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Report on the 2019 Perimeter Monitoring Program and Perimeter Extraction System

Parkland Burnaby Refinery

Parkland Refining (B.C.) Ltd.

Project number: 60601146

March 18, 2021

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Christopher Boys, P.Geo
Sr. Environmental Specialist

Report on the 2019 Perimeter Monitoring Program and Perimeter Extraction System

Dear Chris,

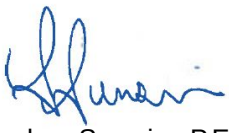
Please accept the re-issued Report on the 2019 Perimeter Monitoring Program and Perimeter Extraction System. The report was revised based on the comment received by e-mail from Lavinia Zanini of the Ministry of the Environment and Climate Changes Strategy (ENV), dated December 7, 2020, below.

> *"I request that the figures highlight those wells that exceed AW standards rather than (or as well as) those that exceed SSSLs. Trend figures should also demonstrate AW concentration levels and it would also be better for me, as a reviewer, to see the wells in the tables that exceed AW standards highlighted better. The bolding does not stand out in electronic format."*

Edits were made to the tables, figures, and graphs to address the above comment. No new data was added, or data evaluation completed as part of this revision. Any text edits were limited to the update of cross-references resulting from revisions to graphs.

Data collected in 2020 will be reported in the Report on the 2020 Perimeter Monitoring Program and Perimeter Extraction System which will be provided under separate cover.

Kind regards,



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Executive Summary

On behalf of Parkland Refining (B.C.) Ltd. (Parkland), AECOM Canada Ltd. (AECOM) completed monitoring and sampling as part of the Perimeter Monitoring Program (PMP) and performed operations, maintenance and monitoring of the Perimeter Extraction System (PES), at the Burnaby Refinery (Refinery) throughout 2019. The PMP and PES are performed under the oversight of the British Columbia Ministry of Environment and Climate Change Strategy (ENV). This report summarizes the activities associated with the 2019 PMP and PES programs.

The Refinery is composed of three areas which are collectively known as the "Site":

1. Area 1: Located at the northern terminus of Willingdon Avenue, this area functions primarily as a tank farm and blending facility
2. Area 2: Located near the end of Penzance Drive, this area contains the refining process units
3. Area 3: Located north of Area 1, this area is leased from the Port, and contains the wharf and some rail loading facilities

Perimeter Monitoring Program

The purpose of the PMP is to monitor groundwater environmental conditions along the down gradient boundary of the Refinery. The PMP is executed once in the wet season (high groundwater table) and once in the dry season (low groundwater table). The two events in 2019 were completed over the following periods:

- Wet Season Event – March 18 to April 17, 2019
- Dry Season Event – September 9 to 26, 2019

Site-Specific Screening Levels (SSSLs) for select parameters were developed to evaluate potential risks to Burrard Inlet resulting from impacted Site groundwater. The results of the PMP groundwater samples are compared to the SSSLs as well as the Contaminated Sites Regulation (CSR) standards for the "protection of marine aquatic life" (AW) (CSR standards). SSSLs are trigger concentrations which indicate the need for further investigation/evaluation or remedial action. For parameters where SSSLs are not available, the CSR standards are used to assess the need for further investigation or remedial action.

Areas 1 and 3 Perimeter Monitoring Program Summary

The sampling program and results for the Areas 1 and 3 PMP for 2019 are summarized in the table below.

Total number of monitoring wells included in the PMP for Areas 1 and 3:	32
Total number of monitoring wells sampled during the wet event:	32
Total number of monitoring wells sampled during the dry event:	30*
Total number of monitoring wells characterized by groundwater sample concentrations below CSR AW standards for petroleum hydrocarbons (PHCs[1]) and/or polycyclic aromatic hydrocarbons (PAHs) parameters for both events	27
Total number of monitoring wells characterized by groundwater sample concentrations below SSSLs, but above the CSR AW standards for PHCs and/or PAHs for either one or both events	4
Total number of monitoring wells characterized by groundwater sample concentrations above SSSLs for PHCs and/or PAHs parameters for either one or both events	1

[1] PHCs including one or more of light and heavy extractable petroleum hydrocarbons in water (LEPHw/HEPHw), extractable petroleum hydrocarbons in water ($EPHw_{C10-C19}$/$EPHw_{C19-C32}$), volatile petroleum hydrocarbons in water (VPHw), and/or benzene/toluene/ethylbenzene/xylenes (BTEX),

* - *discrepancies in number of monitoring wells sampled are due to dry monitoring wells during the dry event; see report for details*

A single well in Area 3 (U07-10S) was found to have SSSL exceedances for both PHCs and PAHs in both events. U07-10S represents a previously investigated area of isolated contamination where PHC and PAH concentrations have exceeded the SSSLs. Nearby monitoring wells continue to demonstrate vertical and horizontal delineation is maintained.

Three monitoring wells in Area 3 (A3MW02-07, A3MW02-08, and A3MW03-02) contained concentrations of PHCs and/or PAHs above the CSR AW standards, but below the SSSLs. Two (A3MW02-07 and A3MW02-08) of the three wells are within the historical influence of the Area 3 Air Sparge (AS) system.

In October 2015, the AS system located in Area 3 was temporarily turned off to assess whether further active remediation in the area was required. Concentrations trends of evaluated PAH parameters in A3MW02-07 and A3MW02-08 appeared to increase prior to 2019, when concentrations stabilized. The increasing concentration trends prior to 2019 may be attributed to rebound following the dormancy of the Area 3 AS system. Although concentrations of PAHs are elevated, they remain orders of magnitude below the SSSL, except for the acenaphthene concentration observed in one well in Area 3 (A3MW02-07) which is located up-gradient of the AS System. The AS system remained on permanent standby throughout 2019.

The influence of the Area 3 AS system is less evident in evaluation of trends for U7-10S and A3MW03-02. At these locations fluctuations in concentrations appear to correlate more closely with changes in groundwater elevation.

The concentration of contaminants of concern in samples collected as part of the 2019 PMP for Areas 1 and 3 do not indicate an immediate need for additional investigation, evaluation, or remediation. Ongoing monitoring of Area 3 will continue without the influence of the AS system. The Area 1 and 3 PMP will therefore continue in 2020 with a similar scope of work as completed in 2019.

Area 2 Perimeter Monitoring Program Summary

The sampling program and results for the Area 2 PMP for 2019 are summarized in the table below.

Total number of monitoring wells included in the PMP for Area 2:	39
Total number of monitoring wells sampled during the wet event:	33*
Total number of monitoring wells sampled during the dry event:	17*
Total number of monitoring wells characterized by groundwater sample concentrations below CSR AW standards for PHCs, PAHs, and/or dissolved metal parameters for both events	28
Total number of monitoring wells characterized by groundwater sample concentrations below SSSLs but above the CSR AW standards for PHCs, PAHs and/or dissolved metals for either one or both events	4
Total number of monitoring wells characterized by groundwater sample concentrations above SSSLs for PHCs, PAHs and/or dissolved metals for either one or both events	1

** - discrepancies in the number of monitoring well sampled are typically due to dry wells; see report for details*

A single SSSL exceedance was associated with the reported xylenes concentration in one well (A2MW09-11) located down gradient of the central section of the PES. Samples from this well have historically contained elevated concentrations of xylenes above the SSSL but have generally demonstrated a decreasing trend since the PES was commissioned. A2MW09-11 was resampled during the wet season on April 17, 2019. Concentrations of xylenes were above the CSR AW standard but below the SSSL in this sample. Due to insufficient water in this well, sampling of this well is typically only possible during the wet season event. Therefore, the xylenes concentration detected in the wet season sampling event could not be verified during the subsequent dry season sampling event.

The results of the 2019 PMP for Area 2 do not indicate an immediate need for additional investigation, evaluation, or remediation other than the continued operation of the PES. The Area 2 PMP will therefore continue in 2020 with a similar scope of work as completed in 2019.

Area 2 Perimeter Extraction System

The PES is a line of closely spaced extraction wells along the Area 2 northern fence line of the Refinery. The pumps in the PES wells extract total fluids to depress the groundwater table and preclude the off-site migration of light non-aqueous phase liquid (LNAPL) and dissolved phase petroleum hydrocarbons (PHCs) in groundwater that originate from Area 2.

Throughout 2019, a water column in the extraction wells measuring one meter above the pump intake during pump operation was used as a pump performance indicator and a trigger for troubleshooting and/or replacement of a groundwater extraction pump. If the pump did not function following troubleshooting or demonstrated poor reliability, then it was removed and replaced with a working pump from the spare pump inventory.

An annual average water column of less than one meter was sustained at 34 of the 40 extractions wells, indicating satisfactory performance. Of the six extraction wells with average water columns greater than one meter, five were located in the eastern section of the PES and demonstrated an average annual water column greater than one meter but less than three meters. The other location is the western most extraction well which also had an average water column less than three meters. In all instances, these wells are outside of the known LNAPL plume in Area 2.

In 2019, the PES collected a total fluid volume of 40,544 cubic meters. Of that volume, 167 litres are estimated to represent LNAPL.

In 2019, the PES effectively controlled potential off-site migration of NAPL and dissolved phase PHCs based on:

- reliable hydraulic drawdown in extraction wells across the entire PES;
- comparison of groundwater elevations in monitoring wells near the PES against reference elevations collected prior to the PES operation;
- groundwater contouring (including particle path evaluations) performed on a quarterly basis; and,
- general stability of the groundwater quality down gradient of the PES.

It is recommended that the PES continue to be operated in 2020 in a similar manner as 2019.

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
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1. INTRODUCTION

The objective of this report is to document the following information to the British Columbia (BC) Ministry of Environment and Climate Change Strategy (ENV):

- 2019 groundwater results from the Refinery Perimeter Monitoring Program (PMP) (wet and dry season events), and
- 2019 performance of the Refinery Area 2 Perimeter Extraction System (PES) located along the perimeter of the Parkland (formerly Chevron) Burnaby Refinery (Refinery).

