



STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000
711 for Washington Relay Service • Persons with a speech disability can call (877) 833-6341

August 21, 2020

Thomas Markl
Nelson Group Properties LLC
16508 NE 79th Street
Redmond, WA 98052
tommarkl@nelrem.com

Re: No Further Action at the following Site:

- **Site Name:** Cleaning Center of Redmond
- **Site Address:** 15796 Redmond Way, Redmond, WA 98052
- **Facility/Site No.:** 26296554
- **Cleanup ID No.:** 4147
- **VCP Project No.:** NW3166

Dear Thomas Markl:

The Washington State Department of Ecology (Ecology) received your request for an opinion on your independent cleanup of the **Cleaning Center of Redmond** facility (Site). This letter provides our opinion. We are providing this opinion under the authority of the Model Toxics Control Act (MTCA), Chapter 70.105D RCW.

Issue Presented and Opinion

Is further remedial action necessary to clean up contamination at the Site?

NO. Ecology has determined that no further remedial action is necessary to clean up contamination at the Site.

This opinion is based on an analysis of whether the remedial action meets the substantive requirements of MTCA, Chapter 70.105D RCW, and its implementing regulations, Chapter 173-340 WAC (collectively “substantive requirements of MTCA”). The analysis is provided below.

Description of the Site

This opinion applies only to the Site described below. The Site is defined by the nature and extent of contamination associated with the following release:

- Tetrachloroethene (PCE) into the Soil.
- PCE into the Ground Water.
- PCE into Soil Vapor and Indoor Air.

Enclosure A includes a detailed description and diagram of the Site, as currently known to Ecology.

Please note that a parcel of real property can be affected by multiple sites. At this time, we have no information that the parcel(s) associated with this Site are affected by other sites.

Basis for the Opinion

This opinion is based on the information contained in the following documents:

1. Farallon Consulting, Technical Memorandum to support Revised CAR, *Former Cleaning Center of Redmond; 15796 Redmond Way, Redmond, Washington; VCP No. NW3166;* dated January 3, 2019.
2. Farallon Consulting, *Response to Request for Additional Information; Former Cleaning Center of Redmond; 15796 Redmond Way, Redmond, Washington; VCP No. NW3166;* dated May 23, 2018.
3. Farallon Consulting, *Site Closure Report Addendum; Former Cleaning Center of Redmond; 15796 Redmond Way, Redmond, Washington;* dated April 26, 2017.
4. Farallon Consulting, *Email Response to Ecology (L Bardy), Former Cleaning Center of Redmond; VCP No. NW1324, 15796 Redmond Way, Redmond, Washington;* dated September 9, 2016.
5. WA Department of Ecology, L Bardy Email to Farallon, *Former Cleaning Center of Redmond; VCP No. NW1324, 15796 Redmond Way, Redmond, Washington;* dated September 1, 2016.
6. WA Department of Ecology, *Confirmational Monitoring Successfully Completed, Cleaning Center of Redmond VCP No. NW1324; 15796 Redmond Way, Redmond, Washington;* dated June 13, 2016.
7. WA Department of Ecology, *No Further Action at a Property Associated with a Site, Cleaning Center of Redmond; 15796 Redmond Way VCP No. NW1324, Redmond, Washington;* dated April 1, 2011.

This opinion is based on the information contained in the documents listed this opinion letter. Those documents are kept in the Central Files of the Northwest Regional Office of Ecology (NWRO) for review by appointment only. You can submit a public records request by creating an account at Public Records Request Center. If you require assistance with this process, you may contact the Public Records Officer at publicrecordsofficer@ecy.wa.gov or 360-407-6040. A number of these documents are accessible in electronic form from the Site web page <https://apps.ecology.wa.gov/gsp/Sitepage.aspx?csid=4147>.

This opinion is void if any of the information contained in those documents is materially false or misleading.

Analysis of the Cleanup

Ecology has concluded that **no further remedial action** is necessary to clean up contamination at the Site. That conclusion is based on the following analysis:

1. Characterization of the Site.

Ecology has determined your characterization of the Site is sufficient to establish cleanup standards and select a cleanup action. The Site is described above and in **Enclosure A**.

2. Establishment of cleanup standards.

Ecology has determined the cleanup levels and points of compliance you established for the Site meet the substantive requirements of MTCA.

Soil Cleanup Standards:

The Site does not meet the MTCA definition of an industrial property; therefore, soil cleanup levels suitable for unrestricted land use are appropriate. For unrestricted land use, through protection of direct contact, and protection of leaching to groundwater, either MTCA Method A or Method B cleanup levels can be used.

The MTCA Method A soil cleanup levels for PCE (0.05 milligrams per kilogram; mg/kg) has been selected.

The following potential exposure/risk pathways are appropriate to consider:

- Human health protection from direct soil contact pathway exposure.
- Human health protection from soil-to-air pathway exposure.
- Terrestrial ecological protection.

Soil cleanup levels protective of terrestrial ecological receptors are not necessary because the Site meets the initial Terrestrial Ecological Evaluation (TEE) exclusion criteria (WAC 173-340-7491(1)(c)(i)). There are less than 1.5 acres of contiguous undeveloped land on or within 500 feet of the area of the Site. The TEE form submitted with the March 14, 2019 *RI/FS Report* was accepted by Ecology.

For soil cleanup levels based on the protection of ground water, the point of compliance is defined as Site wide throughout the soil profile and may extend below the water table. This is the appropriate point of compliance for the Site.

Ground Water Cleanup Standards:

Ground water below the Site is considered potable. The following potential exposure/risk pathways were appropriate to consider:

- Human health protection from drinking groundwater pathway exposure.
- Human health protection from vapor intrusion from groundwater to indoor air pathway.
- Human health and ecological protection from discharge of ground water to surface water (the Sammamish River); see **Enclosure A, Figures 2 and 3**.

The MTCA Method A ground water cleanup levels (5 micrograms per liter; ug/l) has been selected.

Per the Ecology Cleanup Levels and Risk Calculation (CLARC) database, the lowest applicable cleanup level is PCE in surface water is 2.4 µg/L, the human health fresh water cleanup level from 40 CFR 131.45, "Revision of Certain Federal Water Quality Criteria Applicable to Washington."

The point of compliance for ground water is defined as throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the Site. This is the appropriate point of compliance for the Site.

Air Cleanup Standards:

Cleanup levels for air are based on protection of human health. The MTCA Method B indoor air cleanup levels for PCE are the appropriate choice (MTCA Method A values do not exist).

The standard point of compliance for air is in ambient and indoor air throughout the Site.

3. Selection of cleanup action.

Ecology has determined the cleanup action you selected for the Site meets the substantive requirements of MTCA.

PCE was released from the historical dry cleaning machine at the former Cleaning Center of Redmond facility. The PCE migrated through the building foundation into shallow groundwater. Dissolved-phase PCE migrated with the flow of groundwater off the Property to the northwest. Contaminated soil was over-excavated and removed from the Site. A soil vapor extraction (SVE) remediation system was installed in 2003 to address concentrations of PCE in soil and groundwater. The SVE system operated until 2006. Soil and groundwater monitoring data was collected on a scheduled basis from 2003 to 2007 and demonstrated that the SVE remediation system was effective in removing PCE in soil and groundwater to concentrations below MTCA Method A cleanup levels. Indoor air sampling was conducted in 2007 and 2010 in building spaces in overlying the contaminate plum, to assess potential vapor issues. The results showed concentrations below state cleanup levels.

