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ENGINEERING DESIGN REPORT

Property:
Plastic Sales & Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington
Agreed Order No. DE 7084

Prepared for:
The Lutheran Retirement Home of Greater Seattle
6720 East Green Lake Way North
Seattle, Washington

Report Date:
May 9, 2016

ENGINEERING DESIGN REPORT

Prepared for:

The Lutheran Retirement Home of Greater Seattle
6720 East Green Lake Way North
Seattle, Washington 98103

Property:

Plastic Sale & Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington 98115
Agreed Order No. DE 7084

Project No.: 0651-002-02

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May 9, 2016

SoundEarth Strategies

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

FIGURES

TABLE OF CONTENTS (CONTINUED)

CHART

APPENDICES

ACRONYMS AND ABBREVIATIONS

^{o}C	degree Celsius
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
the alley	City of Seattle right-of-way between the Dry Cleaner Building Property and the Hearthstone Property
AST	aboveground storage tank
bgs	below ground surface
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
CMP	Compliance Monitoring Plan
COC	chemical of concern
CSM	conceptual site model
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DCI	City of Seattle Department of Construction and Inspections
Dry Cleaner Building	the building on the Dry Cleaner Building Property
the Dry Cleaner Building Property	6870 Woodlawn Avenue Northeast, Seattle, Washington
Ecology	Washington State Department of Ecology
EDR	Engineering Design Report
EPA	U.S. Environmental Protection Agency
ERD	enhanced reductive dechlorination
ERH	electrical resistance heating
EVO	emulsified vegetable oil
Farallon	Farallon Consulting, L.L.C.

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Former Laundry Property	the former parcel located within the Hearthstone Property, located at 6860 Woodlawn Avenue Northeast
Former Yasuko Property	the former parcel located within the Hearthstone Property, located at 6850 Woodlawn Avenue Northeast
GAC	granulated activated carbon
gpm	gallon per minute
HASP	Health and Safety Plan
The Hearthstone	The Lutheran Retirement Home of Greater Seattle, dba The Hearthstone
the Hearthstone Property	the property adjoining the Dry Cleaner Building to the west, located at 6850 Woodlawn Avenue Northeast
Karkrie	Karkrie LLC
KCIW	King County Industrial Waste
kWh	kilowatt hours
mg/kg	milligrams per kilogram
MTCA	Washington State Model Toxics Control Act
NAVD88	North American Vertical Datum of 1988
North-Adjoining Property	the property adjoining the Dry Cleaner Building Property to the north, located at 6869 Woodlawn Avenue Northeast
NTU	nephelometric turbidity unit
PCE	tetrachloroethene
PID	photoionization detector
PSCAA	Puget Sound Clean Air Agency
PSCAA Regulation I	Section 6.03 (94) Regulation I of the Puget Sound Clean Air Agency dated September 24, 2009
PSS	Plastic Sales & Service
QAPP	Quality Assurance Project Plan
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act

ACRONYMS AND ABBREVIATIONS (CONTINUED)

RCW	Revised Code of Washington
RI/FS Addendum	Revised Remedial Investigation/Feasibility Study Addendum prepared by SoundEarth, 2015 (draft to Ecology)
2013 Draft Final RI/FS Report	Draft Final Remedial Investigation and Feasibility Study Report prepared by Farallon Consulting, L.L.C., dated July 3, 2013
ROW	right-of-way
SAP	Sampling and Analysis Plan
Single-Family Lot	the former parcel located within the Hearthstone Property, located at 6560 Latona Avenue Northeast
the Site	the extent of contamination caused by the releases of hazardous substances at the Dry Cleaner Building Property: includes the Dry Cleaner Building Property; the property adjoining it to the west, located at 6850 Woodlawn Avenue Northeast (the Hearthstone Property); the property adjoining it to the north, located at 6869 Woodlawn Avenue Northeast (North-Adjoining Property); the property adjoining it to the south, located at 6565 4th Avenue Northeast (South-Adjoining Property); and portions of the western alley (the alley), Woodlawn Avenue Northeast, and the 4th Avenue Northeast rights-of-way
SoundEarth	SoundEarth Strategies, Inc.
South-Adjoining Property	the property adjoining the Dry Cleaner Building Property to the south, located at 6565 4th Avenue Northeast
SVE	soil vapor extraction
TCE	trichloroethene
TESC	temporary erosion and sediment control
TMP	temperature monitoring point
trans-1,2-DCE	trans-1,2-dichloroethene
TRS	TRS Group, Inc.
TSDF	treatment, storage, and disposal facility
UST	underground storage tank
VOC	volatile organic compound
WAC	Washington Administrative Code

ACRONYMS AND ABBREVIATIONS (CONTINUED)

ZVI	zero valent iron

1.0 INTRODUCTION

SoundEarth Strategies, Inc. (SoundEarth) has prepared this Engineering Design Report (EDR) on behalf of The Lutheran Retirement Home of Greater Seattle (dba The Hearthstone) for the property located at 6870 Woodlawn Avenue Northeast in Seattle, Washington (the Dry Cleaner Building Property). The location of the Dry Cleaner Building Property is shown on Figure 1. This EDR was prepared under the authority of the Agreed Order No. DE 7084 (Ecology 2009a) between The Lutheran Retirement Home of Greater Seattle; Plastic Sales and Service Inc.; Karkrie, LLC (Karkrie); Ruben and Patricia Rael; and the Washington State Department of Ecology (Ecology). A Consent Decree for the Site is currently in preparation with Ecology. This report contains design information for the cleanup action selected for the Plastic Sales & Service Site (the Site). The Site is defined in the Agreed Order No. DE 7084 as the extent of contamination caused by releases of hazardous substances at the Dry Cleaner Building Property.

The group of properties collectively known as “the Site” include: the Dry Cleaner Building Property located at 6870 Woodlawn Avenue Northeast; the property adjoining it to the west, located at 6850 Woodlawn Avenue Northeast (the Hearthstone Property); the property adjoining it to the north, located at 6869 Woodlawn Avenue Northeast (North-Adjoining Property); and portions of the western alley (the alley), Woodlawn Avenue Northeast, and 4th Avenue Northeast rights-of-way (ROWs; Figure 2).

This EDR was developed to meet the relevant requirements defined by the Washington State Model Toxics Control Act (MTCA) Cleanup Regulation in Section 400 of Chapter 340 of Title 173 of the Washington Administrative Code (WAC 173-340-400[a]). In accordance with WAC 173-340-120(5)(a), WAC 173-340-400(4), and WAC 173-340-800. The Hearthstone and others have performed remedial investigation sufficient to define the extent of contamination, characterize the Site, and select the cleanup action components. The evaluation of cleanup action technologies were summarized in the Revised Remedial Investigation/Feasibility Study Addendum (RI/FS Addendum) prepared by SoundEarth in 2015 (SoundEarth 2015a), and the selected cleanup action components were presented in the Draft Cleanup Action Plan (CAP) prepared by Ecology in 2016 (Ecology 2016).

1.1 PURPOSE AND OBJECTIVE

The purpose of this EDR is to provide sufficient information to implement the CAP at the Site (Ecology 2016). This EDR provides the specifications and procedures necessary to adequately remediate the Site and presents technical information regarding the remedial technologies to be used at the Site, which were developed to satisfy the requirements of WAC 173-340-120, WAC 173-340-380, and WAC 173-340-400.

This EDR presents a summary of information describing the known chemicals of concern (COCs), the primary source areas, the extent of impacts beneath the Site, and the design of the remedial action that will be implemented to address impacts to the media of concern at the Site. This EDR also describes the compliance sampling that will be used to document Site conditions, quality assurance/quality control protocols, data management, health and safety protocols, project organization including relevant project stakeholders, and a comprehensive communication plan that will enable us to address any unforeseen discoveries and observations.

1.2 REPORT ORGANIZATION

This EDR is organized into the following sections:

- **Section 2.0, Site Background.** This section discusses the Site location and description, the current and former uses, and the conceptual site model (CSM).
- **Section 3.0, Remedial Action Objectives.** This section provides an overview of the remedial action objectives (RAOs) developed for the Site, and summarizes the cleanup and remediation standards, and the points of compliance for the Site.
- **Section 4.0, Selected Cleanup Action.** This section provides an overview of the chosen remedial technologies.
- **Section 5.0, Cleanup Action Engineering Design.** This section discusses the required permits and registrations and the health and safety procedures. This section also discusses the procedures and specifications for site preparation, demolition, monitoring well decommissioning, underground storage tank (UST) removal, and the installation, operation and decommissioning of the Electrical Resistance Heating (ERH) system.
- **Section 6.0, Construction Dewatering System Design and Implementation.** This section discusses the procedure and specifications for the installation, operation, and decommissioning of the construction dewatering system.
- **Section 7.0, Excavation Design and Implementation.** This section provides information on the contained-out determination, the shoring, the erosion and sediment controls, the extent of the excavation, and summarizes the soil confirmation grid sampling.
- **Section 8.0, Enhanced Reductive Dechlorination Design and Implementation.** This section discusses the procedure and specifications for the installation of injection wells, injection equipment, operation, and contingency piping for future injections.
- **Section 9.0, Engineered Controls.** This section discusses the specifications and installation of the sub-slab drainage system, vapor barrier, and passive ventilation system.
- **Section 10.0, Compliance Monitoring.** This section discusses the groundwater performance monitoring program to monitor the performance of the cleanup action.
- **Section 11.0, Waste Management.** This section discusses the containment, profiling, treatment, and disposal of waste streams associated with the remedial actions.
- **Section 12.0, Limitations.** This section presents SoundEarth's standard limitations associated with conducting the work reported herein and preparing this EDR.
- **Section 13.0, Bibliography.** This section provides a list of the source materials used in preparing this EDR.

2.0 SITE BACKGROUND

This section provides a summary of the Site features and location, historical Site use, environmental setting, previous investigations, and the CSM. Detailed descriptions of the background information for the Site prior to 2014 are provided in the RI/FS Addendum (SoundEarth 2015a) and the CAP (Ecology 2016).

2.1 SITE DESCRIPTION AND HISTORY

The Site is defined by the extent of contamination caused by the releases of hazardous substances at the Dry Cleaner Building Property, as described above in Section 1.0. The Site consists of four parcels: the Dry Cleaner Building Property, the Hearthstone Property, the North-Adjoining Property, and the City of Seattle ROWs, including the alley (Figure 3). This EDR is focused on the cleanup of the Dry Cleaner Building Property, the North-Adjoining Property, and the City of Seattle ROWs. Descriptions of the properties located within the Site are provided in the following subsections.

2.1.1 Dry Cleaner Building Property

The Dry Cleaner Building Property, located at 6870 Woodlawn Avenue Northeast, includes two tax parcels (King County tax parcels #952810-4725 and #952810-4735) that cover approximately 8,800 square feet (0.20 acres) of land (King County Assessor 2015). The Dry Cleaner Building Property is currently improved with a 1947-vintage, 2-story, masonry warehouse and office (Figure 2).

The Dry Cleaner Building Property was occupied by residences as early as 1904. Sunshine Cleaners acquired the Dry Cleaner Building Property in 1947, demolished the residence, and constructed the Dry Cleaner Building. The building utilized steam heat fueled by a heating oil UST of unknown capacity, located in the western portion of the building. The heating oil UST remains beneath the Dry Cleaner Building Property.

Sunshine Cleaners operated a dry cleaner on the Dry Cleaner Building Property from 1948 to 1977 (Ecology 2009a). Sunshine Cleaners used Stoddard solvent, the primary dry cleaning solvent in use from the late 1920s to late 1950s. The Stoddard solvent was stored in two USTs with capacities of 1,500 and 2,000 gallons. The USTs are currently located in the Woodlawn Avenue Northeast ROW, adjacent to the north side of the Dry Cleaner Building. The USTs were reportedly abandoned in-place in 1958 when Sunshine Cleaners began using tetrachloroethene (PCE) for dry cleaning operations. The Stoddard solvent USTs are still present beneath the Woodlawn Avenue Northeast ROW. Sunshine Cleaners reportedly stored PCE in an aboveground storage tank (AST) with a capacity of 200 gallons. The former location of the AST is unknown. Sunshine Cleaners installed dry cleaning equipment on the western portion of the former Dry Cleaner Building, as shown on Figure 2, and used the equipment for both Stoddard solvent and PCE operations.

Plastic Sales & Service (PSS) began operating in the Dry Cleaner Building in 1978. PSS does not operate as a dry cleaner; however, small quantities of solvent have been used during its tenure (Ecology 2009a). PSS currently operates a plastic fabrication facility in the Dry Cleaner Building. No plastics are manufactured on the Dry Cleaner Building Property, but plastic stock materials are stored, finished, and transformed into final products. The Hearthstone purchased the Dry Cleaner Building Property from Karkrie in June 2014.

2.1.2 Hearthstone Property

The Hearthstone Property is composed of three former parcels: the first parcel located at 6860 Woodlawn Avenue Northeast (Former Laundry Property), the second located at 6850 Woodlawn Avenue Northeast (the Former Yasuko Property), and the third located at 6560 Latona Avenue Northeast (Single-Family Lot). The Hearthstone Property is located to the west of the Dry Cleaner Building Property, across the alley (Figure 2). The three parcels were purchased by The

Hearthstone in 2005, and the Former Laundry and Yasuko Properties were replotted into a single tax parcel (King County tax parcel #952810-4695). The Hearthstone Property currently includes two tax parcels (King County tax parcels #952810-4695 and #952810-4696) that cover approximately 18,203 square feet (0.42 acres) of land. The Hearthstone Property is listed at 6850 Woodlawn Avenue Northeast. The northern portion of the Hearthstone Property has been redeveloped as a 4-story building, with one level of underground parking, to be used as retirement residences, with commercial shops occupying the first floor. The Single-Family Lot (King County tax parcel #952810-4696) is undeveloped and is not considered part of the Site.

Sunshine Cleaners owned and occupied the Former Laundry Property as early as 1931. According to the former owner of Sunshine Cleaners, only laundry, pressing, and packaging operations were conducted on the Former Laundry Property. Former tenants on the Former Yasuko Property included Scott's Trophies, a restaurant, a dance studio, an antique shop, and a cabinetmaker.

In 1977, Mr. Robert Bell, the former owner and operator of Sunshine Cleaners, transferred interest in the Former Laundry Property. Ruben and Patricia Rael acquired the Former Laundry Property in 1995 and transferred the Former Laundry Property to Karkrie in 2000. Karkrie sold the Former Laundry Property to The Hearthstone in 2005. PSS operated at the Former Laundry Property at various times between 1977 and 2006 (Ecology 2009a).

All aboveground structures within the Hearthstone Property were demolished between 2008 and 2009 as part of the Hearthstone Property redevelopment.

2.1.3 North-Adjoining Property

The North-Adjoining Property, located at 6869 Woodlawn Avenue Northeast, includes two tax parcels (King County tax parcels #952810-0525 and #952810-0535) that cover approximately 8,500 square feet (0.20 acres) of land (King County Assessor 2015). The North-Adjoining Property is improved with a 1926-vintage, wood-framed, office building on the eastern portion and an asphalt-paved parking lot on the western portion. The North-Adjoining Property was occupied by residences as early as 1904, a machine shop in the 1950s, and a film development facility in 1966 (GeoEngineers, Inc. 2004).

2.1.4 City of Seattle Rights-of-Way

The existing PCE groundwater plume extends from the Dry Cleaner Building Property into the adjoining City of Seattle ROWs. The adjoining ROWs include the alley located between the Dry Cleaner Building Property and the Hearthstone Property; Woodlawn Avenue Northeast located between the Dry Cleaner Building Property and the North-Adjoining Property; and 4th Avenue Northeast located directly east–northeast of the Dry Cleaner Building Property.

2.2 FUTURE LAND USE

The Hearthstone plans on redeveloping the Dry Cleaner Building Property and South-Adjoining Property as a mixed-use building that includes commercial and residential uses. A mixed-use four-story building with one level of underground parking will be constructed on the Dry Cleaner Building Property and the South-Adjoining Property.

2.3 ENVIRONMENTAL SETTING

Topographically, the Site is relatively flat with a slight slope to the northeast toward the former Ravenna Creek. The Site is situated approximately 150 feet above mean sea level. The nearest surface water body is Green Lake, located approximately 900 feet to the northwest.

Based on field observations from SoundEarth and others, the upper 20 feet of soil beneath the Dry Cleaner Building Property and the Hearthstone Property generally range from stiff to very stiff silt and medium dense to very dense silty sand. The observed soil from borings located north and downgradient of the Dry Cleaner Building Property indicates that the soil profile transitions laterally from silt and silty sand layers to a silt with minimal coarse-grained soil present in Woodlawn Avenue Northeast. Underlying the upper silt and silty sand unit is a dense to very dense, poorly graded sand and gravel to well-graded sand and silty sand unit that ranges in depth from approximately 20 to 70 feet below ground surface (bgs). The silty sand layers encountered in the upper 20 feet contained a higher percentage of silt (30 to 40 percent) versus the silty sand layers encountered in soil deeper than approximately 20 feet bgs. A silt unit has been encountered beneath the sand and gravel unit to the maximum depths explored beneath the Site, approximately 80 feet bgs.

A shallow, unconfined water-bearing zone is present beneath the Site from approximately 6 to 20 feet bgs and is designated as the Shallow Zone based on the observed soil profile and potentiometric surface in the existing well network. The depth to groundwater in the Shallow Zone generally ranges from 4 to 8 feet below the top of well casings; seasonal fluctuations in groundwater elevations range from approximately 2 to 5 feet. The groundwater flow direction in the Shallow Zone is to the north and northwest, with gradients ranging between 0.01 and 0.06 feet per foot (Figure 4). The Shallow Zone is underlain by a semiconfined to confined groundwater-bearing zone designated as the Deep Zone. The Deep Zone static water level ranges in depth from 5 to 9 feet below the top of well casings. The direction of groundwater flow in the Deep Zone is to the northeast with gradients ranging between 0.01 and 0.03 feet per foot (Figure 5). The Shallow Zone appears to act as a semiconfining to confining unit based on observed potentiometric surface measurements from the existing well network that generally indicate a positive hydraulic head in wells installed in the Deep Zone.

2.4 CONCEPTUAL SITE MODEL

This section provides a summary of the conceptual understanding of the Site derived primarily from the results of the subsurface investigations performed at the Site. Included is a discussion of the confirmed and suspected source areas, and the chemicals and media of concern. The CSM serves as the basis for developing remedial technologies for the final cleanup action. The CSM is considered to be dynamic and may be refined throughout the cleanup action process as additional information becomes available. Figures 4 through 9 provide a summary of PCE concentrations in Shallow Zone (Figure 4) and Deep Zone groundwater (Figure 5), in soil (Figure 6), and several cross-sectional views (Figure 7 through 9) of the Site.

2.4.1 <u>Source Areas</u>

The primary source of contamination beneath the Site is the former dry cleaning equipment and/or the floor drain system in the northwest corner of the Dry Cleaner Building on the Dry Cleaner Building Property, as supported by the distribution of high concentrations of PCE in Shallow Zone soil and groundwater, and the possible presence of PCE as dense nonaqueous-phase liquids (DNAPL).

2.4.2 Chemicals and Media of Concern

The primary COC identified for the Site is PCE. Other COCs include the degradation products of PCE: trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), and vinyl chloride.

The media of concern for the Site are soil, groundwater, and air as soil vapor. The remedial action addressed contaminated soil groundwater and vapor within the boundary of the Site.

2.4.3 Conceptual Site Model Summary

The primary source of contamination beneath the Site is the former dry cleaning equipment and/or the floor drain system in the northwest corner of the Dry Cleaner Building on the Dry Cleaner Building Property, as supported by the distribution of high concentrations of PCE in Shallow Zone soil and groundwater, and the possible presence of PCE as DNAPL. Elevated concentrations of dissolved-phase PCE were detected in groundwater on the north-central portion of the Hearthstone Property prior to the remedial action. The suspected source of PCE in groundwater is the Dry Cleaner Building on the Dry Cleaners Property.

As a result of a release from the source area, Shallow Zone and Deep Zone groundwater from the source area contains concentrations of PCE—including PCE degradation products TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride—above applicable cleanup levels. As a result of the release and migration of COCs from the source area, the exposure pathways include the vapor, soil, and groundwater pathways via inhalation, direct contact, and/or ingestion. A detailed discussion of the CSM for the Site is presented in the 2013 Draft Final Remedial Investigation and Feasibility Study Report (2013 Draft Final RI/FS Report) prepared by Farallon Consulting, L.L.C. (Farallon), dated July 3, 2013 (Farallon 2013), and the Revised RI/FS Addendum (SoundEarth 2015a).

2.4.4 Areas of Treatment

The Dry Cleaner Building Property, the City of Seattle ROWs, and the South-Adjoining Property have been divided into five areas based on the level of contamination in the areas and the property lines associated with the areas. The remedial actions are designed to treat each of these areas specific to the levels of contamination that are present in the areas. These areas are described below, and shown on Figure 10.

- Area 1 is generally located within the former dry cleaning machinery source area, beneath the Dry Cleaner Building Property, and contains PCE-contaminated soil and groundwater. The extent of Area 1 is defined by concentrations of PCE in soil exceeding the MTCA Method A cleanup level and the Resource Conservation and Recovery Act (RCRA) Land Ban criteria of greater than 60 milligrams per kilogram (mg/kg) of Title 40, Parts 268(d), 268.40, and 268.49(c)(1)(C) of the Code of Federal Regulations (40 CFR 268[d], 40 CFR 268.40, and 40 CFR 268.49[c][1][C]).
- Area 2 is generally located around the perimeter of Area 1 beneath the Dry Cleaner Building Property and contains PCE-contaminated soil and groundwater. The extent of Area 2 is defined by concentrations of PCE in soil exceeding the MTCA Method A cleanup level and Washington State's Dangerous Waste Toxicity Characteristic List for PCE of a Toxicity Characteristic Leaching Procedure of 0.7 milligrams per liter,

which is equivalent to 14 mg/kg, but not exceeding the RCRA Land Ban criteria of 60 mg/kg (WAC 173-303-090[8][c]).

- Area 3 is generally located directly downgradient of the former dry cleaning machinery source area, beneath the Woodlawn Avenue Northeast ROW, and contains PCE-contaminated soil (less than 60 mg/kg but greater than 14 mg/kg) and groundwater. The extent of Area 3 is defined by concentrations of PCE in soil exceeding the MTCA Method A cleanup level and the Washington State Dangerous Waste criteria for listed wastes, but not exceeding the RCRA Land Ban criteria.
- Area 4 is generally located in remaining areas beneath the Dry Cleaner Building Property and contains PCE-contaminated soil (less than 14 mg/kg) and groundwater. The extent of Area 4 is defined by concentrations of PCE in soil exceeding the MTCA Method A cleanup level, but not exceeding Washington State's Dangerous Waste criteria for listed wastes.
- Area 5 is generally located on the South-Adjoining Property at 6565 4th Avenue Northeast. Area 5 is not part of the Site but is part of the redevelopment planned by The Hearthstone.

3.0 REMEDIAL ACTION OBJECTIVES

The RAOs developed for the Site were used to define the technical elements for the final cleanup action selected for the Site. The RAOs are discussed in greater detail in the CAP (Ecology 2016).

3.1 PURPOSE OF THE REMEDIAL ACTION

The purpose of establishing RAOs for a site is to provide remedial alternatives that protect human health and the environment (WAC 173-340-350). In addition, RAOs are designated in order to:

- Implement administrative principles for cleanup (WAC 173-340-130).
- Meet the requirements, procedures, and expectations for conducting a feasibility study and developing remedial alternatives as discussed in WAC 173-340-350 through WAC 173-340-370.
- Develop cleanup levels (WAC 173-340-700 through WAC 173-340-760) and remedial alternatives that are protective of human health and the environment.

In particular, RAOs must address the following threshold requirements set forth in WAC 173-340-360(2)(a):

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

There are two RAOs for this Site. The first RAO consists of bringing the Dry Cleaner Building Property into compliance with the applicable soil and groundwater cleanup criteria for each of the COCs. The second RAO is to bring those portions of the Site located outside of the Dry Cleaner Building Property boundary into compliance with soil and groundwater cleanup criteria for each of the COCs.

3.2 CLEANUP AND REMEDIATION LEVELS

The cleanup levels for the COCs confirmed or suspected in the environmental media of concern are provided in the 2013 Draft Final RI/FS Report (Farallon 2013). The cleanup levels for individual hazardous substances are based on established MTCA Method A cleanup levels in accordance with WAC 173-340-720 through WAC 173-340-760. MTCA Method B cleanup levels are used for hazardous substances where MTCA Method A cleanup levels have not been established. For example, a MTCA Method A cleanup level has not been established for cis-1,2-DCE; therefore, the MTCA Method B cleanup level is used for cis-1,2-DCE. The cleanup levels for the media of concern for the Site are presented below.

3.2.1 Soil

The CSM for the Site indicates that the most likely human health exposure scenario for soil is by direct contact during excavation. Because groundwater in the Shallow Zone is not considered to be a potable groundwater source per WAC 173-340-720(2)(b)(i), MTCA Method B direct contact cleanup levels were selected as cleanup levels for soil, with one exception. The MTCA Method B cleanup level for PCE protective of direct contact is 480 mg/kg, exceeding the MTCA Method A cleanup level protective of groundwater of 0.05 mg/kg by a factor of nearly 10,000. The MTCA Method A cleanup level was selected as the cleanup level for PCE in soil.

The cleanup levels for COCs in soil are listed below:

- PCE—0.05 mg/kg, MTCA Method A cleanup level, protective of groundwater
- TCE—12.0 mg/kg, MTCA Method B carcinogenic exposure cleanup level, protective of direct contact (ingestion only)
- Cis-1,2-DCE—800 mg/kg, MTCA Method B non-carcinogenic exposure cleanup level, protective of direct contact (ingestion only)
- Trans-1,2-DCE—1,600 mg/kg, MTCA Method B non-carcinogenic exposure cleanup level, protective of direct contact (ingestion only)
- Vinyl chloride—0.67 mg/kg, MTCA Method B carcinogenic exposure cleanup level, protective of direct contact (ingestion only)

Empirical groundwater sample data collected at the conditional point of compliance will be used to demonstrate the soil leaching pathway is incomplete and residual soil concentrations are protective of groundwater in the Shallow Zone and Deep Zone at the Site. The points of compliance are discussed in Section 3.3.

3.2.2 Groundwater

The CSM for the Site indicates that the most likely human health exposure scenario for groundwater is direct (dermal) contact during future excavation. Cleanup levels protective of groundwater quality for drinking water purposes were selected, when available, from applicable state and/or federal laws (WAC 246-290-310 and 40 CFR 141.61).

The cleanup levels for COCs in groundwater are listed below:

- PCE—5 micrograms per liter (µg/L), MTCA Method A cleanup level, based on applicable state and federal laws

- TCE—5 µg/L, MTCA Method A cleanup level, based on applicable state and federal laws
- Cis-1,2-DCE—80 µg/L, MTCA Method B non-carcinogenic exposure cleanup level, standard formula value
- Trans-1,2-DCE—160 µg/L, MTCA Method B non-carcinogenic exposure cleanup level, standard formula value
- Vinyl chloride—0.2 µg/L, MTCA Method A cleanup level, based on applicable state and federal laws

3.2.3 Indoor Air

The CSM indicates that the most likely human health exposure scenario for indoor air is acute inhalation of volatilized contaminants by construction workers during future construction activities on the Site and indoor air inhalation of vapors emanating from contaminated soil and/or groundwater intruding into existing and/or future structures at the Site. Cleanup levels protective of indoor air quality were selected, when available, from applicable state and/or federal laws (WAC 246-290-310 and 40 CFR 141.61).

The cleanup levels for COCs in indoor air are listed below:

- PCE—9.60 micrograms per cubic meter (µg/m3), MTCA Method B carcinogenic cleanup level, standard formula value
- TCE—0.37 µg/m3, MTCA Method B carcinogenic cleanup level, standard formula value
- Cis-1,2-DCE—MTCA Method B cleanup level not established
- Trans-1,2-DCE—2.74 µg/m3, MTCA Method B non-carcinogenic cleanup level, standard formula value
- Vinyl chloride—0.28 µg/m3, MTCA Method B carcinogenic cleanup level, standard formula value

3.2.4 Remediation Levels

The cleanup action involves a combination of cleanup action components to treat soil and groundwater at the Site. Remediation levels are used to identify the concentrations (or other methods of identification) of hazardous substances at which different cleanup action components will be used. Remediation levels are not the same as cleanup levels. A cleanup level defines the concentration of hazardous substances above which a contaminated medium (e.g., soil) must be remediated in some manner (e.g., treatment, containment, or institutional controls). A remediation level defines the concentration (or other method of identification) of a hazardous substance in a particular medium above or below which a particular cleanup action component (e.g., soil treatment or containment) will be used. Remediation levels, by definition, exceed cleanup levels and obtaining a remediation level is not considered being in compliance with cleanup standards.

Remediation levels are applicable for the Site because several treatment technologies are necessary to aggressively treat the majority of the contaminated mass in soil and groundwater at the Site. The remediation levels for soil were established to allow one cleanup technology to transition to another cleanup technology. The selected remediation levels for COCs in soil at the Site are presented below.

3.2.4.1 Remediation Level for Soil Electrical Resistance Heating Treatment

The remediation level for PCE in soil located in the upper Shallow Zone at the Dry Cleaner Building Property is 14 mg/kg. ERH will be used to lower the concentrations of PCE and other F002-listed dangerous waste soil to below soil remediation levels. It is technologically feasible that the ERH treatment will achieve up to a 98 percent reduction from source area average concentration. All ERH-treated soil that is intended for a contained-out proposal to Ecology will be cooled to 30 degrees Celsius (^{o}C) prior to conducting post-treatment soil sampling for such contained-out proposal. The contained-out request is discussed in Section 7.1.

Once the remediation levels for the F002-listed dangerous waste constituents in soil have been achieved and confirmed by compliance soil sampling, the treated soil will be excavated to an average depth of approximately 14 feet bgs, or 163.79 feet above mean sea level, and transported off the Dry Cleaner Building Property for disposal in a Subtitle D landfill under a contained-out determination from Ecology.

Concentrations of the COCs in soil remaining in place after the excavation will likely exceed MTCA cleanup levels. Containment and institutional controls with an environmental covenant will be required for the remaining soil.

3.3 POINTS OF COMPLIANCE

The point of compliance means the point or points where cleanup levels established in accordance with WAC 173-340-720 through WAC 173-340-760 shall be attained at the Site. This term includes both standard and conditional points of compliance. A conditional point of compliance for particular media is only available as provided in WAC 173-340-720 through WAC 173-340-760.

3.3.1 Soil Points of Compliance

In accordance with WAC 173-340-740(6)(b–d), the point of compliance for direct contact exposure is throughout the Site from the ground surface to 15 feet bgs, which is a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of development activities. As part of the development of the Dry Cleaner Building Property, soil containing concentrations of the COCs above applicable MTCA cleanup levels will be excavated to an average depth of approximately 14 feet bgs and removed from the Site.

In order to be protective of groundwater, remaining soil with concentrations of PCE above the MTCA Method A cleanup level of 0.05 mg/kg and below the design depth of the redevelopment, will be treated with in situ technologies, as discussed in Section 4.0. In addition, a 4-inch thick rat slab will be installed on the bottom of the excavation as an engineering control measure to protect workers during the installation of the permanent sub-slab drainage system (described in Section 5.7) from direct contact with the residual soil with concentrations of PCE and its degradation compounds left in place at the Dry Cleaner Building Property.

3.3.2 Groundwater Conditional Point of Compliance

In accordance with WAC 173-340-720(8)(a) and (b), the point of compliance for groundwater is defined as the uppermost level of the saturated zone extending vertically to the lowest depth that potentially could be impacted by the COCs throughout the Site. The lowest depth of the dissolved-phase PCE plume in the Deep Zone is approximately 135 feet above mean sea level (Figures 7 through 9).

The Shallow Zone and Deep Zone dissolved-phase PCE plumes extend downgradient of the Dry Cleaner Building Property beneath the Woodlawn Avenue Northeast ROW. The dissolved-phase PCE plume extends further downgradient in the Deep Zone beneath the North-Adjoining Property. The lateral and vertical extent of Shallow Zone and Deep Zone groundwater has been characterized with the existing monitoring well network and borings. The source of the plume appears to be located at the Dry Cleaner Building property boundary.

An off-Property conditional point of compliance for groundwater in the Shallow Zone and Deep Zone is established because it is not practicable to meet the cleanup level for COCs in groundwater throughout the Site within a reasonable restoration time frame, and the requirements of WAC 173-340-720(8)(d)(ii) will have been met under the requirements of the CAP. Within 30 days from the effective date of the Consent Decree, Hearthstone will provide Ecology with a letter from the affected property owner stating that the property owner agrees to "the use of the groundwater off-property conditional point of compliance detailed in WAC 173-340-720(8)(d)(ii)."

3.3.3 Restoration Time Frame for the Off-Property Conditional Point of Compliance for Groundwater

Groundwater analytical results for selected performance monitoring wells will be used to show the cleanup remedy for the Site will achieve the cleanup objectives in a reasonable restoration time frame, as discussed below.

Following completion of the ERH treatment at the Dry Cleaner Building Property, the upper Shallow Zone groundwater, located directly downgradient of the Dry Cleaner Building Property, will likely exceed the cleanup levels for COCs. Enhanced reductive dechlorination (ERD) will be utilized to biodegrade the remaining COCs present in the Shallow Zone and Deep Zone located downgradient of the Dry Cleaner Building Property. The ERD treatment will remediate the residual source of PCE in the lower Shallow Zone and the Deep Zone groundwater at the Dry Cleaner Building Property and will treat residual dissolved-phase COCs present in the Shallow Zone and Deep Zone groundwater located downgradient of the Dry Cleaner Building Property. The ERD treatment will significantly reduce the overall restoration time frame; however, the estimated time to biodegrade the residual concentrations of COCs in groundwater ranges from 13 to 20 years.

The estimated restoration time for ERD is based on achieving the cleanup level (0.2 µg/L) for vinyl chloride, the last degradation compound in the reductive dechlorination of PCE. To estimate the restoration time frame, SoundEarth used post-ERD groundwater analytical results from a PCE-contaminated property located on Capitol Hill in Seattle, Washington.

Based on the analysis of the groundwater analytical results from the Capitol Hill property, average degradation rates for PCE, TCE, cis-1,2-DCE/trans-1,2-DCE, and vinyl chloride are 1 percent, 1.5 percent, 0.40 percent and 0.30 percent per day, respectively. Accounting for the durations of time (decay rates) needed to complete the reductive dechlorination steps, a restoration time frame for the COCs was calculated. The times needed to complete the reductive dechlorination steps are as follows:

- PCE first degrades at 1 percent per day to TCE.
- The TCE degrades at 1.5 percent per day to DCE.
- The DCE degrades at 0.40 percent per day to vinyl chloride.
- The vinyl chloride at 0.30 percent per day to ethene.

To calculate an estimated restoration time frame for the Site, SoundEarth assumed an initial source concentration of 160,000 µg/L (reconnaissance boring SB-1) of PCE to degrade to 0.2 µg/L of vinyl chloride. Using the above reductive dechlorination steps, the estimated restoration time frame for the Site is approximately 13 to 20 years. Chart 1 presents the estimated degradation of PCE to vinyl chloride with time at the Site using the initial source concentration of 160,000 µg/L. Although a 20-year groundwater restoration time frame is estimated for the Site, a maximum restoration time frame of 30 years for the COCs at the Site is in order to account for variabilities in the bulk attenuation rates between Capitol Hill and the Site. As shown in Chart 1, the concentrations of cis-1,2-DCE and vinyl chloride are anticipated to increase as a result of the degradation of PCE and TCE, which may lead to a temporary expansion of the cis-1,2-DCE and vinyl chloride plumes. However, over the long term cis-1,2-DCE and vinyl chloride will degrade within the 30-year restoration time frame. The bulk attenuation rate for a particular site is a function of advection/depression, sorption, and biological processes. If the analysis of groundwater performance monitoring results indicate the restoration time frame for the Site is greater than 30 years, contingency measures may be implemented in consultation with Ecology to ensure the time frame is achieved.

3.3.4 Indoor Air Point of Compliance

The point of compliance indoor air will be the standard point of compliance in accordance with WAC 173-340-750(6), which is ambient air throughout the Site. To manage the indoor air exposure pathway, engineering controls will be implemented as part of the development of the Hearthstone Property. These engineering controls will include the installation of a vapor barrier and passive ventilation system beneath the floor slab of the proposed underground parking garage at the Hearthstone Property. These engineering controls are preventative measures for managing potential vapor containing PCE and/or its degradation by-products. These measures will provide long-term protection of the indoor air quality within the development building. After completion of the development, vapor sampling will be periodically conducted from the stacks of the passive ventilation system located on the roof the proposed development building. If post-development monitoring indicates the mass of PCE in vapor exceeds the Puget Sound Clean Air Agency (PSCAA) regulatory threshold (500 pounds of PCE per year) at the point of discharge for the passive ventilation system, contingency measures may be implemented in consultation with Ecology to ensure compliance with PSCAA PCE threshold.

4.0 SELECTED CLEANUP ACTION

The selected cleanup action is a series of remedial technologies based on the 2013 Draft Final RI/FS Report (Farallon 2013), the RI/FS Addendum (SoundEarth 2015a), and the CAP (Ecology 2016). The objective of the cleanup action is to treat and remove the source of PCE and its degradation products in soil and to treat the residual groundwater impacts beneath the Site. The cleanup action shall also meet the RAOs, discussed in Section 3.1. As determined during the RI/FS Addendum and the CAP, the appropriate remedial technologies to achieve the RAOs are the removal of underground storage tanks (USTs), ERH, temporary construction dewatering system, removal of contaminated soil, and ERD injections. Additional engineering controls for the future redevelopment include: a sub-slab drainage system, a vapor barrier, and a passive ventilation system.

The remedial technologies were evaluated in accordance with the MTCA criteria for protectiveness, permanence, long-term effectiveness, short-term risk management, and implementability. Table 6 from the RI/FS Addendum shows how each cleanup action alternative was evaluated and ranked for each of the MTCA criteria above (SoundEarth 2015a). For additional selection information and discussion on the alternative selection process, refer to the RI/FS Addendum and the CAP.

4.1 SUMMARY OF REMEDIAL TECHNOLOGIES

A summary of each of the remedial technologies that comprise the cleanup action for the Site is presented below.

UST Removal. There are three USTs on the Site. All USTs will be removed in accordance with Ecology's *Guidance for Site Checks and Site Assessments for Underground Storage Tanks* (Ecology 1991) by a certified UST Site Assessor (Figures 2 and 10). The three tanks consist of the following:

- Two closed in-place Stoddard solvent USTs and associated underground pipelines. The two USTs are located in designated Area 3.
- One closed-in-place heating oil UST is located in the boiler room of the Dry Cleaner Building. This heating oil UST is located in designated Area 4.

Electrical Resistance Heating Treatment. ERH treatment applies heat to the subsurface to degrade or volatilize contaminants. Mobilized and/or volatilized contaminants are then collected by a soil vapor extraction (SVE) system component at each electrode and treated with granulated activated carbon (GAC). The activated carbon can be processed off-Site for recycled use or disposed of in an appropriate treatment, storage, and disposal facility (TSDF). Electrodes will be installed in Area 1, Area 2, and Area 3. The layout of the ERH system is shown on Figure 11 and cross sections of the ERH Treatment area are shown on Figures 12, 13, and 14. The ERH electrode construction and temperature monitoring point (TMP) construction are shown on Figure 15.

Temporary Construction Dewatering System. Dewatering is the process of pumping the groundwater prior to excavating, which will allow for excavation and construction below the water table. The temporary dewatering system is comprised of two components.

The first component includes four dewatering wells that will be installed adjacent to the elevator pit to depress the elevation of the Deep Zone groundwater for the installation of deeper foundation features. The dewatering wells will have dedicated downwell pumps that pump water to a holding tank, and maintain a groundwater level lower than the base of the excavation (Figures 16 through 18). Two additional dewatering wells may be installed and operated in the Woodlawn Avenue Northeast ROW. These would be installed and used if it is determined they are necessary to supplement the four Deep Zone wells around the elevator pit.

The second component is the excavation dewatering to allow for soil removal. This component includes trenches and a sump that will be installed within the limits of the excavation to remove water from the

Shallow Zone that infiltrates the excavation. In addition, six injection wells within Transect D will be used as temporary dewatering wells, if necessary, to remove groundwater from the Shallow Zone (Figure 18).

Water captured by the dewatering system will be temporarily stored in a settling tank, pending the results of self-monitoring data collected in the field and receipt of analytical results for wastewater samples, prior to discharging to the sanitary sewer system, in accordance with the discharge authorization permit. Direct discharge of the captured wastewater to the sanitary sewer may occur with regulatory approval.

Excavation and Disposal of Contaminated Soil. The entire Property and the South-Adjoining Property will be excavated from lot-line to lot-line as part of the planned redevelopment project (Figure 19). The portions of the Dry Cleaner Building Property with soil containing concentrations of the COCs in excess of their respective remediation levels will be referred to as the Areas 1 through 4. The Areas are defined as the vertical and horizontal limit of the soil exhibiting contamination above remediation levels within the Dry Cleaner Building Property boundary (Figure 10). The excavation of contaminated soil from the Dry Cleaner Building Property is anticipated to result in the removal of the ongoing source of COCs to groundwater and reduce the potential for any ongoing impacts to the groundwater and vapor media of concern.

In conjunction with dewatering, the excavation of contaminated soil in Areas 1 through 4 and uncontaminated soil in Area 5 will begin (Figure 19). The excavation will begin with the installation of soldier piles, wood lagging will be installed in 5 foot lifts, and tiebacks will be installed at elevations of approximately 172.5 and 173.5 NAVD along the south shoring wall. The excavation will progress with the shoring installation down to the planned depth of 14 feet of soil from the Dry Cleaner Building Property and the South-Adjoining Property.

Enhanced Reductive Dechlorination Injections. Reductive dechlorination is a proven remedial technology for addressing chlorinated solvents in groundwater and is a biotic process completed by anaerobic bacteria. The fermentation of edible oil by indigenous microorganisms injected into the groundwater produces a rapid and significant reduction in dissolved oxygen concentrations in the saturated zone. This provides the strongly negative oxidation/reduction potential necessary to treat the target COCs by reductive dechlorination. Complete dechlorination of PCE produces nontoxic chloride and carbon dioxide.

The anaerobic zone extends far beyond the radius of influence of the edible oil itself, enhances attenuation of contaminants both upgradient and crossgradient of the active treatment zone, and serves as a barrier around the periphery of the treatment system/groundwater plume, thereby greatly reducing any potential for recontamination of groundwater beneath the Dry Cleaner Building Property and adjoining ROWs.

Once the excavation is completed, injection wells will be advanced in Areas 1 through 4 and along Woodlawn Avenue Northeast (Figures 20 through 26). This well network will form the basis of the ERD injections. The injection wells in the building footprint will have conduits installed to provide access to the injection wells after the building slab is poured.

Engineered Controls. Engineering controls will include a sub-slab drainage system to remove potentially contaminated water from beneath the building, a vapor barrier (Figure 27) to mitigate the potential vapor intrusion pathway from groundwater to indoor air, and a passive ventilation system.