AECOM Canada Ltd. (AECOM) has prepared this report on behalf of Parkland Refining (B.C.) Ltd.

The Site is located on the south side of Burrard Inlet. The Refinery is composed of three areas which are collectively known as the "Site" (Figure 1).

1. Area 1: Located at the northern terminus of Willingdon Avenue, this area functions primarily as a tank farm and blending facility (Figure 2).
2. Area 2: Located near the end of Penzance Drive, this area contains the refining process units (Figure 3).
3. Area 3: Located north of Area 1, this area contains the wharf and some rail loading facilities (Figure 2). This area is leased from the Port of Vancouver and is further divided into two portions:
    a. Land reclaimed from Burrard Inlet, and
    b. Burrard Inlet water lot, including the wharf.

2. GEOLOGY AND HYDROGEOLOGY OVERVIEW

The surficial geology of the Site is generally characterized by varying depths of Pleistocene age glacial till overlying Tertiary bedrock composed of mudstone with minor interbeds of fine-grained sandstone. Soil conditions encountered during drilling programs conducted by AECOM over the years are generally consistent with published surficial geology maps (Holocene sediments) (URS 2012). Fill materials are also encountered in some locations above the glacially consolidated materials. Soil that is close to the foreshore contains marine type sediments with entrained shells.

In Area 2, the topography consists of a flat central portion where most of the Refinery infrastructure is located. To the north, there is a short slope down to a benched area where the water storage ponds are located. This first bench is called the Upper Bench and is bounded to the north by the Area 2 fence line. At the fence line, the elevation lowers down to a second narrow bench at the Refinery property line, referred to as the Lower Bench. The elevation continues to drop to the Canadian Pacific Railway (CPR) right-of-way (ROW) and afterwards, to the foreshore of Burrard Inlet.

Consistent with the steep northward slope of the ground surface, groundwater flows northward from the central upland areas of the Refinery towards the Site perimeter located south of Burrard Inlet. Low permeability soil and bedrock restrict groundwater flow and contaminant migration.

Monitoring wells on-site have a total depth ranging between 1.3 meters (m) and 26.7 m below the top of monitoring well casing. Groundwater depths vary with land surface elevation. In general, the depth to groundwater is shallower near the Foreshore and deeper in upland areas (URS 2012).

The hydraulic conductivities for the PES area range from 5×10^{-6} meters per second (m/s) to 1×10^{-10} m/s with a geometric mean of 5×10^{-7} m/s (URS 2013a). The estimated time required for groundwater to

travel from the PES to the Parkland property boundary under non-pumping conditions is six months (URS 2013b). This was calculated using the following assumptions.

- Hydraulic conductivity of 1.1 x 10^{-6} m/s. This represents the highest measured conductivity from the central section of the PES where most of the light non-aqueous phase liquid (LNAPL) is encountered.
- Calculated groundwater velocity of 30.5 meters/year (m/yr.) under non-pumping conditions.
- The distance from the PES extraction wells on the Upper Bench to the Refinery property line is approximately 15 m.

The groundwater table in Area 3, like the topography, is relatively flat. Groundwater flows northward from Area 1 towards Area 3 and Burrard Inlet. Groundwater near the shoreline is tidally influenced. Siltstone and sandstone bedrock in Area 1 has a hydraulic conductivity of less than 10^{-6} m/s and yields less than 1 litre/minute (Morrow, 2001).

3. BACKGROUND

3.1 Perimeter Monitoring Program Background

The purpose of the PMP is to monitor groundwater environmental conditions along the down gradient boundary of the Refinery. The following bullets are intended to provide relevant program background since the initiation of the PMP in 2004.

- The scope of the original semi-annual groundwater monitoring and sampling program was outlined to the British Columbia (BC) Ministry of Environment (ENV) by Chevron Canada Limited (CCL) in their letter entitled, *Chevron Refinery Well Monitoring Program*, dated October 31, 2003.
- Sentry wells are monitoring wells typically located outside of known Areas of Environmental Concern (AECs).
- Monitoring wells located in the AECs are monitored as part of separate investigation, mitigation, and/or remediation programs. Several of the Area 2 Sentry wells are within the influence of remedial activities.
- Following the 2016 PMP, monitoring and sampling of the methyl tert-butyl ether (MTBE) AEC was reduced from 22 monitoring wells to five monitoring wells in 2017. Based on evaluation of the groundwater quality in the Report on the 2015 and 2016 PMP and PES, the remediation in the MTBE AEC is considered complete. The system status was changed to dormant and the area is no longer considered an AEC (AECOM, 2017).
- Consistent with the intent of the PMP, AECOM monitored 70 sentry monitoring wells at the Refinery perimeter in 2019.

Additional details are presented in Appendix A (Areas 1 and 3 Perimeter Monitoring Program) and Appendix B (Area 2 Perimeter Monitoring Program).

3.2 Perimeter Extraction System Background

The purpose of the PES is to provide a hydraulic barrier to intercept and preclude the off-site migration of LNAPL and dissolved phase petroleum hydrocarbons (PHCs) in groundwater originating from the Area 2 LNAPL plume.

The following bullets are intended to provide relevant system background since the initiation of the PES in 2010.

- In the summer of 2010, the initial portion of the PES was installed along the northern perimeter of Area 2 consisting of 10 total fluid pumps and associated extraction wells. This installation is currently referred to as the central section (Figure 4). Since 2010, all these extraction wells have been replaced with deeper extraction wells to improve the hydraulic capture in this area.
- In the summer of 2011, the PES was expanded to the east to include the Flare Stack Area. The expansion included the installation of an additional 17 pumping locations and associated infrastructure. This installation is currently referred to as the eastern section (Figure 4).
- In the summer of 2012, the PES was expanded to the west to the edge of the ponds area. The expansion included the installation of an additional 13 pumping locations and associated infrastructure. This installation is currently referred to as the western section (Figure 4).
- In 2015, the common header of the eastern section of the PES was enlarged.
- In 2016, the common header of the western and central sections of the PES were enlarged.
- In 2017, the PES process was expanded to include an effluent oil water separator (OWS), including a LNAPL storage tank and effluent flow meter, and a sequestering agent dosing system.

Further details on the PES, LNAPL storage tank and sequestering agent dosing system are presented in Appendix C.

3.3 Air Sparge and MTBE Systems Summary

To improve the reliability of perimeter compliance, groundwater extraction and other treatment systems have been installed and operated at the Refinery at various times in the past. Table 1 summarizes these systems and their current status.

Table 1 - Summary of Air Sparge and MTBE Systems

System Name	Location	Status	Figure Reference
Area 3 Air Sparge System	Area 3	Standby since 2015	Figure 2
Area 2 Air Sparge System	Area 2	Standby since 2012	Figure 3
Area 2 MTBE Extraction System	Area 2	Standby since 2014 Dormant since 2015	NA*

NA - Not applicable

** Figures and additional evaluation of the MTBE Extraction system are provided in the Report on the 2015 and 2016 PMP and PES (AECOM, 2017).*

4. REGULATORY CONTEXT

The *Environmental Management Act* (EMA) was brought into force on July 8, 2004. The applicable regulation under the EMA is the Contaminated Sites Regulation (CSR). The CSR came into effect April 1, 1997 and provides a framework to investigate, assess, and remediate contaminated sites in BC. Twelve amendments to the CSR have been completed since 1997, with the most recent being the Stage 12, which came into effect on January 24, 2019.

Federal environmental legislation applicable to Burrard Inlet adjacent to the Site includes the *Canada Fisheries Act*. A summary of the applicable regulatory context is provided in Appendix D.

4.1 Groundwater Site-Specific Screening Levels

Site-Specific Screening Levels (SSSLs) for select parameters were developed by SLR Consulting Canada Ltd. (SLR), with the support of Parkland and AECOM, to evaluate potential risks to Burrard Inlet resulting from impacted Site groundwater. The SSSLs were based on the CSR Stage 10 Omnibus Amendments in addition to the Updated Screening Levels (USLs) and Risk-Based Management Targets (RBMTs) developed for application along the Foreshore downslope of Area 2 of the Refinery. Upon the release of subsequent housekeeping amendments (Stage 11 and Stage 12), these SSSLs were verified and no updates were warranted.

The SSSLs are listed in Table 2 below, and the basis for their development is presented in Appendix D. The SSSLs were first introduced in the *Report on the 2015 and 2016 Perimeter Monitoring Program and Perimeter Extraction System, Chevron Burnaby Refinery, Burnaby British Columbia* (AECOM 2017).

Table 2 - Site-Specific Screening Levels

PHCs	
PCOC	**SSSL (µg/L)**
LEPHw	3000
VPHw	15000
$EPHw_{10-19}$	5000
VHw (C6-C10)	15000
Benzene	21000
Ethylbenzene	3200
Styrene	720
Toluene	7700
Xylenes	3300

PAHs	
PCOC	**SSSL (µg/L)**
Acenaphthene	60
Acridine	30
Anthracene	40
Benz(a)anthracene	1
Benzo(a)pyrene	2.8
Chrysene	1
Fluoranthene	40
Fluorene	120
Naphthalene	440
Phenanthrene	3
Pyrene	40
Quinoline	34

Metals	
PCOC	**SSSL (µg/L)**
Antimony	2500
Arsenic	125
Barium	5000
Beryllium	1000
Boron	12000
Cadmium	90
Chromium	500
Cobalt	1100
Copper	62
Lead	1400
Molybdenum	10000
Nickel	750
Selenium	20
Thallium	3
Uranium	1000
Zinc	900

Notes:
PHC – Petroleum Hydrocarbon Concentrations
PAH – Polycyclic Aromatic Hydrocarbons
PCOC – Potential Contaminants of Concern
µg/L – micrograms per litre

4.2 Applicable Standards and Screening Levels

The Site is zoned for heavy industrial use. The nearest surface water downgradient of the Site is Burrard Inlet, located approximately 10 m to the north of portions of Area 1, and 40 m north of Area 2. Area 3 borders Burrard Inlet and includes a water lot within the inlet. Assessment of the Site's hydrogeology and potential pathways for groundwater contamination, using the available data from numerous soil and groundwater investigations, indicate that CSR standards for the protection of marine aquatic life (AW) are

applicable at the Site[2]. In addition to Burrard Inlet, Rainbow Creek is located within close vicinity to MW17-04. As a result, this well was also compared against freshwater (FW) aquatic life standards.

