2019 Groundwater Monitoring Compliance Report
Union Station Property
Seattle, Washington

January 6, 2020

Prepared for

Union Station Associates
2401 Utah Avenue South, Suite 305
Seattle, Washington

LANDAU ASSOCIATES

130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

2019 Groundwater Monitoring Compliance Report
Union Station Property
Seattle, Washington

This document was prepared by, or under the direct supervision of, the technical professionals noted below.

Document prepared by: Evelyn Ives
Primary Author
Evelyn Ives, PE

Document reviewed by:
Quality Reviewer
Piper Roelen, PE, CHMM

Date:	January 6, 2020
Project No.:	0429008.010
File path:	P:\429\008\010\R
Project Coordinator:	Christopher C. Young

LANDAU
ASSOCIATES

This page intentionally left blank.

TABLE OF CONTENTS

Page

FIGURES

TABLES

APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
ARI	Analytical Resources, Inc.
BTEX	benzene, toluene, ethylbenzene, xylenes
CAP	cleanup action plan
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CUL	cleanup level
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
FS	feasibility study
LAI	Landau Associates, Inc.
ncPAH	non-carcinogenic polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
Property	Union Station property
RI	remedial investigation
TDS	total dissolved solids
TSS	total suspended solids
UCL	upper confidence limit
UTL	upper tolerance limit

This page intentionally left blank.

1.0 INTRODUCTION

At the request of Union Station Associates, Landau Associates, Inc. (LAI) prepared this report, which describes the groundwater monitoring conducted at the Union Station property (Property) in the downtown area of Seattle, Washington in August 2019. The groundwater monitoring was conducted in accordance with Prospective Purchaser Consent Decree No. 97-2-18936-5SEA between the Washington State Department of Ecology (Ecology) and Union Station Associates (WSAG 1997) and with the associated cleanup action plan (CAP; LAI 1997). Groundwater monitoring completed prior to August 2019 is described in seven previous groundwater monitoring reports (LAI 2000, 2002, 2003a, b, 2004, 2009, 2014). In addition to describing the groundwater monitoring conducted in August 2019, this report includes an evaluation of compliance with the CAP.

1.1 Property Description

The Property consists of three parcels located in Seattle, Washington. Figure 1 provides a vicinity map; Figure 2 shows the Union Station Property and the north, central, and south parcels that it comprises. The Property spans six city blocks and includes portions of the at-grade level beneath the elevated viaduct portions of South Jackson Street, South Airport Way, and 4th Avenue South.

The Property was originally part of the South Seattle industrial neighborhood. In 1874, the Seattle Gaslight Company constructed a coal gasification plant at the Property on pilings over the mudflats of Duwamish Bay. The area surrounding the pile-supported facility was filled prior to about 1912. Around the turn of the 20th century, Vulcan Iron Works manufactured iron, brass, and steel in the southern portion of the Property. In 1911, the Union Station passenger railroad station was constructed at the Property. Union Station served passengers until 1971, when Union Pacific discontinued passenger operations at the Property. From 1971 until the purchase of the Property by Union Station Associates in 1997, the Property was essentially dormant. The southernmost terminus of the downtown Seattle transit project bus tunnel was completed in the subsurface of the property along 5th Avenue South in 1990.

In 1991, the Property was placed on the Washington Hazardous Sites List. Subsequently, a remedial investigation/feasibility study (RI/FS; LAI and Hart Crowser 1996) was conducted for the Property.

The RI report included a review of the Property’s industrial history to identify areas of anticipated contamination for the investigation, evaluation of existing soil and groundwater sampling information, and analysis of new soil and groundwater samples. Soil and groundwater data were compared to applicable screening levels and identified constituents of concern that required additional evaluation in the RI. The RI identified carcinogenic polycyclic aromatic hydrocarbons (cPAHs) from the coal gasification process, and metals from the coal gasification process and the foundry in fill that was historically placed on the former tideflat surface. Concentrations of cPAHs and some metals in some soil samples exceeded screening levels. Groundwater analytical results from the RI and from supplemental monitoring conducted after the RI and before the consent decree showed that concentrations of cPAHs, petroleum hydrocarbons, benzene, and arsenic in groundwater exceeded screening levels in samples from some wells at the Property. Arsenic was found in an upgradient well at concentrations higher than those found in Property wells. There were also strong indications that a source or sources of petroleum hydrocarbons existed upgradient of the Property. No pesticides, polychlorinated biphenyls (PCBs), herbicides, or evidence of dense non-aqueous phase liquids were detected.

The RI findings were used to develop alternatives to remediate contamination at the Property. The evaluation of these alternatives was included in the FS. The FS defined cleanup standards, developed and evaluated four cleanup action alternatives, and identified a preferred cleanup action alternative that would adequately protect human health and the environment. Soil cleanup levels were conservatively based on residential use conditions, although the Property was zoned International District Mixed and was planned for commercial use with limited potential for direct contact. The point of compliance for soil is throughout the Property. Groundwater cleanup levels were based on protection of marine surface water. The point of compliance for groundwater is the Property boundary and extends from the uppermost level of the saturated zone vertically to the lowest depth that could potentially be affected by the Property. The approximate point of compliance established for groundwater at the Property is shown on Figure 2. The cleanup action selected by Ecology includes paving (capping), construction soil excavation, groundwater monitoring, contingent groundwater remediation, and institutional controls.

In 1997, Ecology and Union Station Associates entered into a Prospective Purchaser Consent Decree for the Property. Since that time, Union Station Associates has implemented the selected remedial action for the Property. Paving and soil excavation were completed as part of Property redevelopment. A restrictive covenant implementing the required institutional controls was recorded on the Property deed. Groundwater monitoring began in October 1997 and the results of the monitoring are described in the remainder of this document and in previous groundwater monitoring reports (LAI 2000, 2002, 2003a, 2004, 2009).

A parking garage was completed on the south parcel in 1999. Construction at the main parcel, including renovation of the Union Station building and construction of a parking garage and four new buildings, was completed in 2001. Construction of a new building on the north parcel was completed in 2002.

1.2 Consent Decree Requirements for Groundwater Monitoring

Groundwater monitoring requirements for the Property are described in Table 3 of the CAP and are summarized in Table 1 in this report. Monitoring wells originally included in the monitoring program were HC-101, HC-102, HC-103, MW-104, MW-105, MW-106, MW-107, and upgradient background wells B-4 and B-6. As described in the 2000 monitoring report (LAI 2000), between 1997 and 1999 wells HC-101, HC-102, MW-106, MW-107, MW-108, and B-6 were decommissioned and replaced with monitoring wells in similar locations. In 2000, Ecology approved suspension of water quality monitoring at well HC-103 (Ecology 2000). Background well B-4 was replaced in 2009 with well B-4R, which was installed approximately 20 feet to the east of the former location of well B-4 in the sidewalk on the east side of 5th Avenue South, as discussed in the 2009 report (LAI 2009). Monitoring wells currently included in the groundwater quality and groundwater-level monitoring program are as follows: Property wells MW-101R, MW-102R, MW-104, MW-105, MW-107R, MW-108R, and upgradient background wells B-4R and B-6R. HC-103 is monitored only for groundwater level.

The CAP required quarterly groundwater monitoring for eight quarters beginning within 3 months of the effective date of the consent decree, and again for eight quarters beginning the first quarter after all of the building foundations had been completed. The CAP provided for reduction in the groundwater monitoring frequency to an annual basis if the upper 95 percent confidence limit on the mean (UCL) for results from the compliance monitoring wells was less than or equal to the cleanup levels. Annual monitoring was then required until 3 years after foundation loading (building construction) was complete. Groundwater monitoring frequency was then reduced to every 5 years when the UCL for results from the compliance monitoring wells was less than or equal to the cleanup levels. The CAP also specifies procedures to be implemented if the concentration in any sample exceeds the cleanup levels during monitoring.

A report documenting the eight quarters of groundwater monitoring after the foundation loading was submitted to Ecology in August 2000 (LAI 2000). After review of the report, Ecology required an additional year of quarterly monitoring (Ecology 2000). In March 2002, the results for the additional year of groundwater monitoring were submitted in a report to Ecology with the recommendation to reduce the groundwater monitoring frequency to an annual basis (LAI 2002). In November 2002, Ecology approved reducing the groundwater monitoring frequency to an annual basis (Ecology 2002), and annual groundwater monitoring was subsequently conducted in 2002, 2003, and 2004.

As noted above, construction at the central parcel was completed in 2001, and construction at the south parcel was completed in 1999. The required additional 3 years of groundwater monitoring after foundation loading was then completed with the June 2004 monitoring event. Based on the results of the June 2002, 2003, and 2004 sampling events, Ecology approved reducing the groundwater monitoring frequency to every 5 years (Ecology 2005b). Ecology also issued a Certificate of Completion for the property in 2005 (Ecology 2005b), but did not remove the Property from the Hazard Ranking List due to the presence of petroleum hydrocarbon constituents in groundwater at the Property and upgradient of the Property.

This report presents results for the 2019 groundwater monitoring event, and demonstrates that the concentrations of contaminants originating at the Property comply with applicable cleanup levels. The findings presented below are based on statistical evaluation of the groundwater data from the past eight sampling events.

2.0 GROUNDWATER MONITORING

The groundwater monitoring program consists of both water level and water quality monitoring. The Union Station groundwater monitoring network for water quality is currently composed of eight monitoring wells: upgradient wells B-4R and B-6R, and Property wells MW-101R, MW-102R, MW-104, MW-105, MW-107R, and MW-108R. The monitoring network for groundwater levels includes the eight wells monitored for water quality plus one additional monitoring well, HC-103, monitored only for groundwater level. The locations of the monitoring wells are shown on Figure 2. Procedures used for groundwater monitoring were consistent with those described in the CAP, or as subsequently modified with Ecology approval. Prior to the September 2001 monitoring event, modifications to some of the procedures described in the CAP were approved by Ecology. These modifications include changes to the method of laboratory handling of cPAH and semivolatile organic compound samples and the monitoring of well HC-103 only for groundwater-level measurements (LAI 2000, 2002). In 2005, Ecology acknowledged the completion of all remedial actions specified in the CAP, except the confirmation monitoring, and approved a reduction in the groundwater monitoring frequency to every 5 years (Ecology 2005b) and a reduction in the required constituents for analysis (Ecology 2005a). The following sections describe the monitoring activities and results from the 2019 five-year monitoring event.

2.1 Groundwater-Level Monitoring

At each well location, the groundwater level was measured from a surveyed reference point located at the top of the PVC well casing, to the top of the groundwater table using a hand-held water level indicator. These measurements were recorded to the nearest 0.01 foot. Table 2 provides a summary of information regarding the monitoring well network including the well installation dates, well coordinates, and well elevation information, including top and bottom of screen.

2.2 Groundwater Sampling, Analysis Procedures, and Modifications

Groundwater sampling procedures were consistent with those described in the CAP. Prior to sample collection, each well was slowly purged using a combination of a centrifugal pump with dedicated tubing, a peristaltic pump with dedicated tubing, and/or a disposable bailer. Because most of the wells are low-yield and produce groundwater with moderate to high turbidity, each well was purged at a rate of less than 1 liter per minute to help minimize turbidity. Field parameters such as pH, temperature, and conductivity were measured and recorded about every 5 minutes during purging. Purging continued until at least three well volumes had been removed or, at wells MW-101R, MW-102R, MW-104, MW-105, and MW-108R until the well was purged dry.

Sampling was started when sufficient volume became available in the well. Four replicate measurements of field parameters were conducted prior to sampling, if possible; however, due to low-yield conditions at some locations, sufficient volume for all replicates could not be obtained and priority was given to filling sample bottles. For these locations, field parameters obtained at the end of purging were used for sample quality control purposes. To minimize turbidity during sampling, a target flow rate of less than 0.2 liters per minute was used during sample collection. All purging and sampling information was recorded on a Groundwater Sample Collection Form as specified in the CAP.

Field instruments were calibrated and maintained in accordance with the manufacturer's instructions and the quality assurance/quality control requirements identified in the CAP. Purge water was stored on site in 55-gallon drums, and was removed from the site for disposal on November 26, 2019.

The August 2019 groundwater samples were analyzed at Analytical Resources, Inc. (ARI) in Tukwila, Washington for diesel-, motor oil-, and gasoline-range petroleum hydrocarbons; PAHs; cPAHs using selected ion monitoring; benzene, toluene, ethylbenzene, and xylenes (BTEX); dissolved arsenic; total dissolved solids (TDS); and total suspended solids (TSS).

Some modifications to analytical methods were requested and approved by Ecology prior to the 2019 sampling event. Analytical methods stated in the consent decree for BTEX, TSS, and TDS are now no longer industry standards and are no longer Ecology-certified at some analytical laboratories. As such, the following methods (shown in the "new method" column) were requested as modifications to the consent decree and accepted by Ecology via email on August 20, 2019 (Timm 2019):

	New Method	Old Method
BTEX	EPA 8260C	SW-846 8020
TSS	SM 2540 D-97	SW-846 160.2
TDS	SM 2540 C-97	SW-846 160.1

Note:
EPA = US Environmental Protection Agency

No other modifications to sampling and analysis methods were made. Analytical results from the 2019 sampling event and compliance evaluations are discussed in Sections 3.2 and 4.3, respectively.

3.0 GROUNDWATER MONITORING RESULTS

As described in Section 2.0, the Union Station groundwater-level monitoring network consists of nine monitoring wells that are screened within the shallow fill at or near the Property. Eight of the monitoring wells are sampled for groundwater quality monitoring. The following sections describe the results of the groundwater-level and water quality monitoring conducted in August 2019.

3.1 Groundwater Elevations

Groundwater elevations measured at each well during the 2019 groundwater monitoring event are listed in Table 3. Groundwater elevation contours for the monitoring event (shown on Figure 3) indicate that groundwater flow is generally to the west, consistent with the regional groundwater flow toward Elliott Bay (LAI and Hart Crowser 1996). As shown on Figure 4, the 2019 groundwater elevations are similar to the groundwater elevations observed during prior sampling events. The recent data support the discussion in the 2009 groundwater monitoring report (LAI 2009) that the anomalous groundwater elevations observed at well B-4 from March 2001 through June 2004 were the result of physical changes to the well caused by the Nisqually earthquake, and that well B-4/B4R has always been hydraulically upgradient of the subject property.

3.2 Chemical Analysis Results

ARI analyzed the groundwater samples for the constituents identified in Section 2.2. Following receipt of the analytical results, the data were validated (using Level 3 procedures) by LAI as described in Appendix A of the CAP. Appendix A of this report presents the results of the data validation and a summary of the data qualifiers.

The 2019 analytical results for the samples from the Property wells and background wells are similar to previous results except that most of the PAH concentrations in the samples from the background wells (i.e., B-4R and B-6R) are lower than during historical monitoring events. Analytical results (with data qualifiers added as appropriate) from the August 2019 monitoring event and the seven previous monitoring events are provided in Table 4. Data from these eight monitoring events were used to evaluate compliance with CAP cleanup levels (CULs), as discussed in Section 4.0. The associated Level 4 laboratory data reports are maintained electronically by LAI. The analytical methods (applicable to 2019 data only), CAP cleanup levels, and background-based screening levels are also shown in Table 4.

Graphs showing concentrations over time at all of the wells were prepared for diesel- and gasoline-range petroleum hydrocarbons, benzene, acenaphthene, and arsenic. These constituents were selected for evaluation of the concentrations relative to time because they have consistently been detected above the reporting limit in several wells and, therefore, can be used for comparisons of concentrations between wells over time. Concentration graphs for these five constituents are shown on Figures 5 through 9.

In general, the concentrations of these five constituents measured at the Property wells in 2019 are similar to the concentrations measured previously at the Property wells, as described below:

- Concentrations of diesel-range petroleum hydrocarbons in Property wells were lower compared to concentrations measured at some Property wells during past monitoring events. The highest concentrations of diesel-range petroleum hydrocarbons detected in the Property wells have historically occurred at monitoring well MW-101R; however, these concentrations have generally decreased from 4,200 micrograms per liter (µg/L) in June 2002 to 2,440 µg/L in 2019. Diesel-range hydrocarbons were also detected in 2019 at monitoring wells MW-105 and MW-107R, but at much lower concentrations than MW-101R (less than 300 µg/L).
- Concentrations of gasoline-range petroleum hydrocarbons in Property well MW-101R have been increasing since June 2004, which is likely due to migration from off-Property sources. Concentrations at MW-105 were higher compared to the concentrations measured in 2014, but are within the range of concentrations measured historically at this well (Figure 6). Gasoline-range petroleum hydrocarbons at MW-107R decreased significantly from 4,200 µg/L in 2014 to 135 µg/L in 2019. Gasoline-range petroleum hydrocarbons were detected at Property wells MW-104 and MW-108R in 2019 at concentrations consistent with the last eight sampling events.
- Concentrations of benzene, a typical gasoline component, were detected at MW-101R, MW-104, and MW-105 in 2019. Benzene concentrations appear to be relatively steady with time, except for MW-101R and MW-107R, which have generally decreasing trends (Figure 7).
- The concentration of acenaphthene at MW-101R was higher in 2019 compared to the concentration measured in 2014, but was within the range of concentrations measured historically at this well (Figure 8). Concentrations of acenaphthene were also detected at wells MW-102R, MW-104, MW-105, and MW-107R in 2019 at levels similar in magnitude to those measured during the last eight sampling events.
- Concentrations of arsenic were detected at all Property wells, except MW-108R, in 2019. Concentrations were similar in magnitude over the last eight sampling events. The detected arsenic concentrations at all of the Property wells in 2019 are less than the concentration detected in off-Property well B-6R (Figure 9).

4.0 EVALUATION OF RESULTS

The CAP outlines procedures for conducting a statistical evaluation to evaluate compliance with the cleanup levels at each well and, if appropriate, background-based screening levels. The CAP specifies that basic statistical parameters such as mean and median be developed, and that the UCL be calculated, to evaluate the analytical results for compliance with the cleanup levels. The CAP specifies the use of statistical methods from the Ecology Toxics Cleanup Program guidance document, *Statistical Guidance for Ecology Site Managers* (Ecology 1992), the *Supplement to Statistical Guidance for Ecology Site Managers* (Ecology 1993), and the MTCAStat97 compliance module. However, for this 5-year report, modifications have been made to the statistical procedures listed in the CAP to provide more accurate UCL and background-based screening level values. Modifications were driven by the inability of MTCAStat97 to handle datasets with non-detect observations that have varying reporting limits. The ability to use variable reporting limits is especially important for background data, which span a period of about 18 years during which analytical methods for detecting lower concentrations have improved. Statistical evaluations were completed with the US Environmental Protection Agency's (EPA's) ProUCL (Version 5.1) software, as described below.

In general, compliance was determined by calculating the UCL for each detected compound in samples collected from at each Property well and comparing it to the cleanup level listed in the CAP. For arsenic, acenaphthene, benzene, and some petroleum hydrocarbons, compliance was determined by comparing the UCL to screening levels that were calculated based on concentrations in samples from background wells.

4.1 Calculation of Screening Levels Based on Background Levels

This section discusses the development of background-based screening levels for arsenic, acenaphthene, benzene, and petroleum hydrocarbons (diesel- and gasoline-range organics). For each chemical, a representative dataset was selected based on which background monitoring well contained the highest historically measured concentrations of a given chemical. Statistical calculations were conducted using the entire compliance monitoring dataset (from October 1997 to August 2019) from the selected well. Background-based screening levels were set at the 90 percent upper tolerance limit (UTL) with 90 percent coverage and were computed using ProUCL. Methods for calculating the 90 percent UTL are dependent on the dataset's distribution (or lack thereof) and inclusion of non-detect results. Goodness-of-fit tests and correlation values (R) were used to determine the most appropriate distribution of each dataset. In cases when two or three types of distributions adequately fit a given dataset and R values were similar, then a lognormal distribution was assumed, because environmental data sets are typically lognormally distributed. A summary of the best-fit distributions and associated background-based 90 percent UTL values are presented in Table 5. ProUCL output files are provided in Appendix B.

4.1.1 Arsenic

Arsenic is present in several wells, including background wells B-4R and B-6R, at concentrations above the cleanup level listed in the CAP. For the past 8 sampling events, the highest arsenic concentrations have been detected in the samples from background well B-6R. Therefore, a background-based groundwater screening level was calculated for arsenic using the B-6R analytical results from October 1997 to August 2019. The background-based screening level was used for comparison with data from all Property monitoring wells because it is considered to represent conditions present upgradient of the Property.

4.1.2 Petroleum Hydrocarbons and Related Constituents

Petroleum hydrocarbons and related constituents have been detected in samples from Property wells, but appear to be originating from an offsite source, because of consistent detections at background monitoring wells.

Previous evaluations of monitoring data prior to 2009 have indicated that the source or sources of petroleum hydrocarbons and related constituents were upgradient of the Union Station Property (LAI 2000, 2002, 2003a, b, 2004, 2009). As shown on Figures 5, 6, 7, and 8, and in Table 4, concentrations of petroleum-related constituents, except benzene, in monitoring well B-4 have typically exceeded or been similar to concentrations found in Property wells from 1997 to 2004, and are lower in the groundwater samples collected from replacement well B-4R from 2009 to 2019. This suggests that the offsite source of the petroleum hydrocarbons is no longer present, the groundwater petroleum plume has significantly degraded in the immediate vicinity of well B-4/B-4R in the intervening years, or that the plume does not extend to the location of replacement well B-4R.

To account for the effect of these apparent background sources of petroleum hydrocarbons and related constituents, background-based screening levels were developed for diesel- and gasoline-range petroleum hydrocarbons, benzene, and acenaphthene. Background-based screening levels were developed from the datasets for monitoring well B-4/B-4R from October 1997 to August 2019. These screening levels, in addition to the cleanup levels specified in the CAP, if any, were used for evaluation of data from the Property wells. Motor oil-range petroleum hydrocarbons were not detected at concentrations above the laboratory reporting limit in the Property wells; therefore, a background-based screening level was not calculated.

For other petroleum-related constituents that also appear to be migrating onto the Property from upgradient of the Property, background-based screening levels were not calculated because the concentrations detected in the samples from the Property wells do not exceed the CULs designated in the CAP.

4.1.3 Carcinogenic Polycyclic Aromatic Hydrocarbons

Benzo(a)anthracene and chrysene are two cPAHs often found in motor oil-range petroleum hydrocarbons and asphalt-based products, as well as coal tar. These constituents have been detected at concentrations above the CAP CULs during previous monitoring events and therefore required comparison to background levels to determine compliance. Background-based groundwater screening levels for benzo(a)anthracene and chrysene were calculated using the data from B-4R, where the highest cPAH concentrations have been detected in the past. The background-based screening levels for benzo(a)anthracene and chrysene were used for comparison with the data from the Property monitoring wells because they are considered to represent conditions upgradient of the Property.

4.2 Statistical Methodology for Calculation of Upper Confidence Limit

Procedures for calculating UCLs were modified from those described in the CAP to better characterize datasets containing non-detect (censored) observations. Methods previously used for estimating censored observations (such as Cohen’s method) are no longer broadly used for environmental data statistics. Additionally, the previously used software package, MTCAStat, does not allow for use of multiple reporting limits in one dataset. This report used ProUCL software to determine dataset distributions and to calculate UCLs for compliance with CAP CULs. By way of demonstration, this report requests that the CAP requirements be changed to allow for the use of other statistical methods than those stated in the *Statistical Guidance for Ecology Site Managers* (Ecology 1992)and the *Supplement to Statistical Guidance for Ecology Site Managers* (Ecology 1993), which are outdated methods for statistical evaluations of environmental datasets.

