.2	< 0.2	0.3	< 0.2	< 0.2
	MW-10-9-Dup	8/13/1996	< 0.2	0.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-11 (Shallow)	MW-11-6	11/3/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	37	< 5.0	< 10
	MW-11-7	6/15/1995	< 5.0	< 5.0	< 5.0	14	< 5.0	31	< 5.0	< 10
	MW-11-8	9/27/1995	< 0.5	< 0.5	< 0.5	20	< 0.5	40	< 0.5	< 0.5
	MW-11-8-Dup	9/27/1995	< 0.5	< 0.5	< 0.5	15	< 0.5	39	< 0.5	< 0.5
	MW-11-9	8/13/1996	< 0.2	0.67	0.38	10 E	< 0.2	32 E	< 0.2	< 0.2
MW-12 (Shallow)	MW-12-6	11/3/1994	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-12-7	6/15/1995	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
	MW-12-8	9/27/1995	< 0.5	0.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
	MW-12-9	8/13/1996	< 0.2	1.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.858/0.081 e	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.2/0.39 f	55.6/1.5 d	417,000	3.69

Table A-2 Historic Groundwater Quality: Volatile Organic Compounds (Continued)

Sample Location	Sample Number	Sample Date	Chloroform	1,1-Dichloro-ethane (1,1-DCA)	1,1-Dichloro-ethylene (1,1-DCE)	cis 1,2-Dichloro-ethylene (1,2-DCE)	Tetrachloro-ethylene (PCE)	Trichloro-ethylene (TCE)	1,1,1-Trichloro-ethane (1,1,1-TCA)	Vinyl Chloride
OTHER	RE-051192	*5/11/1992*	*11*	< *1.0*	< *1.0*	< *1.0*	< *1.0*	< *1.0*	*0.8 J*	< *2.0*
	FB-2	*9/17/1992*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	*NA*
	RB	*4/8/1993*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	RB-4	*2/25/1994*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	RB-5	*6/21/1994*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	Decon Blank	*6/16/1995*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	Decon Blank	*9/27/1995*	< *0.5*	< *0.5*	< *0.5*	< *0.5*	< *0.5*	< *0.5*	< *0.5*	< *0.5*
	TB-051192	*5/11/1992*	< *1.0*	< *1.0*	< *1.0*	< *1.0*	< *1.0*	< *1.0*	< *1.0*	< *2.0*
	Trip Blank	*9/17/1992*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	*NA*
	TB	*4/8/1993*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	TB-4	*2/25/1994*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	TN-5	*6/21/1994*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	TB-6	*11/3/1994*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	TB-7	*6/16/1995*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *5.0*	< *10*
	TB-8	*6/16/1995*	< *0.5*	< *0.5*	< *0.5*	< *0.5*	< *0.5*	< *0.5*	< *0.5*	< *0.5*
	TB-9	8/13/1996	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MTCA Method B Groundwater Cleanup Level			7.17	800	72	80	0.858	3.98/0.11 c	7,200	0.029
MTCA Method B Surface Water Cleanup Level			283	113,000 a	4167	NA	4.2	55.6/1.5 d	417,000	3.69

NOTES:

All results in µg/L. 1992 to 1995 analyses by EPA Method 8240; 1996 to present analyses by EPA Method 8260.
Italicized data were collected prior to startup of the hydraulic-containment and groundwater-recovery system.
a - Federal Register 1990 as cited in IRIS, 1994.
b - Analysis by SIM method.
c- TCE Method B groundwater cleanup value was lowered from 3.98 ug/L to 0.11 ug/L - both values are shown for reference.
d- TCE Method B surface water cleanup value was lowered from 55.6 ug/L to 1.5 ug/L - both values are shown for reference.
B - This compound also detected in associated blank.
D - The reported result for this analyte is calculated based on a secondary dilution factor (i.e., results were derived from a laboratory-diluted sample).
E - The concentration of this analyte exceeded the instrument calibration range.
J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UB - Analyte was detected in the associated trip blank. Based on data validation, sample result was reclassified as not detected.
NA - Not Applicable
* - Well renamed with "S" or "M" suffix to denote shallow or intermediate well, as appropriate

Appendix B

Cost Back Up for Proposed Alternatives

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 1
Table B-1a: Net Present Value
GE South Dawson Street

Year	Cost Factor	Implementation of Alternative	Operation of SVE/AS	Operation of Hydraulic Containment	O&M Cost & VIMS	Performance Sampling	Confirmation Sampling	Reporting	Sub Total Annual	Contingency (30%)	Sales Tax (9%)	Total Annual Cost	Discounted Annual	Discount Rate
0	1		$0						$0				$0	1.03
1	0.971	$276,508		$112,800	$46,850	$10,000		$1,000	$447,158	$51,195	$15,359	$513,712	$498,749	
2	0.943	$276,508		$85,800	$46,850	$10,000		$1,000	$420,158	$43,095	$12,929	$476,182	$448,847	
3	0.915		$144,208	$85,800	$71,850	$54,000		$67,000	$422,858	$126,858	$38,057	$587,773	$537,896	
4	0.888		$144,208	$85,800	$71,850	$54,000		$67,000	$422,858	$126,858	$38,057	$587,773	$522,229	
5	0.863		$144,208	$85,800	$71,850	$59,500		$73,270	$434,628	$130,389	$39,117	$604,133	$521,131	
6	0.837		$150,250	$85,800	$71,850	$24,000		$22,000	$353,900	$106,170	$31,851	$491,921	$411,976	
7	0.813		$150,250	$85,800	$71,850	$24,000		$22,000	$353,900	$106,170	$31,851	$491,921	$399,977	
8	0.789		$150,250	$85,800	$71,850	$29,500		$28,270	$365,670	$109,701	$32,910	$508,281	$401,242	
9	0.766			$17,500			$50,000	$25,000	$92,500	$27,750	$8,325	$128,575	$98,542	
10	0.744						$50,000	$25,000	$75,000	$22,500	$6,750	$104,250	$77,572	
11	0.722						$50,000	$25,000	$75,000	$22,500	$6,750	$104,250	$75,312	
											Total Annual Costs	$4,598,772		
											Net Present Worth		**$3,993,473**	

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 1
Table B-1: Soil Vapor Extraction combined with Air Sparge, and Institutional Controls
GE South Dawson Street

			Quantity	Total	Source/Notes
Extraction System					
Relocation of RW-3	20,000	ls	1	$20,000	Cascade Drilling, Price from similar job
Decommissioning of original location of RW-3	5,000	ls	1	$5,000	Cascade Drilling, disposal
Additional Permits Application	2,000	ls	1	$2,000	Estimate using price from similar job
Discharge Disposal	$85,800	yr	8	$686,400	Current rates, 10% increase
Discharge Reporting and Sampling	$11,000	per year	8	$88,000	Current rates, 10% increase
O&M	$24,200	per year	8	$193,600	Current rates, 10% increase
AS/SVE - On-Site Area (Phase 1)					
Initial site testing, prior to set up	$50,000	ls	1	$50,000	H2Oil Estimate
Injection Well Installation and Piping	$1,250	each	10	$12,500	Cascade Drilling, Price from similar job
Air Injection Blower	$9,375	each	1	$9,375	H2Oil Estimate
Manifold	$6,250	each	1	$6,250	H2Oil Estimate
Extraction Well Installation	$3,125	each	12	$37,500	H2Oil Estimate
SVE Piping	$63	per lf	1000	$62,500	H2Oil Estimate
O&M	$25,000	per year	3	$75,000	H2Oil Estimate
Utility Hookup	$25,000	ls	1	$25,000	H2Oil Estimate
Oxidizer Rental	$54,000	per year	3	$162,000	H2Oil Estimate
Natural Gas Utility	$22,500	per year	3	$67,500	H2Oil Estimate
Performance Monitoring & Reporting	$55,000	per event	6	$330,000	ENSR Current rates, estimate on similar job
AS/SVE Off-Site Area (Phase 2)					
Injection Well Installation and Piping	$1,250	each	12	$15,000	H2Oil Estimate
Air Injection Blower	$9,375	each	1	$9,375	H2Oil Estimate
Manifold	$6,250	each	1	$6,250	H2Oil Estimate
Extraction Well Installation	$3,125	each	12	$37,500	H2Oil Estimate
SVE Piping	$63	per lf	2000	$125,000	H2Oil Estimate
O&M	$25,000	per year	3	$75,000	H2Oil Estimate
Utility Hookup	$25,000	ls	1	$25,000	H2Oil Estimate
Oxidizer Rental	$54,000	per year	3	$162,000	H2Oil Estimate
Natural Gas Utility	$22,500	per year	3	$67,500	H2Oil Estimate
Cost of Moving Unit	$3,125	ls	1	$3,125	H2Oil Estimate
Performance Monitoring & Reporting	$35,000	per event	3	$105,000	ENSR Current rates, estimate on similar job
Decommissioning					
Decommissioning of Pump and Treat Systems	$5,000	ls	1	$5,000	Quote from Vendor, Estimate using price from similar j
Decommissioning of injection/observation wells	$12,500	ls	1	$12,500	Quote from Vendor, Estimate using price from similar j
Long-term Maintenance and Monitoring (Groundwater)					
Monitoring (groundwater wells)	$50,000	per year	3	$150,000	ENSR Current rates, estimate on similar job
Reporting	$25,000	per year	3	$75,000	ENSR Current rates, estimate on similar job
Sub Slab Vapor Intrusion System					
Monitoring (8 years)	$10,000	per year	8	$80,000	Current rates
Analytical Monitoring	$5,500	per event	2	$11,000	Air Toxics, 10% increase
O&M (8 years)	$12,650	per year	8	$101,200	Current rates, 10% increase
Reporting (2 events)	$6,270	per year	2	$12,540	Current rates, 10% increase
	Direct Capital:			$2,910,615	
	Remedial Design (8%)			$232,849	EPA, 2000
	Project Management (5 %)			$145,531	EPA, 2000
	Construction Management (6 %)			$174,637	EPA, 2000
	Sales Tax (9 %)			$261,955	WA State Sales Tax
	Contingency (30.0 %)			$873,185	EPA, 2000
			Total Capital:	**$4,598,772**	

Notes: Sales tax applied only on direct capital cost

EPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. Environmental Protection Agency, July 2000.

2008 Dollars

Assumes extraction and subslab system operates during the 2 years of permit/design/remedy selection

FEASIBILITY STUDY COST ESTIMATES

REMEDIAL ALTERNATIVE 2

Table B-2: Optimized Hydraulic Control, Chemical Oxidation with Potassium Permanganate, Sub Slab Depressurization System, and Institutional Controls

GE South Dawson Street

			Quantity	Total	Source/Notes
Extraction System					
Relocation of RW-3	20,000	ls	1	$20,000	Cascade Drilling, Price from similar job
Relocation of RW-2	20,000	ls	1	$20,000	Cascade Drilling, Price from similar job
Decommissioning of original RW-3 and RW-2	10,000	ls	1	$10,000	Cascade Drilling, disposal
Additional Permits Application	2,000	ls	1	$2,000	Estimate using price from similar job
Discharge Disposal	$85,800	yr	5	$429,000	Current rates, 10% increase
Discharge Reporting and Sampling	$11,000	per year	5	$55,000	Current rates, 10% increase
O&M	$24,200	per year	5	$121,000	Current rates, 10% increase
Phase 1 Injection					
Bench Scale Testing	$20,000	event	1	$20,000	Assume small scale bench study
Injection Well Installation and Piping	$16,000	event	I	$16,000	Assume 8 wells, Quote from vendor
Injection Chemical	$19,600	event	1	$19,600	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$2,800	event	1	$2,800	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$29,400	event	1	$29,400	Estimate using price from similar job
On-Site Area (Phase 2 and 3)					
Injection Well Installation and Piping	$40,000	event	2	$80,000	Assume 20 wells, Quote from vendor
Injection Chemical	$98,000	event	2	$196,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$11,200	event	2	$22,400	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$56,000	event	3	$168,000	Estimate using price from similar job
Off-Site Area (Phase 2 and 3)					
Injection Well Installation and Piping	$16,000	event	2	$32,000	Assume 8 wells, Quote from vendor
Injection Chemical	$70,000	event	2	$140,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$11,200	event	2	$22,400	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$35,000	event	3	$105,000	Estimate using price from similar job
Addtional Treatment - optinal					
10% of cost of Phase 1 through Phase 3	$85,360	event	2	$170,720	2 years assumed.
Decommissioning					
Decommissioning of Pump and Treat Systems	$10,000	ls	1	$10,000	Quote from Vendor, Estimate using price from similar job
Decommissioning of injection/observation wells	$18,000	ls	1	$18,000	Quote from Vendor, Estimate using price from similar job
Long-term Maintenance and Monitoring (Groundwater)					
Monitoring (groundwater wells)	$84,000	per year	4	$336,000	Estimate using price from similar job
Reporting	$35,000	per year	4	$140,000	Estimate using price from similar job
Sub Slab Vapor Intrusion System					
Potential downgradient building monitoring	$5,500	per event	4	$22,000	Assume 4 events, Air Toxcis, 10% increase
Monitoring (5 years)	10,000	per year	5	$50,000	Current rates
Analytical Monitoring	$5,500	per event	2	$11,000	Air Toxics, 10% increase
O&M (5 years)	$12,650	per year	5	$63,250	Current rates, 10% increase
Reporting (2 events)	$6,270	per year	2	$12,540	Current rates, 10% increase
	Direct Capital:			$2,344,110	
	Remedial Design (8%)			$187,529	EPA, 2000
	Project Management (5 %)			$117,206	EPA, 2000
	Construction Management (6 %)			$140,647	EPA, 2000
	Sales Tax (9 %)			$210,970	WA State Sales Tax
	Contingency (30 %)			$703,233	EPA, 2000
		Total Capital:		**$3,703,694**	

Notes: Sales tax applied only on direct capital cost

EPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. Environmental Protection Agency, July 2000.

2008 Dollars

Chemical injections rates are based on current site conditions. Injection rates will be determined after the results of Phase 1 are analyzed.

Assumes extraction and subslab system operates during the 2 years of permit/design/remedy selection

Chemical injections volume assume the operation of the recovery system during injection.

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 2
Table B-2a: Net Present Value - 2%
GE South Dawson Street

Year	Cost Factor	Implementation of Alternative	Chemical Oxid. Injection	Operation of Hydraulic Containment	O&M Cost & VIMS	Performance Sampling	Confirmation Sampling	Reporting	Sub Total Annual	Contingency (30%)	Sales Tax (9%)	Total Annual Cost	Discounted Annual	Discount Rate
0	1								$0				$0	1.03
1	0.971	$222,690		$157,800	$46,850	$9,000		$1,000	$437,340	$64,395	$19,319	$521,054	$505,878	
2	0.943	$222,690		$85,800	$46,850	$9,000		$1,000	$365,340	$42,795	$12,839	$420,974	$396,808	
3	0.915		$58,400	$85,800	$46,850	$33,140		$19,030	$243,220	$72,966	$21,890	$338,076	$309,387	
4	0.888		$246,400	$85,800	$57,850	$110,800		$67,700	$568,550	$170,565	$51,170	$790,285	$702,158	
5	0.863		$246,400	$85,800	$46,850	$73,000		$48,270	$500,320	$150,096	$45,029	$695,445	$599,897	
6	0.837		$85,360						$85,360	$25,608	$7,682	$118,650	$99,368	
7	0.813		$85,360				$84,000	$35,000	$204,360	$61,308	$18,392	$284,060	$230,967	
8	0.789			$28,000			$84,000	$35,000	$147,000	$44,100	$13,230	$204,330	$161,300	
9	0.766						$84,000	$35,000	$119,000	$35,700	$10,710	$165,410	$126,773	
10	0.744						$84,000	$35,000	$119,000	$35,700	$10,710	$165,410	$123,081	

Total Annual Costs $3,703,694

Net Present Worth **$3,255,616**

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 2
Table B-2a: Net Present Value - 7%
GE South Dawson Street

Year	Cost Factor	Implementation of Alternative	Chemical Oxid. Injection	Operation of Hydraulic Containment	O&M Cost & VIMS	Performance Sampling	Confirmation Sampling	Reporting	Sub Total Annual	Contingency (30%)	Sales Tax (9%)	Total Annual Cost	Discounted Annual	Discount Rate
0	1								$0				$0	1.07
1	0.935	$222,690		$157,800	$46,850	$9,000		$1,000	$437,340	$64,395	$19,319	$521,054	$486,966	
2	0.873	$222,690		$85,800	$46,850	$9,000		$1,000	$365,340	$42,795	$12,839	$420,974	$367,695	
3	0.816		$58,400	$85,800	$46,850	$33,140		$19,030	$243,220	$72,966	$21,890	$338,076	$275,971	
4	0.763		$246,400	$85,800	$57,850	$110,800		$67,700	$568,550	$170,565	$51,170	$790,285	$602,904	
5	0.713		$246,400	$85,800	$46,850	$73,000		$48,270	$500,320	$150,096	$45,029	$695,445	$495,843	
6	0.666		$85,360						$85,360	$25,608	$7,682	$118,650	$79,062	
7	0.623		$85,360				$84,000	$35,000	$204,360	$61,308	$18,392	$284,060	$176,899	
8	0.582			$28,000			$84,000	$35,000	$147,000	$44,100	$13,230	$204,330	$118,922	
9	0.544						$84,000	$35,000	$119,000	$35,700	$10,710	$165,410	$89,972	
10	0.508						$84,000	$35,000	$119,000	$35,700	$10,710	$165,410	$84,086	

Total Annual Costs $3,703,694

Net Present Worth **$2,778,319**

FEASIBILITY STUDY COST ESTIMATES

REMEDIAL ALTERNATIVE 3

Table B-3: Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation, Sub Slab Depressurization System, and Institutional Controls

GE South Dawson Street

			Quantity	Total	Source/Notes
Extraction System					
Relocation of RW-3	20,000	ls	1	$20,000	Cascade Drilling, Price from similar job
Decommissioning of original location of RW-3	5,000	ls	1	$5,000	Cascade Drilling, disposal
Additional Permits Application	2,000	ls	1	$2,000	Estimate using price from similar job
Discharge Disposal	$85,800	yr	7	$600,600	Current rates, 10% increase
Discharge Reporting and Sampling	$11,000	per year	7	$77,000	Current rates, 10% increase
O&M	$24,200	per year	7	$169,400	Current rates, 10% increase
Phase 1 Injection					
Microbial Counts	$15,000	event	1	$15,000	Quote from Vendor, Estimate using price from similar job
Injection Well Installation	$20,000	event	1	$20,000	Assume 10 wells, Quote from vendor
Injection Chemical	$11,000	event	1	$11,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$2,000	event	1	$2,000	Quote from Vendor, Estimate using price from similar job
Tracer Study	$2,500	event	1	$2,500	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$29,400	event	1	$29,400	Estimate using price from similar job
On-Site Area (Phase 2 and 3)					
Injection Well Installation and Piping	$60,000	event	2	$120,000	Assume 30 wells, Quote from vendor
Injection Chemical	$55,000	event	2	$110,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$4,000	event	2	$8,000	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$49,000	event	3	$147,000	Estimate using price from similar job
Off-Site Area (Phase 2 and 3)					
Injection Well Installation and Piping	$14,700	event	2	$29,400	Assume 10 wells, Quote from vendor
Injection Chemical	$70,000	event	2	$140,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$11,200	event	2	$22,400	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$49,000	event	3	$147,000	Estimate using price from similar job
Decommissioning					
Decommissioning of Pump and Treat Systems	$5,000	ls	1	$5,000	Quote from Vendor, Estimate using price from similar job
Decommissioning of injection/observation wells	$23,675	ls	1	$23,675	Quote from Vendor, Estimate using price from similar job
Long-term Maintenance and Monitoring (Groundwater)					
Monitoring (groundwater wells)	$60,000	per year	3	$180,000	Estimate using price from similar job
Reporting	$25,000	per year	3	$75,000	Estimate using price from similar job
Sub Slab Vapor Intrusion System					
Monitoring (7 years)	10,000	per year	7	$70,000	Current rates
Analytical Monitoring	$5,500	per event	2	$11,000	Air Toxics, 10% increase
O&M (7 years)	$12,650	per year	7	$88,550	Current rates, 10% increase
Reporting (2 events)	$6,270	per year	2	$12,540	Current rates, 10% increase
		Direct Capital:		$2,143,465	
		Remedial Design (8%)		$171,477	EPA, 2000
		Project Management (5 %)		$107,173	EPA, 2000
		Construction Management (6 %)		$128,608	EPA, 2000
		Sales Tax (9 %)		$192,912	WA State Sales Tax
		Contingency (30 %)		$643,040	EPA, 2000
		Total Capital:		**$3,386,675**	

Notes: Sales tax applied only on direct capital cost

EPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. Environmental Protection Agency, July 2000.