As the Site was also defined by the release of PCE to groundwater migrating off-Property to the northwest toward the Sammamish River, additional sampling and analysis has been conducted. Also, an empirical demonstration was conducted in 2018. The computer model confirmed that any remaining PCE in soil or groundwater (below cleanup standards) will not result in future exceedances of the groundwater cleanup levels for the Site under MTCA, and does not pose a potential future risk to human health or the environment. The groundwater modeling was conducted by using the U.S. Environmental Protection Agency BIOCHLOR groundwater model. This analytical fate and transport model simulates one-dimensional advection, three-dimensional dispersion, linear adsorption, and reductive dechlorination with or without decay. Ecology concurred with the modeling results, which are consistent with an independent Ecology evaluation (**Enclosure A, Description and Diagrams of the Site**).

4. Cleanup.

Ecology has determined the cleanup you performed meets the cleanup standards established for the Site.

The groundwater modeling shows the PCE concentrations in groundwater will remain less than the MTCA Method A groundwater cleanup level, and will continue to attenuate over time. Residual PCE concentrations in soil and groundwater throughout the Site are less than the MTCA Method A cleanup levels.

The selected action meets applicable minimum requirements for cleanup actions stipulated in WAC 173-340-360: protect human health and the environment, comply with cleanup standards, use permanent solutions, and provide for reasonable restoration time.

Listing of the Site

Based on this opinion, Ecology will initiate the process of removing the Site from our lists of hazardous waste sites, including:

- Hazardous Sites List (which requires a 30-day comment period)
- Confirmed and Suspected Contaminated Sites List

Decommissioning of Site Resource Protection Wells

When resource protection wells associated with the Site are no longer to be used for their intended purposes, these wells must be decommissioned in accordance with WAC 173-160-460 (<http://apps.leg.wa.gov/wac/default.aspx?cite=173-160-460>). Per WAC 173-160-410 (<http://apps.leg.wa.gov/wac/default.aspx?cite=173-160-410>), resource protection wells include monitoring wells, observation wells, piezometers, spill response wells, remediation wells, environmental investigation wells, vapor extraction wells, ground source heat pump boring, grounding wells, and instrumentation wells.

Limitations of the Opinion

1. Opinion does not settle liability with the state.

Liable persons are strictly liable, jointly and severally, for all remedial action costs and for all natural resource damages resulting from the release or releases of hazardous substances at the Site. This opinion **does not**:

- Resolve or alter a person's liability to the state.
- Protect liable persons from contribution claims by third parties.

To settle liability with the state and obtain protection from contribution claims, a person must enter into a consent decree with Ecology under RCW 70.105D.040(4).

2. Opinion does not constitute a determination of substantial equivalence.

To recover remedial action costs from other liable persons under MTCA, one must demonstrate that the action is the substantial equivalent of an Ecology-conducted or Ecology-supervised action. This opinion does not determine whether the action you performed is substantially equivalent. Courts make that determination. *See* RCW 70.105D.080 and WAC 173-340-545.

3. State is immune from liability.

The state, Ecology, and its officers and employees are immune from all liability, and no cause of action of any nature may arise from any act or omission in providing this opinion. *See* RCW 70.105D.030(1)(i).

Termination of Agreement

Thank you for cleaning up the Site under the Voluntary Cleanup Program (VCP). This opinion terminates the VCP Agreement governing this project (VCP # NW3166).

For more information about the VCP and the cleanup process, please visit our web site: www.ecy.wa.gov/programs/tcp/vcp/vcpmain.htm. If you have any questions about this opinion or the termination of the Agreement, please contact me at 425-649-4422 or gcar461@ecy.wa.gov.

Sincerely,



Glynis A. Carrosino, Project Manager
Ecology NWRO Toxics Cleanup Program

Enclosures (1): A – Description and Diagram of the Site

cc: Brani Jurista, Farallon Consulting, bjurista@farallonconsulting.com
Clifford Schmitt, Farallon Consulting, schmitt@farallonconsulting.com
Sonia Fernandez, VCP Coordinator, Ecology, sonia.fernandez@ecy.wa.gov
Tra Thai, VCP Financial Manager, Ecology, tra.thai@ecy.wa.gov

Enclosure A

Description and Diagrams of the Site

Site Description

This section provides Ecology's understanding and interpretation of Site conditions, and is the basis for the opinions expressed in the body of the letter.

Site: The Site is defined by the release of tetrachloroethene (PCE) to soil, ground water, and soil vapor associated with the use of a former dry cleaning machine at the Cleaning Center of Redmond. The Site is located at 15796 Redmond Way in Redmond, Washington (Property). **(Figure 1).**

Area and Property Description: The Property consists of one King County tax parcel (number 719890-0080) and is approximately 6.93 acres in size. A strip mall currently occupies the Property and is bordered on the west by 158th Avenue South, on the east by 160th Avenue Northeast, on the south by Redmond Way Northeast, and on the north by a parking lot and NE 83rd Street. Land use surrounding the Site includes commercial businesses, residential apartments and condominiums. **(Figure 2).**

Property History and Current Use: According to King County Assessor records, the single-story strip mall (three, single-story commercial buildings of masonry construction) was constructed in various stages from 1966 through the early 1980's. A significant expansion occurred near the western end of the strip mall building in 2002. Asphalt-paved areas with landscaping strips are located north and south of the building. A new building was constructed on the southeastern portion of the Property in 2009. The building houses commercial businesses. The Cleaning Center of Redmond continues to occupy the tenant space at 15796 Redmond Way.

Contaminant Source: The source of contamination on the Property was the former dry cleaning machine which used the dry cleaning solvent PCE **(Figure 4)**. A release occurred in the vicinity of the dry cleaning machine and was documented in 1999. PCE use was disconnected in 2002.

Physiographic Setting: The Property is located within the Puget Lowland physiographic province, a broad, low-lying region situated between the Cascade Range to the east and the Olympic Mountains to the west. The Property is at an elevation between approximately 40 feet above mean sea level (amsl) and is relatively flat. The Property slopes to the west.

Surface/Storm Water System: The Site begins at the Former Cleaning Center of Redmond and continues west to the Sammamish River. The river is approximately 600 feet west of the Property **(Figure 2)**.

Ecological Setting: The Property is covered with a building (single-story, commercial strip mall of masonry construction). Land surrounding the Site is primarily covered with buildings, asphalt and concrete with small landscaped areas.

Geology: The Property is underlain by Quaternary sediments deposited during glacial episodes. The regional sediments consist primarily of interlayered and/or sequential deposits of alluvial

clays, silts, and sands that are typically situated over deposits of glacial till that consist of silty sand to sandy silt with gravel. Outwash sediments consisting of sands, silts, clays, and gravels were deposited by rivers, streams, and post-glacial lakes during the glacial retreats.

Shallow soil encountered during subsurface investigation activities in the vicinity of the Site consisted primarily of sand and gravel, with the exception of soil encountered northwest of the northern commercial building (**Figure 3**). The shallow soil in this location included a layer of silt and peat from approximately 2.5 to 8 feet below the ground surface (bgs). Underlying the silt and peat was sand and gravel consistent with the other boring locations.

Ground Water: The shallow aquifer is unconfined and extends to a minimum of 70 feet bgs at the Site, based on the deep boring assessment conducted in 2006 (**Figure 3**). Groundwater levels measured at the Site in 2007 ranged from 9.62 to 11.99 feet below the top of the well casings. The estimated groundwater flow direction consistently been to the northwest toward the Sammamish River (**Figure 2**). Groundwater elevations calculated from the monitoring well gauge data indicate that the potentiometric surface of the unconfined aquifer is at a similar elevation as the surface of the Sammamish River, suggesting that they are hydrologically connected (**Figure 3**).

Water Supply: Redmond Public Utilities provides drinking water to this strip mall and obtains water supply from City wellfields and an intertie with the City of Seattle supply pipeline from the Tolt Reservoir. The Site is located in the City of Redmond Critical Aquifer Recharge Area 1 (CARA 1), within the 1-year time-of-travel zone to City supply wells.