Procedures for calculating the UCL were determined based on the percent of non-detect values (i.e., censored data) within a dataset, as follows:

- **Case 1:** If the dataset contained no censored data (i.e., all concentrations were detected at or above the laboratory’s reporting limit), then no modifications to the dataset were required for calculating the UCL. Goodness-of-fit tests were used to determine whether the dataset’s distribution was normal, lognormal, gamma, or non-parametric. Based on the best-fit distribution for the dataset, the appropriate UCL calculation was made. ProUCL was used to determine the distribution of each dataset and to calculate the UCL.
- **Case 2:** If the dataset contained between one and four censored observations, then the Kaplan Meir method may be used for estimating values of censored data. The Kaplan-Meier method can accommodate multiple reporting limits and is well-suited for many environmental datasets because it is nonparametric, so no underlying distribution need be assumed. After applying the Kaplan-Meir method, the UCL was calculated as described in Case 1. ProUCL was used to determine Kaplan-Meir estimations, dataset distributions, and UCL values.
- **Case 3:** If the dataset contained more than 50 percent, but less than 100 percent censored data, the UCL was set equal to the maximum concentration in the dataset. The Kaplan-Meier estimation method is not recommended for datasets with more than 50 percent non-detect values, and therefore it was not used for Case 3.

No guidance is available for performing statistical evaluation on datasets that contain 100 percent censored data. For evaluation of the 2019 groundwater monitoring data, if a compound was not detected in any of the wells during the eight groundwater monitoring events, then no further evaluation was performed for that compound. For those wells where the constituent was not detected, the data were considered as follows:

- **Case 0:** If the dataset contained 100 percent censored data, no UCL was calculated and the well was determined to be in compliance.

Table 6 lists the statistical procedure (coded by case number) applied to each well dataset. Also included in Table 6 are the percentages of censored and uncensored data for each well.

The dataset used in each statistical evaluation consisted of eight data points (i.e., the eight groundwater sampling events from December 2001 to August 2019).

4.3 Compliance Evaluation

In accordance with the CAP, the UCLs calculated in 2019 were compared to the CULs for each constituent at each Property well. If the calculated UCL for a Property well was less than or equal to the CUL, then that well was considered to be in compliance for that constituent. In some cases, no UCL was calculated because the analyte was not detected in samples from the last eight events and was therefore considered in compliance. A summary of CULs and screening levels, the calculated UCLs, and other statistical parameters required by the CAP for each constituent at each well is provided in Table 6. For some petroleum-related constituents, cPAHs, and arsenic, the UCL was also compared to a screening level based on the concentrations in background wells B-4/B-4R or B-6/B-6R. The results of the evaluation were similar to those for previous monitoring events, in that the Property is in compliance with the CAP. Compliance is summarized below by well and an evaluation of the constituents that exceeded the CAP CUL, but not background-based screening levels, is presented in Section 4.4.

4.3.1 Monitoring Well MW-101R

For monitoring well MW-101R, UCLs were calculated for all constituents except motor-oil range petroleum hydrocarbons, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene because all of the data for these constituents were censored (i.e., below the laboratory reporting limits). As shown in Table 6, benzene and arsenic UCL values exceeded the CAP CULs, but were less than the background-based screening levels. There is no CUL for diesel- or gasoline-range petroleum hydrocarbons in the CAP; therefore, the UCLs for these constituents were compared to the background-based screening levels. Neither background-based screening level was exceeded.

4.3.2 Monitoring Well MW-102R

For monitoring well MW-102R, UCLs were calculated for diesel-range petroleum hydrocarbons, cPAHs, non-carcinogenic PAHs (ncPAHs), and arsenic. No UCL was calculated for motor oil- and gasoline-range petroleum hydrocarbons and BTEX, because these datasets are completely censored. No UCLs exceed the CAP CUL or background-based screening levels.

4.3.3 Monitoring Well MW-104

For monitoring well MW-104, UCLs were calculated for diesel- and gasoline-range petroleum hydrocarbons, several cPAHs, most ncPAHs, BTEX, and arsenic. No UCLs were calculated for motor oil-range petroleum hydrocarbons, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene because all of the data for these constituents were censored. The UCL for arsenic exceeded the CAP CUL, but was less than the background-based screening level. No other UCLs exceeded the CAP CULs or background-based screening levels.

4.3.4 Monitoring Well MW-105

For monitoring well MW-105, UCLs were calculated for diesel- and gasoline-range petroleum hydrocarbons, cPAHs, ncPAHs, BTEX, and arsenic. No UCL was calculated for motor oil-range hydrocarbons because all of the data were censored. As shown in Table 6, the UCL for benzene exceeded the CAP CUL and the background-based screening level. This exceedance is discussed in Section 4.4. The UCL for arsenic also exceeded the CAP CUL, but was less than the background-based screening level. All other UCLs were less than their respective cleanup levels or background-based screening level.

4.3.5 Monitoring Well MW-107R

For monitoring well MW-107R, UCLs were calculated for diesel- and gasoline-range petroleum hydrocarbons, benzo(a)anthracene, chrysene, all ncPAHs except benzo(g,h,i)perylene, BTEX, and arsenic. No UCL was calculated for the other constituents because all of the data for these constituents were censored. As shown in Table 6, only the UCL for arsenic exceeded the CAP CUL, but was less than the background-based screening level. No other UCLs exceeded their respective CAP CULs or background-based screening levels.

4.3.6 Monitoring Well MW-108R

For monitoring well MW-108R, UCLs were calculated for diesel- and gasoline-range petroleum hydrocarbons, cPAHs, ncPAHs, ethylbenzene, and arsenic. No UCLs were calculated for the other constituents because all the data for these constituents were censored. As shown in Table 6, the UCLs for acenaphthene and arsenic exceeded the CAP CULs, but were less than the background-based screening levels. No other UCLs exceeded their respective CAP CULs or background-based screening levels.

4.4 Summary of Evaluation Results

As discussed above, acenaphthene, benzene, and arsenic were identified as exceeding CAP CULs in one or more wells based on UCLs calculated in 2019. Each of these constituents has also been detected in one of the background wells at concentrations exceeding the CAP CUL during the past eight monitoring events; therefore, a background-based screening level should be considered for compliance determinations. A summary of the constituents that exceeded the cleanup or screening levels is summarized in Table 7 and the results are discussed by constituent below.

4.4.1 Acenaphthene

Acenaphthene is a typical constituent of diesel as well as of coal tar. Acenaphthene was detected in samples from all but one of the Property wells, and has been consistently detected at background well B-4/B-4R. During the 2019 monitoring event, acenaphthene was detected at replacement well B-4R and the calculated background-based screening level is 522 µg/L. The 2019 UCL calculated for acenaphthene at well MW-101R (293 µg/L) exceeded the CAP CUL (225 µg/L). The calculated UCL for acenaphthene at this well did not exceed the background-based screening level.

The historical presence of acenaphthene in monitoring well B-4 at high concentrations relative to concentrations detected at the Property indicates an off-Property source or sources of acenaphthene. Acenaphthene concentrations generally decreased since December 2001 and have been significantly lower since sampling began at replacement well B-4R in 2009. The decrease in the concentration of acenaphthene at well B-4/B-4R suggests that the offsite source is no longer present, the groundwater plume from the offsite source has significantly degraded in the immediate vicinity of well B-4/B-4R in the intervening years, or that the plume does not extend to the location of replacement well B-4R. If the source is no longer present or the plume has moved beyond well B-4/B-4R, the concentrations of acenaphthene at the Property wells should also decrease over time. As shown on Figure 8, concentrations at MW-101R have not been declining as quickly as concentrations observed at B-4 (prior to replacement), and therefore it is unlikely that the offsite source is no longer present.

As shown in Table 7, the UCL values for MW-101R did not exceed background-based screening levels. Based on the apparent background source of acenaphthene, the UCL exceedance of the CAP CUL in well MW-101R does not represent contamination originating from the Property and is not considered evidence of noncompliance with the CUL; therefore, it should not trigger implementation of groundwater treatment or an increase in the frequency of groundwater monitoring.

4.4.2 Benzene

Benzene is a constituent of gasoline and is typically found in groundwater contaminated from relatively recent spills of gasoline. It can also be associated with coal gasification plants; however, groundwater testing prior to and during the RI did not indicate that benzene was present at the Property from the coal gasification plant formerly located on the Property. In addition, gasoline and other gasoline-related constituents, such as ethylbenzene, toluene, xylenes, and substituted benzenes, were also detected in samples from Property monitoring wells, making it likely that the source of the benzene is gasoline. Benzene, along with other petroleum-related constituents, is apparently migrating in groundwater to the Property from an off-Property source. Benzene has been detected consistently in the past in samples from monitoring well B-4, but has not been detected in well B-4R since installation in 2009. Although the background-based screening level used for comparison (230 µg/L) was calculated based on the data from monitoring well B-4 and B-4R, the data from these wells potentially do not reflect the maximum concentration in groundwater migrating onto the Property, because the extent of off-Property benzene sources is unknown. Furthermore, the lack of benzene at replacement well B-4R suggests that the groundwater plume from the offsite has significantly degraded in the immediate vicinity of well B-4/B-4R in the intervening years, or that the plume does not extend to the location of replacement well B-4R. As stated above for acenaphthene, concentrations of benzene have not been declining at MW-105 and therefore suggests that the upgradient source is still affecting Property wells. The UCLs calculated in 2019 for wells MW-101R and MW-105 exceeded the CAP CUL. The UCL for well MW-105 also exceeded the background-based screening level. These detected concentrations are consistent with the data from previous monitoring events and do not represent contamination originating from the Property and are not considered evidence of noncompliance with CULs; therefore, these detected concentrations should not trigger implementation of groundwater treatment or an increase in the frequency of groundwater monitoring.

4.4.3 Arsenic

Arsenic is a naturally occurring metal in soil and groundwater. Ecology determined that the 90th percentile value for the background arsenic concentration in soil in the Puget Sound region is 7 milligrams per kilogram (Ecology 1994). Arsenic was detected in groundwater samples from all but one of the Property wells and at both background wells during the 2019 sampling event. The 2019 UCLs for arsenic exceeded the CAP CUL (4 µg/L) at all Property wells, but were less than the background-based screening level (36 µg/L). The presence of arsenic in a background well at concentrations greater than those found in Property wells indicates that arsenic is present upgradient of the Property. The exceedances of the CAP CUL do not represent contamination originating from the Property and are not considered evidence of noncompliance with CULs; therefore, they should not trigger implementation of groundwater treatment or an increase in the frequency of groundwater monitoring.

4.4.4 Carcinogenic Polycyclic Aromatic Hydrocarbons

Benzo(a)anthracene and chrysene are two cPAHs often found in motor oil-range petroleum hydrocarbons and asphalt-based products, as well as coal tar. Although the 2019 UCLs for benzo(a)anthracene and chrysene did not exceed the CAP CUL, they were included in Table 2 for comparison to historical data. These cPAHs and other cPAHs have typically been detected in samples from background well B-4. Based on the concentrations measured in well B-4/B-4R, the background-based screening levels for benzo(a)anthracene and chrysene are 21 µg/L and 14 µg/L, respectively, and none of the UCLs for the property wells were greater than the background-based screening levels at the Property wells. Based on the historical data from well B-4/B-4R, levels of benzo(a)anthracene and chrysene in well MW-105 do not represent contamination originating from the Property.

5.0 CONCLUSIONS

Evaluation of historical and current groundwater analytical results for the Property indicates that there are upgradient sources of gasoline- and diesel-range petroleum hydrocarbons and related constituents that have migrated in groundwater onto the Property. For this reason, the concentrations detected in groundwater samples from well B-4/B-4R have been used to evaluate compliance for gasoline- and diesel-range petroleum hydrocarbons, acenaphthene, and benzene in Property wells. Additionally, the consistent presence of arsenic in background wells (i.e., B-4/B-4R and B-6/B-6R) indicates that arsenic concentrations in groundwater wells at the Property are also influenced by background sources (naturally occurring or otherwise). Groundwater elevations measured from March 2001 to June 2005 indicated a change in groundwater flow direction. However, groundwater elevations measured during the 2019 sampling event were consistent with elevations measured since 2009 and prior to March 2001, indicating that anomalous groundwater elevations observed at well B-4 in March 2001 through June 2004 were the result of physical changes to the well caused by the Nisqually earthquake, and well B-4/B4R has always been hydraulically upgradient of the Property.

Background-based screening levels were calculated for gasoline- and diesel-range petroleum hydrocarbons, benzene, acenaphthene, and cPAHs using data from well B-4/B-4R and for arsenic using data from B-6R. Data from the entire monitoring period, October 1997 through August 2019, were used to calculate screening levels for each constituent. For diesel- or gasoline-range petroleum hydrocarbons, the background-based screening levels were used to determine compliance because there are no CAP CULs for these constituents.

For each well, UCLs were calculated for the constituents detected during the past eight monitoring events and compared to CAP CULs (or background screening levels as stated above). The only chemicals that exceeded CAP CULs were acenaphthene (well MW-101R); benzene (MW-101R and MW-105); and arsenic (MW-101R, MW-102R, MW-104, MW-105, MW-107R, and MW-108R). These constituents have also been demonstrated to have migrated onto the Property from off site, based on upgradient background well data. Only the UCL for benzene at MW-105 exceeds the background-based screening level. The exceedances of benzene at MW-105 are consistent with the results of previous statistical evaluations. Historical results for groundwater samples at B-4 have consistently demonstrated that petroleum-related constituents were migrating from off-Property onto the Property (LAI 2000, 2002, 2003a, b, 2004, 2009). And although concentrations of petroleum-related constituents have decreased at B-4 since 2009 (when replacement well B-4R was installed), it is unlikely that the offsite source is no longer present, given the consistent detections at Property wells over time.

These exceedances of the CAP CULs and the single exceedance of a background-based screening level do not represent contamination originating on the Property and are not considered evidence of noncompliance with the CAP; therefore, they should not trigger implementation of groundwater treatment or an increase in the frequency of groundwater monitoring.

6.0 RECOMMENDATIONS

Based on the information presented in this report, it is recommended that the groundwater monitoring frequency remain at every 5 years and that the list of constituents remain the same for the next groundwater monitoring event.

7.0 USE OF THIS REPORT

This report has been prepared for the exclusive use of Union Station Associates for specific application to the Union Station property. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

8.0 REFERENCES

Ecology. 1992. *Statistical Guidance for Ecology Site Managers*. Publication No. 92-54. Washington State Department of Ecology. August. https://fortress.wa.gov/ecy/publications/summarypages/9254.html.

Ecology. 1993. *Supplement to Statistical Guidance for Ecology Site Managers*. Analyzing Site or Background Data with Below-Detection Limit or Below-PQL Values (Censored Data Sets). Washington State Department of Ecology. August.

Ecology. 1994. *Natural Background Soil Metals Concentrations in Washington State*. Publication No. 94-115. Washington State Department of Ecology. October. https://fortress.wa.gov/ecy/publications/documents/94115.pdf.

Ecology. 2000. Letter: Union Station Report, Groundwater Monitoring, Union Station, Seattle, Washington, Dated August 31, 2000. From David L. South, Toxics Cleanup Program, Washington State Department of Ecology, to Kristy J. Hendrickson, Landau Associates, Inc. November 22.

Ecology. 2002. Letter: Union Station. From David L. South, Toxics Cleanup Program, Washington State Department of Ecology, to Kristy J. Hendrickson, Landau Associates, Inc. November 4.

Ecology. 2005a. Letter: Union Station Groundwater Monitoring, Union Station Purchaser Consent Decree (97-2-18936-5SEA). From David L. South, Toxics Cleanup Program, Washington State Department of Ecology, to Kristy J. Hendrickson, Landau Associates, Inc. February 24.

Ecology. 2005b. Letter: Union Station Purchaser Consent Decree No. 97-2-18936-5SEA - Certification of Completion. From David L. South, Toxics Cleanup Program, Washington State Department of Ecology, to Kristy J. Hendrickson, Landau Associates, Inc. January 20.

LAI. 1997. Cleanup Action Plan, Union Station Property, Seattle, Washington. Landau Associates, Inc. July 28.

LAI. 2000. Report: Groundwater Monitoring, Union Station, Seattle, Washington. Landau Associates, Inc. August 31.

LAI. 2002. Report: Groundwater Monitoring, Union Station, Seattle, Washington. Landau Associates, Inc. March 4.

LAI. 2003a. Report: Groundwater Monitoring, Union Station, Seattle, Washington. Landau Associates, Inc. February 25.

LAI. 2003b. Report: Groundwater Monitoring, Union Station, Seattle, Washington. Landau Associates, Inc. October 29.

LAI. 2004. Report: Groundwater Monitoring, Union Station, Seattle, Washington. Landau Associates, Inc. October 28.

LAI. 2009. Report: Groundwater Monitoring, Union Station, Seattle, Washington. Landau Associates, Inc. November 5.

LAI. 2014. Report: 2014 Groundwater Monitoring. Landau Associates, Inc. October 21.

LAI and Hart Crowser. 1996. Report: Focused Remedial Investigation and Feasibility Study, Union Station, Seattle, Washington. Landau Associates, Inc. and Hart Crowser, Inc. July 1.

Timm, R.W. 2019. "Re: Union Station, Site 3858, Revision to Analytical Methods." From Ronald W. Timm, Toxics Cleanup Program, Washington State Department of Ecology, to Evelyn Ives, Senior Project Engineer, Landau Associates, Inc. August 20.

WSAG. 1997. Prospective Purchaser Consent Decree No. 97-2-18936-5SEA, Re: Union Station. Ecology Division, Washington State Attorney General's Office. April 1.

G:\Projects\429\008\010\012\F01 VicMap.mxd 11/4/2019

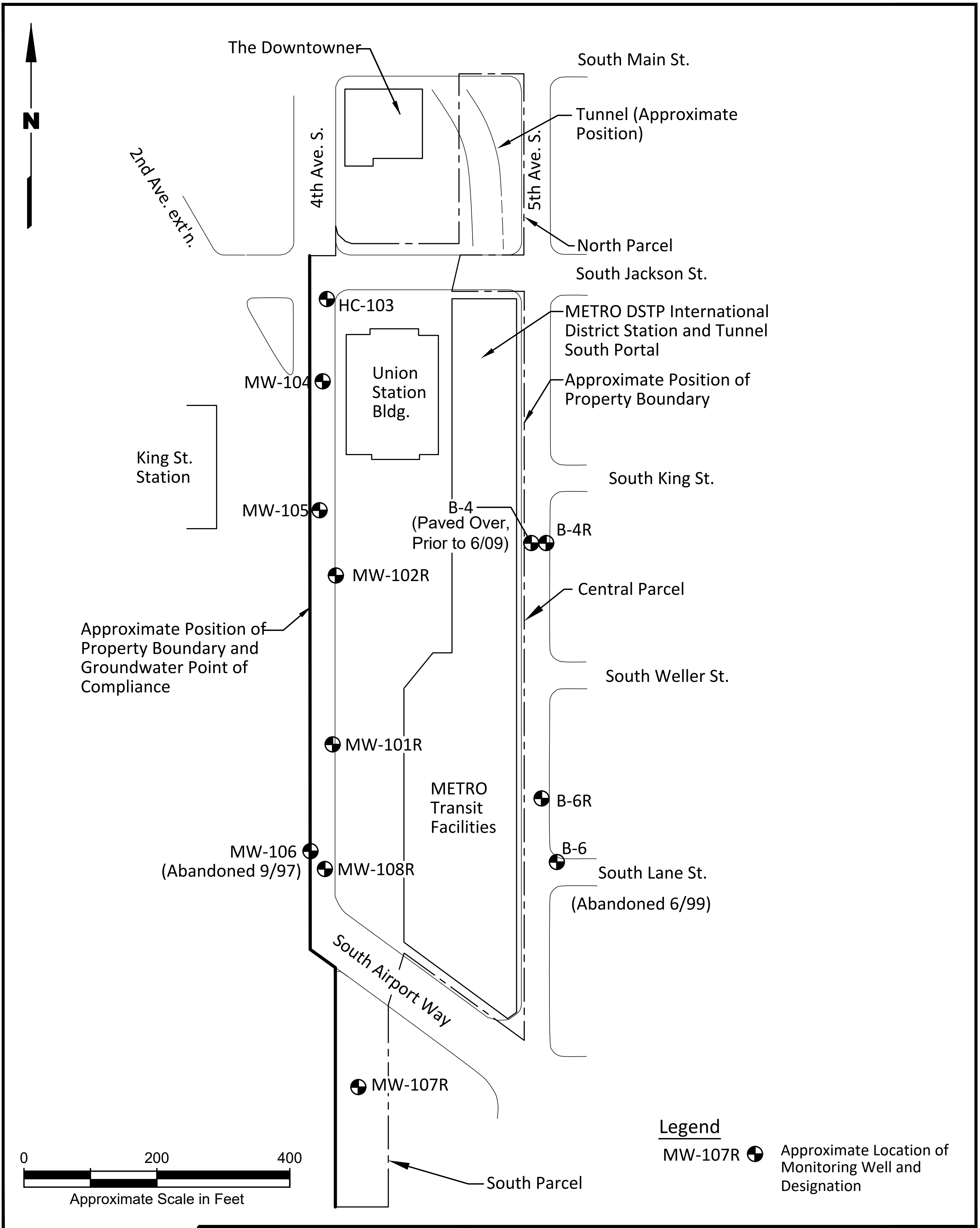
Data Source: Esri 2012

LANDAU ASSOCIATES

Union Station
Seattle, Washington

Vicinity Map

Figure
1



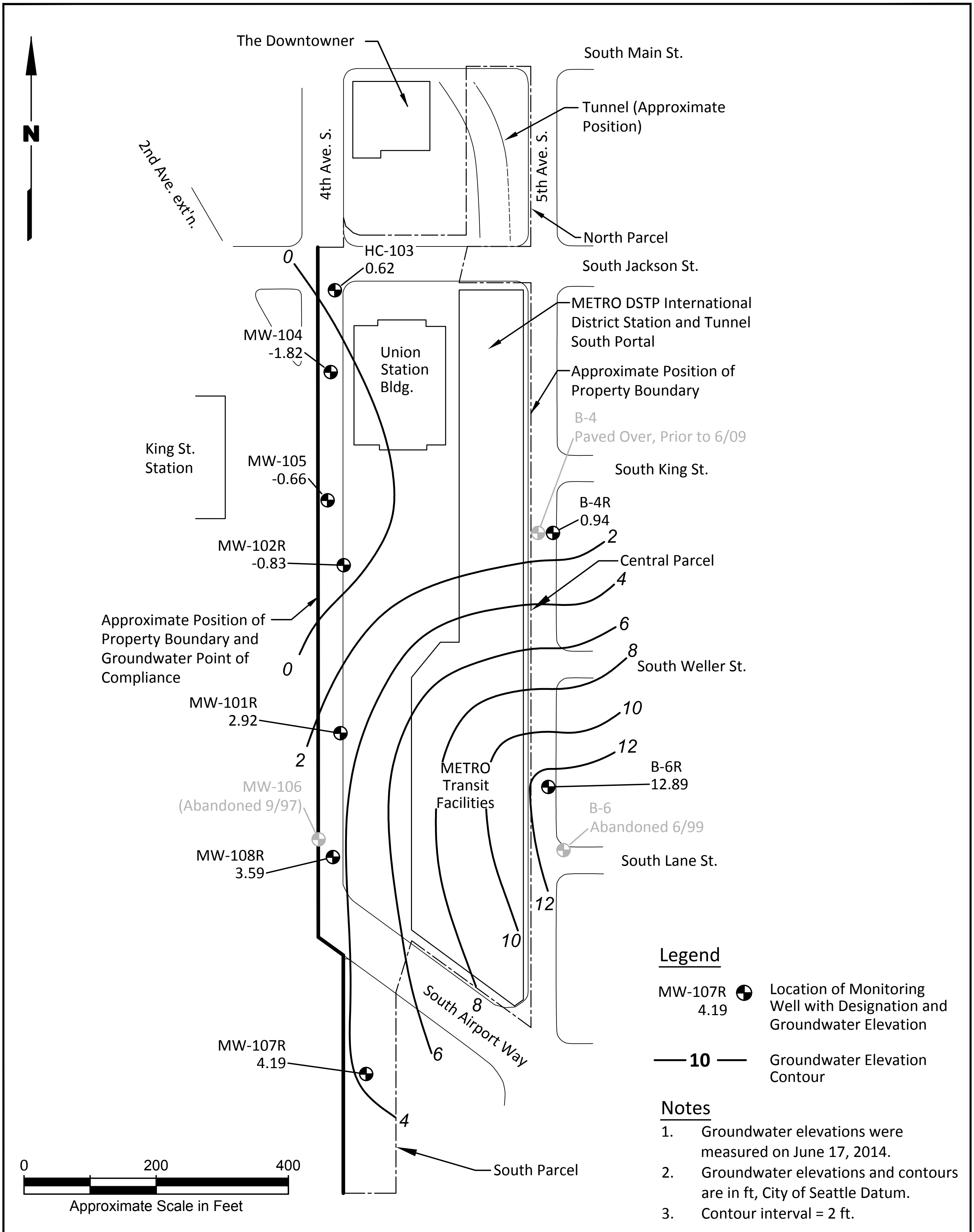
Union Station Associates | G:\Projects\429\008\010\012\F02 MWLocations.dwg (A) "Figure 2" 11/4/2019

LANDAU ASSOCIATES

Union Station
Seattle, Washington

Union Station Groundwater Monitoring Well Locations

Figure
2



Notes

1. Groundwater elevations were measured on June 17, 2014.
2. Groundwater elevations and contours are in ft, City of Seattle Datum.
3. Contour interval = 2 ft.