2008 Dollars

Chemical Injections rates are based on current site conditions. Injection rates will be determined after the results of Phase 1 are analyzed.

Chemical Injections volume assume the operation of the recovery system during injection.

Assumes extraction and subslab system operates during the 2 years of permit/design/remedy selection

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 3
Table B-3a: Net Present Value
GE South Dawson Street

Year	Cost Factor	Implementation of Alternative	Enhanced Bio. Injection	Operation of Hydraulic Containment	O&M Cost & VIMS	Performance Sampling	Confirmation Sampling	Reporting	Sub Total Annual	Contingency (30%)	Sales Tax (9%)	Total Annual Cost	Discounted Annual	Discount Rate
0	1								$0				$0	1.03
1	0.971	$203,629	-	$112,800	$46,850	$10,000		$1,000	$374,279	$51,195	$15,359	$440,833	$427,993	
2	0.943	$203,629		$85,800	$46,850	$10,000		$1,000	$347,279	$43,095	$12,929	$403,303	$380,151	
3	0.915		$50,500	$85,800	$46,850	$27,640		$12,760	$223,550	$67,065	$20,120	$310,735	$284,366	
4	0.888		$107,450	$85,800	$46,850	$59,600		$36,670	$336,370	$100,911	$30,273	$467,554	$415,416	
5	0.863		$107,450	$85,800	$46,850	$54,100		$30,400	$324,600	$97,380	$29,214	$451,194	$389,204	
6	0.837		$107,450	$85,800	$46,850	$54,100		$30,400	$324,600	$97,380	$29,214	$451,194	$377,868	
7	0.813		$107,450	$85,800	$46,850	$59,600		$36,670	$336,370	$100,911	$30,273	$467,554	$380,164	
8	0.789			$28,675			$60,000	$25,000	$113,675	$34,103	$10,231	$158,008	$124,733	
9	0.766						$60,000	$25,000	$85,000	$25,500	$7,650	$118,150	$90,552	
10	0.744						$60,000	$25,000	$85,000	$25,500	$7,650	$118,150	$87,915	
											Total Annual Costs	$3,386,675		
											Net Present Worth		**$2,958,363**	

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 4
Table B-4: Soil Vapor Extraction combined with Air Sparge, and Institutional Controls
GE South Dawson Street

			Quantity	Total	Source/Notes
AS/SVE - On-Site Area (Phase 1)					
Initial site testing, prior to set up	$50,000	ls	1	$50,000	H2Oil Estimate
Injection Well Installation and Piping	$1,250	each	10	$12,500	Cascade Drilling, Price from similar job
Air Injection Blower	$9,375	each	1	$9,375	H2Oil Estimate
Manifold	$6,250	each	1	$6,250	H2Oil Estimate
Extraction Well Installation	$3,125	each	12	$37,500	H2Oil Estimate
SVE Piping	$63	per lf	1000	$62,500	H2Oil Estimate
O&M	$25,000	per year	3	$75,000	H2Oil Estimate
Utility Hookup	$25,000	ls	1	$25,000	H2Oil Estimate
Oxidizer Rental	$54,000	per year	3	$162,000	H2Oil Estimate
Natural Gas Utility	$22,500	per year	3	$67,500	H2Oil Estimate
Performance Monitoring & Reporting	$45,000	per event	6	$270,000	ENSR Current rates, estimate on similar job
AS/SVE Off-Site Area (Phase 2)					
Injection Well Installation and Piping	$1,250	each	12	$15,000	H2Oil Estimate
Air Injection Blower	$9,375	each	1	$9,375	H2Oil Estimate
Manifold	$6,250	each	1	$6,250	H2Oil Estimate
Extraction Well Installation	$3,125	each	12	$37,500	H2Oil Estimate
SVE Piping	$63	per lf	2000	$125,000	H2Oil Estimate
O&M	$25,000	per year	3	$75,000	H2Oil Estimate
Utility Hookup	$25,000	ls	1	$25,000	H2Oil Estimate
Oxidizer Rental	$54,000	per year	3	$162,000	H2Oil Estimate
Natural Gas Utility	$22,500	per year	3	$67,500	H2Oil Estimate
Cost of Moving Unit	$3,125	ls	1	$3,125	H2Oil Estimate
Performance Monitoring & Reporting	$40,000	per event	3	$120,000	ENSR Current rates, estimate on similar job
Decommissioning					
Decommissioning of Pump and Treat Systems	$5,000	ls	1	$5,000	Quote from Vendor, Estimate using price from similar job
Decommissioning of injection/observation wells	$12,500	ls	1	$12,500	Quote from Vendor, Estimate using price from similar job
Long-term Maintenance and Monitoring (Groundwater)					
Monitoring (groundwater wells)	$50,000	per year	3	$150,000	ENSR Current rates, estimate on similar job
Reporting	$25,000	per year	3	$75,000	ENSR Current rates, estimate on similar job
	Direct Capital:			$1,665,875	
	Remedial Design (8%)			$133,270	EPA, 2000
	Project Management (5 %)			$83,294	EPA, 2000
	Construction Management (6 %)			$99,953	EPA, 2000
	Sales Tax (9 %)			$149,929	WA State Sales Tax
	Contingency (30.0 %)			$499,763	EPA, 2000
		Total Capital:		**$2,632,083**	

Notes:
Sales tax applied only on direct capital cost
EPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. Environmental Protection Agency, July 2000.
2008 Dollars

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 4
Table B-4a: Net Present Value
GE South Dawson Street

Year	Cost Factor	Implementation of Alternative	Operation of SVE/AS	Decommission of Hydraulic Containment	O&M Cost	Performance Sampling	Confirmation Sampling	Reporting	SubTotal Annual	Contingency (30%)	Sales Tax (9%)	Total Annual Cost	Discounted Annual	Discount Rate
0	1								$0				$0	1.03
1	0.971	$158,258		$0	$0			$1,000	$159,258	$300	$90	$159,648	$154,998	
2	0.943	$158,258		$0	$0			$1,000	$159,258	$300	$90	$159,648	$150,484	
3	0.915		$144,208	$0	$25,000	$35,000		$55,000	$259,208	$77,763	$23,329	$360,300	$329,725	
4	0.888		$144,208	$0	$25,000	$35,000		$55,000	$259,208	$77,763	$23,329	$360,300	$320,122	
5	0.863		$144,208	$0	$25,000	$35,000		$55,000	$259,208	$77,763	$23,329	$360,300	$310,798	
6	0.837		$150,250	$0	$25,000	$15,000		$25,000	$215,250	$64,575	$19,373	$299,198	$250,573	
7	0.813		$150,250	$0	$25,000	$15,000		$25,000	$215,250	$64,575	$19,373	$299,198	$243,275	
8	0.789		$150,250	$0	$25,000	$15,000		$25,000	$215,250	$64,575	$19,373	$299,198	$236,189	
9	0.766			$17,500			$50,000	$25,000	$92,500	$27,750	$8,325	$128,575	$98,542	
10	0.744						$50,000	$25,000	$75,000	$22,500	$6,750	$104,250	$77,572	
11	0.722						$50,000	$25,000	$75,000	$22,500	$6,750	$104,250	$75,312	
											Total Annual Costs	$2,634,863		
											Net Present Worth		**$2,247,590**	

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 5
Table B-5: Chemical Oxidation with Potassium Permanganate, Sub Slab Depressurization System, and Institutional Controls
GE South Dawson Street

Phase 1 Injection			Quantity	Total	Source/Notes
Bench Scale Testing	$20,000	event	1	$20,000	Assume small scale bench study
Injection Well Installation and Piping	$16,000	event	1	$16,000	Assume 8 wells, Quote from vendor
Injection Chemical	$9,800	event	1	$9,800	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$2,800	event	1	$2,800	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$29,400	event	1	$29,400	Estimate using price from similar job
Preformance Monitoring Phase 1(Groundwater)					
Monitoring (groundwater wells)	$20,000	event	6	$120,000	Estimate using price from similar job and Table C-1
Reporting	$5,000	event	6	$30,000	Estimate using price from similar job
On-Site Area (Phase 2 and 3)					
Injection Well Installation and Piping	$40,000	event	2	$80,000	Assume 20 wells, Quote from vendor
Injection Chemical	$49,000	event	2	$98,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$11,200	event	2	$22,400	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$56,000	event	3	$168,000	Estimate using price from similar job
Off-Site Area (Phase 2 and 3)					
Injection Well Installation and Piping	$16,000	event	2	$32,000	Assume 8 wells, Quote from vendor
Injection Chemical	$35,000	event	2	$70,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$11,200	event	2	$22,400	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$35,000	event	3	$105,000	Estimate using price from similar job
Preformance/ Preveritative Monitoring Phase 2 and 3 (Groundwater)					
Monitoring (groundwater wells)	$20,000	event	10	$200,000	Estimate using price from similar job
Reporting	$5,000	event	10	$50,000	Estimate using price from similar job
Decommissioning					
Decommissioning of Pump and Treat Systems	$10,000	ls	1	$10,000	Quote from Vendor, Estimate using price from similar job
Decommissioning of injection/observation wells	$18,000	ls	1	$18,000	Quote from Vendor, Estimate using price from similar job
Long-term Maintenance and Monitoring (Groundwater)					
Monitoring (groundwater wells)	$84,000	per year	3	$252,000	Estimate using price from similar job
Reporting	$35,000	per year	3	$105,000	Estimate using price from similar job
Sub Slab Vapor Intrusion System					
Potential downgradient building monitoring	$5,500	per event	4	$22,000	Assume 4 events, Air Toxcis, 10% increase
Monitoring (7 years)	10,000	per year	7	$70,000	Current rates
Analytical Monitoring	$5,500	per event	2	$11,000	Air Toxics, 10% increase
O&M (7 years)	$12,650	per year	7	$88,550	Current rates, 10% increase
Reporting (2 events)	$6,270	per year	2	$12,540	Current rates, 10% increase
		Direct Capital:		$1,664,890	
		Remedial Design (12%)		$199,787	EPA, 2000
		Project Management (6 %)		$99,893	EPA, 2000
		Construction Management (8 %)		$133,191	EPA, 2000
		Sales Tax (9 %)		$149,840	WA State Sales Tax
		Contingency (30 %)		$499,467	EPA, 2000
		Total Capital:		**$2,747,069**	

Notes:
EPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. Environmental Protection Agency, July 2000.
2008 Dollars
Chemical injections rates are based on current site conditions. Injection rates will be determined after the results of Phase 1 are analyzed.

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 5
Table B-5a: Net Present Value - 2%
GE South Dawson Street

Year	Cost Factor	Implementation of Alternative	Chemical Oxid. Injection	Operation of Hydraulic Containment	O&M Cost & VIMS	Performance Sampling	Confirmation Sampling	Reporting	SubTotal Annual	Contingency (30%)	Sales Tax (9%)	Total Annual Cost	Discounted Annual	Discount Rate
0	1								$0				$0	1.03
1	0.971	$216,436			$22,650	$11,000			$250,086	$10,095	$3,029	$263,209	$255,543	
2	0.943	$216,436			$22,650	$11,000			$250,086	$10,095	$3,029	$263,209	$248,100	
3	0.915		$48,600		$22,650	$23,140	$66,667	$59,697	$220,753	$66,226	$19,868	$306,847	$280,809	
4	0.888		$162,400		$33,650	$100,800	$66,667	$108,867	$472,383	$141,715	$42,515	$656,613	$583,392	
5	0.863		$162,400		$33,650	$68,500	$66,667	$84,937	$416,153	$124,846	$37,454	$578,453	$498,979	
6	0.837			$28,000	$22,650		$84,000	$45,000	$179,650	$53,895	$16,169	$249,714	$209,131	
7	0.813				$22,650		$84,000	$45,000	$151,650	$45,495	$13,649	$210,794	$171,394	
8	0.789						$84,000	$45,000	$129,000	$38,700	$11,610	$179,310	$141,549	
											Total Annual Costs	$2,747,069		
											Net Present Worth		**$2,388,897**	

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 5
Table B-5a: Net Present Value - 7%
GE South Dawson Street

Year	Cost Factor	Implementation of Alternative	Chemical Oxid. Injection	Operation of Hydraulic Containment	O&M Cost & VIMS	Performance Sampling	Confirmation Sampling	Reporting	SubTotal Annual	Contingency (30%)	Sales Tax (9%)	Total Annual Cost	Discounted Annual	Discount Rate
0	1								$0				$0	1.07
1	0.971	$216,436			$22,650	$11,000			$250,086	$10,095	$3,029	$263,209	$255,543	
2	0.943	$216,436			$22,650	$11,000			$250,086	$10,095	$3,029	$263,209	$248,100	
3	0.915		$48,600		$22,650	$23,140	$66,667	$59,697	$220,753	$66,226	$19,868	$306,847	$280,809	
4	0.888		$162,400		$33,650	$100,800	$66,667	$108,867	$472,383	$141,715	$42,515	$656,613	$583,392	
5	0.863		$162,400		$33,650	$68,500	$66,667	$84,937	$416,153	$124,846	$37,454	$578,453	$498,979	
6	0.837			$28,000	$22,650		$84,000	$45,000	$179,650	$53,895	$16,169	$249,714	$209,131	
7	0.813				$22,650		$84,000	$45,000	$151,650	$45,495	$13,649	$210,794	$171,394	
8	0.789						$84,000	$45,000	$129,000	$38,700	$11,610	$179,310	$101,834	
											Total Annual Costs	$2,747,069		
											Net Present Worth		**$2,349,181**	

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 6
Table B-6: Anaerobic Bioremediation, Sub Slab Depressurization System, and Institutional Controls
GE South Dawson Street

			Quantity	Total	Source/Notes
Phase 1 Injection					
Microbial Counts	$15,000	event	1	$15,000	Quote from Vendor, Estimate using price from similar job
Injection Well Installation	$20,000	event	1	$20,000	Assume 10 wells, Quote from vendor
Injection Chemical	$5,500	event	1	$5,500	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$9,000	event	1	$9,000	Quote from Vendor, Estimate using price from similar job
Equipment Rental	$3,000	event	1	$3,000	Quote from Vendor, Estimate using price from similar job
Tracer Study	$2,500	event	1	$2,500	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$29,400	event	1	$29,400	Estimate using price from similar job
On-Site Area (Phase 2 and 3)					
Injection Well Installation and Piping	$60,000	event	2	$120,000	Assume 30 wells, Quote from vendor
Injection Chemical	$27,500	event	2	$55,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$11,000	event	2	$22,000	Quote from Vendor, Estimate using price from similar job
Equipment Rental	$3,000	event	2	$6,000	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$49,000	event	3	$147,000	Estimate using price from similar job
Off-Site Area (Phase 2 and 3)					
Injection Well Installation and Piping	$14,700	event	2	$29,400	Assume 10 wells, Quote from vendor
Injection Chemical	$35,000	event	2	$70,000	Quote from Vendor, Estimate using price from similar job
Injection Supplies	$11,200	event	2	$22,400	Quote from Vendor, Estimate using price from similar job
Performance Monitoring & Reporting	$49,000	event	3	$147,000	Estimate using price from similar job
Decommissioning					
Decommissioning of Pump and Treat Systems	$5,000	ls	1	$5,000	Quote from Vendor, Estimate using price from similar job
Decommissioning of injection/observation wells	$23,675	ls	1	$23,675	Quote from Vendor, Estimate using price from similar job
Long-term Maintenance and Monitoring (Groundwater)					
Monitoring (groundwater wells)	$60,000	per year	3	$180,000	Estimate using price from similar job
Reporting	$25,000	per year	3	$75,000	Estimate using price from similar job
Sub Slab Vapor Intrusion System					
Monitoring (7 years)	10,000	per year	7	$70,000	Current rates
Analytical Monitoring	$5,500	per event	2	$11,000	Air Toxics, 10% increase
O&M (7 years)	$12,650	per year	7	$88,550	Current rates, 10% increase
Reporting (2 events)	$6,270	per year	2	$12,540	Current rates, 10% increase
		Direct Capital:		$1,168,965	
		Remedial Design (12%)		$140,276	EPA, 2000
		Project Management (6 %)		$70,138	EPA, 2000
		Construction Management (8 %)		$93,517	EPA, 2000
		Sales Tax (8.4 %)		$105,207	WA State Sales Tax
		Contingency (30 %)		$350,690	EPA, 2000
		Total Capital:		**$1,928,792**	

Notes:

Sales tax applied only on direct capital cost

EPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. Environmental Protection Agency, July 2000.

2008 Dollars

Chemical injections rates are based on current site conditions. Injection rates will be determined after the results of Phase 1 are analyzed.

FEASIBILITY STUDY COST ESTIMATES
REMEDIAL ALTERNATIVE 6
Table B-6a: Net Present Value
GE South Dawson Street

Year	Cost Factor	Implementation of Alternative	Enhanced Bio. Injection	Operation of Hydraulic Containment	O&M Cost & VIMS	Performance Sampling	Confirmation Sampling	Reporting	SubTotal Annual	Contingency (30%)	Sales Tax (9%)	Total Annual Cost	Discounted Annual	Discount Rate
0	1								$0				$0	1.03
1	0.971	$151,965		$0	$22,650	$0			$174,615	$6,795	$2,039	$183,449	$178,106	
2	0.943	$151,965		$0	$22,650	$0			$174,615	$6,795	$2,039	$183,449	$172,918	
3	0.915		$55,000	$0	$22,650	$17,640		$11,760	$107,050	$32,115	$9,635	$148,800	$136,173	
4	0.888		$81,200	$0	$22,650	$49,600		$35,670	$189,120	$56,736	$17,021	$262,877	$233,563	
5	0.863		$81,200	$0	$22,650	$44,100		$29,400	$177,350	$53,205	$15,962	$246,517	$212,647	
6	0.837		$81,200	$0	$22,650	$44,100		$29,400	$177,350	$53,205	$15,962	$246,517	$206,454	
7	0.813		$81,200	$0	$22,650	$49,600		$35,670	$189,120	$56,736	$17,021	$262,877	$213,743	
8	0.789			$28,675			$60,000	$25,000	$113,675	$34,103	$10,231	$158,008	$124,733	
9	0.766						$60,000	$25,000	$85,000	$25,500	$7,650	$118,150	$90,552	
10	0.744						$60,000	$25,000	$85,000	$25,500	$7,650	$118,150	$87,915	
											Total Annual Costs	$1,928,792		
											Net Present Worth		**$1,656,803**	

Appendix C

Additional Hydraulic Supporting Data

Appendix C – Part 1

Technical Memorandum – Simulation of Maximum TCE Transport and Dispersion under Natural Conditions

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1.0 Introduction

This technical memorandum describes an analysis of potential upper-bounds on TCE migration and dispersion in the absence of hydraulic controls (groundwater recovery wells) at the former General Electric facility at 220 South Dawson Street, Seattle, Washington. The purpose of the analysis was to assess a worst-case groundwater migration scenario and evaluate appropriate and conservative groundwater monitoring programs (frequency and location) that would measure trends in TCE concentration variation downgradient of the site.

1.1 Objectives of the Simulation

The objective of the analytical simulation was to answer two questions:

1. If there is no hydraulic control, no active treatment, no retardation (e.g., sorption to the soil media), no loss due to volatilization, and no degradation, what is the maximum credible rate at which TCE might migrate and disperse from the source area?
2. Given these conservatively high estimates of transport rate and concentration, could monitoring be performed and any unacceptable downgradient increases be measured such that recovery wells could be restarted and containment reestablished?

A series of simulations were run to identify a high-end credible TCE transport rate if hydraulic control was discontinued and degradation effects of permanganate remediation activities were ignored. The purpose of this analysis was to evaluate the minimum amount of time it would take for additional TCE concentrations to reach the property boundary, and conservatively estimate what concentrations could be expected. This information will support development of a monitoring plan designed to detect unacceptable groundwater concentration increases and implement contingent action as necessary (e.g., restarting the recovery wells).

1.2 Scope

The simulation applied a 2-dimensional analytical equation to estimate the distance and width that a TCE plume would migrate after certain time steps. The analysis focuses on conservative input parameters; a range of input parameters were used to evaluate the credible maximum distances that concentrations might spread and sensitivity of the simulation to various possible input parameters.

It should be emphasized that the analytical simulation estimates TCE transport based on only advection and dispersion (no credit for retardation, degradation or treatment). Therefore, the rate and concentrations are assured to be overestimated. The simulation also ignores vertical dispersion, which results in additional overestimation of concentrations.