5.0 CLEANUP ACTION ENGINEERING DESIGN

This section discusses in greater detail the engineering design, permitting requirements, system operations, safety controls, and monitoring parameters for each component of the remedial action. In addition, the following subsections include discussions on determining the completion of each cleanup action component and the documentation necessary to support completion.

5.1 PERMITS AND REGISTRATIONS REQUIRED FOR IMPLEMENTATION

This section summarizes the permits associated with the cleanup action components. The redevelopment project schedule will include a permitting task to ensure that permits are procured in a timely manner and prior to implementing each component of the remedial action.

5.1.1 Master Use Permit

A Master Use Permit will be required prior to beginning this project, and issued by the City of Seattle Department of Construction and Inspections (DCI). This permit will be necessary for the redevelopment of the Dry Cleaner Building Property and the South-Adjoining Property. This permit includes and fulfills the requirements for a demolition permit, shoring and excavation permit, building permit, and a structural permit. All of these permits are procured from the DCI.

5.1.2 Street Use and Right Of Way Improvement Permit

A Street Use Permit will be required for any and all work in the City of Seattle ROWs. Area 3 is in the ROW and work in this area includes removal of USTs, excavation dewatering, ERH treatment, and ERD injections. An approved traffic control plan and Street Use Permit is required prior to any work in the ROW. The installation of the dewatering and injection wells will require a utility permit as well.

5.1.3 Electrical Permit

An electrical permit, issued by Seattle City Light, will be required prior to beginning this project This permit is necessary for powering the ERH treatment system and dewatering system during the redevelopment of the Dry Cleaner Building Property and the South-Adjoining Property and remedial actions.

5.1.4 Wastewater Discharge Authorization Permit

King County Industrial Waste (KCIW) requires a discharge authorization for any discharge to their facilities. ERH and construction dewatering will require discharge of water to the sanitary sewer for disposal, and will thus require a KCIW Discharge Authorization. This permit will require the treatment and sampling of water streams to prevent discharge of the contaminants and maintain water quality. This discharge will be treated by GAC adsorption filters prior to discharge to sewer.

5.1.5 Puget Sound Clean Air Agency Discharge Permit

Regulations under the federal Clean Air Act (42 USC 7401) and the Washington State Clean Air Act (Revised Code of Washington [RCW] 70.94) govern the discharge of airborne contaminates from point and non-point sources. For the Site, the applicable regulatory body for vapor discharge is PSCAA. The expected total removal of COCs in vapor phase is in excess of the PSCAA threshold for permitting exemption of 500 pounds per year (PSCAA Regulation 1, Section 6.03); necessitating a Notice of Construction and Order of Approval through PSCAA. This permit will require the treatment and sampling of vapor streams to prevent discharge of the contaminants and maintain air quality. The vapor stream will be treated by GAC adsorption filters prior to discharging to the atmosphere.

5.1.6 Underground Injection Control Registration

Ecology requires any material to be injected into the subsurface be registered with the Washington State Ecology Water Quality Program as an underground injection control registration. For the injection associated with ERD, all potential wells must be registered and approval must be received prior to beginning injections. Injections may only occur in the specified wells, time frame, and for the material specified. In addition, the underground injection control registration may be used for the reintroduction of treated condensate during ERH treatment.

5.2 HEALTH AND SAFETY

A Health and Safety Plan (HASP) was prepared in accordance with WAC 296-843, WAC 173-340-810, and 29 CFR 1910-120. Field activities for the cleanup action will only begin with Ecology approval of the CAP and EDR. The HASP will be provided as an attachment to the CAP.

The HASP will be provided to contractors for their review to ensure that the health and safety components related to implementing the remedial action can be incorporated into each contractors HASP. In addition, a pre-construction health and safety meeting with the general contractor and appropriate subcontractors will be conducted. Each subcontractor is responsible for maintaining their respective HASPs to identify potential physical and chemical hazards associated with their own work practices and consistent with the general contractor's HASP.

The main hazards associated with the ERH component include electrical hazards, working with pressurized piping and hoses, extreme temperatures for recovered vapor and condensate, and contact with contaminated water and vapor. Contaminated media will be contained in piping and process units, leaks or spills will be addressed immediately using proper protective equipment. Field personnel will screen ambient air during the course of the treatment to monitor COC levels at the breathing zone of personnel. If COC levels exceed the permissible exposure limits, personal protective equipment will be upgraded accordingly. Electrical hazards are significant due to high voltages and amperage used to heat the subsurface. All potential conductors around the work zone will be cleared prior to operation of the system. The system will be turned off for any work that occurs outside of protected walkways or areas clear of shock hazards.

The main hazards associated with the dewatering system component include contact with contaminated water, working with pressurized piping and hoses, and electricity or compressed air that will be used to power the downwell pumps. System controls include ball valves for each discharge line to allow personnel to isolate a downwell pump or transfer pump if any of the equipment requires maintenance. The ball valves will allow water or air pressure to be slowly relieved so maintenance can then be safely performed. A basic electric panel will allow for lock out/tag out procedures for maintenance on pumps or switches. Each motor will be equipped with a motor starter that will pop or disengage from the electrical contact if the motor tries to draw more amperage than required.

The main hazards associated with the installation of the injection wells include working around heavy equipment. The hazards associated with the injection system include working with pressurized piping and hose and electricity to power the mixing and delivery pumps. System controls include ball valves to allow personnel to close or limit flow to one well, pressure sensors and gauges to notify personnel of back pressure building in the line, and check valves to prevent the backflow of edible oil to the injection skid or to the vault. The edible oil injectate is biodegradable. Although it is non-toxic, face splash shields will be worn when handling the edible oil solution, or moving pressurized lines. A material safety data sheet for the edible oil is provided in Appendix A.

5.3 SITE PREPARATION AND MOBILIZATION

Prior to initiating the redevelopment project, site controls will be established to ensure the work zone is properly secured. The entire perimeter of the Dry Cleaner Building Property and the South-Adjoining Property will be fenced and points of ingress and egress will be clearly marked. The access points to the Dry Cleaner Building Property and the South-Adjoining Property will be monitored by authorized personnel during construction activities and locked during non-business hours.

Prior to beginning excavation activities, temporary erosion and sediment control (TESC) measures will be established as part of the larger redevelopment project. Once all TESC measures are implemented in accordance with the construction project plan, construction equipment and supplies will be mobilized to the Dry Cleaner Building Property. City of Seattle DCI inspections will provide approval of TESC measures.

An exclusion zone will be established around the perimeter of the PCE-contaminated soil to limit the potential for cross-contamination of clean overburden soil. A truck wheel wash area will be established to allow for the washing and decontamination of equipment working in contaminated soil, and personnel will have a boot wash station to ensure proper decontamination procedures. All the wash water will be containerized and processed through the construction dewatering system.

5.4 DEMOLITION

A hazardous materials survey has been completed for all the buildings on the Dry Cleaner Building Property and the South-Adjoining Property before demolition. Recommendations for the following abatement measures are found in the Pre-Demolition Hazardous Materials Survey Report, prepared by SoundEarth in 2015, and should be referenced for full recommendations (SoundEarth 2015c). Recommendations include the following:

- Removal of asbestos-containing material by certified, trained, and protected personnel using appropriate work practices and engineering controls prior to building demolition. Any additional, previously unsampled, suspect materials encountered during demolition activities should be inspected, sampled, and tested by certified persons and/or facilities.

- Identified lead-containing materials should be removed, handled, and disposed of or recycled properly. Unidentified materials that may contain lead should be inspected, sampled, and tested by certified persons and/or facilities.
- The polychlorinated biphenyl-containing fluorescent light ballasts should be removed by properly certified, trained, and protected personnel using appropriate work practices and engineering controls prior to disturbance by renovation or demolition. Any light ballast that is not labeled as polychlorinated biphenyl free should be assumed to contain polychlorinated biphenyl.
- Fluorescent light tubes may contain mercury vapors. These tubes, and mercury-containing heat thermostats, should be removed without breakage and disposed of properly.
- The HVAC system should be evacuated of refrigerant and the portable air conditioners should be properly disposed prior to being impacted by demolition. All refrigerant must be properly transported, recycled, and reclaimed.

The contractor will perform these activities prior to the demolition of the buildings. All structures on the Site, which include the former Dry Cleaner Building and single-family home, will be demolished as part of Site preparation activities. The concrete slab on the former Dry Cleaner Building will be left in place to act as an impermeable barrier for the ERH system. Conductive underground utilities within Areas 1, 2, and 3, will be removed prior to the operation of the ERH system.

5.5 MONITORING WELL DECOMMISSIONING

Monitoring wells within the treatment area (including MW04, MW06, and MW07) will be decommissioned by a licensed well driller or under the supervision of a professional engineer in accordance with the Ecology Water Well Construction Act (1971), RCW 18.104 (WAC 173-160-460). The wells will be abandoned in place using bentonite clay. Following decommissioning, the required paperwork will be submitted to Ecology. Excavation activities will not begin until the monitoring wells have been decommissioned.

5.6 UST DECOMMISSIONING

All known USTs on the Dry Cleaner Building Property and adjacent ROW will be decommissioned and a UST site assessment will be conducted under the oversight of a Washington State-certified UST site assessor in accordance with Ecology's *Guidance for Site Checks and Site Assessment for Underground Storage Tanks* (Ecology 1991), Ecology's *Guidance for Remediation of Petroleum Contaminated Sites* (Ecology 2010), and the Underground Storage Tank Regulations (WAC 173-360),

Prior to any ERH or other remedial actions, the USTs must be properly decommissioned and removed. Removal of the USTs is also a safety precaution, as the USTs and or metallic piping remaining in place can act as electrodes. When acting as electrodes, the USTs become a shock hazard, and degrade the efficacy of the ERH treatment. The USTs could also act as a source of additional contamination.

5.6.1 Stoddard Solvent USTs

The two USTs are located in designated Area 3, where detectable concentrations of PCE were not above 60 mg/kg, but were greater than 14 mg/kg (Figure 10). The two USTs have a capacity of 1,500 and 2,000 gallons. Removal will include limited soil removal with waste disposal profiling and transportation to a TSDF for proper disposal. Any piping connected to the USTs will be removed to the extent practical.

5.6.2 Heating Oil USTs

One closed-in-place heating oil UST is located in the boiler room of the Dry Cleaner Building. This heating oil UST is located in Area 4, where detectable concentrations of PCE were not above 14 mg/kg, but greater than 0.05 mg/kg. Generated waste soil from UST removal activities will be temporarily placed in plastic-lined containers, sampled for waste profiling, and transported to a TSDF for proper disposal.

A second heating oil UST is located directly southwest of the single-family house at the South-Adjoining Property. While outside the Site, the UST will be removed during demolition and Site preparation. This heating oil UST is located in Area 5. Residential heating oil tanks with capacities less than 1,100 gallons are not regulated under Ecology; however, when removed, any contaminated soil encountered during the UST decommissioning process will be disposed of off the Site to an appropriate TSDF.

5.7 ELECTRICAL RESISTANCE HEATING DESIGN AND IMPLEMENTATION

The remediation objective for ERH is to reduce the concentration of COCs in soil to less than 14 mg/kg as a target remedial level. ERH has treatment efficiencies of up to 98 percent removal of the COCs. The treatment of soil by this method will remove a significant quantity of contaminant mass in the Shallow Zone within Areas 1, 2, and 3, but is unlikely to fully remediate the Site. The ERH system is comprised of a network of 19 electrodes and vapor recovery points and 4 temperature monitoring probes in within Areas 1 through 3 (Figure 11). A hollow-stem auger drilling rig is used to advance the electrodes and temperature probes. Electrical current is then passed through and between the electrodes, with the soil acting as a resistor. The resistance of the soil to the electrical current causes the subsurface to heat up.

As the subsurface temperature rises, the COCs and water are volatilized. The steam mobilizes the COCs and improves recovery as a carrier gas. The electrodes are used as SVE points for the collection of the mobilized COCs. The collected vapors are then passed through a moisture separator and a condenser to remove water and condensation from the vapor stream. The contaminated water is then processed through GAC to remove any COCs prior to discharging to the sanitary sewer under the KCIW discharge authorization. The vapor stream passes through vapor-phase GAC and discharges to the atmosphere, under the PSCAA discharge authorization. The system design, construction, operation, and system removal is discussed in the following sections. Additional information regarding the ERH design is provided in Appendix B.

5.7.1 Treatment Area

The ERH system will encompass 3,140 square feet and consist of 19 electrodes and vapor collection points and 4 TMPs that will be installed in Areas 1 through 3, as designated on Figure 11. These points will be installed on an average of 13.6-foot centers, but may be changed due to field conditions. Areas 1 through 3 have PCE concentrations in soil greater than 14 mg/kg. Areas 4 and 5 are already below 14 mg/kg and do not necessitate ERH prior to excavation.

Once subsurface heating starts, the boiling points of various volatile organic compounds (VOCs)/water mixtures are reached in the following order: DNAPL, in contact with water or soil moisture; followed by dissolved-phase VOCs; and, finally, uncontaminated groundwater. This is explained by Dalton's law of partial pressures. When a VOC is immersed in water, the combined boiling point is depressed. Consequently, the VOC/water interface will boil when the vapor pressure of the VOC plus the vapor pressure of water are equal to the ambient pressure. The boiling temperature of water that contains dissolved-phase VOCs is also depressed, depending on the VOC concentration. However, the boiling point depression due to dissolved-phase VOCs is negligible unless the concentration is in the percent range. The targeted temperature for the treatment zone is 100^{o} C.

Once installed, the treatment area of the system will encompass 3,140 square feet and treat to a depth of 16 feet bgs. This will treat an approximate total of 1,700 cubic yards of soil. ERH treatment will be targeting Shallow Zone groundwater to remove contamination from the groundwater and the soil. Deep Zone groundwater will be treated with ERD and is discussed further in Section 8.0.

5.7.2 <u>Electrode Design and Install</u>

A hollow-stem auger drill rig will be used to advance 23 borings to a maximum depth of 17 feet bgs (i.e., approximately 159 feet North American Vertical Datum of 1988 [NAVD88]). The location of each boring is presented in Figure 11. The design of the electrodes, vapor recovery screen, and TMPs is presented in Figure 15 and in the TRS Group, Inc. (TRS) design documents in Appendix B. Electrodes, vapor recovery screen, and a clean water return will be installed in 19 borings and temperature probes will be installed in the four remaining borings. The electrodes will be comprised of Schedule 40 steel. Hose and pipes for the collection of recovered soil vapor will be connected to the electrodes to convey soil vapor from the treatment area by vacuum to a treatment building during heating, subsurface temperatures will be measured at TMPs located within the treatment area. Each of the TMPs will consist of CPVC pipe installed in the borings with four thermocouples installed in the treatment zone.

Electrodes will be installed in an offset grid pattern for uniform heating to all parts of the treatment area. Uniform heating will ensure that the entire treatment area temperature remains consistent and treatment for the entire area will be completed at the same time. Temperature fluctuation or gradients across the treatment area can cause residual contamination above the treatment area or prolong treatment. As such, the TMPs will be monitored to verify and correct any temperature disparities. If corrections need to be made the amperage that will be applied may be varied to correct for any inconsistencies in the heating of the treatment area. Four additional TMPs may be installed to monitor when the formation is cool enough for excavation.

5.7.3 <u>System Layout and Equipment</u>

The ERH system layout is shown on Figure 11. The system will require equipment to be staged on-Site for the duration of ERH treatment. The equipment is listed in the table below.

ERH System Equipment	Quantity
500-kilowatt Power Control Unit	1
ERH Steam Condenser and Cooling Tower	1
Vapor Recovery Blower	1
Electrodes with SVE and Condensate Return	19
Temperature Monitoring Points	4

ERH System Equipment	Quantity
Thermocouples	16
Vapor-Phase Carbon Treatment Vessels	3
Water-Phase Carbon Treatment Vessels	2

NOTES:
ERH = electrical resistance heating
SVE = soil vapor extraction

5.7.4 Equipment Installation

The equipment installation involves the advancement of the ERH electrodes and TMPs and the subsurface elements. The ERH electrodes have a vapor recovery component and clean water injection lines, and the TMPs are comprised of thermocouples and cables (Figure 15). Above-grade equipment will be mobilized and staged on the Dry Cleaner Building Property. The ERH electrodes and TMPs will be connected to the above-grade equipment through system piping and process lines. The system will be tested over the course of one to two weeks prior to fully energizing.

5.7.5 Operation and Maintenance

The following is an overview of system operation and maintenance. TRS will provide a complete ERH Operation and Maintenance Plan prior to system operation (Appendix B). The ERH system will be operated and maintained by qualified staff from TRS. Trained SoundEarth staff will provide support, as needed, for ERH operation. It is anticipated that the ERH system will operate continuously for 45 to 60 days.

Once installed, the ERH system will heat the subsurface to 100^{o} C to ensure vapor mobilization of COCs and water.

5.7.6 Operational Setpoints and Monitoring

While in operation, the system will be monitored daily by qualified TRS personnel. The system will be monitored by collecting data from TMPs and electrodes to develop an understanding of how the cleanup is progressing and to allow for system optimization. The parameters to be monitored include the following:

- Temperature of the formation. This will mirror the level of completion of the remedial action. As temperature increases to the target of 100^{o} C, the cleanup progresses to completion.
- Soil sampling. TRS will shut down the system at staggered intervals and use Hot Soil Sampling techniques, developed by TRS for ERH sites, to evaluate if the treatment area has reached cleanup levels. The events will be staggered to reduce operational time and costs. The first soil sampling event will likely occur at 50–60 percent completion, and is anticipated to be six weeks after system startup.
- Energy usage. Energy usage will be measured by voltage, current, and power.
  - Site-wide measurements. The total power usage to complete the remedial action is estimated to be 280,000 kilowatt hours (kWh). As the power usage approaches the total, the peak temperature will approach the target temperature of 100^{o} C.

- Individual electrode measurements. The total power usage to each electrode will determine if certain areas are requiring additional or less energy to reach benchmarks. If certain electrodes are utilizing less energy, the energy can be utilized by electrodes identified as requiring more energy. This will maintain consistent heating throughout the formation.

- Vapor stream volatile concentration and treatment efficiencies. Monitoring concentrations of COCs will identify when certain removal levels, including final remedial levels, are achieved. It will also identify when, and if, carbon filter change outs are required.
- Total mass removal. Monitoring mass removal will identify when the Dry Cleaner Building Property is below remedial levels based on initial mass estimates.
- Total water recovered. Identification of water removal rates and total mass will identify when the formation is dewatered due to heating, and if water needs to be reinjected into the subsurface to improve mass recovery. This number will be broken out into two subsets of total water discharged and total water reinjected.
- Applied subsurface vacuum and flow rate. The flow and concentration of vapors from the subsurface will be used to calculate total mass removal, further vacuum and flow will be used to identify any abnormal conditions that affect the remediation.

5.7.7 Operational Requirements

The system will be operated within the regulations and operating parameters of the applicable permits and HASPs. Requirements to operate the system include access to the following:

- Electrical service for 260,000 kWh of electrical energy for subsurface heating, and 20,000 kWh for surface equipment
- Liquid GAC treatment sufficient for water discharge
- Discharge water sampling, as required by the permit
- Water discharge location or method
- Vapor GAC treatment sufficient for vapor discharge
- Discharge vapor sampling, as required by the permit
- Ambient air monitoring, as required
- Potable water source with a minimum of 5 gallons per minute (gpm) flow.

5.7.8 Vapor System Monitoring

While operating, the vapor process stream will be monitored and sampled as required by the PSCAA discharge authorization. System monitoring and data collection will be further described once the PSCAA discharge authorization is obtained.

5.7.9 Vapor Stream Treatment

During operation the SVE blowers will draw contaminated air and vapor from the subsurface. The air and vapor will be processed through a condenser. The condenser will remove water vapor from the process stream and discharge it through a liquid stream. The remaining air and vapor will then be pumped through two pressure-rated GAC vessels. The GAC will adsorb the COCs with a clean airstream as the residual. The clean air will then be discharged to atmosphere in accordance with the discharge authorization.

5.7.10 Termination of Operation

During operation, TRS and SoundEarth will monitor the temperature of the formation, duration of peak temperature, energy usage, the vapor stream VOC concentrations, total mass removal, and total energy used. When the system reaches the target energy usage of 260,000 kWh or when soil analytical results indicates all areas are below the soil remediation level, the system will be de-energized. If it is determined all areas are not below the target concentration, the system can be restarted and operated for additional time to complete the cleanup.

5.8 CONFIRMATION OF REMEDIATION

Confirmation soil sampling will be conducted to confirm that the remediation level for soil of 14 mg/kg in remediation Areas 1, 2, and 3 have been achieved to procure a contained-out determination to allow for the disposal of the soil at a non-hazardous Subtitle D landfill. The confirmation soil sampling will be performed when the ERH performance data, including soil vapor recovery of COCs, temperatures, and energy input indicate that the remediation level has likely been achieved. The confirmation sampling event will consist of using a probe rig and collecting performance soil samples at locations determined by historical soil sampling data in the treatment area, performance soil vapor monitoring results from the ERH operations, and agreed on locations with Ecology to attain a contained-out determination for PCE-contaminated soil located within the designated remediation Areas 1, 2, and 3. Hot soil sampling procedures will be specified in the Sampling and Analysis Plan (SAP).

5.9 ELECTRICAL RESISTANCE HEATING SYSTEM DECOMISSIONING

Demobilization of the ERH system will occur within 60 days of cessation of operation. All surface and subsurface equipment will be removed. All piping will be removed and disposed of appropriately. Electrical service to the Dry Cleaner Building Property will be abandoned, as appropriate. Any other actions that must be taken to restore the ROW or the Dry Cleaner Building Property to a usable condition will also be completed during decommissioning. When they are no longer required, all TMPs and ERH electrodes will be removed during excavation, and the material will be disposed of at an appropriate TSDF.

6.0 CONSTRUCTION DEWATERING SYSTEM DESIGN AND IMPLEMENTATION

Installation and operation of a temporary construction dewatering system on the Dry Cleaner Building Property and in the ROW of Woodlawn Avenue Northeast will occur to remove contaminated groundwater from the subsurface, and to remove water from the construction area (Figure 16). Operation of the system will coincide with the excavation and well installation activities. Groundwater in the Shallow Zone flows roughly perpendicular to Woodlawn Avenue Northeast, and the dewatering system is designed to capture water leaving the Dry Cleaner Building Property (Appendix C). The dewatering system will prevent and minimize water infiltration to allow for excavation to the depth of approximately 14 feet bgs during redevelopment, as well as to remove or reduce the concentrations of PCE in groundwater in the Shallow Zone.

The dewatering system design elements are summarized below, shown on Figures 16 through 18 and discussed in greater detail in Appendix C. The temporary dewatering system will consist of the following:

- Trenches around the perimeter of the excavation, to dewater the Shallow Zone, and sump with a high-capacity pump at the north corner of the Dry Cleaner Building Property.
- Six of the injection wells located in the southern sidewalk of Woodlawn Avenue Northeast (Figure 18) will be utilized as temporary Shallow Zone dewatering wells during the construction as necessary.
- Four dewatering wells installed in the Deep Zone around the elevator pit.
- Two or more dewatering wells installed in the Deep Zone in the southern sidewalk of Woodlawn Avenue Northeast.

6.1 WELL DESIGN AND INSTALL

The dewatering system is based on the recommendations by Richard Martin Groundwater LLC and the full design is discussed in further detail in Appendix C).

The six wells installed in the Woodlawn Avenue Northeast ROW will be used to dewater the Shallow Zone, as necessary (Figure 18). These wells will be constructed of 4-inch-diameter blank PVC casing, flush-threaded to 0.020-inch slotted well screen. The bottom of each well will be fitted with a threaded PVC bottom cap. Each well will be completed with a bentonite seal extending down from the top of casing, which will be the approximate elevation at the base of the excavation. The annulus of the wells will be filled with #10/20 silica sand extending from the bottom of the bentonite seal to the total depth. The well completion will be recorded on boring log forms. The wells will be installed at 20-foot centers near the Dry Cleaner Building Property boundary. These wells will only be used to dewater the Shallow Zone as needed.

Four dewatering wells will be installed approximately 5 feet from the corners of the proposed elevator shaft excavation (Figure 16 and 17). The wells will be installed to a depth of 65 feet bgs and screened from the top of the lower soil zone to the bottom of the well. The dewatering evaluation indicated required pumping rates could be as high as 20 gpm per well.

Two contingency wells may be installed in the Woodlawn Avenue Northeast ROW if performance of the dewatering system demonstrates the wells are necessary, as measured by pressure head in the Deep Zone being too high. They will likely be installed once excavation has achieved the desired depth. If operated, the wells will likely produce an additional 10 to 20 gpm per well.

6.2 SYSTEM LAYOUT

The proposed layout of the dewatering wells for the Deep Zone is presented on Figure 16 and for the Shallow Zone on Figure 18. As discussed above, the dewatering system for the Deep Zone consists of four wells in along the perimeter of the elevator pit. Two contingency dewatering wells are proposed outside the excavation area, along Woodlawn Avenue Northeast, to facilitate the installation of injection wells. The decision to install the contingency dewatering wells will be made based on the observation of groundwater levels in existing monitoring wells.

The results of the dewatering system analysis for the Deep Zone, including the contingency dewatering wells, indicate an increase in the total pumping rate by approximately 10 to 20 gpm. Based on simulated hydraulic conductivity values, total pumping rate ranged from approximately 20 to 80 gpm. After 30 days of pumping, the total pumping rate decreases by approximately 25 to 30 percent.

Water captured by the dewatering system will be temporarily stored in a settling tank, passed through bag filters to remove particulates, and then treated with zero valent iron (ZVI) and GAC filtration systems prior to discharging to the sanitary sewer system. A flow meter will be installed prior to the discharge point to monitor volume discharged. See Figure 17 for a process and instrumentation diagram of the water treatment system. Discharge and sampling requirements will be stipulated in the discharge authorization permit.

6.3 EQUIPMENT INSTALL

Once the dewatering wells are installed and developed, the downwell pumps will be installed. Above grade equipment consisting of a water storage tank, bag filters; ZVI and GAC treatment units will be installed and process lines connecting the downwell pumps to the above-grade equipment will be completed. This will include electrical or pneumatic power and water discharge lines. System operations will be tested prior to full time operation.

7.0 EXCAVATION DESIGN AND IMPLEMENTATION

Once the remediation level for PCE in soil has been reduced to 14 mg/kg or less, and confirmed by compliance soil sampling, the treated soil will be excavated. The excavation will remove the contaminated soil in Areas 1 through 4 containing PCE and degradation products at concentrations that present a risk to human health and the environment. Additional excavation in potentially clean soil will occur in Area 5. The excavation will be bounded by the property lines of the Dry Cleaner Building Property and the South-Adjoining Property, as shown in the excavation plan (Figure 19). Shoring will be installed on the perimeter of the Dry Cleaner Building Property and the South-Adjoining Property. Excavation of the Dry Cleaner Building Property and the South-Adjoining Property shall commence once dewatering has begun and the post-ERH treated soil has cooled to 30^{o} C or less.

7.1 CONTAINED-OUT DETERMINATION

We estimate 8,782 tons of soil to contain detectable concentrations of PCE, which, if generated, would constitute a F002-listed dangerous waste (Figure 10). Under the Ecology-provided contingent management option, the Contained-Out Policy, Ecology may determine that the concentrations of PCE in soil are below risk-based levels and exempt from management as an F002 listed dangerous waste. After the completion of the ERH treatment, confirmation monitoring for soil will be conducted to verify that concentrations of F002-listed dangerous waste constituents are below the remediation levels required to obtain a contained-out determination from Ecology for soil with concentrations of PCE and its degradation compounds. Based on the anticipated extent of the remedial excavation and estimated extent of soil potentially requiring disposal, confirmation samples will be collected with direct-push borings advanced to confirm that F002-listed dangerous waste contaminated soils are below remediation levels designated for this Site (Figure 28). A contained-out request will be prepared and submitted to Ecology's Hazardous Waste & Toxics Reduction department requesting that an estimated 8,782 tons of PCE-contaminated soil be managed as non-dangerous waste.

The contained-out soil would be managed in accordance with the contained-out determination provided by Ecology. Requirements of a typical contained-out determination include the following:

- Soil will be transported directly to a permitted Subtitle D TSDF or a Washington State solid waste landfill permitted under Chapter 173-351 WAC.
- Copies of all signed soil waste landfill receipt records will be provided to Ecology in the specified amount of time.
- Soil will cool off to less than 30^{o} C prior to excavation.
- Concentrations of PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride in soil are less than 14 mg/kg, 40 mg/kg, 160 mg/kg, 1,600 mg/kg, and 0.67 mg/kg, respectively.
- Concentrations of leachable PCE, TCE, and vinyl chloride are less than 0.7, 0.5, and 0.2 milligrams per liter respectively. Soil samples with concentrations of PCE greater than 10 mg/kg will be analyzed for leachable PCE, TCE, and vinyl chloride using EPA Test Methods 1311/8260C.
- Concentrations of PCE, TCE, and vinyl chloride are less than the RCRA Land Disposal Restriction limit of 60 mg/kg for each compound.

Ecology will not use statistics to evaluate the analytical results for the contained-out determination, but instead use individual analytical results compared directly to the contained-out threshold concentrations for the PCE and its degradation products. If concentrations of PCE are greater than the remediation level, soil is not suitable for disposal under a contained-out determination. Excavated soil not suitable for disposal at a Subtitle D TSDF will be disposed of at a Subtitle C TSDF.

7.2 SHORING

Shoring will be installed around the entire perimeter of the redevelopment and will consist of soldier piles and lagging (Figure 19). The shoring along the southern property line of the South-Adjoining Property will also include tie backs. An example of the proposed shoring design is shown in Figure 19; however, the final shoring designs for the building may vary. Shoring will be designed by a qualified engineer and will be included in the building and permitting plans. Shoring will be installed as the excavation proceeds, to facilitate the safe excavation of contaminated soil to the total depth.

It is anticipated that soil removed from the perimeter during the shoring installation activities will meet the contained-out criteria for PCE for disposal at a Subtitle D TSDF. To meet the requirements of the contained-out determination, detectable concentrations of PCE must be below the remediation level. Approximately 350 cubic yards of soil cuttings from the perimeter of the excavation area will be removed from the perimeter of the excavation.

7.3 TEMPORARY EROSION AND SEDIMENT CONTROLS

All appropriate TESC will be implemented by the general contractor during the excavation. Relevant personnel shall meet with a representative of the City of Seattle prior to beginning excavation. TESC measures shall be installed prior to any Site construction, grading, clearing, or excavation, in accordance with regulations. All TESC shall comply with the Dry Cleaner Building Property and the South-Adjoining Property TESC plan and be properly maintained. Maintenance shall include regular inspections of all materials and inspections following storm events. Catch basins shall be inspected daily, and replacement of filters or sediment removal from catch basins shall be completed as needed.

All exposed stock piles shall be covered with plastic when the stock piles are not in use. Filter fence shall be used to prevent runoff from leaving the Dry Cleaner Building Property and the South-Adjoining Property. Stabilization of areas that will be undisturbed for 15 or more days is required. All water leaving the Dry Cleaner Building Property and the South-Adjoining Property, including water in trucks, shall be clean. Additional TESC may be added, modified, or removed by the street use inspector or DCI inspector. The turbidity of water leaving the Dry Cleaner Building Property and the South-Adjoining Property may not exceed 25 nephelometric turbidity units (NTU), and TESC must be increased or modified if necessary to meet the 25 NTU standard.

7.4 EXTENT OF EXCAVATION

The average ground surface elevation for the Dry Cleaner Building Property and the South-Adjoining Property is 177.84 feet NAVD88. The excavation limits will extend from lot-line to lot-line and to an average bottom elevation of approximately 164 feet NAVD88. Based on the averages of the ground surface and bottom of excavation elevations, the average depth of excavation will be approximately 14 feet bgs. See Figure 19 for a plan view of the excavation and Figures 7-9 for excavation cross sections.

Excavation of the elevator pit will extend deeper than the rest of the excavation to approximately 160.5 feet NAVD88. See Figure 19 for elevator pit location. It is anticipated that soil removed from the excavation area will meet the contained-out criteria for PCE for disposal at a Subtitle D TSDF. To meet the requirements of the contained-out determination, detectable concentrations of PCE must be below the remediation level. Approximately 8,782 tons of soil will be removed from the Dry Cleaner Building Property for off-Site disposal from all areas (Figure 10).

As Area 5 may have areas of limited contamination, any overburden soil encountered will be segregated to the extent practical, and disposed of at a proper TSDF. Soil will be confirmed as non-detect for COCs prior to disposal.

7.5 EXCAVATION SOIL CONFIRMATION GRID SAMPLING

Confirmation soil samples will be collected at the bottom of the remedial excavation once the design depth of the development has been reached. Confirmation samples will be collected within a surveyed grid to confirm that concentrations of PCE and other COCs are below the applicable soil cleanup levels. The sampling grid will be segregated into 25 discrete grid cells (GC01 through GC25), each measuring 20 feet by 20 feet. The samples will be collected in the center of each grid square at the limits of the remedial excavation (14 feet bgs). Analytical results for soil samples collected from the bottom of the remedial excavation will used to determine the residual concentrations of PCE and its degradation products at the design depth for the development. Soil concentrations will be compared to applicable soil cleanup levels. Grid sampling locations are shown on Figure 29.

Ten sidewall samples will be collected between Areas 4 and 5 only because shoring installed in conjunction with the redevelopment will prevent access to the remaining sidewall. Sidewall samples collected at depths of 6 and 12 feet bgs and/or where photoionization detector (PID) readings indicate the presence of elevated concentrations of volatile organic compounds. The purpose of sidewall samples between Areas 4 and 5 is to confirm that concentrations of COCs in Area 5 are below the applicable soil cleanup levels, and soil can be disposed of at a non-hazardous waste TSDF. Soil samples will be analyzed for COCs using U.S. Environmental Protection Agency (EPA) Method 8260C. Soil samples will be collected in accordance with the SAP. Samples will be analyzed in accordance with the methods presented in the CAP Quality Assurance Project Plan (QAPP; Ecology 2016).

7.6 UNKNOWN CONTAMINATION

The presence of aesthetic impacts and conditions encountered by Site employees and equipment operators during the construction excavation activities at the Dry Cleaner Building Property and the South-Adjoining Property may be indicative of conditions associated with affected environmental media. Equipment operators will be instructed to use the following criteria to alert the superintendent and construction manager of potential issues of previously unidentified contamination at the Dry Cleaner Building Property and the South-Adjoining Property. Any of the following occurrences are considered common-sense criteria that may require a mitigation or remediation response. These criteria include, but are not limited to, the following:

- Obvious petroleum staining, sheen, or colored hues in soil or standing water.
- The presence of petroleum products or leachate of other chemicals.
- The presence of utility pipelines with sludge or trapped liquid indicating petroleum or chemical discharge sludge.
- The presence of buried pipes, conduits, tanks, or unexplained metallic objects or debris.
- Materials with a granular texture that suggests industrial origin.
- Vapors causing eye irritation or nose tingling or burning.
- White, chalky compounds or fine particulate soil layers.
- The presence of gasoline- or oil-like vapor or odor.
- The presence of burnt debris or slag-like material.

Any criteria identified by on-Site personnel will be evaluated, and a SAP will be developed, as appropriate, to properly characterize and manage the material in accordance with state and federal regulations.

8.0 ENHANCED REDUCTIVE DECHLORINATION DESIGN AND IMPLEMENTATION

Following completion of ERH treatment and the excavation of contaminated soil, it is anticipated that residual concentrations of COCs in groundwater exceeding the applicable cleanup levels will be remain beneath the Site. ERD will degrade the remaining COCs. The cleanup objective for ERD is to reduce the concentration of COCs in groundwater to less than the applicable MTCA cleanup levels. The implementation of ERD involves the injection of emulsified vegetable oil (EVO). The injected EVO will act as a carbon source for the co-metabolism of the remaining COCs in soil and groundwater. The EVO selected for this remedial action is the Tersus Environmental product EDS-ER. EDS-ER is a vegetable oil that self-emulsifies on contact with water (Appendix A). Once mixed with water on-Site, the EVO will emulsify, forming droplets with an average diameter of 1 micron. EDS-ER does not contain any water until it is mixed on-Site. ERD is based on biological activity, and as such, part of the advantage of this treatment is that future injections can be implemented and improve the remedial action.

EVO functions as a carbon source, which during fermentation releases an electron donor source. The electron donor can then be used by bacteria, like *Dehalococcoides*, which then respirate halogenated hydrocarbons to grow and reproduce. Initially, bacteria will consume any dissolved oxygen, nitrates, iron or sulfates in the subsurface for respiration, but after these are consumed COCs will be used. The respiration of the bacteria will dehalogenate PCE down the normal degradation pathway. PCE will degrade into TCE, TCE will degrade into the isomers of DCE, and DCE will degrade into vinyl chloride. Vinyl chloride will degrade into hydrocarbons that will degrade independently of the COCs.

One of the side effects of ERD is a production of hydrochloric acid and acetic acid. This will cause the subsurface to become more acidic. If Site conditions are or become too acidic for biologic activity, buffering of the subsurface may be necessary to prevent pH inhibition of the biological growth. It is not anticipated that this Site will require buffering due to measured pH in wells within the Site.

ERD will further reduce impacts to soil and groundwater within the treatment area, and will act as a barrier preventing the flow of contamination through the barrier and off-Site.

8.1 WELL DESIGN AND INSTALL

A hollow-stem auger drill rig will be used to advance 45 borings into the Shallow Zone and Deep Zone (Figures 20 and 21). Each injection well will be constructed of 2- or 4-inch-diameter blank PVC casing, flush-threaded to 0.020-inch slotted well screen. The bottom of each well will be fitted with a threaded PVC bottom cap. Each injection well will be completed with a bentonite seal extending down from the top of casing, which will be the approximate elevation at the base of the excavation. The annulus of the injection wells will be filled with #10/20 silica sand extending from the bottom of the bentonite seal to the total depth. The well completion will be recorded on boring log forms.

Of the 45 wells, 22 will have a single-screen and 23 will be dual-screened. Single-screen wells will have a coupler installed at the top of the well with reducing bushing, a close nipple, and a threaded ball valve. The dual-screen wells will have 2 segments of screen across the Shallow Zone and Deep Zone, and a blank piece of pipe between the 2 zones. Installed in the blank pipe between screens will be a specialized bushing solvent welded into place. This specialized bushing will have a port with a riser installed inside the well. Thus each dual-screened well will be separated into a nested well. Dual-screened wells will be finished with valves and a wellhead assembly to allow access to both screened intervals. See Figure 25 for the well construction details.

Single-screen wells and the upper screen of dual-screen wells will be screened from approximately 160 feet to 175 feet NAVD88 (15 feet). The Shallow Zone wells in the excavation will have their screens terminated at the bottom of the excavation. The rat slab will then act as a seal for those wells.

Dual-screened wells will be installed with a bottom of approximately 130 feet NAVD88 and screened to approximately 155 feet NAVD (25 feet). The specialized bushing in dual-screened wells will be installed in the blank section between the screens. This bushing will have an outside diameter of approximately 2.067 inches (the same as the inside diameter of 2-inch nominal pipe) and a threaded inside diameter of approximately 1.315 inches (the same as the outside diameter of 1-inch nominal pipe). The bushing will then be solvent welded, according to manufacturer recommendations, inside the blank well casing, and a 1-inch-diameter PVC adapter and a 1-inch-diameter conveyance pipe will be installed into the bushing (Figure 25). The conveyance pipe will run up the interior of the well casing and pass through a specialized wellhead fitting. Each dual-screened injection well will have a dedicated conveyance pipe that connects to the injection well head and system piping.

Wells will be spaced in 5 transects, Transects A through E, on 10-foot centers (Figures 20 and 21). Transects A through C will be on the Dry Cleaner Building Property, Transect D will be on the southeast sidewalk of Woodlawn Avenue Northeast, and Transect E will be on the northwest sidewalk. All locations are subject to relocation as field conditions require.

Injection wells that are not in the building footprint will be finished 3 to 12 inches below final grade and have an H-20 traffic-rated monument set around them flush with the final grade. Wells in the building footprint will be routed below the building to an access vault on the southwest side of the building. The access vault will have an H-20 traffic rated lid set flush with the final grade. The injection wells will be stubbed up and capped in the vault and labeled for potential future injections.

8.2 INJECTION EQUIPMENT

SoundEarth will provide a portable automated multipoint injection system skid (injection skid) for the injection of EVO. The equipment will be powered by an on-Site electrical service or by portable generator, and water will be provided from a fire hydrant or from the Dry Cleaner Building Property water supply. The injection system is capable of injecting into 10 wells simultaneously, up to 20 gpm, and up to 55 pounds per square inch (gauge pressure). Once mobilized to the Dry Cleaner Building Property, the injection system will be attached to the injection points using flex tubing. The injection skid will then be programmed for the design volume to each well and the maximum pressure for injection.

The system will use the water supply to power up to two Dosatron metering pumps. The Dosatron metering pumps will then draw up the EDS-ER and inject it into the water stream. The Dosatron pumps have a range of 5–20 percent addition rate of EDS-ER. The process stream of EDS-ER and water will then self-emulsify creating a homogenous injectate. The emulsified EDS-ER will then flow through the injection system and be distributed through a manifold to process lines and to the wells.

The system will meter each leg of the manifold, and when the proper volume of EVO has been injected the system will close the manifold leg. If pressure exceeds the operational maximum, the system will close the manifold leg and, after a preset time, the valve will reopen and continue with the injection.

The system is capable of shutting down if it loses power, preventing unregulated flow. Once a well has received its allotment of emulsified EDS-ER, the line can be moved to the next well and a new volume can be programmed. A process and instrumentation diagram is provided on Figure 26.

8.3 SHALLOW ZONE INJECTIONS

EDS-ER, an EVO, will be injected into the Shallow Zone. This EVO is 100 percent fermentable and contains no water. It contains food-grade soybean oil, food-grade vegetable oil, and fatty acid esters (derived from the oils), but does not contain preservatives. All components are classified as “Generally Recognized as Safe.”

To ensure that the proper nutrients are present in the subsurface, Nutrimens by Tersus Environmental will also be added. Nutrimens is an all-natural bio fermentation product produced during the fermentation of an unmodified strain of botanical classification *Saccharomyces cerevisiae*. It is designed to enhance the kinetics and efficiency of microbial systems.

Other advantages of Nutrimens are that it provides a source of soluble donor and it contains over 12 percent total carbon. Shallow Zone injections will consist of a 12 percent EDS-ER, 1 percent Nutrimens, and 87 percent water emulsion. Approximately 500 gallons of emulsion will be injected into each Shallow Zone injection point.

8.4 DEEP ZONE INJECTIONS

EDS-ER will also be used for Deep Zone Injections. To ensure that the proper nutrients are present in the subsurface, Nutrimens will also be added. Deep Zone injections will consist of a 12 percent EDS-ER, 1 percent Nutrimens, and 87 percent water emulsification. Approximately 1,000 gallons of emulsion will be injected into each Deep Zone injection point.