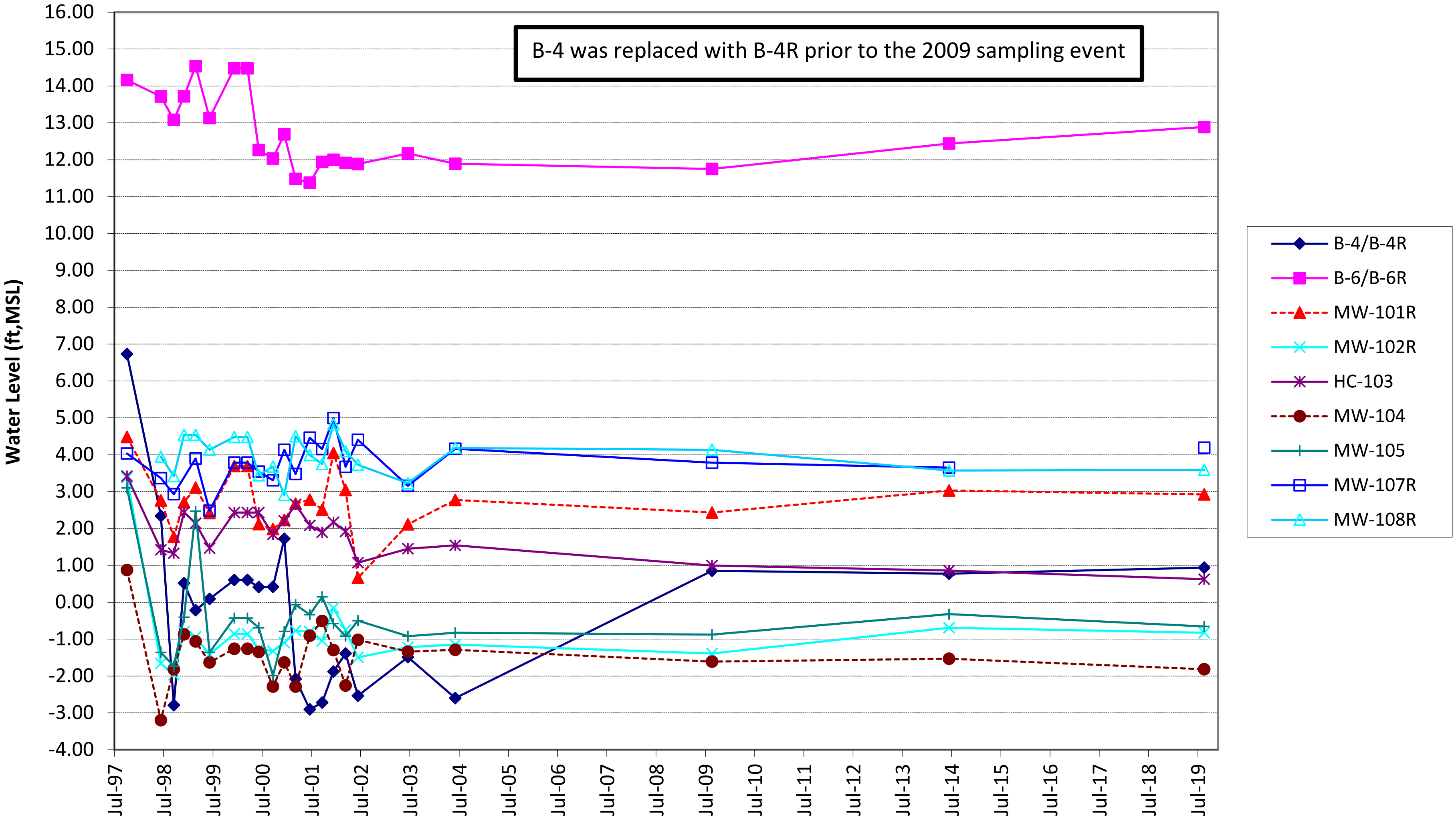
Landau Associates | G:\Projects\429\008\010\011\F03-1 GWContoursAug2019.dwg | 10/22/2019 11:21 AM | JVALLUZZI

Landau Associates

Union Station
Seattle, Washington

Groundwater Elevation Contours: August 2019

Figure
3

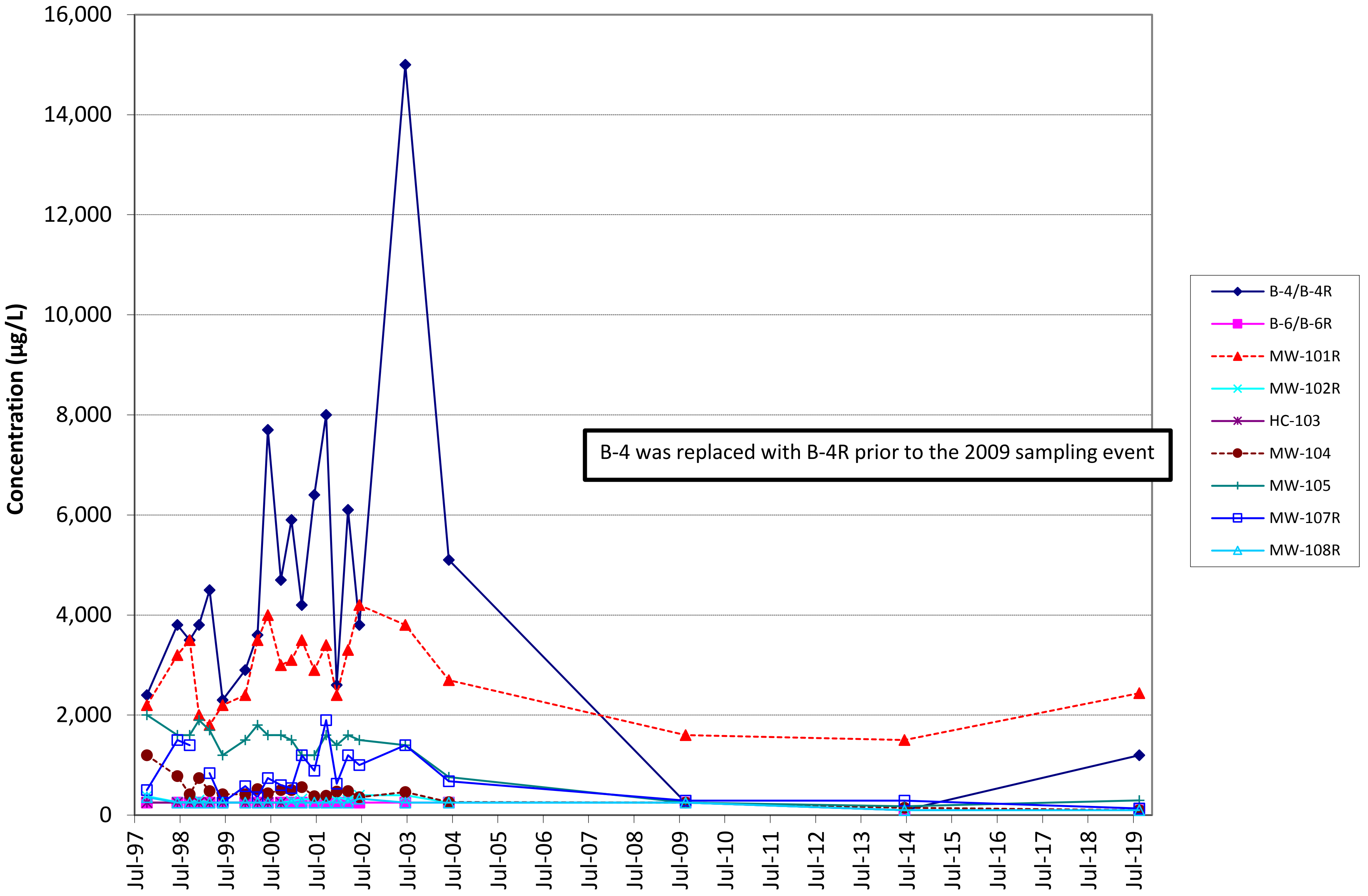


Landau Associates

Union Station
Seattle, Washington

Groundwater Elevations
October 1997 through August 2019

Figure
4

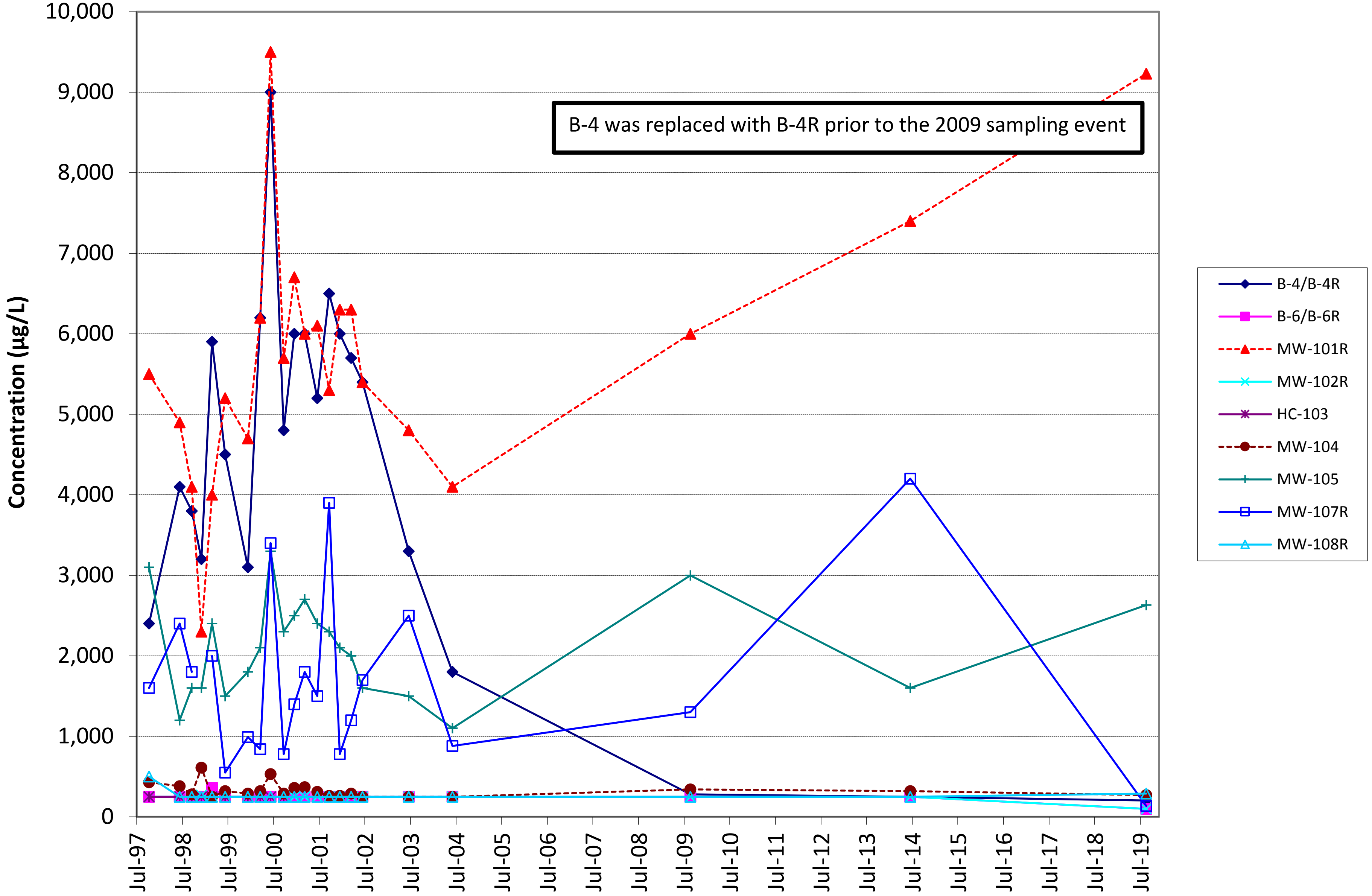


LANDAU ASSOCIATES

Union Station
Seattle, Washington

Diesel-Range Petroleum Hydrocarbon Concentrations vs. Time

Figure
5

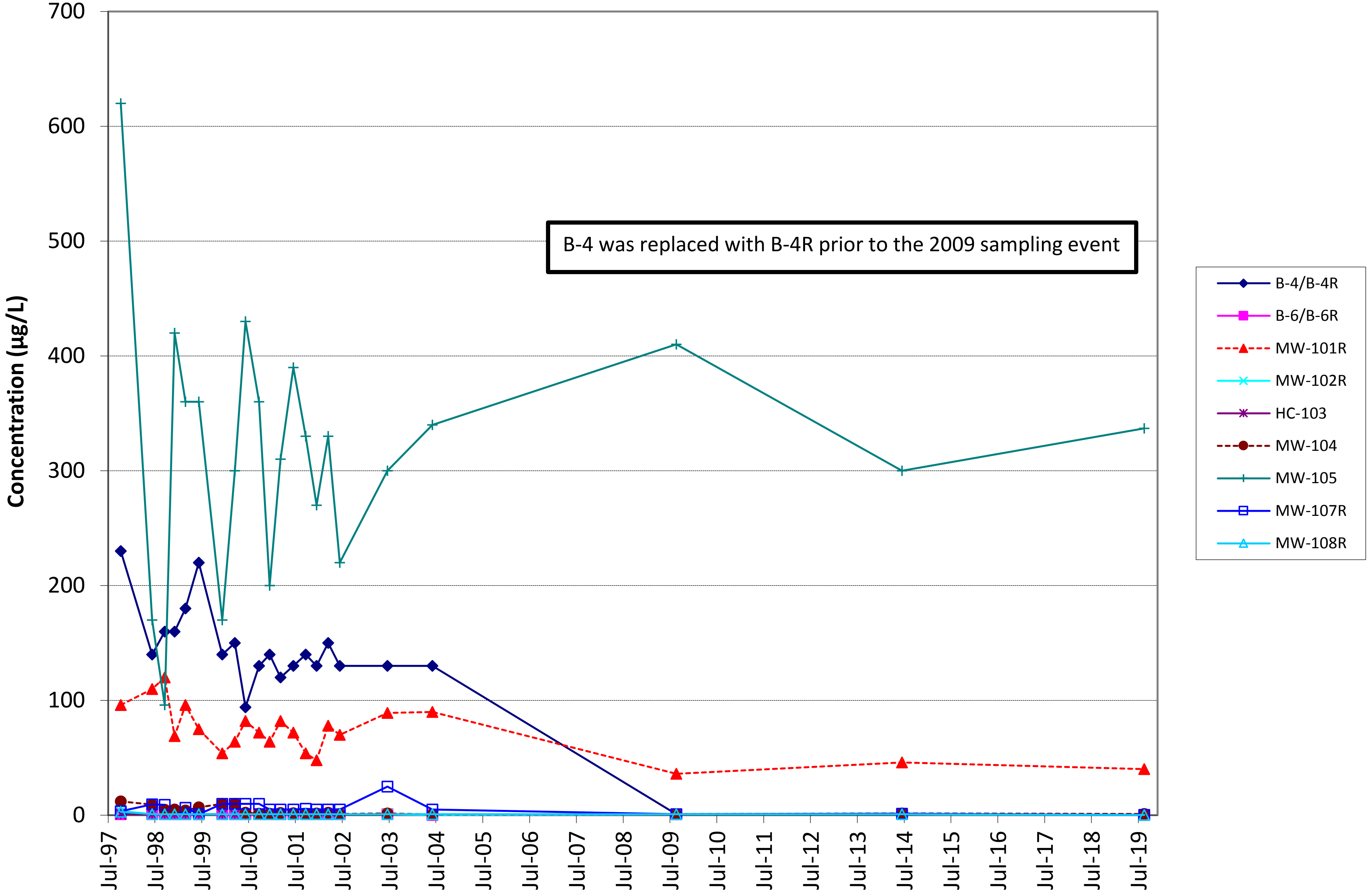


Union Station
Seattle, Washington

Gasoline-Range Petroleum Hydrocarbon Concentrations vs. Time

Figure
6

LANDAU ASSOCIATES

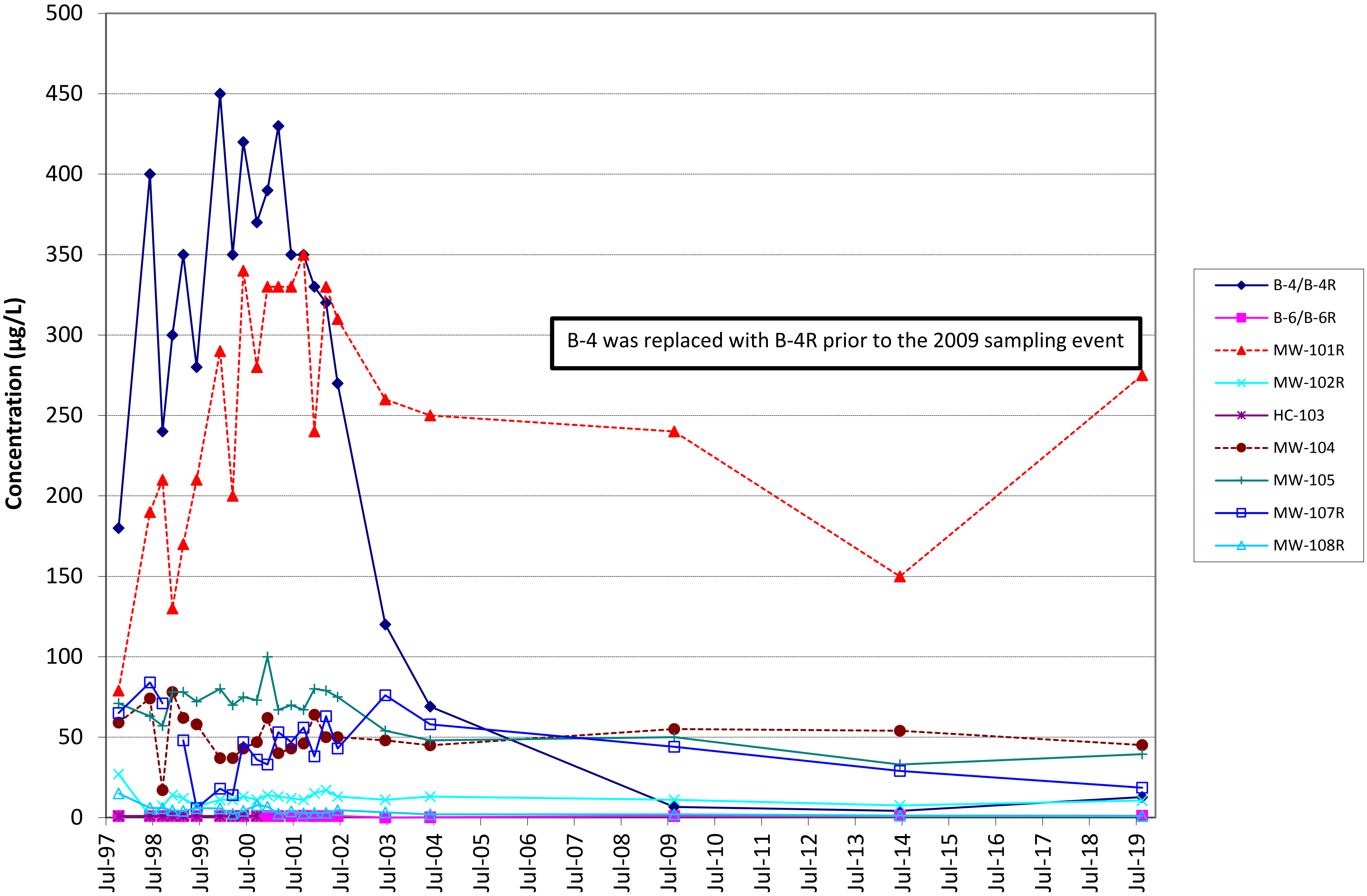


LANDAU ASSOCIATES

Union Station
Seattle, Washington

Benzene Concentrations vs. Time

Figure
7

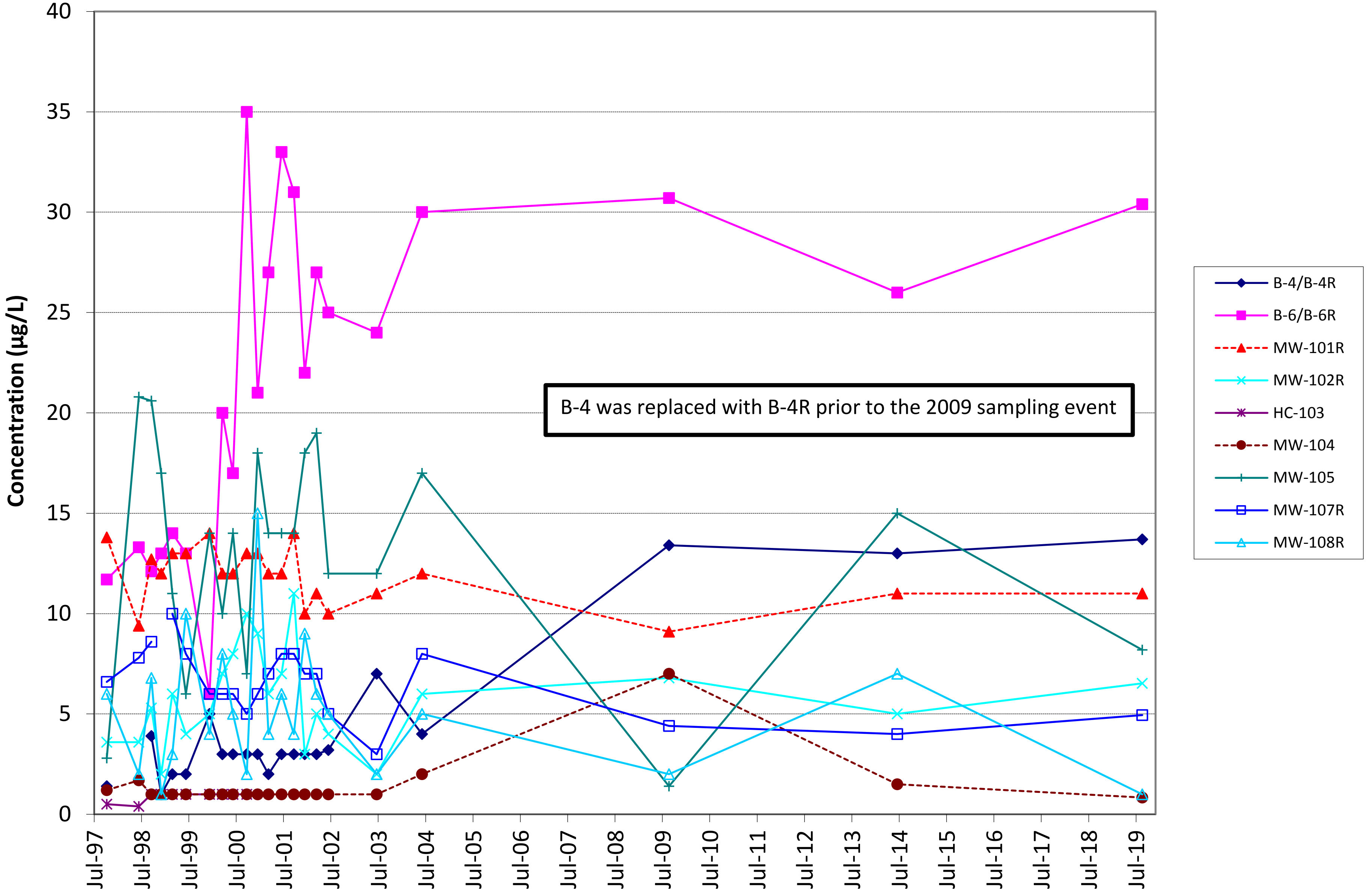


B-4 was replaced with B-4R prior to the 2009 sampling event

Union Station
Seattle, Washington

Acenaphthene Concentrations vs. Time

Figure
8



B-4 was replaced with B-4R prior to the 2009 sampling event

LANDAU ASSOCIATES

Union Station
Seattle, Washington

Arsenic Concentrations vs. Time

Figure
9

Table 1
Consent Decree Groundwater Monitoring and Remediation Requirements
2019 Groundwater Monitoring Compliance
Union Station Property
Seattle, Washington

Groundwater Monitoring

Quarterly monitoring for 8 quarters beginning within 3 months of the effective date of the consent decree.