Under ENV guidance, drinking water standards are applicable at all sites unless they can be removed using Protocol 21 (ENV 2017), or an exemption is granted by the ENV. Drinking water is not applicable at the Site for the following reasons.

- A drinking water exemption was provided by ENV for Area 2 on May 15, 2017. A copy of the letter is included in Appendix D.
- Completed CSR Protocol 21 drinking water flowcharts (Figures 1 and 4 in Protocol 21) for Areas 1 and 3 indicate the drinking water standard is not applicable; therefore, direct approval from ENV is not required. The completed flow charts are included in Appendix D.

The results of the PMP groundwater samples were compared to the SSSLs and the CSR AW standards. SSSLs represent a concentration which will indicate the need for further assessment/evaluation or remedial action. For those parameters where SSSLs are not available, the CSR standards will be the basis for evaluating the need for further assessment or remedial action.

5. SCOPE OF WORK

The 2019 scope of work included:

- Updating and following the Refinery-wide AECOM Health and Safety Plan (HASP).
- Completion of the 2019 PMP in accordance with the work plan submitted to ENV on October 31, 2003 and AECOM's work plan dated March 29, 2004. In general, this work included:
    - Completion of two groundwater monitoring and sampling events per year, one during the wet season (high water table) and the other during the dry season (low water table),
    - Submission of groundwater samples for laboratory chemical analysis of petroleum hydrocarbon (PHC) related parameters (refer to Table 5), polycyclic aromatic hydrocarbons (PAHs), and dissolved metals, and
    - Comparison of the analytical results to applicable standards.
- Operating, monitoring, and maintaining the PES in accordance with the PES Operations, Monitoring and Maintenance Plan (AECOM 2016), which consisted of monitoring pump operation twice a month and quarterly groundwater and effluent monitoring. Additional detail is provided in Appendix C.

The 2019 monitoring programs were completed by Mr. Justin Becker, E.I.T, Ms. Sofia Ramos Ajas, G.I.T., Mr. Aaron Rysdale, B.Sc., and Mr. Carny Wong, B.Sc. The report was led by Mr. Stephen Sumsion, P.Eng with contributions by Mr. Justin Becker, E.I.T and Mr. Aaron Rysdale, B.Sc.; senior reviews were conducted by Ms. Leslie Southern M.Sc., P.Ag., Mr. Robert Dickin, M.Sc., P.Geo. CSAP, FGC., and Lesley Reid, M.Eng., P.Eng., CSAP.

6. AREAS 1 AND 3 PERIMETER MONITORING RESULTS

The monitoring wells sampled as part of the Areas 1 and 3 2019 PMP are shown on Figure 2. The details of the Area 1 and 3 2019 PMP groundwater monitoring and sampling program and associated results are included in Appendix A.

[2] http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/protocols/protocol_21.pdf

The total number of monitoring wells sampled for each of the two PMP seasonal events, are provided in Table 3 below.

Table 3 - Summary of PMP Sampling Program for Areas 1 and 3

Total number of monitoring wells included in the PMP for Areas 1 and 3:	32
Wet Season Event – March 27 to April 17, 2019 - Total number of monitoring wells sampled during the wet event: - Total number of dry monitoring wells monitored during the wet event: - Total number of monitoring wells that could not be sampled due to other reasons:	 32 0 0
Dry Season Event – September 19 to 26, 2019 - Total number of monitoring wells sampled during the dry event: - Total number of dry monitoring wells monitored during the dry event: - Total number of monitoring wells that were not sampled due to other reasons:	 30 2 0

The summary of water quality for Areas 1 and 3 is provided in Table 4 and associated notes below.

Table 4 - Summary of PMP Results for Areas 1 and 3

Total number of monitoring wells characterized by groundwater sample concentrations below CSR AW standards for PHCs and/or PAHs parameters for both events.	27
Total number of monitoring wells characterized by groundwater sample concentrations below SSSLs, but above the CSR AW standards for PHCs and/or PAHs parameters for either one or both events	4
Total number of monitoring wells characterized by groundwater sample concentrations above SSSLs for PHCs and/or PAHs parameters for either one or both events	1

Reported concentrations for samples collected from 31 of the 32 monitoring wells sampled in Areas 1 and 3 were below the SSSLs. All the reported concentrations above the SSSLs are from the samples collected from a single monitoring well (U07-10S) in Area 3, additional information is provided below:

- U07-10S had reported concentrations of LEPHw, $EPHw_{(C10-C19)}$, acenaphthene, benz(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene and pyrene above the SSSLs in 2019. U07-10S also had reported concentrations of anthracene and acridine above CSR AW standards, but below the SSSLs in 2019.
- The time series graphs (Graphs 1 and 2) illustrates LEPHw, acenaphthene, benz(a)anthracene, benzo(a)pyrene, chrysene, fluorene, fluoranthene, naphthalene, phenanthrene, and pyrene for samples collected from U07-10S. When the sample concentrations are graphed alongside groundwater fluctuations, peak concentrations appear to correlate with groundwater fluctuations. In all instances the reported concentrations above the SSSLs and CSR AW standards were generally consistent with historical data.
- U07-10S is part of a nested installation near the wharf approach in Area 3 of the Refinery. The two other nested monitoring wells in this cluster (U07-10I and U07-10D) are screened at deeper intervals. The concentrations of parameters exceeding the SSSLs in samples from U07-10S are below the SSSLs in samples collected from U07-10I and U07-10D, providing vertical delineation.
- Samples collected from monitoring wells (A3MW03-01, A3MW03-03 and A3MW02-05) located adjacent and downgradient to U07-10S all contained concentrations below the SSSLs providing horizontal delineation between U07-10S and waters of Burrard Inlet.

Three monitoring wells (A3MW02-07, A3MW02-08, and A3MW03-02) contained concentrations of PHCs and/or PAHs above the CSR AW standards, but below the SSSLs. For reference, the Area 3 AS system commissioning (October 2010) and system standby (August 2015) dates have been represented as vertical black lines in the pertinent graphs. A discussion, by monitoring well, is provided in the bullets below.

- The time series graph (Graph 3) illustrates acenaphthene, anthracene, fluoranthene, naphthalene, and pyrene concentrations for samples collected from A3MW02-07. In 2019, the reported contaminant concentrations were all below the SSSLs, and except for pyrene, below CSR AW standards. Though all parameters are below CSR AW standards they appear to have an increasing trend following the cessation of the AS system in 2015 but the addition of the 2019 sample results suggest concentrations appear to be stabilizing.
- The time series graph (Graph 4) illustrates pyrene concentrations for samples collected from A3MW02-08. In 2019, the observed pyrene concentrations were above the CSR AW standard but within the historical range of concentrations reported for this monitoring well. The reported concentration was below the SSSL for pyrene in all samples. Based on the observed concentrations from 2017 to present, the pyrene concentration in A3MW02-08 does not appear to fluctuate with water level as observed prior to 2017. All reported concentrations were more than an order of magnitude below the SSSL for pyrene.
- The time series graph (Graph 5) illustrates LEPHw and pyrene concentrations for samples collected from A3MW03-02. The variation of LEPHw concentrations in samples from this well appear to correlate better with fluctuations in the groundwater, rather than the influence of the AS system. The LEPHw concentrations continue to remain below the SSSLs and are within the historical range for this monitoring well. The reported pyrene concentration in the wet season sampling event was higher than the historical range but remained below the SSSLs. Based on sampling notes for the April 2019 sampling event, it appears that the sample may have contained entrained sediment, which has the potential to artificially elevate the reported concentration in this sample. The reported concentration of pyrene in the subsequent sample collected in September 2019 was below the reported detection limit and does not indicate an increasing trend at this time.

Based on the above evaluation, the increasing concentration trends of evaluated PAH parameters in A3MW02-07 and A3MW02-08 from 2015 to 2018 may be attributed to rebound following the cessation of the Area 3 AS system. However, when the 2019 PAH sample concentrations are added to the dataset, concentrations appear to be stabilizing. Except for the acenaphthene concentration observed in A3MW02-07, PAH parameters remain orders of magnitude below the SSSL.

The influence of the Area 3 AS system is less evident in the trend evaluation for U7-10S and A3MW03-02. At these locations the fluctuations in the concentrations appear to correlate better with changes in groundwater elevation.

6.1 Area 1 and 3 PMP Summary

The semi-annual PMP was successfully completed in Areas 1 and 3 of the Parkland Burnaby Refinery. With the exception of select reported parameters for U07-10S, all reported concentrations were below the SSSLs established for the Refinery in 2019 groundwater samples.

The concentrations of LEPHw, $EPHw_{C10-C19}$, and select PAHs reported in the groundwater sample collected from U07-10S in 2019 exceeded the SSSLs, but concentrations were generally within historical ranges. Nearby monitoring wells which provide horizontal and vertical delineation indicate that the contamination is localized to the vicinity of U07-10S and is unlikely to represent a risk to Burrard Inlet at this time. Therefore, the SSSL exceedances do not indicate an immediate need for additional investigation, evaluation, or remediation.