8.5 BIOFOULING

When injecting the carbon substrate, SoundEarth will chase the substrate with water to push the injectate into the formation which in turn reduces biofouling at the well. If biofouling occurs it may results in an increased pressure or extended duration of time to inject the carbon substrate, reduced water quality, higher iron or manganese concentrations, and increased bacteria counts. Fouling through biological activity can occur due to four primary mechanisms: the physical presence of extracellular slimes that are excreted by bacteria to aid in their attachment to surfaces within the well bore or formation, accumulation of soil particles and precipitated minerals within those slime layers, occlusion due to gas generation from active bacteria, and corrosion of well components associated with biological activity generating hydrogen sulfide or organic acids. When biofouling occurs, it typically is seen as a white, gray, orange slime on the water in the well. In addition, sometimes a rotten egg, fishy, earthy, sewage and/or vegetable smell can be observed.

At the Site, if biofouling is observed, the injection wells will be treated by mechanical agitation, by surging, water jetting, scrubbing, and/or air sparging to remove the fouling agent. Ethyl lactate, which functions as a surfactant, may be added to the wells to scrub away the fouling agent. In addition, the injections wells can be flushed with water to remove suspended or soluble debris that have been physically removed by mechanical agitation.

8.6 WELL DECOMISSIONING

Upon completion of the Ecology-required confirmation monitoring, the injection wells will be decommissioned in accordance with the Ecology Water Well Construction Act (1971), RCW 18.104 (WAC 173-160-460). The wells will be decommissioned in place using bentonite clay chips or slurry or equivalent under the supervision of a licensed well driller or professional engineer.

8.7 CONTINGENCY INJECTION PIPING AND INJECTIONS

After injections, all well head connections on the Dry Cleaner Building Property will be modified and additional conveyance piping will be added. The new conveyance piping will be plumbed to and fixed into an access vault on the southwest side of the future building. See the dewatering plan sheet EVL 1.1 in Appendix D for the location of the contingency conveyance piping.

Future injections will be determined based on the response of the Site to the planned injections. If the response by the Site to the injections does not indicate achieving the cleanup within the 30-year time frame, additional injections will be considered. Future contingency injections will be defined by, and optimized based on, groundwater monitoring and correspondence with Ecology. The installed piping can be used for future injections. Future injections may include any one or combination of the following: EVO, nutritional supplements, bacterial culture, buffering agents, an alternative carbon source, or ZVI.

9.0 ENGINEERED CONTROLS

The RAO for the engineering controls is to prevent COC vapors above the indoor air standards inside the building. The standards that shall be used for indoor air intrusion are listed below:

- PCE—9.60 µg/m^3, MTCA Method B carcinogenic cleanup level, standard formula value
- TCE—0.37 µg/m^3, MTCA Method B carcinogenic cleanup level, standard formula value
- Cis-1,2-DCE—MTCA Method B non-carcinogenic cleanup level not established
- Trans-1,2-DCE—2.74 µg/m^3, MTCA Method B non-carcinogenic cleanup level, standard formula value
- Vinyl chloride—0.28 µg/m3, MTCA Method B carcinogenic cleanup level, standard formula value

The engineering controls include three components: a sub-slab drainage system that will collect Shallow Zone groundwater and drain it into a centrally located sump; a vapor barrier that will be installed below the foundation slab to mitigate potential vapor intrusion of soil gas to indoor air quality within the building; and a passive ventilation system that will alleviate any vapors that may accumulate beneath the vapor barrier. The water will be pumped through filter media to remove any contaminants, before discharge of the wastewater to the sanitary sewer.

9.1 SUB-SLAB DRAINAGE SYSTEM

A permanent sub-slab drainage system will be installed within the footprint of the new building footprint. The primary functions of the sub-slab drainage system are to minimize the amount of groundwater in contact with the vapor barrier and to drain water collected between the soldier pile shoring system and shotcrete wall. The design drawings for the sub-slab system are included in Appendix D.

The sub-slab drainage system will be installed beneath the concrete foundation slab and vapor barrier and above the concrete rat slab. The sub-slab drainage piping will be installed within an approximate 1-foot-thick layer of drainage rock.

The sub-slab drainage system will consist of 12 lines that will connect to 2 header lines and then drain into a water collection sump. The 6 collection lines on the northeast side of the sump will drain to 1 header. The 4 collection lines on the southwest side of the sump will drain to the other header. Two lines will drain directly into the sump (Appendix D, Figure EVL 1.1). Sump placement and line branching is determined by the final depth and design of the building foundation.

The water collection sump will be equipped with 2 sump pumps. The pumps will be Liberty Pumps model number FL104M-3, and will run on 460 Volt 3-phase power. The pumps will be controlled by Liberty Pumps AE-Series controllers with high and low level switches.

The water discharge will be routed through 2 pressure-rated vessels filled with a filter media. Media will be determined based on the initial water recovery and concentrations of COCs from the sub-slab system. Each vessel will be plumbed with valves for the isolation of each vessel, and equipped with pressure gauges prior to the first vessel, between the vessels, and after the second vessel. Sample ports will also be installed pre, post, and midpoint for any sampling the discharge permit requires.

The sump will have a vent pipe that will vent any vapors to the atmosphere, and prevent buildup of vapors in the sump and in the garage. The vent will be placed away from locations where the vapors can be inhaled or drawn into the building ventilation system.

9.2 VAPOR BARRIER

The vapor barrier to be installed will be Liquid Boot (Appendix E). This vapor barrier is a barrier that creates a physical barrier between any subsurface vapors and the building foundation. This barrier was selected due to extremely low permeability and resistance to COCs and other chemicals. Prior to pouring of the foundation slab, the barrier will be sprayed on to the prepared surfaces. Application will be by professional installation technicians and will include application on all piping or conduits into and through the foundation slab.

9.3 PASSIVE VENTILATION SYSTEM

The sub-slab drainage system will double as a vapor collection piping for passive sub-slab ventilation. The vapors in the formation will collect in the drainage piping, before flowing to the sump. The sump of the sub-slab drainage system will have a vertical conduit, with a minimum nominal diameter of 4 inches, installed to the roof. The installed vent conduit will vent any accumulating vapors to atmosphere, and prevent buildup of vapors under the building. The vent will be installed away from locations where the vapors can be inhaled or drawn into the building ventilation system. The top stack will be capped with a non-restricting rain guard to prevent any debris, animals, or fluids from going down the conduit. The conduit will be fastened to the roof appropriately, and will extend at least 2 feet above the roof, and will not be located within 10 feet from any window, door, or building air intake.

The depressurization of the subsurface will occur as a result of convective air currents up and out of the building. As the air in the pipe warms while inside the building, it will rise creating a slight vacuum. This conductive vacuum will draw vapors from the sump up into the conduit before heating and rising out the top stack. The displacement of vapors in the sump will draw vapors from the collection piping, and thereby the formation. See Appendix D for the piping and sump layout.

10.0 COMPLIANCE MONITORING

The following section discusses the groundwater performance monitoring program to monitor the performance of the cleanup action.

10.1 GROUNDWATER PERFORMANCE MONITORING FOR THE REMEDY

Performance of the cleanup action and its impact on groundwater quality at the Site will be evaluated using first-order decay rate constants and analysis of plume stability to assess effectiveness of the remediation of the Shallow Zone and Deep Zone. Specifically, point decay rates will be derived from single well concentrations versus time plots (linear regression) to determine the point decay rate and how long the Shallow Zone and Deep Zone groundwater plumes will persist and whether the plumes are expanding, shrinking, or stabilizing. In accordance with Ecology *Guidance on Remediation of Petroleum-Contaminated Ground Water By Natural Attenuation* (Ecology Guidance 2005), a shrinking plume is confirmed if the confidence level is greater than 85 percent, the slope of the linear regression line is negative, and the coefficient of variation less than or equal to 1.

The point decay rate will be used to determine the restoration time frame for each COC, where applicable, at each performance monitoring well. To evaluate the uncertainty in the calculated decay rates and restoration time frame that may result from the design of the monitoring well network, seasonal variation, and uncertainty in sampling methods and laboratory analysis, a predetermined confidence level of 85 percent for each point decay rate at each well will be used. The 85 percent confidence level represents the probability that the true rate of decay is within the lower and upper limits confidence interval for the calculated decay rate. The selected confidence level is in accordance with the 2005 Ecology Guidance. Refer to Section 3.3.3 for the degradation rates and pathways of the COCs.

For COCs in groundwater at the Site, Ecology selected a 30 year restoration time frame that will commence two quarters after the final implementation of the remedy. The final implementation of the remedy, as discussed in the CAP, is the injection of carbon substrate into the groundwater to enhance biological degradation (Ecology 2016). Groundwater analytical results collected for a period of 8 quarters will be used to calculate decay rates and the subsequent restoration time frame. The restoration time frame will be presented as number of years to achieve the restoration time since the second quarter after the final implementation of the remedy.

For example, if the final injection event occurs in the third quarter of 2016, the first of eight quarters of groundwater performance monitoring sampling will begin in second quarter of 2017. After eight quarters of collecting groundwater analytical results, concentrations versus time plots will be used to estimate the time since second quarter of 2017 to achieve the restoration time frame and estimate of the date to achieve restoration.

For groundwater at the Site, the estimated restoration time frame will be based on achieving the cleanup level for vinyl chloride (0.2 µg/L), the last degradation compound in the reductive dechlorination of PCE. If the analysis of groundwater performance monitoring results indicate the restoration time frame for the Site is greater than 30 years, contingency measures will be implemented in consultation with Ecology to ensure the time frame is achieved.

10.2 GROUNDWATER PERFORMANCE SAMPLING METHODS AND FREQUENCY

After completing the initial ERD injection event at the Site, groundwater performance monitoring will begin two quarters thereafter and continue for eight quarters. Shallow Zone and Deep Zone monitoring wells outside of the Dry Cleaner Building Property boundary will be monitored for PCE; TCE; cis-1,2-DCE; trans-1,2-DCE; vinyl chloride; and natural attenuation parameters. Performance monitoring results will be used to evaluate primary and secondary lines of evidence to support the conclusion that ERD is occurring in the groundwater at the Site.

Primary lines of evidence will include analytical data that define a contaminated groundwater plume as shrinking, stable, or expanding for the COCs, and time-series analyses to confirm the restoration time frame for the COCs will not exceed 30 years. If the analysis of groundwater analytical results indicates the 30-year restoration time frame may not be achieved, a contingency injection event may be implemented in consultation with Ecology.

Secondary lines of evidence for natural attenuation will include the evaluation of geochemical indicators (dissolved oxygen, oxidation-reduction potential, pH, alkalinity, nitrate, total manganese, ferric and ferrous iron, sulfate, methane, ethene, ethane, chloride, and fatty acids) for the impact of ERD on groundwater quality and estimates of attenuation rates and biodegradation capacity. The performance monitoring well network will include the following wells:

- Shallow Zone: MW-2, MW-3, MW-4, MW-5, MW-6, MW-15, MW-21, MW-24, MW-25 and MW-27, in addition to some wells from Transect D and E.
- Deep Zone: MW-7, MW-8, MW-9, MW-10, and MW-22, in addition to some wells from Transect D and E.

Groundwater performance monitoring groundwater samples will be analyzed for COCs and natural attenuation parameters, in accordance with the SAP for the CAP. Groundwater samples will not be analyzed for natural attenuation parameters at each sampling event, but at a frequency needed to monitor the biodegradation capacity of the groundwater and the performance of the ERD treatment.

10.3 INDOOR AIR SAMPLING METHODS AND FREQUENCY

Indoor air performance monitoring will not be performed after the redevelopment is complete because a permanent vapor barrier and a passive ventilation system will be installed beneath the concrete slab foundation as a preventive measure for managing potential soil vapor containing PCE and its degradation byproducts, and to provide long-term protection of the indoor air quality for future building occupants.

11.0 WASTE MANAGEMENT

The procedures for managing waste for each of the expected waste streams are discussed below. Specific documentation requirements will be met for transportation and disposal of the contaminated soil and groundwater during the excavation activities, as required by state and federal regulations. The waste disposal tracking documentation includes analytical data, waste profiles, waste manifests, and bills of lading.

11.1 SOIL

Soil will be generated during the following remedial actions, and disposed of as described. All soil will be profiled prior to disposal. Soil disposal will conform to all applicable state, federal, and local rules, regulations and requirements. Soil samples will be collected in accordance with the SAP. Samples will be analyzed for in accordance with the methods presented in the CAP QAPP (Ecology 2016).

- UST Decommissioning. Soil generated may have impacts in excess of 14 mg/kg. If concentrations in soil exceed this level, the soil will be disposed of following the procedure for disposal of PCE-contaminated soil, according to the Washington State Dangerous Waste Regulations (WAC 173-303). Dangerous waste soil will be disposed of at a Subtitle C landfill, or other appropriate facility. Any generated waste below 14 mg/kg may be subject to disposal as non-hazardous and disposed of at a Subtitle D landfill, or other appropriate facility. Generated waste soil from UST removal activities will be temporarily placed in plastic-lined containers, sampled for waste profiling, and taken to a TSDF for proper disposal.

- TRS Electrodes. Representative soil samples will be collected from soil cuttings stored in 55-gallon drums at the Site. The number of soil samples collected to characterize the soil for disposal will be based on the volume of soil cuttings in accordance *the Guidance for Remediation of Petroleum Contaminated Sites* (Ecology 2010). Soil cutting collected from drums will be analyzed for VOCs by EPA Method 8260C. Soil samples will be collected in accordance with the SAP. Samples will be analyzed in accordance with the methods presented in the QAPP.

- Excavation. Soil generated during the excavation with impacts less than 14 mg/kg will be subject to disposal under the contained-out determination, and disposed of at a Subtitle D landfill, or other appropriate facility. Thirty direct-push borings will be advanced to a maximum depth of 16 feet bgs in Areas 1 through 4. Eleven borings will be advanced in the ERH treatment Areas 1 through 3, and 19 borings in Area 4, which will not be treated (Figure 28). After the soil temperature in the ERH treatment areas have cooled to 30^{o} C, soil samples will be collected from each soil boring. In Areas 1 through 3, the following soil borings will be advanced proximate to former borings that previously contained one or more soil samples with concentrations of PCE greater than 14 mg/kg:

    - SB1—at a minimum, soil samples will be collected at approximately 5–7 feet and 13–16 feet bgs
    - SB2—at a minimum, soil sample will be collected at approximately of 4–6 feet bgs
    - SB3—at a minimum, soil samples will be collected at approximately 6–8 feet and 14–16 feet bgs
    - SB27—at a minimum, soil samples will be collected at approximately 2.5 feet, 7.5 feet, and 12 feet bgs
    - SB37—at a minimum, soil samples will be collected at approximately 6 feet, 9.5 feet and 16 feet bgs
    - MW-7—at a minimum, soil samples will be collected at approximately 10 feet and 14–15.5 feet bgs

    Soil will not be used as fill at the Site or any other Property. Trucks and/or containers will be plastic-lined and covered during transportation to the solid waste landfill. Adequate measures will be taken to prevent spills and dispersion due to wind or rain erosion.

    Soil samples collected from the remaining borings advanced in Areas 1 through 4 will be collected at 6, 10, and/or 14 feet bgs (sample depths may vary based on PID readings). All soil samples will be screened with a handheld PID. Soil samples not analyzed will be archived at the laboratory. Soil samples <u>will not</u> be collected in accordance with TRS hot sampling protocols since the soil will have reached ambient temperature before sampling. Analytical results will be used to profile the soil cuttings for disposal at a Subtitle D landfill under a contained-out determination. Two to three soil samples will be collected from each boring and analyzed for PCE by EPA Method 8260C. Soil samples with concentrations of PCE greater than 10 mg/kg, but less than 14 mg/kg, will analyzed for leachable PCE, TCE, and vinyl chloride by EPA Test Methods 1311/8260C.

- Dewatering Well Installation. Soil generated from the Shallow Zone will have impacts less than 14 mg/kg and will be subject to disposal under the contained-out determination, and disposed of at a Subtitle D landfill, or other appropriate facility. Soil generated from the Deep Zone will be characterized and disposed of at an appropriate TSDF, based on the results of the characterization.
- Injection Well Installation. One hundred and thirty-five soil samples will be collected, three samples from each boring, in order to characterize the soil cuttings for disposal. At the time of drilling, all soil samples will be screened with a handheld PID. At a minimum, samples will be collected at the soil/water interface (approximately 8 feet bgs) and at the bottom of the each boring. Based on PID readings, an additional soil sample will be collected from the borings and analyzed. Analytical results will be used to profile the soil cuttings for disposal. Soil samples will be analyzed for VOCs using EPA Method 8260C. Alternatively, soil samples may be collected from soil cuttings stored in 55-gallon drums at the Site. The number of soil samples collected to characterize the soil for disposal will be based on the volume of soil cuttings in accordance the Guidance for Remediation of Petroleum Contaminated Sites (Ecology 2010). Soil cuttings collected from drums will be analyzed for VOCs by EPA Method 8260C. Soil samples will be collected in accordance with the SAP. Samples will be analyzed in accordance with the methods presented in the QAPP.

11.2 WASTEWATER

Water will be generated during the following remedial actions, and disposed of as described. Regardless of disposal method, disposal of all fluids will conform to all state, federal, and local rules, regulations and requirements.

- Water, if generated during the removal, cleaning, and decommissioning of the USTs will be collected, profiled, and disposed of properly at licensed facility.
- Well development, decontamination, and purge water will be collected, drummed, and disposed of properly at a licensed facility.
- Water captured by the ERH condensate treatment system will be pumped through liquid GAC prior to discharge on a batch basis or continuous basis to the sanitary sewer system, in accordance with the discharge authorization permit.
- Water captured by the dewatering system will be temporarily stored in a settling tank prior to discharge to the sanitary sewer system, in accordance with the discharge authorization permit.

11.3 VAPOR

Vapor will be generated during ERH treatment. Vapor will be pumped through at least two pressure-rated vessels, in series, containing GAC. The GAC will adsorb the COCs prior to discharging to the atmosphere, in accordance with the PSCAA discharge authorization. This process will generate GAC contaminated with PCE that will need to be profiled and removed off-Site for treatment and disposal at a licensed facility.

11.4 TANKS

All USTs and associated piping will be removed by the excavation contractor under the direction of the UST Decommissioner and placed on a truck for transport off-Site. The contractor will dispose of the tanks at an appropriate facility.

11.5 SPENT CARBON

When the GAC is saturated with PCE, it will be profiled for recycling or disposed following the procedure for disposal of PCE-contaminated waste, according to the Washington State Dangerous Waste Regulations (WAC 173-303). If classified as a dangerous waste it will be disposed of at a Subtitle C landfill, or other appropriate facility. It is expected that ERH will remove approximately 4,000 pounds of PCE which will be adsorbed into the GAC.

11.6 CONSTRUCTION AND MISCELLANEOUS

Construction and miscellaneous waste (including but not limited to: PPE, sampling equipment, concrete, asphalt, metals, etc.) will be segregated, cleaned to the extent practical, containerized, and disposed of at a municipal solid waste facility, recycling facility, or other appropriate facility.

12.0 LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, expressed or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report are derived, in part, from data gathered by others, and from conditions evaluated when services were performed, and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We do not warrant and are not responsible for the accuracy or validity of work performed by others, nor from the impacts of changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the use of segregated portions of this report.

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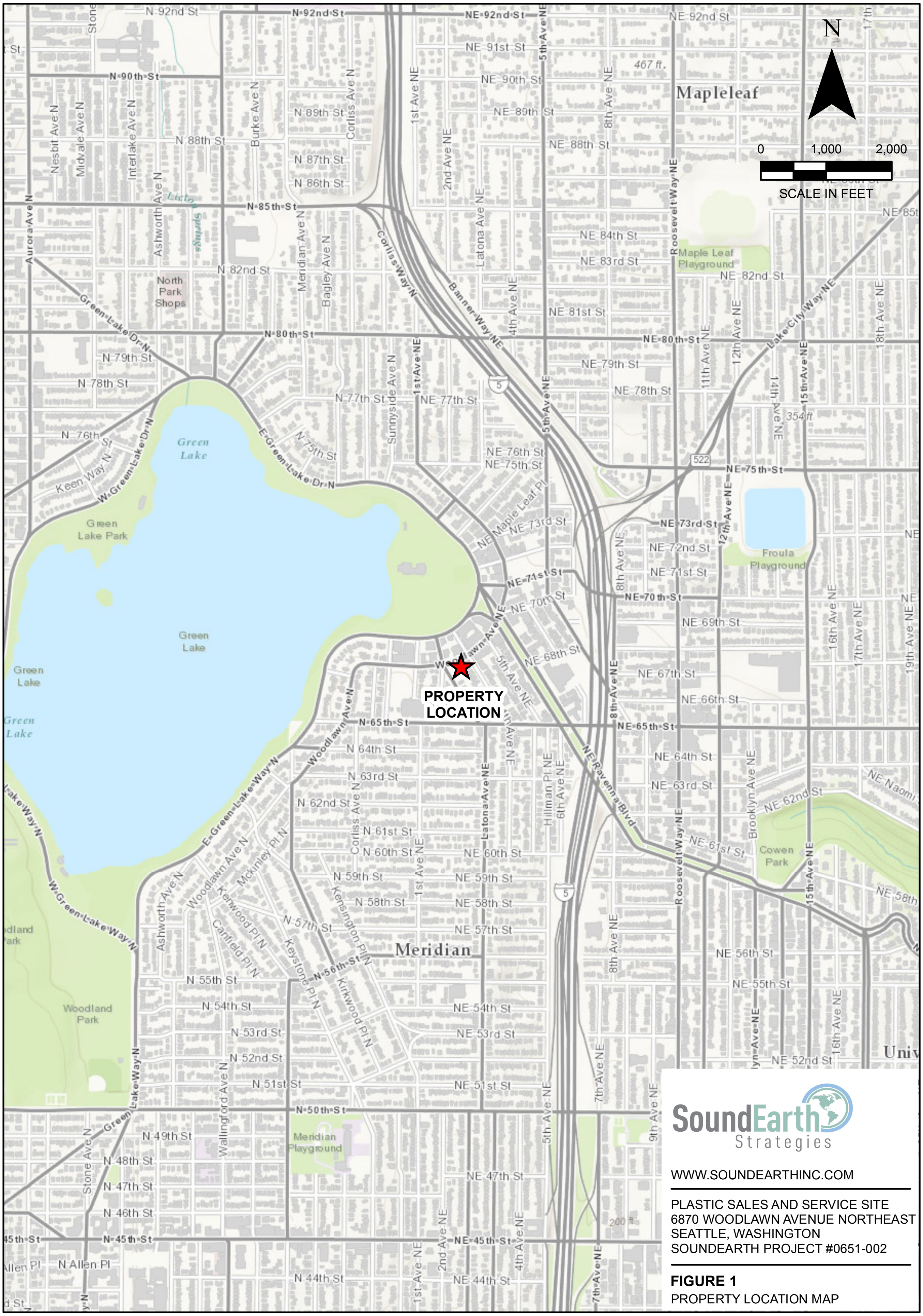
FIGURES



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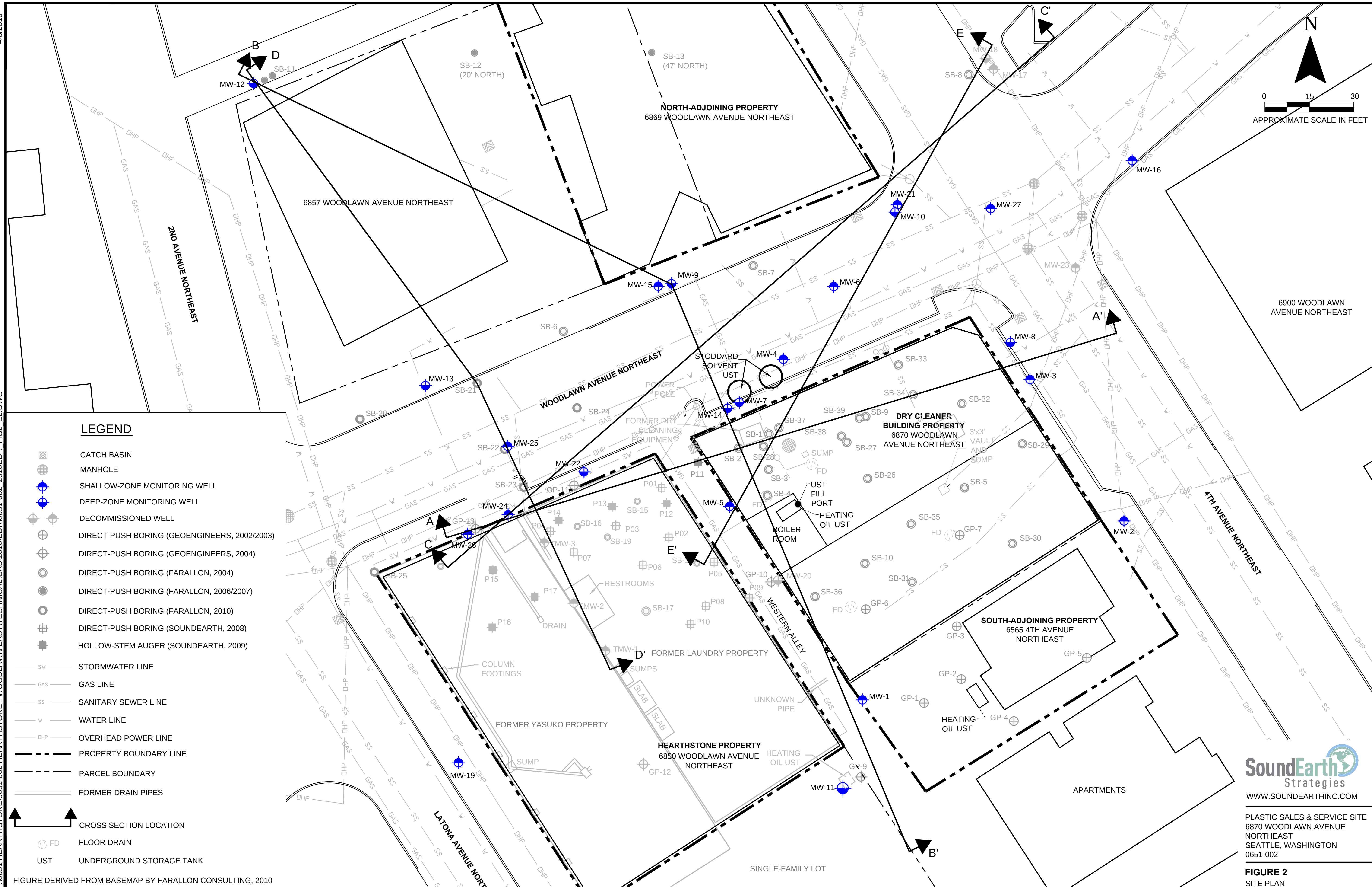
PLASTIC SALES AND SERVICE SITE
6870 WOODLAWN AVENUE NORTHEAST
SEATTLE, WASHINGTON
SOUNDEARTH PROJECT #0651-002

FIGURE 1
PROPERTY LOCATION MAP



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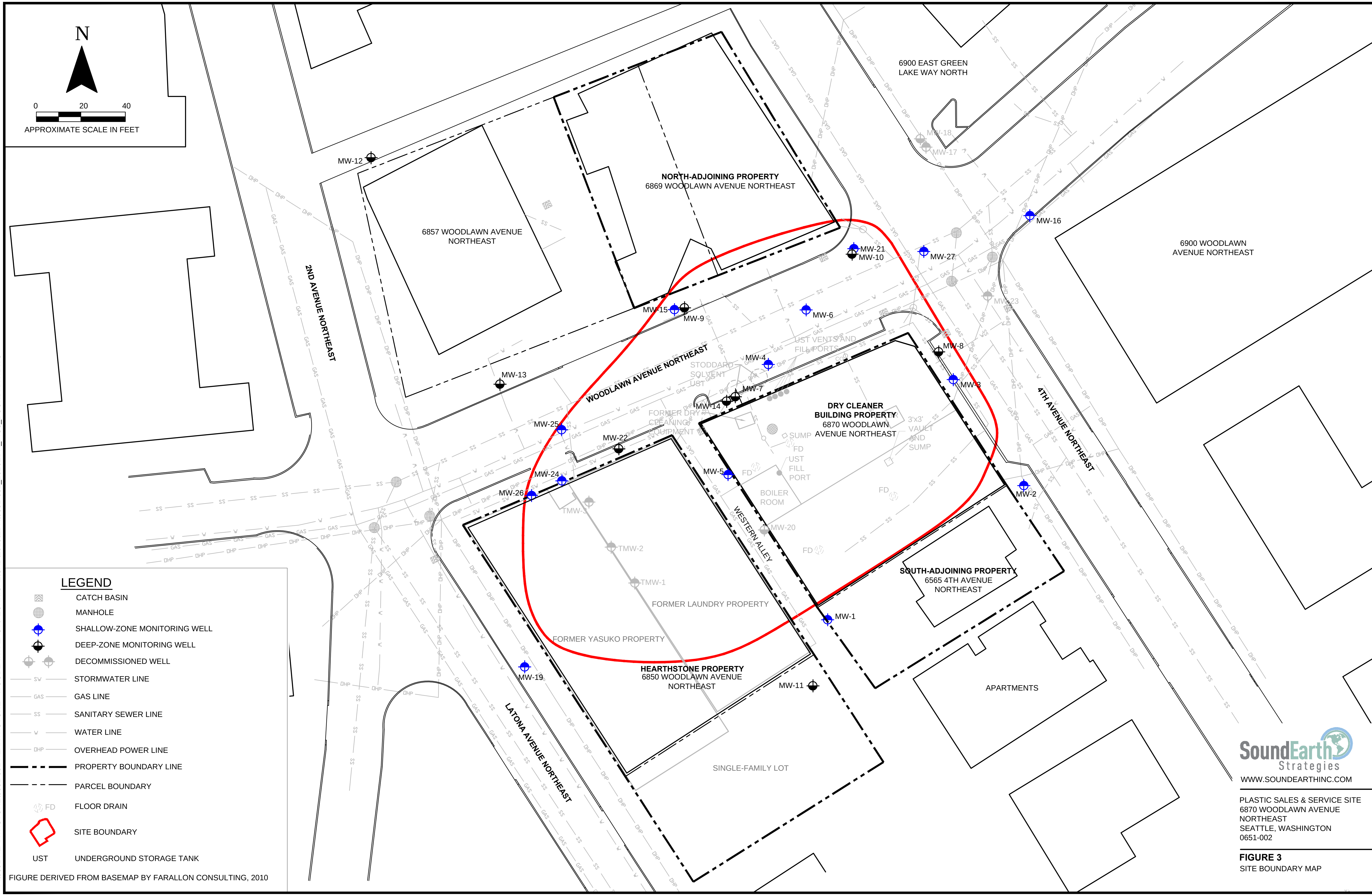
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG2_EL.DWG



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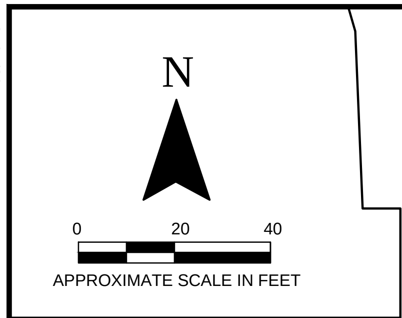

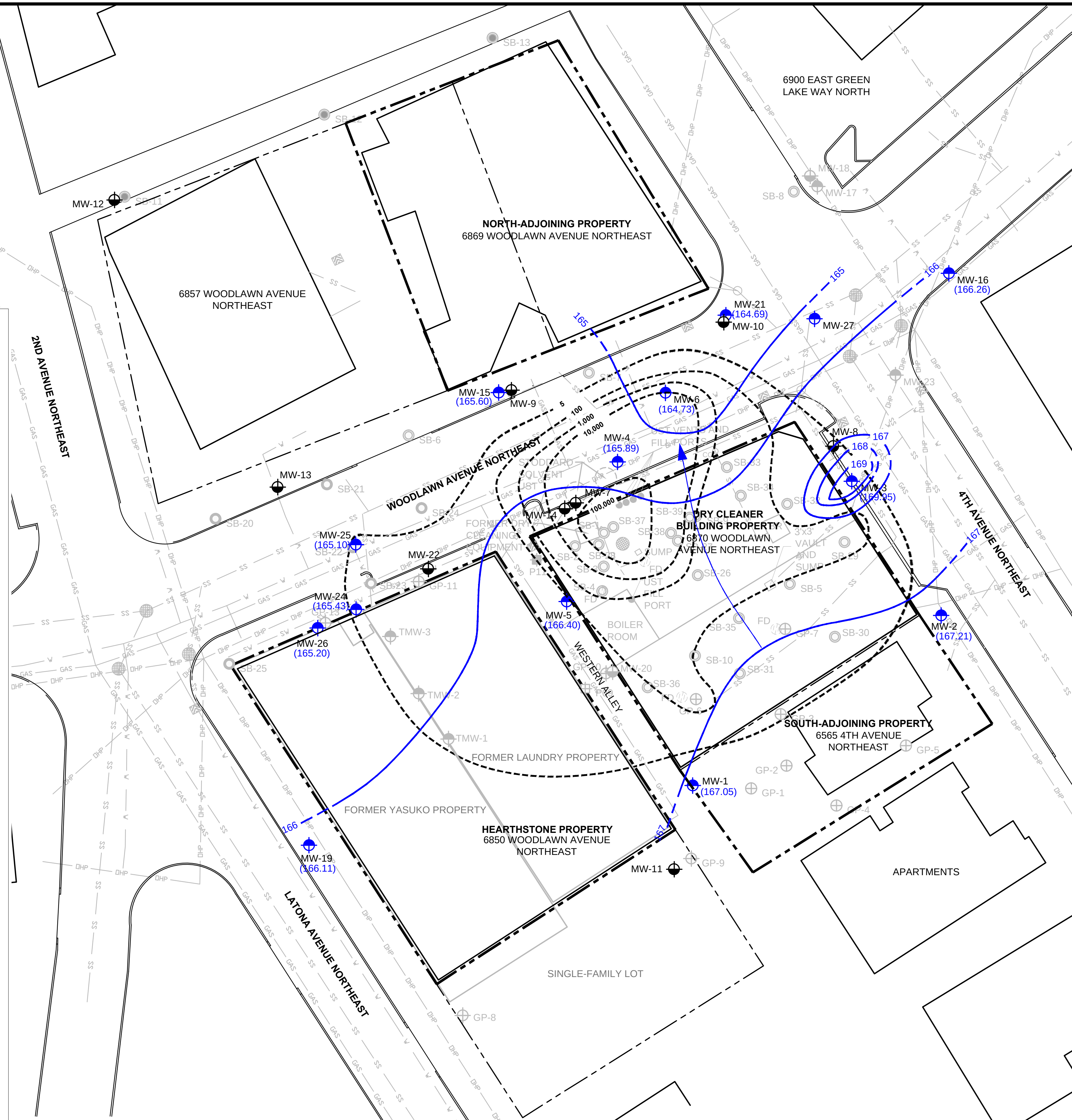

LEGEND

- CATCH BASIN
- MANHOLE
- SHALLOW-ZONE MONITORING WELL
- DEEP-ZONE MONITORING WELL
- DECOMMISSIONED WELL
- DIRECT-PUSH BORING (GEOENGINEERS, 2002/2003)
- DIRECT-PUSH BORING (GEOENGINEERS, 2004)
- DIRECT-PUSH BORING (FARALLON, 2004)
- DIRECT-PUSH BORING (FARALLON, 2006/2007)
- DIRECT-PUSH BORING (FARALLON, 2010)
- DIRECT-PUSH BORING (SOUNDEARTH, 2008)
- HOLLOW-STEM AUGER (SOUNDEARTH, 2009)
- (166.26) GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL (SEPTEMBER 9, 2014)
- 166 SHALLOW ZONE POTENTIOMETRIC SURFACE CONTOUR (SEPTEMBER 9, 2014)
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW (SHALLOW ZONE)
- SW STORMWATER LINE
- GAS GAS LINE
- SS SANITARY SEWER LINE
- W WATER LINE
- OHP OVERHEAD POWER LINE
- PROPERTY BOUNDARY LINE
- PARCEL BOUNDARY
- 5 PCE ISOCONCENTRATIONS IN SHALLOW ZONE GROUNDWATER
- FD FLOOR DRAIN
- DCE DICHLOROETHENE
- PCE TETRACHLOROETHENE
- TCE TRICHLOROETHENE
- UST UNDERGROUND STORAGE TANK
- MTCA WASHINGTON STATE MODEL TOXICS CONTROL ACT
- RED DENOTES CONCENTRATION EXCEEDS MTCA METHOD A OR B CLEANUP LEVEL

RESULTS REPORTED IN MICROGRAMS PER LITER

FIGURE DERIVED FROM BASEMAP BY FARALLON CONSULTING, 2010

Well ID	Sample Date	Analytical Results				
		PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl Chloride
MW-1	10/30/03	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
	06/02/06	1.1	< 0.2	< 0.2	< 0.2	< 0.2
	11/20/08	1.5	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	1.8	< 0.2	< 0.2	< 0.2	< 0.2
	09/10/14	1.6	< 0.2	< 0.2	< 0.2	< 0.2
MW-2	10/30/03	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
	06/01/06	< 0.2	5.5	< 0.2	< 0.2	< 0.2
	11/19/08	6.80	4.6	< 0.2	< 0.2	< 0.2
	05/04/10	9.50	3.5	< 0.2	< 0.2	< 0.2
	09/10/14	4.00	0.49	< 0.2	< 0.2	< 0.2
MW-3	10/30/03	170	< 2.0	< 2.0	< 2.0	< 2.0
	06/01/06	150	1.1	< 1.0	< 1.0	< 1.0
	11/19/08	230	1.6	2.0	< 1.0	< 1.0
	05/04/10	150	< 1.0	< 1.0	< 1.0	< 1.0
	09/10/14	64	0.58	0.79	< 0.2	< 0.2
MW-4	10/30/03	2,100	220	92	< 2.0	20
	08/05/04	860	1200	250	< 10	68
	06/02/06	1,100	730	590	< 10	170
	04/20/07	3,100	720	940	< 20	160
	11/20/08	10,000	640	1,100	< 50	130
	05/05/10	10,000	1,000	1,600	< 50	370
	09/10/14	28,000	3,400	3,800	< 200	920
MW-5	10/30/03	270	46	< 2.0	< 2.0	< 2.0
	06/01/06	54	9.6	3.3	< 0.4	< 0.4
	03/28/08	19	110	40	< 1	2.8
	11/20/08	86	67	37	1.4	5.5
	05/04/10	82	34	27	0.44	0.88
	09/11/14	71	22	5.6	0.27	< 0.2
MW-6	11/08/04	29	18	11	< 2.0	6
	05/04/10	4,100	330	440	< 20	110
	10/07/14	10,000	450	320	< 50	72
MW-15	06/01/06	0.22	< 0.2	< 0.2	< 0.2	< 0.2
	11/20/08	0.26	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/10/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-16	06/01/06	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	11/19/08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	05/05/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/09/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-17	06/01/06	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-19	03/28/08	< 1	< 1	< 1	< 1	< 0.2
	03/11/09	< 1	< 1	< 1	< 1	< 0.2
	05/03/10	< 1	< 0.2	< 0.2	< 0.2	< 0.2
	09/09/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-21	11/20/08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/09/14	< 0.2	< 0.2	< 0.2	< 0.2	0.73
MW-23	11/20/08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
MW-24	03/28/08	650	< 10	< 10	< 10	< 2.0
	11/20/08	360	3.4	< 2.0	< 2.0	< 2.0
	03/04/09	290	< 10	< 10	< 10	< 2.0
	05/05/10	40	0.42	< 0.2	< 0.2	< 0.2
	09/10/14	17	0.27	< 0.2	< 0.2	< 0.2
MW-25	05/04/10	14	0.31	1.1	< 0.2	< 0.2
	10/07/14	12	0.36	0.37	< 0.2	< 0.2
MW-26	05/04/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/10/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-27	07/01/11	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	10/07/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
TMW-1	04/05/10	15	0.29	< 0.2	< 0.2	< 0.2
	04/05/10	16	< 1	< 1	< 1	< 0.2
TMW-2	04/05/10	110	1.5	< 1.0	< 1.0	< 1.0
	04/05/10	150	1.5	< 1	< 1	< 0.2
TMW-3	04/05/10	310	3.6	< 2.0	< 2.0	< 2.0
	04/05/10	350	3.7	< 1	< 1	< 0.2
MTCA Cleanup Levels		5	5	16	160	0.2

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FIGURE 4

GROUNDWATER ANALYTICAL RESULTS FOR SHALLOW ZONE MONITORING WELLS

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P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG4_GD_S.DWG

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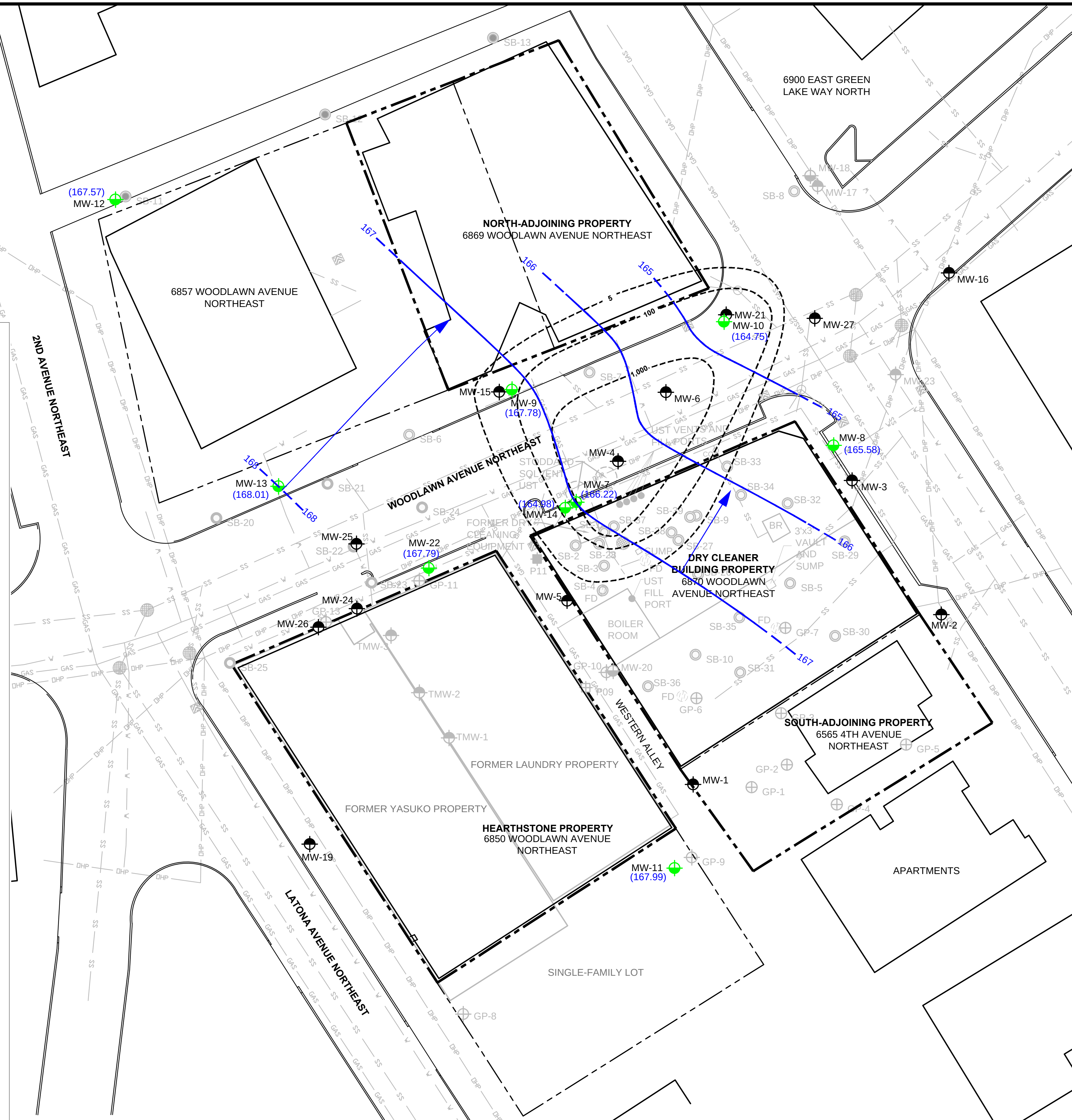