> Calculate upper 95% confidence limit (UCL) using the 8 quarters of data.
>
> If UCL exceeds cleanup levels, implement groundwater treatment if directed by the Washington State Department of Ecology (Ecology) to prevent contamination from leaving the site. The parties anticipate that Ecology may revise this cleanup action plan to incorporate new cleanup standards if the cleanup standards are revised by an amendment to the regulations and Ecology determines the use of the new standards is appropriate.
>
> If UCL is less than or equal to cleanup levels, commence annual monitoring.

Annual monitoring until all foundations are completed or until two years after any foundation construction is initiated.

Quarterly sampling for 8 quarters beginning the first quarter after all foundations are completed or the first quarter occurring 2 years after any foundation construction is initiated.

> Calculate 95% UCL using the last 8 quarters of data.
>
> If UCL exceeds cleanup levels, implement groundwater treatment if directed by Ecology to prevent contamination from leaving the site. The parties anticipate that Ecology may revise this cleanup action plan to incorporate new cleanup standards if the cleanup standards are revised by an amendment to the regulations and Ecology determines the use of the new standards is appropriate.
>
> If UCL is less than or equal to cleanup levels, commence annual monitoring.

Annual monitoring until foundation loading (building construction) is complete plus 3 additional years.

> If any sample exceeds cleanup levels, collect another sample 1 quarter later.
>
> If the second sample is less than cleanup levels, return to annual monitoring.
>
> If the second sample exceeds cleanup levels, commence quarterly monitoring for 1 year (see below).
>
> If no exceedance of cleanup levels has occurred after 3 years, commence monitoring every 5 years.

Monitoring every 5 years.

> If any sample exceeds cleanup levels, collect another sample 1 quarter later.
>
> If the second sample is less than cleanup levels, return to annual monitoring for 1 year.
>
> If the second sample exceeds cleanup levels commence quarterly monitoring for 1 year (see below).
>
> If UCL is less than or equal to cleanup levels continue monitoring every 5 years so long as residual hazardous substance concentrations contained onsite exceed site cleanup levels [see WAC 173-340-360 (8)(b)].

Quarterly sampling for 1 year

> At end of year, if UCL based on 4 quarters of data is less than cleanup levels, return to annual monitoring for 3 years.
>
> At end of year, if UCL based on 4 quarters of data is greater than cleanup levels and data show increasing trend and last sample exceeds twice the cleanup level, implement groundwater treatment if directed by Ecology to prevent contamination from leaving the site. Otherwise, continue monitoring for another 4 quarters.
>
> If, after 8 quarters of data have been collected, the UCL based on the 8 quarters of data exceeds the cleanup level, implement groundwater treatment if directed by Ecology to prevent contamination from leaving the site.
>
> If, after 8 quarters of data have been collected, the UCL based on the 8 quarters of data is less than the cleanup level, continue monitoring for another 4 quarters.
>
> If, at the end of the last 4 quarters, the UCL based on the last 8 quarters of data exceeds the cleanup level, implement groundwater treatment if directed by Ecology to prevent contamination from leaving the site.

Table 1
Consent Decree Groundwater Monitoring and Remediation Requirements
2019 Groundwater Monitoring Compliance
Union Station Property
Seattle, Washington

If, at the end of the last 4 quarters, the UCL based on the last 8 quarters of data is less than the cleanup level, return to annual monitoring for 5 years. If there are no exceedances of cleanup levels during that time, return to monitoring every 5 years.

Groundwater Treatment

Minimize present worth of capital and operations and maintenance costs to determine the size and estimated operating time of the system.

Performance monitoring.

Quarterly monitoring during groundwater treatment.

Plot data and do statistical evaluation as directed by Ecology to determine when to terminate treatment or when cleanup standards are met.

Post-Treatment Monitoring

Quarterly monitoring for 8 quarters.

If UCL exceeds cleanup levels and trend analysis does not indicate decreasing trend, return to groundwater treatment.

If UCL exceeds cleanup levels and trend analysis indicates decreasing trend, continue monitoring quarterly. If UCL calculated using the last 8 quarters of data exceeds cleanup levels after 12 quarters of data have been collected, return to groundwater treatment.

If UCL is less than or equal to cleanup levels, commence annual monitoring for 3 years.

Annual monitoring for 3 years.

If any sample exceeds cleanup levels, collect another sample 1 quarter later.

If the second sample is less than cleanup levels return to annual monitoring.

If the second sample exceeds cleanup levels, commence quarterly monitoring for 1 year and use triggers in quarterly monitoring above.

If no exceedance of cleanup levels has occurred after 3 years, commence monitoring every 5 years.

Monitoring every 5 years.

If any sample exceeds cleanup levels, collect another sample 1 quarter later.

If the second sample is less than cleanup levels return to monitoring every 5 years.

If the second sample exceeds cleanup levels commence quarterly monitoring (see above).

If UCL is less than or equal to cleanup levels, continue monitoring every 5 years so long as residual hazardous substance concentrations contained on site exceed site cleanup levels [see WAC 173-340-360 (8)(b)].

Notes:

1. This table was prepared for and originally presented in the CAP.
2. As described in Appendix A of the CAP, alternate statistical methods may be used upon approval by Ecology.

Abbreviations and Acronyms:

Ecology = Washington State Department of Ecology
UCL = upper confident limit
WAC = Washington Administrative Code

Table 2
Monitoring Well Summary
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Well	Installation Date	Decommissioning Date[a]	Northing	Easting	Ground Surface Elevation[b]	Reference Elevation[c]	Top of Screen Elevation	Bottom of Screen Elevation	Top of Native Soil Elevation	Notes
HC-101	4-96	3-98	1583.27	1695.87	8.80	9.09	3.8	-6.2	NA	Well was damaged during construction activities and decommissioned
MW-101R	3-98	N/A	1583.24	1695.87	9.77	9.06	2.8	-7.2	NA	Replacement well for HC-101; boring could not be advanced beyond 16 ft bgs
HC-102	4-96	3-98	1837.46	1700.69	9.30	8.64	4.3	-5.7	NA	Well was damaged during construction activities and decommissioned
MW-102R	3-98	N/A	1837.26	1700.58	9.97	8.60	-3.7	-13.7	-14.7	Replacement well for HC-102
HC-103	4-96	N/A	2253.49	1687.23	10.30	8.99	5.5	-4.5	NA	
MW-104	11-96	N/A	2129.50	1680.99	10.65	9.59	-0.1	-10.1	-12.6	
MW-105	11-96	N/A	1935.82	1676.45	10.07	8.92	-4.5	-14.0	-15.5	
MW-106	11-96	9-97	1422.63	1662.65	9.50	9.07	-1.0	-11.0	-13.5	Well was decommissioned to accommodate construction
MW-107	11-96	10-98	1048.59	1728.86	13.30	12.59	-1.7	-11.7	-12.7	Well was decommissioned to accommodate construction
MW-107R	2-99	N/A	1067.59	1734.64	12.99	12.43	-1.5	-7.0	-10.0	Replacement well for MW-107
MW-108	9-97	4-98	NA	NA	NA	NA	NA	NA	NA	Replacement well for MW-106; well was later damaged during construction activities and decommissioned
MW108R	4-98	N/A	1395.75	1684.25	9.56	8.78	-3.4	-13.4	-14.4	Replacement well for MW-108
B-4	12-85	Paved over between 6/04 and 8/09	1886.32	1994.74	36.80	36.36	-4.6	-9.6	-12.1	Well was paved over by Seattle DOT
B-4R	08-09	N/A	221730.54[d]	1271778.6[d]	36.74	36.35	5.74	-4.26	NA	Replacement well for B-4

Table 2
Monitoring Well Summary
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Well	Installation Date	Decommissioning Date[a]	Northing	Easting	Ground Surface Elevation[b]	Reference Elevation[c]	Top of Screen Elevation	Bottom of Screen Elevation	Top of Native Soil Elevation	Notes
B-6	12-85	6-99	1406.35	2033.29	34.30	34.08	-0.9	-5.7	NA	Well was decommissioned to accommodate construction
B-6R	11-99	N/A	1501.99	2010.27	34.38	34.38	10.4	-9.6	-17.1	Replacement well for B-6

Notes:

[a] Wells were decommissioned in accordance with applicable regulations in place at the time.

[b] Ground surface elevation at time of well installation.

[c] Reference elevation is used for measuring groundwater levels and represents most current survey information.

[d] Elevations are in NAVD 88.

Note: All elevations except well B-4R are in feet, City of Seattle Datum.

Abbreviations and Acronyms:

bgs = below ground surface
DOT = Department of Transportation
ft = feet
NA = Not available
N/A = Not applicable
NAVDD88 = North American Vertical Datum of 1988

Table 3
August 2019 Groundwater Elevation Summary
2019 Groundwater Monitoring Compliance
Union Station Property - Seattle, Washington

Well	Measuring Point Elevation	Measured Depth to Groundwater	Groundwater Elevation
B-4R	36.35	35.41	0.94
B-6R	34.38	21.49	12.89
MW-101R	9.06	6.14	2.92
MW-102R	8.60	9.43	-0.83
HC-103	8.99	8.37	0.62
MW-104	9.59	11.41	-1.82
MW-105	8.92	9.58	-0.66
MW-107R	12.43	8.24	4.19
MW-108R	8.78	5.19	3.59

Note: All elevations are in feet, City of Seattle Datum.

Table 4
Groundwater Analytical Results
September 2001 to August 2019
Union Station Property – Seattle, Washington

Analyte	Method	B-4 DY69A 12/19/2001	B-4 EE79H 3/20/2002	B-4 EM41H 6/19/2002	B-4 FP47G/P 6/25/2003	B-4 GS18I 6/9/2004	B-4R PL85B 8/25/2009	B-4R YO99D 06/19/2014	B-4R 19H0298 8/20/2019
TPH (µg/L)									
Diesel-Range Petroleum Hydrocarbons	NWTPH-Dx	2,600	6,100	3,800	15,000	5,100	250 U	100 U	1,200 J
Motor Oil-Range Petroleum Hydrocarbons	NWTPH-Dx	570	2,500 U	620	6,800	2,000	500 U	200 U	780 J
Gasoline-Range Petroleum Hydrocarbons	NWTPH-G	6,000 J	5,700	5,400	3,300	1,800	280	250 UJ	204
cPAH (µg/L)									
Benzo(a)anthracene	8270 (a)	1.7	1.4	0.41	2.1	2.0	0.37	0.12 U	1.1 U
Chrysene	8270 (a)	1.5	1.3 J	0.36	2.0	1.7	0.45	0.12 U	1.1 U
Benzo(a)pyrene	8270 (a)	1.3	1.0	0.12	0.16	1.2	0.36	0.12 U	1.1 U
Indeno(1,2,3-cd)pyrene	8270 (a)	0.57	0.53	0.10 U	NA	0.44	0.17	0.12 U	1.1 U
Dibenzo(a,h)anthracene	8270 (a)	0.20 U	0.20 M	0.10 U		0.28	0.10 U	0.12 U	1.1 U
Total Benzofluoranthenes	8270 (a)	NA	NA	NA		NA	NA	0.12 U	2.1 U
ncPAH (µg/L)									
Naphthalene	8270 (a)	2,700 J	2,400 J	1,200	710 J	0.41	4.6	1.1 U	1.1 U
1-Methylnaphthalene	8270 (a)	--	--	--	--	--	--	--	1.1 U
2-Methylnaphthalene	8270 (a)	480	510	260	160	0.46	1.0 U	1.1 U	1.1 U
Acenaphthylene	8270 (a)	3.2	3.0	10	1.6	2.9	1.0 U	1.1 U	1.1 U
Acenaphthene	8270 (a)	330 J	320	270	120	69	6.6	4.2	12.7
Fluorene	8270 (a)	88	96	78	45	18	1.0 U	1.1 U	1.1 U
Phenanthrene	8270 (a)	110	110	69	46	7.8	1.7	1.1 U	1.1 U
Anthracene	8270 (a)	16	15	10	9.1	4.6	1.0 U	1.1 U	1.1 U
Fluoranthene	8270 (a)	14	11	9.1	8.3	9.0	1.0 U	1.1 U	1.1 U
Pyrene	8270 (a)	14	11	9.1	12	12	1.0 U	1.1 U	1.1 U
Benzo(g,h,i)perylene	8270 (a)	1.0 U	1.0 U	1.0 U	0.53	0.45	1.0 U	1.1 U	1.1 U
cPAH (µg/L)									
Benzo(a)anthracene	8270D SIM	--	--	--	--	--	--	--	0.11 U
Benzo(a)pyrene	8270D SIM	--	--	--	--	--	--	--	0.11 U
Chrysene	8270D SIM	--	--	--	--	--	--	--	0.11 U
Dibenzo(a,h)anthracene	8270D SIM	--	--	--	--	--	--	--	0.11 U
Indeno(1,2,3-cd)pyrene	8270D SIM	--	--	--	--	--	--	--	0.11 U
Total Benzofluoranthenes	8270D SIM	--	--	--	--	--	--	--	0.22 U
BTEX (µg/L)									
Benzene	8260/8021MOD	130	150	130	130	130	1.0 U	1.0 UJ	0.20 U
Toluene	8260/8021MOD	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	1.0 U	1.0 UJ	0.20 U
Ethylbenzene	8260/8021MOD	190	230	190	160	110	1.0 U	1.0 UJ	0.20 U
m,p-Xylene	8260/8021MOD	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	1.0 U	2.0 UJ	0.40 U
o-Xylene	8260/8021MOD	5.0 U	5.6	5.0 U	5.0 U	5.0 U	1.0 U	1.0 UJ	0.20 U
Xylenes, Total	8260/8021MOD	--	--	--	--	--	--	--	0.60 U
DISSOLVED METALS (µg/L)									
Arsenic	200.8	3 J	3	3.2	7	4	13	13	13.7
CONVENTIONALS									
Total Dissolved Solids (µg/L)	160.1/SM2540D	770,000	740,000	790,000	790,000	751,000	538,000	498,000	530,000
Total Suspended Solids (µg/L)	160.2	1,400,000 J	920,000	680,000	270,000	938,000	8,300,000	4,130,000	4,600,000
pH	Field	NM	NM	NM	NM	NM	7.36	6.68	6.97
Specific Conductance (µmhos)	Field	NM	NM	NM	NM	NM	1398	763	741
Temperature (°C)	Field	NM	NM	NM	NM	NM	15.01	15.48	16.7

Table 4
Groundwater Analytical Results
September 2001 to August 20019
Union Station Property – Seattle, Washington

				Dup of B-6R						
		B-6R	B-6R	MW-109R	B-6R	B-6R	B-6R	B6R	B6R	B-6R
		DY69B	EE79I	EE79G	EM41I	FP47H/Q	GS18J	PL85A	YO99E	19H0298
Analyte	**Method**	**12/19/2001**	**3/20/2002**	**3/20/2002**	**6/19/2002**	**6/25/2003**	**6/9/2004**	**8/25/2009**	**06/19/2014**	**08/20/19**
TPH (µg/L)										
Diesel-Range Petroleum Hydrocarbons	NWTPH-Dx	250 U	250 U	250 U	250	250 U	250 U	250 U	100 U	100 U
Motor Oil-Range Petroleum Hydrocarbons	NWTPH-Dx	500 U	500 U	500 U	500 U	500 U	500 U	500 U	200 U	200 U
Gasoline-Range Petroleum Hydrocarbons	NWTPH-G	250 UJ	250 U	250 U	250 U	250 U	250 U	250 U	250 U	100 U
cPAH (µg/L)										
Benzo(a)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.020	0.035	0.19	0.12 U	1.1 U
Chrysene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.020	0.030	0.21	0.12 U	1.1 U
Benzo(a)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.010 U	0.023	0.19	0.12 U	1.1 U
Indeno(1,2,3-cd)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.010 U	0.016	0.11	0.12 U	1.1 U
Dibenzo(a,h)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.010 U	0.010 U	0.10 U	0.12 U	1.1 U
Total Benzofluoranthenes	8270 (a)	NA	NA	NA	NA	NA	NA	NA	0.12 U	2.1 U
ncPAH (µg/L)										
Naphthalene	8270 (a)	4.9 J	4.0 J	2.9 J	1.0 U	0.14	0.13 U	2.6	1.2 U	1.1 U
1-Methylnaphthalene	8270 (a)	--	--	--	--	--	--	--	--	1.1 U
2-Methylnaphthalene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.090	0.030 U	1.0 U	1.2 U	1.1 U
Acenaphthylene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.010 U	0.010 J	1.0 U	1.2 U	1.1 U
Acenaphthene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.050	0.14 U	1.0 U	1.2 U	1.1 U
Fluorene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.020	0.053	1.0 U	1.2 U	1.1 U
Phenanthrene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.080	0.16	1.0 U	1.2 U	1.1 U
Anthracene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.040	0.065	1.0 U	1.2 U	1.1 U
Fluoranthene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.060	0.081	1.0 U	1.2 U	1.1 U
Pyrene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.080	0.11	1.0 U	1.2 U	1.1 U
Benzo(g,h,i)perylene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.010 U	0.019	1.0 U	1.2 U	1.1 U
cPAH (µg/L)										
Benzo(a)anthracene	8270D SIM	--	--	--	--	--	--	--	--	0.11 U
Benzo(a)pyrene	8270D SIM	--	--	--	--	--	--	--	--	0.11 U
Chrysene	8270D SIM	--	--	--	--	--	--	--	--	0.11 U
Dibenzo(a,h)anthracene	8270D SIM	--	--	--	--	--	--	--	--	0.11 U
Indeno(1,2,3-cd)pyrene	8270D SIM	--	--	--	--	--	--	--	--	0.11 U
Total Benzofluoranthenes	8270D SIM	--	--	--	--	--	--	--	--	0.22 U
BTEX (µg/L)										
Benzene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.20 U
Toluene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.20 U
Ethylbenzene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.20 U
m,p-Xylene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.4 U	1.0 U	2.0 U	0.40 U
o-Xylene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2	1.0 U	1.0 U	0.20 U
Xylenes, Total	8260/8021MOD	--	--	--	--	--	--	--	--	0.60 U
DISSOLVED METALS (µg/L)										
Arsenic	200.8	22 J	27 J	38 J	25	24	30	31	26	30.4
CONVENTIONALS										
Total Dissolved Solids (µg/L)	160.1/SM2540D	780,000	780,000 J	1,100,000 J	890,000	790,000	923,000	891,000	518,000	666,000
Total Suspended Solids (µg/L)	160.2	1,400,000 J	360,000 J	790,000 J	1,100,000	430,000	940,000	1,040,000	927,000	324,000
pH	Field	NM	6.65	6.90	6.95	7.06	6.89	7.39	6.87	6.92
Specific Conductance (µmhos)	Field	NM	1,340	1,733	1,348	1,708	1,570	2,392	995	1,061
Temperature (°C)	Field	NM	15.0	14.1	16.1	16.8	16.6	15.5	16.4	16.4

Table 4
Groundwater Analytical Results
September 2001 to August 2019
Union Station Property – Seattle, Washington