Detectable concentrations of LEPHw and select PAHs above the applicable CSR AW standards were reported for samples collected from three additional monitoring wells (A3MW02-07, A3MW02-08, and A3MW03-02) located in Area 3. None of these concentrations exceeded the SSSLs.

7. AREA 2 PERIMETER MONITORING RESULTS

The monitoring wells sampled as part of the 2019 PMP for Area 2 are shown on Figure 3. The details of the Area 2 2019 PMP groundwater monitoring and sampling program and associated results are included in Appendix B.

The total number of monitoring wells sampled for each of the two PMP seasonal events is provided in Table 5.

Table 5 - Summary of PMP Sampling Program for Area 2

Total number of monitoring wells included in the PMP for Area 2:	39
Wet Season Event – March 18 to April 17, 2019 - Total number of monitoring wells sampled during the wet event: - Total number of dry monitoring wells monitored during the wet event: - Total number of monitoring wells not sampled due to other reasons:	 33 6 0
Dry Season Event – September 9 to 18, 2019 - Total number of monitoring wells sampled during the dry event: - Total number of dry monitoring wells monitored during the dry event: - Total number of monitoring wells that were not sampled due to other reasons:	 17 22 0

The summary of water quality for Area 2 is provided in Table 6 and associated note below.

Table 6 - Summary of PMP Results for Area 2

Total number of monitoring wells characterized by groundwater sample concentrations below CSR AW standards for PHCs and/or PAHs parameters for both events	28
Total number of monitoring wells characterized by groundwater sample concentrations below SSSLs but above the CSR AW standards for PHCs, PAHs and/or dissolved metals for either one or both events	4
Total number of monitoring wells characterized by groundwater sample concentrations above SSSLs for PHCs, PAHs and/or dissolved metals for either one or both events	1

- In addition to PHC parameters, seven monitoring wells (G2-9A, G2-9B, G2-10, G2-3B, G2-3C, WS2-D and WS2-D2) were also analyzed for MTBE. None of the MTBE reported concentrations were greater than the CSR AW standard.

Reported concentrations for groundwater samples above the CSR AW standards and SSSL are summarized in Table 7 with associated notes below. Interpretation of groundwater quality trends with respect to the PES operation is included in Section 9 - PES Performance Discussion.

Table 7 - Summary of Samples with Concentrations above the Site Standards

Monitoring Well ID	Parameter below SSSLs but Greater Than the CSR AW Standards	Parameters Greater Than the SSSLs
A2MW09-11	LEPHw, VPHw and Naphthalene	Xylenes
A2MW09-06I	LEPHw and Pyrene	-
G2-3B	Pyrene	-
PW03-6	Pyrene	-
MW11-4S	Dissolved copper	-

All reported concentrations were below the SSSLs established for the Refinery except for the reported concentration of xylenes in the sample collected from A2MW09-11 in March 2019.

Concentrations of select parameters, above the applicable CSR AW standards, were reported for samples collected from five monitoring wells (A2MW09-06I, A2MW09-11, G2-3B, PW03-6 and MW11-4S). Of the five monitoring wells listed in Table 7, three monitoring wells (A2MW09-11, A2MW09-06I and PW03-6) are located down gradient of the PES. Additional information is provided below.

- The time series graph (Graph 6) illustrates LEPHw, VPHw, toluene, xylenes, and naphthalene concentrations for samples collected from A2MW09-11 as well as groundwater and historical LNAPL elevations. LNAPL was consistently detected in this well until 2012 when the PES was commissioned. LNAPL was then detected sporadically until May 2015.
- The single Area 2 SSSL exceedance in 2019 was the reported xylenes concentration (5,540 µg/L) in the sample collected from A2MW09-11 during the wet season event. The reported concentrations of LEPHw, VPHw, and naphthalene were above the CSR AW standards, but below the SSSLs in the same sample. A2MW09-11 was resampled approximately one month later on April 17, 2019. The reported xylene concentration of this sample (2,190 µg/L) was above the CSR AW standard but below the SSSL. Concentrations of LEPHw, VPHw and naphthalene also exceeded the CSR standards in the April 2019 sample. A2MW09-11 could not be sampled during the dry season sampling event due to insufficient water in the well. The original and resampled results for xylenes were within the historical ranges observed from this well. The reported concentrations of LEPHw, VPHw and naphthalene were also within the historical ranges. This well is located down gradient of the central section of the PES in the vicinity of UEIB-46.
- The time series graphs (Graphs 7 and 8) illustrates LEPHw, VPHw, benzene, xylenes, naphthalene, and pyrene concentrations for samples collected from A2MW09-06I. Sufficient water was present at this location, and therefore a sample was collected, in both the wet and dry season sampling events. During the wet season, the reported concentrations of LEPHw and pyrene were below CSR AW standards and generally consistent with historically collected concentrations from this monitoring well. The sample collected during the dry event had reported concentrations of 1,720 µg/L and 0.592 µg/L for LEPHw and pyrene, respectively. These concentrations exceed the CSR AW standards but not the SSSLs for the respective parameters. The concentrations of LEPHw and pyrene were lower than those detected in April 2018 (the highest reported concentrations in this well). A2MW09-06I is located down gradient of the west section of the PES in the vicinity of UEIB-32.
- The time series graph (Graph 9) illustrates pyrene concentrations for samples collected from G2-3B. In 2019, G2-3B was sampled during both events. The sample collected during the wet event was below CSR AW standards for all parameters. The sample collected during the dry event had a reported concentration of 0.235 µg/L for pyrene, which exceeded the CSR AW standard but remains two orders of magnitude below the SSSL. Reported concentrations of pyrene from both events were consistent with historically collected concentrations. G2-3B is located west of the PES and outside of its influence.
- The time series graph (Graph 10) illustrates pyrene concentrations for samples collected from PW03-6. During the wet season sampling program this well was monitored on three instances (March 26, March 27, and April 16) to identify if sufficient water was available for sampling following a period of rain. On April 16, a water column of 0.339 m was measured and a sample was collected. The reported concentration of pyrene (0.28 µg/L) in the sample collected on April 16, was slightly above the CSR AW standard (0.2 µg/L), but not the SSSL. Historically, the reported concentrations of PAHs in samples from this well are less than the reported detection level, when sufficient water is available for sampling. Due to insufficient water, a sample was not collected during the dry event. This reported pyrene concentration represents the first detection above the RDL at this location since it was added to the program in 2004, however, it is likely that the reported concentration is artificially elevated due to the silt which was entrained in the sample, as documented in field sampling notes. The presence of silt in the sample likely biased the analysis high. Concentrations of pyrene in samples collected from two monitoring wells (PW03-03 and PW03-1A) located adjacent to PW03-06 were below the RDL in 2019. Graph 10 illustrates that the groundwater elevation at the

time of the 2019 sample collection was lower than what was historically viable for sampling. PW03-6 is located down gradient of the west section of the PES in the vicinity of UEIB-36.

- The time series graph (Graph 11) illustrates dissolved copper concentrations for samples collected from MW11-4S. In 2019, MW11-4S was sampled during both events. The reported concentrations of dissolved metals were below the CSR AW standards except for the concentration of dissolved copper (23.9 µg/L) in the March 18, 2019 sample which exceeded the CSR AW standard, but not the SSSL. The subsequent sample collected during the 2019 dry season was well below the CSR AW standard with a reported concentration of 0.42 µg/L. The results are within the historical ranges observed from this well. MW11-4S is in the Flare Zone East of UEIB-55.

7.1 Area 2 PMP Summary

The semi-annual PMP was successfully completed in Area 2 of the Parkland Burnaby Refinery. All reported concentrations were below the SSSLs, except for a single exceedance of xylenes in one well (A2MW09-11) during the wet season sampling event. The concentration of xylenes in this well will continue to be monitored in 2020. Concentrations of select parameters above the applicable CSR AW standards, were reported for samples collected from five monitoring wells (A2MW09-06I, A2MW09-11, G2-3B, PW03-6 and MW11-4S).

Based on comparison of analytical results collected during the 2019 PMP to recent historical data, the Site perimeter groundwater quality conditions are generally similar to historical concentrations. The results of the 2019 PMP for Area 2 do not indicate an immediate need for additional investigation, evaluation, or remediation other than the continued operation of the PES.

8. PES OPERATIONS AND PERFORMANCE

The purpose of the PES is to provide a hydraulic barrier to intercept and preclude the off-site migration of LNAPL and PHCs in groundwater originating from the Area 2 LNAPL plume. The PES, relative to monitoring wells containing measurable LNAPL in 2019, is shown on Figure 4. Additional details of PES operation, maintenance, monitoring, and system performance are summarized in Appendix C.

In 2019, the system was operated in accordance with the PES Operation Maintenance and Monitoring Plan (AECOM, 2016). This included the completion of:

- Semi-monthly system monitoring,
- Quarterly performance assessments,
- Quarterly effluent characterization and groundwater monitoring, and
- Annual and semi-annual maintenance events.

Throughout 2019, the average water column above the pump was evaluated each quarter to identify underperforming pumps as well as an indicator of overall PES reliability.

A water column more than one meter above the pump intake was used as a trigger for trouble shooting and / or replacement of a groundwater extraction pump. If the pump did not function following troubleshooting, it was removed and replaced with a working pump from the spare pump inventory. If the pump worked following troubleshooting but subsequent monitoring demonstrated poor reliability, the pump was also replaced with a functioning spare pump.

Semi-monthly system monitoring activities verified consistent overall groundwater drawdown in active extraction wells through 2019 across the entire PES. Instances where isolated drawdown was reduced due to poor pump performance at a single location, were promptly resolved by replacing the malfunctioning pumps with functioning spare pumps. This approach was effective at maintaining an

average annual water column less than 3 m above the pump intake at all extraction wells, and less than 1 m at most extraction wells throughout 2019.