Well ID	Sample Date	Analytical Results				
		PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl Chloride
MW-7	11/19/04	7,000	47	< 20	< 20	< 20
	06/02/06	530	16	< 4.0	< 4.0	< 4.0
	04/20/07	2.5	< 2.0	< 2.0	< 2.0	< 2.0
	11/20/08	18.0	0.69	< 2.0	< 2.0	< 2.0
	05/04/10	12.0	0.49	< 0.2	< 0.2	< 0.2
	09/10/14	4.5	0.26	< 0.2	< 0.2	< 0.2
MW-8	11/19/04	0.36	< 0.2	< 0.2	< 0.2	< 0.2
	06/01/06	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	11/19/08	0.70	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/09/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-9	11/19/04	210	< 1.0	< 1.0	< 1.0	< 1.0
	06/01/06	390	< 2.0	< 2.0	< 2.0	< 2.0
	04/20/07	410	< 2.0	< 2.0	< 2.0	< 2.0
	11/20/08	220	< 2.0	< 2.0	< 2.0	< 2.0
	05/04/10	190	< 0.2	< 0.2	< 0.2	< 0.2
	09/10/14	89	< 0.2	< 0.2	< 0.2	< 0.2
MW-10	11/19/04	2.50	< 0.2	< 0.2	< 0.2	< 0.2
	06/01/06	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	04/20/07	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	11/20/08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	3.30	< 0.2	< 0.2	< 0.2	< 0.2
	09/10/14	600	< 0.2	< 0.2	< 0.2	< 0.2
MW-11	06/02/06	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	11/20/08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	05/03/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	10/07/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-12	06/02/06	0.76	< 0.2	< 0.2	< 0.2	< 0.2
	11/19/08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	05/03/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/09/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-13	06/02/06	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	04/20/07	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	11/19/08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	05/03/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/09/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-14	06/02/06	0.99	< 0.2	< 0.2	< 0.2	< 0.2
	03/25/07	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	04/20/07	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	11/20/08	1.10	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/10/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-18	06/01/06	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MW-20	11/20/08	0.28	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
MW-22	11/20/08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	05/04/10	< 1.0	< 0.2	< 0.2	< 0.2	< 0.2
	09/10/14	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
MTCA Cleanup Levels		5	5	16	160	0.2

LEGEND

- CATCH BASIN
- MANHOLE
- SHALLOW-ZONE MONITORING WELL
- DEEP-ZONE MONITORING WELL
- DECOMMISSIONED WELL
- DIRECT-PUSH BORING (GEOENGINEERS, 2002/2003)
- DIRECT-PUSH BORING (GEOENGINEERS, 2004)
- DIRECT-PUSH BORING (FARALLON, 2004)
- DIRECT-PUSH BORING (FARALLON, 2006/2007)
- DIRECT-PUSH BORING (FARALLON, 2010)
- DIRECT-PUSH BORING (SOUNDEARTH, 2008)
- HOLLOW-STEM AUGER (SOUNDEARTH, 2009)
- (166.26) GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL (SEPTEMBER 9, 2014)
- 166 SHALLOW ZONE POTENTIOMETRIC SURFACE CONTOUR (SEPTEMBER 9, 2014)
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW (SHALLOW ZONE)
- SW STORMWATER LINE
- GAS GAS LINE
- SS SANITARY SEWER LINE
- W WATER LINE
- OHP OVERHEAD POWER LINE
- PROPERTY BOUNDARY LINE
- PARCEL BOUNDARY
- 5 PCE ISOCONCENTRATIONS IN SHALLOW ZONE GROUNDWATER
- FD FLOOR DRAIN
- DCE DICHLOROETHENE
- PCE TETRACHLOROETHENE
- TCE TRICHLOROETHENE
- UST UNDERGROUND STORAGE TANK
- MTCA WASHINGTON STATE MODEL TOXICS CONTROL ACT
- RED DENOTES CONCENTRATION EXCEEDS MTCA METHOD A OR B CLEANUP LEVEL

RESULTS REPORTED IN MICROGRAMS PER LITER

FIGURE DERIVED FROM BASEMAP BY FARALLON CONSULTING, 2010

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG5_GD_D.DWG

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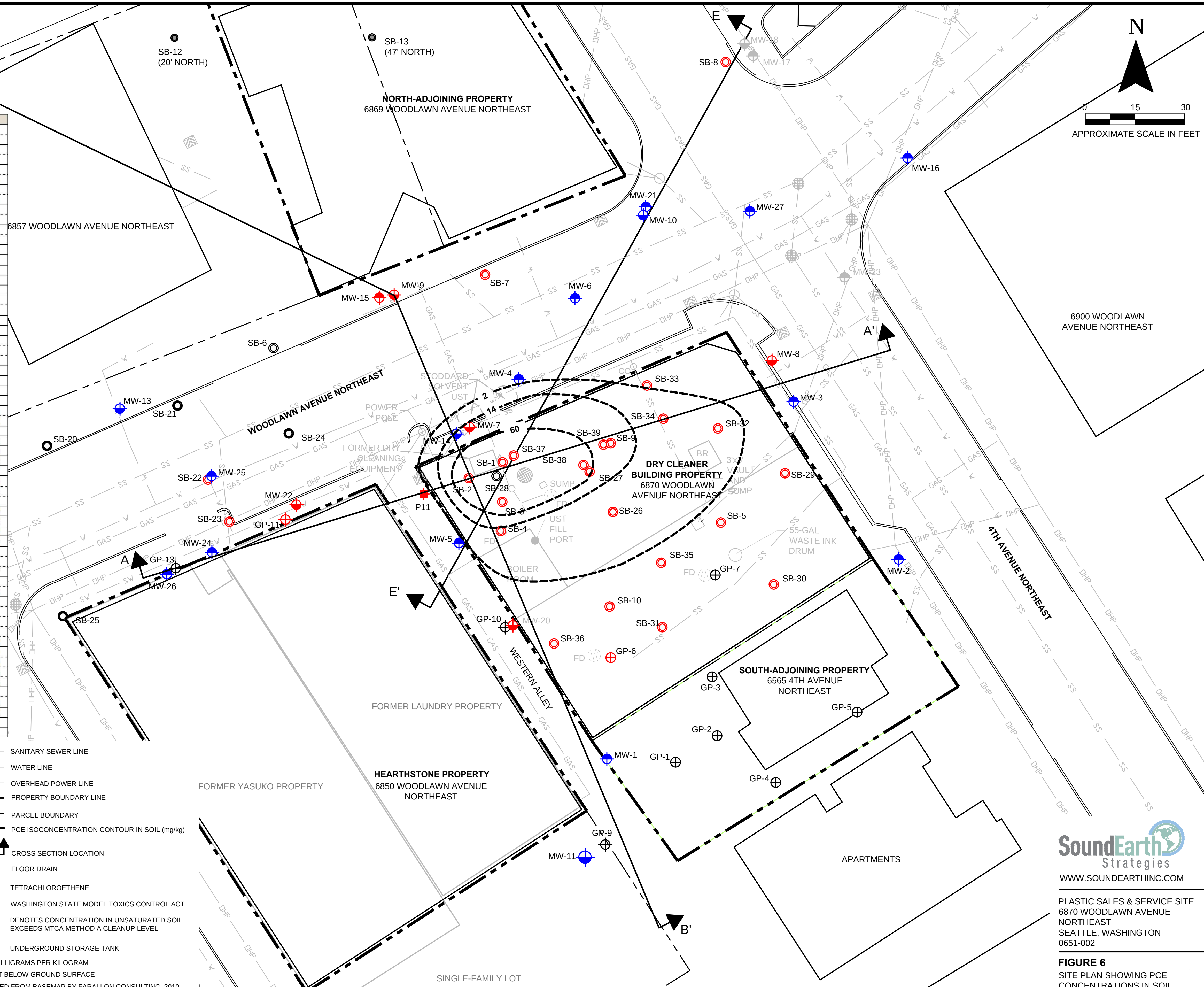
SEATTLE, WASHINGTON
0651-002

FIGURE 5

GROUNDWATER ANALYTICAL RESULTS FOR DEEP ZONE MONITORING WELLS

Sample ID	Depth	PCE
GP-6-6	6	0.266
GP-7-8	8	<0.005
GP-9-9	9.0	<0.010
GP-10-12	12.0	<0.010
GP-11-6	6.0	1.50
GP-11-8	8.0	0.22
GP-13-4	4.0	<0.010
GP-13-14	14.0	<0.010
SB1-5-7	5 to 7	230
SB1-13-16	13 to 16	58
SB2-4-6	4 to 6	190
SB2-14-16	14 to 16	64
SB3-6-8	6 to 8	240
SB3-14-15.5	14 to 15.5	570
SB4-6-8	6 to 8	7.0
SB4-10-12	10 to 12	4.2
SB5-6-8	6 to 8	1.2
SB5-14-16	14 to 16	0.076
SB7-2-4	2 to 4	0.17
SB7-15-18	15 to 18	0.38
SB8-2-4	2 to 4	0.46
SB9-4-6	4 to 6	29
SB9-8-10	8 to 10	1.3
SB10-4-6	4 to 6	0.64
SB10-10-12	10 to 12	0.23
SB11-66.5-67	66.5 to 67	<0.00084
SB12-66-67	66 to 67	<0.00096
SB13-70-71	70 to 71	<0.00087
P07-05	5	<0.05
P07-07	7	<0.05
P07-10	10	<0.05
P09-08	8	<0.05
P09-13	13	<0.05
P11-07.5	7.5	0.77
P11-09	9	<0.025
P11-12	12	0.48
SB-20-2.5	2.5	<0.00091
SB-20-7	7	<0.00078
SB-20-13.5	13.5	<0.00080
SB-21-2.5	2.5	<0.00096
SB-21-10	10	<0.00090
SB-21-14.5	14.5	<0.00068
SB-22-2.5	2.5	0.0028
SB-22-11	11	0.13
SB-22-14	14	0.19
SB-23-2.5	2.5	0.051
SB-23-10	10	0.0087
SB-23-13.5	13.5	0.052
SB-24-2.5	2.5	0.0035
SB-24-11	11	0.013
SB-24-14	14	0.013
SB-25-2.5	2.5	<0.0011
SB-25-9	9	<0.00067
SB-25-17	17	<0.0011
SB26-1.3	1.3	2.5
SB26-8.0	8	0.16
SB27-2.5	2.5	48
SB27-7.5	7.5	40
SB27-12.0	12	170
SB29-4.0	4.0	1.0
SB29-9.0	9.0	<0.0077
SB30-3.0	3.0	0.071
SB30-10.0	10.0	0.020
SB31-2.0	2.0	0.67
SB31-8.5	8.5	0.013
SB32-3.0	3.0	1.9
SB32-7.5	7.5	2.9
MTCA Cleanup Level		0.05

Sample ID	Depth	PCE
SB33-3.0	3.0	0.46
SB33-8.5	8.5	<0.0075
SB34-3.0	3.0	0.12
SB34-8.0	8.0	7.3
SB35-5.0	5.0	0.12
SB35-10.5	10.5	<0.0077
SB36-3.0	3.0	0.075
SB36-10.5	10.5	<0.0061
SB37-5.5	5.5	54
SB37-9.5	9.5	79,000
SB38-5.5	5.5	4.3
SB38-9.0	9.0	17
SB39-5.5	5.5	1.5
SB39-10.0	10.0	11
MW-1-8.0	8	<0.010
MW-2-10.5	10.5	<0.010
MW-3-8.0	8	<0.010
MW-4-8.0	8	<0.010
MW-4-11.0	11	<0.010
MW-5-7.5	7.5	<0.010
MW-6-15	15.0	<0.010
MW7-6.5-8.0	6.5 to 8.0	6.30
MW7-14-15.5	14 to 15.5	17.0
MW7-21.5-23	21.5 to 23	0.042
MW7-35-36	35 to 36	0.034
MW8-5-6.5	5 to 6.5	0.18
MW8-45-46.5	45 to 46.5	0.0012
MW9-45-46.5	45 to 46.5	0.13
MW10-111204-5-6.5	5 to 6.5	<0.0010
MW10-111204-22.5-24	22.5 to 24	<0.00083
MW10-111204-45-46.5	45 to 46.5	<0.045
MW11-67-67.5	67 to 67.5	<0.00079
MW12-65.5-67	65.5 to 67	<0.00078
MW13-64-65.5	64-65.5	<0.00078
MW14-67.5-70	67.5 to 70	<0.0010
MW15-5-6.5	5 to 6.5	<0.00093
MW15-15-16.5	15 to 16.5	<0.00083
MW15-25-25.5	25 to 25.5	9.5
MW16-7.5-9	7.5 to 9	<0.00075
MW17-2.5-3.5	2.5 to 3.5	<0.00076
MW18-27.5-28.5	27.5 to 28.5	<0.00073
MW18-77-80	77 to 80	<0.00089
MW-20-6-111008	6	0.69
MW-20-26-111008	26	0.0013
MW-20-45-111008	45	<0.00087
MW-21-6-111008	6.0	0.01
MW-21-16-111008	16.0	<0.00095
MW-22-6-111108	6	0.12
MW-22-10.5-111108	10.5	0.025
MW-22-15-111108	15	0.013
MW-22-25-111108	25	0.002
MW-22-45-111108	45	<0.00095
MW-23-5-111208	5.0	<0.00081
MW-23-11-111208	11.0	<0.00089
MW-23-16-111208	16.0	<0.00086
MW-23-11-111210	20.5	<0.00088
MW26-5.0	5.0	0.0047
MW26-10.0	10.0	<0.00069
MW26-20.0	20.0	<0.00081
MW27-13.5	13.5	<0.0012
MTCA Cleanup Level		0.05



LEGEND

CATCH BASIN
MANHOLE
SHALLOW-ZONE MONITORING WELL
DEEP-ZONE MONITORING WELL
DECOMMISSIONED WELL
DIRECT-PUSH BORING (GEOENGINEERS, 2002/2003)
DIRECT-PUSH BORING (GEOENGINEERS, 2004)
DIRECT-PUSH BORING (FARALLON, 2004)
DIRECT-PUSH BORING (FARALLON, 2006/2007)
DIRECT-PUSH BORING (FARALLON, 2010)
DIRECT-PUSH BORING (SOUNDEARTH, 2008)
HOLLOW-STEM AUGER (SOUNDEARTH, 2009)
STORMWATER LINE
GAS LINE
SANITARY SEWER LINE
WATER LINE
OVERHEAD POWER LINE
PROPERTY BOUNDARY LINE
PARCEL BOUNDARY
PCE ISOCONCENTRATION CONTOUR IN SOIL (mg/kg)
CROSS SECTION LOCATION
FLOOR DRAIN
PCE TETRACHLOROETHENE
MTCA WASHINGTON STATE MODEL TOXICS CONTROL ACT
RED DENOTES CONCENTRATION IN UNSATURATED SOIL EXCEEDS MTCA METHOD A CLEANUP LEVEL
UST UNDERGROUND STORAGE TANK

RESULTS IN MILLIGRAMS PER KILOGRAM
DEPTH IN FEET BELOW GROUND SURFACE
FIGURE DERIVED FROM BASEMAP BY FARALLON CONSULTING, 2010

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FIGURE 6
SITE PLAN SHOWING PCE CONCENTRATIONS IN SOIL

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG6_PCE_SD.DWG
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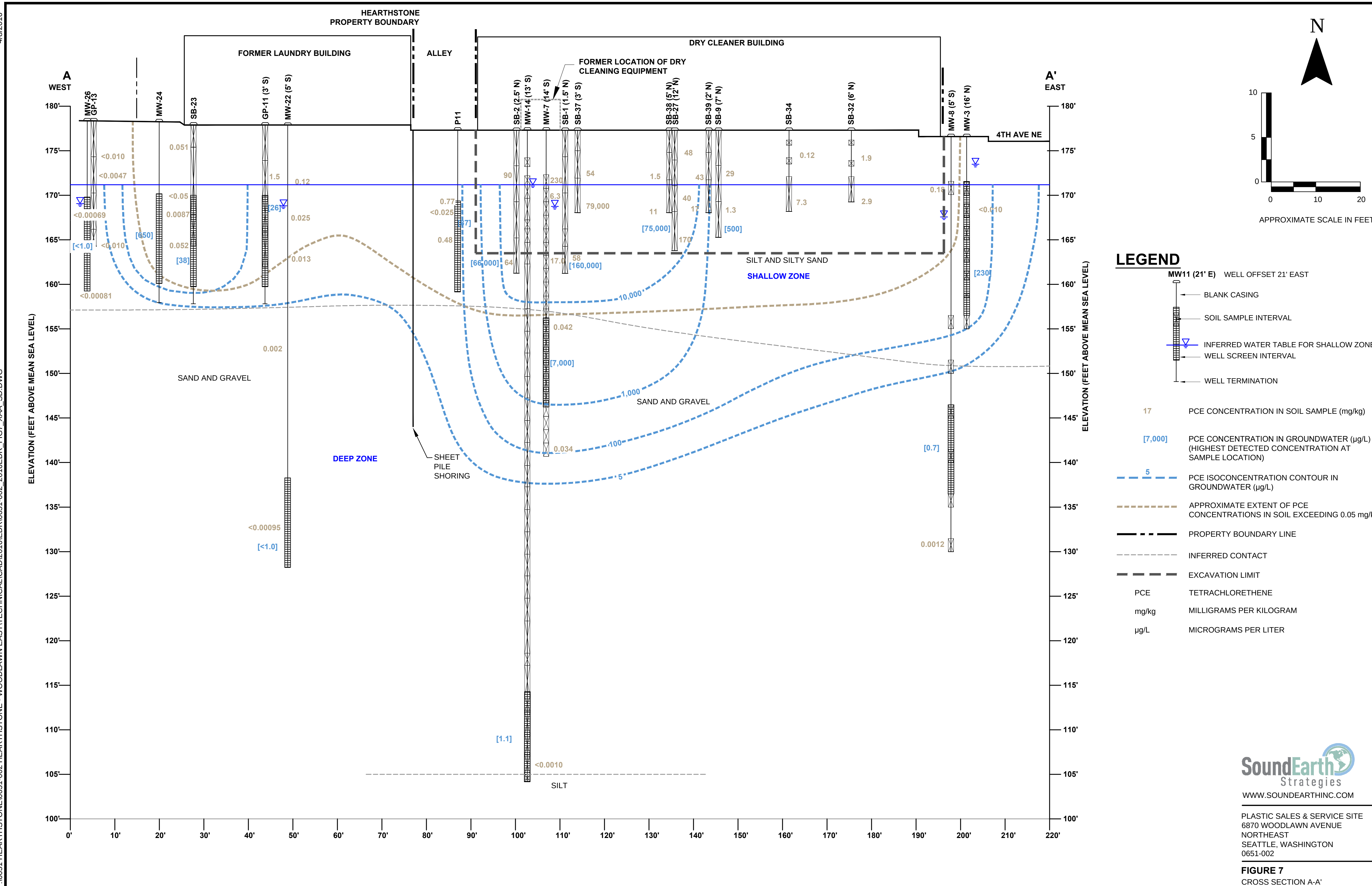
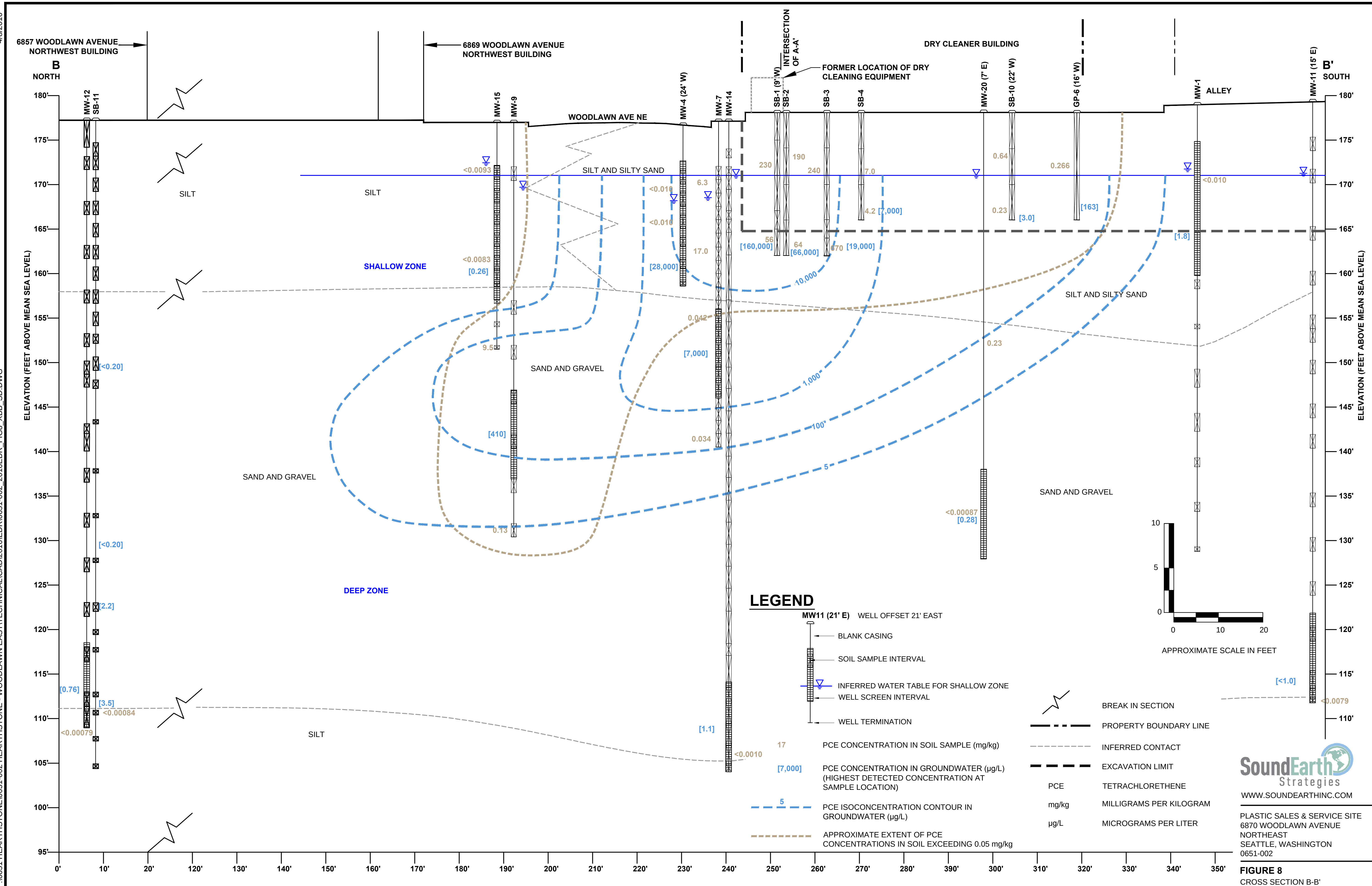


FIGURE 7
CROSS SECTION A-A'



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6857 WOODLAWN AVENUE NORTHWEST BUILDING
6869 WOODLAWN AVENUE NORTHWEST BUILDING
B
NORTH
B'
SOUTH
INTERSECTION OF A-A'
FORMER LOCATION OF DRY CLEANING EQUIPMENT
DRY CLEANER BUILDING
ALLEY
WOODLAWN AVE NE
MW-12
SB-11
MW-15
MW-9
MW-4 (24' W)
MW-7
MW-14
SB-1 (9' W)
SB-2
SB-3
SB-4
MW-20 (7' E)
SB-10 (22' W)
GP-6 (16' W)
MW-1
MW-11 (15' E)
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
SILT
SILT AND SILTY SAND
SHALLOW ZONE
SAND AND GRAVEL
DEEP ZONE
SILT AND SILTY SAND
SAND AND GRAVEL
SILT
10,000
1,000
100
5
APPROXIMATE SCALE IN FEET
LEGEND
MW11 (21' E) WELL OFFSET 21' EAST
BLANK CASING
SOIL SAMPLE INTERVAL
INFERRED WATER TABLE FOR SHALLOW ZONE
WELL SCREEN INTERVAL
WELL TERMINATION
17 PCE CONCENTRATION IN SOIL SAMPLE (mg/kg)
[7,000] PCE CONCENTRATION IN GROUNDWATER (µg/L) (HIGHEST DETECTED CONCENTRATION AT SAMPLE LOCATION)
5 PCE ISOCONCENTRATION CONTOUR IN GROUNDWATER (µg/L)
APPROXIMATE EXTENT OF PCE CONCENTRATIONS IN SOIL EXCEEDING 0.05 mg/kg
BREAK IN SECTION
PROPERTY BOUNDARY LINE
INFERRED CONTACT
EXCAVATION LIMIT
PCE TETRACHLOROETHENE
mg/kg MILLIGRAMS PER KILOGRAM
µg/L MICROGRAMS PER LITER
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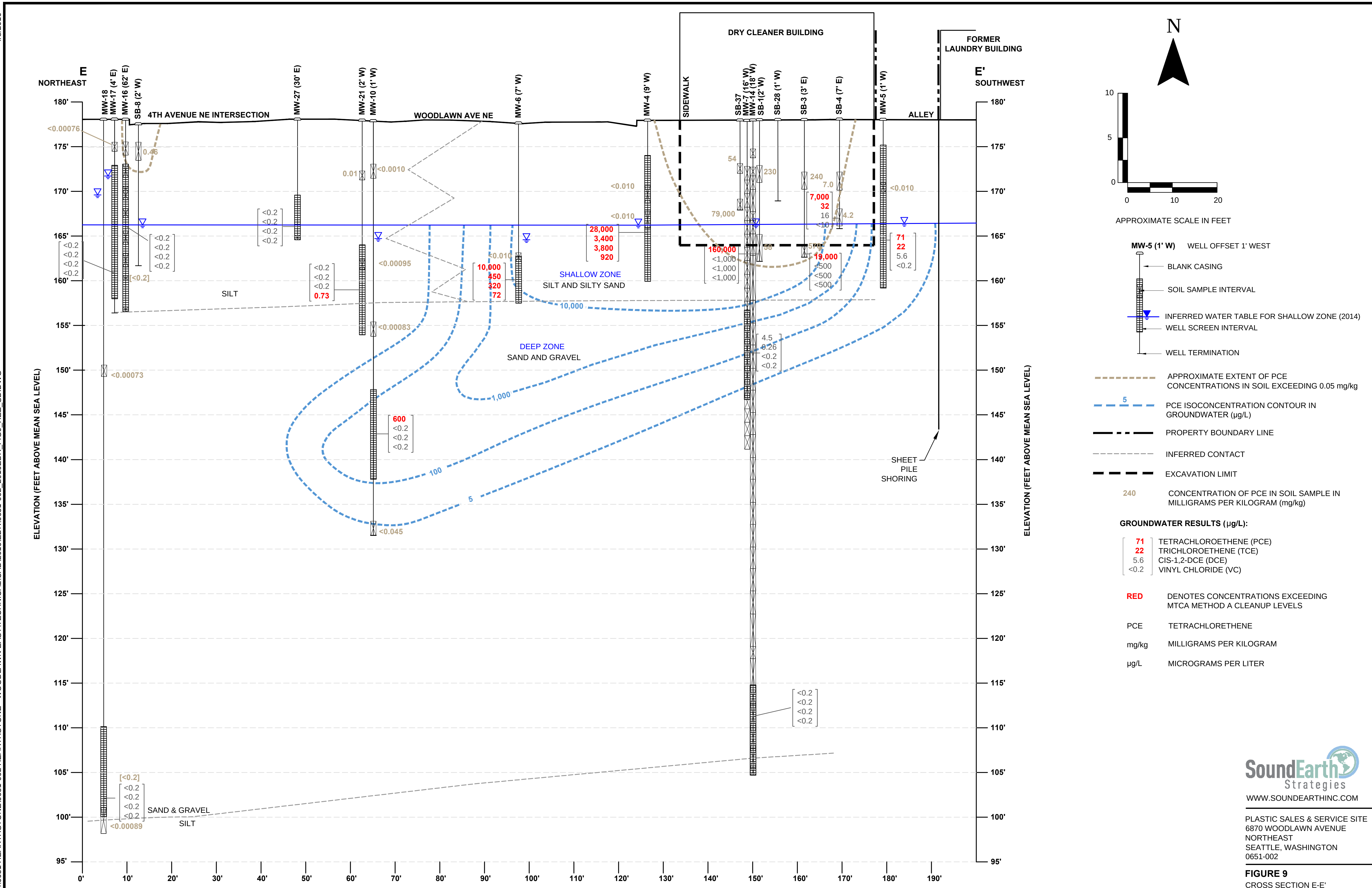
PLASTIC SALES & SERVICE SITE
6870 WOODLAWN AVENUE NORTHEAST
SEATTLE, WASHINGTON
0651-002
FIGURE 8
CROSS SECTION B-B'
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG8_XBB_SD.DWG

4/8/2016



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NORTHEAST
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FIGURE 9
CROSS SECTION E-E'

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG9_XEE_SD.DWG

Symbol	Area	Area (Square Feet)	Average Thickness (Feet)	Volume (Cubic Yards)	Mass (Tons)	Current PCE Concentration (mg/kg)	TYPE
(magenta)	1	1,160	13.5	580	986	>60	Thermal Treatment
(orange)	2	1,062	13.5	531	903	14-60	Thermal Treatment
(light orange)	3	730	13.5	365	621	14-60	Thermal Treatment
(yellow)	4	6,870	14.5	3,689	6,272	0.05-14	No Treatment
(light green)	5	4,567	14.5	2,453	4,170	<0.05-14	No Treatment

* Note that conversion factor of 1.7 was used from cubic yards to tons.

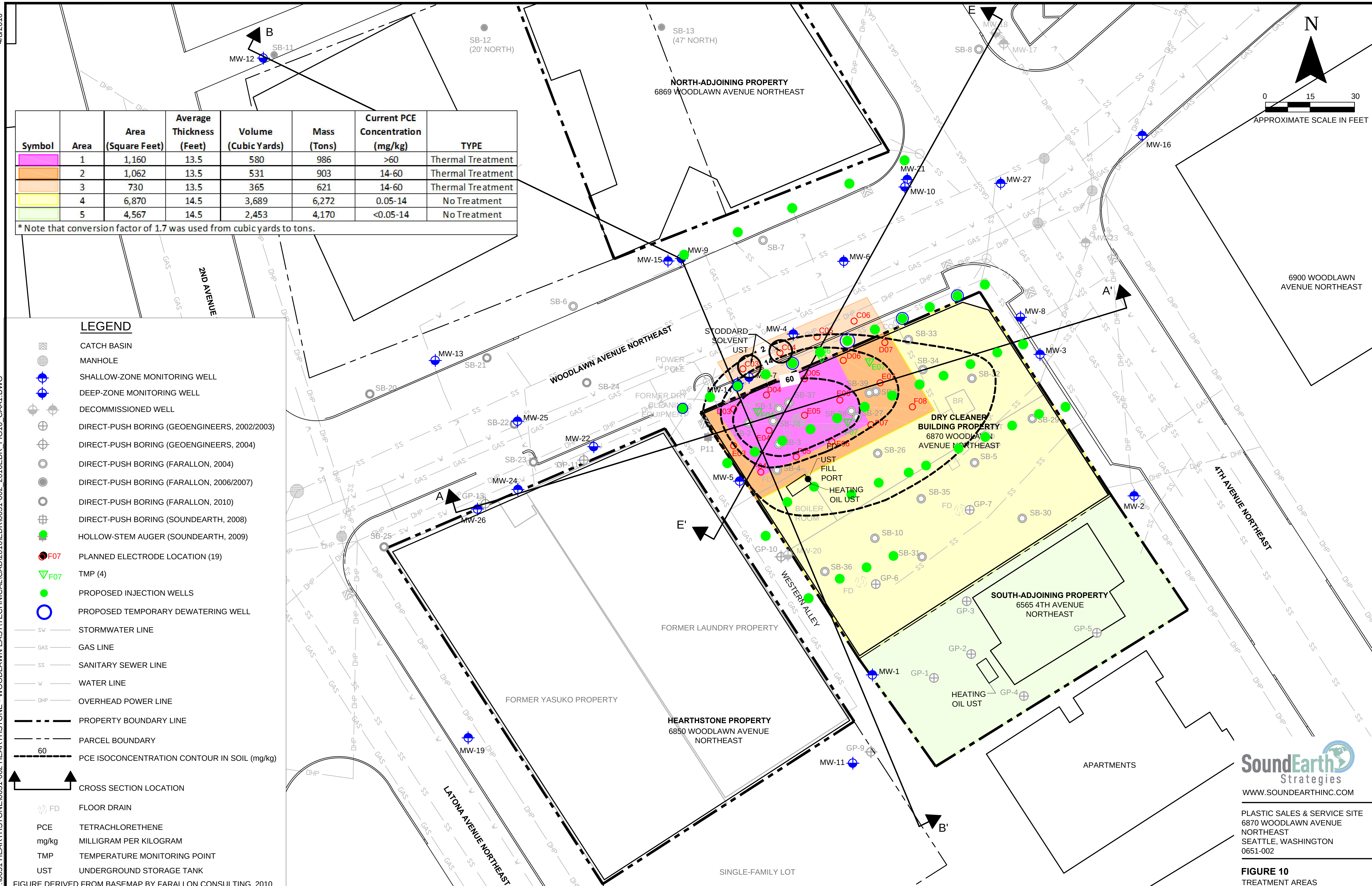

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FIGURE 10
TREATMENT AREAS

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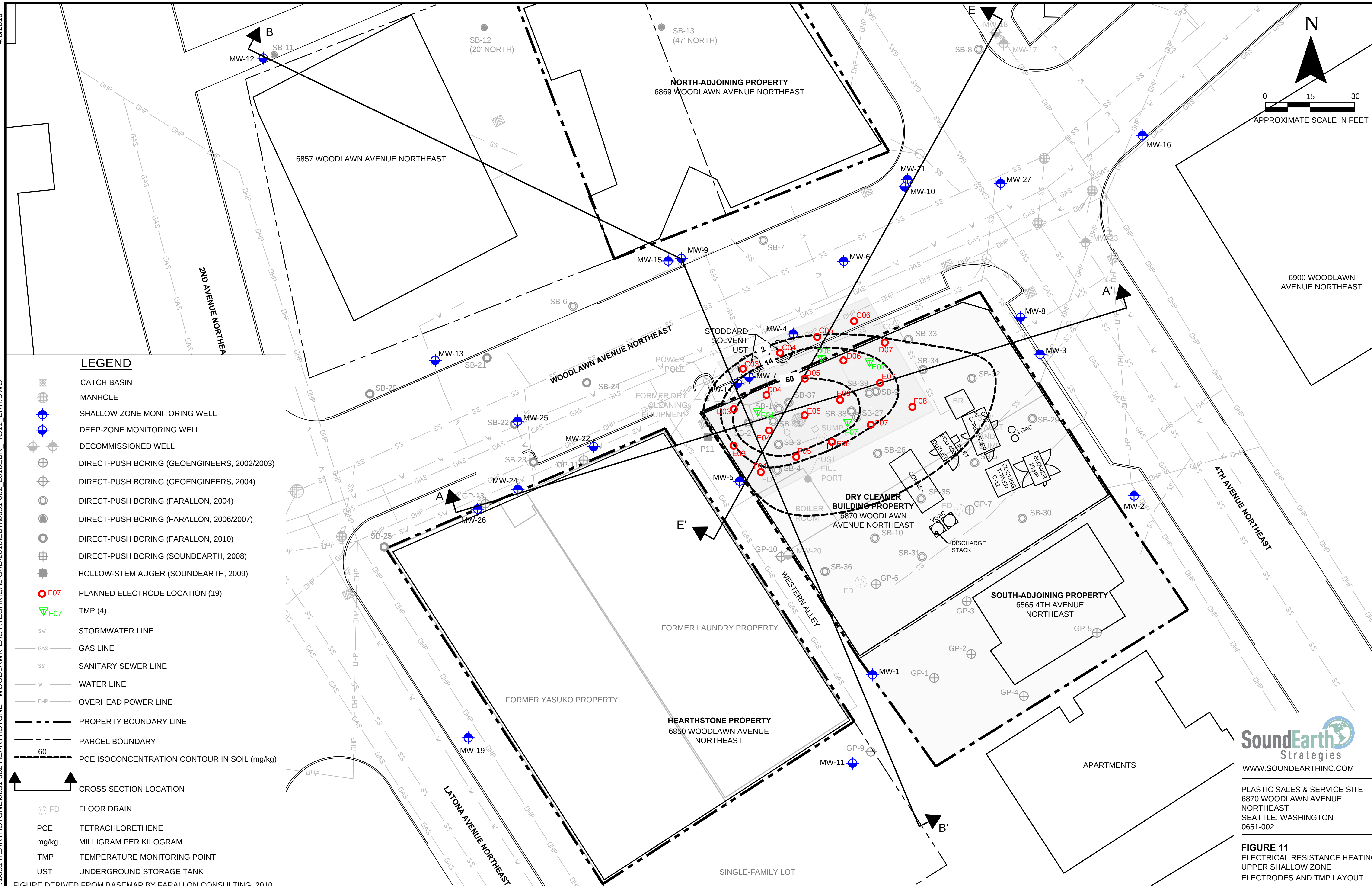
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG10_CAA1.DWG


LEGEND
CATCH BASIN
MANHOLE
SHALLOW-ZONE MONITORING WELL
DEEP-ZONE MONITORING WELL
DECOMMISSIONED WELL
DIRECT-PUSH BORING (GEOENGINEERS, 2002/2003)
DIRECT-PUSH BORING (GEOENGINEERS, 2004)
DIRECT-PUSH BORING (FARALLON, 2004)
DIRECT-PUSH BORING (FARALLON, 2006/2007)
DIRECT-PUSH BORING (FARALLON, 2010)
DIRECT-PUSH BORING (SOUNDEARTH, 2008)
HOLLOW-STEM AUGER (SOUNDEARTH, 2009)
F07 PLANNED ELECTRODE LOCATION (19)
F07 TMP (4)
STORMWATER LINE
GAS LINE
SANITARY SEWER LINE
WATER LINE
OVERHEAD POWER LINE
PROPERTY BOUNDARY LINE
PARCEL BOUNDARY
60 PCE ISOCONCENTRATION CONTOUR IN SOIL (mg/kg)
CROSS SECTION LOCATION
FD FLOOR DRAIN
PCE TETRACHLORETHENE
mg/kg MILLIGRAM PER KILOGRAM
TMP TEMPERATURE MONITORING POINT
UST UNDERGROUND STORAGE TANK
FIGURE DERIVED FROM BASEMAP BY FARALLON CONSULTING, 2010
N
0 15 30
APPROXIMATE SCALE IN FEET
NORTH-ADJOINING PROPERTY
6869 WOODLAWN AVENUE NORTHEAST
6857 WOODLAWN AVENUE NORTHEAST
6900 WOODLAWN AVENUE NORTHEAST
WOODLAWN AVENUE NORTHEAST
2ND AVENUE NORTHEAST
4TH AVENUE NORTHEAST
LATONA AVENUE NORTHEAST
WESTERN ALLEY
STODDARD SOLVENT UST
DRY CLEANER BUILDING PROPERTY
6870 WOODLAWN AVENUE NORTHEAST
SOUTH-ADJOINING PROPERTY
6565 4TH AVENUE NORTHEAST
FORMER LAUNDRY PROPERTY
FORMER YASUKO PROPERTY
HEARTHSTONE PROPERTY
6850 WOODLAWN AVENUE NORTHEAST
SINGLE-FAMILY LOT
APARTMENTS
DISCHARGE STACK
SoundEarth Strategies
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PLASTIC SALES & SERVICE SITE
6870 WOODLAWN AVENUE NORTHEAST
SEATTLE, WASHINGTON
0651-002
FIGURE 11
ELECTRICAL RESISTANCE HEATING
UPPER SHALLOW ZONE
ELECTRODES AND TMP LAYOUT
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG11_ERH.DWG
4/8/2016

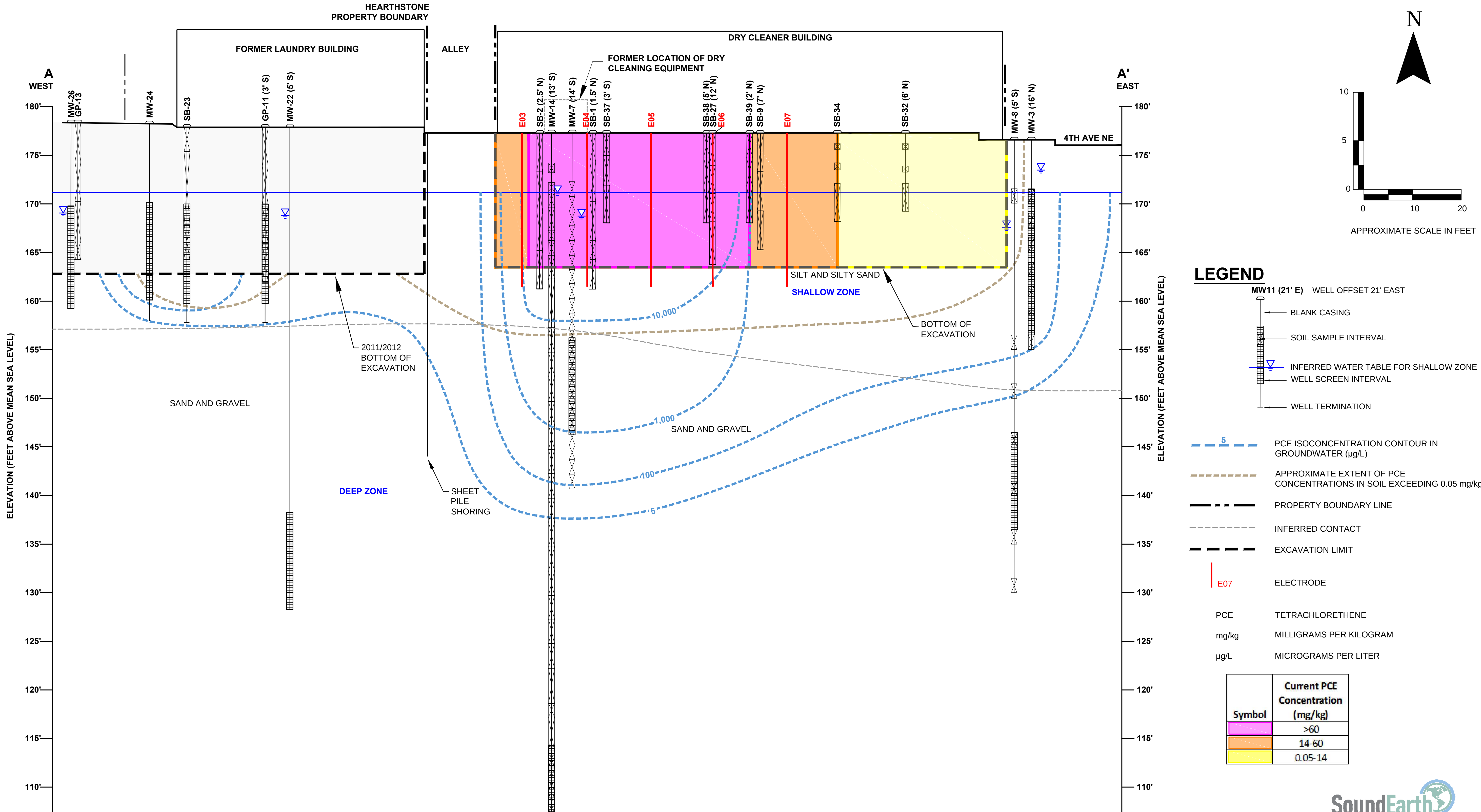

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FIGURE 12

ELECTRICAL RESISTANCE HEATING
UPPER SHALLOW ZONE
CROSS SECTION A-A'