Analyte	Method	MW-101R DY69C 12/19/2001	MW-101R EE79A 3/20/2002	MW-101R EM41A 6/19/2002	Dup of MW-101R MW-109 EM41B 6/19/2002	MW-101R FP47A/J 6/25/2003	Dup of MW-101R MW-109 FP47F/O 6/25/2003	MW-101R GS18F 6/9/2004	Dup of MW-101R MW-109 GS18G 6/9/2004	MW-101R PL72A 8/24/2009	Dup of MW-101R MW-109R PL72E 8/24/2009	MW-101R YO69E 06/18/2014	MW-101R 19H0324 08/21/19
TPH (µg/L)													
Diesel-Range Petroleum Hydrocarbons	NWTPH-Dx	2,400	3,300	4,200	3,800	3,800	3,900	2,700	2,600	1,600	1,500	1,500	2,440
Motor Oil-Range Petroleum Hydrocarbons	NWTPH-Dx	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	200 U	200 U
Gasoline-Range Petroleum Hydrocarbons	NWTPH-G	6,300 J	6,300	5,400	5,400	4,800	4,800	4,100	4,100	6,000	6,000	7,400	9,230
cPAH (µg/L)													
Benzo(a)anthracene	8270 (a)	0.16	0.25	0.17	0.17	0.20	0.20	0.23	0.25	0.28 J	0.43 J	0.24	1.0 U
Chrysene	8270 (a)	0.15	0.14 J	0.14	0.13	0.15	0.13	0.16	0.17	0.20 J	0.33 J	0.18	1.0 U
Benzo(a)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.040	0.040	0.052	0.060	0.10 U	0.14	0.11 U	1.0 U
Indeno(1,2,3-cd)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.010 U	0.010 U	0.050 U	0.050 U	0.10 U	0.10 U	0.11 U	1.0 U
Dibenzo(a,h)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.010 U	0.010 U	0.050 U	0.050 U	0.10 U	0.10 U	0.11 U	1.0 U
Total Benzofluoranthenes	8270 (a)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.13	102.0 U
ncPAH (µg/L)													
Naphthalene	8270 (a)	2,000 J	3,400 J	3,200	3,400	2,900 J	2,000 J	1,800	1,800	1,500	1,400	1,200	1,770
1-Methylnaphthalene	8270 (a)	--	--	--	--	--	--	--	--	--	--	--	412.0
2-Methylnaphthalene	8270 (a)	350	570	530	530	490 J	600 J	280	290	440	400	300	551
Acenaphthylene	8270 (a)	1.0 J	1.5	2.4	2.1	0.58 J	0.53 J	2.0	2.3	1.0 U	1.0 U	1.5	1 U
Acenaphthene	8270 (a)	240 J	330	310	310	260	280	250	260	240	220	150	275
Fluorene	8270 (a)	72	75	83	88	79	90	72	79	85	76	54	95.9
Phenanthrene	8270 (a)	97	77	92	99	63	68	66	75	93	86	63	99.8
Anthracene	8270 (a)	6.9	7.4	6.5	6.4	7.2	8.2	6.5	7.6	7.6	7.1	3.9	8.1
Fluoranthene	8270 (a)	5.4	4.7	5.4	5.2	5.4	5.3	5.0	5.6	6.8	6.0	3.4	6.2
Pyrene	8270 (a)	5.1	4.2	5.0	5.2	6.1	6.1	4.6	5.3	6.2	5.3	3.4	8.3
Benzo(g,h,i)perylene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.010 U	0.010 U	0.050 U	0.050 U	1.0 U	1.0 U	1.2 U	1 U
cPAH (µg/L)													
Benzo(a)anthracene	8270D SIM	--	--	--	--	--	--	--	--	--	--	--	0.22
Benzo(a)pyrene	8270D SIM	--	--	--	--	--	--	--	--	--	--	--	0.10 U
Chrysene	8270D SIM	--	--	--	--	--	--	--	--	--	--	--	0.16
Dibenzo(a,h)anthracene	8270D SIM	--	--	--	--	--	--	--	--	--	--	--	0.10 U
Indeno(1,2,3-cd)pyrene	8270D SIM	--	--	--	--	--	--	--	--	--	--	--	0.10 U
Total Benzofluoranthenes	8270D SIM	--	--	--	--	--	--	--	--	--	--	--	0.20 U
BTEX (µg/L)													
Benzene	8260/8021MOD	48 J	78	70	69	89	96	90	92	36	36	46	40.1
Toluene	8260/8021MOD	5.0 UJ	7.6	5.7	5.5	5.0 U	4.1	5.5	6.0	2.2	2.3	5.9	1.9
Ethylbenzene	8260/8021MOD	130 J	260	250	240	300	260	210	230	150	150	200	120
m,p-Xylene	8260/8021MOD	46 J	92	46	43	45	48	38	43	25	25	42	15
o-Xylene	8260/8021MOD	18 J	37	23	22	17	19	17	19	18 J	1.0 UJ	34	19
Xylenes, Total	8260/8021MOD	--	--	--	--	--	--	--	--	--	--	--	33.9
DISSOLVED METALS (µg/L)													
Arsenic	200.8	10 J	11	10	11	11	11	12	12	9.1	9.5	11	11.0
CONVENTIONALS													
Total Dissolved Solids (µg/L)	160.1/SM2540D	1,100,000	970,000	1,000,000	1,000,000	960,000	950,000	1,250,000	1,390,000	1,130,000	1,080,000	1,610,000	1,480,000
Total Suspended Solids (µg/L)	160.2	65,000 J	71,000	72,000	72,000	79,000	78,000	284,000 J	90,100 J	60,400	59,300	357,000	459,000
pH	Field	NM	6.70	6.92	6.98	6.96	6.96	6.67	6.67	6.88	6.88	8.15	6.74
Specific Conductance (µmhos)	Field	NM	2,540	1,860	2,418	1,510	1,510	2,012	2,012	2,899	2,899	2,405	2,276
Temperature (°C)	Field	NM	14.2	12.8	13.6	14.8	14.8	15.3	15.3	15.0	15.0	14.3	17.4

Table 4
Groundwater Analytical Results
September 2001 to August 2019
Union Station Property – Seattle, Washington

Analyte	Method	MW-102R DY69D 12/19/2001	MW-102R EE79B 3/20/2002	MW-102R EM41C 6/19/2002	MW-102R FP47B/K 6/25/2003	MW-102R GS18E 6/9/2004	MW-102R PL72B 8/24/2009	MW-102R YO69D 06/18/2014	MW-102R 19H0324 08/21/19
TPH (µg/L)									
Diesel-Range Petroleum Hydrocarbons	NWTPH-Dx	370	300	400	400	250 U	250 U	100 U	100 U
Motor Oil-Range Petroleum Hydrocarbons	NWTPH-Dx	500 U	500 U	500 U	500 U	500 U	500 U	200 U	200 U
Gasoline-Range Petroleum Hydrocarbons	NWTPH-G	250 UJ	250 U	250 U	250 U	250 U	250 U	250 U	100 U
cPAH (µg/L)									
Benzo(a)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.030 J	0.12	0.10 U	0.12 U	1.0 U
Chrysene	8270 (a)	0.10 U	0.10 U	0.10 U	0.020 J	0.098	0.10 U	0.12 U	1.0 U
Benzo(a)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 UJ	0.064	0.10 U	0.12 U	1.0 U
Indeno(1,2,3-cd)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 UJ	0.069	0.10 U	0.12 U	1.0 U
Dibenzo(a,h)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 UJ	0.074	0.10 U	0.12 U	1.0 U
Total Benzofluoranthenes	8270 (a)	NA	NA	NA	NA	NA	NA	0.12 U	2.0 U
ncPAH (µg/L)									
Naphthalene	8270 (a)	12 J	22 J	1.5	0.060 UJ	0.24 U	3.1	2.4	1.0 U
1-Methylnaphthalene	8270 (a)	--	--	--	--	--	--	--	1.0 U
2-Methylnaphthalene	8270 (a)	2.1	2.6	1.0 U	0.12 J	0.67	1.0 U	1.2 U	1.0 U
Acenaphthylene	8270 (a)	1.0 U	1.0 U	1.0 U	0.16 J	0.28	1.0 U	1.2 U	1.0 U
Acenaphthene	8270 (a)	15 J	17	13	11	13	11	7.6	10.6
Fluorene	8270 (a)	3.4	3.7	2.6	2.9	3.2	2.8	1.8	2.1
Phenanthrene	8270 (a)	3.3	3.8	1.0 U	2.7	3.8	3.5	1.6	3.1
Anthracene	8270 (a)	1.0 U	1.1	1.0 U	0.84 J	0.98	1.0 U	1.2 U	1.0 U
Fluoranthene	8270 (a)	1.0 U	1.0 U	1.0 U	0.48 J	1.0	1.0 U	1.2 U	1.0 U
Pyrene	8270 (a)	1.0 U	1.0 U	1.0 U	0.40 J	0.85	1.0 U	1.2 U	1.0 U
Benzo(g,h,i)perylene	8270 (a)	1.0 U	1.0 U	1.0 U	0.010 UJ	0.059	1.0 U	1.2 U	1.0 U
cPAH (µg/L)									
Benzo(a)anthracene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Benzo(a)pyrene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Chrysene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Dibenzo(a,h)anthracene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Indeno(1,2,3-cd)pyrene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Total Benzofluoranthenes	8270D SIM	--	--	--	--	--	--	--	0.20 U
BTEX (µg/L)									
Benzene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.20 U
Toluene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.20 U
Ethylbenzene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.20 U
m,p-Xylene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	0.4 U	1.0 U	2.0 U	0.40 U
o-Xylene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.20 U
Xylenes, Total	8260/8021MOD	--	--	--	--	--	--	--	0.60 U
DISSOLVED METALS (µg/L)									
Arsenic	200.8	3 J	5	4	2 U	6	6.8	5	6.52
CONVENTIONALS									
Total Dissolved Solids (µg/L)	160.1/SM2540	1,900,000	1,800,000	1,900,000	1,500,000	1,590,000	1,700,000	1,530,000	1,630,000
Total Suspended Solids (µg/L)	160.2	61,000 J	51,000	41,000	51,000	40,600	45,500	53,400	98,000
pH	Field	6.47	6.64	6.70	6.80	6.65	6.43	8.33	6.90
Specific Conductance (µmhos)	Field	3,740	3,090	3,753	2,710	2,415	3,262	2,391	2,725
Temperature (°C)	Field	15.1	14.2	15.0	15.6	15.9	16.2	15.3	17.6

Table 4
Groundwater Analytical Results
September 2001 to August 2019
Union Station Property – Seattle, Washington

		MW-104	MW-104	MW-104	MW-104	MW-104	MW-104	MW-104	MW-104
		DY69E	EE79C	EM41D	FP47C/L	GS18B	PL72D	YO69B	19H0324
Analyte	**Method**	**12/19/2001**	**3/20/2002**	**6/19/2002**	**6/25/2003**	**6/9/2004**	**8/24/2009**	**06/18/2014**	**08/21/19**
TPH (µg/L)									
Diesel-Range Petroleum Hydrocarbons	NWTPH-Dx	470	480	360	460	260	250 U	150	100 U
Motor Oil-Range Petroleum Hydrocarbons	NWTPH-Dx	500 U	500 U	500 U	500 U	500 U	500 U	200 U	200 U
Gasoline-Range Petroleum Hydrocarbons	NWTPH-G	260 J	290	250 U	250 U	250 U	340	320	270
cPAH (µg/L)									
Benzo(a)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.090	0.070	0.14	0.18	1.0 U
Chrysene	8270 (a)	0.10 U	0.10 U	0.10 U	0.060	0.047	0.13	0.23	1.0 U
Benzo(a)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 U	0.010 U	0.10 U	0.14	1.0 U
Indeno(1,2,3-cd)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 U	0.010 U	0.10 U	0.12 U	1.0 U
Dibenzo(a,h)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 U	0.010 U	0.10 U	0.12 U	1.0 U
Total Benzofluoranthenes	8270 (a)	NA	NA	NA	NA	NA	NA	0.24	2.0 U
ncPAH (µg/L)									
Naphthalene	8270 (a)	1.0 U	1.0 UJ	1.0 U	0.40	0.75 U	4.5	1.9	1.0 U
1-Methylnaphthalene	8270 (a)	--	--	--	--	--	--	--	10.2
2-Methylnaphthalene	8270 (a)	1.0 U	2.0	1.0 U	9.3	1.5	7.8	11	1.9
Acenaphthylene	8270 (a)	1.0 U	1.0 U	2.3	0.47	0.70	1.0 U	1.2 U	12.4
Acenaphthene	8270 (a)	64 J	50	50	48	45	55	54	45.1
Fluorene	8270 (a)	11	10	6.8	8.5	4.0	15	15	10.4
Phenanthrene	8270 (a)	1.0 U	1.2	1.0 U	0.010 U	0.36	15	12	2.8
Anthracene	8270 (a)	1.1	1.2	1.0 U	0.77	0.010 U	1.7	2.1	1.0
Fluoranthene	8270 (a)	1.7	1.4	1.4	1.4	1.4	1.8	1.6	1.4
Pyrene	8270 (a)	1.4	1.0	1.1	1.3	1.1	1.3	1.6	1.6
Benzo(g,h,i)perylene	8270 (a)	1.0 U	1.0 U	1.0 U	0.010 U	0.010 U	1.0 U	1.2 U	1.0 U
cPAH (ug/L; SW-846 8270D SIM)									
Benzo(a)anthracene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Benzo(a)pyrene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Chrysene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Dibenzo(a,h)anthracene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Indeno(1,2,3-cd)pyrene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Total Benzofluoranthenes	8270D SIM	--	--	--	--	--	--	--	0.20 U
BTEX (µg/L)									
Benzene	8260/8021MOD	1.6	2.1	1.1	1.5	0.7	1.0	1.5	1.05
Toluene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.20
Ethylbenzene	8260/8021MOD	1.0 U	1.4	1.0 U	1.1	0.6	1.0 U	1.0 U	0.94
m,p-Xylene	8260/8021MOD	1.9	2.7	1.9	1.6	1.5	1.0 U	2.0 U	0.80
o-Xylene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	1.0 U	1.0 U	0.30
Xylenes, Total	8260/8021MOD	--	--	--	--	--	--	--	1.10
DISSOLVED METALS (µg/L)									
Arsenic	200.8	1 J	1	1.0	1	2	7.0	1.5	0.842
CONVENTIONALS									
Total Dissolved Solids (µg/L)	160.1/SM2540D	550,000	530,000	530,000	510,000	500,000	502,000	455,000	437,000
Total Suspended Solids (µg/L)	160.2	11,000 J	19,000	4,900	6,200	7,900	14,800	4,630,000	17,000
pH	Field	6.82	7.27	7.32	7.26	6.86	7.88	8.13	6.92
Specific Conductance (µmhos)	Field	1,270	920	1,088	641	930	1,314	724	701
Temperature (°C)	Field	13.2	11.4	14.6	15.4	15.2	16.6	15.9	18.2

Table 4
Groundwater Analytical Results
September 2001 to August 2019
Union Station Property – Seattle, Washington

Analyte	Method	MW-105 DY69F 12/19/2001	MW-105 EE79D 3/20/2002	MW-105 EM41E 6/19/2002	MW-105 FP47D/M 6/25/2003	MW-105 GS18D 6/9/2004	MW-105 PL85D 8/25/2009	MW-105 YO69C 06/18/2014	MW-105 19H0324 08/21/19
TPH (µg/L)									
Diesel-Range Petroleum Hydrocarbons	NWTPH-Dx	1,400	1,600	1,500	1,400	760	250 U	180	296
Motor Oil-Range Petroleum Hydrocarbons	NWTPH-Dx	500 U	500 U	500 U	500 U	500 U	500 U	200 U	200 U
Gasoline-Range Petroleum Hydrocarbons	NWTPH-G	2,100 J	2,000	1,600 J	1,500	1,100	3,000	1,600	2,630
cPAH (µg/L)									
Benzo(a)anthracene	8270 (a)	0.77 J	0.85	0.24	0.24	0.46	1.2	0.35	1.1
Chrysene	8270 (a)	0.56 J	0.66 J	0.16	0.15	0.28	1.1	0.28	1.0 U
Benzo(a)pyrene	8270 (a)	0.40 J	0.41	0.10 U	0.040	0.14	1.0	0.19	1.0 U
Indeno(1,2,3-cd)pyrene	8270 (a)	0.19 J	0.15	0.10 U	0.010 U	0.068	0.48	0.12 U	1.0 U
Dibenzo(a,h)anthracene	8270 (a)	0.10 UJ	0.10 U	0.10 U	0.010 U	0.053	0.17	0.12 U	1.0 U
Total Benzofluoranthenes	8270 (a)	NA	NA	NA	NA	NA	NA	0.29	2.1 U
ncPAH (µg/L)									
Naphthalene	8270 (a)	860 J	940 J	410	480 J	540	240	180	269
1-Methylnaphthalene	8270 (a)	--	--	--	--	--	--	--	30.6
2-Methylnaphthalene	8270 (a)	74	96	76	71	62	29	19	26.8
Acenaphthylene	8270 (a)	1.2	1.0 U	1.1	0.29 J	0.98	1.0 U	1.2 U	1.0 U
Acenaphthene	8270 (a)	80 J	79	75	54	48	50	33	39.5
Fluorene	8270 (a)	35	30	32	24	20	19	12	15.3
Phenanthrene	8270 (a)	73	65	57	40	34	30	23	31
Anthracene	8270 (a)	9.6	8.1	5.8	5.6	4.8	4.3	3.1	3.5
Fluoranthene	8270 (a)	11	11	7.4	5.9	6.5	6.0	4.7	6.1
Pyrene	8270 (a)	9.8	8.2	6.8	6.1	5.7	4.8	4.6	7.3
Benzo(g,h,i)perylene	8270 (a)	1.0 U	1.0 U	1.0 U	0.010 U	0.062	1.0 U	1.2 U	1.0 U
cPAH (ug/L; SW-846 8270D SIM)									
Benzo(a)anthracene	8270D SIM	--	--	--	--	--	--	--	0.27
Benzo(a)pyrene	8270D SIM	--	--	--	--	--	--	--	0.12
Chrysene	8270D SIM	--	--	--	--	--	--	--	0.24
Dibenzo(a,h)anthracene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Indeno(1,2,3-cd)pyrene	8270D SIM	--	--	--	--	--	--	--	0.10 U
Total Benzofluoranthenes	8270D SIM	--	--	--	--	--	--	--	0.21 U
BTEX (µg/L)									
Benzene	8260/8021MOD	270 J	330	220	310	340	410	300	337
Toluene	8260/8021MOD	18 J	29	22	32	41	92	63	33.9
Ethylbenzene	8260/8021MOD	56 J	68	50	52	49	66	43	33.5
m,p-Xylene	8260/8021MOD	38 J	47	36	37	39	66	38	24.4
o-Xylene	8260/8021MOD	29 J	29	21	19	15	24	16	10.9
Xylenes, Total	8260/8021MOD	--	--	--	--	--	--	--	35.4
DISSOLVED METALS (µg/L)									
Arsenic	200.8	18 J	19	12	12	17	1.4	15	8.19
CONVENTIONALS									
Total Dissolved Solids (µg/L)	160.1/SM2540D	2,700,000	2,700,000	3,300,000	2,400,000	3,510,000	3,100,000	2,800,000	3,860,000
Total Suspended Solids (µg/L)	160.2	110,000 J	97,000	88,000	98,000	44,900	91,100	996,000	46,000
pH	Field	6.73	6.87	6.94	7.08	7	NM	8.34	7.06
Specific Conductance (µmhos)	Field	5,850	5,460	6,830	6,610	5,262	NM	4,239	6,446
Temperature (°C)	Field	16.6	15.8	17.0	17.3	17.2	NM	17.7	18.3

Table 4
Groundwater Analytical Results
September 2001 to August 2019
Union Station Property – Seattle, Washington

Analyte	Method	MW-107R DY69G 12/19/2001	MW-107R EE79E 3/20/2002	MW-107R EM41F 6/19/2002	MW-107R FP47E/N 6/25/2003	MW-107R GS18C 6/9/2004	MW-107R PL85C 8/25/2009	MW-107R YO99C 06/19/2014	MW-107R 19H0298 08/20/19	DUP of MW-107R DUP-1 19H0298 08/20/19
TPH (µg/L)										
Diesel-Range Petroleum Hydrocarbons	NWTPH-Dx	630	1,200	1,000	1,400	680	290	290	136	100 U
Motor Oil-Range Petroleum Hydrocarbons	NWTPH-Dx	500 U	500 U	500 U	500 U	500 U	500 U	200 U	200 U	200 U
Gasoline-Range Petroleum Hydrocarbons	NWTPH-G	780 J	1,200	1,700	2,500	880	1,300	4,200	135	138
cPAH (µg/L)										
Benzo(a)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 U	0.053	0.10 U	0.12 U	1.0 U	1.0 U
Chrysene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 U	0.051	0.10 U	0.12 U	1.0 U	1.0 U
Benzo(a)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 U	0.050 U	0.10 U	0.12 U	1.0 U	1.0 U
Indeno(1,2,3-cd)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 U	0.050 U	0.10 U	0.12 U	1.0 U	1.0 U
Dibenzo(a,h)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.010 U	0.050 U	0.10 U	0.12 U	1.0 U	1.0 U
Total Benzofluoranthenes	8270 (a)	NA	NA	NA	NA	NA	NA	0.12 U	2.0 U	2.1 U
ncPAH (µg/L)										
Naphthalene	8270 (a)	990 J	2,200 J	1,000	1,400 J	1,200	480	160	2.8 J	4.8 J
1-Methylnaphthalene	8270 (a)	--	--	--	--	--	--	--	18.4 J	23.5 J
2-Methylnaphthalene	8270 (a)	66	150	77	220	140	100	57	19.1 J	26.0 J
Acenaphthylene	8270 (a)	1.0 U	1.0 U	1.0 U	0.30 J	0.47	1.0 U	3.4 U	1 U	1.0 U
Acenaphthene	8270 (a)	38 J	63	43	76	58	44	29	18.6 J	24.1 J
Fluorene	8270 (a)	10	17	13	27	19	12	8.5	5.7 J	7.5 J
Phenanthrene	8270 (a)	7.6	14	8.8	18	14	8.7	8.4	5.4 J	6.8 J
Anthracene	8270 (a)	1.0 U	1.0	1.0 U	1.4	1.0	1.0 U	3.4 U	1.0 U	1.0 U
Fluoranthene	8270 (a)	1.0 U	1.0 U	1.0 U	0.49	0.47	1.0 U	3.4 U	1.0 U	1.0 U
Pyrene	8270 (a)	1.0 U	1.0 U	1.0 U	0.44	0.49	1.0 U	3.4 U	1.0 U	1.0 U
Benzo(g,h,i)perylene	8270 (a)	1.0 U	1.0 U	1.0 U	0.010 U	0.050 U	1.0 U	3.4 U	1.0 U	1.0 U
cPAH (ug/L; SW-846 8270D SIM)										
Benzo(a)anthracene	8270D SIM	--	--	--	--	--	--	--	0.10 U	0.10 U
Benzo(a)pyrene	8270D SIM	--	--	--	--	--	--	--	0.10 U	0.10 U
Chrysene	8270D SIM	--	--	--	--	--	--	--	0.10 U	0.10 U
Dibenzo(a,h)anthracene	8270D SIM	--	--	--	--	--	--	--	0.10 U	0.10 U
Indeno(1,2,3-cd)pyrene	8270D SIM	--	--	--	--	--	--	--	0.10 U	0.10 U
Total Benzofluoranthenes	8270D SIM	--	--	--	--	--	--	--	0.20 U	0.20 U
BTEX (µg/L)										
Benzene	8260/8021MOD	5.0 UJ	5.0 U	5.0 U	5.0 U	5.0 U	1.0 U	1.4	0.20 U	0.20 U
Toluene	8260/8021MOD	5.0 UJ	5.0 U	5.0 U	9.0	5.0 U	1.0 U	1.1	0.20 U	0.20 U
Ethylbenzene	8260/8021MOD	21 J	33	32	72	24	15	32	0.20 U	0.20 U
m,p-Xylene	8260/8021MOD	15 J	23	23	45	15	7.8	16	0.40 U	0.40 U
o-Xylene	8260/8021MOD	11 J	15	13	30	11	5.9	11	0.20 U	0.20
Xylenes, Total	8260/8021MOD	--	--	--	--	--	--	--	0.60 U	0.60 U
DISSOLVED METALS (µg/L)										
Arsenic	200.8	7 J	7	5	3	8	4.4	4	4.95	4.88
CONVENTIONALS										
Total Dissolved Solids (µg/L)	160.1/SM2540D	1,700,000	1,500,000	1,800,000	1,500,000	1,550,000	1,250,000	917,000	900,000	909,000
Total Suspended Solids (µg/L)	160.2	53,000 J	46,000	48,000	53,000	45,800	38,400	28,600	32,000	30,000
pH	Field	6.79	6.85	6.90	6.94	6.85	7.36	6.67	6.73	6.73
Specific Conductance (µmhos)	Field	3,710	2,780	3,303	2,630	2,792	3,107	1,208	1,222	1,223
Temperature (°C)	Field	12.4	11.9	13.0	14.0	14.0	13.1	13.0	13.7	13.7