2.0 Methodology

2.1 Analytical Method

The governing equation for the simulation is:

$$R\frac{\partial C}{\partial t} = D_x\frac{\partial^2 C}{\partial x^2} + D_y\frac{\partial^2 C}{\partial y^2} - V\frac{\partial C}{\partial x} - \lambda RC \quad \text{(Wexler 1992)}$$

Where:

C = concentration

R = retardation factor

D_x = longitudinal dispersivity

D_y = transverse dispersivity

λ = degradation (decay) constant

V = seepage velocity

This analytical solution is universally recognized for the estimation of advection and dispersion in a porous medium. It was selected for use in this simulation because it provides a simple simulation of chemical movement and provides a conservative estimate (does not account for the complexities that may retard chemical flow).

As described previously, the affects of degradation (decay) and retardation were ignored. In addition, the simplifying assumption that allows for the use of an analytical solution to describe a complex system of solids and voids is that the aquifer is an isometric and homogeneous continuum. This is conservative because it assumes that advection and dispersion would occur at an ideal (100% efficient) rate. In reality, there are imperfections in the continuum, which, in sum, would result in less efficient (retarded) advection/dispersion rates. Therefore, by making the simplifying assumption that allows for an analytical solution, we are (by the very definition of the assumption) overestimating both concentration and rate of migration.

2.2 Conservative Assumptions

The objective of the simulations is to identify high-end estimates of plume migration to facilitate understanding of the risks associated with discontinuing groundwater pumping and appropriate monitoring scenarios. Conservative assumptions were used in setting up the simulations, and selecting the range of input parameters. Conservative assumptions include:

- The simulation assumes no treatment of TCE in groundwater (treatment in the source area will be ongoing after the pumps are turned off).
- There is no chemical or biological degradation (decay) or retardation of TCE during transport. Only advection and dispersion are assumed used to affect TCE concentration during groundwater migration.
- Inherent to the analytical method (the equation cited above) is the assumption that the aquifer is homogeneous both vertically and laterally (the aquifer is isometric). This assumption is conservative because it assumes that advection and dispersion would occur at an ideal (100% efficient) rate. In reality, there are imperfections in the continuum, which, in sum, would result in less efficient (retarded) advection/dispersion rates. With a high-end transmissivity (representing the most permeable portions of the aquifer) being used in the analysis, the simulation overestimates both concentration and rate of migration.
- The simulation assumes a homogeneously mixed solute concentration with depth; in the source area. In reality, the source concentration attenuates vertically and diminishes with time. The simulation assumes a constant (and infinite) source introduced to groundwater and instantaneous mixing.
- Simulations were completed using input parameters that are more conservative than those supported by empirical data. The assumed input parameters therefore overestimate groundwater movement and TCE concentrations. Whenever possible, simplifying assumptions were used and a broad range of input values were tested.

These compounding conservative assumptions yield a high-end (worst-case plausible) estimate of potential TCE migration and the resultant TCE plume.

3.0 Input Parameters

Simulations were completed using: (1) conservative, base-case scenario values for input parameters and (2) a range of other conservative possible values to assess sensitivity of migration rates and predicted concentrations. For inputs that have differing interpretations for the site (e.g., velocity, as calculated from multiple transmissivity values), multiple values were simulated in the base-case scenario. The robust sensitivity analysis was conducted to evaluate the plume response to the extreme ends of the range of credible potential values for each input parameter. The ranges of input parameters are listed in Table 1 and the base-case assumptions are listed on Table 2. Metric units were chosen for use by the program; results were converted to feet for plotting on the site map. The methods and specific rationale for each input parameter chosen or developed is discussed below.

3.1 Selection of Input Flux

The source flux chosen for the simulations assumes that groundwater conditions would rebound to concentrations observed prior to the installation of pumping well RW-3. This rebound source flux is substantially higher than any of the concentrations that have been observed at the site since 2003 (when RW-3 was turned on). The source strength, or flux, was derived based on an estimate of how much TCE would need to be introduced to the groundwater (under base-case conditions) to result in an eventual source area concentration of over 150 µg/L (3 times the current maximum source area concentration). The chosen flux was selected as a conservative upper-bound value and is expected to overestimate additional TCE introduced to the groundwater. The source strength represents a flux (kg/day) of additional TCE introduced to the groundwater at a constant rate throughout the duration of the simulation run.

The flux was derived from the starting concentration by converting concentration (µg/L) and discharge rate (L/day) to flux (kg/day). The transmissivity value used for this conversion was 15,000 ft^2/d, the maximum value provided by Ecology in their analysis of site transmissivity.

The resulting flux (mass of TCE per day) estimated was 0.006 kg/d. The analytical solution then assumes a constant source (i.e., there is enough TCE in the soil that 0.006 kg/d would be delivered to the groundwater in the source area continuously through the analysis). In order to simulate areal coverage, this flux is introduced to the groundwater at three on-site locations.

3.2 Evaluation of Potential Credible Parameter Ranges and Base-case Values

An initial range of credible values was determined for each input parameter. These ranges were the limits used in the sensitivity analysis testing described below. They also provided the starting point for the input parameter selection for the base-case scenario. The ranges of values for each input parameter are presented in Table 1 and the base-case scenario input parameters are provided in Table 2.

3.2.1 Groundwater velocity

Groundwater velocity was calculated using the following equation:

$$v = Ki/n$$

where:

K = hydraulic conductivity (ft/d),

i = hydraulic gradient (ft/ft), and

n = porosity.

The hydraulic conductivity was calculated from the transmissivity (T, ft^2/d) and aquifer thickness (b, ft) as follows:

$$K = T/b$$

A range of credible velocities was determined by varying the transmissivity value used in the above equation. The range of transmissivity values used to calculate velocity was obtained from the low end of the transmissivities calculated by GE from pump test data (2,700 ft^2/d) to the high end of the range of transmissivities estimated by Ecology (15,000 ft^2/d). These transmissivities return a range of velocities from 0.1 to 0.5 m/d.

Groundwater flow velocity is the only input parameter that was varied in the base-case simulations. Three velocities were calculated from three different transmissivity values. The first value (4,990 ft^2/d) represents the GE-estimated transmissivity. This is the mean of the high and low ends of the range of transmissivities that GE calculated from pump test data in the Capture Zone Analysis (RETEC, 2007). The second and third transmissivities are the high and low ends of the range of values estimated by Ecology (12,000 to 15,000 ft^2/d) (Li, 2008).

The groundwater gradients used in the groundwater velocity calculation was estimated from groundwater contour maps ranging from 1992 to the present. The horizontal groundwater gradient across the site is consistently 0.001, with a measured variation of only about ±0.0003[1]. Due to the small variation observed in groundwater gradients, it was not analyzed individually; the affect of small variations in gradients on the velocity calculation are sufficiently accounted for in the range of transmissivity values that were tested in the base-case and sensitivity analyses.

3.2.2 Aquifer thickness

In the context of this simulation, the aquifer thickness parameter defines how the TCE mixes in the groundwater. In order for the two-dimensional simulation to function, the model assumes that the TCE mixes uniformly over a specified vertical thickness. The aquifer thickness can be estimated as the maximum depth (bgs) to which TCE was observed in groundwater in the source area (ground surface to lower TCE bounds), or 9 meters. A range was also determined. The lower-bound range was selected as the distance from the groundwater table to the lower TCE bound (4.6 meters).

An upper bound aquifer thickness of 100 feet (30 meters) was selected based on half the estimated total aquifer thickness. A lower confining unit was not encountered during field boring investigations; therefore, an absolute aquifer thickness is unknown. The aquifer extends at least to the depth of the deepest boring, but is believed to be up to 200 feet thick based on accounts of the regional aquifer in the Duwamish Valley (Fabritz et al., 1998).

It should be noted that an increase in aquifer thickness acts to decrease the source area concentration (greater vertical mixing [dilution]). Therefore, by using a lower number (9 meters) for the base-case, the simulation is expected to further overestimate TCE concentrations.

3.2.3 Porosity

The textbook range of porosities is 0.20 to 0.35 for mixed sand and gravel, 0.25 to 0.50 for well-sorted sand or gravel and 0.35 to 0.50 for silt (Fetter 1988). The upper groundwater unit at the site is comprised of silty sand and sand. To account for any variation in the aquifer material, the full range of porosities (from 0.20 to 0.50) was tested in the sensitivity analysis. For the base-case analysis, a relatively central value was used (0.3).

3.2.4 Dispersivity

3.2.4.1 Longitudinal

Measured ranges for longitudinal dispersivity for alluvial and glacial soils is 12 to 61 m (excluding one or two outliers) (Beljin 1993). This range was tested for sensitivity. Since the upper portion of the site aquifer is comprised of relatively-clean sand/silty sand, it is expected to be very homogeneous. Literature on ranges of dispersivity state that homogeneous sand tends to be on the lower end of the dispersivity range (Fetter 1988). Comparison of simulation results of to empirical observations of TCE plumes dating back to 1992 verify this.

For the base-case, a dispersivity value of 20 meters was selected. The base-case longitudinal dispersivity (20 m) produced plume simulations consistent with empirically measured conditions. Fetter (1988) cites that very homogeneous sand could have a longitudinal dispersivity as low as 1 meter (which would result in very little

[1] There was only one gradient that displayed a variance greater than ±0.0003 from the selected gradient of 0.001. In August, 1998, a gradient was estimated at 0.0017.

spreading). Therefore, the base-case longitudinal dispersivity produces a conservatively high estimate of both migration and dispersion.

3.2.4.2 Lateral

Lateral (transverse) dispersivity typically varies within a ratio of 0.1 to 0.3 of the longitudinal dispersivity (Beljin 1993). The range of lateral dispersivities used in the sensitivity analysis represent 0.05 to 0.5 times the chosen longitudinal dispersivity.

Based on the rationale described for longitudinal dispersivity, a ratio of 0.2 was selected for the base-case (4 meters). The chosen lateral dispersivity (4 m) produced plume simulations well-matched to empirically measured conditions.

3.2.5 Retardation

To represent the worst-case plume migration scenario, a retardation factor of 1 (no retardation) was applied to all simulations; therefore, a range is not presented. Although the actual retardation factor for the site is likely to be higher than 1, it is may only be slightly higher. Site data show TOC in soil is undetected or slightly above the detection limit. Retardation is strongly linked to organic carbon content. Due to the high sorption potential for organic carbon, retardation increases as TOC content increases (Olsen 1990). However, TCE is known to also sorb to inorganic soil particles; therefore, not accounting for retardation is a conservative assumption.

3.2.5.1 Half-life

To represent the worst-case scenario, degradation was also ignored (half-life of 0 days); therefore a range is not presented. Therefore, the simulation does not take credit for any attenuation due to degradation or volatilization. This is a very conservative assumption that is expected to portray a worst-case plume migration.

3.2.5.2 Elapsed time

A wide variety of elapsed times were tested; time steps 60 days and 90 days were concluded to be adequate for the objectives of this study. The purpose of these simulations was to evaluate the amount of time that would elapse before substantive concentrations arrived at the property boundary; therefore, how frequently monitoring should occur to assure safe on-site and off-site conditions. Based on these objectives, 2-month and 3-month time steps were adequate.

3.2.5.3 Number of point sources

The two- dimensional analytical solution supports multiple point sources using the principle of superposition to calculate the accumulated effects of various sources or to represent line (strip) or areal (patch) sources. These multiple sources may have a different starting time and be of limited duration.

The number of point sources was not varied over a range for this analysis. One to five sources were examined in initial simulations; three sources were identified as producing plumes most representative of the empirically observed plume shape and were used in this analysis.

3.2.5.4 Grid

The grid parameters simply identify the areal extent over which the concentrations are calculated. It defines the extent of the X and Y axes on which the simulated plume is plotted. Initial simulations identified the optimal grid inputs that allowed for plotting over the entire plume extent inside the observable window. These parameters are presented in Table 2. Since these parameters have no affect on the extent or rate of plume migration, a range was not developed or tested.

4.0 Base-case Results

The simulation results are contour maps of predicted TCE concentrations and plume distribution. The magnitude of the simulated plume contours can be interpreted in a range of ways, from being an estimate of the total concentrations to being an incremental increase in concentrations.

On the low end, these contours may be interpreted to represent the total quantity of TCE in the groundwater at some point in the future, under the simulated conditions.

On the high end (greatest concentration), the contours would be interpreted to represent the amount of additional TCE concentrations in the groundwater due to the introduction of additional source (e.g., more TCE is added due to "rebound" when the pumps are turned off). In this analysis, the concentration contours would represent the added concentration at any point on the site, so the simulated plume contours would represent the incremental increase in concentration, based on the amount of TCE flux the simulation specifies.

The real-world case would likely by closer to the lower end scenario, as the source flux used in the simulation was estimated to represent an upper-bound of the total amount of TCE that could be introduced to the groundwater from the source area soils; only a small portion of the simulated TCE input would be additional above current source flux due to "rebound". Therefore the simulated plume would only include a small percentage of increased source compared to current conditions.

However, since the objective of this analysis is to estimate the maximum plausible (worst-case) concentration increases at the property boundary, no credit is taken for the incremental change in flux and the results are assumed to be additive (current concentrations PLUS simulation concentrations).

Therefore, in the following discussion, the simulation results are described very conservatively as *additive concentrations.*

Figures 1 through 6 present the resultant base-case plumes (the additional concentration after the pumping is discontinued) for the three velocities and for 60- and 90-day time steps. Table 2 provides the input parameters for the base-case scenarios.

The results of the base-case simulations estimate that the range of concentration increases after 60 days range from ≤1 µg/L to ≤10 µg/L. After 90 days the estimate ranges from less than 10 µg/L to slightly higher than 10 µg/L.

Also notable is that the simulations result in maximum increase in on-site concentrations of up to 150 µg/L, which is substantially higher than concentrations currently observed onsite and higher than onsite concentrations that have been observed since at least 2003. This is further evidence of the conservative nature of the simulation and the likelihood that it overestimates concentrations (as it was designed to do).

The range of seasonal variation observed in both onsite and offsite wells has often exceeded 10 µg/L. Therefore, these conservatively estimated increases fall into the range of natural seasonal variation.

5.0 Sensitivity Analysis

The input parameters for the base-case scenario were developed using conservative, but plausible, assumptions. The sensitivity analysis was conducted to verify the conservatism and evaluate the range of variation that may result from changing the parameter values. A sensitivity analysis was performed to evaluate the plume response to inputs parameters at the extreme ends of the range of possible values. The range of values that were evaluated is presented in Table 1.

There were two objectives of the sensitivity analysis. The first objective was to provide an additional layer of confidence that plume migration rates were adequately characterized and that monitoring frequency could be established with a high level of confidence. The second objective was to evaluate which input parameters most affect the plume shape or extent.

In addition to the range of values discussed in Section 3.2, the source strength, or source flux, was also varied over a broad range. The range of source flux used in the sensitivity analysis included a range from half the base-case flux (0.003 kg/d) to an order of magnitude above the base-case (0.03 kg/d). Although the upper-bound flux far exceeds a plausible source flux at the site, it was tested to evaluate the factor of safety that the simulation is providing.

The sensitivity analysis was performed by varying an individual input parameter, while holding all other base-case parameters constant. The resulting plumes are plotted in Figures 7 through 16. For comparison purposes, all sensitivity simulations were run for 60 days. All sensitivity simulations were run using the upper bound base-case velocity (0.5 m/d based on Ecology's high end transmissivity, 15,000 ft^2/d).

Aquifer thickness was evaluated across a range 4.6 to 30 meters. The lower bound value resulted in a plume that was not substantially different than the base-case, with an increase in concentration at the property boundary of about 10 µg/L. The upper bound value resulted in plume concentrations that were substantially lower; resulting in concentrations at the property boundary of ≤1 µg/L after 60 days.

The simulation is not very sensitive to porosity. But the lower bound and upper bound (0.2 and 0.5, respectively) resulted in plumes similar to the base-case, with a concentration at the property boundary of ≤10 µg/L.

Changes in longitudinal dispersivity did not significantly change the concentrations. However, it illustrated the simulation's sensitivity with regard to plume shape. Based on these results, the site-specific longitudinal dispersivity may be in the range of 20 to 60 meters, but is not likely to be lower than that.

Changes to the lateral (transverse) dispersivity returned similar results. Although concentrations did not differ significantly from the base-case, lower values resulted in plume shapes that are more consistent with empirical observations. Higher values can be discounted, as the resultant plume shape bears no resemblance to empirical observations over the last 15 or more years.

Finally, source flux results were more a test of extremes than an attempt to test the plausible boundaries. Using the lower flux (which may be more consistent with available source flux) after 60 days the increased concentration was just over 1 µg/L. At the other end of the spectrum, the higher flux (0.03 kg/day), which would not be sustainable at this site based on estimates of available TCE source, resulted in a maximum onsite concentration of 400 µg/L, higher than at any time since the soil removal action. This provides further evidence that the base-case flux rate was appropriate and conservative (intended to over-estimate).

These results verify the validity of the base-case simulations for their intended purpose; that is that the base-case simulations adequately estimate (0r overestimate) the potential change in concentrations at the property boundary after 60 days, and provide sufficiently conservative information to enable an estimate of frequency and location of monitoring after hydraulic controls are discontinued.

6.0 Conclusions and Recommendations

The purpose of this analysis was to evaluate upper-bound (worst case) limits to potential TCE migration in the absence of hydraulic controls. That information would then be used in the remedial design to provide guidance in developing a monitoring program and mitigation contingencies.

Based on comparison of the base-case simulations to empirical data and sensitivity analyses, the analysis is sufficiently conservative to provide the information to provide:

- A reasonable maximum timeframe for evaluation monitoring frequency
- Substantial assurance that a monitoring program would provide adequate safety both on and offsite

- Evidence that even with an analytical solution and input parameters that were designed to overestimate risk, the anticipated increase in concentrations at the property boundary (after 60 days) would be within the range of seasonal variation that is currently observed at the site

Based on these conclusions, this simulation is adequate for the intended purposes.