4/8/2016

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG12_XAA_CAA1.DWG

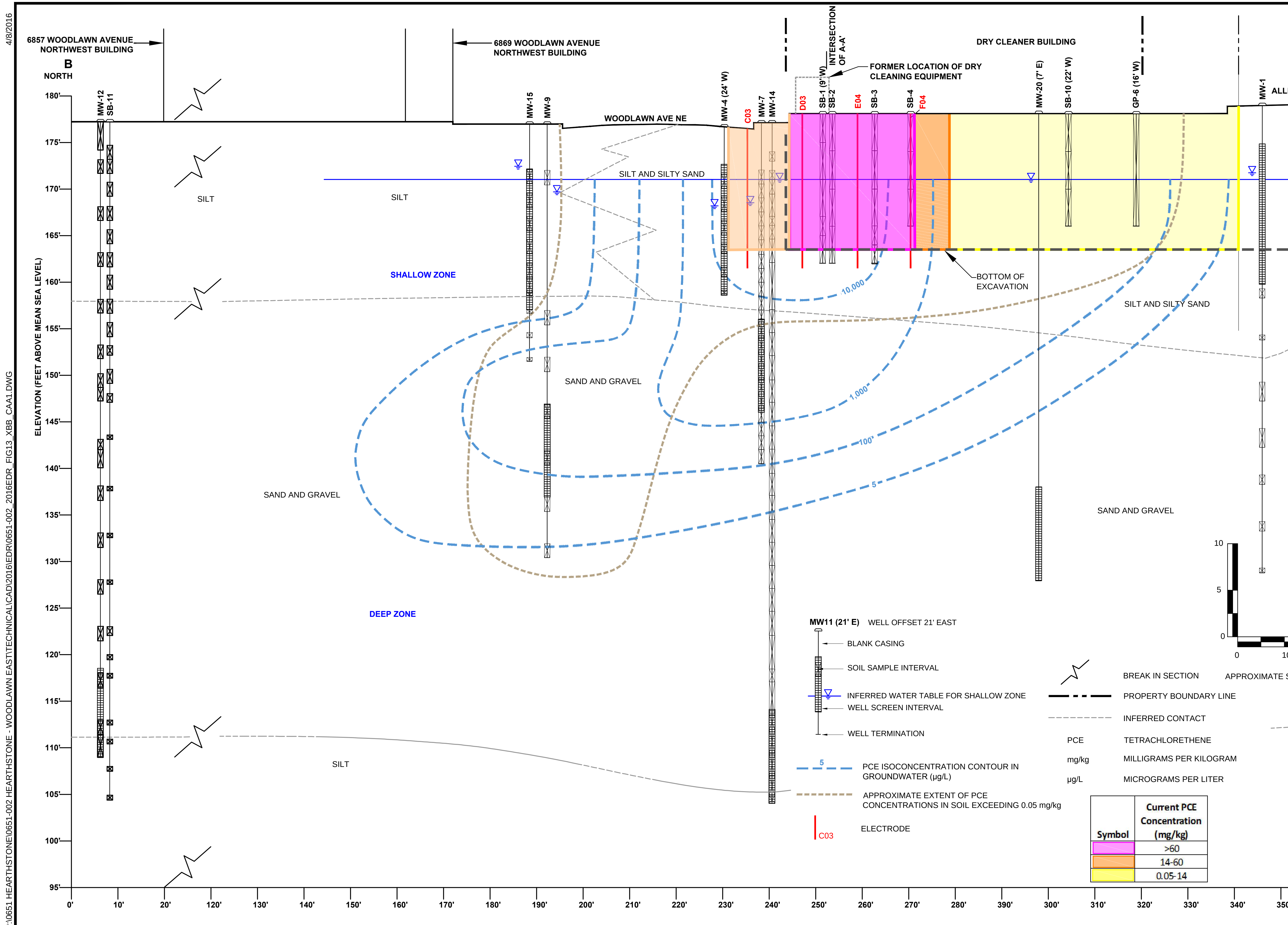

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FIGURE 13
ELECTRICAL RESISTANCE HEATING
UPPER SHALLOW ZONE
CROSS SECTION B-B'

4/8/2016

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG14_XEE_CAA1.DWG

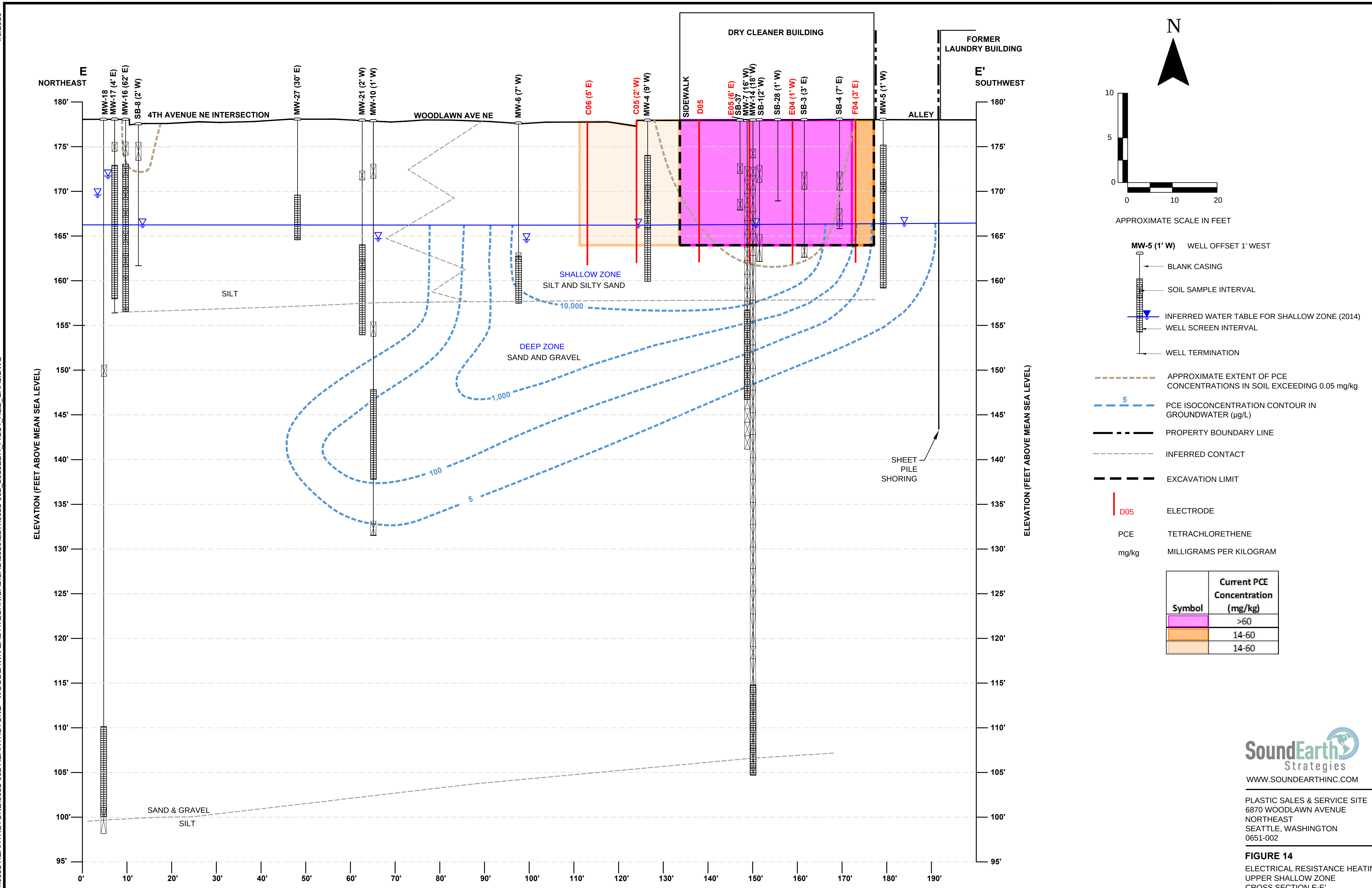

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FIGURE 14

ELECTRICAL RESISTANCE HEATING
UPPER SHALLOW ZONE
CROSS SECTION E-E'

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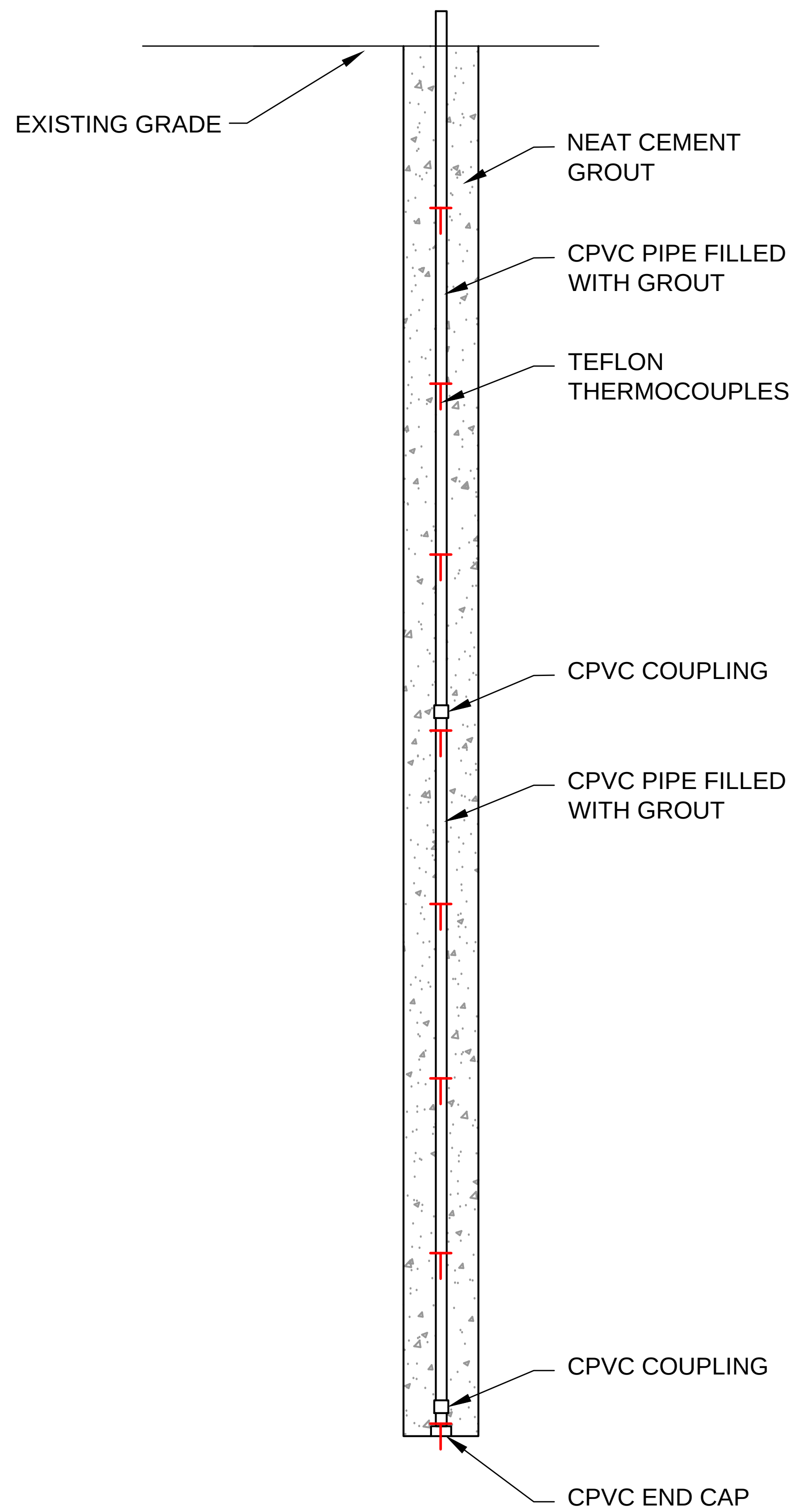
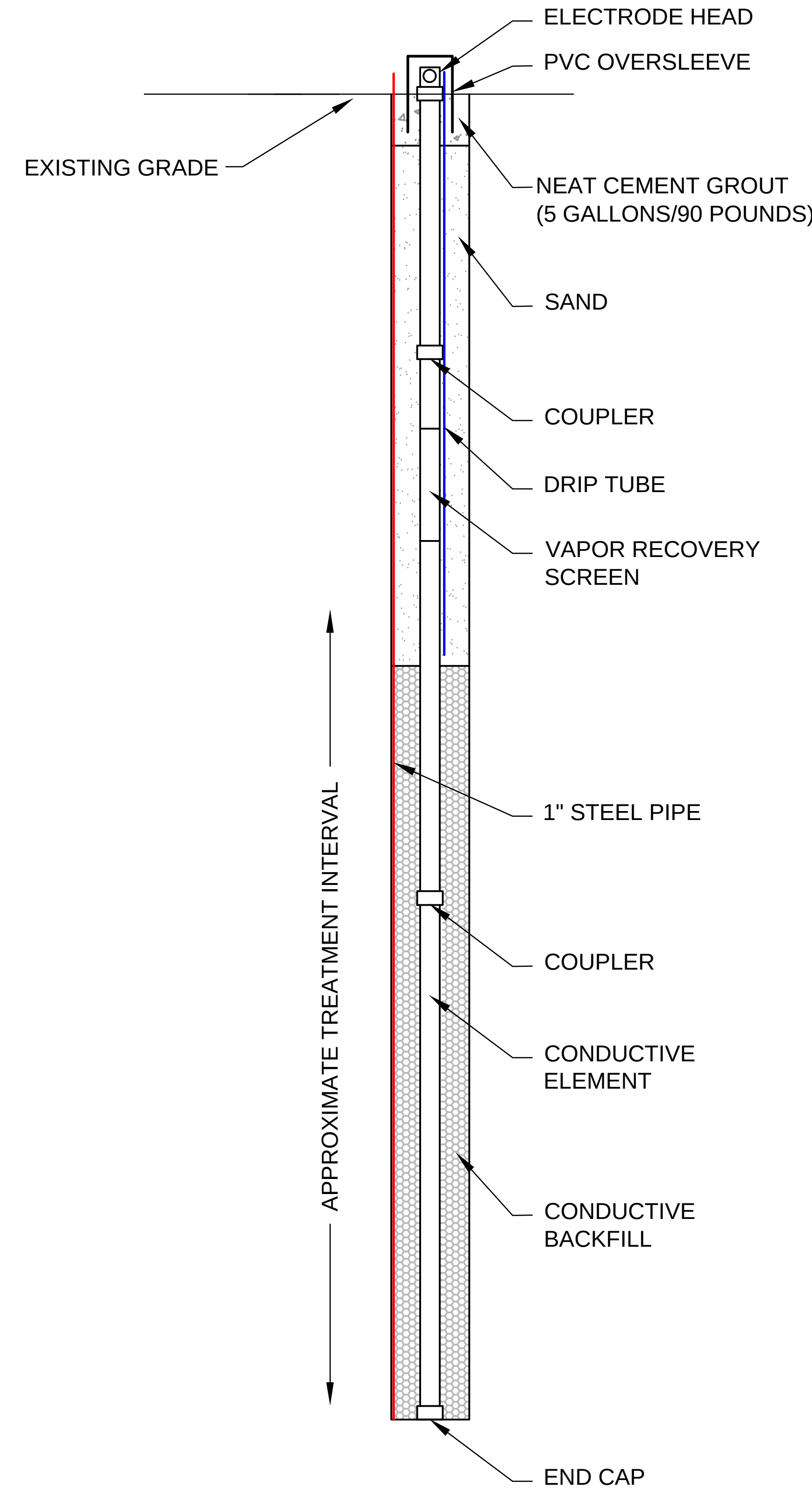
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG15_ERH WELLS.DWG



TEMPERATURE MONITORING POINT



ELECTRODE

LEGEND

CPVC	CHLORINATED POLYVINYL CHLORIDE
ERA	ELECTRICAL RESISTANCE HEATING
TMP	TEMPERATURE MONITORING POINT

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FIGURE 15
STANDARD ERH WELL AND TMP CONSTRUCTION

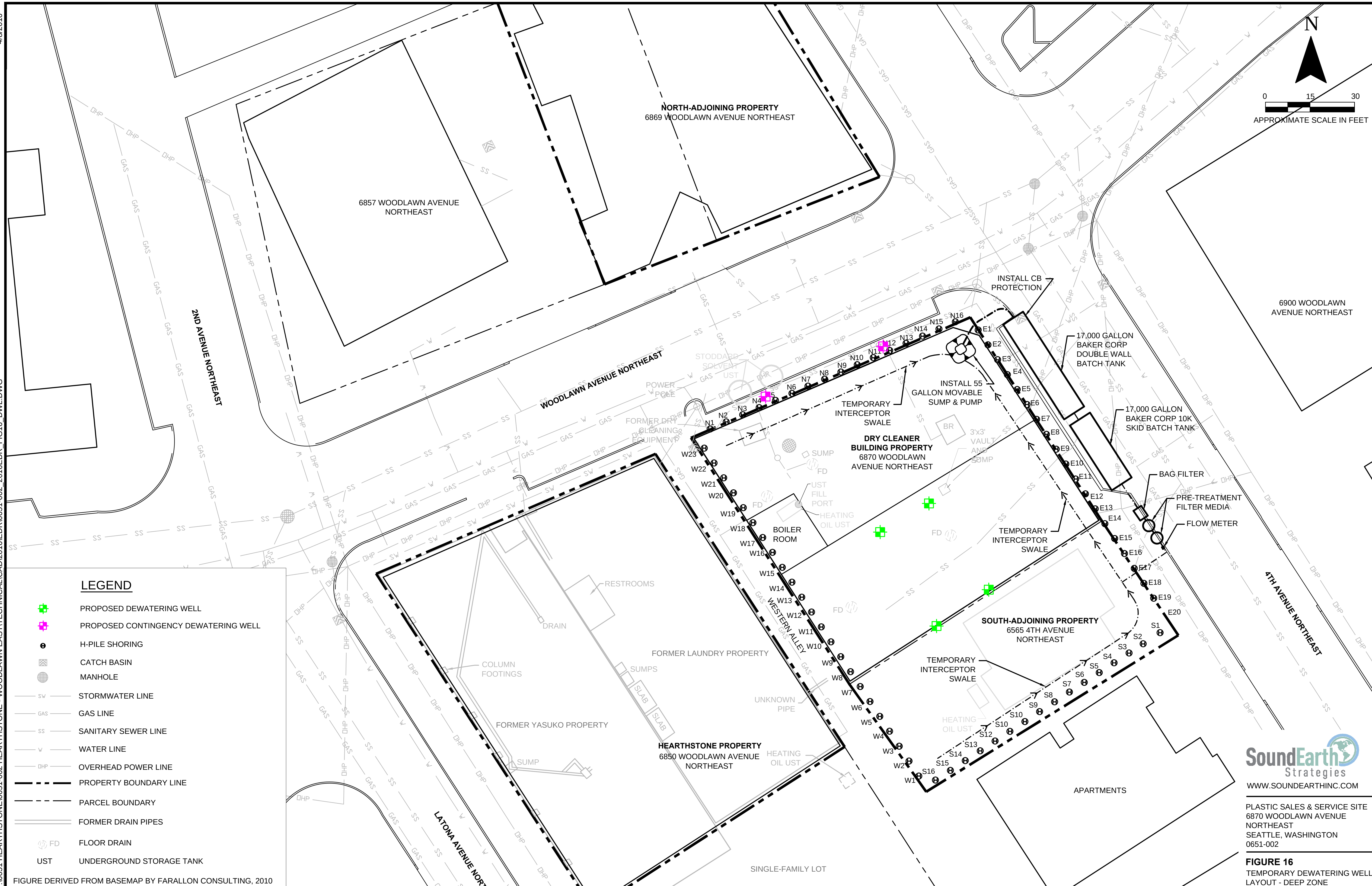

FIGURE 16
TEMPORARY DEWATERING WELL LAYOUT - DEEP ZONE

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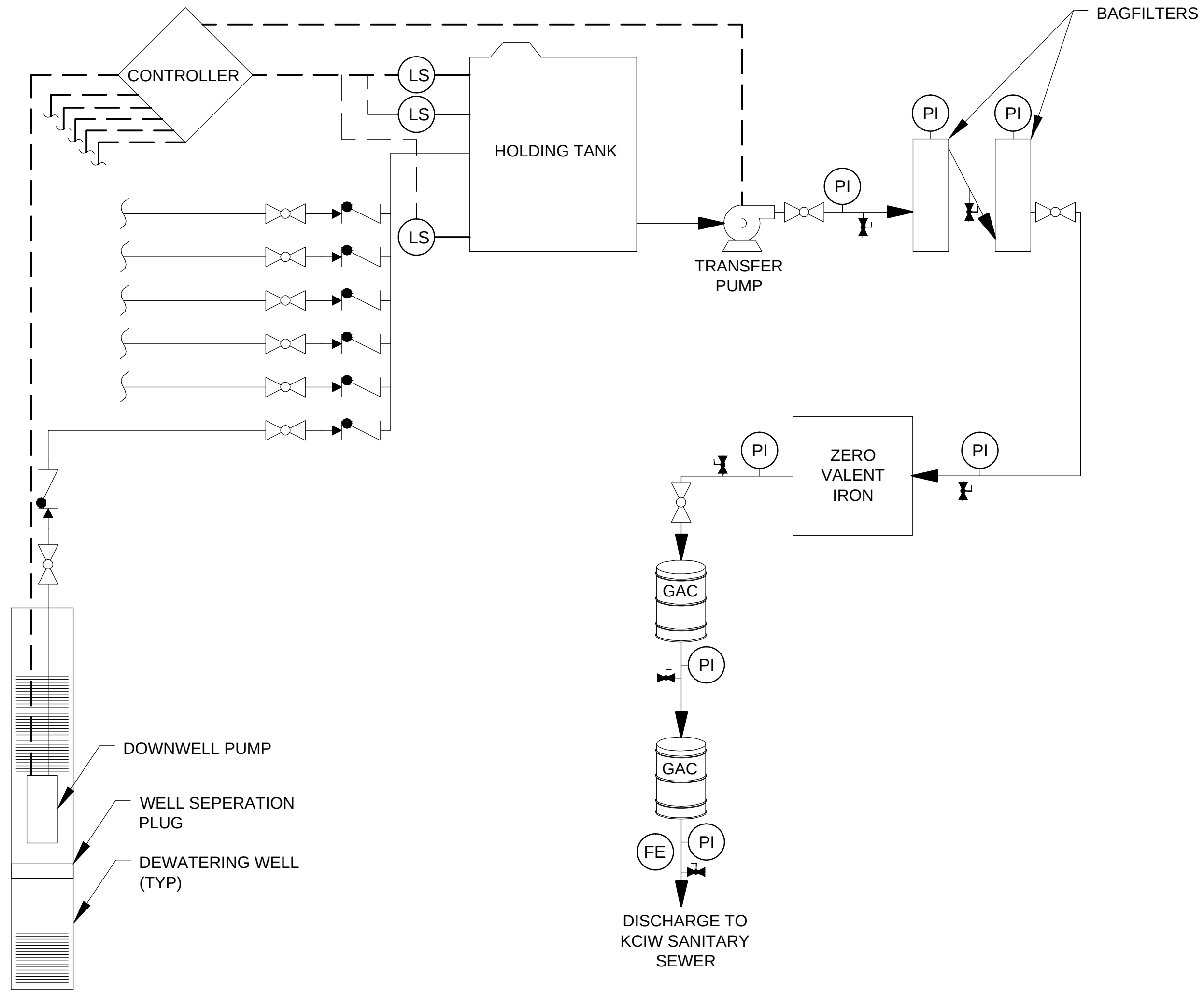
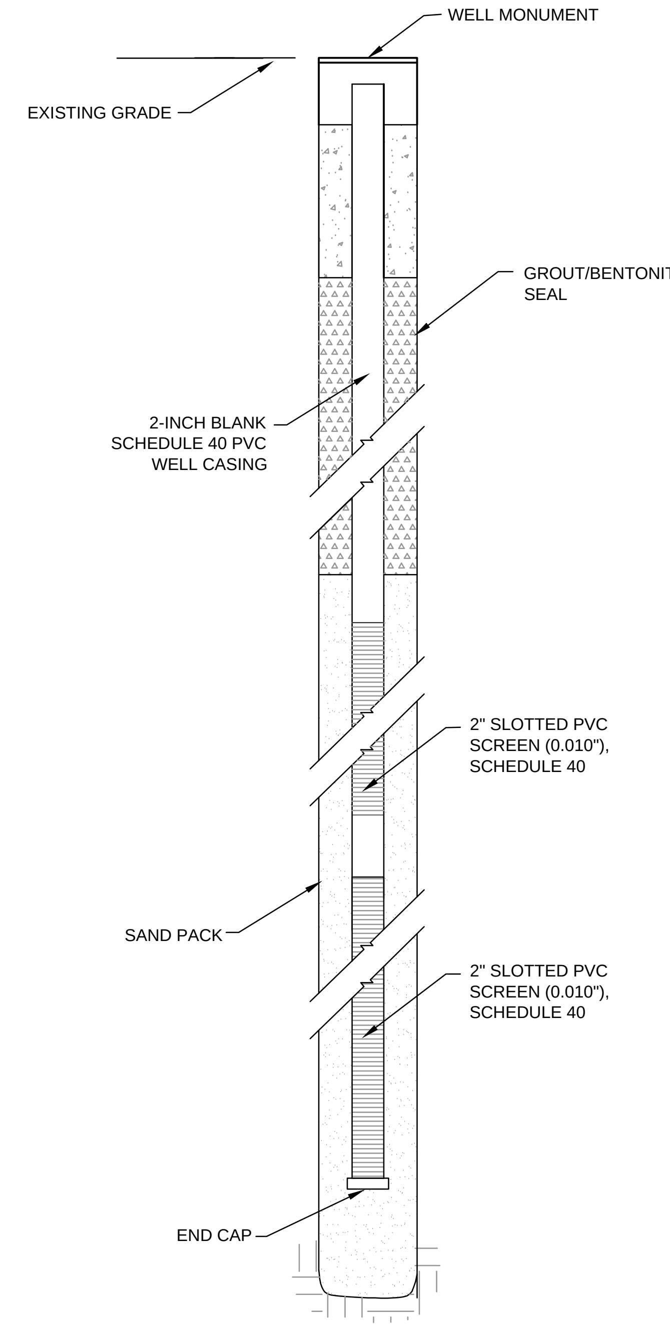
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG17_PID1.DWG





TYPICAL DUAL-SCREEN DEWATERING WELL DETAIL

LEGEND

CHECK VALVE

BALL VALVE

SAMPLE PORT

FE FLOW ELEMENT

GAC GRANULATED ACTIVATED CARBON

LS LEVEL SWITCH

PI PRESSURE INDICATOR

P&ID PROCESS AND INSTRUMENTATION DIAGRAM

KCIW KING COUNTY INDUSTRIAL WASTE PROGRAM

WATER LINE

ELECTRICAL LINE

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FIGURE 17
DEWATERING SYSTEM P&ID

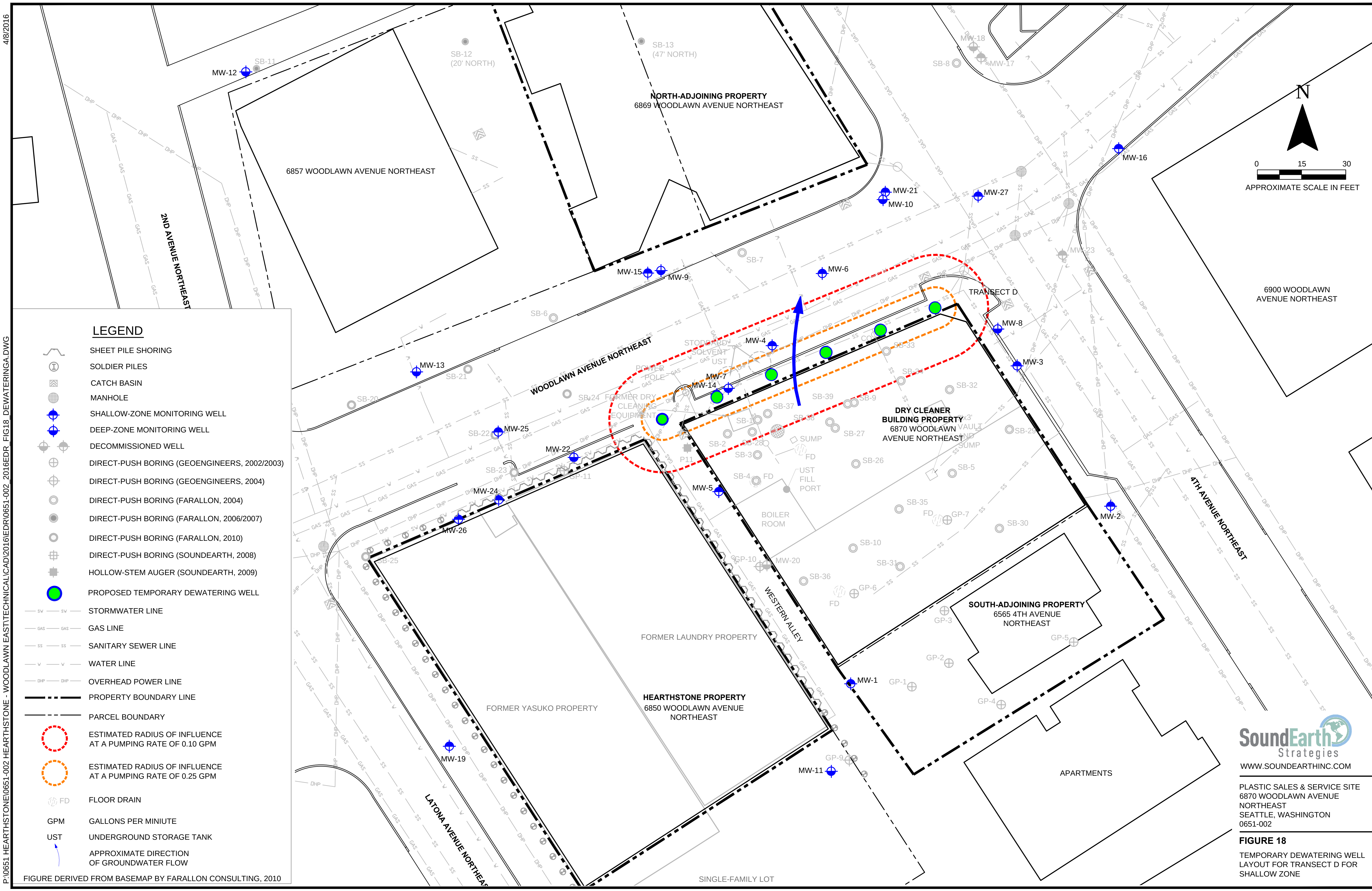

FIGURE 18
TEMPORARY DEWATERING WELL LAYOUT FOR TRANSECT D FOR SHALLOW ZONE

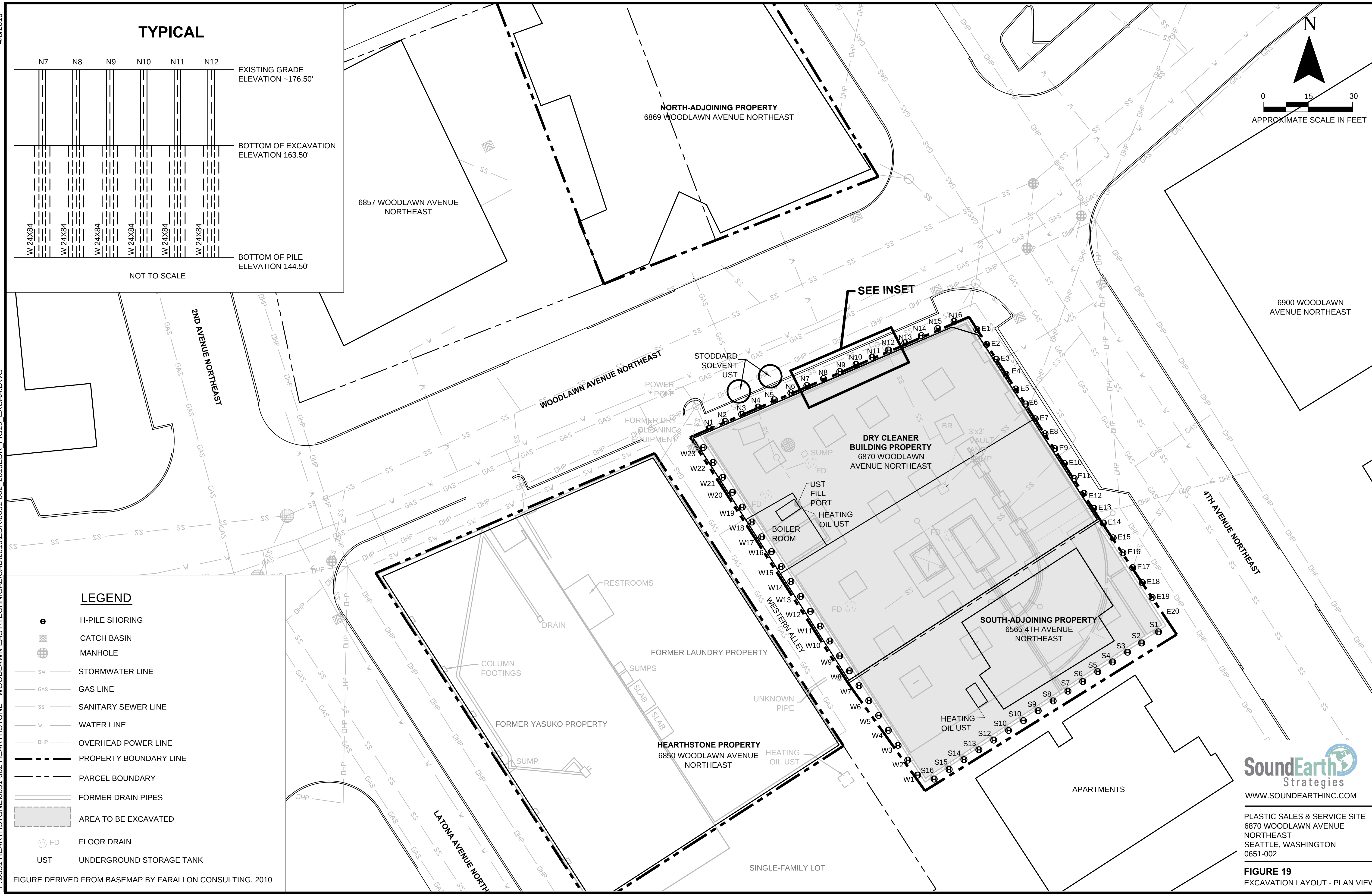

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FIGURE 19
EXCAVATION LAYOUT - PLAN VIEW

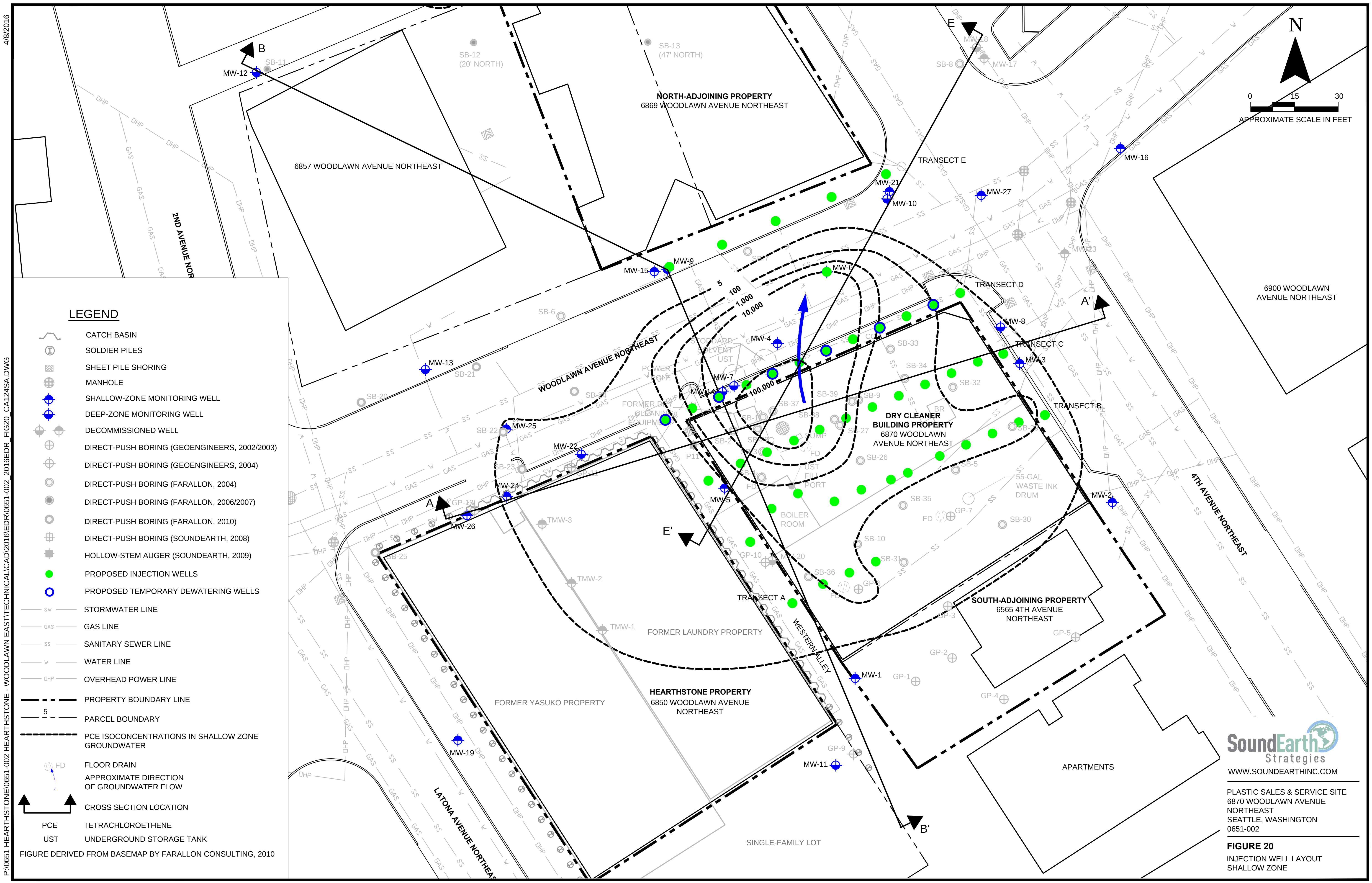
4/8/2016
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG20_CA124SA.DWG
N
0 15 30
APPROXIMATE SCALE IN FEET
NORTH-ADJOINING PROPERTY
6869 WOODLAWN AVENUE NORTHEAST
6857 WOODLAWN AVENUE NORTHEAST
6900 WOODLAWN AVENUE NORTHEAST
WOODLAWN AVENUE NORTHEAST
2ND AVENUE NOR
4TH AVENUE NORTHEAST
LATONA AVENUE NORTHEAS
DRY CLEANER BUILDING PROPERTY
6870 WOODLAWN AVENUE NORTHEAST
SOUTH-ADJOINING PROPERTY
6565 4TH AVENUE NORTHEAST
HEARTHSTONE PROPERTY
6850 WOODLAWN AVENUE NORTHEAST
FORMER YASUKO PROPERTY
FORMER LAUNDRY PROPERTY
WESTERN ALLEY
APARTMENTS
SINGLE-FAMILY LOT
BOILER ROOM
55-GAL WASTE INK DRUM
TRANSECT A
TRANSECT B
TRANSECT C
TRANSECT D
TRANSECT E
5
100
1,000
10,000
100,000
LEGEND
CATCH BASIN
SOLDIER PILES
SHEET PILE SHORING
MANHOLE
SHALLOW-ZONE MONITORING WELL
DEEP-ZONE MONITORING WELL
DECOMMISSIONED WELL
DIRECT-PUSH BORING (GEOENGINEERS, 2002/2003)
DIRECT-PUSH BORING (GEOENGINEERS, 2004)
DIRECT-PUSH BORING (FARALLON, 2004)
DIRECT-PUSH BORING (FARALLON, 2006/2007)
DIRECT-PUSH BORING (FARALLON, 2010)
DIRECT-PUSH BORING (SOUNDEARTH, 2008)
HOLLOW-STEM AUGER (SOUNDEARTH, 2009)
PROPOSED INJECTION WELLS
PROPOSED TEMPORARY DEWATERING WELLS
STORMWATER LINE
GAS LINE
SANITARY SEWER LINE
WATER LINE
OVERHEAD POWER LINE
PROPERTY BOUNDARY LINE
PARCEL BOUNDARY
PCE ISOCONCENTRATIONS IN SHALLOW ZONE GROUNDWATER
FLOOR DRAIN
APPROXIMATE DIRECTION OF GROUNDWATER FLOW
CROSS SECTION LOCATION
PCE TETRACHLOROETHENE
UST UNDERGROUND STORAGE TANK
FIGURE DERIVED FROM BASEMAP BY FARALLON CONSULTING, 2010
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FIGURE 20
INJECTION WELL LAYOUT
SHALLOW ZONE