Table 4
Groundwater Analytical Results
September 2001 to August 2019
Union Station Property – Seattle, Washington

Analyte	Method	MW-108R DY69H 12/19/2001	Dup of MW108R MW-109R DY69I 12/19/2001	MW-108R EE79F 3/20/2002	MW-108R EM41G 6/19/2002	MW-108R FP47I/R 6/25/2003	MW-108R GS18H 6/9/2004	MW-108R PL72C 8/24/2009	MW-108R YO99B 06/19/2014	Dup of MW108R DUP-1 YO99A 06/19/2014	MW-108R 19H0324 08/21/19
TPH (µg/L)											
Diesel-Range Petroleum Hydrocarbons	NWTPH-Dx	250 U	250 U	250 U	330	250 U	250 U	250 U	100 U	100 U	100 U
Motor Oil-Range Petroleum Hydrocarbons	NWTPH-Dx	500 U	500 U	500 U	500 U	500 U	500 U	500 U	200 U	200 U	200 U
Gasoline-Range Petroleum Hydrocarbons	NWTPH-G	250 UJ	250 UJ	250 U	250 UJ	250 U	250 U	250 U	250 U	250 U	289 J
cPAH (µg/L)											
Benzo(a)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.030	0.10	0.10 U	0.12 U	0.11 U	1.0 U
Chrysene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.020	0.099	0.10 U	0.12 U	0.11 U	1.0 U
Benzo(a)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.010 U	0.066	0.10 U	0.12 U	0.11 U	1.0 U
Indeno(1,2,3-cd)pyrene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.010 U	0.070	0.10 U	0.12 U	0.11 U	1.0 U
Dibenzo(a,h)anthracene	8270 (a)	0.10 U	0.10 U	0.10 U	0.10 U	0.010 U	0.070	0.10 U	0.12 U	0.11 U	1.0 U
Total Benzofluoranthenes	8270 (a)	NA	NA	NA	NA	NA	NA	NA	0.12 U	0.11 U	2.1 U
ncPAH (µg/L)											
Naphthalene	8270 (a)	31 J	20 J	27 J	49	33 J	11	12	1.4	1.7	1 U
1-Methylnaphthalene	8270 (a)	--	--	--	--	--	--	--	--	--	1.0 U
2-Methylnaphthalene	8270 (a)	4.7	3.7	5.0	7.9	6.2	2.8	1.6	1.1 U	1.2 U	1.0 U
Acenaphthylene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.040	0.050 U	1.0 U	1.1 U	1.2 U	1.0 U
Acenaphthene	8270 (a)	3.0 J	2.3 J	3.0	4.6	3.3	2.1	2.1	1.3	1.2	1.0 U
Fluorene	8270 (a)	1.1	1.0 U	1.0	1.4	1.1	1.0	1.0 U	1.1 U	1.2 U	1.0 U
Phenanthrene	8270 (a)	2.0	1.7	1.6	1.7	1.5	1.9	1.0	1.1 U	1.2 U	1.0 U
Anthracene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.22	0.29	1.0 U	1.1 U	1.2 U	1.0 U
Fluoranthene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.16	0.28	1.0 U	1.1 U	1.2 U	1.0 U
Pyrene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.21	0.30	1.0 U	1.1 U	1.2 U	1.0 U
Benzo(g,h,i)perylene	8270 (a)	1.0 U	1.0 U	1.0 U	1.0 U	0.010 U	0.058	1.0 U	1.1 U	1.2 U	1.0 U
cPAH (µg/L)											
Benzo(a)anthracene	8270D SIM	--	--	--	--	--	--	--	--	--	0.10 U
Benzo(a)pyrene	8270D SIM	--	--	--	--	--	--	--	--	--	0.10 U
Chrysene	8270D SIM	--	--	--	--	--	--	--	--	--	0.10 U
Dibenzo(a,h)anthracene	8270D SIM	--	--	--	--	--	--	--	--	--	0.10 U
Indeno(1,2,3-cd)pyrene	8270D SIM	--	--	--	--	--	--	--	--	--	0.10 U
Total Benzofluoranthenes	8270D SIM	--	--	--	--	--	--	--	--	--	0.21 U
BTEX (µg/L)											
Benzene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.20 UJ
Toluene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.20 UJ
Ethylbenzene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	2.5	1.0 U	1.0 U	1.0 U	1.0 U	0.21 J
m,p-Xylene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	0.40 UJ
o-Xylene	8260/8021MOD	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.20 UJ
Xylenes, Total	8260/8021MOD	--	--	--	--	--	--	--	--	--	0.60 U
DISSOLVED METALS (µg/L)											
Arsenic	200.8	9 J	14 J	6	5	2 U	5 U	2 U	7	7	1.00 U
CONVENTIONALS											
Total Dissolved Solids (µg/L)	160.1/SM2540D	9,900,000	9,800,000	10,000,000	10,000,000	11,000,000	8,970,000	9,040,000	5,760,000	6,400,000	9,340,000
Total Suspended Solids (µg/L)	160.2	130,000 J	94,000 J	87,000	84,000	86,000	79,100	60,100	135,000	136,000	167,000
pH	Field	6.76	6.77	6.72	6.73	6.71	6.76	6.45	6.62	6.62	7.06
Specific Conductance (µmhos)	Field	19,300	19,300	1,800	2,548	21,100	11,900	16,760	12,780	12,748	14,461
Temperature (°C)	Field	13.6	13.4	13.1	14.4	15.2	15.4	15.5	16.1	16.1	17.5

Table 4
Groundwater Analytical Results
September 2001 to August 2019
Union Station Property – Seattle, Washington

Notes:

µg/L = Micrograms per liter.
°C = degrees Celsius
NA = Not analyzed for this constituent.
NM = Not measured due to insufficient volume.
U = Indicates the compound was undetected at the listed concentration
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
M = Indicates an estimated value of analyte detected and confirmed by analyst with low spectral match parameters.
Note: All metals samples were field-filtered.

(a) Analytical results reported from analyses using EPA Method 8270 or EPA Method 8270-SIM

Abbreviations and Acronyms:

BTEX = Benzene, toluene, ethylbenzene, and xylenes
cPAH =Carcinogenic polycyclic aromatic hydrocarbons
ncPAH = Noncarcinogenic polycyclic aromatic hydrocarbons
TPH = Total petroleum hydrocarbons

Table 5
Summary of Background-Based Screening Level Development
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Well	Chemical	Distribution Determination	Statistical Method for Background Calulcation	Background-Based Screening Level (µg/L)
B-4/B-4R	Diesel-Range Petroleum Hydrocarbons	Lognormal[a]	90% KM UTL (Lognormal) 90% Coverage	23,709
B-4/B-4R	Gasoline-Range Petroleum Hydrocarbons	Normal	90% UTL 90% Coverage	8,129
B-4/B-4R	Benzo(a)anthracene	Lognormal	90% KM UTL (Lognormal) 90% Coverage	21
B-4/B-4R	Chrysene	Lognormal[b]	90% KM UTL (Lognormal) 90% Coverage	18
B-4/B-4R	Acenaphthene	Normal	90% UTL with 90% Coverage	522
B-4/B-4R	Benzene	Nonparametric	90% UTL with 90% Coverage	230
B-6/B-6R	Arsenic	Normal	90% UTL with 90% Coverage	36

Notes:

[a] Data appeared to fit normal, gamma, or lognormal distributions at 5% significance levels, therefore, correlation values (R) were used to determine the best fit. The best

[b] Data appeared to fit gamma and lognormal distributions at 5% significance levels, therefore R values were used to determine the best fit. The R values determined by each assumed distribution were nearly the same. Therefore, the lognormal data distribution was assumed, because this is consistent with environmental datasets.

Abbreviations and Acronyms:

µg/L = micrograms per liter
KM = Kaplan-Meier estimation method
UTL = upper tolerance limit

Table 6
Statistical Summary of Groundwater Data – Background Well B4R
December 2001 to August 2019
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Analyte	Method	CAP CUL (a) (µg/L)	Background-Based Screening Level (b) (µg/L)	No. of Samples (c)	No. of Detects (d)	No. of Censored Data (e)	Percent Censored Data	Minimum Uncensored Data	Maximum Uncensored Data	Mean of Uncensored Data (g)	Std. Dev. of Uncensored Data (g)	Median of Uncensored Data (g)
TPH (µg/L)												
Diesel-Range Petroleum Hydrocarbons	WTPH-Dx		23,709	8	6	2	25%	1200	15000	5633	4908	4450
Motor Oil-Range Petroleum Hydrocarbons	WTPH-Dx			8	5	3	38%	570	6800	2154	2663	780
Gasoline-Range Petroleum Hydrocarbons	WTPH-G		8,129	8	7	1	13%	204	6000	3241	2530	3300
cPAH (µg/L)												
Benzo(a)anthracene	8270 (h)	1.0	21	8	6	2	25%	0.11	2.10	1.03	0.86	0.91
Chrysene	8270 (h)	1.0	18	8	6	2	25%	0.11	2.00	0.94	0.76	0.88
Benzo(a)pyrene	8270 (h)	1.0		8	6	2	25%	0.11	1.30	0.66	0.53	0.68
Indeno(1,2,3-cd)pyrene	8270 (h)	1.0		8	5	3	38%	0.10	0.57	0.32	0.22	0.31
Dibenzo(a,h)anthracene	8270 (h)	1.0		8	3	5	63%	0.10	0.28	0.16	0.06	0.14
Total Benzofluoranthenes	8270 (h)	1.0		8	5	3	38%	0.43	2.20	1.51	0.66	1.63
ncPAH (µg/L)												
Naphthalene	8270 (h)	9,880		8	6	2	25%	0.41	2700	1169	1166	955
2-Methylnaphthalene	8270 (h)			8	5	3	38%	0.46	510	282	216	260
Acenaphthylene	8270 (h)			8	5	3	38%	1.6	10	4.1	3.3	3.0
Acenaphthene	8270 (h)	225	522	8	8	0	0%	4.2	330	142	143	94.5
Fluorene	8270 (h)	2,422		8	5	3	38%	18	96	65	33	78
Phenanthrene	8270 (h)			8	6	2	25%	1.1	110	43	48	26.9
Anthracene	8270 (h)	25,900		8	5	3	38%	4.6	16	11	4.7	10
Fluoranthene	8270 (h)	27.1		8	5	3	38%	8.3	14	10	2.3	9.1
Pyrene	8270 (h)	777		8	5	3	38%	9.1	14	12	1.8	12
Benzo(g,h,i)perylene	8270 (h)			8	3	5	63%	0.45	3.6	1.5	1.8	0.53
BTEX (µg/L)												
Benzene	8260	71	230	8	5	3	38%	130	150	134	8.9	130
Toluene	8260	485		8	0	8	100%	--	--	--	--	--
Ethylbenzene	8260	276		8	5	3	38%	110	230	176	44	190
m,p-Xylene	8260			8	0	8	100%	--	--	--	--	--
o-Xylene	8260			8	1	7	88%	5.6	5.6	--	--	--
DISSOLVED METALS (µg/L)												
Arsenic	200.8	4	36	8	8	4	50%	3	14	8	5	6

Table 6
Statistical Summary of Groundwater Data – Background Well B6R
December/2001 to August 2019
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Analyte	Method	CAP CUL (a) (µg/L)	Background-Based Screening Level (b) (µg/L)	No. of Samples (c)	No. of Detects (d)	No. of Censored Data (e)	Percent Censored Data	Minimum Uncensored Data	Maximum Uncensored Data	Mean of Uncensored Data (g)	Std. Dev. of Uncensored Data (g)	Median of Uncensored Data (g)
TPH (µg/L)												
Diesel-Range Petroleum Hydrocarbons	WTPH-Dx		23,709	8	1	7	88%	250	250	--	--	--
Motor Oil-Range Petroleum Hydrocarbons	WTPH-Dx			8	0	8	100%	--	--	--	--	--
Gasoline-Range Petroleum Hydrocarbons	WTPH-G		8,129	8	0	8	100%	--	--	--	--	--
cPAH (µg/L)												
Benzo(a)anthracene	8270 (h)	1.0	21	8	3	5	63%	0.02	0.19	0.10	0.05	0.10
Chrysene	8270 (h)	1.0	18	8	3	5	63%	0.02	0.21	0.10	0.06	0.10
Benzo(a)pyrene	8270 (h)	1.0		8	2	6	75%	0.01	0.19	0.09	0.06	0.10
Indeno(1,2,3-cd)pyrene	8270 (h)	1.0		8	2	6	75%	0.01	0.12	0.08	0.04	0.10
Dibenzo(a,h)anthracene	8270 (h)	1.0		8	0	8	100%	--	--	--	--	--
Total Benzofluoranthenes	8270 (h)	1.0		8	2	6	75%	0.03	0.26	0.15	0.16	0.15
ncPAH (µg/L)												
Naphthalene	8270 (h)	9,880		8	4	4	50%	0.14	4.9	2.53	1.99	2.6
2-Methylnaphthalene	8270 (h)			8	1	7	88%	0.09	0.09	--	--	--
Acenaphthylene	8270 (h)			8	1	7	88%	0.01	0.01	--	--	--
Acenaphthene	8270 (h)	225	522	8	1	7	88%	0.05	0.05	--	--	--
Fluorene	8270 (h)	2,422		8	2	6	75%	0.02	0.053	0.04	0.02	0.0365
Phenanthrene	8270 (h)			8	2	6	75%	0.08	0.16	0.12	0.06	0.12
Anthracene	8270 (h)	25,900		8	2	6	75%	0.04	0.065	0.05	0.02	0.0525
Fluoranthene	8270 (h)	27		8	2	6	75%	0.06	0.081	0.07	0.01	0.0705
Pyrene	8270 (h)	777		8	2	6	75%	0.08	0.11	0.10	0.02	0.095
Benzo(g,h,i)perylene	8270 (h)			8	1	7	88%	0.019	0.019	--	--	--
BTEX (µg/L)												
Benzene	8260	71	230	8	0	8	100%	--	--	--	--	--
Toluene	8260	485		8	0	8	100%	--	--	--	--	--
Ethylbenzene	8260	276		8	0	8	100%	--	--	--	--	--
m,p-Xylene	8260			8	0	8	100%	--	--	--	--	--
o-Xylene	8260			8	1	7	88%	0.2	0.2	--	--	--
DISSOLVED METALS (µg/L)												
Arsenic	200.8	4	36	8	8	0	0%	22	31	26.89	3.23	27

Table 6
Statistical Summary of Groundwater Data – Well MW101R
December 2001 to August 2019
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Analyte	Method	Back-ground	CAP CUL (a) (µg/L)	Background-Based Screening Level (b) (µg/L)	No. of Samples (c)	No. of Detects (d)	No. of Censored Data (e)	Percent Censored Data	Statistical Case No. (f)	UCL (g)	UCL Calculation Method	Minimum Uncensored Data	Maximum Uncensored Data	Mean of Uncensored Data (g)	Std. Dev. of Uncensored Data (g)	Median of Uncensored Data (g)
TPH (µg/L)																
Diesel-Range Petroleum Hydrocarbons	WTPH-Dx	B4		23,709	8	8	0	0%	1	3394	95% Student's-t UCL	1500	4200	2743	972.0	2570
Motor Oil-Range Petroleum Hydrocarbons	WTPH-Dx				8	0	8	100%	0	--	--	--	--	--	--	--
Gasoline-Range Petroleum Hydrocarbons	WTPH-G	B4		8,129	8	8	0	0%	1	7256	95% Student's-t UCL	4100	9230	6191	1589.7	6150
cPAH (µg/L)																
Benzo(a)anthracene	8270 (h)	B4	1.0	21	8	8	0	0%	1	0.25	95% Student's-t UCL	0.16	0.28	0.22	0.04	0.23
Chrysene	8270 (h)	B4	1.0	18	8	8	0	0%	1	0.17	95% Student's-t UCL	0.14	0.20	0.16	0.02	0.16
Benzo(a)pyrene	8270 (h)		1.0		8	2	6	75%	3	0.05	Max Detect	0.04	0.05	0.05	0.01	0.05
Indeno(1,2,3-cd)pyrene	8270 (h)		1.0		8	0	8	100%	0	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	8270 (h)		1.0		8	0	8	100%	0	--	--	--	--	--	--	--
Total Benzofluoranthenes	8270 (h)		1.0		8	3	5	63%	3	0.13	Max Detect	0.06	0.13	0	0.0	0.10
ncPAH (µg/L)																
Naphthalene	8270 (h)		9,880		8	8	0	0%	1	2776	95% Student's-t UCL	1200	3400	2221	828.2	1900
2-Methylnaphthalene	8270 (h)				8	8	0	0%	1	516	95% Student's-t UCL	280	570	439	115.3	465
Acenaphthylene	8270 (h)				8	6	2	25%	2	1.7	95% KM (t) UCL	0.58	2.4	1	0.7	1.5
Acenaphthene	8270 (h)	B4	225	522	8	8	0	0%	1	293	95% Student's-t UCL	150	330	257	54.2	255
Fluorene	8270 (h)		2,422		8	8	0	0%	1	85	95% Student's-t UCL	54	95.9	77	12.2	77
Phenanthrene	8270 (h)				8	8	0	0%	1	92	95% Student's-t UCL	63	99.8	81	15.9	84.5
Anthracene	8270 (h)		25,900		8	8	0	0%	1	7.6	95% Student's-t UCL	3.9	8.1	7	1.3	7.05
Fluoranthene	8270 (h)		27		8	8	0	0%	1	6.0	95% Student's-t UCL	3.4	6.8	5	1.0	5.4
Pyrene	8270 (h)		777		8	8	0	0%	1	6.4	95% Student's-t UCL	3.4	8.3	5	1.5	5.05
Benzo(g,h,i)perylene	8270 (h)				8	0	8	100%	0	--	--	--	--	--	--	--
BTEX (µg/L)																
Benzene	8260	B4	71	230	8	8	0	0%	1	77	95% Student's-t UCL	36	90	62	22.2	59
Toluene	8260		485		8	6	2	25%	2	5.7	95% KM (t) UCL	1.9	7.6	5	2.3	5.6
Ethylbenzene	8260		276		8	8	0	0%	1	246	95% Student's-t UCL	120	300	203	65.4	205
m,p-Xylene	8260				8	8	0	0%	1	59	95% Student's-t UCL	15	92	44	22.5	43.5
o-Xylene	8260				8	8	0	0%	1	28	95% Student's-t UCL	17	37	23	8.1	18.5
DISSOLVED METALS (µg/L)																
Arsenic	200.8	B6	4	36	8	8	0	0%	1	11	95% Student's-t UCL	9	12	11	0.9	11

Table 6
Statistical Summary of Groundwater Data – Well MW102R
December 2001 to August 2019
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Analyte	Method	Back-ground	CAP CUL (a) (μg/L)	Background-Based Screening Level (b) (μg/L)	No. of Samples (c)	No. of Detects (d)	No. of Censored Data (e)	Percent Censored Data	Statistical Case No. (f)	UCL (g)	UCL Calculation Method	Minimum Uncensored Data	Maximum Uncensored Data	Mean of Uncensored Data (g)	Std. Dev. of Uncensored Data (g)	Median of Uncensored Data (g)
TPH (μg/L)																
Diesel-Range Petroleum Hydrocarbons	WTPH-Dx	B4		23,709	8	4	4	50%	2	339.6	95% KM (t) UCL	300	400	367.5	47.17	385
Motor Oil-Range Petroleum Hydrocarbons	WTPH-Dx				8	0	8	100%	0	--	--	--	--	--	--	--
Gasoline-Range Petroleum Hydrocarbons	WTPH-G	B4		8,129	8	0	8	100%	0	--	--	--	--	--	--	--
cPAH (μg/L)																
Benzo(a)anthracene	8270 (h)	B4	1.0	21	8	2	6	75%	3	0.12	Max Detect	0.03	0.12	0.08	0.06	0.08
Chrysene	8270 (h)	B4	1.0	18	8	2	6	75%	3	0.10	Max Detect	0.02	0.10	0.06	0.06	0.06
Benzo(a)pyrene	8270 (h)		1.0		8	1	7	88%	3	0.06	Max Detect	0.06	0.06	--	--	--
Indeno(1,2,3-cd)pyrene	8270 (h)		1.0		8	1	7	88%	3	0.07	Max Detect	0.07	0.07	--	--	--
Dibenzo(a,h)anthracene	8270 (h)		1.0		8	1	7	88%	3	0.07	Max Detect	0.07	0.07	--	--	--
Total Benzofluoranthenes	8270 (h)		1.0		8	1	7	88%	3	0.13	Max Detect	0.13	0.13	--	--	--
ncPAH (μg/L)																
Naphthalene	8270 (h)		9,880		8	5	3	38%	2	11	95% KM (t) UCL	1.5	22	8.2	8.80	3.1
2-Methylnaphthalene	8270 (h)				8	4	4	50%	2	1.6	95% KM (t) UCL	0.12	2.6	1.4	1.17	1.385
Acenaphthylene	8270 (h)				8	2	6	75%	3	0.28	Max Detect	0.16	0.28	0.2	0.08	0.22
Acenaphthene	8270 (h)	B4	225	522	8	8	0	0%	1	14	95% Student's-t UCL	7.6	17	12.3	2.90	12
Fluorene	8270 (h)		2,422		8	8	0	0%	1	3.2	95% Student's-t UCL	1.8	3.7	2.8	0.64	2.85
Phenanthrene	8270 (h)				8	7	1	13%	2	3.6	95% KM (t) UCL	1.6	3.8	3.1	0.77	3.3
Anthracene	8270 (h)		25,900		8	3	5	63%	3	1.1	Max Detect	0.84	1.1	1.0	0.09	1
Fluoranthene	8270 (h)		27		8	2	6	75%	3	1	Max Detect	0.48	1	0.7	0.37	0.74
Pyrene	8270 (h)		777		8	2	6	75%	3	0.85	Max Detect	0.4	0.85	0.6	0.32	0.625
Benzo(g,h,i)perylene	8270 (h)				8	1	7	88%	3	0.059	Max Detect	0.059	0.059	--	--	--
BTEX (μg/L)																
Benzene	8260	B4	71	230	8	0	8	100%	0	--	--	--	--	--	--	--
Toluene	8260		485		8	0	8	100%	0	---	--	--	--	--	--	--
Ethylbenzene	8260		276		8	0	8	100%	0	--	--	--	--	--	--	--
m,p-Xylene	8260				8	0	8	100%	0	---	--	--	--	--	--	--
o-Xylene	8260				8	0	8	100%	0	---	--	--	--	--	--	--
DISSOLVED METALS (μg/L)																
Arsenic	200.8	B6	4	36	8	7	2	25%	2	5.9	95% KM (t) UCL	3	7	5.2	1.37	5