7.0 References

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Table 1 Input Parameter Ranges and Sensitivity Analysis Inputs

Input Parameter	Low Value	High Value	Units
Groundwater Velocity	0.1	0.5	m/d
Aquifer Thickness	4.6	30	m
Porosity	0.2	0.5	
Longitudinal Dispersivity	12	61	m
Lateral Dispersivity	1	10	m
Source Strength	0.003	0.03	kg/d
Elapsed Time	60	90	d

NOTES
For the sensitivity analyses, all simulations used:
Elapsed Time = 60 days
v = 0.5

Table 2 Base-Case Input Parameters

Input Parameter	Value	Units
Groundwater Velocity	0.2[1]; 0.4[2]; 0.5[3]	m/d
Aquifer Thickness	9	m
Porosity	0.3	
Longitudinal Dispersivity	20	m
Lateral Dispersivity	4	m
Retardation Factor	1	
Half-life	0	d
Number of Point Sources	3	
Source No. 1		
X-coordinate of the Source	1690	m
Y-coordinate of the Source	1603	m
Source Strength	0.002	kg/d
Elapsed Times	60, 90	d
Source No. 2		
X-coordinate of the Source	1703	m
Y-coordinate of the Source	1602	m
Source Strength	0.002	kg/d
Elapsed Time	60, 90	d
Source No. 3		
X-coordinate of the Source	1715	m
Y-coordinate of the Source	1602	m
Source Strength	0.002	kg/d
Elapsed Time	60, 90	d
Grid Data		
X-coordinate of the Grid Origin	1650	m
Y-coordinate of the Grid Origin	1500	m
Length of Distance Increment DELX	15	m
Length of Distance Increment DELY	10	m
Number of Nodes in X-direction	20	
Number of Nodes in Y-direction	20	

Notes:
[1]Scenario 1: based on transmissivity = 4,990 ft^2/d
[2]Scenario 2: based on transmissivity = 12,000 ft^2/d
[3]Scenario 3: based on transmissivity = 15,000 ft^2/d

Table 1 Input Parameter Ranges and Sensitivity Analysis Inputs

Input Parameter	Low Value	High Value	Units
Groundwater Velocity	0.1	0.5	m/d
Aquifer Thickness	4.6	30	m
Porosity	0.2	0.5	
Longitudinal Dispersivity	12	61	m
Lateral Dispersivity	1	10	m
Source Strength	0.003	0.03	kg/d
Elapsed Time	60	90	d

NOTES
For the sensitivity analyses, all simulations used:
Elapsed Time = 60 days
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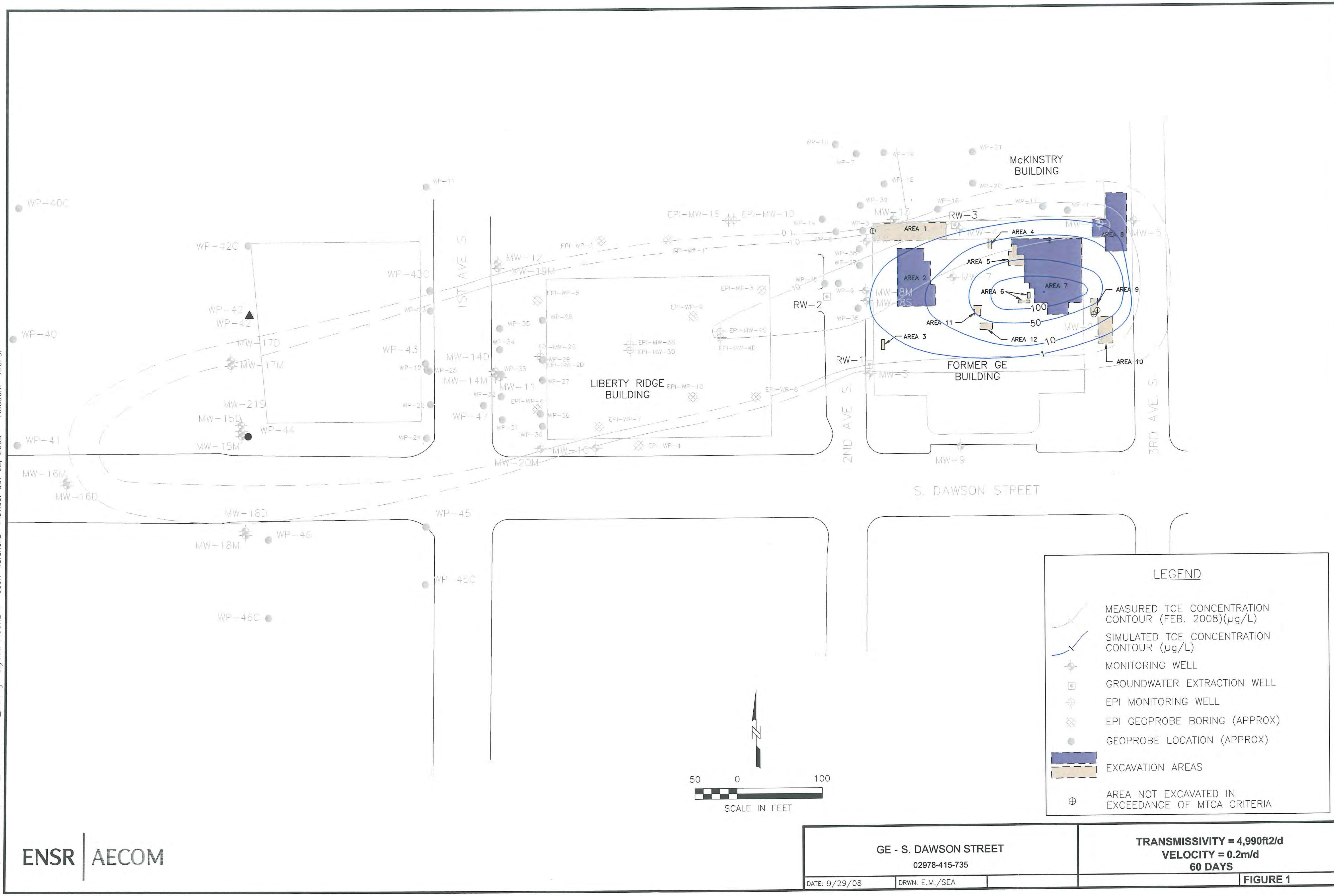
Porosity	0.3	
Longitudinal Dispersivity	20	m
Lateral Dispersivity	4	m
Retardation Factor	1	
Half-life	0	d
Number of Point Sources	3	
Source No. 1		
X-coordinate of the Source	1690	m
Y-coordinate of the Source	1603	m
Source Strength	0.002	kg/d
Elapsed Times	60, 90	d
Source No. 2		
X-coordinate of the Source	1703	m
Y-coordinate of the Source	1602	m
Source Strength	0.002	kg/d
Elapsed Time	60, 90	d
Source No. 3		
X-coordinate of the Source	1715	m
Y-coordinate of the Source	1602	m
Source Strength	0.002	kg/d
Elapsed Time	60, 90	d
Grid Data		
X-coordinate of the Grid Origin	1650	m
Y-coordinate of the Grid Origin	1500	m
Length of Distance Increment DELX	15	m
Length of Distance Increment DELY	10	m
Number of Nodes in X-direction	20	
Number of Nodes in Y-direction	20	

Notes:

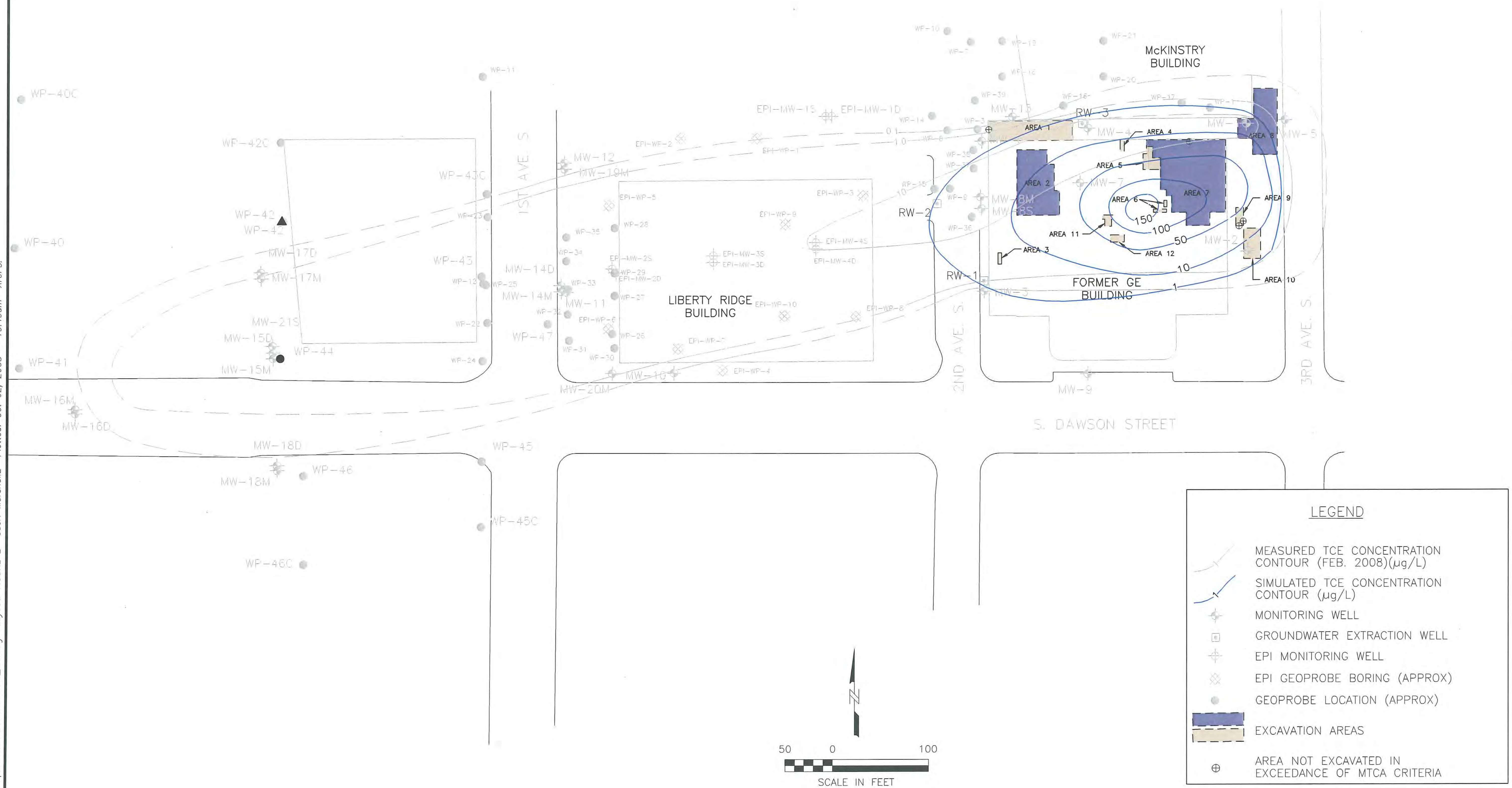
[1]Scenario 1: based on transmissivity = 4,990 ft^2/d

[2]Scenario 2: based on transmissivity = 12,000 ft^2/d

[3]Scenario 3: based on transmissivity = 15,000 ft^2/d



File: L:\GE-S.Dawson\02978_TRANSMISSIVITY_02.dwg Layout: FIGURE 1 User: MarshallE Plotted: Oct 02, 2008 - 10:39am Xref's:



File: L:\GE-S.Dawson\02978_TRANSMISSIVITY_01.dwg Layout: FIGURE 2 User: MarshallE Plotted: Oct 02, 2008 - 10:40am Xref's:

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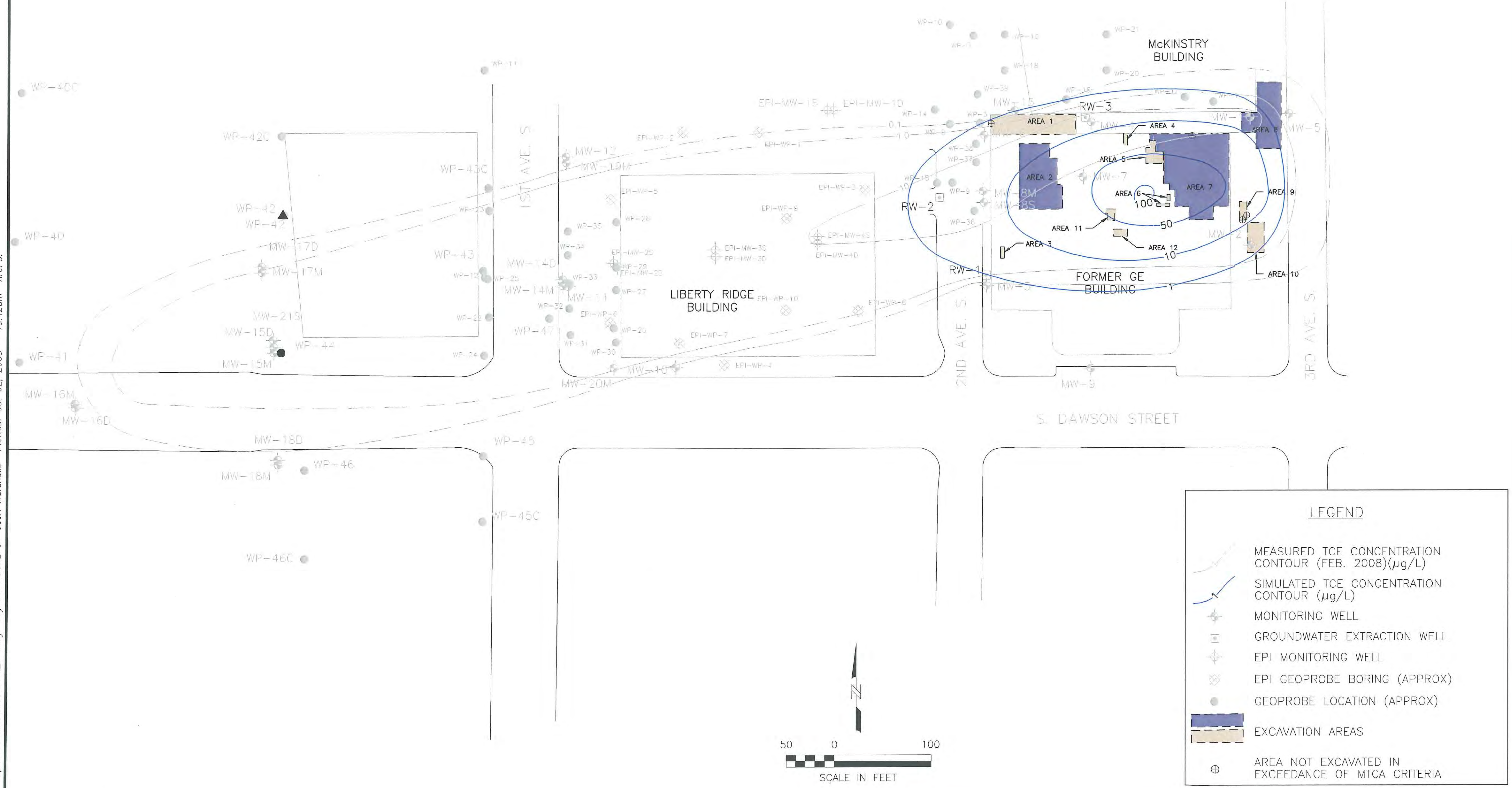
GE - S. DAWSON STREET

02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

TRANSMISSIVITY = 4,990ft2/d
VELOCITY = 0.2m/d
90 DAYS

FIGURE 2



LEGEND

- MEASURED TCE CONCENTRATION CONTOUR (FEB. 2008)(μg/L)
- SIMULATED TCE CONCENTRATION CONTOUR (μg/L)
- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- EPI MONITORING WELL
- EPI GEOPROBE BORING (APPROX)
- GEOPROBE LOCATION (APPROX)
- EXCAVATION AREAS
- AREA NOT EXCAVATED IN EXCEEDANCE OF MTCA CRITERIA

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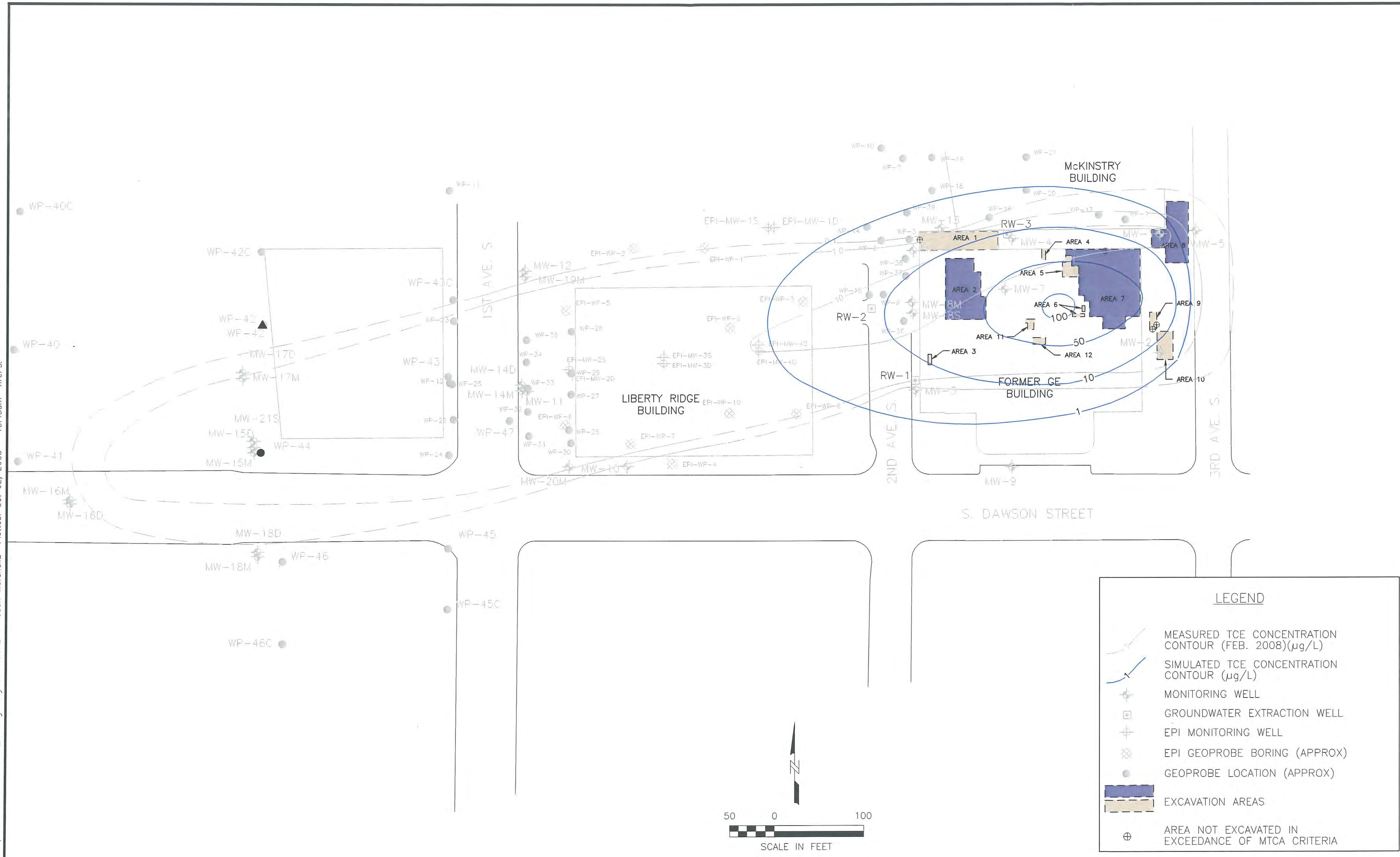
GE - S. DAWSON STREET 02978-415-735	TRANSMISSIVITY = 12,000ft2/d VELOCITY = 0.4m/d 60 DAYS
DATE: 9/29/08 DRWN: E.M./SEA	FIGURE 3

File: L:\GE-S.Dawson\02978_TRANSMISSIVITY_04.dwg Layout: FIGURE 3 User: MarshallE Plotted: Oct 02, 2008 - 10:42am Xref's:



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GE - S. DAWSON STREET

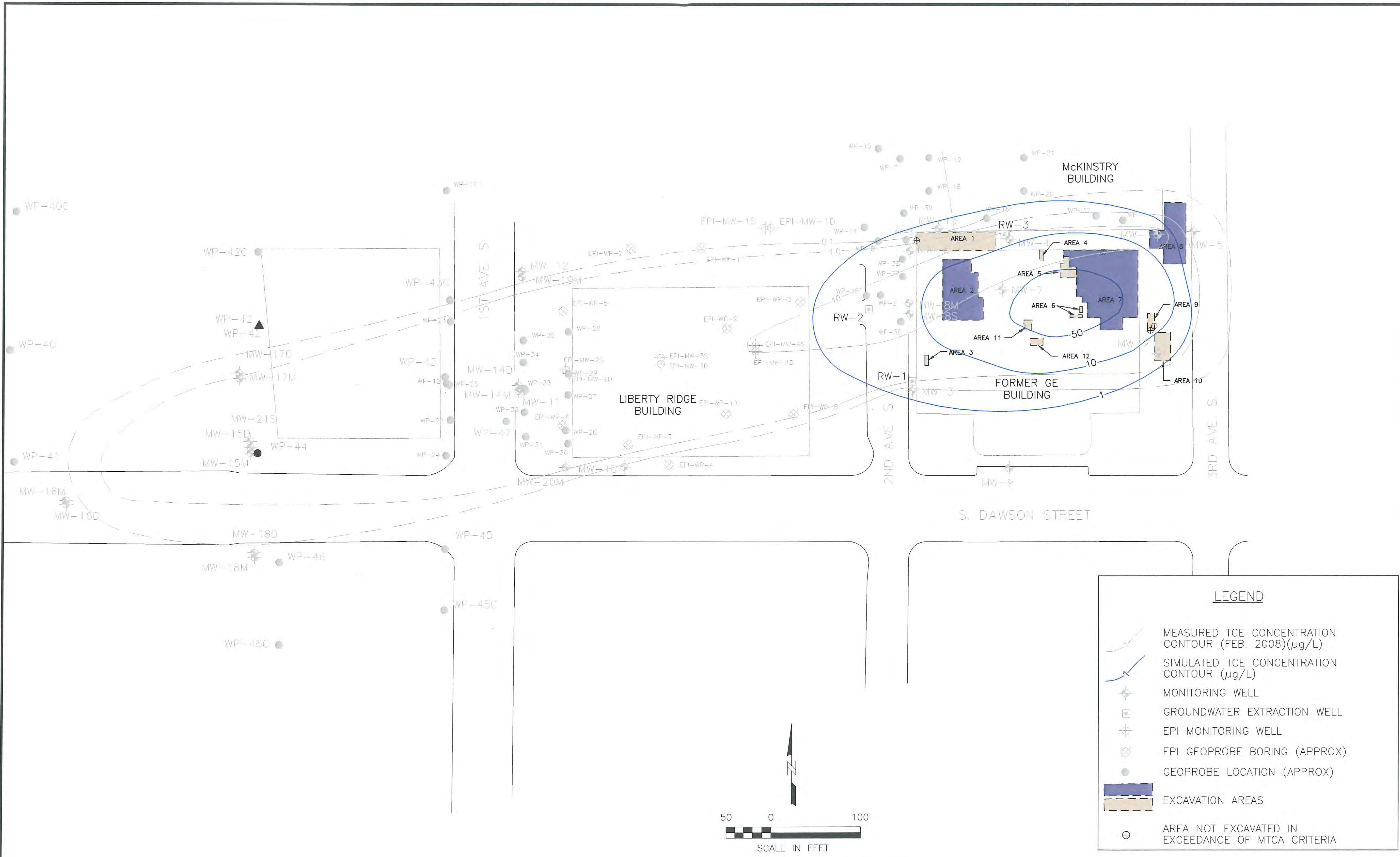
02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