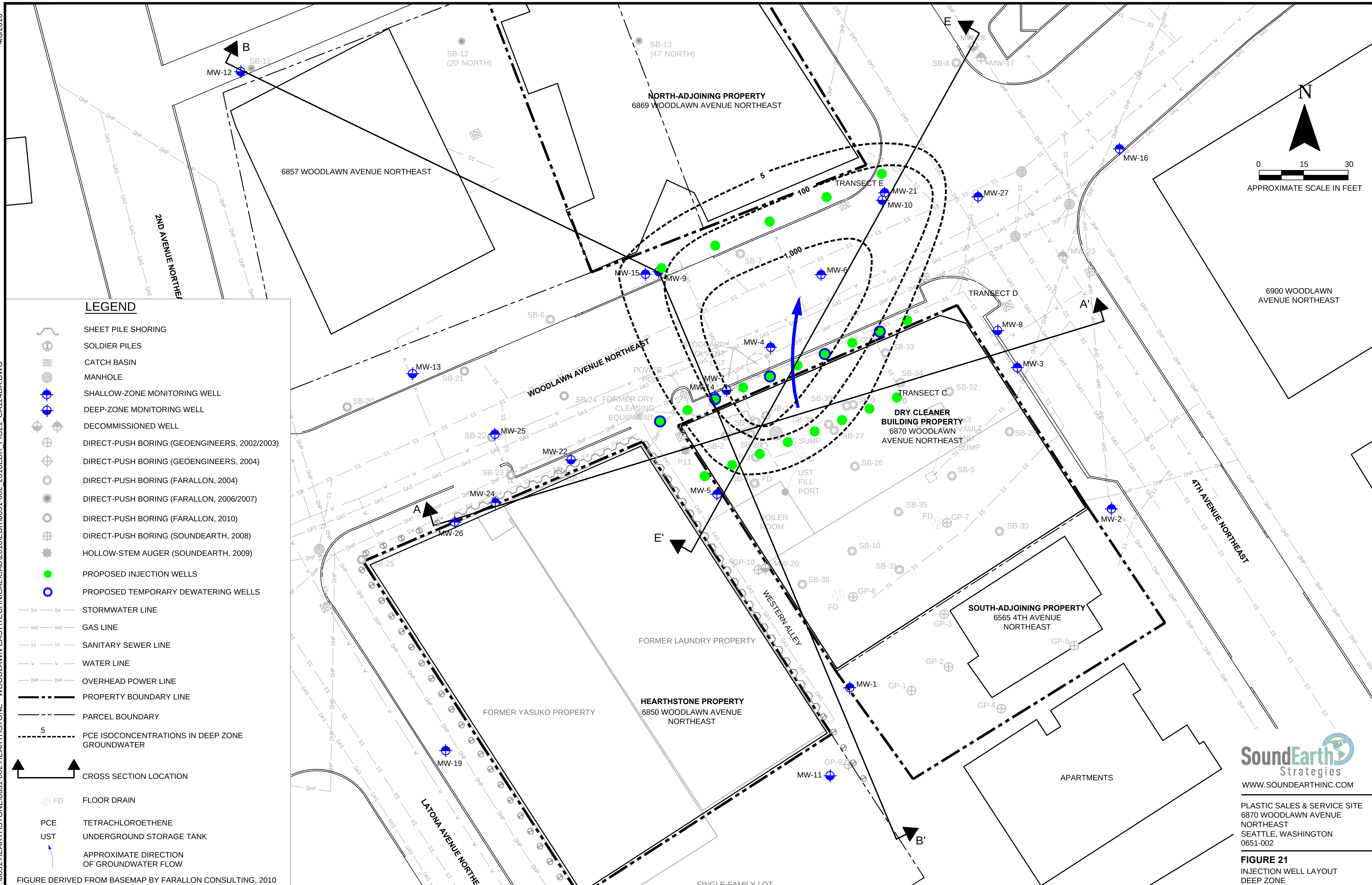

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FIGURE 21
INJECTION WELL LAYOUT
DEEP ZONE

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG21_CA124DA.DWG 4/8/2016

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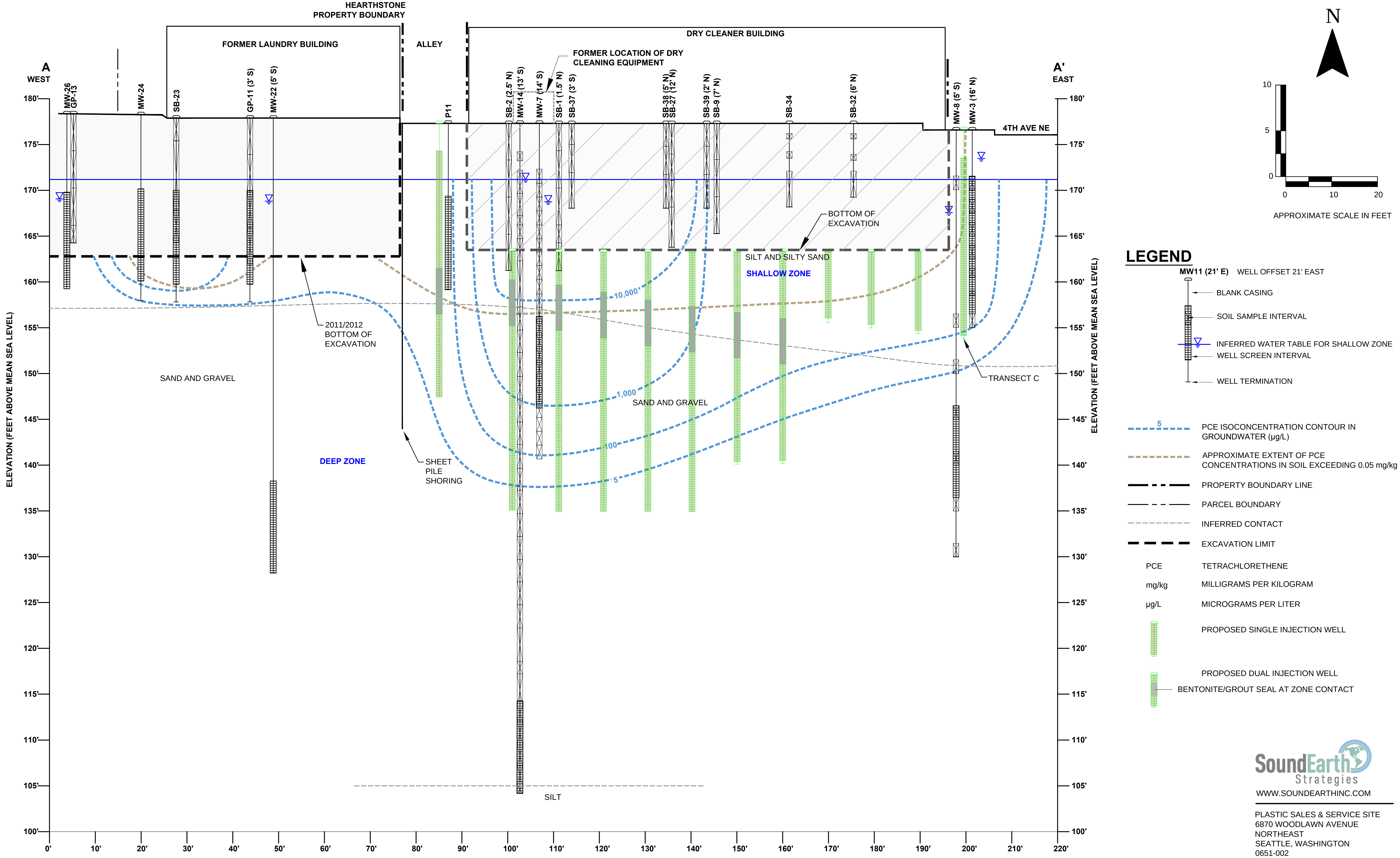

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FIGURE 22
INJECTION WELL
CROSS SECTION A-A'

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG22_XAA_ERDA.DWG

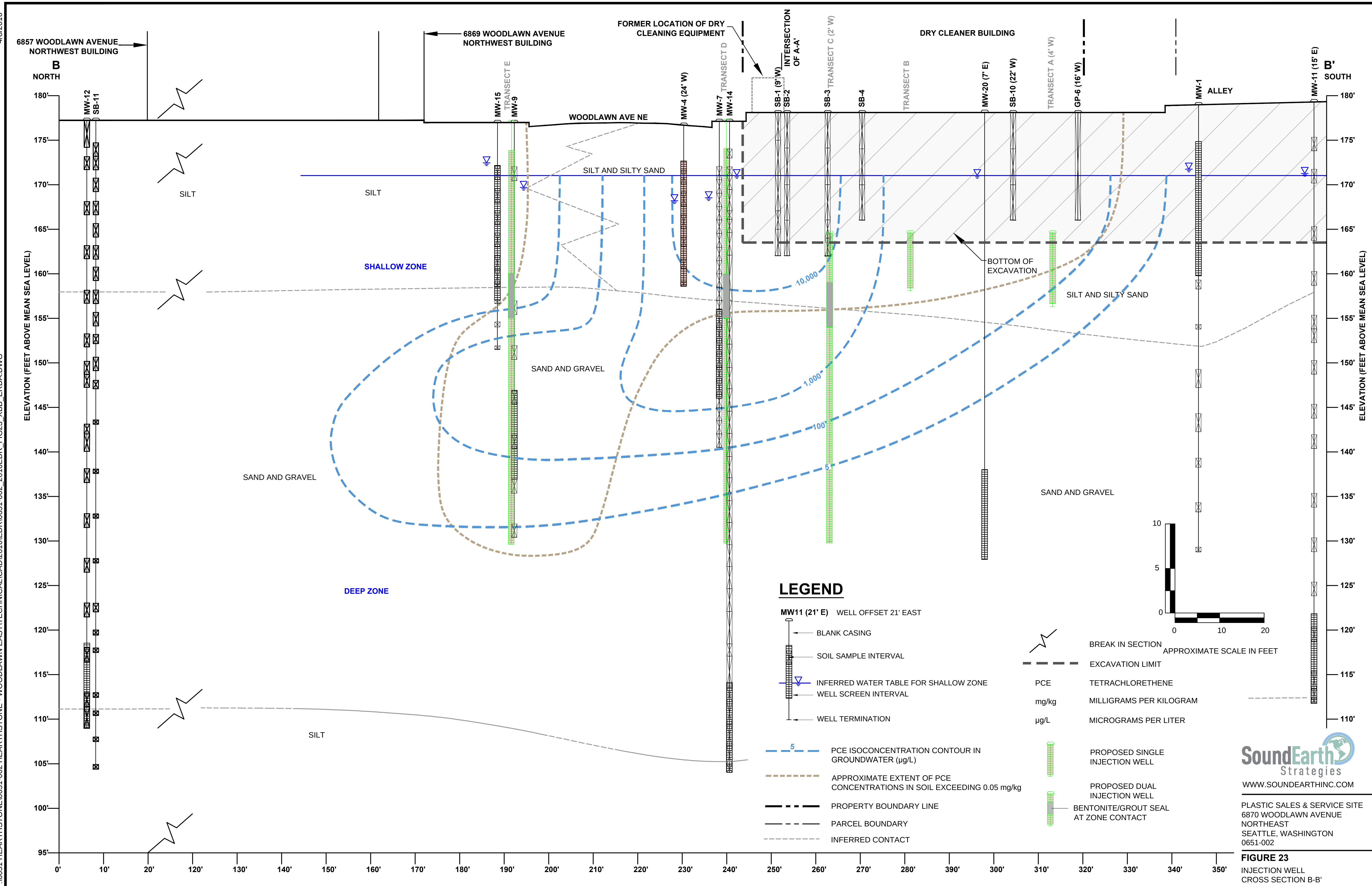
4/8/2016
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG23_XBB_ERDA.DWG
6857 WOODLAWN AVENUE NORTHWEST BUILDING
6869 WOODLAWN AVENUE NORTHWEST BUILDING
FORMER LOCATION OF DRY CLEANING EQUIPMENT
INTERSECTION OF A-A'
DRY CLEANER BUILDING
B
NORTH
B'
SOUTH
ALLEY
WOODLAWN AVE NE
MW-12
SB-11
MW-15
TRANSECT E
MW-9
MW-4 (24' W)
TRANSECT D
MW-7
MW-14
SB-1 (9' W)
SB-2
SB-3
TRANSECT C (2' W)
SB-4
TRANSECT B
MW-20 (7' E)
SB-10 (22' W)
TRANSECT A (4' W)
GP-6 (16' W)
MW-1
MW-11 (15' E)
SILT
SILT AND SILTY SAND
SHALLOW ZONE
SAND AND GRAVEL
DEEP ZONE
BOTTOM OF EXCAVATION
10,000
1,000
100
5
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
180' 175' 170' 165' 160' 155' 150' 145' 140' 135' 130' 125' 120' 115' 110' 105' 100' 95'
0' 10' 20' 120' 130' 140' 150' 160' 170' 180' 190' 200' 210' 220' 230' 240' 250' 260' 270' 280' 290' 300' 310' 320' 330' 340' 350'
LEGEND
MW11 (21' E) WELL OFFSET 21' EAST
BLANK CASING
SOIL SAMPLE INTERVAL
INFERRED WATER TABLE FOR SHALLOW ZONE
WELL SCREEN INTERVAL
WELL TERMINATION
PCE ISOCONCENTRATION CONTOUR IN GROUNDWATER (µg/L)
APPROXIMATE EXTENT OF PCE CONCENTRATIONS IN SOIL EXCEEDING 0.05 mg/kg
PROPERTY BOUNDARY LINE
PARCEL BOUNDARY
INFERRED CONTACT
BREAK IN SECTION
EXCAVATION LIMIT
PCE TETRACHLORETHENE
mg/kg MILLIGRAMS PER KILOGRAM
µg/L MICROGRAMS PER LITER
PROPOSED SINGLE INJECTION WELL
PROPOSED DUAL INJECTION WELL
BENTONITE/GROUT SEAL AT ZONE CONTACT
0 10 20
APPROXIMATE SCALE IN FEET
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FIGURE 23
INJECTION WELL CROSS SECTION B-B'

4/8/2016

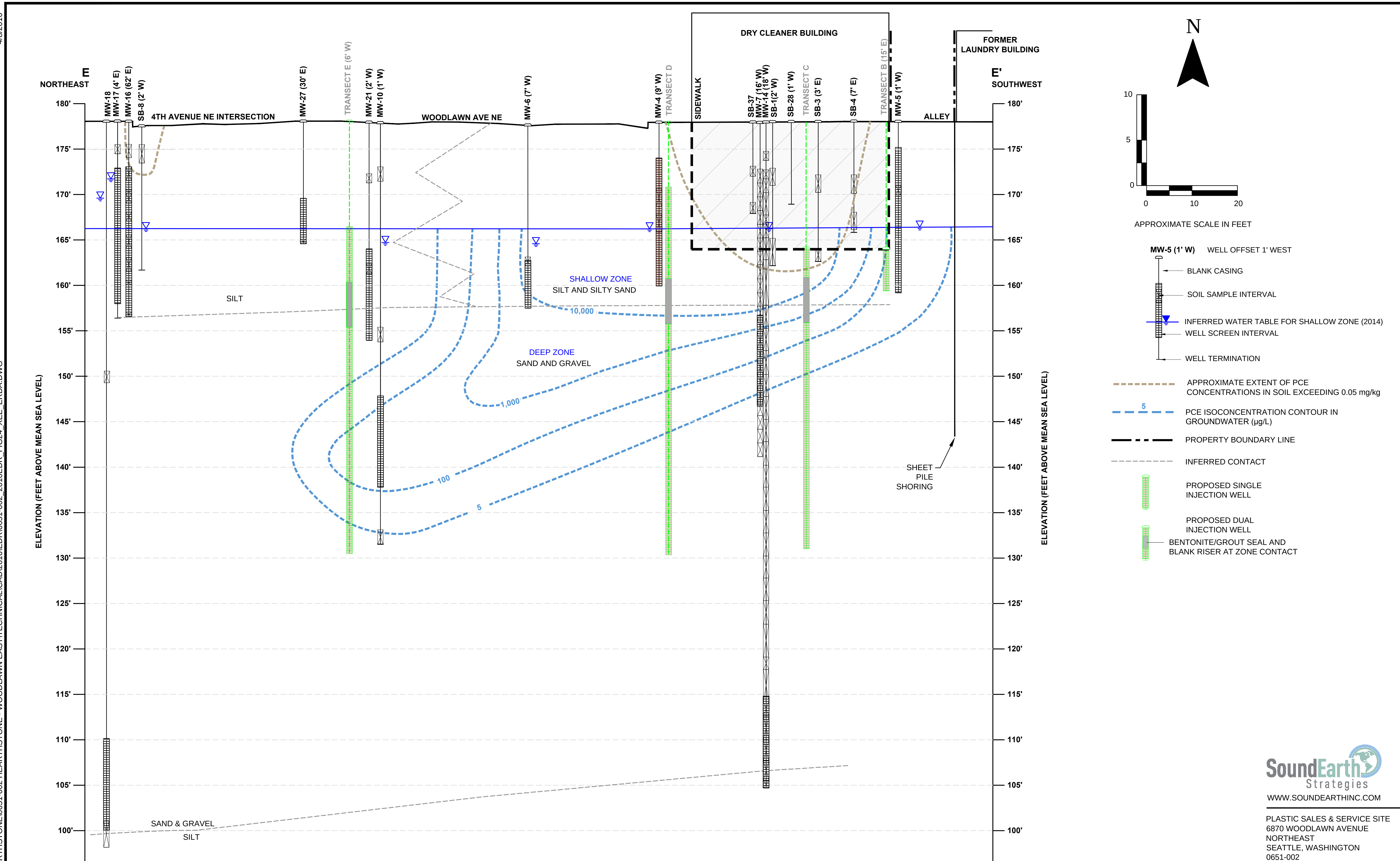
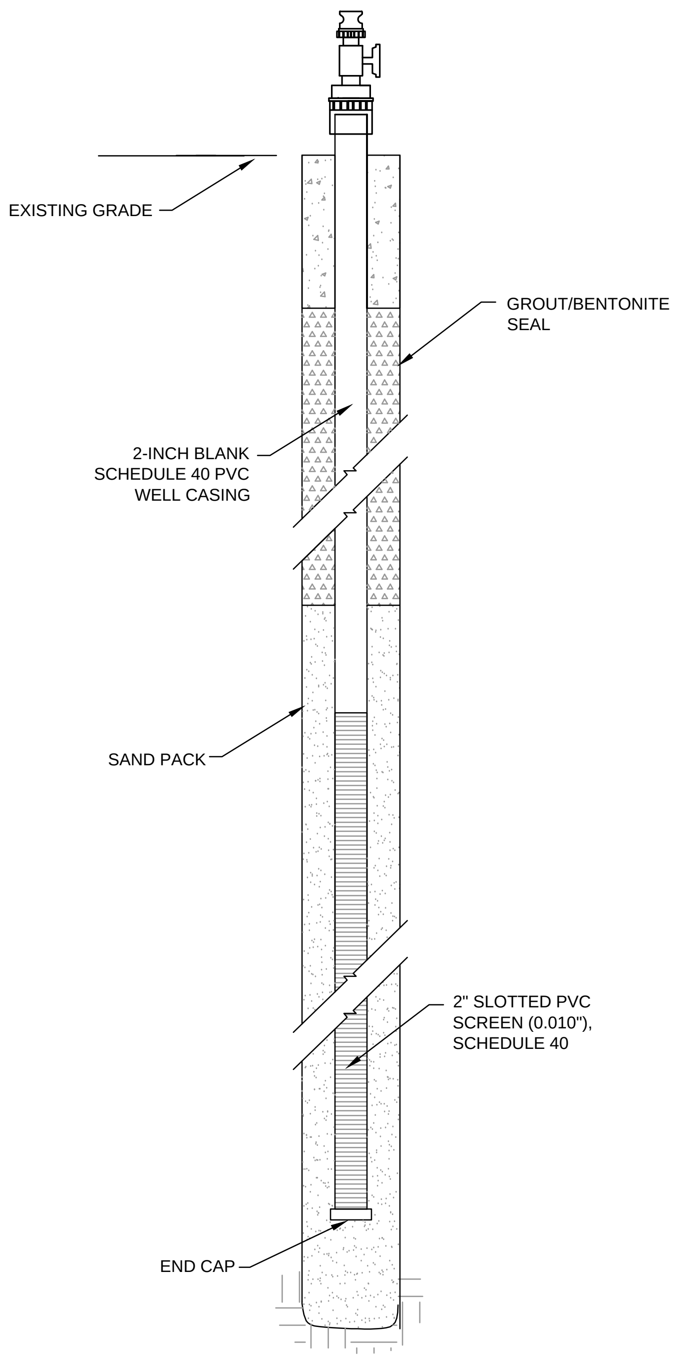


FIGURE 24
INJECTION WELL
CROSS SECTION E-E'

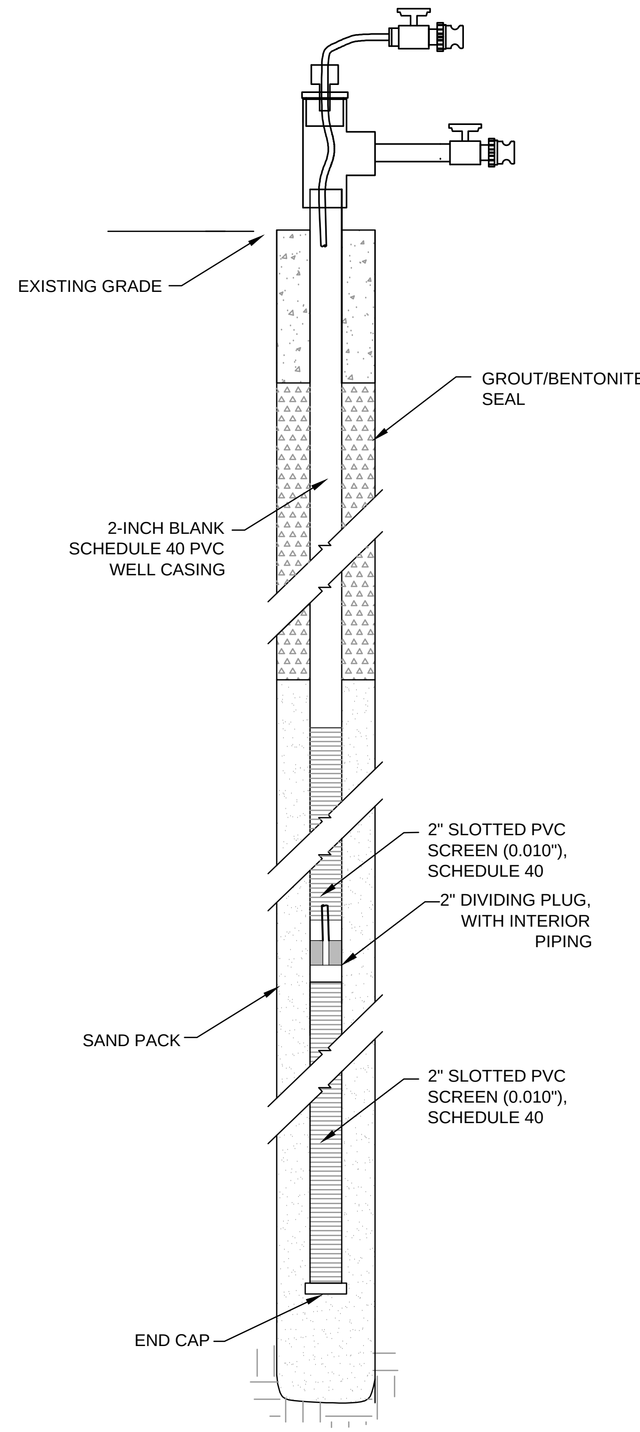
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG24_XEE_ERDA.DWG

4/8/2016

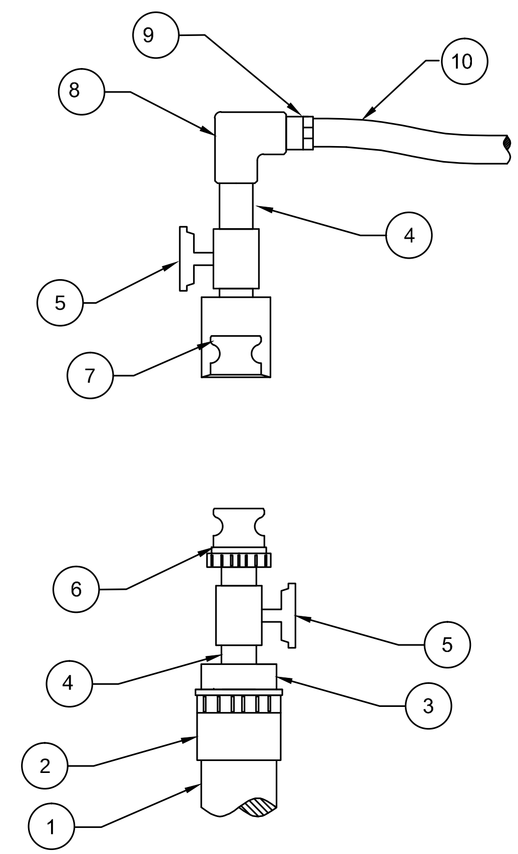
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG25_ERDA.DWG



TYPICAL SINGLE-SCREEN INJECTION WELL DETAIL



TYPICAL DUAL-SCREEN INJECTION WELL DETAIL



TYPICAL INJECTION WELLHEAD ASSEMBLY DETAIL

DESCRIPTION OF WELLHEAD ASSEMBLY ITEMS:

1. 2-INCH SCHEDULE 40 INJECTION WELL CASING
2. 2-INCH SCHEDULE 40 PVC FEMALE ADAPTER
3. 2-INCH x 1/2-INCH SCHEDULE 40 PVC THREADED REDUCING BUSHING
4. 3/4-INCH SCHEDULE 80 PVC CLOSE NIPPLE
5. 3/4-INCH SCHEDULE 40 PVC THREADED BALL VALVE
6. 3/4-INCH POLYPROPYLENE CAMLOCK X MNPT
7. 3/4-INCH POLYPROPYLENE CAMLOCK COUPLER X MNPT
8. 3/4-INCH SCHEDULE 40 PVC THREADED ELBOW
9. 3/4-INCH MNPT BY 3/4-INCH COMPRESSION FITTING
10. 3/4-INCH HDPE HOSE

LEGEND

ERD ENHANCED REDUCTIVE DECHLORINATION

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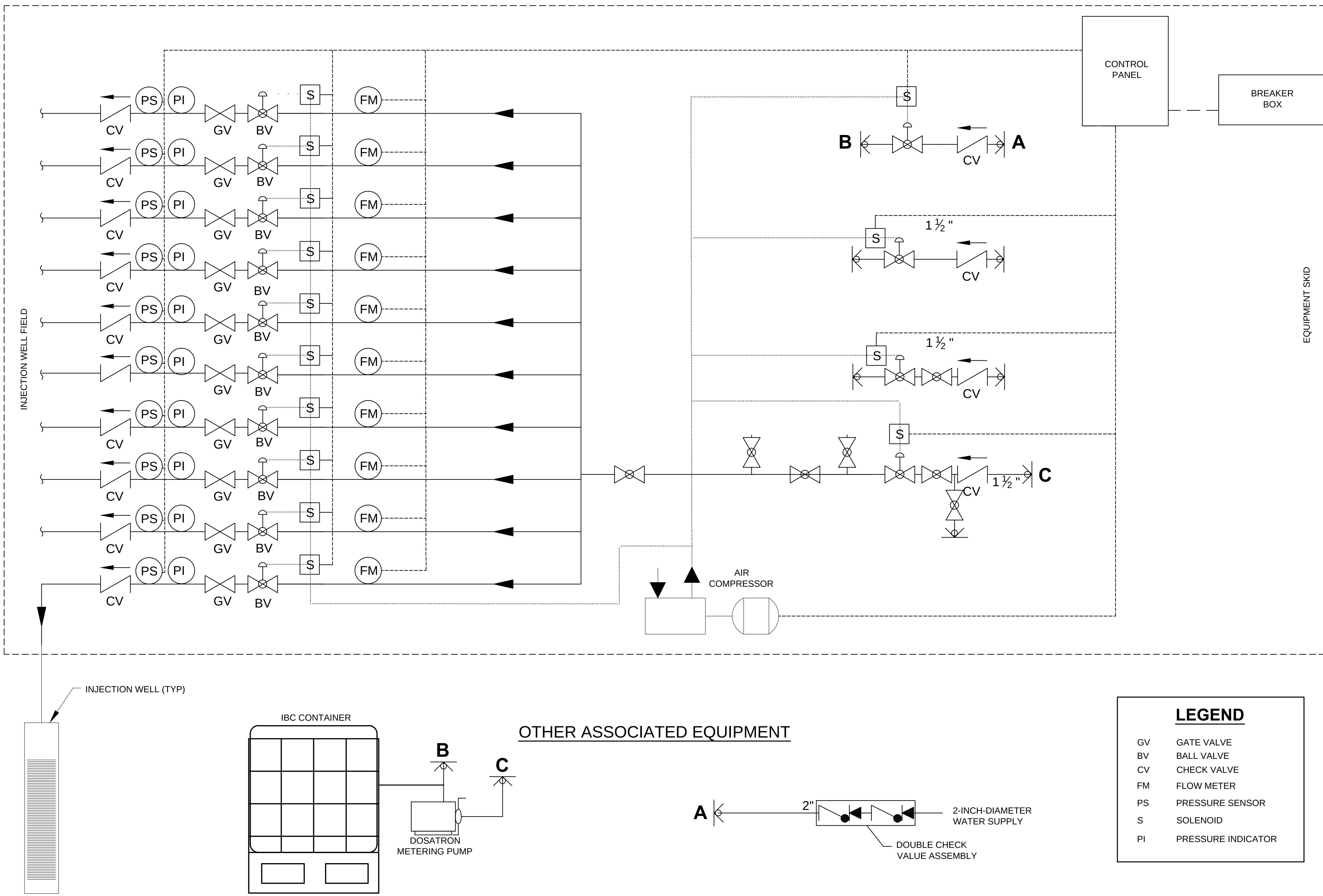
FIGURE 25
STANDARD ERD WELL CONSTRUCTION



LEGEND

GV	GATE VALVE
BV	BALL VALVE
CV	CHECK VALVE
FM	FLOW METER
PS	PRESSURE SENSOR
S	SOLENOID
PI	PRESSURE INDICATOR

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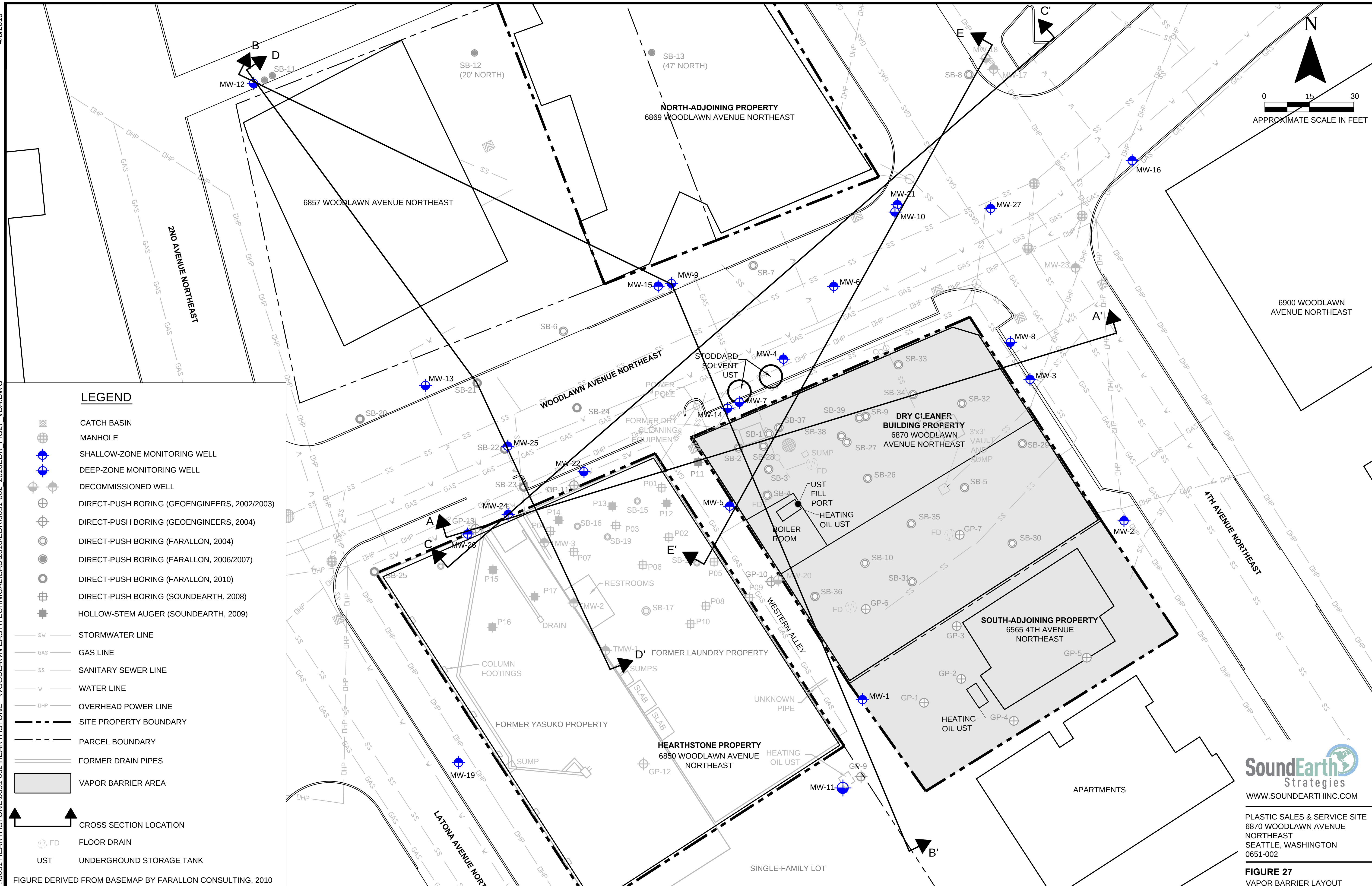
FIGURE 26
INJECTION SYSTEM PIPING AND INSTRUMENTATION DIAGRAM

4/8/2016
P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG27_VBA.DWG



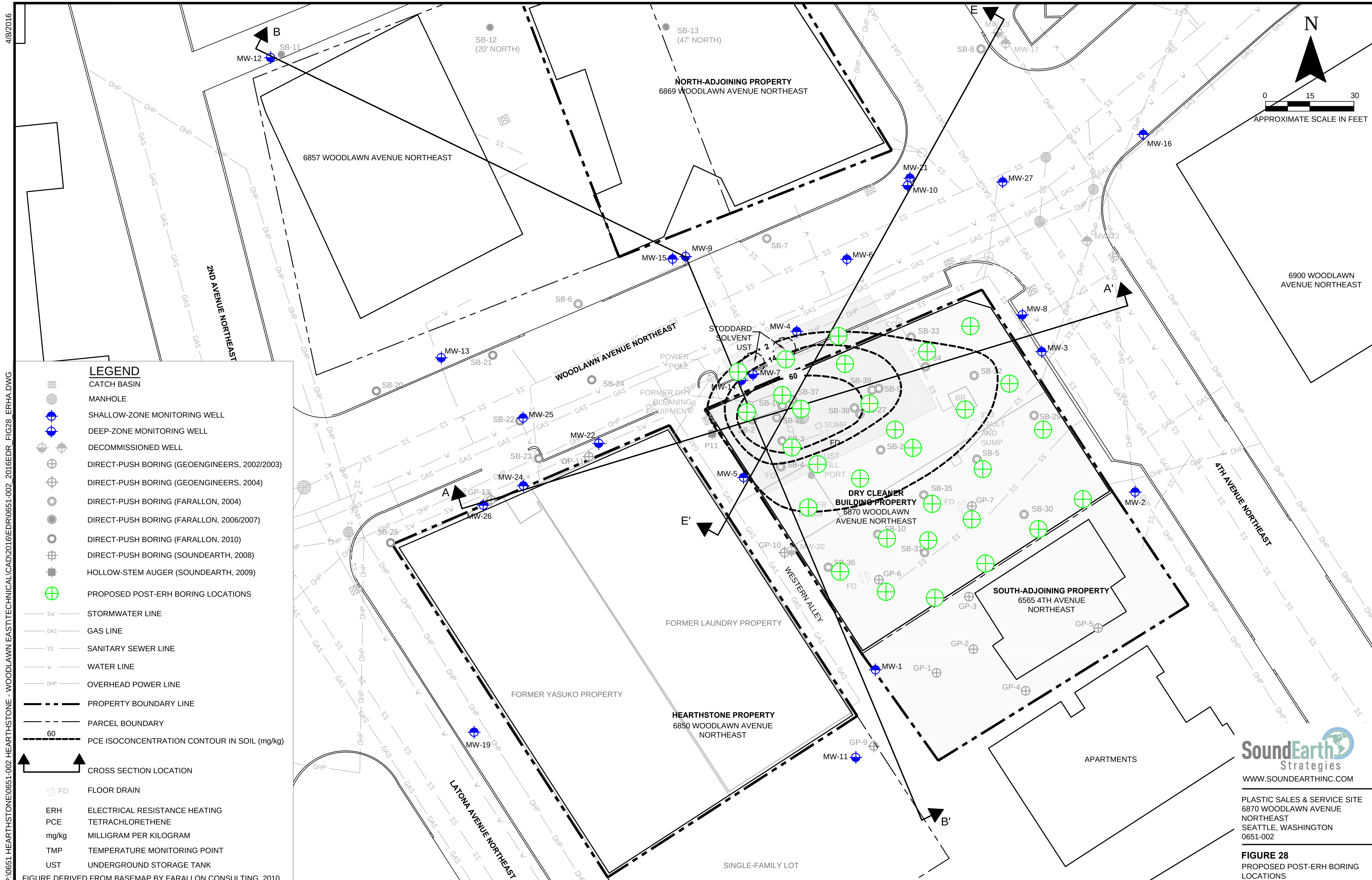


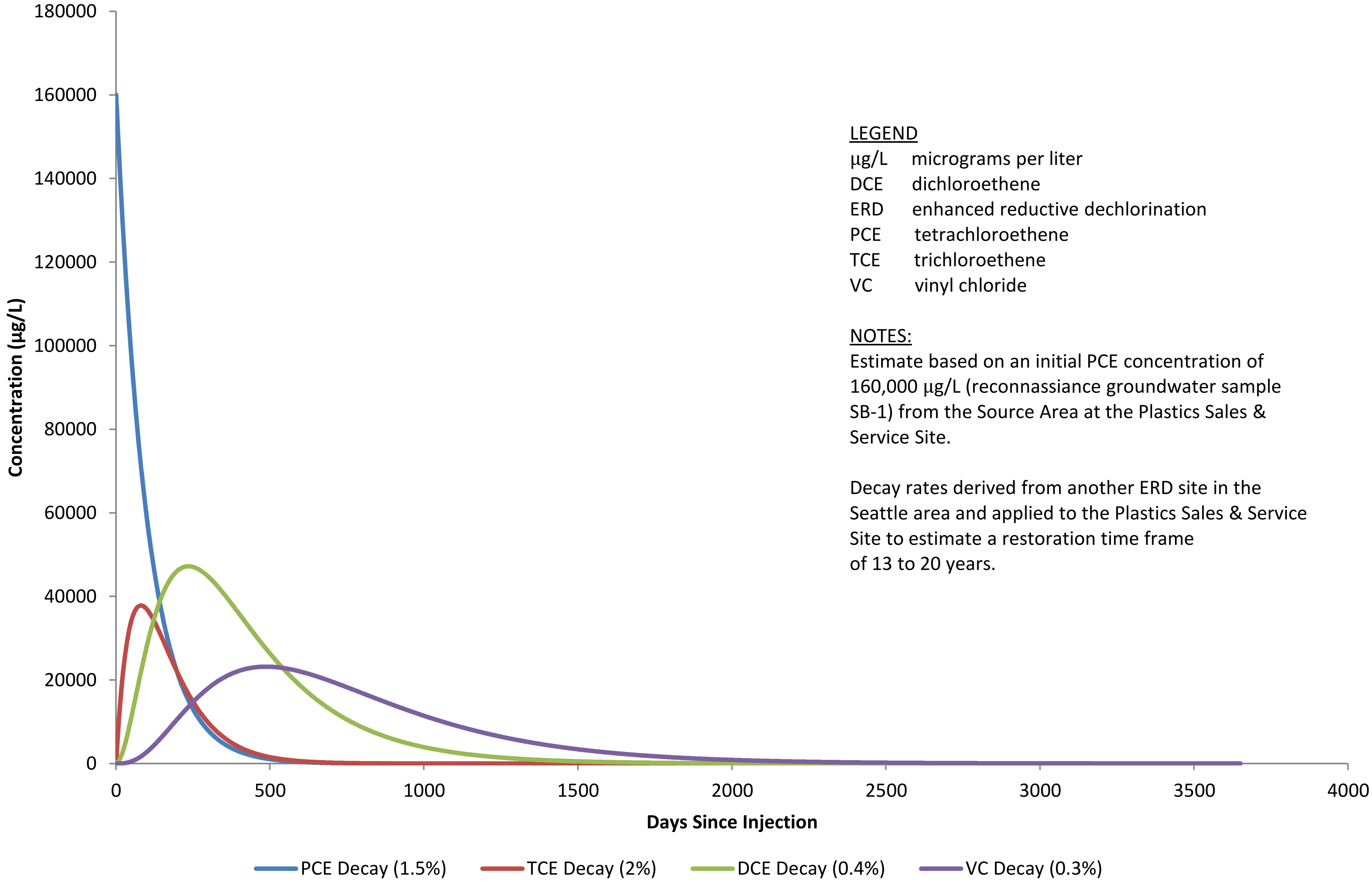
FIGURE 28
PROPOSED POST-ERH BORING LOCATIONS

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\2016\EDR\0651-002_2016EDR_FIG29_GRID.DWG 4/8/2016

CHART

Chart 1

Estimated Degradation of Chlorinated Solvents in Groundwater with Time by Enhanced Reductive Dechlorination



APPENDIX A

EDIBLE OIL MATERIAL SAFETY DATA SHEET

Material Safety Data Sheet

Electron Donor Solution

Section 1: Chemical Product and Company Identification

Product Name: Electron Donor Solution Extended Release
Catalog Codes: EDS-ER
CAS#: 8001-22-7
TSCA: TSCA 8(b) inventory: Soybean oil
HMIS Code: H F R P: 10 0 A
Trade Name and Synonyms: EDS-ER
Chemical Family: Glyceride Oils

Contact Information:
Tersus Environmental, LLC
109 E. 17th Street, Suite #3880
Cheyenne, WY 82001
Ph: 307.638.2822 • info@tersusenv.com
www.tersusenv.com
For emergency assistance, call: 919.638.7892

Section 2: Composition and Information on Ingredients

COMPONANT	CAS #	OSHA TWA	OSHA STEL	ACGIH TWA	ACGIH STEL
Soybean Oil	8001-22-7	---	10 mg/m^3	---	---
Emulsifiers	Confidential	---	---	---	---

HAZARDOUS INGREDIENTS: NONE AS DEFINED UNDER THE U.S. OSHA HAZARD COMMUNICATION STANDARD (29 CFR 1910.1200) OR THE CANADIAN HAZARDOUS PRODUCTS. ACT S.C. 1987, C.30 (PART 1).