The reliability of the entire PES is further demonstrated by an average annual 2019 water column above the pump intake of less than 1 meter at 34 of the 40 extraction wells. Of the six locations (UEIB-18, UEIB-19, UEIB-27, UEIB-43, UEIB-55, and UEIB-56) with an average annual water column between 1-3 m above the pump intake, five are in the eastern section of the PES. The other location (UEIB-43) is the western most extraction well. In all instances these wells are outside of the known LNAPL plume in Area 2.

The pump in well UEIB-55 has become stuck and cannot be removed for maintenance, although it is still cycling. UEIB-55 is a replacement extraction well for original extraction well UEIB-31. The replacement of UEIB-31 was due to a malfunctioning pump that could not be removed from the well for maintenance.

Quarterly performance assessments and supporting groundwater level monitoring events were completed to verify the influence of the PES on surrounding monitoring wells as the basis for capture interpretation. In general, the 2019 groundwater elevations along the Upper and Lower Benches remained below the 2012 reference baseline elevations. The 2012 elevations have historically been used as the baseline to demonstrate the influence of the PES (i.e. drawdown which correlates with better capture). Drawdown influence was present across the entire PES in 2019, despite periodic events when reduced drawdown was observed in isolated extraction wells. The complete evaluation of the PES performance, along with the results of the PMP, is discussed in Section 9 of this report.

Quarterly effluent characterization was performed to estimate the total fluid extracted by the PES as well as the total volume of LNAPL collected. A summary of the total fluids and LNAPL removed by the PES, by year, is listed in Table 8.

Table 8 - Summary of Total Fluids and LNAPL Removed by the PES

Year	Total fluids extracted	NAPL extracted
2019	40,544 m^3	~ 167L^2
2018	32,402 m^3	~ 190 L^2
2017	38,642 m^3	~ 210 L^2
2016[1]	33,369 m^3	~ 200 L^2
2015[1]	43,218 m^3	~ 240 L^2
2014[1]	54,213 m^3	~ 500 L^2
2013[1]	48,491 m^3	~ 300 L^2
2012[1]	40,159 m^3	~ 500 L^2
2011	12,900 m^3	~21,700 L^3

Note:

[1] - Historically reported volumes have been corrected in this report to include only the total fluids collected by the PES. Previous totals also include total fluids collected by pumps located in EX-1 to EX-4, and U2-5.

[2] - NAPL Extracted = 0.01% x the total volume of water collected from an extraction well during a quarter where NAPL or sheen was observed during the drum test for that extraction well.

[3] - NAPL Extracted = 0.1% x the total volume of water collected from an extraction well during a quarter where NAPL or sheen was observed during the drum test for that extraction well.

9. PES PERFORMANCE DISCUSSION

As summarized in Section 8 and Appendix C, reliable drawdown across the entire the PES was maintained for 2019 and the PES effectively precluded the off-site migration of LNAPL and contaminated groundwater from the Site.

The following discussion of groundwater quality down-gradient of the PES provides secondary information on the PES long-term effectiveness. However, the presence of legacy contamination downgradient of the PES and other industrial activities (e.g. active railway) prevents direct correlation of the PES performance with downgradient water quality. For example, an anomalous spike of a PHC related parameter observed in a groundwater sample collected from a well within the influence of the PES could be unrelated to its performance. Instead, such a spike could be attributed to the mobilization of legacy PHC contamination resulting from the fluctuating groundwater level or infiltration of precipitation.

Although there is uncertainty inherent in the following evaluation for the reasons previously stated, the water quality discussion provides a secondary line of evidence on PES performance in 2019.

Western PES Section

The PMP groundwater monitoring results and associated analytical from wells below the western section of the PES generally indicated that hydraulic control was maintained across this section throughout 2019.

Down gradient wells PW03-A1, PW03-B1, PW03-2A, PW03-2B, PW03-3, PW03-4, PW03-5, PW03-06, and A2MW09-06S remained under the drawdown influence of the PES as indicated by lack of water for sampling purposes, particularly during the dry season sampling event.

Samples collected from A2MW09-06I are the only samples below the western section of the PES that consistently exceeded CSR AW standards in 2019. This well is located near the western boundary of the central section of the PES and is down gradient of UEIB-32 and UEIB-33. The average water columns above the pumps in these extraction wells did not exceed 1m when averaged over a quarterly or annual basis. Therefore, upgradient hydraulic capture is deemed to have been reliable. Both the measured groundwater elevations and reported hydrocarbon concentrations for samples from this well were generally within the historical range.

Central PES Section

The general stability of the groundwater quality down gradient of the central section of the PES or the lack of water for sampling purposes suggest that hydraulic control was maintained across this section throughout 2019 in down gradient wells MW03-02, A2MW09-12, A2MW09-11, A2MW09-10, U9, U8, and A2MW09-05I. A2MW09-11 was the only monitoring well, below the central section of the PES, that had sample concentrations of hydrocarbon parameters greater than the CSR AW in 2019. At this location the concentration of xylenes was also greater than the SSSLs in one of the two samples collected in 2019. Extraction well UEIB-46 is located upgradient of A2MW09-11 and operated efficiently without issue throughout 2019. Although hydrocarbon related parameters remain elevated in this well, they are within historical ranges.

Eastern PES Section

The general stability of the groundwater quality down gradient of the eastern section of the PES and/or the lack of water for sampling purposes suggest that hydraulic control was maintained across this section throughout 2019 in down gradient wells A2MW09-13, A2MW09-14, A2MW09-15, MW02-02, MW02-03, MW02-04, and MW03-03.

Historically, biofouling has been present in the eastern section of the PES. The accumulation of the biofoul on the internal pump controls results in reduced pump performance and reliability. The pump replacement program implemented in 2018 has continued to reduce the time required to replace

underperforming pumps and thus provide sustained drawdown across the eastern section of the PES. Due to water table decline caused by PES pumping and insufficient water in monitoring wells, only three samples (MW02-02, MW02-03, and A2MW09-13) could be collected from downgradient wells of the eastern PES section during 2019. All three samples were collected during the wet sampling event. Analytical results were below the CSR AW standard and are consistent with historical data. Increased frequency of dry wells downgradient of the PES across this section are attributed to the maintained PES reliability and sustained drawdown across this section of the PES.

10. AIR SPARGE and MTBE SYSTEMS

A brief status of each system and other pertinent information regarding the ongoing operation of the other remediation systems is summarized in the following subsections.

10.1 Area 3 Air Sparge System

In October 2015, the AS system was temporarily turned off to assess the need for further remediation in the area. Based on the assessment provided in the 2015 and 2016 Perimeter Monitoring Program and Perimeter Extraction System Report (AECOM, 2017), the AS system remained on permanent standby throughout 2019 to facilitate ongoing monitoring of Area 3 without the influence of the AS system.

The Area 3 AS system will remain off but on standby through 2020 to allow continued monitoring of groundwater trends without the influence of the AS system. The location of the Area 3 AS is shown on Figure 2.

10.2 Area 2 Air Sparge System

Due to the up-gradient influence of the PES system, the Area 2 AS system in no longer required and will be decommissioned. The location of the Area 2 AS is shown on Figure 3.

10.3 Area 2 MTBE Remediation Area

The remediation of MTBE in Area 2 is considered complete (AECOM, 2017). Sampling activities in this area were reduced in 2017. Ongoing groundwater quality sampling of seven wells (G2-3B, G2-3C, G2-9A, G2-9B, G2-10, WS2-D, and WS2-D2) will continue as part of the PMP. None of the MTBE reported concentrations were greater than the CSR AW standard in 2019. The Area 2 MTBE remediation was in the approximate location of well WS2-D shown on Figure 3.

11. CONCLUSIONS and RECOMMENDATIONS

Perimeter Monitoring Program

Areas 1 and 3

The semi-annual PMP was successfully completed in Areas 1 and 3 of the Parkland Burnaby Refinery. All but one of the 32 monitoring wells (U07-10S), had reported concentrations below the SSSLs established for the Refinery. The LEPHw and various PAH concentrations above the SSSLs at U07-10S had been previously detected in this well. Results from nearby monitoring wells have continued to demonstrate that this contamination is highly localized and is vertically and horizontally delineated.

A concentration of pyrene was detected in A3MW03-02 above the CSR AW standard, but below the SSSL for the first time since May 2012. Concentrations of pyrene in A3MW03-02 were below the RDL in the subsequent dry season sample.

Two monitoring wells (A3MW02-07 and A3MW02-08) located within the historical influence of the Area 3 AS system, contained concentrations of PHCs and/or PAHs above the CSR AW standards, but below the SSSLs. In October 2015, the AS system located in Area 3 was temporarily turned off to assess whether further active remediation in the area was required. Concentrations trends of evaluated PAH parameters in A3MW02-07 and A3MW02-08 appeared to increase prior to 2019, when concentrations stabilized. The increasing concentration trends prior to 2019 may be attributed to rebound following the dormancy of the Area 3 AS system. Although concentrations of PAHs are elevated, they remain orders of magnitude below the SSSL, except for the acenaphthene concentration observed in one well in Area 3 (A3MW02-07) which is located up-gradient of the AS System. The AS system remained on permanent standby throughout 2019.

Based on the 2019 PMP results for Areas 1 and 3 there is no immediate need for additional investigation, evaluation, or remediation.

AECOM recommends that the AS system should remain off (but on standby) through 2020 and monitoring of Area 3 continue without the influence of the AS system. The Area 1 and 3 PMP should continue in 2020 with a similar scope of work as completed in 2019.

Area 2

Thirty-nine monitoring wells were monitored as part of the 2019 Area 2 PMP. During the wet season, 29 monitoring wells were sampled; during the dry season, 17 monitoring wells were sampled. The reported concentrations of parameters of concern were below SSSLs established for the Site in samples collected from all monitoring wells except for the sample collected from A2MW09-11.