Release and Extent of Soil and Ground Water Contamination:

PCE was released from the historical dry cleaning machine at the former Cleaning Center of Redmond facility. The PCE migrated through the building foundation into shallow groundwater. Dissolved-phase PCE migrated with the flow of groundwater off the Property to the northwest.

An SVE remediation system was installed in 2003 to address concentrations of PCE in soil and groundwater. Soil and groundwater monitoring data was collected on a scheduled basis from 2003 to 2007 and demonstrated that the SVE remediation system was effective in removing PCE in soil and groundwater to concentrations below MTCA Method A cleanup levels (**Figures 4 and 2, respectively**).

Indoor air sampling was conducted in 2007 in building spaces overlying the contaminant plume, to assess potential vapor intrusion impacts. The results showed concentrations below MTCA air cleanup levels (**Figure 5**).

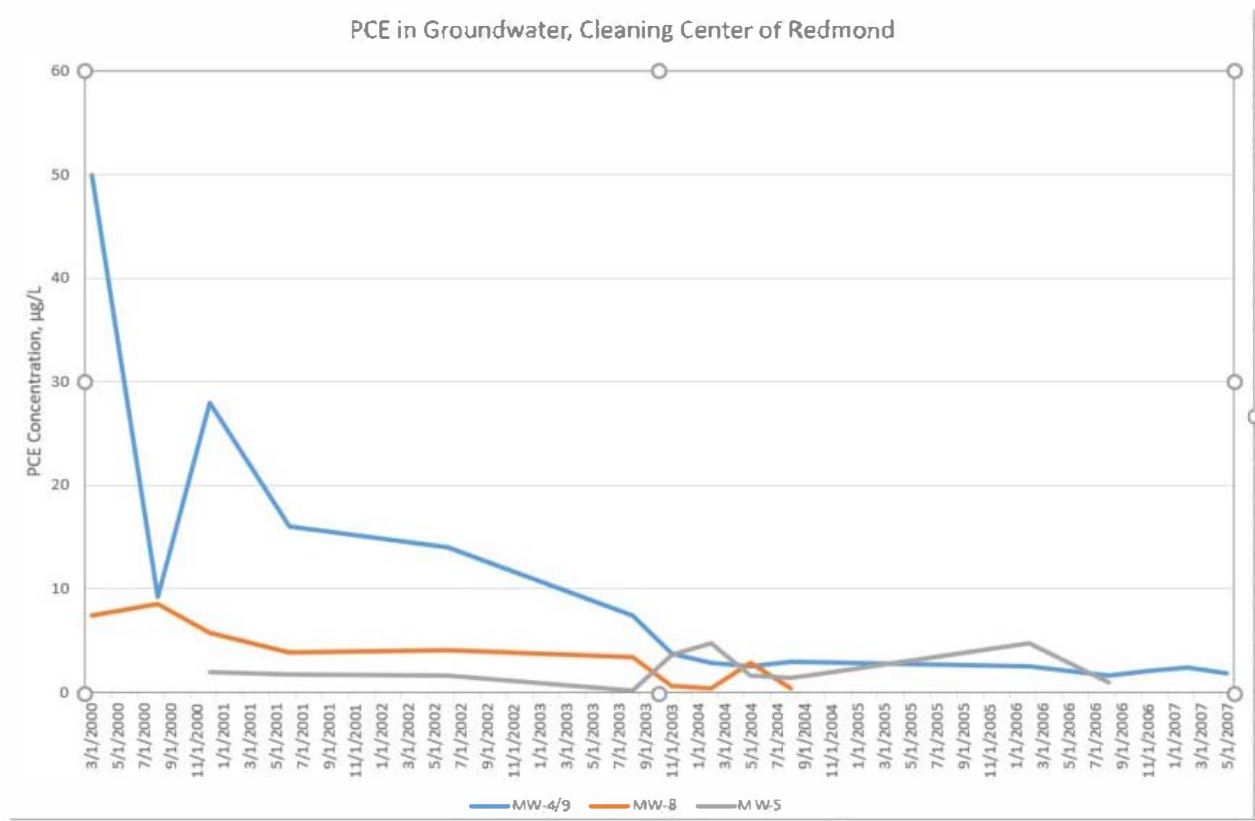
As the Site was also defined by the release of PCE to ground water migrating off-Property to the northwest, additional sampling and analysis has been conducted. An empirical evaluation was conducted, and confirmed that the PCE-contaminated ground water is no longer moving off-Property, and will not result in future exceedances of the ground water cleanup levels for the Site under MTCA (**Figures 6 and 7**).

Site ground water sampling data confirmed that breakdown of PCE into trichloroethene, dichloroethene, and vinyl chloride (reductive dechlorination by means of anaerobic biodegradation is negligible, based on the presence of these compounds at concentrations near or below laboratory detection limits).

Summary of Regulatory Correspondence:

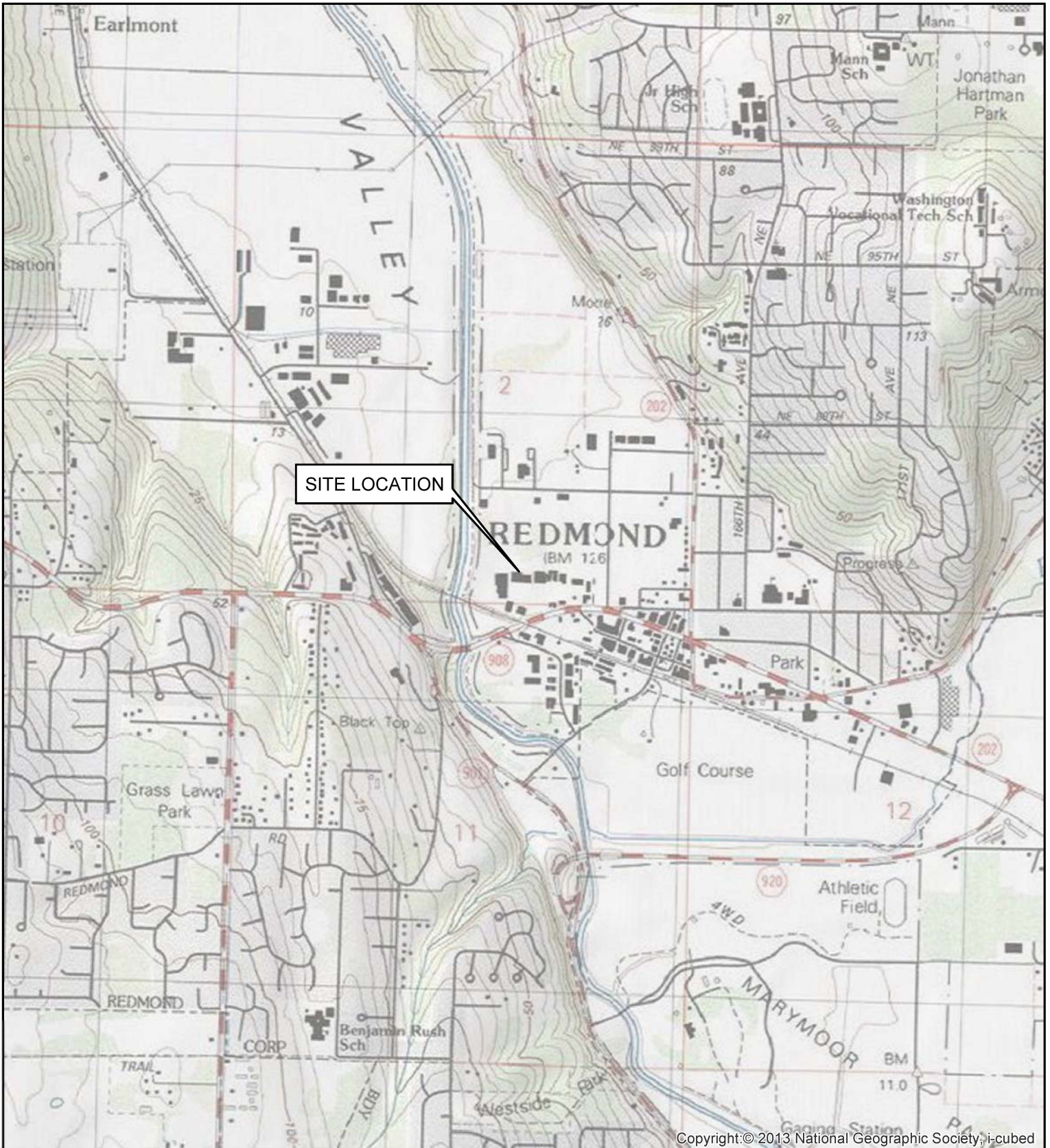
- WA Department of Ecology, Property NFA Opinion, *Cleaning Center of Redmond; 15796 Redmond Way VCP No. NW1324, Redmond, Washington*; dated April 1, 2011. Opinion regarding effectiveness of soil excavation and removal, and soil vapor extraction (SVE) cleanup action remedies.
- WA Department of Ecology, *Confirmational Monitoring Successfully Completed, Cleaning Center of Redmond VCP No. NW1324; 15796 Redmond Way, Redmond, Washington*; dated June 13, 2016. Opinion regarding confirmational indoor air monitoring to confirm the long term effectiveness of the remedy.
- Farallon letter response (dated 5/23/2018) to Ecology request for additional information.
- Ecology/Farallon meeting (10/15/2018) to provide feedback on needed supplemental information: redefined list of Site media of concern; redefined list of Site cleanup levels established under MTCA; and empirical demonstration that PCE remaining in soil and groundwater at the Site will not result in future exceedances of the ground water cleanup levels for the Site under MTCA.
- Empirical demonstration specifics:
 - The data document that no exceedances in MTCA cleanup levels exist in ground water throughout the site. An empirical demonstration (as stipulated in Ecology Implementation Memo #15) was considered. Farallon included the empirical demonstration in the next submittal.
 - Farallon reviewed the hydrogeological data provided in the City of Redmond groundwater model, including the transmissivity and seepage velocity estimations. A summary of these groundwater parameters, along with the hydraulic gradient and other pertinent hydrogeologic information, were provided in the next submittal.
 - The transmissivity and seepage velocity information could best be used in a simple groundwater model (e.g. Biochlor) to demonstrate how long it would take for the plume to attenuate once the source was removed. BIOCHLOR modeling was acceptable to Ecology as a line of evidence. Ecology recommended running the model with the following data and objectives:

- Use the 12/20/2000 PCE concentration at MW-4 (28 ug/L) as the source strength. Check model concentrations with time at downgradient MW-8 and compare with MW-8 data. A quick plot of MW-4/MW-9 and MW-8 data (see attached graph) shows the MW-4 “peak” likely appeared at MW-8 in 5-10-2004. Compare the estimated travel time indicated by the time-series plot to travel time predicted by the model.
- Use the 5/15/2007 data to evaluate model predictions through October 2018.
- Discuss the presence, fluctuations, and potential source(s) of PCE in cross-gradient/up-gradient well MW-5 (see attached graph) and potential impacts on the Site contaminant plume. Use the model to assess downgradient transport along the flow path of MW-5, MW-1, MW-2 and westward to the Sammamish River through October 2018.



Ecology also evaluated the behavior of PCE in groundwater at the Site over time, with respect to groundwater flow velocity (Figure 8). This evaluation is consistent with the empirical demonstration and modeling results.

Site Diagrams



Copyright © 2013 National Geographic Society, i-cubed

REFERENCE: 7.5 MINUTE USGS QUADRANGLE KIRKLAND, WASHINGTON, DATED 2013

Enclosure A, Figure 1



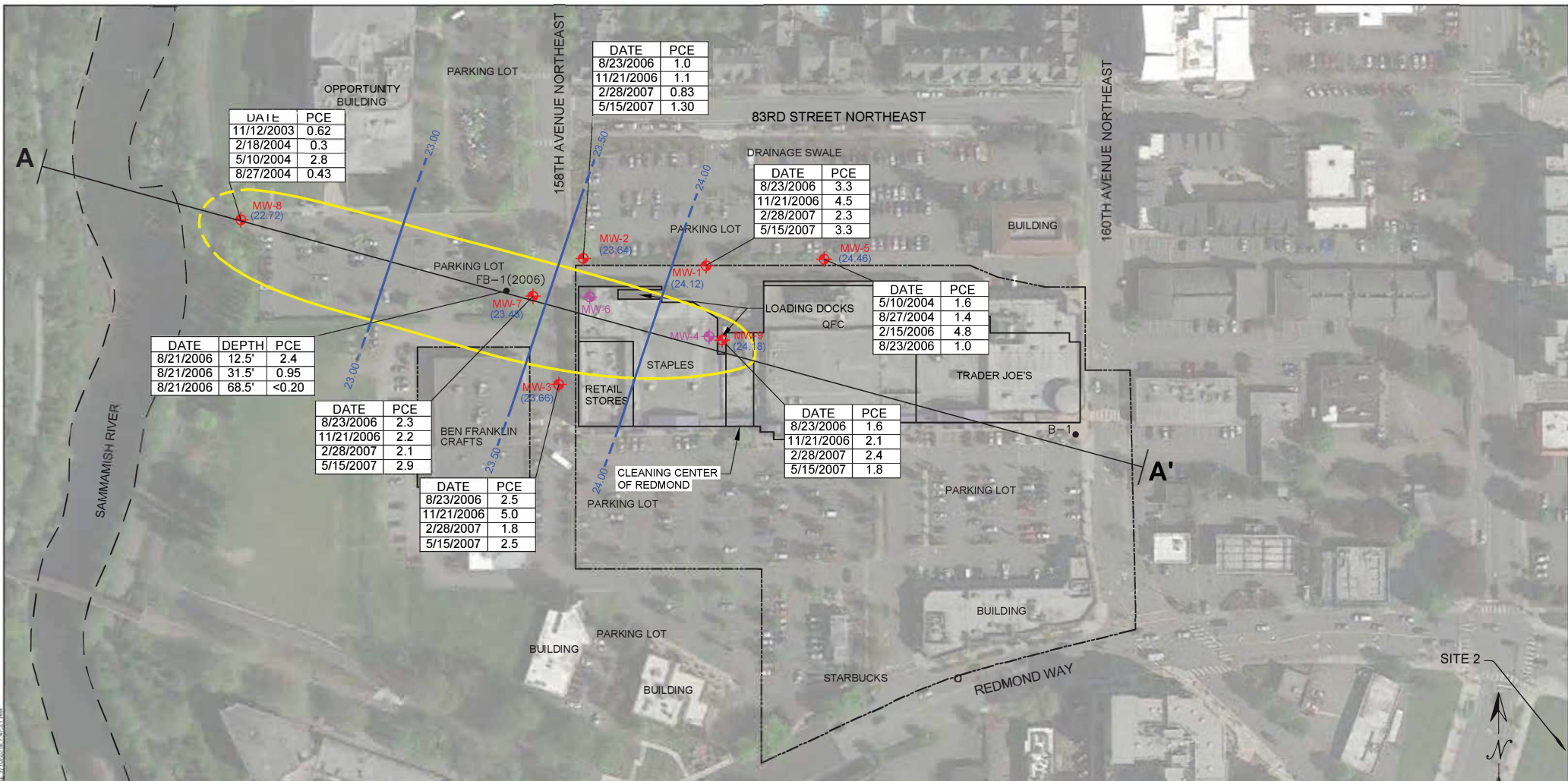

Washington
Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Folsom | Irvine

Quality Service for Environmental Solutions | farallonconsulting.com

FIGURE 1
SITE VICINITY MAP
FORMER CLEANING CENTER OF REDMOND
15796 REDMOND WAY
REDMOND, WASHINGTON
 FARALLON PN: 650-001



DATE	PCE
11/12/2003	0.62
2/18/2004	0.3
5/10/2004	2.8
8/27/2004	0.43

DATE	PCE
8/23/2006	1.0
11/21/2006	1.1
2/28/2007	0.83
5/15/2007	1.30

DATE	PCE
8/23/2006	3.3
11/21/2006	4.5
2/28/2007	2.3
5/15/2007	3.3

DATE	PCE
5/10/2004	1.6
8/27/2004	1.4
2/15/2006	4.8
8/23/2006	1.0

DATE	DEPTH	PCE
8/21/2006	12.5'	2.4
8/21/2006	31.5'	0.95
8/21/2006	68.5'	<0.20

DATE	PCE
8/23/2006	2.3
11/21/2006	2.2
2/28/2007	2.1
5/15/2007	2.9

DATE	PCE
8/23/2006	2.5
11/21/2006	5.0
2/28/2007	1.8
5/15/2007	2.5

DATE	PCE
8/23/2006	1.6
11/21/2006	2.1
2/28/2007	2.4
5/15/2007	1.8

- LEGEND**
- PROPERTY BOUNDARY
 - FORMER EXTENT OF PCE PLUME IN GROUNDWATER (SITE 1)
 - PERFORMANCE AND CONFIRMATION MONITORING WELL NETWORK (DECOMMISSIONED FOLLOWING RECEIPT OF NO FURTHER ACTION DETERMINATION)
 - MONITORING WELL (DECOMMISSIONED PRIOR TO CLEANUP DUE TO CONSTRUCTION OF NEW BUILDING)
 - BORING LOCATION
 - GROUNDWATER ELEVATION RELATIVE TO MEAN SEA LEVEL (MAY 2007)
 - GROUNDWATER ELEVATION CONTOUR (MAY 2007)
 - APPROXIMATE DIRECTION OF GROUNDWATER FLOW

LEGEND

DEPTH IN FEET BELOW GROUND SURFACE

PCE = TETRACHLOROETHENE

BOLD = INDICATE CONCENTRATIONS EXCEEDED WASHINGTON STATE MODEL TOXICS CONTROL ACT CLEANUP REGULATIONS (MTCA) METHOD A CLEANUP LEVEL

< = INDICATES ANALYTE NOT DETECTED AT CONCENTRATIONS AT OR EXCEEDING THE LABORATORY PRACTICAL QUANTITATION LIMIT

= DATE SAMPLED AND PCE CONCENTRATION IN GROUNDWATER IN MICROGRAMS PER LITER (ug/L)

ALL LOCATIONS ARE APPROXIMATE

DATE	PCE
8/23/2006	1.6

FARALLON CONSULTING

Quality Service for Environmental Solutions | farallonconsulting.com

Washington
Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Folsom | Irvine

FIGURE 2

GROUNDWATER ELEVATION CONTOURS AND PCE CONCENTRATIONS IN GROUNDWATER FORMER CLEANING CENTER OF REDMOND
15796 REDMOND WAY
REDMOND, WASHINGTON