TRANSMISSIVITY = 12,000ft2/d
VELOCITY = 0.4m/d
90 DAYS

FIGURE 4

File: L:\GE-S.Dawson\02978_TRANSMISSIVITY_03.dwg Layout: FIGURE 4 User: MarshallE Plotted: Oct 02, 2008 - 10:43am Xref's:



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GE - S. DAWSON STREET

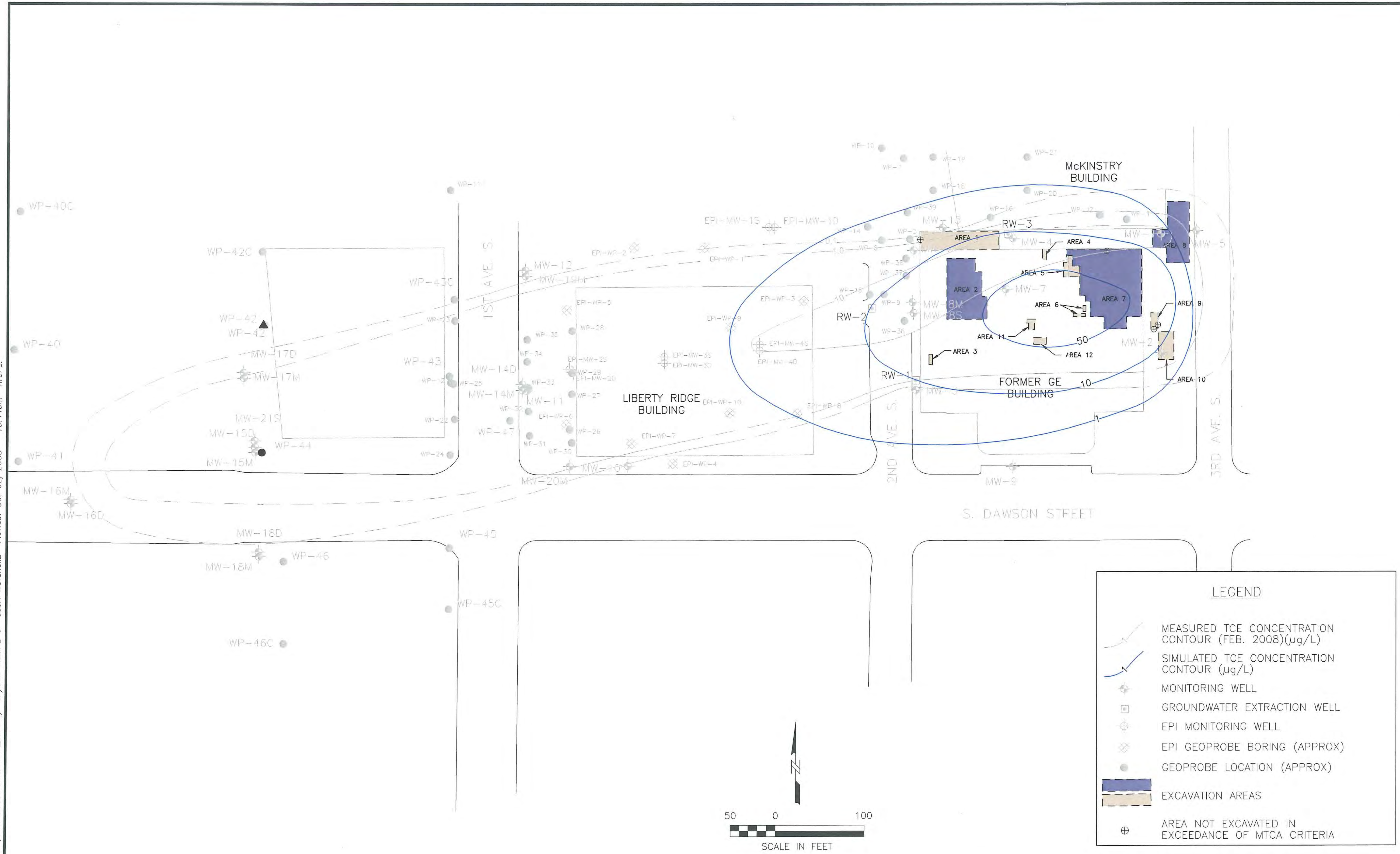
02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

TRANSMISSIVITY = 15,000ft2/d
VELOCITY = 0.5m/d
60 DAYS

FIGURE 5

File: L:\GE-S.Dawson\02978_TRANSMISSIVITY_06.dwg Layout: FIGURE 5 User: MarshallE Plotted: Oct 02, 2008 - 10:43am Xref's:



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GE - S. DAWSON STREET

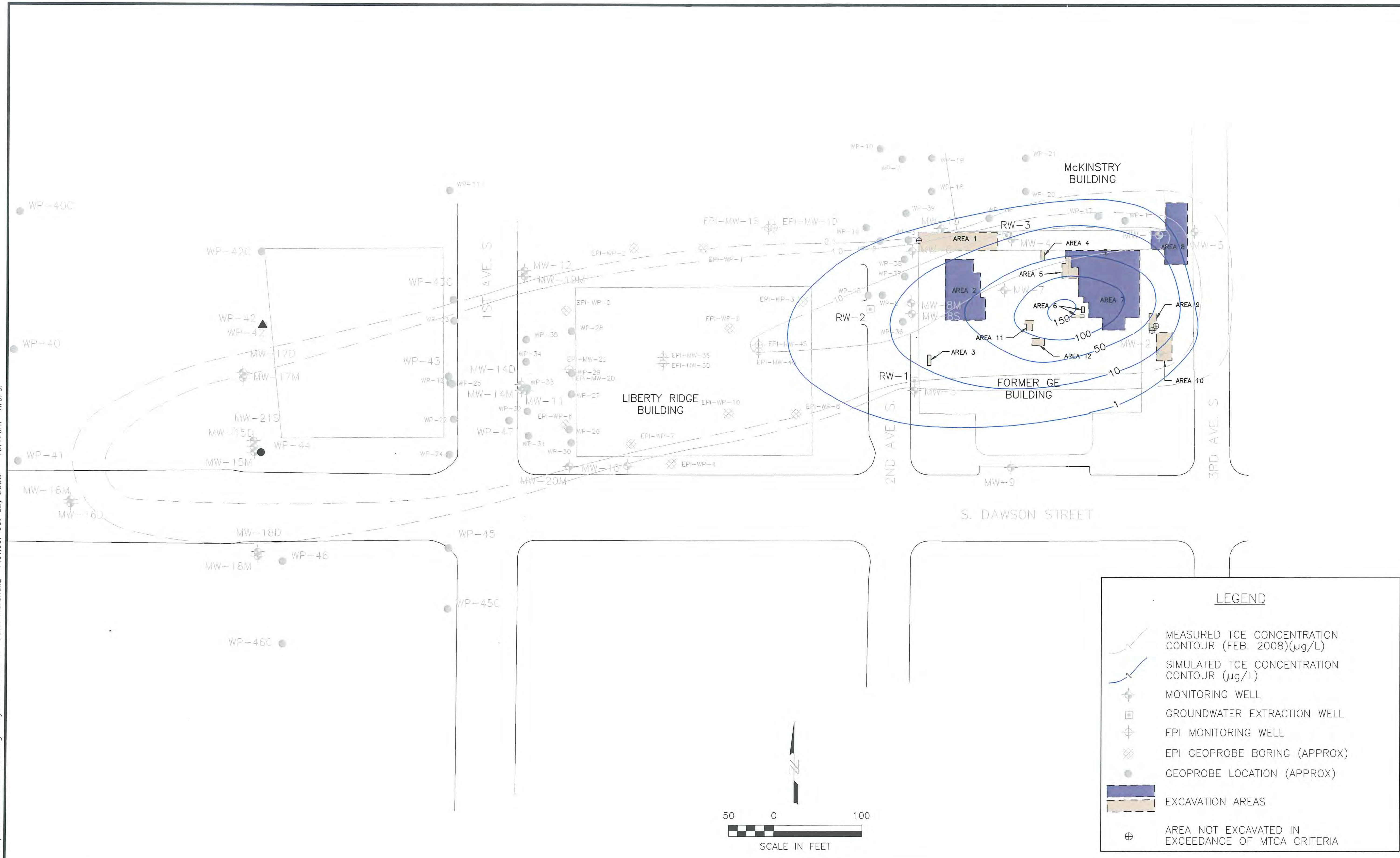
02978-415-735

DATE: 9/29/08 DRWN: E.M./SEA

TRANSMISSIVITY = 15,000ft2/d
VELOCITY = 0.5m/d
90 DAYS

FIGURE 6

File: L:\GE-S.Dawson\02978_TRANSMISSIVITY_05.dwg Layout: FIGURE 6 User: MarshallE Plotted: Oct 02, 2008 - 10:44am Xref's:



File: L:\GE-S.Dawson\02978_ANALYSIS_23.dwg Layout: FIGURE 9 User: MarshallE Plotted: Oct 02, 2008 - 10:47am Xref's:

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GE - S. DAWSON STREET

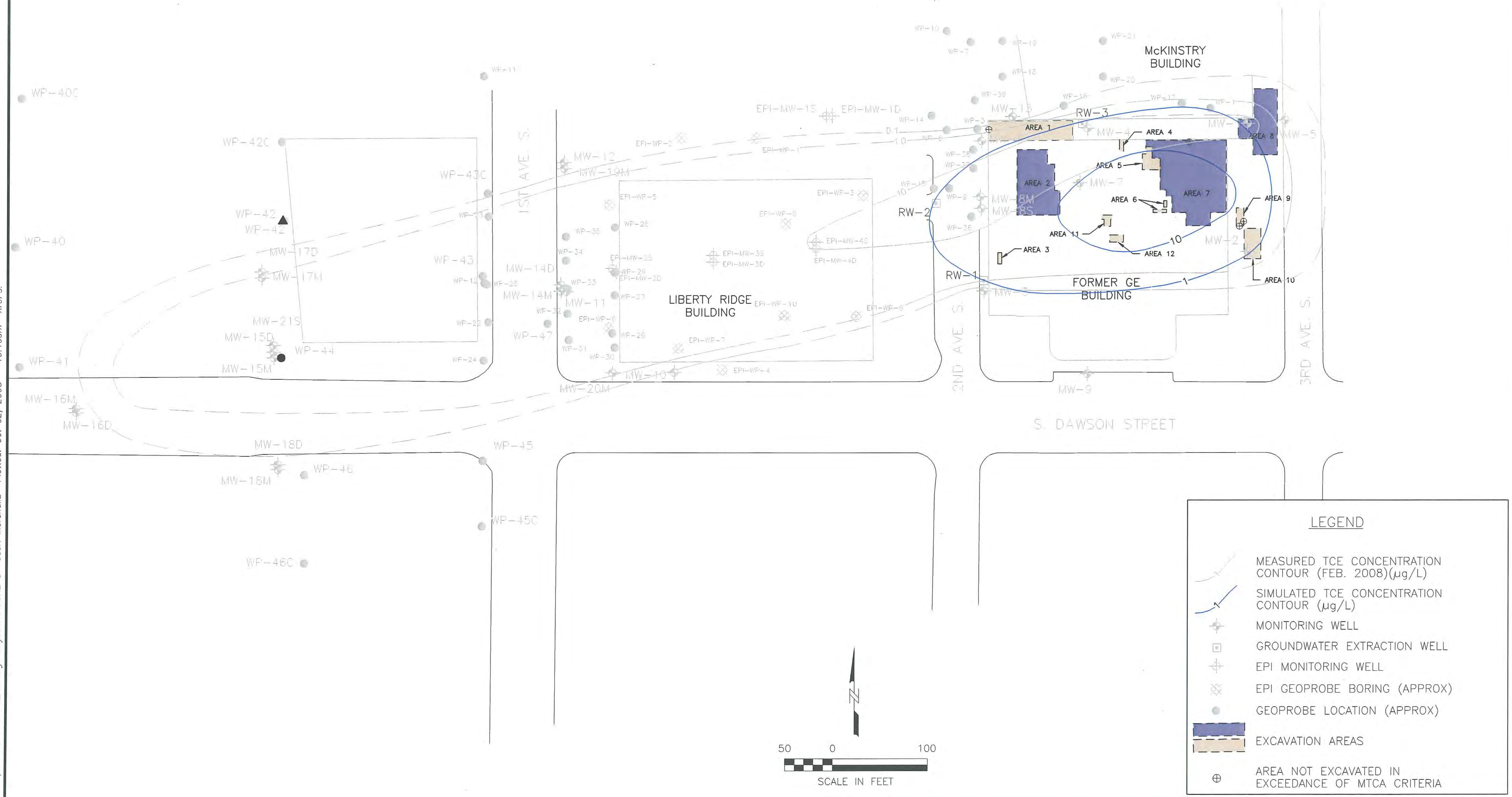
02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

SENSITIVITY ANALYSIS: AQUIFER THICKNESS = 4.6m 60 DAYS

FIGURE 7

File: L:\GE-S.Dawson\02978_ANALYSIS_18.dwg Layout: FIGURE 8 User: MarshallE Plotted: Oct 02, 2008 - 10:46am Xref's:



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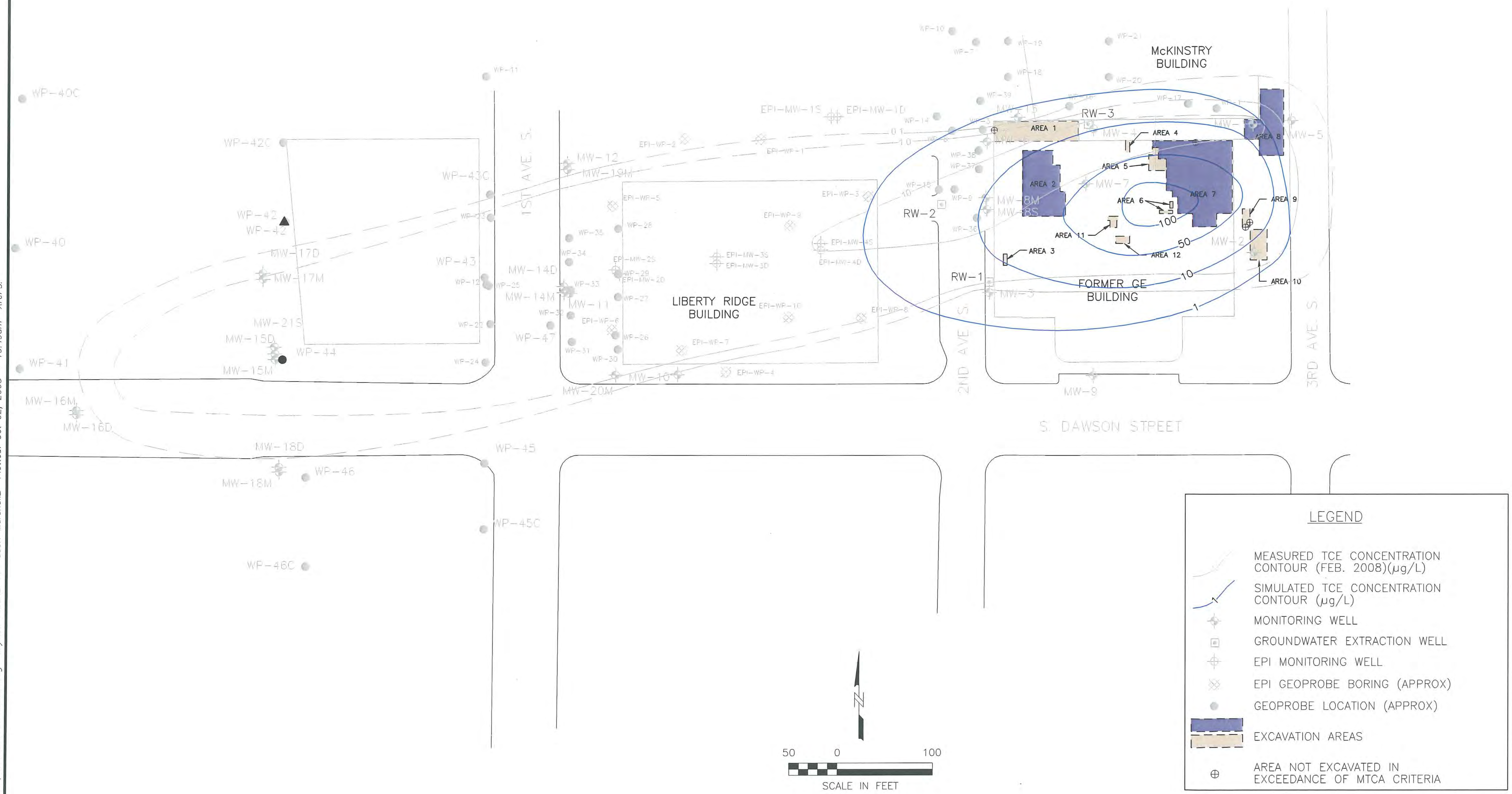
GE - S. DAWSON STREET 02978-415-735	SENSITIVITY ANALYSIS: AQUIFER THICKNESS = 30m 60 DAYS
DATE: 9/29/08 DRWN: E.M./SEA	FIGURE 8



File: L:\GE-S.Dawson\02978_ANALYSIS_22.dwg Layout: FIGURE 11 User: MarshallE Plotted: Oct 02, 2008 - 10:49am Xref's:

ENSR | AECOM

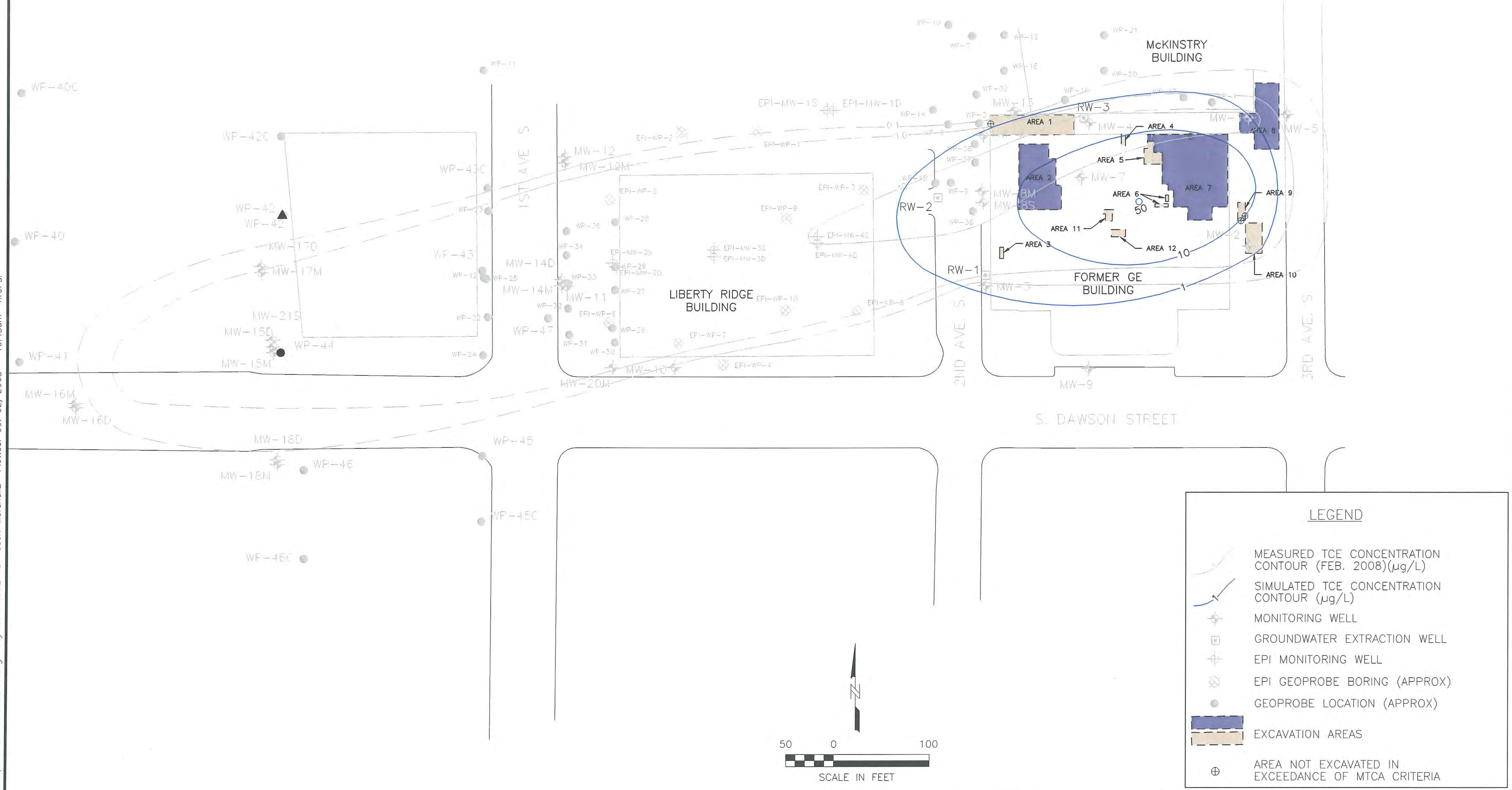
GE - S. DAWSON STREET

02978-415-735

DATE: 9/30/08 | DRWN: E.M./SEA

SENSITIVITY ANALYSIS: POROSITY = 0.2 60 DAYS

FIGURE 9



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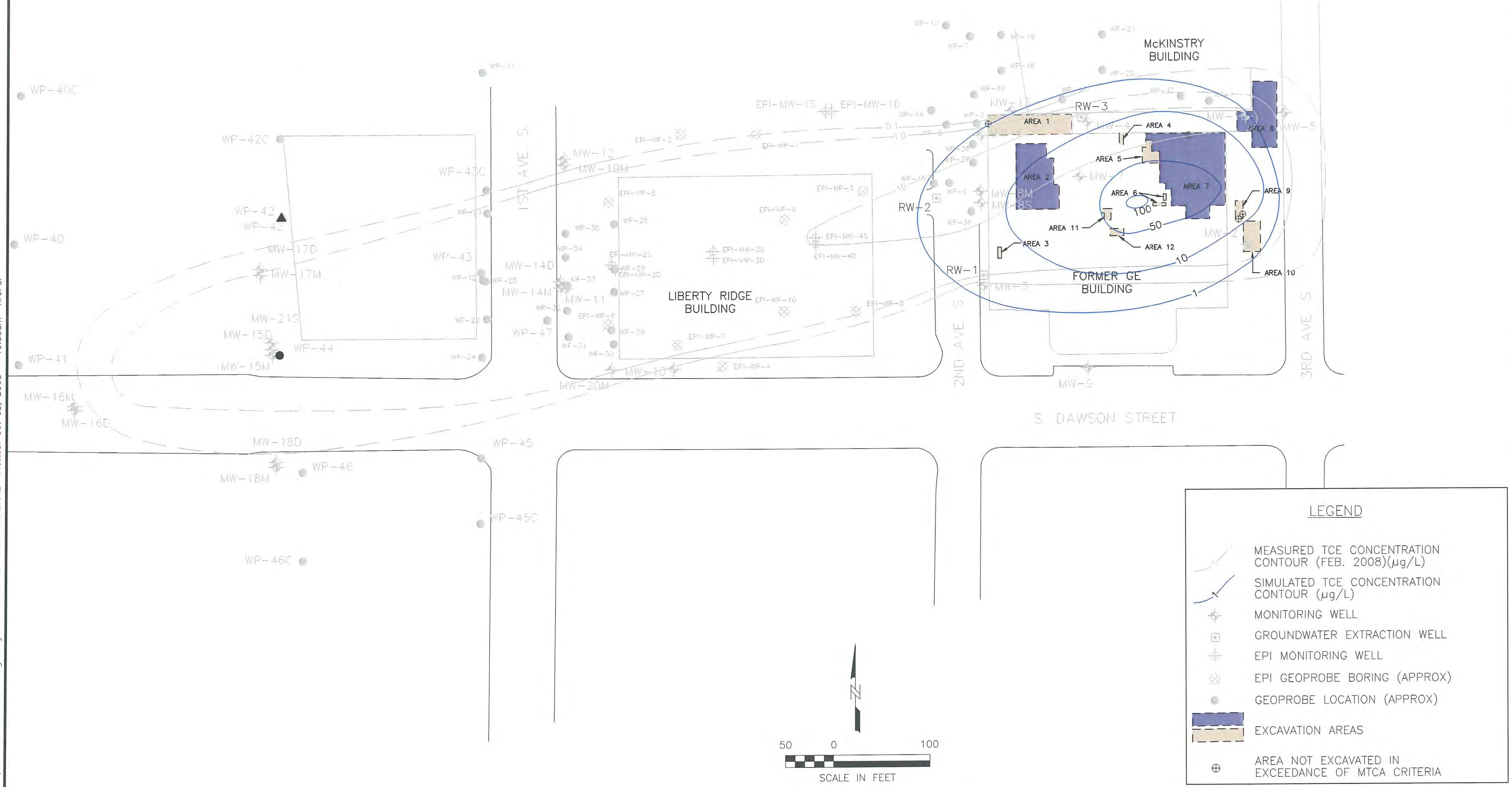
02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

SENSITIVITY ANALYSIS: POROSITY = 0.5 60 DAYS

FIGURE 10

File: L:\GE-S.Dawson\02978_ANALYSIS_17.dwg Layout: FIGURE 10 User: MarshallE Plotted: Oct 02, 2008 - 10:48am Xref's:



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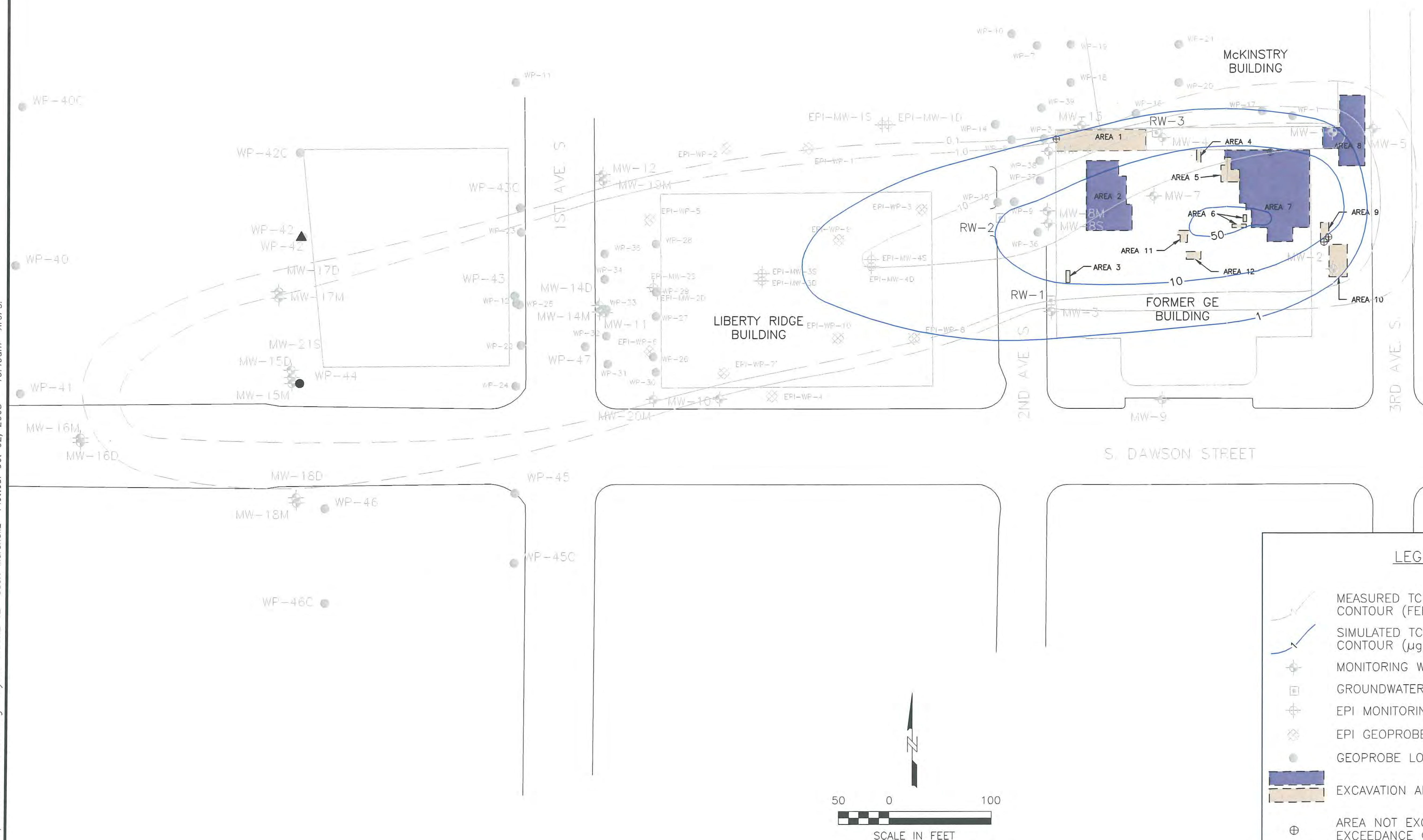
02978-415-735

SENSITIVITY ANALYSIS: LONGITUDINAL DISPERSIVITY = 12m 60 DAYS

DATE: 9/29/08 | DRWN: E.M./SEA

FIGURE 11

File: L:\GE-S.Dawson\02978_ANALYSIS_21.dwg Layout: FIGURE 13 User: MarshallE Plotted: Oct 02, 2008 - 10:50am Xref's:



LEGEND

MEASURED TCE CONCENTRATION CONTOUR (FEB. 2008)(μg/L)

SIMULATED TCE CONCENTRATION CONTOUR (μg/L)

MONITORING WELL

GROUNDWATER EXTRACTION WELL

EPI MONITORING WELL

EPI GEOPROBE BORING (APPROX)

GEOPROBE LOCATION (APPROX)

EXCAVATION AREAS

AREA NOT EXCAVATED IN EXCEEDANCE OF MTCA CRITERIA

ENSR | AECOM

GE - S. DAWSON STREET

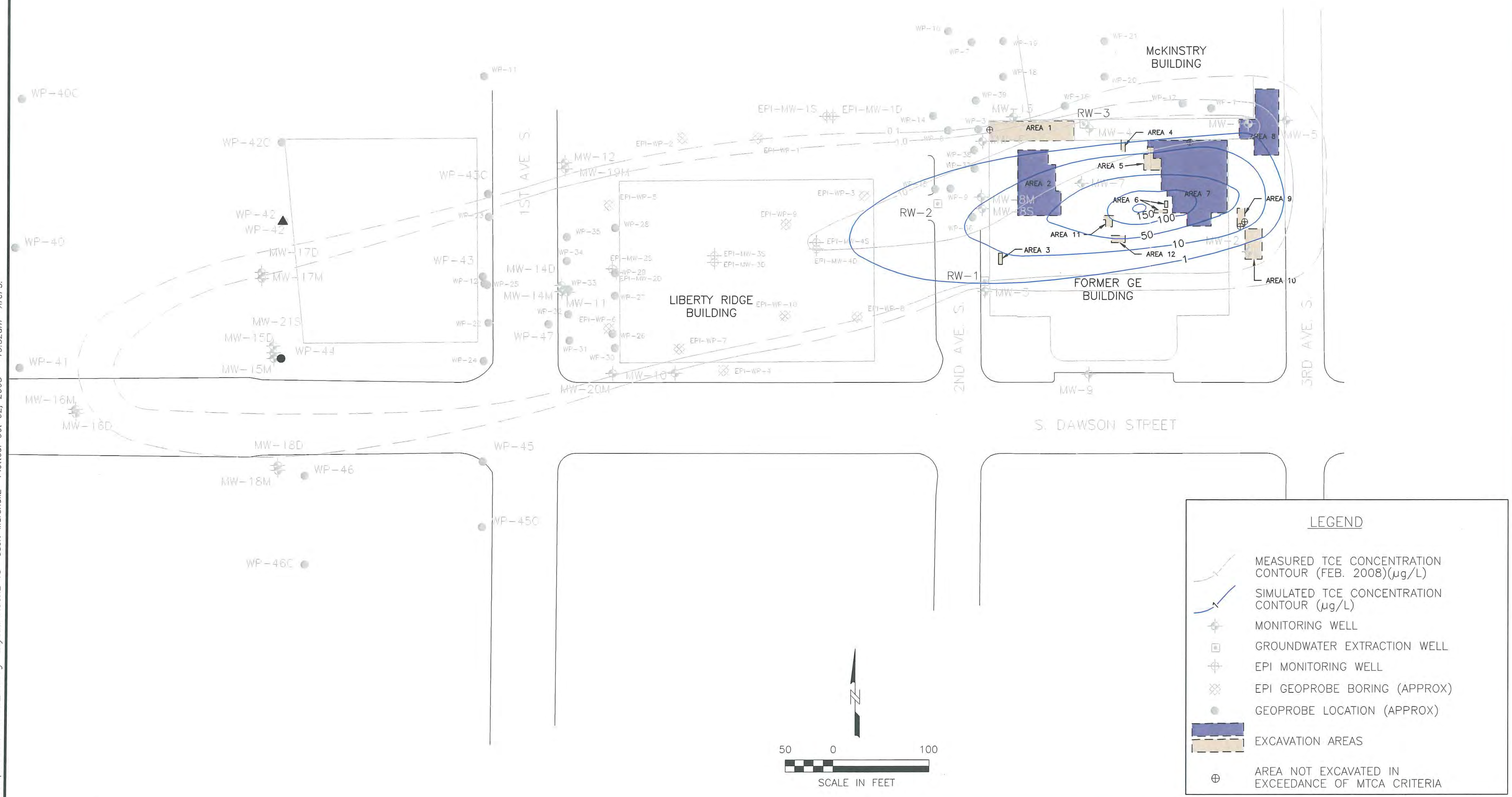
02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

SENSITIVITY ANALYSIS: LONGITUDINAL DISPERSIVITY = 61m 60 DAYS

FIGURE 12

File: L:\GE-S.Dawson\02978_ANALYSIS_16.dwg Layout: FIGURE 12 User: MarshallE Plotted: Oct 02, 2008 - 10:49am Xref's:



LEGEND

- MEASURED TCE CONCENTRATION CONTOUR (FEB. 2008)(μg/L)
- SIMULATED TCE CONCENTRATION CONTOUR (μg/L)
- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- EPI MONITORING WELL
- EPI GEOPROBE BORING (APPROX)
- GEOPROBE LOCATION (APPROX)
- EXCAVATION AREAS
- AREA NOT EXCAVATED IN EXCEEDANCE OF MTCA CRITERIA

File: L:\GE-S.Dawson\02978_ANALYSIS_20.dwg Layout: FIGURE 15 User: MarshallE Plotted: Oct 02, 2008 - 10:52am Xref's:

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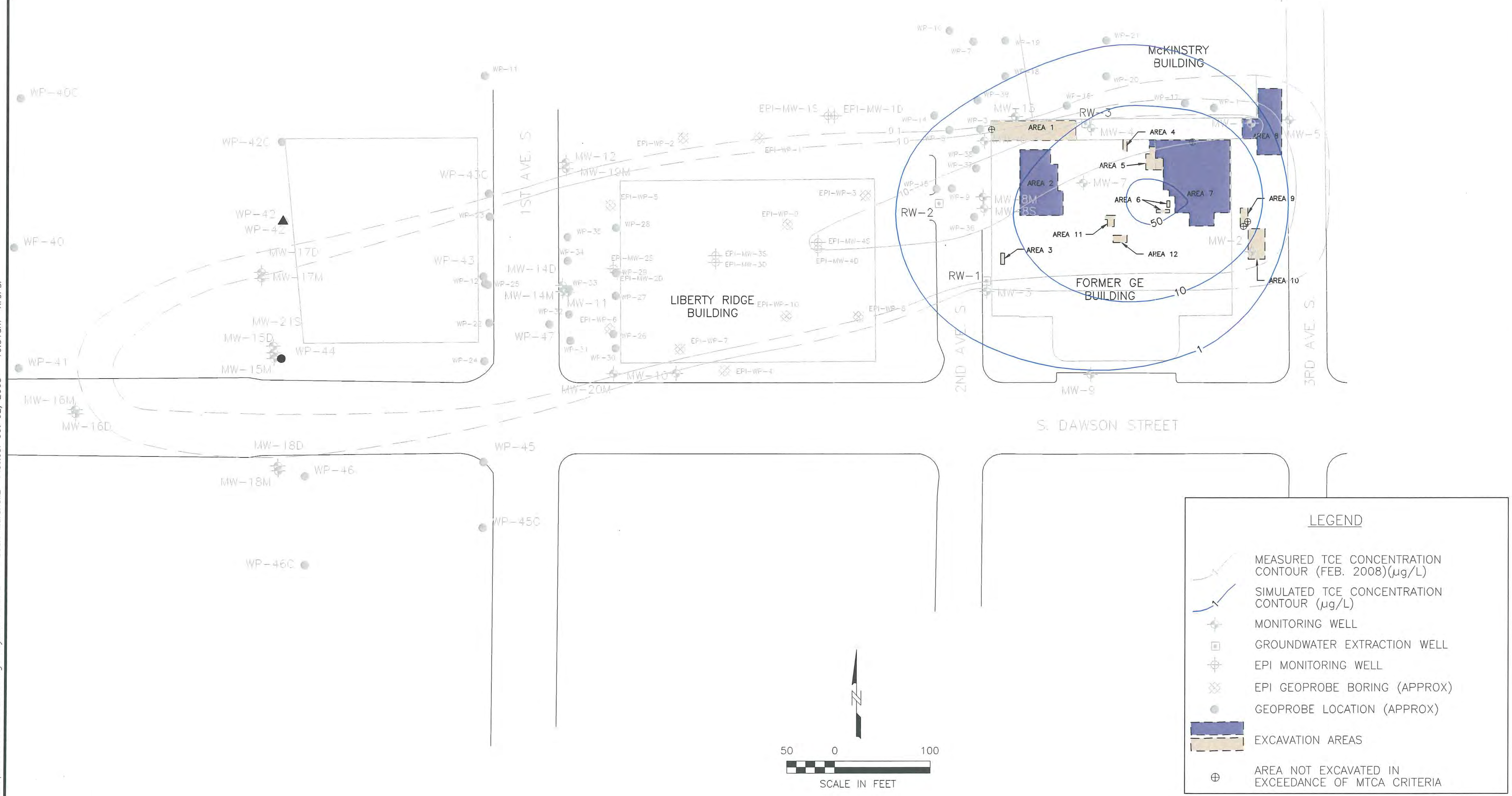
GE - S. DAWSON STREET 02978-415-735	SENSITIVITY ANALYSIS: LATERAL DISPERSIVITY = 1m 60 DAYS
DATE: 9/29/08 DRWN: E.M./SEA	FIGURE 13



LEGEND

- MEASURED TCE CONCENTRATION CONTOUR (FEB. 2008)(µg/L)
- SIMULATED TCE CONCENTRATION CONTOUR (µg/L)
- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- EPI MONITORING WELL
- EPI GEOPROBE BORING (APPROX)
- GEOPROBE LOCATION (APPROX)
- EXCAVATION AREAS
- AREA NOT EXCAVATED IN EXCEEDANCE OF MTCA CRITERIA

File: L:\GE-S.Dawson\02978_ANALYSIS_15.dwg Layout: FIGURE 14 User: MarshallE Plotted: Oct 02, 2008 - 10:51am Xref's:

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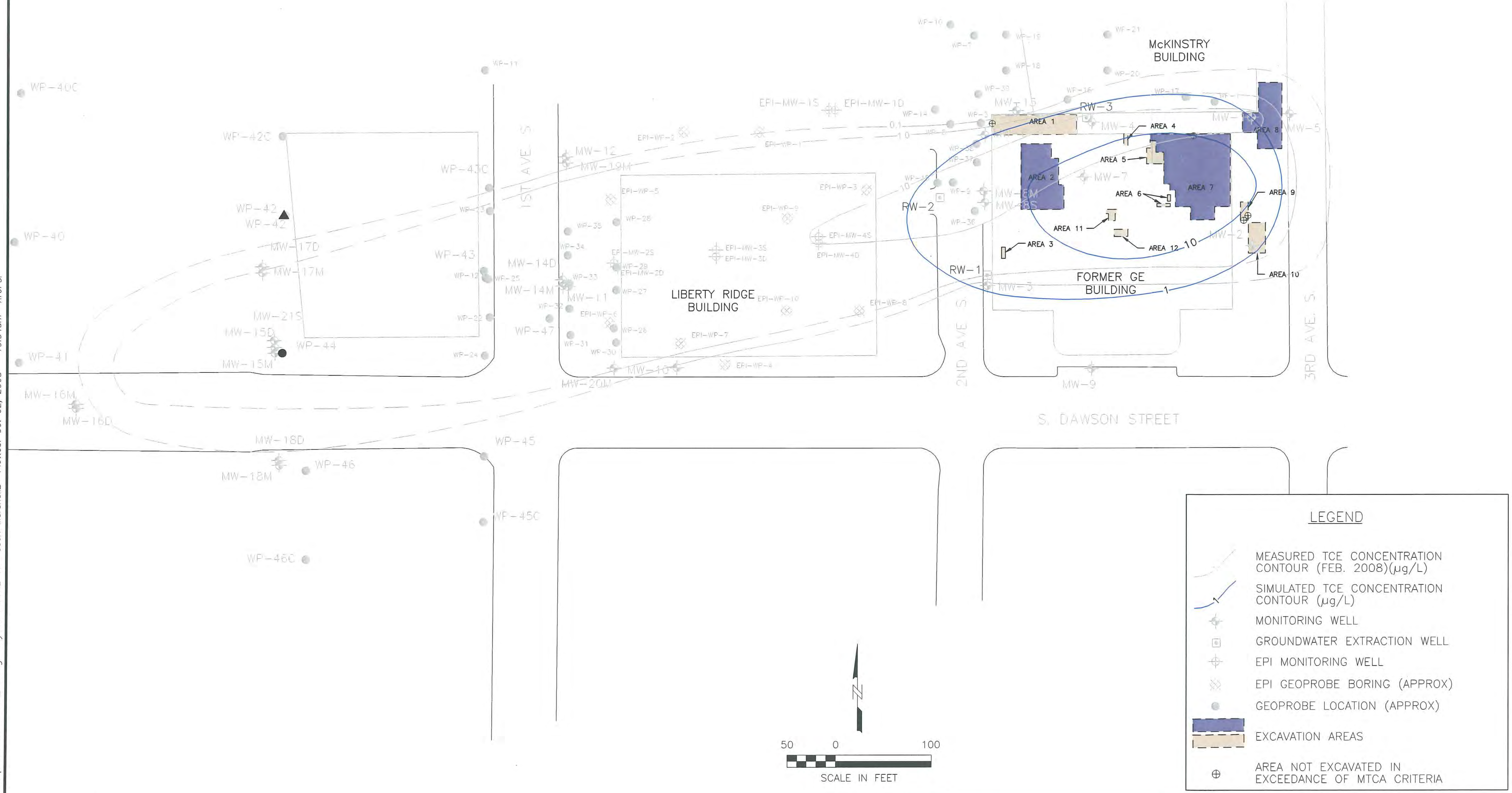
02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

SENSITIVITY ANALYSIS: LATERAL DISPERSIVITY = 10m 60 DAYS

FIGURE 14



File: L:\GE-S.Dawson\02978_ANALYSIS_19.dwg Layout: FIGURE 17 User: MarshallE Plotted: Oct 02, 2008 - 10:54am Xref's:

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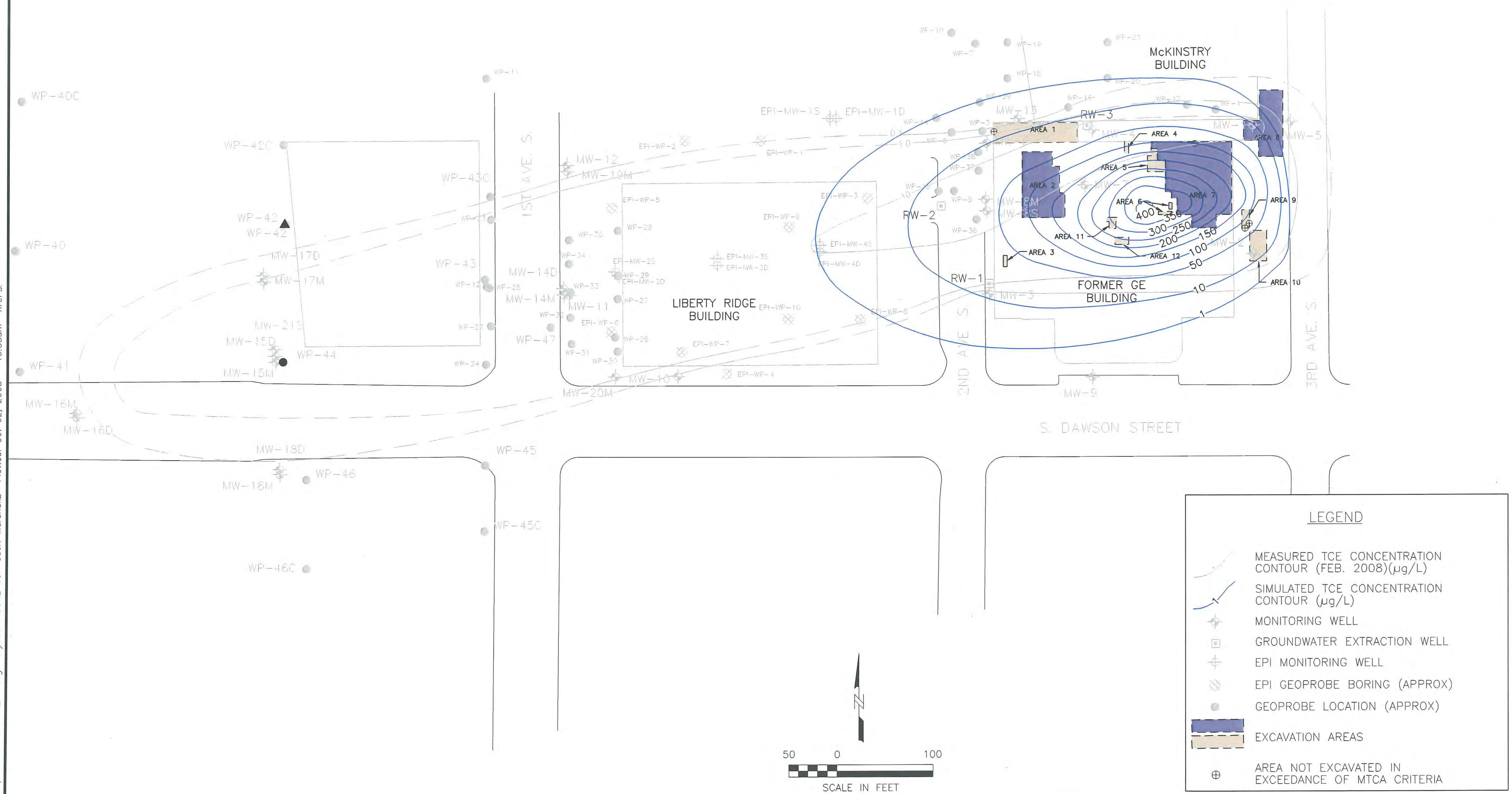
GE - S. DAWSON STREET

02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

SENSITIVITY ANALYSIS:
SOURCE FLUX = 0.001kg/d EA. INJECTION POINT
(TOTAL 0.003 kg/d)
60 DAYS

FIGURE 15



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GE - S. DAWSON STREET

02978-415-735

DATE: 9/29/08 | DRWN: E.M./SEA

SENSITIVITY ANALYSIS: SOURCE FLUX = 0.01kg/d EA. INJECTION POINT (TOTAL = 0.03 kg/d) 60 DAYS

FIGURE 16

File: L:\GE-S.Dawson\02978_ANALYSIS_14.dwg Layout: FIGURE 16 User: MarshallE Plotted: Oct 02, 2008 - 10:53am Xref's:

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1011 SW Klickitat Way, Suite 207, Seattle, WA 98134-1162
T 206.624.9349 F 206.624.2839 www.ensr.aecom.com

Memorandum

Date: October 16, 2008

To: Jamie Stevens

From: Cassie Smith

Subject: Trichloroethylene (TCE) mass in soil

This memorandum describes the methodology used to prepare the attached figure. The figure was created to evaluate the mass of trichloroethylene (TCE) in the soil at the former GE facility, located at 220 S Dawson St, in support of the focused feasibility study (FFS).

Background

In the early 1990s, Dames & Moore Group collected soil samples from multiple locations within a proposed excavation area for analyses to estimate the extent of suspected TCE-affected soil. From 1992-1994 Dames & Moore collected several soil samples from 12 areas under and around the Former GE building at 220 S. Dawson Street in Seattle, WA. The twelve areas are shown on the attached map (Figure 1). These areas and their results are outlined in the removal action report (Dames & Moore 1996).

Dames & Moore used the soil analytical results to determine which of the twelve areas would undergo soil excavation and disposal. The purpose of the excavations was to comply with the MTCA cleanup standards of that time.

Three areas (Area 2, Area 7, and Area 8, as defined in Figure 1) were found to contain soils with TCE concentrations that exceeded the cleanup action levels at that time. The areas were excavated in 1995 through 1996. After the removal action, a second group of soil samples were collected to ensure that TCE concentrations in soil were below the EPA cleanup levels at that time.

ENSR Analysis Methodology

Using the information provided in the excavation report (Dames & Moore 1996), ENSR prepared an estimate of the amount of TCE removed from the site compared to the approximate amount of TCE left in place. For the purposes of this analysis, it was assumed that areal extent of TCE-affected soil was defined by the twelve areas defined in the report (Dames & Moore 1996) and shown on the attached figure.

Excavated TCE Mass. Using the analytical data from the pre-excavation soil samples (Dames & Moore 1996), using ½ the detection limit for non-detect results, ENSR calculated a 95% upper confidence limit (UCL) of the TCE concentrations for each of the removal areas. These UCL calculations provide an estimate of the pre-excavation upper-bound mean TCE concentration in the soil mass for each area. These estimated concentrations were used as the basis for the estimate of removed TCE mass.

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ENSR then calculated the mass of soil removed from each area during the 1996 excavation based on figures 4, 9 and 10, (Dames & Moore 1996). The soil mass (volume x unit weight) was estimated by measuring area in ft^2, using the scale on Figures 4-9 and 4-10 (Dames & Moore, 1996) and multiplying it by the excavation depths provided in the report (Dames & Moore 1996). The total volume for each area was then converted to ^{m3} and multiplied by 1,922 kg/m^3, the estimated soil density used for unit weight (generic density for medium sand (Glover, 2000). The removal areas defined in the report were taken as the extent of TCE-affected soil. Using the pre-excavation upper-bound mean concentrations and the removed soil mass, the mass of removed TCE was calculated for each removal area ($Concentration_{TCE\ (UCL)}$ x $Mass_{soil}$). The TCE mass removed at each location is summarized in Table 1 and shown on Figure 1.

Table 1 Removed TCE-mass Calculations.

Location (also called Area)	Area (ft^2)	Depth Range of Soil Removed (ft)	Unit Weight (kg/m^3)	Soil Mass (kg)	TCE Concentration (mg/kg)	Mass of TCE Removed (kg)
2	2023.63	4-6	1,922	135926.39	0.22	0.9
7	4639.0	5-10	1,922	487898.17	0.22	5
8	998.043	3-8	1,922	821566.83	0.16	0.13

Left in Place TCE Mass. The second estimate was the mass of TCE left in the soil. For this estimate, it was assumed that the excavated areas defined in the report (Dames & Moore 1996) defined the areal extent of TCE-affected soil. The estimate is limited to TCE in the vadose zone; therefore, the water table was used as a lower limit of TCE-affected soil. The water table elevations that were used as the basis for soil thickness were derived from a groundwater elevation contour map that was created based on groundwater elevations taken by ENSR (formerly RETEC) from surrounding wells on November 20, 1996 (Figure 2). The upper limit of TCE-affected soil left in place was the total depth of excavation. Using the same area as the soil removed, we subtracted the difference between the excavated depth and the water table to get thickness (vadose zone). By multiplying these numbers, we obtained the volume of TCE-affected soil left in place. Using the vadose zone volume and the same generic density (1,922 kg/m^3 (Glover, 2000) the mass of remaining TCE soil was calculated. Using the UCL TCE concentration and the mass of soil, the mass of TCE in-place was calculated ($Concentration_{TCE\ (UCL)}$ x $Mass_{soil}$). The TCE mass remaining after all excavation activities is summarized in Table 2 and shown on Figure 1.

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Table 2 Left In-place TCE Mass Calculations.

Location (also called Area)	Vadose Zone Area (ft^2)	Thickness Range of Soil Left In-place (ft)	Unit Weight (kg/m^3)	Soil Mass (kg)	TCE Concentration (kg/mg)	Mass of TCE Left In-place (kg)
2	2023.63	2.9-4.9	1,922	761138.78	0.22	0.17
7	3779*	5-.9 BWL	1,922	1842519.57	0.22	0.4
8	998.043	1.2-6.2	1,922	217906.73	0.16	0.04

*Area differs from area removed due to excavation below water table in a section of area 7. Therefore, we estimate no TCE mass left in place and the area was not included in this calculation.

BWL = Below Water Level

Results. Based on this analysis, the total mass of TCE that was in the vadose zone soil in Areas 2, 7, and 8 was about 7.25 kg. Of that amount, a little over 6 kg was removed (or 92 percent). That means that only about 0.67 kg of the original 7.25 kg was left in place.

Sincerely yours,

Cassie R. Smith
Cassie.Smith@aecom.com

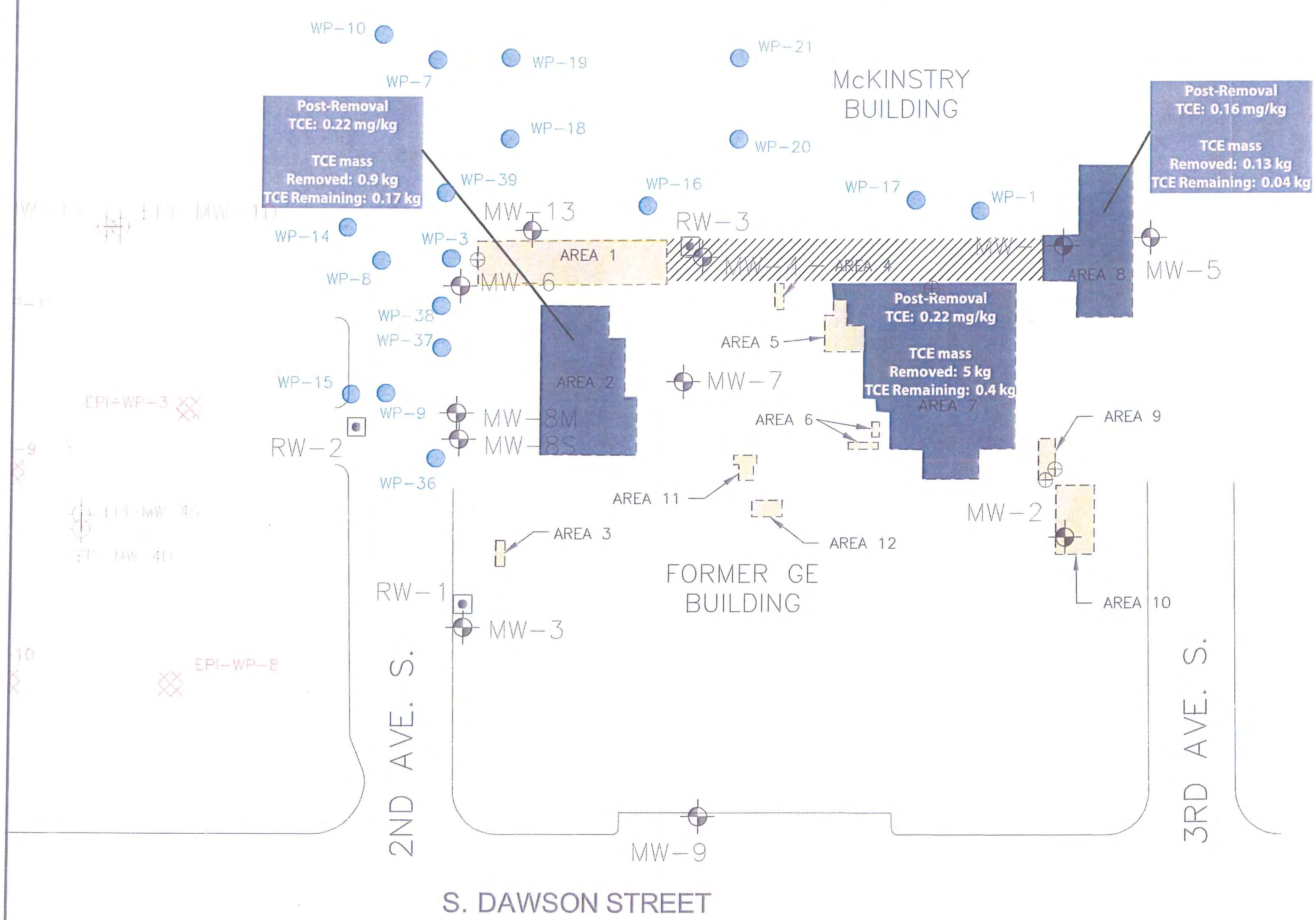
Attachments:

Figure 1: Soil Removal Areas and TCE Concentrations
Figure 2: November 1996 Groundwater Elevation Contour Map

References:

Dames & Moore *Report: Independent Interim Remedial Action of Soils, GEAE Plant 1 facility 220 S. Dawson St. Seattle, Washington.* Prepared for General Electric Aircraft Engines. *Dec 17, 1996.*

Glover, Thomas J. *Pocket Ref. Second Edition.* January, 2000.



NOTES:

1. Explanation of information provided for Areas 2, 7, and 8:

   a. "Post-Removal TCE: xx mg/kg" is the 95% upper confidence limit (UCL) for detected TCE Concentrations (1/2 detection limits were used for non-detected concentrations)

   b. "TCE Mass - Removed:" is an estimate of the mass of TCE that was removed from the vadose zone in each of the three removal areas. "TCE Mass - Remaining:" is an estimate of the mass of TCE that remained in place at the end of the removal action.

   c. Removal Volumes were estimated from information provided in the removal action report (Dames & Moore 1996). Removed and remaining TCE mass was estimated by comparing total volume of remaining (left inplace) soil to 95% UCL concentrations for each specified area.