The single SSSL exceedance was associated with the reported xylenes concentration in one well (A2MW09-11) located down gradient of the central section of the PES. Samples from this well have historically contained elevated concentrations of xylenes above the SSSL but have generally demonstrated a decreasing trend. A2MW09-11 was resampled during the wet season on April 17, 2019. Concentrations of xylenes were above the CSR AW standard but below the SSSL in this sample. Due to insufficient water in this well, sampling of this well is typically only possible during the wet season event. Therefore, the xylenes concentration detected in the wet season sampling event could not be verified during the subsequent dry season sampling event.

The results of the 2019 PMP for Area 2 do not indicate an immediate need for additional investigation, evaluation, or remediation other than the continued operation of the PES.

AECOM recommends that the Area 2 PMP continue in 2020 with a similar scope of work as completed in 2019.

Perimeter Extraction System (PES) Operation

To evaluate the influence of the PES hydraulic barrier along the northern perimeter of the Refinery semi-monthly and quarterly system monitoring activities were completed for 2019 including:

a) verify consistent groundwater drawdown in active extraction wells,

b) collect groundwater extraction data,

c) collect surrounding groundwater elevation data.

Throughout 2019, a water column measuring one meter above the pump intake during pump operation was used as a trigger for trouble shooting and / or replacement of a groundwater extraction pump. If a pump did not function following troubleshooting, or demonstrated poor reliability, then it was removed and replaced with a working pump from the spare pump inventory.

An annual average water column of less than one meter was sustained at 34 of the 40 extractions wells, indicating satisfactory performance. Of the six extraction wells with average water columns greater than one meter, five were located in the eastern section of the PES and demonstrated an average annual water column greater than one meter but less than three meters. The other location is the western most extraction well which also had an average water column less than three meters. In all instances, these wells are outside of the known LNAPL plume in Area 2.

In 2019, the PES operated within acceptable limits for controlling the off-site migration of LNAPL and dissolved phase PHC concentrations based on:

- adequate water table drawdown compared to reference elevations collected prior to the PES operation;
- the groundwater contouring (including particle path evaluations) performed on a quarterly basis; and,
- general stability of the groundwater quality down gradient of the PES.

AECOM recommends that the PES continues to be operated in 2020 in a similar manner to 2019.

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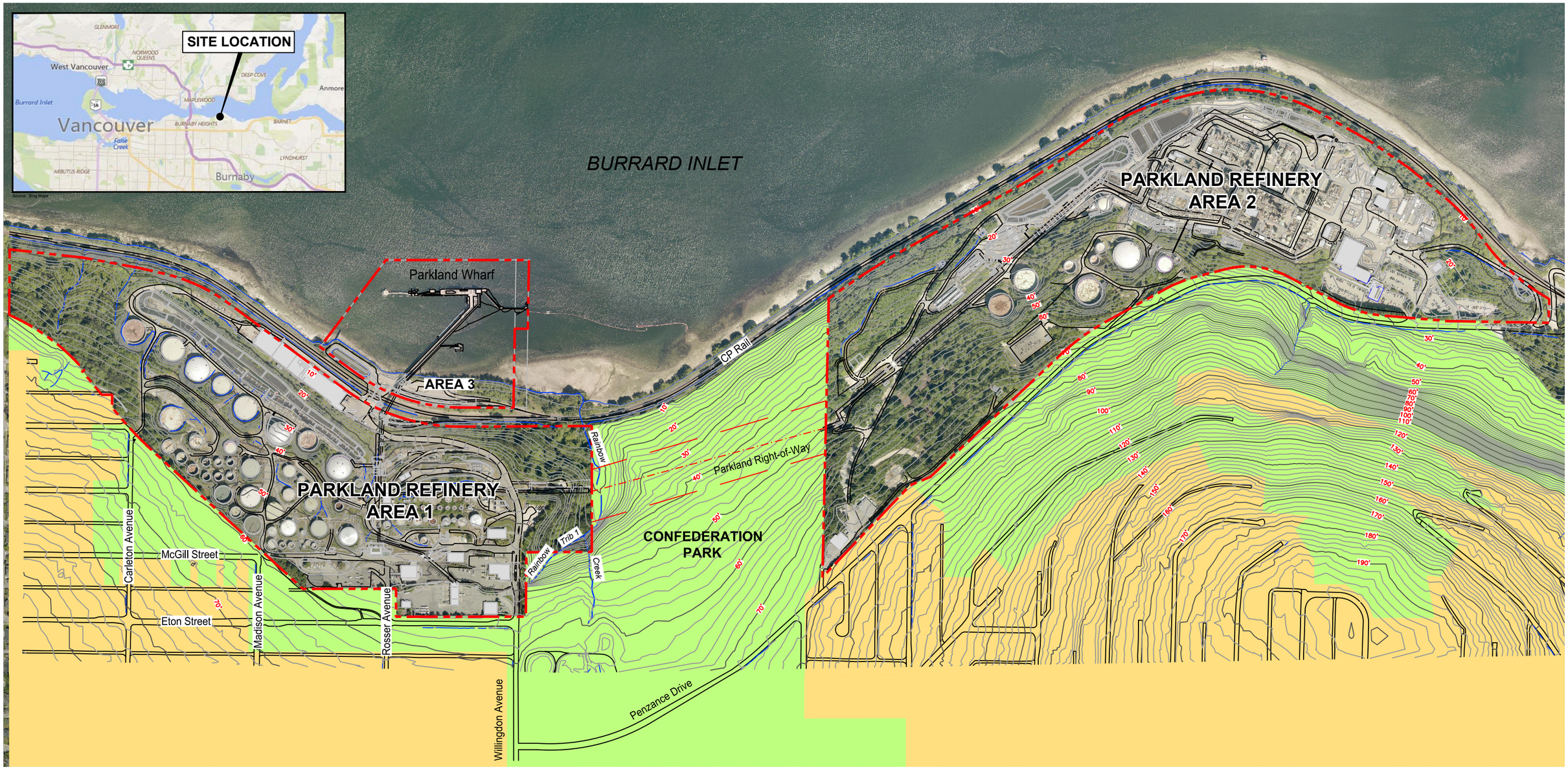
URS 2013b. *Response to Ministry Comments to Perimeter Extraction System Update Addendum*, Chevron Burnaby Refinery, BC, December 19, 2013.

FIGURES



LEGEND:

- Property Line
- Contour Line (contour interval 2 feet) — 50'
- Zoning Boundary
- Approximate Location of Parkland Pipeline
- Park and Public Use District
- Residential District
- Industrial

NOTE: Zoning information taken from City of Burnaby website, BurnabyMap. (February 28, 2018)

N W E S

metres 0 150 300

AECOM

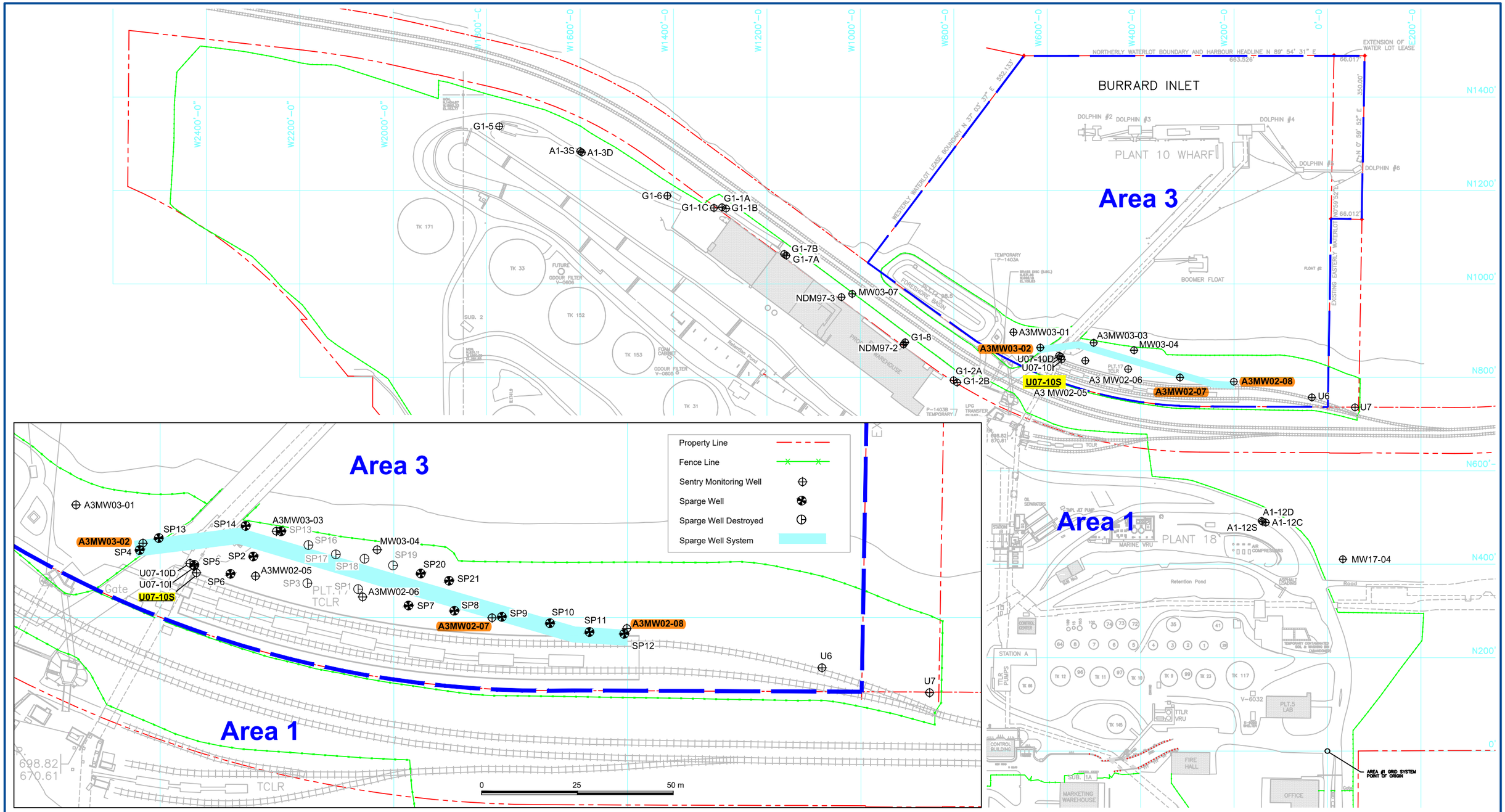
REFINERY SITE PLAN AND LOCATION MAP AREAS 1, 2 AND 3

The 2019 Perimeter Monitoring Program and Perimeter Extraction System
Parkland Burnaby Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2021	60601146	TS	0	FIGURE 1