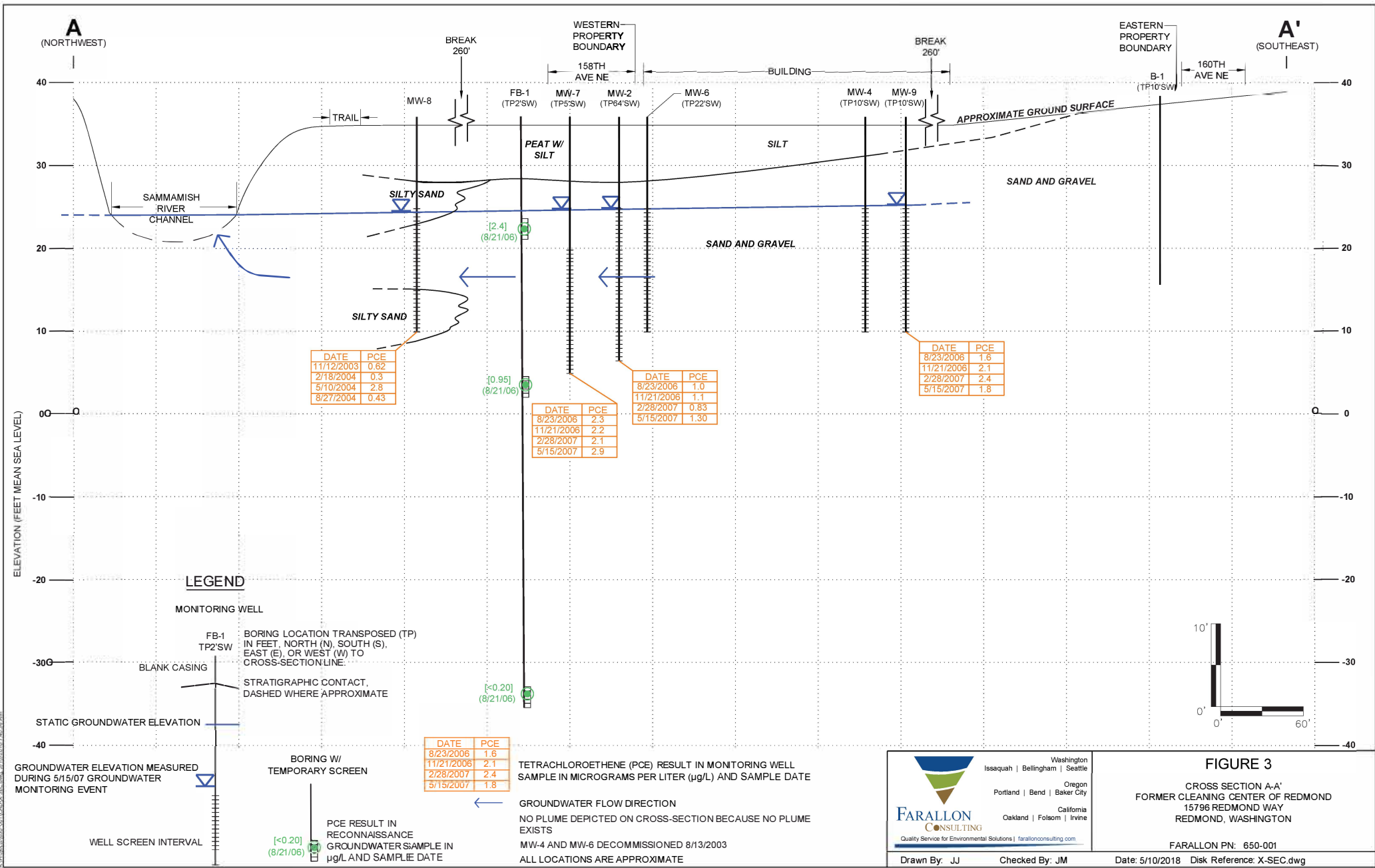
FARALLON PN: 650-001

Date: 5/10/2018 Disk Reference: 650-001_00.dwg

Drawn By: JJ

Checked By: JM

Enclosure A, Figure 2



Enclosure A, Figure 3

Enclosure A, Figure 4

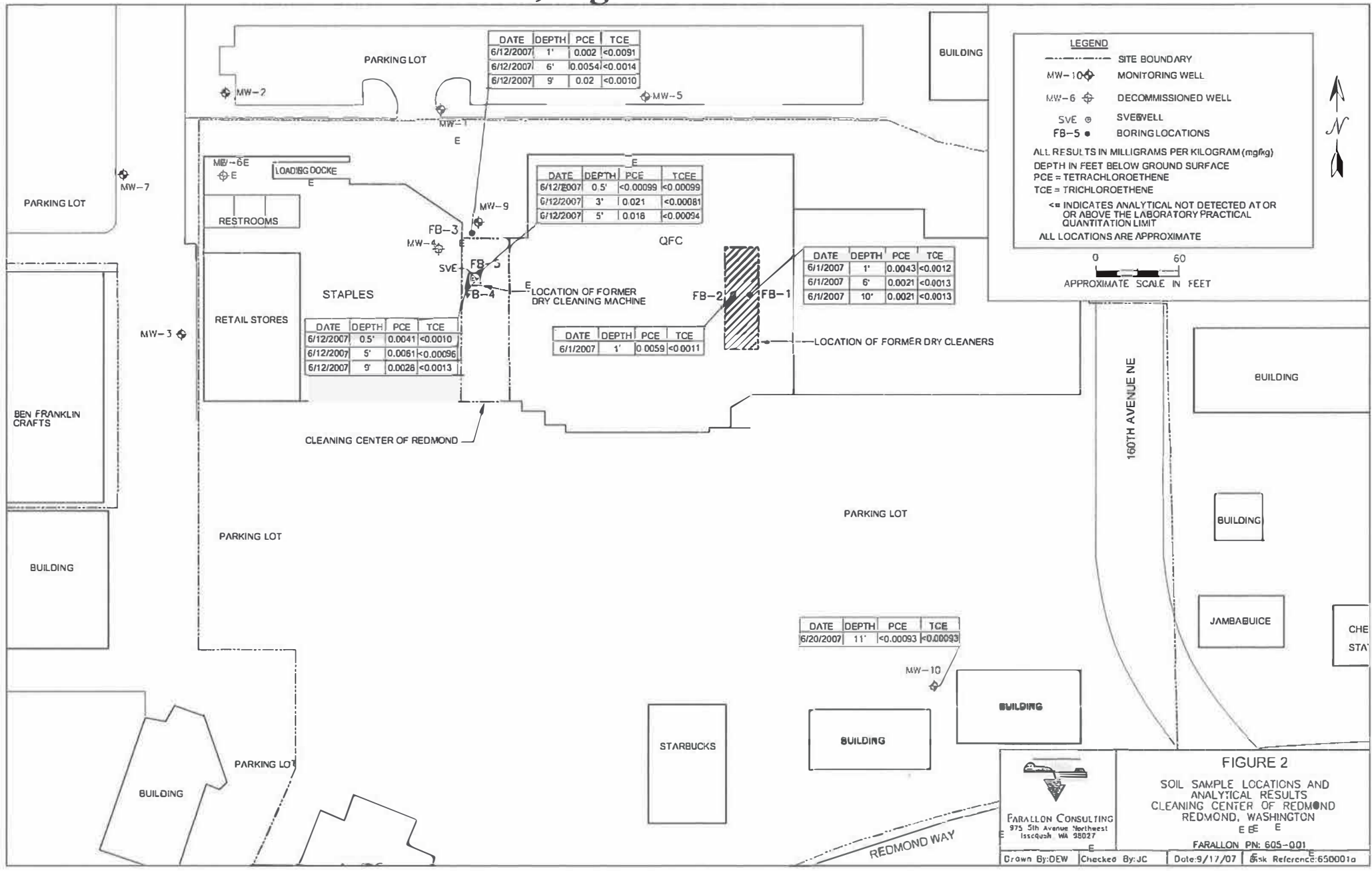


FIGURE 2

SOIL SAMPLE LOCATIONS AND ANALYTICAL RESULTS
 CLEANING CENTER OF REDMOND
 REDMOND, WASHINGTON

FARALLON CONSULTING
 975 5th Avenue Northwest
 Issaquah WA 98027

FARALLON PN: 605-001

Drawn By: DEW Checked By: JC Date: 9/17/07 File Reference: 650001a

Enclosure A, Figure 5

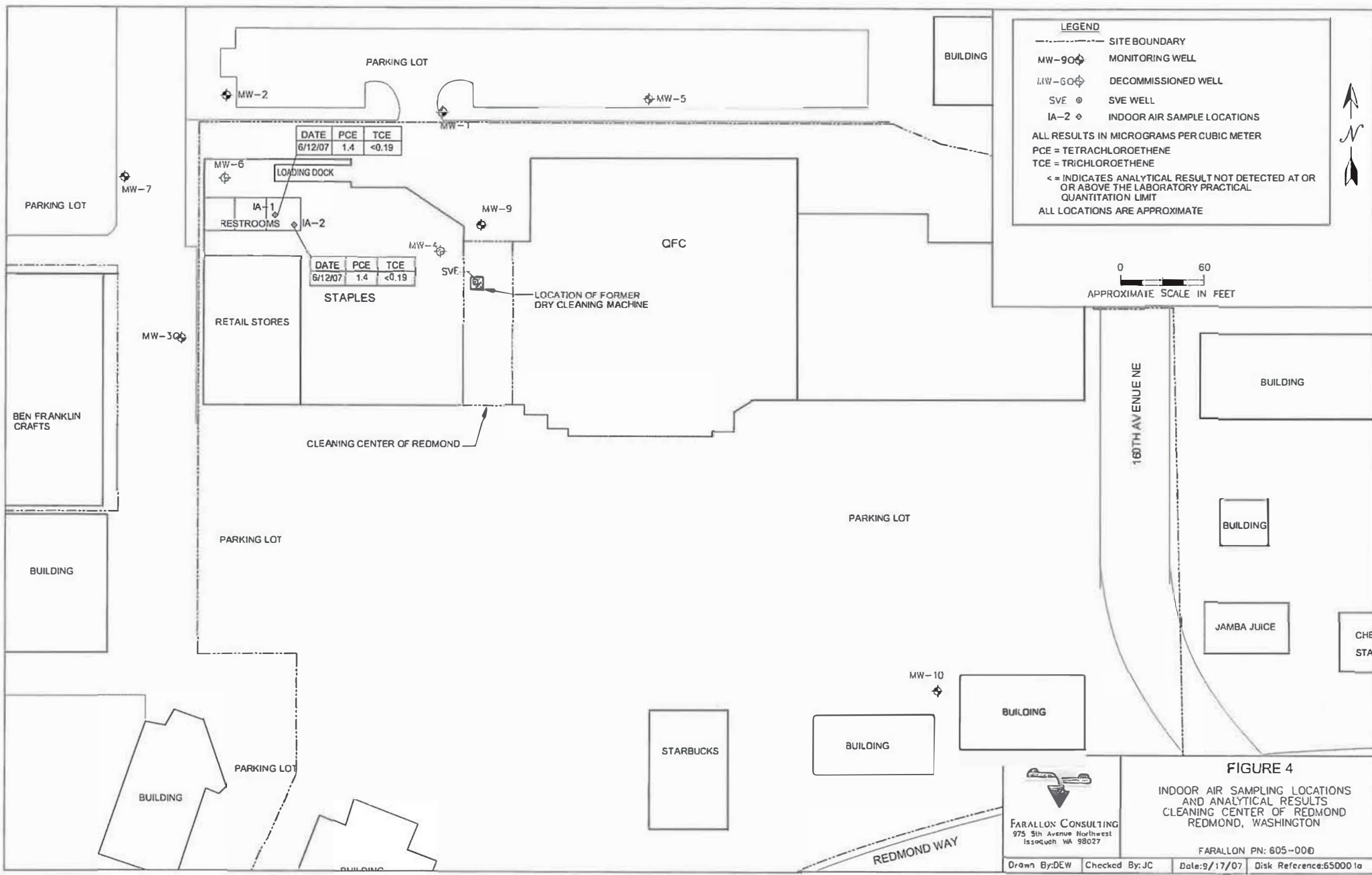


FIGURE 4

INDOOR AIR SAMPLING LOCATIONS AND ANALYTICAL RESULTS
CLEANING CENTER OF REDMOND
REDMOND, WASHINGTON

FARALLON CONSULTING
975 5th Avenue Northwest
Issaquah WA 98027

FARALLON PN: 605-000

Drawn By: DEW | Checked By: JC | Date: 9/17/07 | Disk Reference: 650001a

Figure 6A
 BIOCHLOR Model Inputs - Decaying Source at MW-9 Using 2007 Data
 Former Cleaning Center of Redmond
 Redmond, Washington
 Farallon PN: 650-001

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Redmond Clean. Ctr.
 Redmond, WA
 Run Name

Data Input Instructions:
 115 → 1. Enter value directly...or
 ↑ or 0.02 → 2. Calculate by filling in gray cells. Press Enter, then **C**
 (To restore formulas, hit "Restore Formulas" button)
 Variable* → Data used directly in model.

 Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes / Ethanes

1. ADVECTION

Seepage Velocity* Vs (ft/yr) ↑

Hydraulic Conductivity K (cm/sec)

Hydraulic Gradient i (ft/ft)

Effective Porosity n (-)

2. DISPERSION

Alpha x* (ft)

(Alpha y) / (Alpha x)* (-)

(Alpha z) / (Alpha x)* (-)

3. ADSORPTION

Retardation Factor* →

Soil Bulk Density, rho (kg/L)

Fraction Organic Carbon, foc (-)

Partition Coefficient Koc

PCE	426 (L/kg)	<input type="text" value="5.09"/> (-)
TCE	130 (L/kg)	<input type="text" value="2.25"/> (-)
DCE	125 (L/kg)	<input type="text" value="2.20"/> (-)
VC	30 (L/kg)	<input type="text" value="1.28"/> (-)
ETH	302 (L/kg)	<input type="text" value="3.90"/> (-)

Common R (used in model)* = ←

4. BIOTRANSFORMATION

Zone	Path	λ (1/yr)	half-life (yrs)	Yield
Zone 1	PCE → TCE	<input type="text" value="0.000"/> ←	<input type="text"/>	0.79
	TCE → DCE	<input type="text" value="0.000"/> ←	<input type="text"/>	0.74
	DCE → VC	<input type="text" value="0.000"/> ←	<input type="text"/>	0.64
	VC → ETH	<input type="text" value="0.000"/> ←	<input type="text"/>	0.45
Zone 2	PCE → TCE	<input type="text" value="0.000"/> ←	<input type="text"/>	
	TCE → DCE	<input type="text" value="0.000"/> ←	<input type="text"/>	
	DCE → VC	<input type="text" value="0.000"/> ←	<input type="text"/>	
	VC → ETH	<input type="text" value="0.000"/> ←	<input type="text"/>	

5. GENERAL

Simulation Time* (yr)

Modeled Area Width* (ft)

Modeled Area Length* (ft)

Zone 1 Length* (ft)

Zone 2 Length* (ft)

Zone 2 = L - Zone 1

6. SOURCE DATA

Source Options

Source Thickness in Sat. Zone* (ft)

Width* (ft)

Conc. (ug/L)* C1

PCE	<input type="text" value="2.4"/>
TCE	<input type="text"/>
DCE	<input type="text"/>
VC	<input type="text"/>
ETH	<input type="text"/>

TYPE: Decaying Single Planar

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

k_s^* (1/yr)

PCE	<input type="text" value="0.35"/>
TCE	<input type="text" value="0.35"/>
DCE	<input type="text" value="0.35"/>
VC	<input type="text" value="0.35"/>
ETH	<input type="text" value="0.35"/>

7. FIELD DATA FOR COMPARISON

PCE Conc. (ug/L)	<input type="text" value="2.1"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
TCE Conc. (ug/L)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
DCE Conc. (ug/L)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
VC Conc. (ug/L)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
ETH Conc. (ug/L)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Distance from Source (ft)	<input type="text" value="0"/>	<input type="text" value="240"/>	<input type="text" value="600"/>	<input type="text"/>	<input type="text"/>
Date Data Collected	<input type="text"/>	<input type="text" value="MW-7"/>	<input type="text" value="MW-8"/>	<input type="text"/>	<input type="text"/>

8. CHOOSE TYPE OF OUTPUT TO SEE:

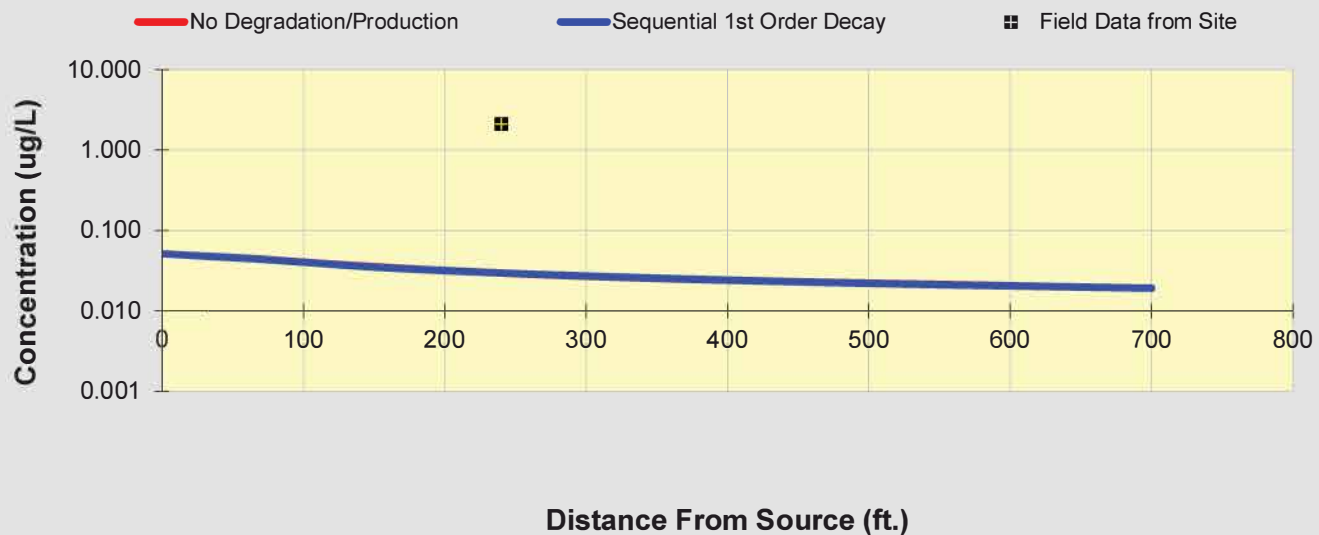
Enclosure A, Figure 6

Figure 6B
 Simulated PCE Concentration Downgradient of MW-9 With Decaying PCE Source of 2.4 ug/L
 Estimated PCE Concentrations 11 Years After February 2007 Sample Event (2018)
 Former Cleaning Center of Redmond
 Redmond, Washington
 Farallon PN: 650-001

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (ug/L) at Z=0

PCE	Distance from Source (ft)										
	0	70	140	210	280	350	420	490	560	630	700
No Degradation	0.051	0.044	0.036	0.031	0.028	0.025	0.024	0.022	0.021	0.020	0.019
Biotransformation	0.0511	0.044	0.036	0.031	0.028	0.025	0.024	0.022	0.021	0.020	0.019

Field Data from Site	Monitoring Well Locations (ft)										
	0			240						600	
				2.100							