Table 6
Statistical Summary of Groundwater Data – Well MW104
December 2001 to August 2019
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Analyte	Method	Back-ground	CAP CUL (a) (µg/L)	Background-Based Screening Level (b) (µg/L)	No. of Samples (c)	No. of Detects (d)	No. of Censored Data (e)	Percent Censored Data	Statistical Case No. (f)	UCL (g)	UCL Calculation Method	Minimum Uncensored Data	Maximum Uncensored Data	Mean of Uncensored Data (g)	Std. Dev. of Uncensored Data (g)	Median of Uncensored Data (g)
TPH (µg/L)																
Diesel-Range Petroleum Hydrocarbons	WTPH-Dx	B4		23,709	8	6	2	25%	2	413	95% KM (t) UCL	150	480	363.333	134.56	410
Motor Oil-Range Petroleum Hydrocarbons	WTPH-Dx				8	0	8	100%	0	--	--	--	--	--	--	--
Gasoline-Range Petroleum Hydrocarbons	WTPH-G	B4		8,129	8	5	3	38%	2	303	95% KM (t) UCL	260	340	296.000	33.62	290
cPAH (µg/L)																
Benzo(a)anthracene	8270 (h)	B4	1.0	21	8	4	4	50%	2	0.13	95% KM (t) UCL	0.07	0.18	0.120	0.05	0.12
Chrysene	8270 (h)	B4	1.0	18	8	4	4	50%	2	0.13	95% KM (t) UCL	0.05	0.23	0.117	0.08	0.10
Benzo(a)pyrene	8270 (h)		1.0		8	1	7	88%	3	0.14	Max Detect	0.14	0.14	--	--	--
Indeno(1,2,3-cd)pyrene	8270 (h)		1.0		8	0	8	100%	0	--	--	0.00	0.00	--	--	--
Dibenzo(a,h)anthracene	8270 (h)		1.0		8	0	8	100%	0	--	--	0.00	0.00	--	--	--
Total Benzofluoranthenes	8270 (h)		1.0		8	1	7	88%	3	0.24	Max Detect	0.24	0.24	--	--	--
ncPAH (µg/L)																
Naphthalene	8270 (h)		9,880		8	3	5	63%	3	4.5	Max Detect	0.4	4.5	2.267	2.07	1.9
2-Methylnaphthalene	8270 (h)				8	6	2	25%	2	7.3	95% KM (t) UCL	1.5	11	5.583	4.27	4.9
Acenaphthylene	8270 (h)				8	4	4	50%	2	5.3	95% KM (t) UCL	0.47	12.4	3.968	5.68	1.5
Acenaphthene	8270 (h)	B4	225	522	8	8	0	0%	1	56	95% Student's-t UCL	45	64	51.388	6.26	50
Fluorene	8270 (h)		2,422		8	8	0	0%	1	13	95% Student's-t UCL	4	15	10.088	3.77	10.2
Phenanthrene	8270 (h)				8	5	3	38%	2	8.2	95% KM (t) UCL	0.36	15	6.272	6.74	2.8
Anthracene	8270 (h)		25,900		8	6	2	25%	2	1.5	95% KM (t) UCL	0.77	2.1	1.312	0.49	1.15
Fluoranthene	8270 (h)		27		8	8	0	0%	1	1.6	95% Student's-t UCL	1.4	1.8	1.513	0.16	1.4
Pyrene	8270 (h)		777		8	8	0	0%	1	1.5	95% Student's-t UCL	1	1.6	1.300	0.23	1.3
Benzo(g,h,i)perylene	8270 (h)				8	0	8	100%	0	---	--	--	--	--	--	--
BTEX (µg/L)																
Benzene	8260	B4	71	230	8	8	0	0%	1	1.6	95% Student's-t UCL	0.7	2.1	1.319	0.44	1.3
Toluene	8260		485		8	1	7	88%	3	0.2	Max Detect	0.2	0.2	--	--	--
Ethylbenzene	8260		276		8	4	4	50%	2	1.2	95% KM (t) UCL	0.6	1.4	1.010	0.33	1.02
m,p-Xylene	8260				8	6	2	25%	2	2.0	95% KM (t) UCL	0.8	2.7	1.733	0.62	1.75
o-Xylene	8260				8	1	7	88%	3	0.30	Max Detect	0.3	0.3	--	--	--
DISSOLVED METALS (µg/L)																
Arsenic	200.8	B6	4	36	8	8	7	88%	3	7	Max Detect	1	7	1.918	2.09	1

Table 6
Statistical Summary of Groundwater Data – Well MW105
December 2001 to August 2019
2019 Groundwater Monitoring Complaince
Union Station Property – Seattle, Washington

Analyte	Method	Back-ground	CAP CUL (a) (µg/L)	Background-Based Screening Level (b) (µg/L)	No. of Samples (c)	No. of Detects (d)	No. of Censored Data (e)	Percent Censored Data	Statistical Case No. (f)	UCL (g)	UCL Calculation Method	Minimum Uncensored Data	Maximum Uncensored Data	Mean of Uncensored Data (g)	Std. Dev. of Uncensored Data (g)	Median of Uncensored Data (g)
TPH (µg/L)																
Diesel-Range Petroleum Hydrocarbons	WTPH-Dx	B4		23,709	8	7	1	13%	2	1340	95% KM (t) UCL	180	1600	1019.43	599.02	1400
Motor Oil-Range Petroleum Hydrocarbons	WTPH-Dx				8	0	8	100%	0	--	--	--	--	--	--	--
Gasoline-Range Petroleum Hydrocarbons	WTPH-G	B4		8,129	8	8	0	0%	1	2362	95% Student's-t UCL	1100	3000	1941.25	627.84	1800
cPAH (µg/L)																
Benzo(a)anthracene	8270 (h)	B4	1.0	21	8	8	0	0%	1	0.91	95% Student's-t UCL	0.24	1.20	0.65	0.38	0.62
Chrysene	8270 (h)	B4	1.0	18	8	8	0	0%	1	0.65	95% Student's-t UCL	0.15	1.10	0.43	0.33	0.28
Benzo(a)pyrene	8270 (h)		1.0		8	7	1	13%	2	0.51	95% KM (t) UCL	0.04	1.00	0.33	0.33	0.19
Indeno(1,2,3-cd)pyrene	8270 (h)		1.0		8	4	4	50%	2	0.11	95% KM (t) UCL	0.07	0.48	0.22	0.18	0.17
Dibenzo(a,h)anthracene	8270 (h)		1.0		8	2	6	75%	3	0.17	Max Detect	0.05	0.17	0.11	0.08	0.11
Total Benzofluoranthenes	8270 (h)		1.0		8	6	2	25%	2	0.67	95% KM (t) UCL	0.07	1.29	0.49	0.43	0.41
ncPAH (µg/L)																
Naphthalene	8270 (h)		9,880		8	8	0	0%	1	679	95% Student's-t UCL	180	940	489.88	281.79	445
2-Methylnaphthalene	8270 (h)				8	8	0	0%	1	76	95% Student's-t UCL	19	96	56.73	28.11	66.5
Acenaphthylene	8270 (h)				8	4	4	50%	2	1.2	95% KM (t) UCL	0.29	1.2	0.89	0.41	1.04
Acenaphthene	8270 (h)	B4	225	522	8	8	0	0%	1	70	95% Student's-t UCL	33	80	57.31	18.35	52
Fluorene	8270 (h)		2,422		8	8	0	0%	1	29	95% Student's-t UCL	12	35	23.41	8.27	22
Phenanthrene	8270 (h)				8	8	0	0%	1	56	95% Student's-t UCL	23	73	44.13	18.41	37
Anthracene	8270 (h)		25,900		8	8	0	0%	1	7.1	95% Student's-t UCL	3.1	9.6	5.60	2.24	5.2
Fluoranthene	8270 (h)		27		8	8	0	0%	1	8.9	95% Student's-t UCL	4.7	11	7.33	2.39	6.3
Pyrene	8270 (h)		777		8	8	0	0%	1	7.8	95% Student's-t UCL	4.6	9.8	6.66	1.76	6.45
Benzo(g,h,i)perylene	8270 (h)				8	1	7	88%	3	0.062	Max Detect	0.062	0.062	--	--	--
BTEX (µg/L)																
Benzene	8260	B4	71	230	8	8	0	0%	1	352	95% Student's-t UCL	220	410	314.63	55.62	320
Toluene	8260		485		8	8	0	0%	1	---	95% Student's-t UCL	18	92	41.36	24.64	32.95
Ethylbenzene	8260		276		8	8	0	0%	1	60	95% Student's-t UCL	33.5	68	52.19	11.36	51
m,p-Xylene	8260				8	8	0	0%	1	---	95% Student's-t UCL	24.4	66	40.68	11.94	38
o-Xylene	8260				8	8	0	0%	1	---	95% Student's-t UCL	10.9	29	20.49	6.57	20
DISSOLVED METALS (µg/L)																
Arsenic	200.8	B6	4	36	8	8	1	13%	2	17	95% Student's-t UCL	1	19	12.82	5.86	14

Table 6
Statistical Summary of Groundwater Data – Well MW107
December 2001 to August 2019
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Analyte	Method	Back-ground	CAP CUL (a) (µg/L)	Background-Based Screening Level (b) (µg/L)	No. of Samples (c)	No. of Detects (d)	No. of Censored Data (e)	Percent Censored Data	Statistical Case No. (f)	UCL (g)	UCL Calculation Method	Minimum Uncensored Data	Maximum Uncensored Data	Mean of Uncensored Data (g)	Std. Dev. of Uncensored Data (g)	Median of Uncensored Data (g)
TPH (µg/L)																
Diesel-Range Petroleum Hydrocarbons	WTPH-Dx	B4		23,709	8	8	0	0%	1	1012	95% Student's-t UCL	136	1400	703	461	655
Motor Oil-Range Petroleum Hydrocarbons	WTPH-Dx				8	0	8	100%	0	--	--	--	--	--	--	--
Gasoline-Range Petroleum Hydrocarbons	WTPH-G	B4		8,129	8	8	0	0%	1	2433	95% Student's-t UCL	135	4200	1587	1263	1250
cPAH (µg/L)																
Benzo(a)anthracene	8270 (h)	B4	1.0	21	8	1	7	88%	3	0.053	Max Detect	0.053	0.053	--	--	--
Chrysene	8270 (h)	B4	1.0	18	8	1	7	88%	3	0.051	Max Detect	0.051	0.051	--	--	--
Benzo(a)pyrene	8270 (h)		1.0		8	0	8	100%	0	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	8270 (h)		1.0		8	0	8	100%	0	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	8270 (h)		1.0		8	0	8	100%	0	--	--	--	--	--	--	--
Total Benzofluoranthenes	8270 (h)		1.0		8	0	8	100%	0	--	--	--	--	--	--	--
ncPAH (µg/L)																
Naphthalene	8270 (h)		9,880		8	8	0	0%	1	1407	95% Student's-t UCL	2.8	2200	929	714	995
2-Methylnaphthalene	8270 (h)				8	8	0	0%	1	146	95% Student's-t UCL	19.1	220	104	64	88.5
Acenaphthylene	8270 (h)				8	2	6	75%	3	0.47	Max Detect	0.3	0.47	0.39	0.12	0.385
Acenaphthene	8270 (h)	B4	225	522	8	8	0	0%	1	59	95% Student's-t UCL	18.6	76	46	19	43.5
Fluorene	8270 (h)		2,422		8	8	0	0%	1	19	95% Student's-t UCL	5.7	27	14	6.79	12.5
Phenanthrene	8270 (h)				8	8	0	0%	1	13	95% Student's-t UCL	5.4	18	11	4.24	8.75
Anthracene	8270 (h)		25,900		8	3	5	63%	3	1.4	Max Detect	1.0	1.4	1.13	0.23	1.0
Fluoranthene	8270 (h)		27		8	2	6	75%	3	0.49	Max Detect	0.47	0.49	0.48	0.01	0.48
Pyrene	8270 (h)		777		8	2	6	75%	3	0.49	Max Detect	0.44	0.49	0.47	0.04	0.465
Benzo(g,h,i)perylene	8270 (h)				8	0	8	100%	0	--	--	--	--	--	--	--
BTEX (µg/L)																
Benzene	8260	B4	71	230	8	1	7	88%	3	1.4	Max Detect	0.2	1.4	0.80	0.85	0.8
Toluene	8260		485		8	2	6	75%	3	9	Max Detect	0.2	9	3.43	4.84	1.1
Ethylbenzene	8260		276		8	7	1	13%	2	58	KM Adjusted Gamma	0.2	72	28.65	20.69	28
m,p-Xylene	8260				8	7	1	13%	2	27	95% KM (t) UCL	0.4	45	18.15	13.17	15.5
o-Xylene	8260				8	7	1	13%	2	18	95% KM (t) UCL	0.2	30	12.14	8.56	11
DISSOLVED METALS (µg/L)																
Arsenic	200.8	B6	4	36	8	8	0	0%	1	7	95% Student's-t UCL	3	8	5.42	1.73	5

Table 6
Statistical Summary of Groundwater Data – Well MW108
December 2001 to August 2019
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Analyte	Method	Back-ground	CAP CUL (a) (µg/L)	Background-Screening Level (b) (µg/L)	No. of Samples (c)	No. of Detects (d)	No. of Censored Data (e)	Percent Censored Data	Statistical Case No. (f)	UCL (g)	UCL Calculation Method	Minimum Uncensored Data	Maximum Uncensored Data	Mean of Uncensored Data (g)	Std. Dev. of Uncensored Data (g)	Median of Uncensored Data (g)
TPH (µg/L)																
Diesel-Range Petroleum Hydrocarbons	WTPH-Dx	B4		23,709	8	1	7	88%	3	330	Max Detect	330	330	--	--	--
Motor Oil-Range Petroleum Hydrocarbons	WTPH-Dx				8	0	8	100%	0	--	--	--	--	--	--	--
Gasoline-Range Petroleum Hydrocarbons	WTPH-G	B4		8,129	8	1	7	88%	3	289	Max Detect	289	289	--	--	--
cPAH (µg/L)																
Benzo(a)anthracene	8270 (h)	B4	1.0	21	8	2	6	75%	3	0.10	Max Detect	0.03	0.10	0.07	0.05	0.07
Chrysene	8270 (h)	B4	1.0	18	8	2	6	75%	3	0.10	Max Detect	0.02	0.10	0.06	0.06	0.06
Benzo(a)pyrene	8270 (h)		1.0		8	1	7	88%	3	0.07	Max Detect	0.07	0.07	--	--	--
Indeno(1,2,3-cd)pyrene	8270 (h)		1.0		8	1	7	88%	3	0.12	Max Detect	0.01	0.12	--	--	--
Dibenzo(a,h)anthracene	8270 (h)		1.0		8	1	7	88%	3	0.07	Max Detect	0.07	0.07	--	--	--
Total Benzofluoranthenes	8270 (h)		1.0		8	1	7	88%	3	0.13	Max Detect	0.13	0.13	--	--	--
ncPAH (µg/L)																
Naphthalene	8270 (h)		9880		8	7	1	13%	2	32	95% KM (t) UCL	1.4	49	23.49	16.26	27
2-Methylnaphthalene	8270 (h)				8	6	2	25%	2	5.5	95% KM (t) UCL	1.6	7.9	4.70	2.27	4.85
Acenaphthylene	8270 (h)				8	1	7	88%	3	0.04	Max Detect	0.04	0.04	--	--	--
Acenaphthene	8270 (h)	B4	225	522	8	7	1	13%	2	3.3	95% KM (t) UCL	1.3	4.6	2.77	1.06	3
Fluorene	8270 (h)		2422		8	5	3	38%	2	1.2	95% KM (t) UCL	1	1.4	1.12	0.16	1.1
Phenanthrene	8270 (h)				8	6	2	25%	2	1.7	95% KM (t) UCL	1	2	1.62	0.35	1.65
Anthracene	8270 (h)		25900		8	2	6	75%	3	0.29	Max Detect	0.22	0.29	0.26	0.05	0.255
Fluoranthene	8270 (h)		27		8	2	6	75%	3	0.28	Max Detect	0.16	0.28	0.22	0.08	0.22
Pyrene	8270 (h)		777		8	2	6	75%	3	0.3	Max Detect	0.21	0.3	0.26	0.06	0.255
Benzo(g,h,i)perylene	8270 (h)				8	1	7	88%	3	0.058	Max Detect	0.058	0.058	--	--	--
BTEX (µg/L)																
Benzene	8260	B4	71	230	8	0	8	100%	0	--	--	--	--	--	--	--
Toluene	8260		485		8	0	8	100%	0	--	--	--	--	--	--	--
Ethylbenzene	8260		276		8	2	6	75%	3	2.5	Max Detect	0.21	2.5	1.36	1.62	1.355
m,p-Xylene	8260				8	0	8	100%	0	--	--	--	--	--	--	--
o-Xylene	8260				8	0	8	100%	0	--	--	--	--	--	--	--
DISSOLVED METALS (µg/L)																
Arsenic	200.8	B6	4	36	8	4	3	38%	2	6	95% KM (t) UCL	5	9	6.75	1.71	7

Table 6
Statistical Summary of Groundwater Data
December 2001 to August 2019
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

-- = Not applicable.
J = Data qualifier indicating that the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
CUL = cleanup level
UCL = upper confidence limit
Max Detect = The maximum value detected above applicable laboratory reporting limits
95% Student's-t UCL = UCL based upon using the Student's t-distribution critical value calculated in EPA's ProUCL software (Version 5.1)
95% KM (t) UCL = UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value calculated in EPA's ProUCL software (Version 5.1)
95% KM Adjusted Gamma UCL = UCL based upon Kaplan-Meier estimates using the Gamma distribution critical value calculated in EPA's ProUCL software (Version 5.1)
🟨 = UCL exceeds the cleanup level.

(a) Cleanup levels are from Table 1 of the Cleanup Action Plan, unless otherwise indicated.
(b) Screening level is based on the 90% Upper Tolerance Limit (UTL) with 90% coverage calculated in EPA's ProUCL software (Version 5.1)
(c) Only samples from the last eight monitoring events are included in these statistical evaluations.
(d) Number of detects consists of concentrations detected above laboratory reporting limits and J-flagged data that were positively identifed between the method detection limit and the reporting limit.
(e) Censored data consist of results not detected above reported laboratory reporting limits or U-flagged as non-detect.
(f) Statistical Case Nos:
    0 = Data set consists of 100% censored data
    1 = Data set contains no censored data.
    2 = Data set contains between one and four censored observations (i.e., is less than or equal to 50% censored data)
    3 = Data set consists of more than 50 % censored data but less than 100% censored data.
(g) No UCL, mean, standard deviation, or median were calculated for data sets consisting of one or no uncensored observations.
Also, UCLs were calculated for background wells B-4 and B-6/B-6R.
(h) Analytical results reported from analyses using EPA Method 8270 or EPA Method 8270-SIM

Table 7
Summary of Cleanup Level and Screening Level Exceedances
2019 Groundwater Monitoring Compliance
Union Station Property – Seattle, Washington

Constituent	Location	CAP CUL	Background-Based Screening Level	12/2001-9/2019 UCL	9/2001-6/2014 UCL	6/2001 - 8/2009 UCL	3/2001 - 6/2004 UCL	12/2000 - 6/2003 UCL	9/2000 - 6/2002 UCL	9/1999 - 6/2001 UCL	6/1998 - 6/2000 UCL	Comments
Acenaphthene	MW-101R	225	522	293	309	350	350	350	350	340	276	Apparent off-Property sources
Benzene	MW-101R	71	230	77	84	87	87	82	77	78	104	Apparent off-Property sources
	MW-105	71	230	352	359	337	346	350	361	376	373	
Arsenic	MW-101R	4	36	11	12	12	12	13	13	14	14	Apparent off-Property sources
	MW-102R	4	36	6	8	9	8	9	9	9	7	
	MW-104	4	36	7	7	7	--	--	--	--	--	
	MW-105	4	36	17	19	19	17	19	19	18	21	
	MW-107R	4	36	7	8	8	8	8	8	8	10	
	MW-108R	4	36	6	7	7	9	15	15	12	8	
Benzo(a)anthracene	MW-105	1.0	21	0.9	1.2	1.2	--	--	--	--	--	Apparent off-Property sources
Chrysene	MW-105	1.0	18	0.6	1.1	1.1	--	--	--	--	--	Apparent off-Property sources

Notes:

All concentrations are in micrograms per liter (µg/L).

CAP CUL = Cleanup level listed in the Cleanup Action Plan.
UCL = Upper Confidence Limit.
-- = Indicates a UCL was not calculated because all concentrations were below the practical quantitation limit during the respective period

APPENDIX A

Laboratory Data Quality Evaluation

Technical Memorandum

TO: Evelyn Ives

FROM: Kristi Schultz and Danille Jorgensen

DATE: October 1, 2019

RE: **Laboratory Data Quality Evaluation**
Union Station 2019 Groundwater Sampling
Seattle, Washington
LAI Project No. 0429008.010

Landau Associates, Inc. (LAI) prepared this technical memorandum, which provides the results of a Stage III verification and validation check of analytical data for nine groundwater samples and two trip blanks collected on August 20-21, 2019 at Union Station in Seattle, Washington. All sample analyses were conducted at Analytical Resources, Inc (ARI), located in Tukwila, Washington. Samples submitted to ARI were analyzed for the following: volatile organic compounds (VOCs; US Environmental Protection Agency [EPA] Method SW-846 8260C), gasoline-range petroleum hydrocarbons (TPH-G; Washington State Department of Ecology [Ecology]-approved Method NWTPH-Gx); polycyclic aromatic hydrocarbons (PAHs; EPA Method SW-846 8270D); carcinogenic polycyclic aromatic hydrocarbons (cPAHs; EPA Method SW-846 8270D with selected ion monitoring [SIM]); diesel- and oil-range petroleum hydrocarbons (TPH-D/TPH-O; Ecology-approved Method NWTPH-Dx with sulfuric acid and silica gel cleanups); dissolved arsenic (EPA Method 200.8); total dissolved solids (SM 2540 C-97); and total suspended solids (SM 2540 D-97). The analytical results are reported in the ARI laboratory data packages identified as 19H0298 and 19H0324. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage III verification and validation check was conducted in accordance with the EPA's Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 2009), and with guidance from applicable portions of the National Functional Guidelines for Organic Data Review (EPA 2016b) and the National Functional Guidelines for Inorganic Data Review (EPA 2016a), and the Cleanup Action Plan for the Union Station Property (LAI 1997). The Stage III verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control (QC) data, and QC acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that QC samples were analyzed as specified in the Cleanup Action Plan (LAI 1997).