FILE NAME: \\CABNY1FP001\prod\1686\Projects\URS-CHEVRON\60601146 2019 Perimeter Monitoring\400-Technical\2019 Annual PMP Report\Figures\FIG01 - Site Plan - 20200310 - 60601146 Parkland Ref.dwg



LEGEND:

- Property Line
- Fence Line
- Sentry Monitoring Well
- Sparge Well System
- Concentration exceeding CSR Standards, but below SSSLs; details in the report and tables of Appendix A — A3MW03-02
- Concentration exceeding SSSL and CSR Standards; details in the report and tables of Appendix A — U07-10S

ABBREVIATIONS:

CSR	Contaminated Sites Regulation
AW	Aquatic Life
SSSL	Site-Specific Screening Level

GRID NORTH

N, W, E, S

0 50 100 m

AECOM

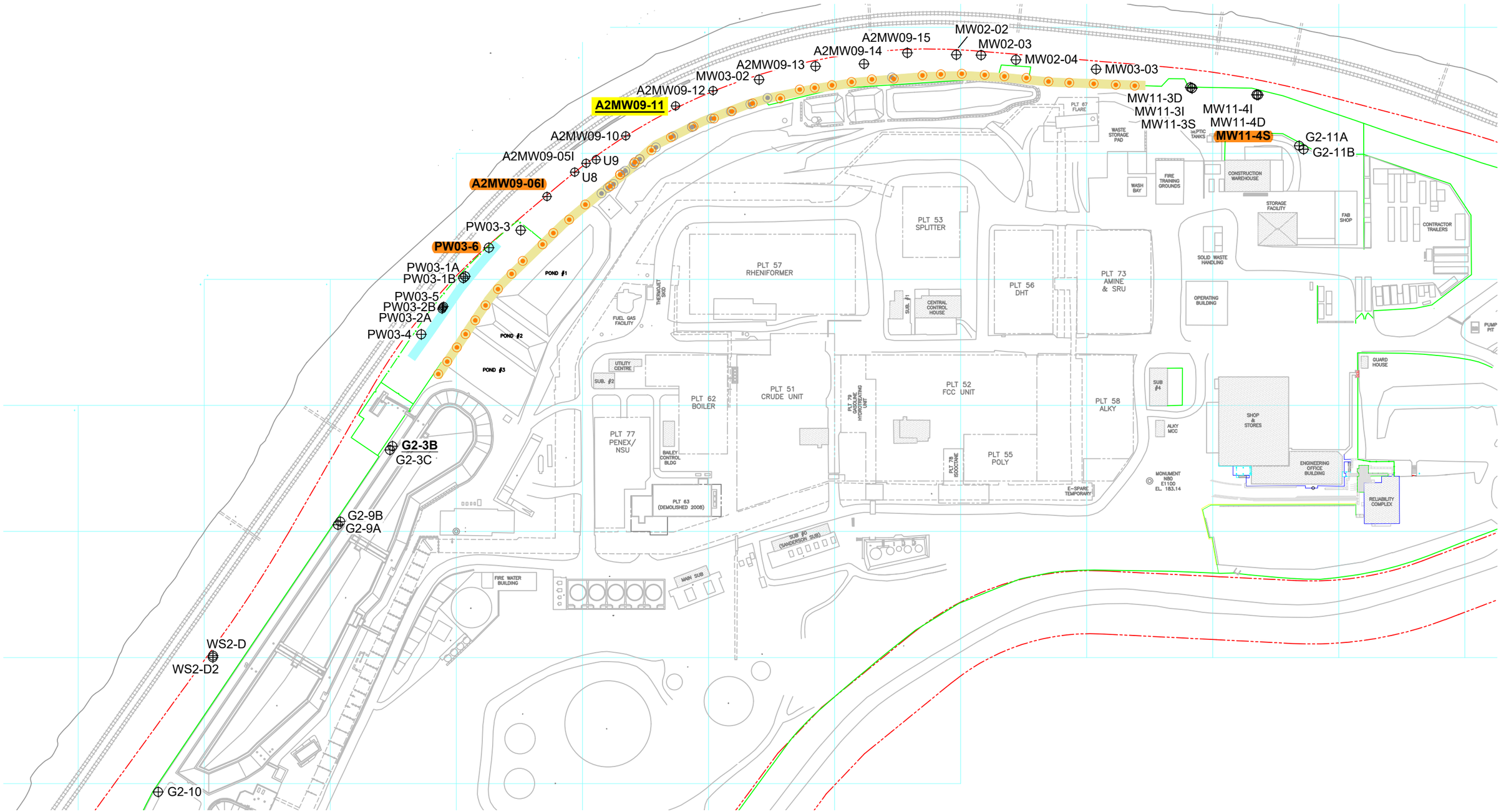
AREAS 1 AND 3 SENTRY WELLS

The 2019 Perimeter Monitoring Program and Perimeter Extraction System
Parkland Burnaby Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2021	60601146	NT	0	FIGURE 2

FILE NAME: \\CABNY1FP001\prod\1686\Projects\URS-CHEVRON\60601146 2019 Perimeter Monitoring\400-Technical\2019 Annual PMP Report\Figures\FIG02 - Area 1 and 3 Sentry Wells - 20200310 - 60601146 Parkland Ref.dwg



LEGEND:

- Property Line
- Fence Line
- Sentry Monitoring Well
- Inactive Extraction Well
- Active Extraction Well
- Perimeter Extraction Well System
- Sparge Well System
- Concentration Exceeding CSR Standards but below SSSLs, details in the text and tables of Appendix B — A2MW09-06I
- Concentration Exceeding SSSL and CSR Standards; details in the text and tables of Appendix B — A2MW09-06I

ABBREVIATIONS:

CSR	Contaminated Sites Regulation
AW	Aquatic Life
SSSL	Site -Specific Screening Level
PMP	Perimeter Monitoring Program

GRID NORTH

N W E S

metres
0 50 100

AREA 2
SENTRY WELLS

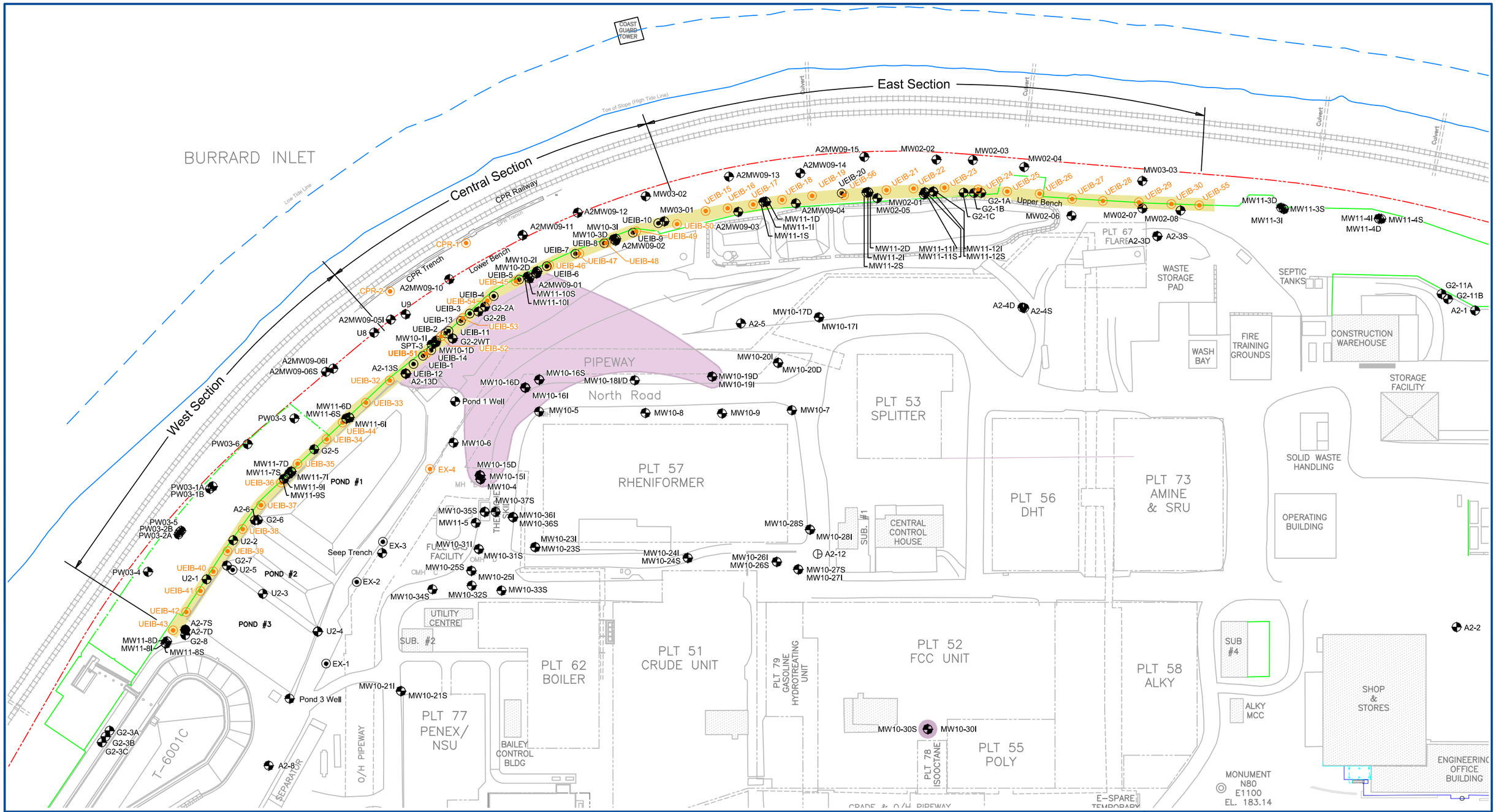
The 2019 Perimeter Monitoring Program and Perimeter Extraction System
Parkland Burnaby Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2021	60601146	NT	0	FIGURE 3