2. Hatched Area was the site of a RCRA Clean Closure.

N

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SCALE IN FEET

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- EPI MONITORING WELL
- EPI GEOPROBE BORING (APPROX)
- GEOPROBE LOCATION (APPROX)
- EXCAVATION AREA — Left in Place Conc. and Mass Shown; Less than 0.03 mg/kg or ND
- AREA NOT EXCAVATED IN EXCEEDANCE OF MTCA CRITERIA

ENSR | AECOM

GE - S. DAWSON STREET

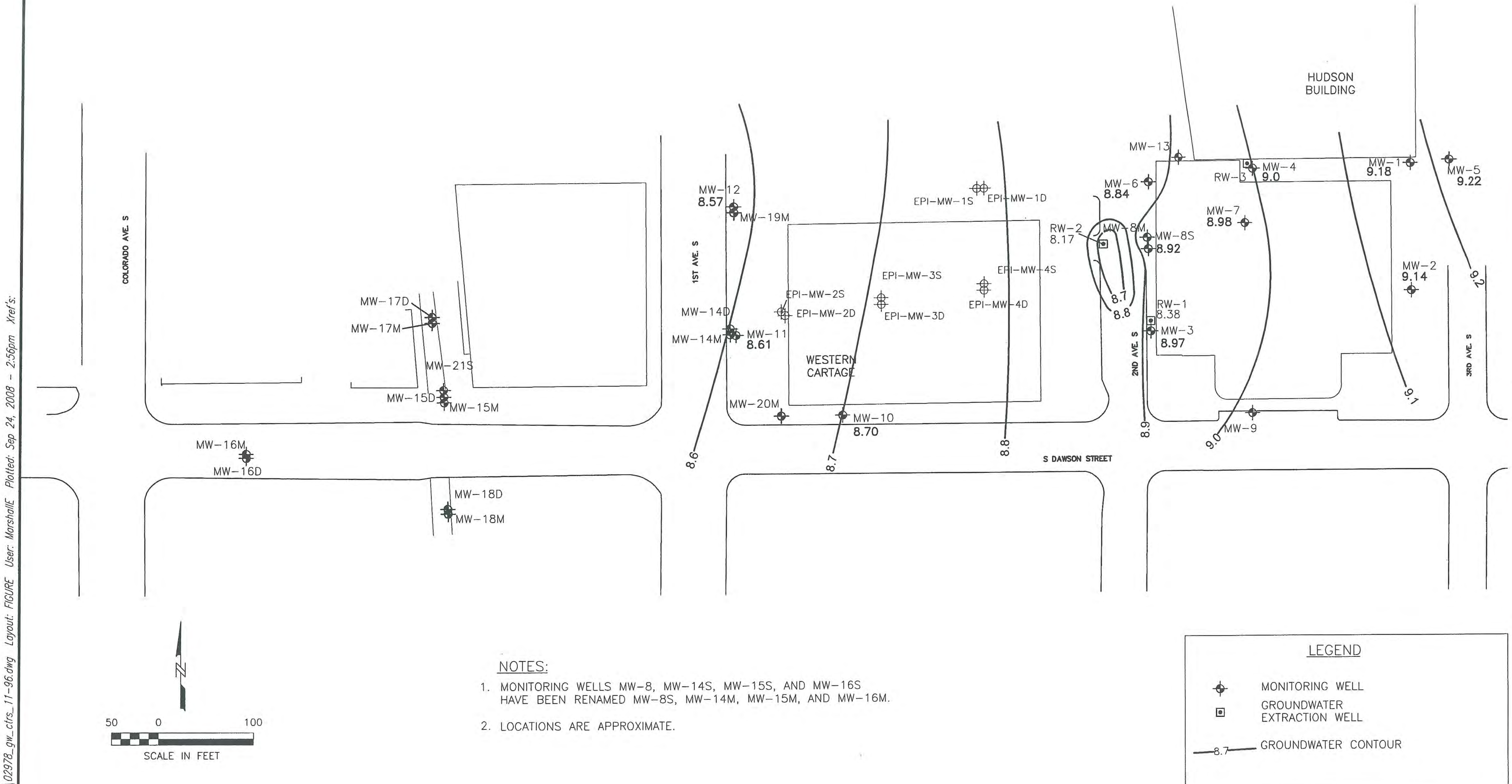
02978-415-735

DATE: 09/23/08

DRWN: TB/SEA

Figure: Illustration of Soil Removal Areas and Concentrations Left In Place

Figure 1



NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.
2. LOCATIONS ARE APPROXIMATE.

ENSR | AECOM

GE - S. DAWSON STREET 02978-415	**GROUNDWATER ELEVATION CONTOURS** **NOVEMBER 1996**
DATE: 9/24/08 DRWN: E.M./SEA	FIGURE 2

File: L:\GE-S.Dawson\02978_gw_ctrs_11-96.dwg Layout: FIGURE User: MarshallE Plotted: Sep 24, 2008 - 2:56pm Xref's:

Appendix C-1 Example Active Monitoring Frequency
This example is only provided for discussion purposes.

Location	Field Measurements[1]	$KMnO_4$	Total Organic Carbon	CVOC[2]	Metals[3]
Phase 1 - Performance Monitoring [4]					
Observation Wells	See Phase 1 - Preventative Monitoring, below	See Phase 1 - Preventative Monitoring, below	—	—	—
Select Observation Wells			2 samples - week 1 and Week 8	2 samples - week 1 and Week 8	2 samples - week 1 and Week 8
On-Site Area: MW-1, MW-4 MW-6, MW-7,MW-8S, MW-8M,MW-13			2 samples - week 1 and Week 8	2 samples - week 1 and Week 8	2 samples - week 1 and Week 8
On-Site Area: MW-5, RW-4 and recovery wells			—	—	—
Off-Site Area: EPI-MW-1S/1D			—	—	—
Phase 1 - Performance/Preventative Monitoring [5]					
Select Observation Wells	daily - for 7 days (during injection), weekly for 4 weeks	daily - for 7 days (during injection), weekly for 4 weeks	—	biweekly for 8 weeks	—
On-Site Area: MW-1, MW-4 MW-6, MW-7,MW-8S, MW-8M,MW-13	daily - for 7 days (during injection), weekly for 4 weeks	daily - for 7 days (during injection), weekly for 4 weeks	—	biweekly for 8 weeks	—
On-Site Area: Recovery wells	daily - for 7 days (during injection), weekly for 4 weeks	daily - for 7 days (during injection), weekly for 4 weeks	—	—	—
Off-Site Area: EPI-MW-1S/1D	daily - for 7 days (during injection), weekly for 4 weeks	daily - for 7 days (during injection), weekly for 4 weeks	—	—	—
Phase 2 - Performance Monitoring [4]					
Observation Wells	See Phase 2 - Preventative Monitoring, below	See Phase 2 - Preventative Monitoring, below	—	—	—
Select Observation Wells			2 samples -start and middle of Phase 2	2 samples -start and middle of Phase 2	2 samples -start and middle of Phase 2
On-Site Area: MW-1, MW-4 MW-6, MW-7, MW-13,MW-8S, MW-8M			2 samples -start and middle of Phase 2	2 samples -start and middle of Phase 2	2 samples -start and middle of Phase 2
On-Site Area: MW-5, RW-4 and recovery wells			—	—	—
Off-Site Area: MW-11, MW-14M/D, MW-15M/D, MW-21S, MW-16M/D			2 samples -start and middle of Phase 2	2 samples -start and middle of Phase 2	2 samples -start and middle of Phase 2
EPI-MW-2D, EPI-MW-4S/4D			2 samples -start and middle of Phase 2	2 samples -start and middle of Phase 2	2 samples -start and middle of Phase 2
Off-Site Area: MW-17D/M and EPI-MW-1S/1D			—	—	—
Phase 2- Performance/Preventative Monitoring [5]					
Observation Wells	daily - for 7 days (during injection), biweekly for 6	daily - for 7 days (during injection), biweekly for 6	—	—	—
On-Site Area: MW-1, MW-4 MW-6, MW-7,MW-8S, MW-8M,MW-13	daily - for 7 days (during injection), biweekly for 6	daily - for 7 days (during injection), biweekly for 6	—	biweekly for 4 weeks, monthly for 2 months	—
On-Site Area: Recovery wells	daily - for 7 days (during injection), biweekly for 6	daily - for 7 days (during injection), biweekly for 6	—	—	—
Off-Site Area: EPI-MW-1S/1D	daily - for 7 days (during injection), biweekly for 6	daily - for 7 days (during injection), biweekly for 6	—	—	—

Appendix C-1 Example Active Monitoring Frequency
This example is only provided for discussion purposes.

Location	Field Measurements[1]	$KMnO_4$	Total Organic Carbon	CVOC[2]	Metals[3]
Phase 3 - Performance Monitoring [4]					
Observation Wells	See Phase 3 - Preventative Monitoring, below	See Phase 3 - Preventative Monitoring, below	—	—	—
Select Observation Wells			2 samples -start and middle of Phase 3	2 samples -start and middle of Phase 3	2 samples -start and middle of Phase 3
On-Site Area: MW-1, MW-4 MW-6, MW-7, MW-13,MW-8S, MW-8M			2 samples -start and middle of Phase 3	2 samples -start and middle of Phase 3	2 samples -start and middle of Phase 3
On-Site Area: MW-5, RW-4 and recovery wells			—	—	—
Off-Site Area: MW-11, MW-14M/D, MW-15M/D, MW-21S, MW-16M/D			2 samples -start and middle of Phase 3	2 samples -start and middle of Phase 3	2 samples -start and middle of Phase 3
EPI-MW-2D, EPI-MW-4S/4D			2 samples -start and middle of Phase 3	2 samples -start and middle of Phase 3	2 samples -start and middle of Phase 3
Off-Site Area: MW-17D/M and EPI-MW-1S/1D			—	—	—
Phase 3- Performance/Preventative Monitoring [5]					
Preventative Monitoring is reduced during this phase inconsideration of the data collected during Phase 1 and 2, and the reduced total concentrations					
Observation Wells	daily - for 7 days (during injection)	daily - for 7 days (during injection), biweekly for 6	—	—	—
On-Site Area: MW-1, MW-4 MW-6, MW-7,MW-8S, MW-8M,MW-13	daily - for 7 days (during injection), biweekly for 6	daily - for 7 days (during injection), biweekly for 6	—	monthly for 2 months	—
On-Site Area: Recovery wells	daily - for 7 days (during injection), biweekly for 6	daily - for 7 days (during injection), biweekly for 6	—	—	—
Off-Site Area: EPI-MW-1S/1D	daily - for 7 days (during injection), biweekly for 6	daily - for 7 days (during injection), biweekly for 6	—	—	—

Notes:

1. Field measurements include specific conductivity, pH, oxidation/ reduction potential, temperature, dissolved oxygen, turbidity, and visual observation of color ($KMnO_4$)

2. CVOC list includes 1,1-Dichloro-ethylene, cis-1,2-Dichloro-ethylene, Tetrachloro-ethylene, Trichloro-ethylene, 1,1,1-Trichloro-ethane, Vinyl Chloride. Locations which are pink or purple in color, indicating $KMnO_4$ is present, will not be sampled. Field Measurements will be collected during sampling. Low flow sampling procedures consistent with previous sampling events will be used.

3. Metals include potassium, iron, manganese, arsenic; (total and dissolved)

4. Performance monitoring - is intended to focus on data collection specific to the remedy design
Monitoring - all monitoring data will be used in conjunction to determine the overall effectiveness of the remedial design.

5. Preventative monitoring - is intended to focus on collecting additional data to track the plume and groundwater movement.
Monitoring - all monitoring data will be used in conjunction to determine the overall effectiveness of the remedial design.

Appendix C - Table C-2 Example Active Monitoring Frequency - Well Screen Information
This example is only provided for discussion purposes.

	TOC Elevation[1]	Total Well Depth (feet - TOC PVC)[2]	Elevation of Well Depth (feet)	Elevation to Top of Screen (feet)	Elevation to Bottom of Screen (feet)	Screen Length (feet)
MW-1	18.38	15.5	2.9	12.9	2.9	10
MW-2	18.22	15.3	2.9	12.9	2.9	10
MW-3	16.87	15.5	1.4	11.4	1.4	10
MW-4	19.54	16.6	2.9	12.9	2.9	10
MW-5	17.92	18.6	-0.7	14.3	-0.7	15
MW-6	17.74	18.4	-0.7	14.3	-0.7	15
MW-7	20.38	18.7	1.7	16.7	1.7	15
MW-8S	17.58	18.9	-1.3	13.7	-1.3	15
MW-8M	17.14	30.0	-12.9	-2.9	-12.9	10
MW-9	16.56	18.8	-2.2	12.8	-2.2	15
MW-10	17.44	14.6 [2]	2.8	12.8	2.8	10
MW-11	17.49	18.9	-1.4	13.6	-1.4	15
MW-12	17.75	19.0	-1.3	13.8	-1.3	15
MW-13	18.38	19.0	-0.6	14.4	-0.6	15
MW-14M	17.38	29.6	-12.2	-2.2	-12.2	10
MW-14D	16.90	54.7	-37.8	-27.8	-37.8	10
MW-15M	16.95	29.7	-12.8	-2.8	-12.8	10
MW-15D	16.62	54.7	-38.1	-28.1	-38.1	10
MW-16M	16.68	29.7	-13.0	-3.0	-13.0	10
MW-16D	16.55	54.6	-38.1	-28.1	-38.1	10
MW-17M	17.74	29.9	-12.2	-2.2	-12.2	10
MW-17D	17.80	54.8	-37.0	-27.0	-37.0	10
MW-18M	15.76	29.8	-14.0	-4.0	-14.0	10
MW-18D	15.55	54.9	-39.4	-29.4	-39.4	10
MW-19M	17.65	29.1	-11.5	-1.5	-11.5	10
MW-20M	17.63	29.6	-11.9	-1.9	-11.9	10
MW-21S	17.09	16.0	1.1	-2.9	1.1	10

Notes:

1 Survey elevations based on Mean Lower Low Water NAVD 88 DATUM.
2 Total well depths as measured.
3 Required pump inlet depth based on placing pump inlet midway between the low water level and the bottom of the well (as measured).
4 Observation wells - see Figure 5-6 for screen intervals.

Appendix D

Calculation of Cleanup Levels

Appendix D
Calculation of Cleanup Levels

1.0 Introduction

This Appendix provides the equations used in calculating groundwater cleanup levels for a construction/trench worker potentially exposed via incidental ingestion, dermal contact, and inhalation of volatiles in ambient air. The equations for calculating intake factors and cleanup levels presented here are derived using guidance from USEPA's *Risk Assessment Guidance for Superfund (RAGS) Part A,* Section 6.6 (U.S. EPA, 1989) and RAGS *Part B, Development of Risk-Based Preliminary Remediation Goals* (U.S. EPA, 1991). Although presented in a slightly different manner, these equations are similar to those presented in Washington State's Department of Ecology's *Cleanup Levels and Risk Calculation under the Model Toxics Control Act Cleanup Regulation* (CLARC) and the outcome is essentially the same (Ecology, 2001).

1.1 Calculation of Intake Factors

Intake Factors (IFs) related to media-specific exposure pathways consider the frequency at which a receptor is expected to contact a particular medium, the duration of the contact, and the mechanisms that enable the chemical to be potentially assimilated by the receptor. Note, exposure assumptions for the construction worker are provided in Table 3-3 of the main report. The rest of this section presents the pathway-specific IF equations for groundwater.

1.1.1 Groundwater

The intake factor for ingestion of groundwater exposure route is generally calculated with Equation 1:

$$IF_{w-ing} = \frac{IR * EF * ED}{BW * AT * 365 days / year} \qquad (1)$$

where:

$IF_{w\text{-}ing}$	=	Ingestion intake factor (L groundwater/ kg BW-day)
IR	=	Ingestion rate for groundwater (L/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Average body weight of the receptor (kg)
AT	=	Averaging time of the exposure (years), 70 years for carcinogens and equal to the ED for noncarcinogens

The intake factor for dermal contact with groundwater exposure route is generally calculated with Equation 2:

$$IF_{w-derm} = \frac{BSAE * ET * EF * ED * Kp * CF}{BW * AT * 365 days / year} \quad (2)$$

where:

$IF_{w\text{-}derm}$	=	Dermal intake factor (L groundwater/kg BW-day)
BSAE	=	Surface area of the body parts exposed (cm^2)
ET	=	Exposure time (hr/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
Kp	=	Permeability Constant (cm/hr)
CF	=	Conversion factor (10^{-3} L/cm^3)
BW	=	Average BW of the receptor (kg)
AT	=	Averaging time of the exposure (years), 70 years for carcinogens and equal to the ED for noncarcinogens

The intake factor for the inhalation of volatiles from groundwater exposure route is calculated with Equation 3:

$$IF_{w-inhal} = \frac{((IR * ET)/20) * EF * ED}{AT * 365 days / year} * VF \quad (3)$$

where:

$IF_{w\text{-}inhal}$	=	Inhalation intake factor (L/m^3)
IR	=	Inhalation rate (m^3/hr)
ET	=	Exposure time (hr/day)
20	=	standard default adult inhalation rate, 20 m^3/day
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time of the exposure (years), 70 years for carcinogens and equal to the ED for noncarcinogens
VF	=	Volatilization Factor for volatile groundwater COPC (L/m^3)

The VF applied for inhalation of groundwater volatiles in ambient air is based on the upper-bound Andelman constant of 0.5 L/m^3 discussed in RAGS Part B (U.S. EPA, 1991; 2004). Use of this value for the construction worker scenario is conservative because it is based on inhalation of volatiles emanating from groundwater during residential uses (i.e., household uses such as showering, laundering, and dish washing) where the conditions are different than those encountered while working in a trench.

1.2 Methodology for Calculation of Cleanup Levels

The methodology for calculating noncancer and cancer cleanup levels is presented below. Toxicity values for COCP are provided in Table 3-4 of the main report. Cleanup levels can then be compared to site data on a point-by point basis or through use of area-wide average concentrations. Note, for COPC where both noncancer and cancer endpoints are present, the lower cleanup level is selected for comparison to site data.

1.2.1 Cleanup Levels for Non-carcinogenic Compounds

The noncancer CL for ingestion is presented below.

$$CL_{ing-nc} = \frac{THI}{IF_{ing} / RfD_{oral}} \tag{4}$$

where:

$CL_{ing\text{-}nc}$	=	Cleanup level for ingestion, noncancer effects (mg/L)
THI	=	Target hazard index (unitless) = 1
IF_{ing}	=	Ingestion Intake Factor (L-water/kg-BW-day)
RfD_{oral}	=	Oral Reference Dose (mg/kg-day)

The noncancer CL for dermal contact is presented below.

$$CL_{der-nc} = \frac{THI}{IF_{der} / RfD_{dermal}} \tag{5}$$

where:

$CL_{der\text{-}nc}$	=	Cleanup level for dermal contact, noncancer effects (mg/L)
THI	=	Target hazard index (unitless) = 1
IF_{der}	=	Dermal Intake Factor (L-water/kg-BW-day)
RfD_{dermal}	=	Dermal Reference Dose (mg/kg-day)

The noncancer CL for inhalation of volatiles in air is presented below.

$$CL_{inh-nc} = \frac{THI}{IF_{inh} / RfC_{inh}} \tag{6}$$

where:

CL_{inh-nc}	=	Cleanup level for inhalation, noncancer effects (mg/L)
THI	=	Target hazard index (unitless) = 1
IF_{inh}	=	Inhalation Intake Factor (L/m^3)
RfC_{inh}	=	Inhalation Reference Concentration (mg/m^3)

1.2.2 Cleanup Levels for Carcinogenic Compounds

The carcinogenic acceptable target risk level (TRL) is set to $1x10^{-6}$.

The carcinogenic CL for ingestion is presented below.

$$CL_{ing-c} = \frac{TRL}{IF_{ing} * CSF_{oral}} \tag{7}$$

where:

CL_{ing-c}	=	Cleanup level for ingestion, cancer effects (mg/L)
TRL	=	Target risk level (unitless) = 10^{-6}
IF_{ing}	=	Ingestion Intake Factor (L-water/kg-BW-day)
CSF_{oral}	=	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$

The carcinogenic CL for dermal contact is presented below.

$$CL_{der-c} = \frac{TRL}{IF_{der} * CSF_{dermal}} \tag{8}$$

where:

CL_{der-c}	=	Cleanup level for dermal contact, cancer effects (mg/L)
TRL	=	Target risk level (unitless) = 10^{-6}
IF_{der}	=	Dermal Intake Factor (L-water/kg-BW-day)
CSF_{dermal}	=	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$

The carcinogenic CL for inhalation of volatiles in air is presented below.

$$CL_{inh-c} = \frac{TRL}{IF_{inh} * UR_{inh} * CF} \tag{9}$$

where:

CL_{inh-c}	=	Cleanup level for inhalation, cancer risk (mg/L)
TRL	=	Target Risk Level (unitless) = 10^{-6}
IF_{inh}	=	Inhalation intake factor (L/m^3)

UR_{inh} = Inhalation Unit Risk $(\mu g/m^3)^{-1}$
CF = Conversion Factor (1,000 μg/mg)

1.2.3 Cleanup Levels for all Pathways Combined

The equation used to calculate the final CL that combines all exposure pathways for noncarcinogenic and carcinogenic compounds is presented below:

Combined CL:

$$CL_{comb} = \frac{1}{\frac{1}{CL_{ing}} + \frac{1}{CL_{der}} + \frac{1}{CL_{inh}}} \qquad (10)$$

where:

CL_{comb}= Combined cleanup level, (mg/L)
CL_{ing}= Cleanup level, ingestion pathway, (mg/L)
CL_{der}= Cleanup level, dermal pathway, (mg/L)
CL_{inh}= Cleanup level, inhalation pathway, (mg/L)

Groundwater cleanup levels for the construction worker are presented in Table 3-5 of the main report.

References

Ecology, 2001. *Cleanup Levels and Risk Calculations under the Model Toxics Control Act.* Cleanup Regulation (CLARC) Version 3.1. Washington State Department of Ecology Toxics Cleanup Program. Publication No. 94-145. Updated November 2001.

U.S. EPA, 1989. *Risk Assessment Guidance for Superfund, Volume I – Human Health Evaluation Manual (Part A)*. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December 1989.

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U.S. EPA, 2004. *Region 9 Preliminary Remediation Goals.* San Francisco, California. On-line database. U.S. Environmental Protection Agency. October 2004.