THE PRECISE COMPOSITION OF THIS PRODUCT IS PROPRIETARY INFORMATION. A MORE COMPLETE DISCLOSURE WILL BE PROVIDED TO A PHYSICIAN IN THE EVENT OF A MEDICAL EMERGENCY.

SARA HAZARD: NONE NOTED (SECTION 311/312) TITLE III SECTION 313 - NOT LISTED
All components of this product are listed on the TSCA registry.

Section 3: Physical/Chemical Characteristics

BOILING RANGE: Not applicable

VAPOR DENSITY: Exceeds 1.0

SPECIFIC GRAVITY (H20=1.0): 0.93

VAPOR PRESSURE: Not applicable

PERCENT VOLATILE BY VOLUME: 0%

SOLUBILITY IN WATER: Miscible

EVAPORATION RATE: Not applicable
APPEARANCE AND ODOR: A pale yellow, oily liquid - only a faint odor.
WEIGHT PER GALLON: 7.7 lbs. at 60F.

Section 4: Fire and Explosion Data

FLAMMABILITY CLASSIFICATION: Combustible Liquid - Class IIIB.
FLASHPOINT: Greater than 550 F (288 C).
METHOD USED: Tag Closed Cup.
EXTINGUISHING MEDIA: CO_2, dry chemical, foam, sand.
SPECIAL FIREFIGHTING PROCEDURES: Avoid use of water as it may spread fire by dispersing oil. Use water to keep fire-exposed containers cool. Water spray may be used to flush spills away from fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Rags soaked with any oil or solvent can present a fire hazard and should always be stored in UL Listed or Factory Mutual approved, covered containers. Improperly stored rags can create conditions that lead to oxidation. Oxidation, under certain conditions can lead to spontaneous combustion.

Section 5: Reactivity Data

STABILITY: Generally stable. Spontaneous combustion can occur. See Unusual Fire and Explosion Procedures, Section IV.

CONDITIONS TO AVOID: High surface area exposure to oxygen can result in polymerization and release of heat.

INCOMPATABILITY (MATERIALS TO AVOID): Avoid contact with strong oxidizing agents.

HAZARDOUS DECOMPOSITIONS OR BY-PRODUCTS: Decomposition may produce carbon dioxide and carbon monoxide.

HAZARDOUS POLYMERIZATION: Will not occur.

Section 6: Health Hazard Data

THRESHHOLD LIMIT VALUE: As a liquid - none. As oil mist - 10 mg/m3 total particulate.

INHALATION HEALTH RISKS AND SYMPTOMS OF EXPOSURE: Excessive inhalation of oil mist may affect the respiratory system. Oil mist is classified as a nuisance particulate by ACGIH.

SKIN ABSORPTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE: Not classified as a primary skin irritant or corrosive material. Sensitive individuals may experience dermatitis after long exposure of oil on skin.

HEALTH HAZARDS (ACUTE AND CHRONIC): Acute: none observed by inhalation. Chronic: none reported.

EMERGENCY AND FIRST AID PROCEDURES FOR:

SKIN CONTACT: May be removed from skin by washing with soap and warm water.

EYE CONTACT: Immediately flush eyes with plenty of cool water for at least 15 minutes. Do NOT let victim rub eyes.

INHALATION: Immediately remove exposed individual to fresh air source. If victim has stopped breathing give artificial respiration, get medical attention immediately.

Section 7: Precautions for Safe Handling and Use

ENVIRONMENTAL PRECAUTIONS: Where large spills are possible, a comprehensive spill response plan should be developed and implemented.

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Wear appropriate respiratory protection and protective clothing as described in section VIII. Depending on quantity of spill: (a) Small spill - add solid adsorbent, shovel into disposable container and wash the area. Clean area with detergent. (b) Large spill - Squeegee or pump into holding container. Clean area with detergent. In the event of an uncontrolled release of this material, the user should determine if this release is reportable under applicable laws and regulations.

WASTE DISPOSAL METHOD: All recovered material should be packaged, labeled, transported, and disposed or reclaimed in accordance with local, state, and federal regulations and good engineering practices.

Section 8: Control Measures

RESPIRATORY PROTECTION: Not normally needed. A qualified health specialist should evaluate whether there is a need for respiratory protection under specific conditions.

VENTILATION: Handle in the presence of adequate ventilation. Intermittent clean air exchanges recommended, but not required.

PROTECTIVE GLOVES: Not normally needed. However, protective clothing is always recommended when handling chemicals.

EYE PROTECTION: Eye protection is always recommended when handling chemicals. Wear safety glasses meeting the specifications established in ANSI Standard Z87.1.

Section 9: Special Precautions

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Store away from flame, fire, and excessive heat.

Section 10: Disposal Considerations

General Information: Do not discharge into drains, watercourses or onto the ground. Discharge, treatment, or disposal may be subject to national, state, or local laws. Empty containers may contain product residues.

Disposal Methods: No specific disposal method required.

Container: Since emptied containers retain product residue, follow label warnings even after container is emptied.

Section 11: Transportation Information

DOT Not regulated.
TDG Not regulated.
IATA Not regulated.
IMDG Not regulated.

Section 12: Other Information

Hazard Ratings

	Health Hazard	Fire Hazard	Instability	Special Hazard
NFPA	1	1	0	NONE

Hazard rating: 0 - Minimal; 1 - Slight; 2 - Moderate; 3 - Serious; 4 - Severe
NFPA Label colored diamond code: Blue - Health; Red - Flammability; Yellow - Instability; White - Special Hazards

	Health Hazard	Flammability	Physical Hazard	Personal Protection
HMIS	1	1	0	--

Hazard rating: 0 - Minimal; 1 - Slight; 2 - Moderate; 3 - Serious; 4 - Severe
HMIS Label colored bar code: Blue - Health; Red - Flammability; Orange - Physical Hazards; White - Special

Section 13: Disclaimer and/or Comments

We suggest that containers be either professionally reconditioned for re-use by certified firms or properly disposed of by certified firms to help reduce the possibility of an accident. Disposal of containers should be in accordance with applicable federal, state and local laws and regulations. "Empty" drums should not be given to individuals.

The conditions of handling, storage, use and disposal of the product are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Tersus Environmental be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Tersus Environmental has been advised of the possibility of such damages.

APPENDIX B
ELECTRICAL RESISTANCE HEATING SYSTEM DESIGN

TRS Group, Inc.
PO Box 737
Longview, WA 98632
www.thermalrs.com

EXHIBIT B-4

January 22, 2016

Subject: Revised Proposal and Scope of Work (SOW) split for ERH Remediation Plastic Sales and Service Site, Seattle, WA

TRS Group, Inc. (TRS) is pleased to provide Ramras Specialty Group and The Hearthstone with a revised proposal and Scope of Work (SOW) split for installation, operation, and decommissioning of the Electrical Resistance Heating (ERH) remediation system at 6870 Woodlawn Ave. NE in Seattle, Washington.

In accordance with Section 1, of the Master Service Agreement, dated May 8, 2015 (the "Agreement") by and between TRS Group Inc. ("TRS") and the Lutheran Retirement Home of Greater Seattle, a Washington non-profit corporation d/b/a The Hearthstone ("Client"), this Exhibit B-4 is proposed to be incorporated into and form part of the Agreement and is made effective as of the date executed by signature at the bottom of this Exhibit (the "Exhibit B-4 Effective Date"). The Agreement, as amended by this Exhibit B-4, constitutes the complete and entire understanding of the parties with respect to the subject matter hereof.

This proposal presents the site parameters, our technical approach, and respective scopes of work and subsequent pricing for ERH remediation based on the remedial objectives presented in the Remediation Objectives section of this proposal.

SITE DATA REVIEW

Sound Earth Strategies, Inc. (SoundEarth) prepared and submitted the Remedial Investigation/Feasibility Study (RI/FS) Addendum to the Washington Department of Ecology (Ecology) on behalf of The Lutheran Retirement Home of Greater Seattle. The ERH design approach is based on the remedial objectives and approach described in the RI/FS. In addition, TRS reviewed site data contained within the documents listed in Exhibit C of the Master Service Agreement (MSA) between TRS Group, Inc. and the Lutheran Retirement Home of Greater Seattle, a Washington non-profit corporation d/b/a The Hearthstone.

SITE DESCRIPTION AND BACKGROUND

Site descrption and background information presented within this section (including all subsections) was obtained directly from the RI/FS Addendum (SoundEarth, April 2015). The Site is defined in Ecology Agreed Order No. DE 7084 (AO), dated September 14, 2009, as the extent of contamination caused by the releases of hazardous substances at the property located at 6870 Woodlawn Avenue Northeast in Seattle, Washington (the Dry Cleaner Building Property). The Site includes the Dry Cleaner Building Property, the property adjoining it to the west, located at 6850 Woodlawn Avenue Northeast (the Hearthstone Property); the property adjoining it to the north, located at 6869 Woodlawn Avenue Northeast (north-adjoining property); the property adjoining it to the south, located at 6565 4th Avenue Northeast (south-adjoining property) and portions of the western alley (the alley), Woodlawn Avenue Northeast and 4th Avenue Northeast rights-of-way (ROWs); and is collectively referred to as "the Site".

Environmental Setting

Topographically, the Site is relatively flat with a slight slope to the northeast toward the former Ravenna Creek. The Site is situated approximately 150 feet above mean sea level. The nearest surface water body is Green Lake, located approximately 900 feet to the northwest.

Based on field observations from SoundEarth and others, the upper 20 feet of soil beneath the Dry Cleaner Building Property and the Hearthstone Property generally range from stiff to very stiff silt and medium dense to very dense silty sand. Trace amounts of gravel were also observed in borings advanced in the vicinity of the Hearthstone Building Property in the upper 15 feet below ground surface (bgs). The observed soil from borings located north and downgradient of the Dry Cleaner Building Property indicates that the soil profile transitions laterally from silt and silty sand layers to a silt with minimal coarse-grained soil present in Woodlawn Avenue Northwest. Underlying the upper silt and silty sand unit is a dense to very dense, poorly graded sand and gravel to well-graded sand and silty sand unit that ranges in depth from approximately 20 to 70 feet bgs. The silty sand layers encountered in the upper 20 feet contained a higher percentage of silt (30 to 40 percent) versus the silty sand layers encountered in soil deeper than approximately 20 feet bgs.

A shallow, unconfined water-bearing zone is present beneath the Site from approxiately 6 to 20 feet bgs and is designated as the Shallow Zone based on the observed soil profile and potentiometric surface in the existing well network. The depth to groundwater in the Shallow Zone generally ranges from 4 to 8 feet below the top of well casings; seasonal fluctuations in groundwater elevations range from approximately 2 to 5 feet. Based on groundwater elevations measured in September 2014 at monitoring wells located at the Site, the groundwater flow direction in the Shallow Zone was to the north and northwest, with gradients ranging between 0.01 and 0.06 feet per foot (ft/ft). The Shallow Zone is underlain by a semiconfined to confined groundwater-bearing zone designated as the Deep Zone. The Deep Zone ranges in depth from 5 to 9 feet below the top of well casings. Based on depth-to-groundwater measurements collected in September 2014, the direction of groundwater flow in the Deep Zone was to the northeast with gradients ranging between 0.01 and 0.03 ft/ft. The Shallow Zone appears to act as a semiconfining to confining unit based on observed potentiometric surface measurements from the existing well network that generally indicate a positive hydraulic head in wells installed in the Deep Zone.

SoundEarth has subdivided the site into five remediation areas. SoundEarth described these areas depicted on a figure and described within the RI/FS Addendum as follows:

- Area 1 is generally located within the former dry cleaning machinery source area, beneath the Dry Cleaning Building Property, and contains PCE-contaminated soil and groundwater. The extent of Area 1 is defined by concentrations of PCE in soil exceeding the MTCA Method A Cleanup level and Resource Conservation and Recovery Act (RCRA) Land Ban criteria (60 mg/kg); 40 Code of Federal Regulations Part 268, Subpart D, 268.40 and 268.49 [c][1][C]).
- Area 2 is generally located around the perimeter of Area 1 beneath the Dry Cleaning Building Property and contains PCE-contaminated soil and groundwater. The extent of Area 2 is defined by concentrations of PCE in soil exceeding the MTCA Method A Cleanup level and Washington State's Dangerous Waste (DW) Toxicity Characteristic List for PCE of a Toxicity Characteristic Leaching Procedure (TCLP) of 0.7 milligrams per liter, which is equivalent to 14 mg/kg, but not exceeding RCRA Land Ban criteria (WAC173-303-090[8][c]).

- Area 3 is generally located directly downgradient of the former dry cleaning machinery source area, beneath the Woodlawn Avenue Northeast ROW, and contains PCE-contaminated soil and groundwater. The extent of Area 3 is defined by concentrations of PCE in soil exceeding the MTCA Method A Cleanup level and DW criteria for listed wastes, but not exceeding RCRA Land Ban criteria.
- Area 4 is generally located in remaining areas beneath the Dry Cleaning Building Property and contains PCE-contaminated soil and groundwater. The extent of Area 4 is defined by concentrations of PCE in soil exceeding the MTCA Method A Cleanup level, but not exceeding DW criteria for listed wastes.
- Area 5 is generally located on the 6565 4th Avenue Northwest Property. Concentrations of PCE and its degradation compounds have not been fully assessed in soil or groundwater on this property. However, concentrations of PCE in soil and groundwater have been detected in exceedance of the MTCA Method A cleanup level at boring and well locations directly north on the Dry Cleaner Building Property.

REMEDIATION OBJECTIVES AND APPROACH

ERH will be implemented in areas 1, 2, and 3 to an approximate depth of 16 feet bgs. The primary chlorinated volatile organic compounds (CVOC) at the site requiring remediation in soil and groundwater are tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride. The remedial objective for ERH remediation at the site is to lower contaminant concentrations of PCE in soil to below 14 mg/kg.

ERH is a process whereby soils and groundwater are heated by passing an electrical current through the subsurface volume to be remediated. It is the resistance by the soil matrix to the flow of electricity between electrodes that heats the subsurface and boils a portion of the soil moisture into steam. This in situ steam generation occurs in all soil types, regardless of permeability. The heat generated by resistance to the induced electrical current also evaporates the target contaminants. The in situ steam generated by ERH acts as a carrier gas to sweep VOCs to negative pressure vapor recovery (VR) wells. The VR wells will produce an over-lapping vacuum influence across the treatment area. Steam and soil vapors are then transported by plastic piping headers to the ERH treatment compound.

Contaminant mass has been moving out of the source region since the time of the original release and continues today (a.k.a. “CVOC flux”), albeit very slowly. Operation of the ERH system will affect the CVOC flux. During the early stages of ERH operation, the CVOC flux downgradient of the treatment area may temporarily increase due to increases in the CVOC solubility’s and decreases in groundwater viscosity as the site is heated through 80 degrees Celsius (°C). Once the ERH system is up to steaming temperatures, the net extraction of water from the treatment volume in the form of steam will reduce or eliminate the CVOC flux depending on the net water removal rate and the groundwater flow rate. Continued ERH operation will deplete the CVOC source mass and will inevitably result in a permanent reduction of the CVOC flux.

After ERH, groundwater flow will return to existing conditions and clean, warm groundwater with dissolved organic carbon (DOC) will slowly flow downgradient. This “beneficial flux” may significantly speed natural attenuation of the downgradient plume.

SCOPE OF WORK

The sections that follow present summaries of the upcoming tasks and the corresponding responsible company for each ERH project task. TRS' experience suggests that the most efficient and economical approach to ERH project execution is the formation of a strong team with specific experience, skills and attributes. TRS' suggested task split attempts to capitalize on the strengths of SoundEarth for specific ERH project tasks and also utilize their local presence for efficiency.

TRS intends to work between 7:00 AM and 6:00 PM on Monday through Friday. We may shift work hours based on weather conditions. Initial start-up of the ERH system may occur outside of normal work hours in order to prevent disturbance of work by our testing. TRS might need to respond to a fault condition of the ERH system at any time.

Design and Permitting

Split scope and pricing for ERH system design and permitting is presented in Exhibits B and B-2. No additional design or permitting activities are anticipated to complete the ERH remediation.

ERH Subsurface System Installation

TRS proposes 19 electrodes with vapor recovery (VR) screens and four temperature monitoring points (TMPs). TMPs will be installed within the treatment volume as a means to provide continuous temperature monitoring within the subsurface. Temperature data will be automatically recorded at least once per day from the four TMPs that will be located within the treatment volume. Procurement of materials described in this section is being completed under Exhibit B-3.

<u>TRS will supply and complete the following related to subsurface installation:</u>

- Coordinate with SoundEarth to jointly mark all drilling locations. TRS assumes marking of drilling locations will not require the services of a surveyor.
- On-site technical supervision of electrode installation. TRS does not plan to provide a Washington registered geologist for drilling oversight and will not produce boring logs for the electrodes or TMPs.
- While SoundEarth will be responsible for contracting and payment of the drilling subcontractor, TRS will assist in the installation of electrodes and TMPs. This will include supplying and installing all electrode conductive materials, well screens, and casings for all electrodes VR wells in the ERH treatment areas. The electrode conductive backfill interval will extend from 1 to 17 ft bgs within all three treatment areas. If 12-inch diameter borings are not possible, this will be considered a changed condition requiring redesign and re-pricing by TRS.
- Supply and oversee installation of TMP casing.
- Supply and install TMP cables and thermocouple strands.
- Prior to the initiation of remedial design, permitting, or mobilization activities, TRS may collect three soil samples during TMP drilling to spot-check the baseline subsurface CVOC concentrations and/or TOC.

<u>SoundEarth or the client's representative will supply and complete the following:</u>

- Coordinate with TRS to jointly mark all drilling locations.
- Obtain all necessary right of entry/access agreements required for TRS to perform this scope of work.

- Complete a subsurface utility survey and mark the locations of the subsurface utilities and piping prior to starting intrusive activities. It is important to identify all buried utilities in and adjacent to the ERH treatment area so that proper measures can be designed into the system to mitigate the potential for preferential pathways.
- Contract with the drilling company and supervise the installation of the electrodes and TMPs. The electrode and VR well borings require utilizing a drill rig to produce a 12-inch o.d. borehole.
- Sand and neat Portland cement grout for electrode and TMP construction and completion.
- Provide waste roll-off bins or drums to containerize drilling spoils
- Responsible for characterization, manifest preparation, and transportation of the wastes for disposal. TRS estimates that 12 tons of contaminated soil cuttings will be generated during system construction.
- Safety monitoring (PID).
- Any soil sampling and analysis required.
- Identify a potable water source with a capacity of at least five gpm on or near the property and provide this water source to the ERH system.
- Electrical service to the TRS Power Control Unit (PCU).

ERH Surface Installation

<u>TRS will supply and complete the following related to surface installation:</u>

- An internal security system. TRS will provide the security sensors and security monitoring system on a rental basis for the job. The security system will be interlocked to the PCU to prevent contact with voltage should unauthorized access occur into the treatment volume.
- 500 kilowatt (kW) Power Control Unit with operating system for remote telemetry.
- One specialty ERH Condenser and cooling tower.
- Cabling electrodes to ERH equipment.
- Provide and install the piping and fittings necessary to connect the electrode VR wells to the inlet of the steam condenser and interconnection piping between the condenser, VR blower, vapor granular activated carbon (VGAC) and liquid granular activated carbon (LGAC) vessels.
- One Vapor Recovery blower.
- Provide and install a temperature monitoring system, interlock wiring between all system components, and a remote monitoring system.
- Complete electrical connections downstream of the PCU, including power connections to the condenser, cooling tower, and VR blower and to each of the electrodes.
- Flow measuring devices and vacuum gauges. Please note: flow cannot accurately be determined in pipes or other locations containing steam.

<u>The client or their representative will supply and complete the following related to surface installation:</u>

- Establish a new electrical service from Seattle City Light (SCL) to the input disconnect of TRS' 500-kW PCU.
- The water treatment system (LGAC vessels and carbon) for liquid treatment.
- The vapor treatment system (VGAC vessels and carbon) for vapor treatment.

- All vapor and liquid permit-related sampling and analysis.
- Maintain a potable water source with a capacity of at least five gpm on or near the property and provide this water source to the ERH system.
- Maintain electrical service with SCL for the TRS Power Control Unit (PCU).

ERH Operations

Once installation is complete, TRS will perform system startup and testing. This process is anticipated to take a week or two to complete. Once testing is complete, power application to the treatment volume will be continuous except for system adjustments, routine maintenance, and scheduled soil sampling events. TRS estimates that 260,000 kWh of electrical energy will need to be input to the subsurface in order to achieve the established remedial goals. A further approximate 20,000 kWh will be used by the surface equipment. The approximate time to apply this amount of energy to the subsurface will be 45 to 60 days.

Due to the high cost of electrical usage during ERH, it is most cost-effective to conduct soil sampling in an iterative manner.

For example, the first round of sampling will likely be scheduled near the time when 50-70% of the planned ERH energy has been input to the subsurface. TRS does not expect that <u>all</u> regions of the Site will meet the remediation goal on this first event. However, the sample results will allow TRS to shut down the portions of the Site that are clean, which reduces power and saves on-going energy costs. In addition, shutting down a portion of the system allows TRS to concentrate efforts in a smaller region(s) and may allow faster progress on the remaining region(s). Such iterative soil sampling saves energy and money. Only locations that are above the treatment goals will be re-sampled in subsequent soil sample events. The exact location of the final confirmatory samples will be agreed to by TRS and the client or the client's representative.

<u>During startup and operations, TRS will provide the following:</u>

- Equipment operational checkout.
- Data acquisition verification.
- ERH system interlock verifications and safety checks.
- ERH system voltage safety checks and required corrections.
- Pre-startup equipment function testing.
- Completion of Startup Checklist. TRS safety procedures require completion of an extensive checklist before the first application of ERH power to the site. As part of the startup checklist, TRS will provide written notification to the client that TRS must be notified before any digging occurs within 50 feet of the ERH system. TRS recommends forwarding this written notification to adjacent property owners or occupants. This "pre-dig" requirement is also described on warning signs that TRS will post on the remediation area fence at the Site.
- ERH system application verification.
- Establishment of baseline vapor recovery flow and subsurface vacuum conditions.
- System safety training with SoundEarth and any other site personnel.
- Operate TRS equipment listed in Surface Installation (above).
- Operational oversight and monitoring of the heating, vapor capture, and temperature monitoring systems.

- On-site checks, including electrode current surveys and voltage surveys.
- ERH Equipment maintenance.
- Bi-weekly operational status reports provided in electronic format. Reports include temperature, power, energy, and condensate rates along with recommendations for confirmatory sampling and system optimization.
- Provide estimation of the appropriate schedule to collect confirmatory soil samples. Each TRS weekly report will include an updated estimate of the optimal time to conduct the next round of soil samples. The first such weekly report is likely to estimate that the first round of soil samples will occur in Week 6 after start-up.
- Provide alarm or emergency response.

<u>During startup and operations, the client or their representative will provide the following:</u>

- All LGAC for water/condensate treatment including LGAC change-out.
- All VGAC for vapor treatment.
- All vapor sampling and analyses for air permit compliance.
- All water sampling and analyses required for water discharge compliance.
- Sampling and analyses for estimation of mass recovery rates.
- All ambient air monitoring required for project compliance.
- Coordination and completion of confirmation soil sampling and analysis. A confirmatory sampling plan will be developed and agreed upon between all parties prior to commencing ERH system installation. All confirmation soil sampling will be completed with a 72-hour turn-around time (TAT). The hot soils will be sampled using brass or stainless steel core barrels. The borings will be drilled using a direct push method. The cores will be brought to the surface, capped, and a thermometer will be inserted through the cap into the core. The soil sample will be placed on ice to cool. When the soil has cooled to below ambient temperatures, the core will be opened and a sub-sample will be collected from near the center of the core barrel for submittal to the laboratory. The samples will be sent to a certified laboratory and tested for VOCs using EPA Method 8260B. This hot soil sampling procedure has been used at many dozens of ERH projects for both state and federal environmental compliance agencies. A copy of the hot soil sampling procedure will be maintained onsite.
- Regulatory reporting of confirmation soil sampling.
- Continue to provide a potable water source with a capacity of at least five gpm on or near the property.
- Maintain electrical service with SCL for the TRS PCU.
- Coordination and payment for permit fees and wastewater disposal (if required).

Demobilization and Final Report

Demobilization will be completed within 60 days of ERH completion. After ERH remediation is complete, the subsurface will slowly cool. The long period at elevated temperatures provides an important polishing step for further reduction in CVOC concentrations by heat-enhanced bioremediation.

Upon completion of power application, and receipt of the confirmatory soil sample results, TRS will prepare a final report that summarizes the ERH system installation, power application to the subsurface over time, subsurface temperatures over time, and CVOC extraction data. This report will be provided to SoundEarth in electronic format.

TRS will provide the following demobilization activities and final reporting:

- TRS will be responsible for removing all above grade temporary structures, piping, and equipment that it placed on the site. TRS provides equipment and cable as rented items and maintains ownership of these items at project completion.
- The final report will cover topics including:
  - As-built drawing package.
  - Site background and construction description.
  - Total Energy Application.
  - Power delivery and energy usage summaries.
  - Temperature profiles at various points during operations.
  - A summary of pneumatic control throughout operations
  - Vapor Stream parameters including flow, vacuum and volume.
  - Condensate production, blow down discharge, and water balance.
  - Any major operational changes.
  - Soil result analysis (based on samples collected and analytical results provided by others).

The client or their representative will provide the following demobilization and final reporting:

- Coordination with City and Regulatory agencies related to any decommissioning or abandonment of ERH system subsurface components.
- Abandon in place all of the electrodes, co-located VR wells and TMPs in accordance with local regulations.
- Tabulated analytical data and mass removed calculations for inclusion in TRS final reporting (with TRS support).
- Electrical service to the TRS PCU until directed by TRS that it is no longer required.
- Abandonment of the electrical services that feed the PCU.
- Decommissioning of the electrical service with SCL including removal costs.
- Continue to provide a potable water source with a capacity of at least five gpm on or near the property until directed by TRS that it is no longer required.
- Coordination and payment for wastewater disposal (if required).

CONTRACTING

Based on our SFPR contract, TRS will continue operation until the remedial goals have been reached or until 260,000 kWh have been input to the subsurface, whichever occurs first. Based on previous experience, TRS estimates that about 80 percent of our remediation projects reach the remedial goal prior to inputting the design remediation energy.

In the unlikely event that the remediation goal has not been reached, but the design remediation energy has been input to the subsurface, TRS will continue to operate the remediation system at an additional TRS cost of $19,800 per week. However, the client will also have additional electrical usage and vapor, process water, and soil sampling and analysis costs. It is unlikely that TRS will be operating at full power after inputting 260,000 kWh – if any continued operation is required then it is likely to be required for just a small portion of the Site and daily energy costs are likely to be about half that of the full-power rate.

The remediation parameters and corresponding best and final pricing for our SFPR contract are presented in Table 1.

STANDBY

Our pricing includes the assumption that others do not delay TRS' work. In the event that TRS' equipment is on-site while others delay TRS' progress in completion of ERH system installation and startup activities, or TRS' equipment must sit idle during operation due to factors outside TRS' control, an equipment standby charge of $1,190 per day will apply for the SFPR. If others require that TRS work at a reduced pace (e.g. limit ERH power application), then the equipment standby charge will be applied *pro rata* in proportion to the limitation. For example, if the client or their representative instructs TRS to reduce its ERH power input rate by half, then an additional charge of $595 per day will apply for the SFPR during the power restriction.

TRS price includes time downtime for the collecting samples from four discrete depths at 12 locations. No additional standby will be charged if soil sampling is conducted in a timely manner and samples are submitted for analysis with a 72-hour TAT. TRS estimates that confirmatory sampling will be completed in three days.

TERMS AND PAYMENT

Because of the volatility in the commodity markets, the terms of this proposal and pricing are valid until February 1, 2015. In the event of a prolonged delay or changes in the scope of work or approach, price adjustments may be required.

This TRS proposal is based on payment terms of net 30 days from the date of our approved invoice.

Total compensation to TRS for ERH design, installation, operation, and decommissioning is $533,000. ERH system design will be completed under Exhibits B and B-2 of the MSA. Payment for the Electrode Materials Mobilization task ($84,000) is due prior to starting field work and is being completed under Exhibit B-3. As shown in Table 1, a credit of $165,000 from the total cost has been provided. Total compensation to TRS for work activities described in this proposal is $368,000.

TRS will invoice monthly on a percent complete basis. Due to the relatively fast pace of the remediation, it is likely that only the operation task will span more than two monthly billing cycles. Operations completion percentage will be measured by the ratio of applied electrical energy (kWh) to the estimated Design Remediation Energy of 260,000 kWh. If an invoice is due during drilling and TRS has installed 12 out of 19 electrodes then TRS will bill 66% of the subsurface installation task.

EXHIBIT B-4 EFFECTIVE DATE

The undersigned, on behalf of The Hearthstone, hereby authorizes TRS Group, Inc. to complete the additional scope of work described above in accordance with the terms and conditions described above and in accordance with the Master Services Agreement and associated exhibits executed on May 8, 2015.

Mary Lou Stuenzi, Date
CEO of The Lutheran Retirement Home of Greater Seattle

Table 1 Remediation Parameters and SFPR pricing

TRS Accelerating Value

Plastics Site - Soil Only, 14 mg/kg goal Remediation Parameters

www.thermalrs.com

		>60 mg/kg Area 1, 1B	14-60 mg/kg Area 2	14-60 mg/kg Area 3
Electrical Resistance Heating Treatment Area:	3,140 sq. ft	1,160	1,062	918
Average Shallow Extent of ERH:	1 ft	1	1	1
Average Deep Extent of ERH:	16 ft	16	16	16
Typical Depth to Groundwater:	7 ft			
Treatment Volume:	1,700 cu. yd	600	600	500
Assumed Total Organic Carbon Content of Soil:	0.25%	0.25%	0.25%	0.25%
Number of Electrodes:	19	8	6	5
Electrode Boring Diameter (in.):		12	12	12
Average Distance Between Electrodes:	13.6 ft	13	14	14
Avg. Total Depth of Electrodes:	17 ft	17	17	17
Avg. Depth to Top of Electrode Conductive Zone:	2 ft	2	2	2
Number of Co-located Vapor Recovery Wells:	19	8	6	5
Number of Temperature Monitoring Points:	4 (4 sensors each)			
Is a New Insulating Surface Cap Required?	yes, 71% coverage presently covered w/ concrete		yes	no
Controlling Contaminant:	PCE			
Average Clean-up Percent:	93%	97%	83%	83%
Client-provided VOC Mass Estimate:	4,000 lb	The Client-estimated mass of 4000 lb results in an avg. conc. of 849 mg/kg.		
Vapor Recovery Air Flow Rate:	210 scfm using a 10-hp vapor recovery blower			
Condensate Production Rate:	0.4 gpm			
Vapor Treatment Method:	carbon			
Assumed Activated Carbon Required:	24,000 lb			
Power Control Unit (PCU) Capacity:	500 kW			
Average Electrical Heating Power Input:	220 kW			
Total Heating Treatment Time:	45 - 60 days			
Design Remediation Energy (kWh):	260,000	An additional 20,000 kWh is used by surface equipment.		
Assumed Number of Confirmatory Borings:	4	With 3 soil samples per boring. Budget for 19 total confirmatory samples.		

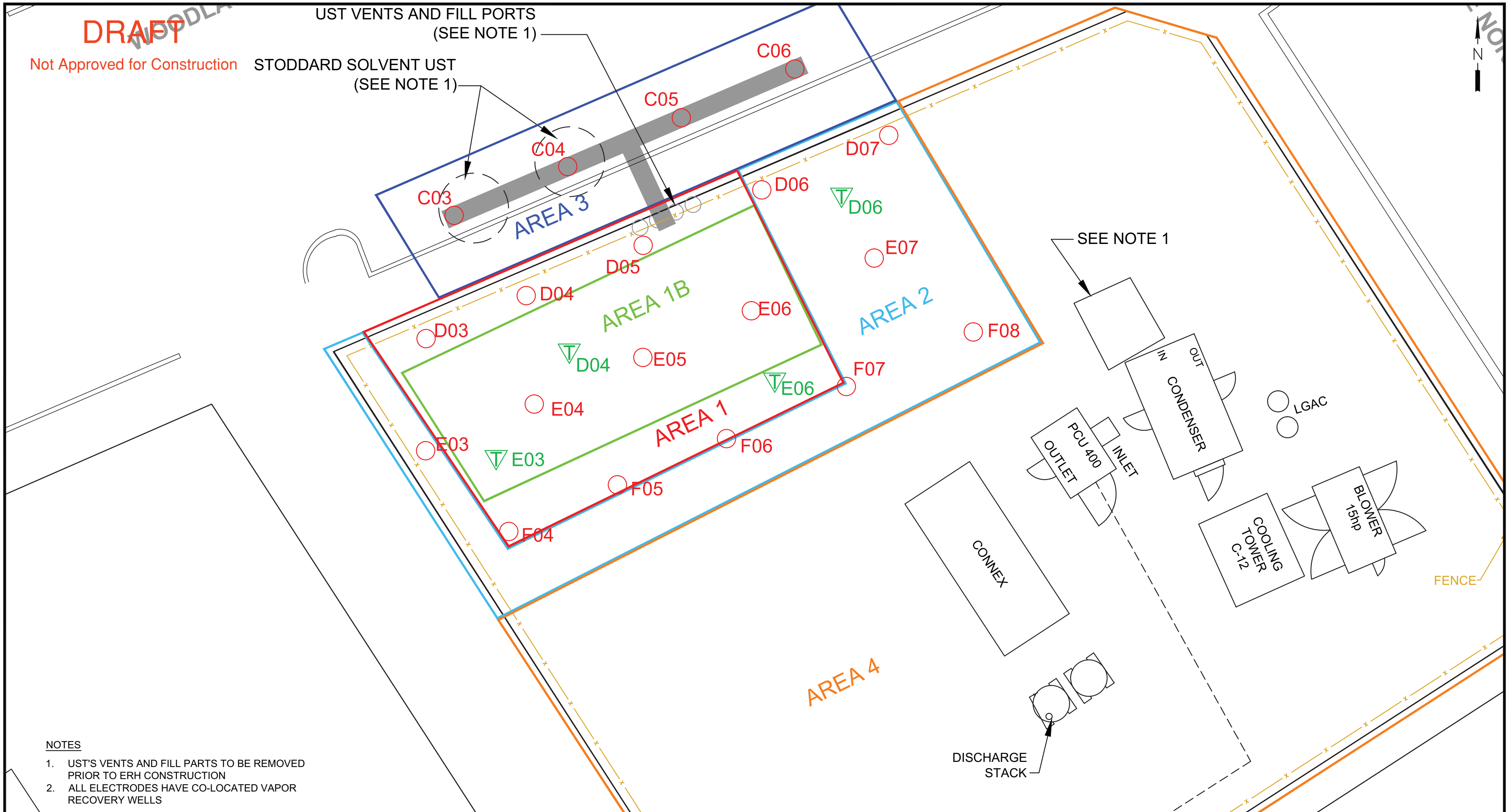
The above remediation parameters are estimated +/- 20%. Final parameters will be determined during system design.

Budgetary (+/- 20%) Standard Fixed Price for Plastics Site - Soil Only, 14 mg/kg goal

Price Charged by TRS Group	Price	Percent	
Design, Work Plans, Permits:	$81,000	10%	
Electrode Materials Mobilization:	$84,000	11%	Payment due before starting field work.
Subsurface Installation:	$30,000	4%	
Surface Installation and Start-up:	$160,000	20%	
Remediation System Operation:	$134,000	17%	
Demobilization and Final Report:	$44,000	6%	
Total TRS Price	**$533,000**	**68%**	Based on payment terms of net 30 days.
Credit for Work completed under Exhibits B, B-2, and B-3	-$165,000		
Total TRS Price for Work Completed under Exhibit B-4	**$368,000**		

Estimated Costs by Others	Cost	Percent	Key Assumptions
Trenching and Restoration (29% below grade):	$8,000	1%	assumes $36 per ft
Drilling and Soil Sampling:	$65,000	8%	assumes $62 per ft
Drill Cuttings and Waste Disposal:	$4,000	1%	assumes $300 per ton
Electrical Permit and Utility Connection to PCU:	$100,000	13%	This is a highly variable cost.
Electrical Energy Usage:	$20,000	3%	assumes $0.07 per kWh
Carbon Usage, Transportation & Regeneration:	$48,000	6%	assumes $2.00 per lb
Condensate Disposal:	$0	0%	condensate disposal by TRS
Other Operational Costs:	$9,000	1%	includes vapor sampling
Total Estimated Costs by Others	**$254,000**	**32%**	
Total Estimated Remediation Cost:	**$787,000**	**$463 per cu. yd**	carbon neutral info
Go Carbon Neutral (No Net CO_2), Add:	**$1,800**	0%	*Ask us how!*

PARTNER Carbonfree



NOTES

1. UST'S VENTS AND FILL PARTS TO BE REMOVED PRIOR TO ERH CONSTRUCTION
2. ALL ELECTRODES HAVE CO-LOCATED VAPOR RECOVERY WELLS

LEGEND

- ELECTRODE (19)
- TMP (4)
- TRENCH
- REMEDIATION AREAS

0 5 10 20

SCALE IN FEET

TRS
Accelerating Value

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	NOT APPROVED
PROJECT MANAGER	J. LILLIE
FOR	WOODLAWN PLASTICS, SEATTLE, WASHINGTON
TITLE	ELECTRODE AND TMP LAYOUT
APPROVED FOR CONSTRUCTION	BY ____ DATE ____
DATE	02/01/16
PROJECT	GRL69
SHEET	Y-1

APPENDIX C

DEWATERING SYSTEM DESIGN

Richard Martin Groundwater LLC

February 8, 2016

Tom Cammarata
SoundEarth Strategies, Inc.
2811 Fairview Avenue East, Suite 2000
Seattle, Washington 98102

RE: Construction Dewatering Evaluation and Design Recommendations, Hearthstone Woodlawn East Project – 6870 Woodlawn Avenue, Seattle, Washington

This letter presents our evaluation and recommendations for temporary construction dewatering at 6870 Woodlawn Avenue in Seattle, Washington. The proposed project is the site of a former dry cleaner and includes excavation of contaminated soil, installation of injection wells for additional remediation below the water table, and construction of a new development. Because of soil and groundwater conditions observed at the site (see discussion below), depressurization of an underlying confined aquifer will be necessary to reduce the risk of soil instability at the base of the excavation from excessive groundwater pressure. These services were performed in general accordance with our proposal dated December 4, 2015.

Our services included:

- Reviewing subsurface conditions described in the SoundEarth's draft Revised Remedial Investigation/Feasibility Study (RI/FS) Addendum (2015) for the site, excavation plans for the contaminated soil, and subsurface information from nearby sites;
- Evaluating potential spacing and location of dewatering wells to meet dewatering goals;
- Estimating potential discharge rates from the dewatering system; and
- Providing this brief letter describing construction dewatering design recommendations.

SUBSURFACE CONDITIONS

Site soil and groundwater conditions are described in SoundEarth's RI/FS report. In general, soil conditions at the site consist of stiff silt and dense silty sand to about 20 feet below ground surface. Laboratory analysis of soil samples collected from this layer indicate a silt content of greater than 30 percent. Underlying this upper layer is dense, poorly graded sand and gravel to well graded sand to silty sand. More details about the soil conditions at the site are provided in the RI/FS report.

Groundwater in both the upper fine-grained soil zone and in the lower coarse-grained soil zone show similar groundwater elevations, generally ranging from about elevation 164 to 170 feet. In the shallow zone, groundwater flow is generally to the northeast to north toward Green Lake. The deeper zone has a groundwater flow direction generally to northeast toward Green Lake.

Aquifer testing had previously been performed by Farallon (2013) in both the shallow (slug tests) and the deep (pumping test) zones. The results indicate that the shallow, fine-grained soil zone has a hydraulic conductivity approximately 2 to 3 orders of magnitude lower than the lower, coarse-grained soil zone with values ranging from approximately 5×10^{-6} to 3×10^{-5} centimeters per second (cm/sec). The results of the pumping test indicate the hydraulic conductivity of the lower zone ranges from 1×10^{-3} to 5×10^{-3} cm/sec. This difference in the hydraulic conductivity ranges between the upper and lower zones combined with the groundwater elevations, indicate that groundwater in the lower zone is likely under confined to semi-confined conditions.

TEMPORARY CONSTRUCTION DEWATERING EVALUATION

A dewatering design was developed using an analytical groundwater model based on the Theis non-equilibrium well equation for confined aquifers and modified using the Jacob correction factor for unconfined aquifers. Because drawdown near the dewatering wells will result in a shift from confined conditions to unconfined conditions in order to meet depressurization goals, the Jacob correction factor was necessary. Results of the dewatering model were used to estimate an approximate configuration of dewatering components to achieve required drawdown for the excavation.

The evaluation was performed using the following range of aquifer parameters:

1. Hydraulic conductivity: (K) = 0.0005 to 0.005 cm/sec (based on aquifer testing at the site and our experience with similar soils and groundwater conditions in the area).

2. Saturated aquifer thickness: (b) = 50 feet (based on observed soil and groundwater conditions).

3. Specific Yield: (Sy) = 0.1 dimensionless (based on experience with similar groundwater conditions in the Seattle area).

4. Drawdown criterion for excavation = 14 feet total (4 feet below base of elevator shaft excavation).

5. Well efficiency: 75 percent (assumed based on observations of soil and groundwater conditions and typical performance of properly installed and operated dewatering systems).

6. Pumping period: 7 days prior to start of excavation below the water table.

The primary focus of depressurization is the area around the elevator shaft, which will be the deepest part of the excavation at approximately elevation 160 feet. Some depressurization may be needed in the area of the sump and some of the deeper footings.

A dewatering configuration of 4 dewatering wells approximately 5 feet from each corner of the proposed excavation (25-foot spacing) was evaluated. The results of the analysis indicate that the simulated dewatering system can achieve the drawdown criterion within 7 days. Over the range of simulated hydraulic conductivity values, total pumping rate ranged from approximately 20 to 80 gallons per minute (gpm). After 30 days of pumping, the total pumping rate decreases by approximately 25 to 30 percent.

Depending on the performance of the dewatering system and scheduling, two additional dewatering wells may be needed to facilitate installation of injection wells that are being used for contaminant remediation. The injection wells are likely to be installed once the excavation has reached full depth and drilling into the lower water bearing zone result in flowing water conditions during drilling. If groundwater levels in the lower water bearing zone have not been sufficiently lowered by the dewatering wells near the elevator shaft, two contingency dewatering wells are proposed outside the excavation area along Woodlawn Avenue Northeast. The results of the analysis with the contingency dewatering wells indicate an increase in the total pumping rate by approximately 10 to 20 gpm. The decision to install the contingency dewatering wells will be made based on the observation of groundwater levels in existing monitoring wells.

PERMANENT DRAINAGE EVALUATION

Prior to completing the floor slab, a permanent underdrain system will be installed to capture groundwater moving toward the subsurface portion of the building from the upper soil zone. An evaluation was performed to estimate steady-state flow rates to the underdrain system using groundwater flow equations described in Powers (1981).