- Evaluation of sample holding times.
- Evaluation of QC data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of reporting limits compared to target reporting limits specified in the Cleanup Action Plan.
- Verification that initial and continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification (CCV) and continuing calibration blank (CCB) standards as appropriate.
- Method-specific instrument performance checks are present as appropriate (e.g., DDT/Endrin breakdown checks for pesticides and aroclors).
- Frequency of instrument QC samples is checked for appropriateness (e.g., gas chromatography-mass spectrometer checks and/or calibrations have been run every 12 hours)
- Sample results are evaluated by comparing instrument-related QC data to the requirements and guidelines in national or regional data validation documents, analytical methods, or contract.
- Analytical instrument response data are reported for requested analytes, surrogates, and internal standards for all requested field samples, matrix spikes (MS), matrix spike duplicates (MSD), laboratory control samples (LCS), method blanks, and calibration data and instrument QC checks.
- Reported target analyte instrument responses are associated with appropriate internal standards for selected analytes (for methods requiring an internal standard for calibration).
- Fit and appropriateness of the initial calibration curve used or required is checked with recalculation of the initial calibration curve for selected analytes from the instrument response.
- Comparison of instrument response to the minimum response requirements for selected analytes.
- Recalculation of selected opening and closing CCV and CCB response from the peak data reported for selected analytes from the instrument response, as appropriate.
- Compliance check of recalculated opening and/or closing CCV and CCB response to recalculated initial calibration response for selected analytes.
- Compliance check and recalculation of percent ratios for selected tunes from the instrument responses, as appropriate.
- Recalculation of selected instrument performance checks (i.e., instrument blanks, interference checks) from the instrument response.
- Recalculation and compliance check of retention time windows (for chromatographic methods) for selected analytes from the laboratory-reported retention times.

- Recalculation of reported results for selected target analytes from the instrument response.
- Recalculation of selected reported spike recovery (surrogate recoveries, LCS recoveries, duplicate analyses, MS/MSD recoveries, etc.) from the instrument response.
- Selected sample results and spike recoveries are evaluated by comparing the recalculated numbers to the laboratory-reported numbers according to the requirements and guidelines in national or regional data validation documents, analytical methods, or contract.

Data validation qualifiers are added to the sample results, as appropriate, based on the Stage III verification and validation check; a summary of the data validation qualifiers is presented in Table 2. The results of the verification and validation check are summarized below.

Laboratory Data Package Completeness

Each laboratory data package contained a signed chain-of-custody (COC) form, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, instrument performance checks and quality control sample results, and instrument response data). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

During the validation process, the data validator contacted the laboratory with a request to provide relative response factors (RRFs) for the associated data. The laboratory indicated the associated forms for the RRFs were actually labeled as response factors (RFs), as the forms were initially created for analyses without internal standard requirements.

For the petroleum hydrocarbon analyses, the quantitation report result frequently did not match the reported result on the summary forms. The laboratory indicated that this was due to the application of dilution factors to the raw data; the laboratory subsequently provided the equation for calculating the concentrations, which included accounting for the dilution factor. This information and/or documentation of this calculation was not present in the laboratory data package.

Also for the petroleum hydrocarbon analyses, the applicable dilution factors were reported incorrectly on the summary forms and bench sheets; comparison of initial and final sample volumes was used to determine correct dilution factors.

For the MS/MSD analyses, the data validator determined that the raw data recoveries did not account for parent sample concentrations. The laboratory provided the equation for calculating the percent recoveries, which included accounting for the parent sample concentration. This information and/or documentation of this calculation was not present in the laboratory data package. See the MS/MSD section for additional information.

For all applicable analyses, RFs were not provided in the laboratory data package (only RRFs were provided). RRFs could not be recalculated without reviewing chromatographs, but were verified against the raw data when available.

Documentation to recalculate or verify coefficients of determination for linear or quadratic calibrations without reviewing chromatographs was not provided in the laboratory data packages.

Sample Conditions and Analysis

The laboratory received all samples in good condition, and all analyses were performed as requested.

Upon receipt by ARI, the sample container information was compared to the associated COC form and the cooler temperatures were recorded. All coolers were received at the laboratory with temperatures within the EPA-recommended limit of ≤6°C.

Reported detected concentrations of target compounds were confirmed against raw data when available.

The laboratory case narrative indicated that MW-108R in data package 19H0324 was reanalyzed at dilution for VOCs and TPH-G due to sample foaming. The initial analysis results contained detected concentrations of target analytes; therefore, neither set of reanalysis results (which had no detected concentrations above the elevated laboratory reporting limits) was considered necessary, and the results were qualified as “DNR” (do not report), as indicated in Table 2.

The case narrative for data package 19H0324 indicated sample MW-105 was reanalyzed at dilution for TPH-G due to the high concentration in the initial analysis saturating the instrument. The original analysis result was qualified as “DNR” (do not report), as indicated in Table 2.

Holding Times

For all analyses and all samples, the time between sample collection, extraction, and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks

A field (trip) blank was submitted and analyzed with each batch of samples analyzed for VOCs. Target analytes were not detected at concentrations greater than the reporting limits in the associated field blanks. No qualification of the data was necessary.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for each organic analysis as required by the analytical method. Surrogate percent recoveries were recalculated from raw data when available, and confirmed against the summary forms. Recovery values for the surrogate spikes were within the current laboratory-specified control limits, with the following exceptions:

- Recovery of the surrogate o-terphenyl associated with the TPH-D/TPH-O analysis of sample B-4R in data package 19H0298 was less than the laboratory-specified control limit. The associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.
- Recovery of the surrogate 1,2-dichloroethane-d4 associated with the VOC dilution reanalysis of sample MW-101R in data package 19H0324 was greater than the laboratory-specified control limit. Associated reported sample results were qualified as estimated (J), as indicated in Table 2.

Matrix Spike/Matrix Spike Duplicate and Laboratory Replicate Results

An MS/MSD and/or laboratory duplicate sample was analyzed with the analyses in data package 19H0324. Percent recoveries for each spiking compound were recalculated and verified against the raw data, and were within the laboratory-specified control limits for all project samples, with the following exceptions:

- The MS/MSD recoveries of multiple compounds associated with the VOC analysis of sample MW-108R in data package 19H0324 were less than the laboratory-specified control limits. The associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.
- The MS/MSD recoveries of gasoline-range organics associated with the TPH-G analysis of sample MW-108R in data package 19H0324 were less than the laboratory-specified control limits. The associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.
- The MS/MSD recoveries for several of the PAH and cPAH compounds could not be properly recalculated and verified for reported non-detected results, as the raw data did not include the actual detected concentrations in the parent sample (notes in the raw data indicated “Compound Not Detected”); the laboratory would not provide more accurate concentrations to recalculate and match the recoveries listed on the summary forms.
- The MS/MSD recoveries for the TPH-D/TPH-O analyses recalculations did not match the recoveries listed on the summary form. The laboratory indicated that the difference in percent recoveries was due to rounding, but would not provide more accurate concentrations to recalculate and match the recoveries listed on the summary forms.

Laboratory-specified control limits were used to evaluate the relative percent differences (RPDs) between the MS/MSD or laboratory replicate results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the MS/MSDs or laboratory replicate results were recalculated and verified against the raw data and were within the current laboratory-specified control limits for all project samples. No qualification of the data was necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

At least one laboratory control sample (LCS) and/or laboratory control sample duplicate (LCSD) sample was analyzed with each batch of samples for each analysis. LCS/LCSD recoveries and RPDs were recalculated from the raw data and confirmed against the summary sheets. Recoveries and RPDs for the LCS/LCSDs were within the current laboratory-specified control limits. No qualification of the data was necessary.

Blind Field Duplicates

One pair of blind field duplicate groundwater samples (Dup-1 / MW-107R) was submitted for analysis with data package 19H0298 and analyzed for VOCs, TPH-G, PAHs, cPAHs, TPH-D/TPH-O, dissolved arsenic, total dissolved solids, and total suspended solids. A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate groundwater samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits, with the following exception:

- The RPDs for several compounds associated with the PAH analysis of sample pair Dup-1 / MW-107R were greater than the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.

Reporting Limits

Target reporting limits were achieved for all project samples, except in those instances when dilution was necessary due to high concentrations of target analytes. In each of those instances, the detected concentration was greater than the elevated reporting limit. No qualification of the data was necessary.

In those instances when an analysis result exceeded the linear range of the instrument, the laboratory appended an “E” flag to the data, and reported a subsequent dilution analysis. For those samples, the “E”-flagged result was qualified as “DNR” (do not report), and the dilution analysis result was reported for that specific compound. For all other results, the original analysis results were reported because of the lower reporting limits, so the corresponding dilution analysis results were qualified as “DNR.”

Instrument Performance Checks

Gas chromatograph/mass spectrometer instrument performance checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory and method requirements. Ion abundance criteria reported ratios were recalculated from the averaged ion abundances, confirmed against the summary forms, and were within specified control limits. Mass listings were normalized to the appropriate specified mass-to-charge (m/z).

For the dissolved metals analyses, the inductively coupled plasma (ICP) interference check sample reported concentrations were confirmed against the raw data; percent recoveries were recalculated and confirmed against the summary forms.

The ICP interference check samples were analyzed for each sequence and were analyzed after the initial calibration verification (ICV), but were not immediately followed by a CCV and then a CCB as specified in the National Functional Guidelines for Inorganic Data Review (EPA 2016a). Upon confirmation that all other QC results were considered acceptable, no qualification of the data was determined necessary.

Initial and Continuing Calibrations

Initial calibrations (ICALs) and initial and continuing calibration verifications (ICVs/CCVs) were performed for all requested analyses and were appropriate in number and frequency based on laboratory and method requirements. ICAL and ICV/CCV results were within laboratory-specified requirements.

Documentation to recalculate or verify coefficients of determination for linear or quadratic calibrations without reviewing chromatographs was not provided in the laboratory data packages.

ICAL RRFs, mean RRFs, and percent relative standard deviations (%RSDs) were reported by the laboratory as necessary for the applicable analytical methods. ICAL RRFs were greater than the minimum RRFs specified in the National Functional Guidelines for Organic Data Review (EPA 2016b); %RSDs were less than the specified maximum %RSD values in the National Functional Guidelines for Organic Data Review (EPA 2016b).

Mean RRFs and %RSDs for one target analyte and one surrogate were recalculated from the raw data and confirmed for each ICAL against the summary forms for each applicable analytical method. Raw data to confirm RRFs without reviewing chromatographs for the TPH-D/TPH-O analyses were not provided in the laboratory data packages.

For ICVs/CCVs, mean RRFs and percent differences (%D) were reported by the laboratory as necessary for the applicable analytical methods. ICV/CCV RRFs were greater than the minimum RRFs specified in the National Functional Guidelines for Organic Data Review (EPA 2016b); %Ds were less than the specified maximum %D values in the National Functional Guidelines for Organic Data Review (EPA 2016b).

Appropriate mid-point standards from the associated ICALs were applied in calculations for the ICVs/CCVs; detected concentrations in the ICVs/CCVs were confirmed against the applicable raw data. Percent differences (%D) for one target analyte and one surrogate were recalculated and confirmed for each ICV/CCV against the summary forms for each applicable analytical method.

Internal Standards

Appropriate internal standards were added to applicable samples and blanks for analysis as necessary; documentation of the exact concentrations added to each sample was not provided in the laboratory data package and internal standard recoveries were not listed on the summary forms. Response times and area responses were within laboratory-specified criteria for all applicable samples.

Retention Times

Relative retention times (RRTs) for detected compounds in applicable project samples were recalculated and confirmed against the raw data. Where applicable, RRTs were compared against the associated ICV/CCV to verify that they were within specified limits.

Completeness and Overall Data Quality

Data precision was evaluated through blind field duplicates, laboratory duplicates, matrix spike duplicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

Use of this Report

This laboratory data quality evaluation has been prepared for the exclusive use of Union Station Associates and applicable regulatory agencies for specific application to the Union Station site. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user’s sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. LAI makes no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

LANDAU ASSOCIATES, INC.

Kristi Schultz

Kristi Schultz
Data Specialist

Danille

Danille Jorgensen
Environmental Data Manager

KES/DRJ/ccy
P:\429\008\010\R\App A_DV Memo\Union Station 2019 Level III DV_tm - 10-01-19.docx

References

EPA. 2009. Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. US Environmental Protection Agency.

EPA. 2016a. *National Functional Guidelines for Inorganic Superfund Methods Data Review*. EPA-540-R-2016-001 OLEM 9355.0-133. US Environmental Protection Agency. September. https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/national_functional_guidelines_for_superfund_inorganic_methods_data_review_0.pdf.

EPA. 2016b. *National Functional Guidelines for Superfund Organic Methods Data Review*. EPA-540-R-2016-002 OLEM 9355.0-134. US Environmental Protection Agency. September. https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/national_functional_guidelines_for_superfund_organic_methods_data_review_0.pdf.

LAI. 1997. Cleanup Action Plan, Union Station Property, Seattle, Washington. Landau Associates, Inc. July 28.

Attachments

Table 1: Sample Names and Dates of Sample Collection, Extraction, and Analysis
Table 2: Summary of Data Qualifiers

Table 1
Sample Names and Dates of Sample Collection, Extraction, and Analysis
Union Station 2019 Groundwater Sampling
Seattle, Washington

Sample Name	Lab Sample ID	Sample Collection Date	Sample Preparation/ Extraction Date	Sample Analysis Date
Dup-1	19H0298-01	8/20/2019	8/21/2019 (Dx; Gx; VOCs; TSS); 8/23/2019 (PAHs; TDS); 8/26/2019 (cPAHs); 9/2/2019 (Metals)	8/21/2019 (Gx; VOCs; TSS); 8/23/2019 (TDS); 8/24/2019 (Dx); 8/26/2019 (PAHs); 8/29/2019 (cPAHs); 9/2/2019 (Metals)
B-6R	19H0298-02	8/20/2019	8/21/2019 (Dx; Gx; VOCs; TSS); 8/23/2019 (PAHs; TDS); 8/26/2019 (cPAHs); 9/2/2019 (Metals)	8/21/2019 (TSS); 8/22/2019 (Gx; VOCs); 8/23/2019 (TDS); 8/24/2019 (Dx); 8/26/2019 (PAHs); 8/29/2019 (cPAHs); 9/2/2019 (Metals)
B-4R	19H0298-03	8/20/2019	8/21/2019 (Dx; Gx; VOCs; TSS); 8/23/2019 (PAHs; TDS); 8/26/2019 (cPAHs); 9/2/2019 (Metals)	8/21/2019 (TSS); 8/22/2019 (Gx; VOCs); 8/23/2019 (TDS); 8/24/2019 (Dx); 8/26/2019 (PAHs); 8/29/2019 (cPAHs); 9/2/2019 (Metals)
MW-107R	19H0298-04	8/20/2019	8/21/2019 (Dx; TSS); 8/22/2019 (Gx; VOCs); 8/23/2019 (TDS); 8/26/2019 (PAHs; cPAHs); 9/2/2019 (Metals)	8/21/2019 (TSS); 8/22/2019 (Gx; VOCs); 8/23/2019 (TDS); 8/24/2019 (Dx); 8/26/2019 (PAHs); 8/29/2019 (cPAHs); 9/2/2019 (Metals)
Trip Blanks	19H-0298-05	8/20/2019	8/22/2019 (Gx; VOCs)	8/22/2019 (Gx; VOCs)
MW-104	19H0324-01	8/21/2019	8/22/2019 (TSS); 8/23/2019 (Dx; PAHs; TDS); 8/26/2019 (cPAHs); 8/29/2019 (Gx; VOCs); 9/2/2019 (Metals)	8/22/2019 (TSS); 8/23/2019 (TDS); 8/24/2019 (Dx); 8/26/2019 (PAHs); 8/29/2019 (Gx; cPAHs; VOCs); 9/2/2019 (Metals)
MW-105	19H0324-02	8/21/2019	8/22/2019 (TSS); 8/23/2019 (Dx; PAHs; TDS); 8/26/2019 (cPAHs); 8/29-8/30/2019 (Gx; VOCs); 9/2/2019 (Metals)	8/22/2019 (TSS); 8/23/2019 (TDS); 8/25/2019 (Dx); 8/26-8/27/2019 (PAHs); 8/29/2019 (cPAHs); 8/29-8/30/2019 (Gx; VOCs); 9/3/2019 (Metals)
MW-102R	19H0324-03	8/21/2019	8/22/2019 (TSS); 8/23/2019 (Dx; PAHs; TDS); 8/26/2019 (cPAHs); 8/29/2019 (VOCs); 8/30/2019 (Gx); 9/2/2019 (Metals)	8/22/2019 (TSS); 8/23/2019 (TDS); 8/25/2019 (Dx); 8/26/2019 (PAHs); 8/29/2019 (cPAHs; VOCs); 8/30/2019 (Gx); 9/2/2019 (Metals)
MW-101R	19H0324-04	8/21/2019	8/22/2019 (TSS); 8/23/2019 (Dx; PAHs; TDS); 8/26/2019 (cPAHs); 8/29-8/30/2019 (Gx; VOCs); 9/2/2019 (Metals)	8/22/2019 (TSS); 8/23/2019 (TDS); 8/25/2019 (Dx); 8/26-8/27/2019 (PAHs); 8/29/2019 (cPAHs); 8/29-8/30/2019 (Gx; VOCs); 9/2/2019 (Metals)
MW-108R	19H0324-05	8/21/2019	8/22/2019 (TSS); 8/23/2019 (Dx; PAHs; TDS); 8/26/2019 (cPAHs); 8/29-8/30/2019 (Gx; VOCs); 9/2/2019 (Metals)	8/22/2019 (TSS); 8/23/2019 (TDS); 8/25/2019 (Dx); 8/26/2019 (PAHs); 8/29-8/30/2019 (Gx; VOCs); 8/30/2019 (cPAHs); 9/3/2019 (Metals)
Trip Blanks	19H0324-06	8/21/2019	8/29/2019 (Gx; VOCs)	8/29/2019 (Gx; VOCs)

Abbreviations/Acronyms:

cPAH = carcinogenic polycyclic aromatic hydrocarbon
Dx = diesel- and oil-range petroleum hydrocarbon analysis
Gx = gasoline-range hydrocarbon analysis
ID = identification
PAH = polycyclic aromatic hydrocarbon
TDS = total dissolved solids
TSS = total suspended solids
VOC = volatile organic compound

Table 2
Summary of Data Qualifiers
Union Station 2019 Groundwater Sampling
Seattle, Washington

Data Package	Analytical Group	Sample ID	Analyte	Result	Lab Qualifier	Data Qualifier	Reason
19H0298	PAHs	Dup-1	Naphthalene	4.8		J	High field duplicate RPD
19H0298	PAHs	Dup-1	2-Methylnaphthalene	26		J	High field duplicate RPD
19H0298	PAHs	Dup-1	Acenaphthene	24.1		J	High field duplicate RPD
19H0298	PAHs	Dup-1	Fluorene	7.5		J	High field duplicate RPD
19H0298	PAHs	Dup-1	Phenanthrene	6.8		J	High field duplicate RPD
19H0298	PAHs	Dup-1	1-Methylnaphthalene	23.5		J	High field duplicate RPD
19H0298	PAHs	MW-107R	Naphthalene	2.8		J	High field duplicate RPD
19H0298	PAHs	MW-107R	2-Methylnaphthalene	19.1		J	High field duplicate RPD
19H0298	PAHs	MW-107R	Acenaphthene	18.6		J	High field duplicate RPD
19H0298	PAHs	MW-107R	Fluorene	5.7		J	High field duplicate RPD
19H0298	PAHs	MW-107R	Phenanthrene	5.4		J	High field duplicate RPD
19H0298	PAHs	MW-107R	1-Methylnaphthalene	18.4		J	High field duplicate RPD
19H0298	TPH-Dx	B-4R	Diesel-Range Organics (C12-C24)	1.2		J	Low surrogate recovery
19H0298	TPH-Dx	B-4R	Motor Oil-Range Organics (C24-C38)	0.78		J	Low surrogate recovery
19H0324	VOCs	MW-105	Benzene	323	E	DNR	Do not report; use dilution reanalysis result
19H0324	VOCs	MW-105	Toluene	33.2		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-105	Ethylbenzene	28		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-105	m,p-Xylene	21.4		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-105	o-Xylene	10.1		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-105	Total Xylenes	31.6		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-101R	Ethylbenzene	123	E	DNR	Do not report; use dilution reanalysis result
19H0324	VOCs	MW-101R	Benzene	32.6		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-101R	Toluene	2.08		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-101R	m,p-Xylene	14.6		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-101R	o-Xylene	17.7		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-101R	Total Xylenes	32.3		DNR	Do not report; use original analysis result
19H0324	VOCs	MW-101R	Ethylbenzene	120		J	High surrogate recovery
19H0324	VOCs	MW-108R	Benzene	0.2	U	UJ	Low MS/MSD recovery
19H0324	VOCs	MW-108R	Toluene	0.2	U	UJ	Low MS/MSD recovery
19H0324	VOCs	MW-108R	Ethylbenzene	0.21		J	Low MS/MSD recovery
19H0324	VOCs	MW-108R	m,p-Xylene	0.4	U	UJ	Low MS/MSD recovery
19H0324	VOCs	MW-108R	o-Xylene	0.2	U	UJ	Low MS/MSD recovery
19H0324	TPH-Gx	MW-105	Gasoline-Range Organics (Tol-Nap)	2420		DNR	Do not report; use dilution reanalysis result
19H0324	TPH-Gx	MW-101R	Gasoline-Range Organics (Tol-Nap)	7350	E	DNR	Do not report; use dilution reanalysis result
19H0324	TPH-Gx	MW-108R	Gasoline-Range Organics (Tol-Nap)	289		J	Low MS/MSD recovery
19H0324	PAHs	MW-105	Naphthalene	392	E	DNR	Do not report; use dilution reanalysis result

Table 2
Summary of Data Qualifiers
Union Station 2019 Groundwater Sampling
Seattle, Washington

Data Package	Analytical Group	Sample ID	Analyte	Result	Lab Qualifier	Data Qualifier	Reason
19H0324	PAHs	MW-105	2-Methylnaphthalene	27.6		DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Acenaphthylene	10.4		DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Acenaphthene	41.1		DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Fluorene	15.5		DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Phenanthrene	31.5		DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Anthracene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Fluoranthene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Pyrene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Benzo(a)anthracene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Chrysene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Benzo(a)pyrene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Indeno(1,2,3-cd)pyrene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Dibenz(a,h)anthracene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Benzo(g,h,i)perylene	10.4	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-105	Total Benzofluoranthenes	20.8	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Naphthalene	5910	E	DNR	Do not report; use dilution reanalysis result
19H0324	PAHs	MW-101R	2-Methylnaphthalene	1100	E	DNR	Do not report; use dilution reanalysis result
19H0324	PAHs	MW-101R	Acenaphthene	347	E	DNR	Do not report; use dilution reanalysis result
19H0324	PAHs	MW-101R	Fluorene	137	E	DNR	Do not report; use dilution reanalysis result
19H0324	PAHs	MW-101R	Phenanthrene	115	E	DNR	Do not report; use dilution reanalysis result
19H0324	PAHs	MW-101R	Acenaphthylene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Anthracene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Fluoranthene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Pyrene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Benzo(a)anthracene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Chrysene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Benzo(a)pyrene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Indeno(1,2,3-cd)pyrene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Dibenz(a,h)anthracene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Benzo(g,h,i)perylene	51.2	U	DNR	Do not report; use original analysis result
19H0324	PAHs	MW-101R	Total Benzofluoranthenes	102	U	DNR	Do not report; use original analysis result

Table 2
Summary of Data Qualifiers
Union Station 2019 Groundwater Sampling
Seattle, Washington

Notes:

U = The analyte was analyzed for but was not detected above the level of the reported sample quantitation limit.
UJ = The analyte was analyzed for but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
E = The concentration indicated for this analyte is an estimated value above the calibration range of the instrument. This value is considered an estimate.

Abbreviations/Acronyms:

DNR = do not report
MS = matrix spike
MSD = matrix spike duplicate
PAHs = polycyclic aromatic hydrocarbons
RPD = relative percent difference
VOCs = volatile organic compounds

APPENDIX B

ProUCL Output Files (on DVD)