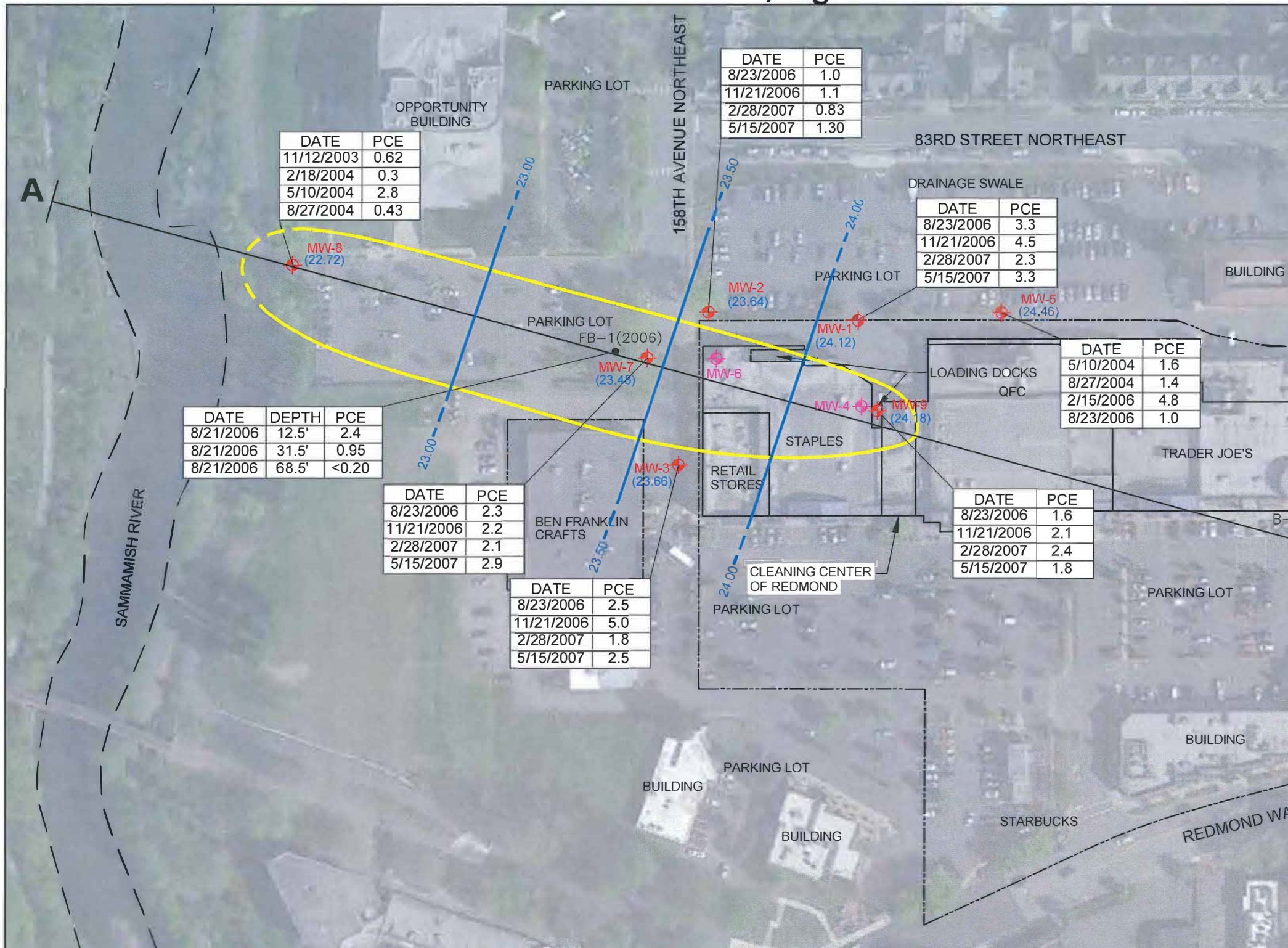


- [See PCE](#)
- [See TCE](#)
- [See DCE](#)
- [See VC](#)
- [See ETH](#)

Time:

Enclosure A, Figure 7

Enclosure A, Figure 8



DATE	PCE
11/12/2003	0.62
2/18/2004	0.3
5/10/2004	2.8
8/27/2004	0.43

DATE	PCE
8/23/2006	1.0
11/21/2006	1.1
2/28/2007	0.83
5/15/2007	1.30

83RD STREET NORTHEAST

DRAINAGE SWALE

DATE	PCE
8/23/2006	3.3
11/21/2006	4.5
2/28/2007	2.3
5/15/2007	3.3

DATE	PCE
5/10/2004	1.6
8/27/2004	1.4
2/15/2006	4.8
8/23/2006	1.0

DATE	DEPTH	PCE
8/21/2006	12.5'	2.4
8/21/2006	31.5'	0.95
8/21/2006	68.5'	<0.20

DATE	PCE
8/23/2006	2.3
11/21/2006	2.2
2/28/2007	2.1
5/15/2007	2.9

DATE	PCE
8/23/2006	2.5
11/21/2006	5.0
2/28/2007	1.8
5/15/2007	2.5

DATE	PCE
8/23/2006	1.6
11/21/2006	2.1
2/28/2007	2.4
5/15/2007	1.8

Estimated GW Velocity

① PCE Time-Series Plot

$$V = \frac{[5/10/2004] - [12/20/2000]}{650 \text{ ft}} = 192 \text{ ft/yr}$$

② Darcy Calculation

$$V = \frac{KI}{n} \quad \begin{array}{l} K = \text{hydraulic cond.} \\ I = \text{gradient} \\ n = \text{porosity} \end{array}$$

- for sands/gravel aquifer
est $K = 10^3 \text{ gal/day/ft}^2$
 $n = 30\%$

$$V = \frac{\left(\frac{1,000 \text{ gal}}{\text{day} \cdot \text{ft}^2} \right) \left(\frac{0.0015 \text{ ft}}{\text{ft}} \right)}{0.3} \times \frac{\text{ft}}{7.48 \text{ gal}} = 0.67 \frac{\text{ft}}{\text{day}} = 245 \text{ ft/yr}$$

- PROPERTY BOUNDARY
- FORMER EXTENT OF PCE PLUME IN GROUNDWATER (SITE 1)
- ◆ PERFORMANCE AND CONFIRMATION MONITORING WELL NETWORK (DECOMMISSIONED FOLLOWING RECEIPT OF NO FURTHER ACTION DETERMINATION)
- ◆ MONITORING WELL (DECOMMISSIONED PRIOR TO CLEANUP DUE TO CONSTRUCTION OF NEW BUILDING)
- FB-1(2006) BORING LOCATION
- (23.66) GROUNDWATER ELEVATION RELATIVE TO MEAN SEA LEVEL (MAY 2007)
- 24.00 - - - - - GROUNDWATER ELEVATION CONTOUR (MAY 2007)
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW

LEGEND

- DEPTH IN FEET BELOW GROUND SURFACE
- PCE = TETRACHLOROETHENE
- BOLD** = INDICATE CONCENTRATIONS EXCEEDED WASHINGTON STATE MODEL TOXICS CONTROL ACT CLEANUP REGULATIONS (MTCA) METHOD A CLEANUP LEVEL
- < = INDICATES ANALYTE NOT DETECTED AT CONCENTRATIONS AT OR EXCEEDING THE LABORATORY PRACTICAL QUANTITATION LIMIT
- = DATE SAMPLED AND PCE CONCENTRATION IN GROUNDWATER IN MICROGRAMS PER LITER (ug/L)

DATE	PCE
8/23/2006	1.6

ALL LOCATIONS ARE APPROXIMATE



Quality Service for Environmental Solutions | farallonconsulting.com

Drawn By: JM Checked By: MB

FIGURE 2
GROUNDWATER ELEVATION CONTOURS AND PCE CONCENTRATIONS IN GROUNDWATER
CLEANING CENTER OF REDMOND
REDMOND, WASHINGTON

FARALLON PN: 650-001

Date: 3/8/2017 Disk Reference: 650-001_00.dwg