The evaluation used similar inputs as were used for the temporary construction dewatering evaluation except that the hydraulic conductivity of the upper zone was used. The hydraulic conductivity of the upper zone was based on the results of slug tests performed by Farallon (2013). The estimated range of hydraulic conductivity was from approximately $5x10^{-6}$ to $3x10^{-5}$ cm/sec.

For the approximate 100 by 115 feet of the underdrain footprint, the flow to the underdrain system is expected to be less than 5 gpm. The evaluation assumed that during construction of the underdrain system, the lower soil zone is isolated from the system and not contributing groundwater to the system. If the lower soil zone is in hydraulic connection to the underdrain system, flow rates could be substantially higher.

Discharge should be to the sanitary sewer in accordance with the King County Wastewater Discharge Permit for the project.

DEWATERING RECOMMENDATIONS

Dewatering wells are suitable to reduce hydrostatic pressure below the elevator shaft excavation. Based on an assumed well efficiency of 75 percent, we recommend installing the wells to a depth of approximately 65 feet below ground surface and screened from the top of the lower soil zone to the bottom of the well. The wells should be installed approximately 5 feet from the corners of the proposed elevator shaft excavation. The dewatering evaluation indicated required pumping rates could be as high as 20 gpm per well.

During excavation of the adjacent property, some groundwater was observed flowing from the upper silt/clay layer. A perimeter drain may be necessary to control and collect groundwater seeping in from the sidewalls. If groundwater seepage from the sidewalls results in soil erosion or slumping, or if the seepage impacts installation of excavation support, groundwater control in areas of seepage may be needed. Gravity drains or vacuum well points may be suitable for controlling groundwater in areas of seepage.

Water from the dewatering system should be routed to settling tank prior to discharge to allow fine soil particles to settle out. Discharge should be to the sanitary sewer in accordance with King County Wastewater Discharge Permit.

All dewatering wells and vacuum well points should be drilled and constructed in accordance with Washington Administrative Code (WAC) 173-160. Following completion of dewatering activities, the dewatering wells and vacuum well points should be decommissioned in accordance with WAC 173-160.

ADDITIONAL RECOMMENDATIONS

We recommend that a qualified geotechnical engineer review the current plans and profiles for the proposed excavation, review the dewatering evaluation and recommendations provided in this letter, and evaluate the potential for dewatering related ground settlement on adjacent properties.

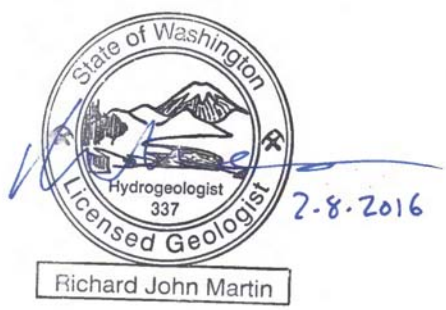
We recommend that Richard Martin Groundwater LLC be contracted during dewatering and excavation activities to observe soil and groundwater conditions and provide additional recommendations on dewatering as needed.

LIMITATIONS

This letter was prepared for the exclusive use of SoundEarth. The opinions and conclusions provided in this report are based on review of site soil and groundwater data provided in the SoundEarth RI/FS report, review of existing information from adjacent sites, and our experience with dewatering and drainage design in the Seattle area. This report was prepared in accordance with generally accepted professional principles and practice in this area at this time. No other warranty, either express or implied, is made.

If you have any questions or comments, please contact me at 206-979-1530 or at Richard.martin.gw@gmail.com.

Sincerely,



Richard J. Martin, L.H.G.
Richard Martin Groundwater LLC

REFERENCES

Cooper, H.H., and Jacob, C.E., 1946, A generalized graphical method for evaluating formation constants and summarizing well field history: Trans. Amer. Geophys. Union, v. 27, p. 526-534.

Farallon, 2013, Draft Final Remedial Investigation and Feasibility Study Report - 6860 and 6870 Woodlawn Avenue Northeast, Seattle, Washington, prepared for Plastic Sales and Service, Inc.

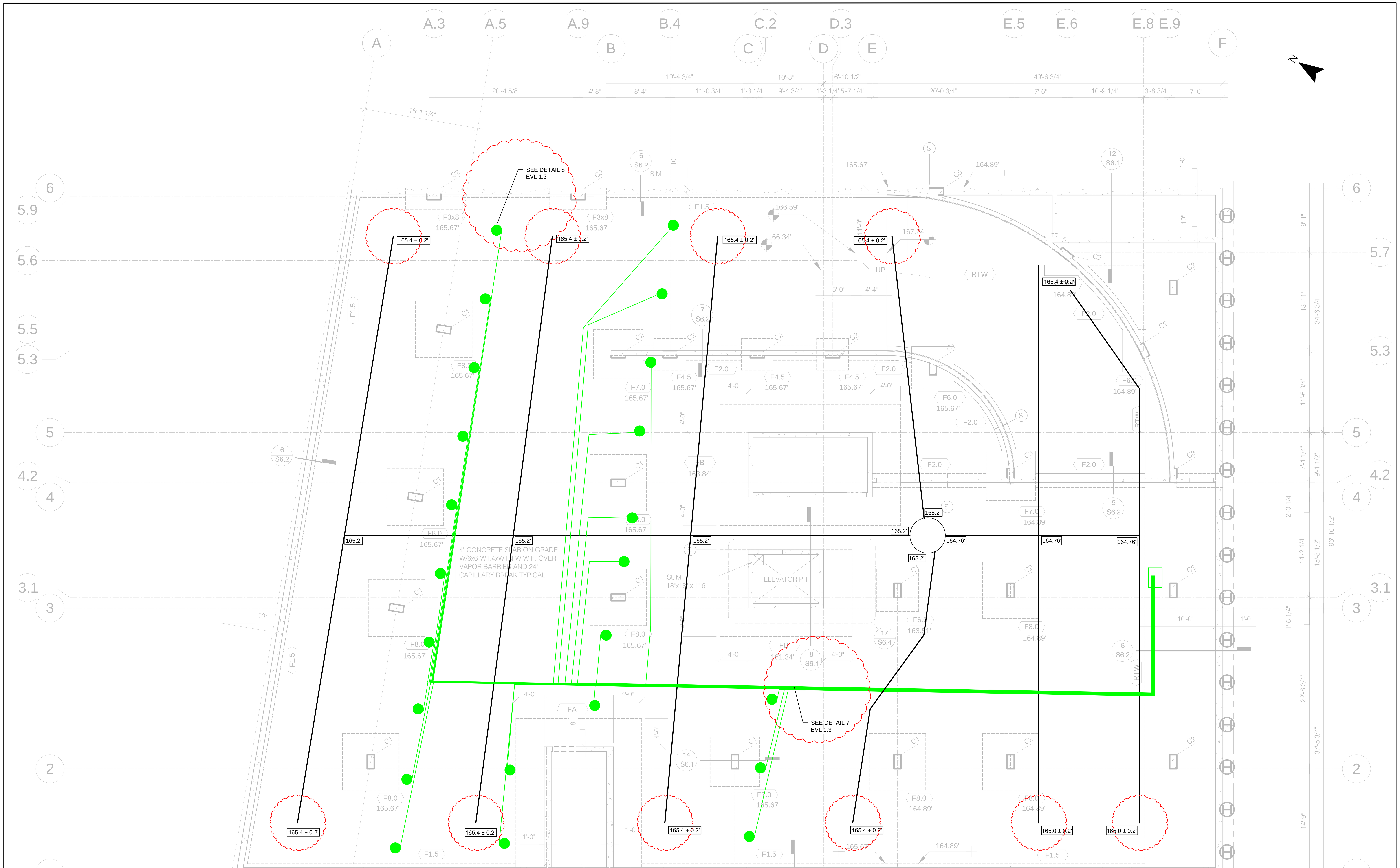
Powers, J.P., 1981, Construction Dewatering – A Guide to Theory and Practice, John Wiley & Sons,, New York, 484p.

SoundEarth, 2015, Draft Revised Remedial Investigation/Feasibility Study Addendum - Plastics Sale and Service Site, prepared for The Lutheran Retirement Home of Greater Seattle (d/b/a The Hearthstone).

Theis, C.V., 1935, The relation between the lowering of the piezometric surface and rate and duration of discharge of a well using groundwater storage: Trans. Amer. Geophys. Union, v. 2, p. 519-524.

APPENDIX D

SUB-SLAB DRAINAGE SYSTEM DESIGN



LEGEND

- 6" PVC PIPE
- 4" PVC DRAINAGE PIPE
- PROPOSED INJECTION WELLS
- REMOTE INJECTION TUBING
- 165.4 INVERT ELEVATION

APPROVAL

PROJECT
HEARTSTONE PROPERTY
6860 WOODLAWN AVENUE NORTHEAST
SEATTLE, WASHINGTON

SCALE	0 40 80 160 APPROXIMATE SCALE IN FEET
DATE	06/09/2015
DRAWN BY	TWM
CHECKED BY	TGO
CAD FILE	0651-002_EVL11
PROJECT NAME	6860 WOODLAWN AVENUE NORTHEAST
PROJECT NO.	0651-001

PROJ. ENG. | PROJ. MGR. | APPROVED | ISSUED FOR | DATE

SHEET TITLE
WOODLAWN EAST SUB-SLAB DRAINAGE PLAN

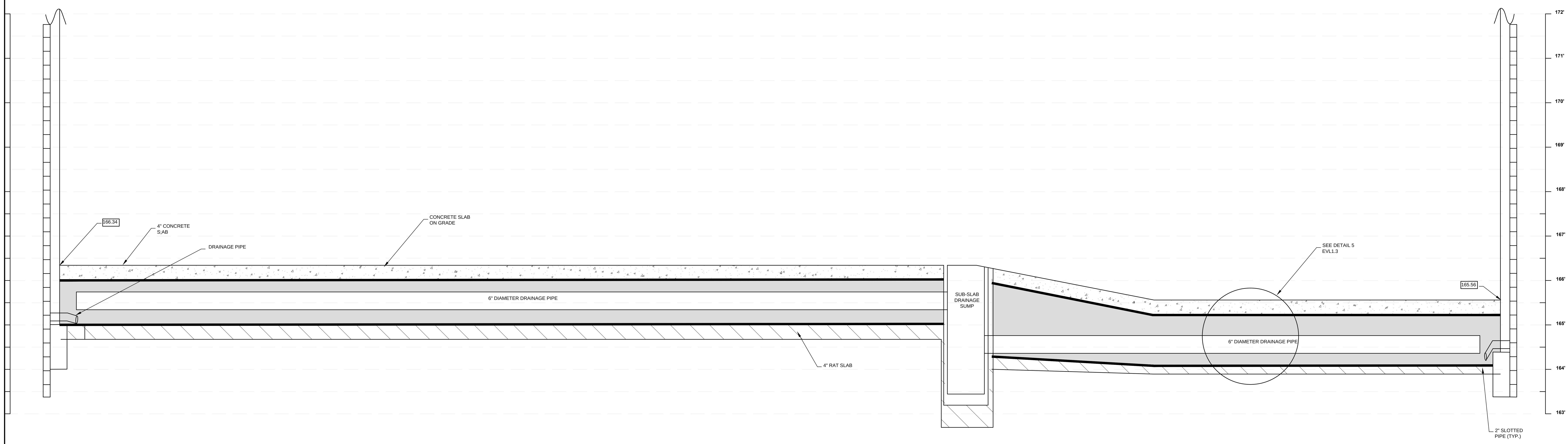
SoundEarth Strategies
WWW.SOUNDEARTHINC.COM

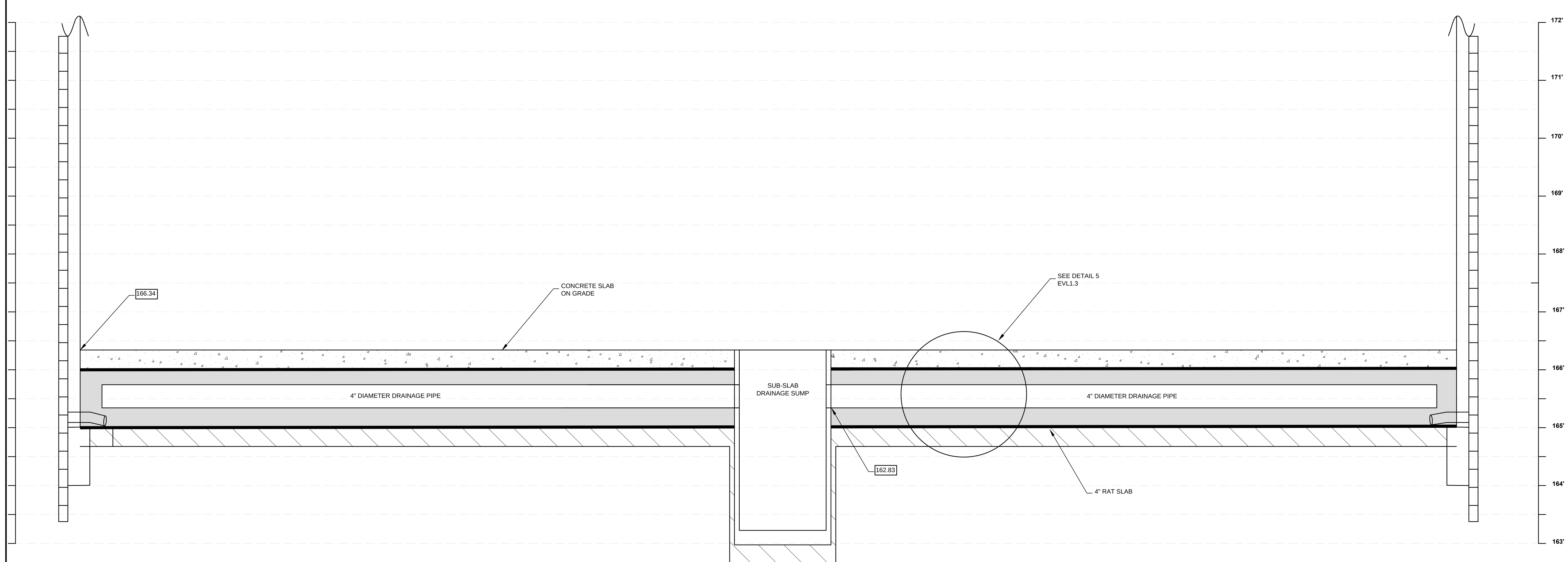
SOUNDEARTH STRATEGIES, INC.
2811 FAIRVIEW AVENUE EAST, SUITE 2000,
SEATTLE, WA 98102

#	DATE	REVISION
1		Building Permit Correction Cycle 1
2		Building Permit Correction Cycle 2
A		

SHEET NO. 1 OF 3
EVL1.1

6/10/2015





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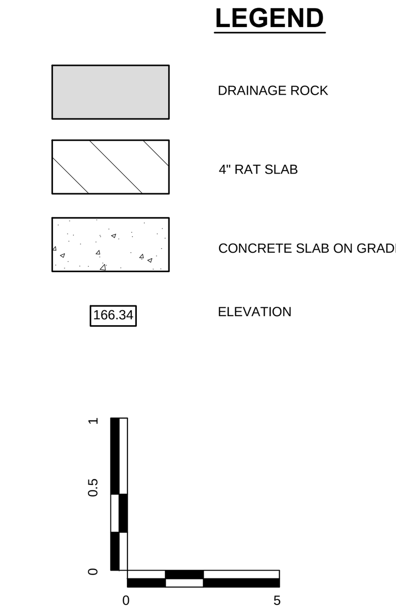

APPROVAL

PROJECT
HEARTSTONE PROPERTY
6860 WOODLAWN AVENUE NORTHEAST
SEATTLE, WASHINGTON

SCALE	
DATE	06/09/2015
DRAWN BY	TWM
CHECKED BY	TGO
CAD FILE	0651-002_EVL12
PROJECT NAME	6860 WOODLAWN AVENUE NORTHEAST
PROJECT NO.	0651-001

PROJ. ENG. / PROJ. MGR. / APPROVED / ISSUED FOR / DATE

SHEET TITLE

WOODLAWN EAST SUB-SLAB DRAINAGE PLAN

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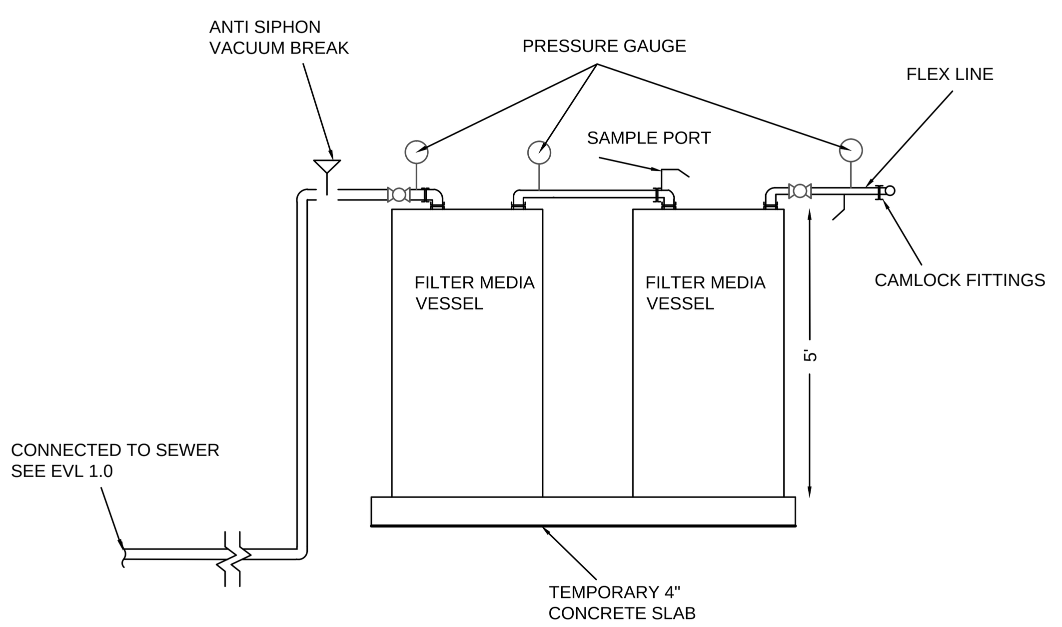
SOUNDEARTH STRATEGIES, INC.
2811 FAIRVIEW AVENUE EAST, SUITE 2000,
SEATTLE, WA 98102

#	DATE	REVISION
1		Building Permit Correction Cycle 1
2		Building Permit Correction Cycle 2
3		
4		
5		

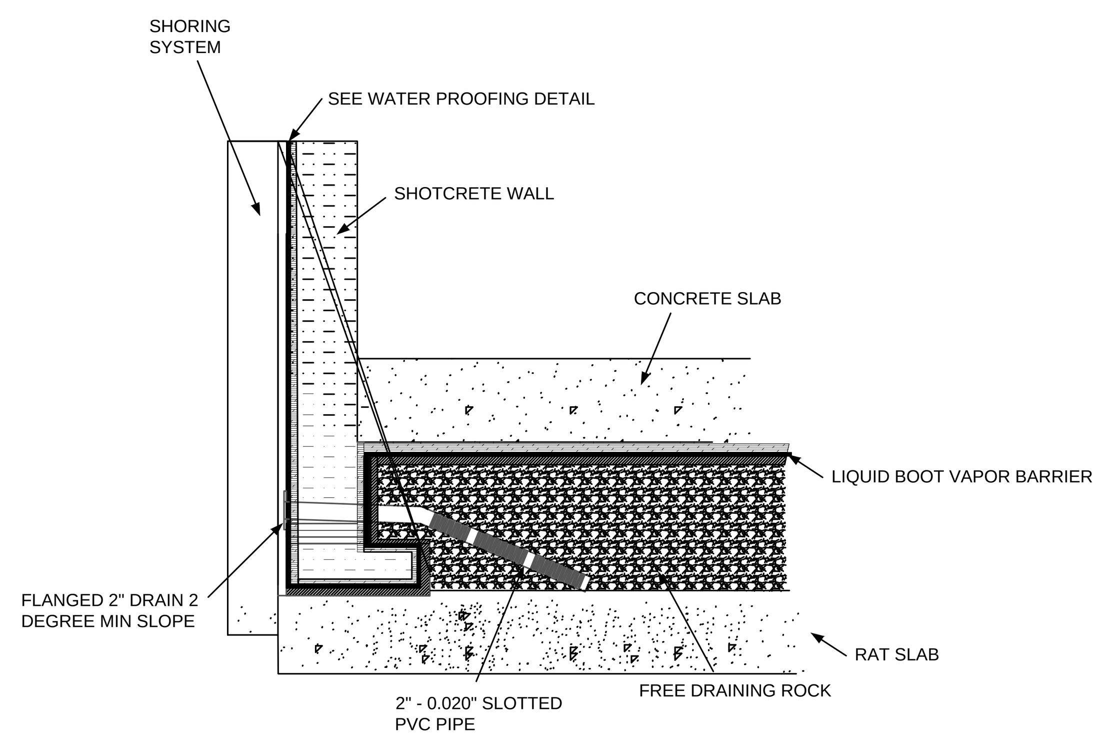
SHEET NO. 2 OF 3
EVL1.2

\\FS\SES\CurrentProjects\0651 Heartstone\0651-002 Heartstone - Woodlawn East\Technical\CAD\2015\Footing Drain Design\0651-002_EVL12cycle 2.dwg

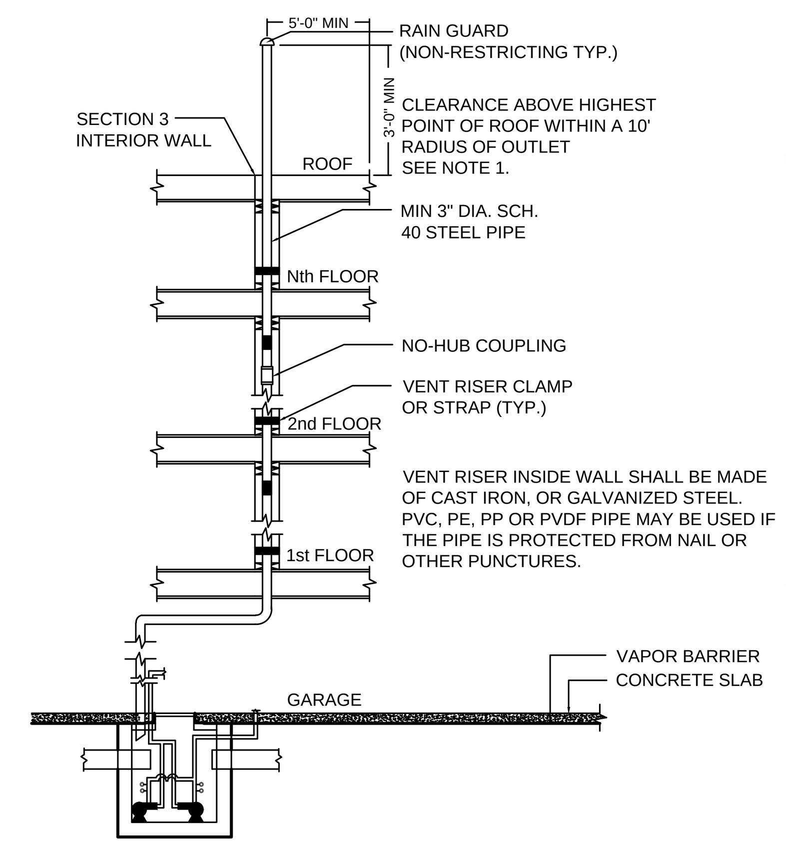
1. WATER TREATMENT TRAIN DETAIL



2. UNDER SLAB TO BLINDSIDE WITH FOOTER DETAIL

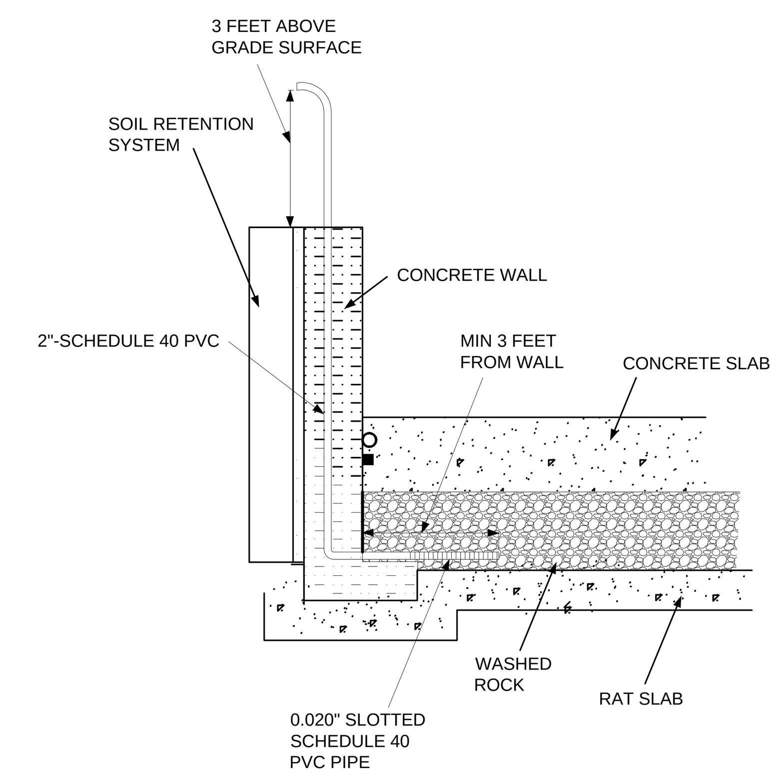


3. VENT RISER DETAIL

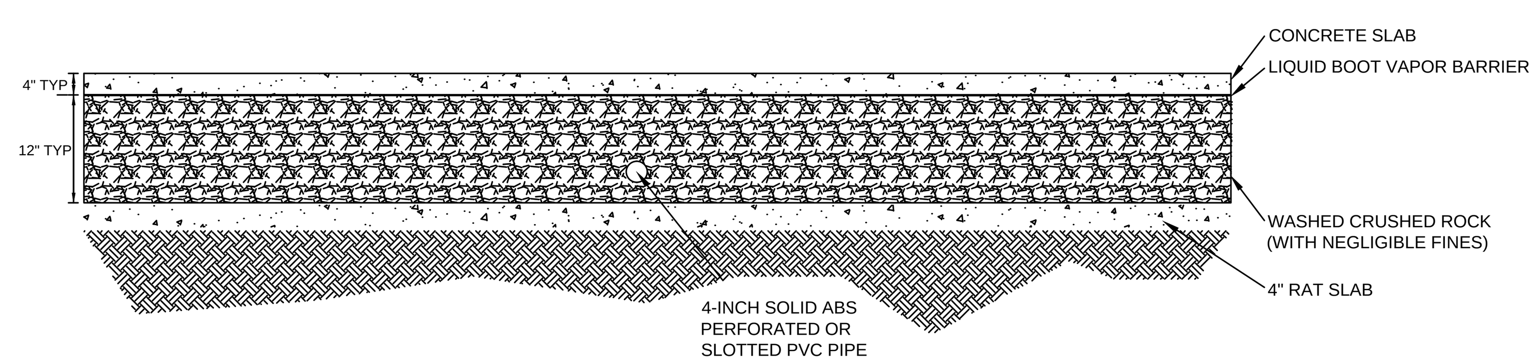


NOTES:
1. TERMINATION OF VENT RISER SHALL BE AS FOLLOWS:
   A. 10' MINIMUM ABOVE GRADE.
   B. 10' MINIMUM AWAY FROM ANY WINDOW, DOOR, DOOR HATCH, OPENING OR AIR INTAKE INTO THE BUILDING.
   C. 3' MINIMUM ABOVE HIGHEST POINT OF ROOF
   D. NO BUILDING AIR INTAKES WITHIN A 20' RADIUS OF OUTLET.
   E. 4' MINIMUM AWAY FROM PROPERTY LINE, AND
   F. 5' MINIMUM AWAY FROM ELECTRICAL DEVICES.
2. WRAP AND PROTECT ALL PIPING THROUGH CONCRETE SLAB OR FLOOR.
3. SUPPORT ALL PIPING PER LOCAL CODES.

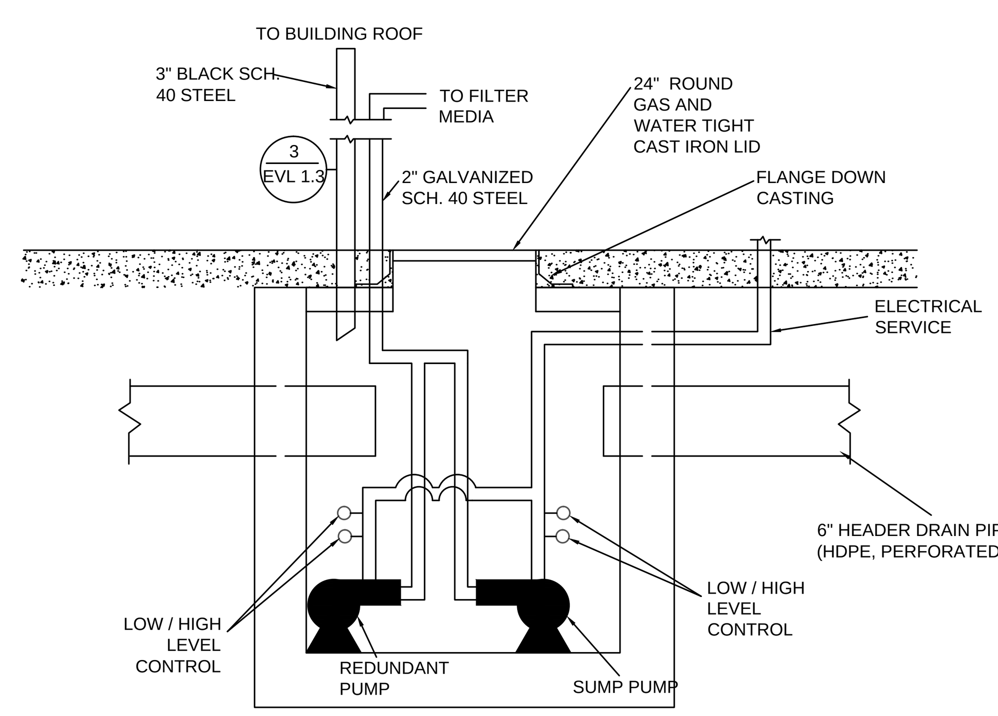
4. UNDER SLAB INLET VENT DETAIL



5. PIPE BEDDING DETAIL

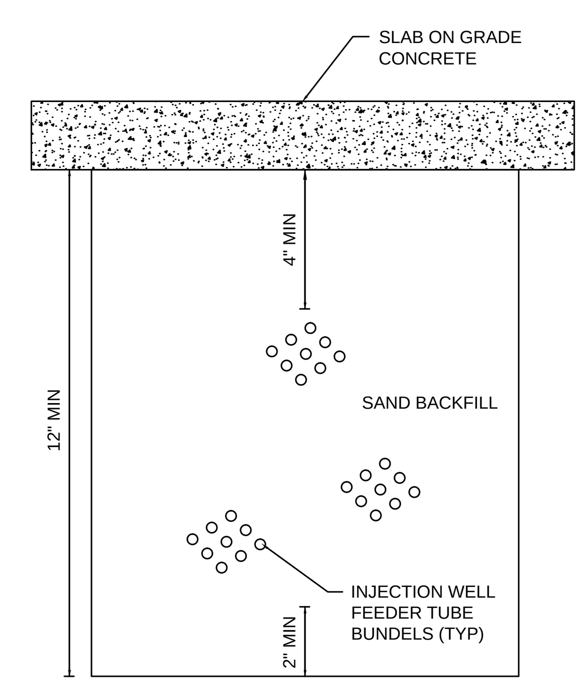


6. SUMP DETAIL

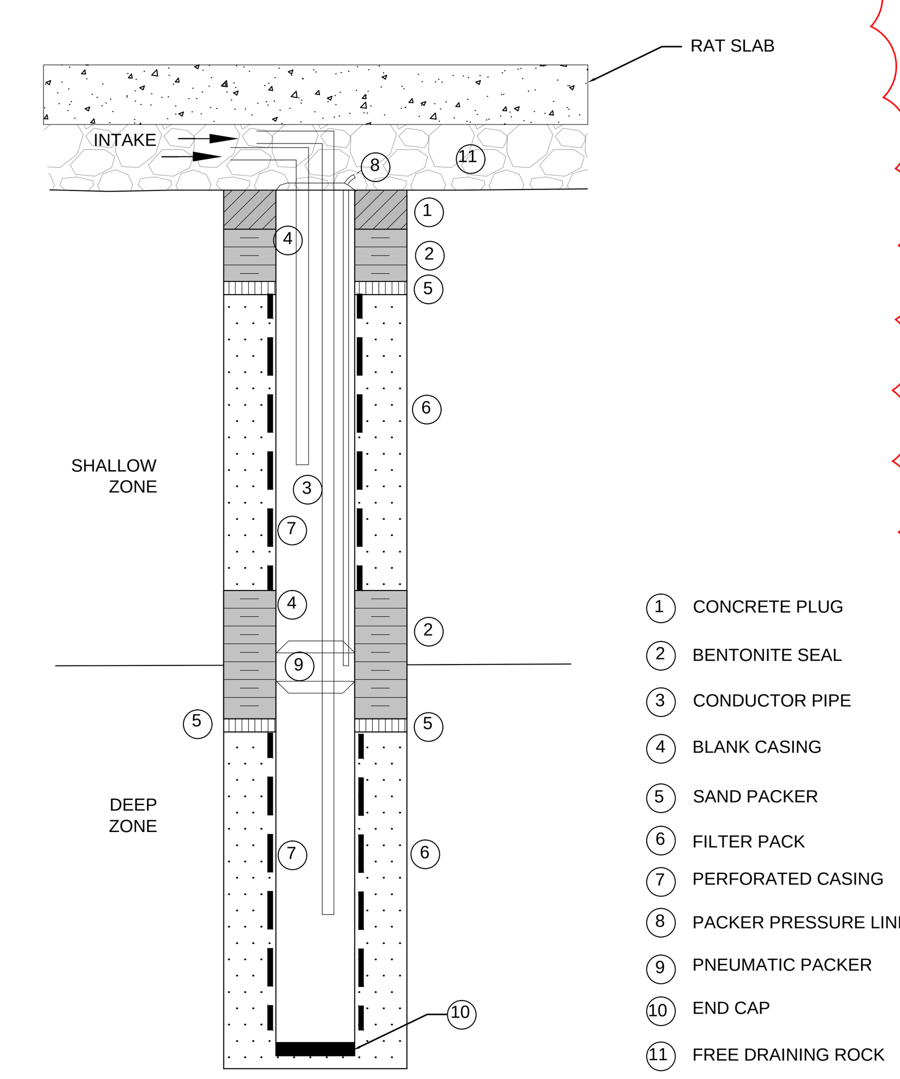


LIBERTY PUMPS - AE-SERIES DUPLEX CONTROL BOX
FL104M 460 3Ø PUMPS

7. INECTION PIPING TRENCH DETAIL



8. INJECTION WELL DETAIL



APPROVAL

PROJECT
HEARTSTONE PROPERTY
6860 WOODLAWN AVENUE NORTHEAST
SEATTLE, WASHINGTON

SCALE	
DATE	06/09/2015
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PROJ ENG. | PROJ MGR. | APPROVED | ISSUED FOR | DATE

SHEET TITLE

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1		Building Permit Correction Cycle 1
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3		
4		
5		

SHEET NO. 3 OF 3
EVL1.3

6/9/2015

\\FS\SES\Current\Projects\0651 Hearthstone\0651-002 Hearthstone - Woodlawn East\Technical\CAD\2015\Footing Drain Design\0651-002_EVL13cycle 1.dwg

APPENDIX E

LIQUID BOOT VAPOR BARRIER SPECIFICATION

LIQUID BOOT®

SPRAY-APPLIED GAS VAPOR BARRIER

DESCRIPTION

LIQUID BOOT® is a seamless, spray-applied, water-based membrane containing no VOCs, which provides a barrier against vapor intrusion into structures. LIQUID BOOT® is installed under slab and on below grade vertical walls as a gas vapor barrier to minimize vapor and nuisance water migration into buildings. LIQUID BOOT® spray-application directly to penetrations, footings, grade beams, pile caps and other irregular surfaces, provides for a fully-adhered gas vapor barrier system.

APPLICATIONS

LIQUID BOOT® is used as an underslab and below-grade vertical wall gas vapor barrier, used to minimize vapor and nuisance water (non-hydrostatic conditions) migration into buildings. LIQUID BOOT® is ideal for methane migration control. LIQUID BOOT® is also NSF® certified for use as a potable water liner in concrete water reservoirs and tanks greater than 300,000 gallons to protect the concrete from water seepage.

BENEFITS

- Spray-application provides excellent sealing of penetrations, eliminating the need for mechanical fastening
- Seamless, monolithic membrane eliminates seaming-related membrane failures
- Unique formulation provides superior protection from methane gases and water vapor
- Fully adhered system reduces risk of gas migration
- Protection from methane gas, VOCs, chlorinated solvents and other contaminates

INSTALLATION

Protect all adjacent areas not to receive gas vapor barrier. Ambient temperature shall be within man-ufacturer's specifications. All plumbing, electrical, mechanical and structural items to be under or passing through the gas vapor barrier shall be secured in their proper positions and appropriately protected prior to membrane application. Gas vapor barrier shall be installed before placement of rein-forcing steel. Expansion joints must be filled with a conventional waterproof expansion joint material. Surface preparation shall be per manufacturer's specification. A minimum thickness of 60 dry mils, unless specified otherwise.

LIMITED WARRANTY

CETCO warrants its products to be free of defects. This warranty only applies when the product is applied by Approved Applicators trained by CETCO. As factors which affect the result obtained from this product, including weather, equipment, construction, work-manship and other variables are all beyond CETCO's control, we warrant only that the material herein conforms to our product specifications. Under this warranty we will replace at no charge any product proved to be defective within 12 months of manufacture, provided it has been applied in accordance with our written directions for uses we recommend as suitable for this product. This warranty is in lieu of any and all other warranties expressed or implied (including any implied warranty of merchantability or fitness for a particular use), and the Manufacturer shall have no further liability of any kind including liability for consequential or incidental damages resulting from any defects or any delays caused by replacement or otherwise. This warranty shall become valid only when the product has been paid for in full.

In addition to superior chemical resistance performance, LIQUID BOOT® spray-application effectively seals penetrations, footings, grade beams and other irregular surfaces that are considered critical vapor intrusion pathways.

EQUIPMENT

- COMPRESSOR: Minimum output of 155-185 cubic feet per minute (CFM)
- PUMPS: For "A" drum, an air-powered piston pump of 4:1 ratio (suggested model: Graco, 4:1 Bulldog). For "B" drum, an air-powered diaphragm pump (0 -100 psi)
- HOSES: For "A" drum, ½" wire hose with a solvent resistant core (for diesel cleaning flush), hose rated for 500 psi minimum. For "B" drum, a 3/8" fluid hose rated at only 300 psi may be used.
- SPRAY WAND: Only the spray wand sold by CETCO is approved for the application of LIQUID BOOT®.
- SPRAY TIPS: Replacement tips can be purchased separately from CETCO.

PACKAGING

LIQUID BOOT® is available in the following packaging options:

- 55 Gallon Drum
- 275 Gallon Tote

LIQUID BOOT ®

SPRAY-APPLIED GAS VAPOR BARRIER

TESTING DATA

CHEMICAL & PHYSICAL PROPERTIES		
CHEMICAL PROPERTY	**TEST METHOD**	**RESULT**
Acid Exposure (10% H_2SO_4 for 90 days)	ASTM D543	Less than 1% weight change
Benzene Diffusion Test	Tested at 43,000 ppm	2.90 x 10^{-11} m^2/day
Chemical Resistance: VOCs, BTEXs (tested at 20,000 ppm)	ASTM D543	Less than 1% weight change
Chromate Exposure (10% Chromium6+ salt for 31 days)	ASTM E96	Less than 1% weight change
Diesel (1000 mg/l), Ethylbenzene (1000 mg/l), Naphthalene (5000 mg/l) and Acetone (500 mg/l) Exposure for 7 days	ASTM D543	Less than 1% weight change; Less than 1% tensile strength change
Hydrogen Sulfide Gas Permeability	ASTM D1434	None Detected
Methane Permeability	**ASTM 1434-82**	**Passed***
Microorganism Resistance	**ASTM D4068-88**	**Passed***
Oil Resistance	**ASTM D543-87**	**Passed***
PCE Diffusion Coefficient	Tested at 120 mg/L	1.32 x 10^{-13} m^2/sec
Radon Permeability	Tested by US Dept. of Energy	Zero permeability to Radon (222Rn)
TCE Diffusion Coefficient	Tested at 524 mg/L	9.07 x 10^{-13} m^2/sec

PHYSICAL PROPERTY	TEST METHOD	RESULT
Accelerated Weathering and Ultraviolet Exposure	ASTM D822	No adverse effect after 500 hours
Air Infiltration	ASTM E283-91	0 cfm/sq. ft.
Bonded Seam Strength Tests	ASTM D6392	Passed*
Coefficient of Friction (with geotextile both sides)	ASTM D5321	0.72
Cold Bend Test	ASTM D146	Passed. Ø cracking at -25°F
Dead Load Seam Strength	City of Los Angeles	Passed*
Electric Volume Resistivity	ASTM D257	1.91 x 1010 ohms-cm
Elongation	ASTM D412	1,332% Ø reinforcement, 90% recovery
Elongation w/8 oz. non-woven geotextile both sides	ASTM D751	100% (same as geotextile tested separately)
Environmental Stress-Cracking	ASTM D1693-78	Passed*
Flame Spread	ASTM E108	Class A with top coat (comparable to UL790)
Freeze-Thaw Resistance (100 Cycles)	ASTM A742	Meets criteria. Ø spalling or disbondment
Heat Aging	ASTM D4068-88	Passed*
Hydrostatic Head Resistance	ASTM D751	Tested to 138 feet or 60 psi
Potable Water Containment	ANSI/NSF 61	NSF Certified for tanks >300,000 gal
Puncture Resistance w/8 oz. non-woven geotextile both sides	ASTM D4833	286 lbs. (travel of probe = 0.756 in)
Sodium Sulfate (2% water solution)	ASTM D543, D412, D1434	Less than 1% weight change
Soil Burial	ASTM E154-88	Passed
Tensile Bond Strength to Concrete	ASTM D413	2,556 lbs/ft^2 uplift force
Tensile Strength	ASTM D412	58 psi without reinforcement
Tensile Strength w/8 oz. non-woven geotextile both sides	ASTM D751	196 psi (same as geotextile tested separately)
Toxicity Test	22 CCR 66696	Passed
Water Penetration Rate	ASTM D2434	<7.75 x 10^{-9} cm/sec
Water Vapor Permeance	ASTM E96	0.069 perms

*Passes all Los Angeles City and County Methane Criteria

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

UPDATED: NOVEMBER 2013

TDS_LIQUIDBOOT_AM_EN_201311_v1