AECOM

FILE NAME: \\CABNY1FP001\prod\1686\Projects\IURS-CHEVRON\60601146 2019 Perimeter Monitoring\400-Technical\2019 Annual PMP Report\Figures\FIG03 - Area 2 Sentry Wells - 20200310 - 60601146 Parkland Ref.dwg



LEGEND:

- Property Line
- Fence Line
- Perimeter Well Extraction System
- Inferred NAPL Plume Extents 2019
- Monitoring Well
- Inactive Extraction Well
- Active Extraction Well
- Destroyed Monitoring Well Location

GRID NORTH

N W E S

metres 0 20 40

AECOM

AREA 2 PERIMETER EXTRACTION SYSTEM

The 2019 Perimeter Monitoring Program and Perimeter Extraction System
Parkland Burnaby Refinery, Burnaby, BC

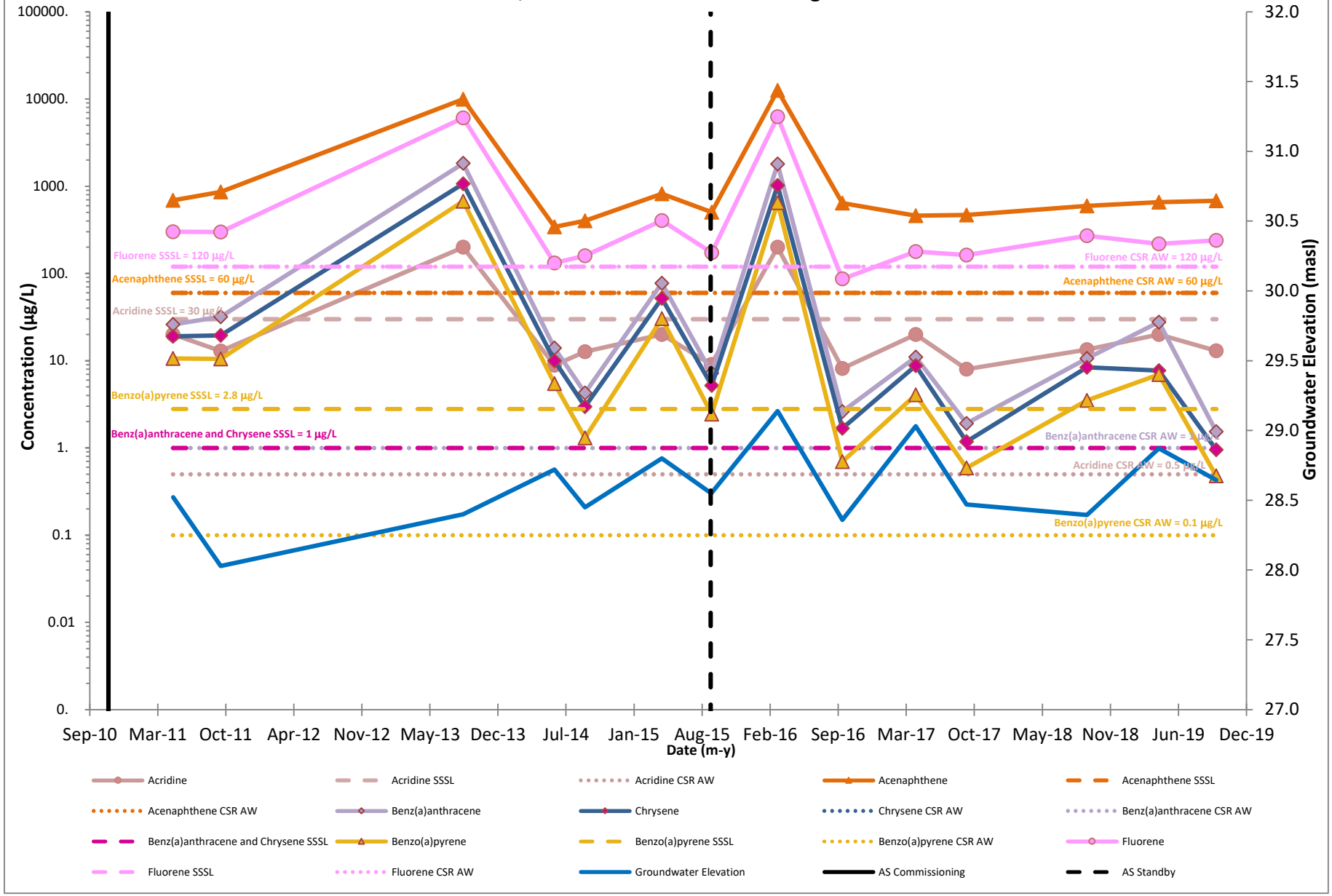
PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2021	60601146	NT	0	FIGURE 4

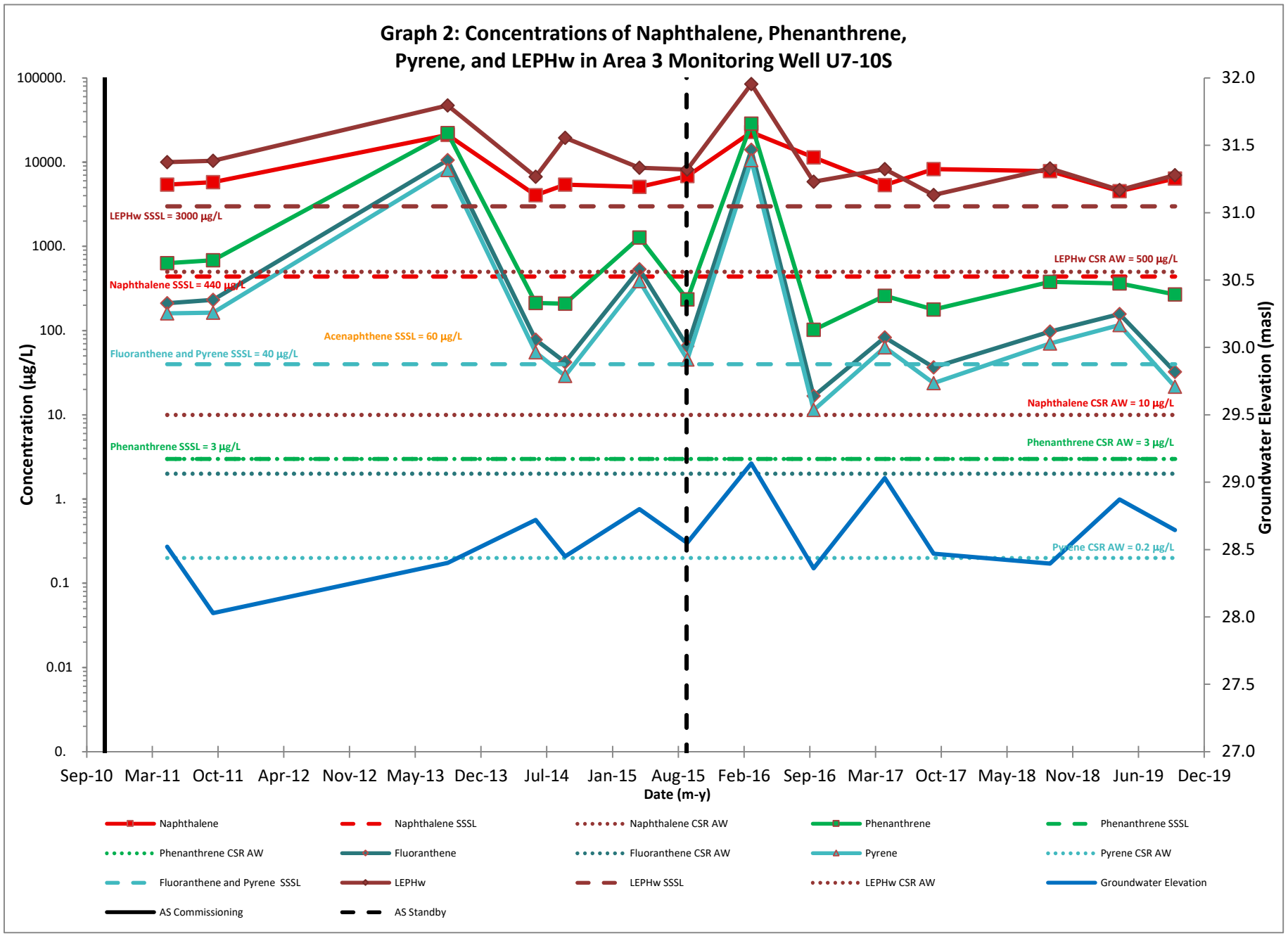
FILE NAME: \\CABNY1FP001\prod\1686\Projects\IURS-CHEVRON\60601146 2019 Perimeter Monitoring\400-Technical\2019 Annual PMP Report\Figures\FIG04 - Area 2 Perimeter Extraction System - 20200310 - 60601146 - Parkland Ref.dwg

GRAPHS

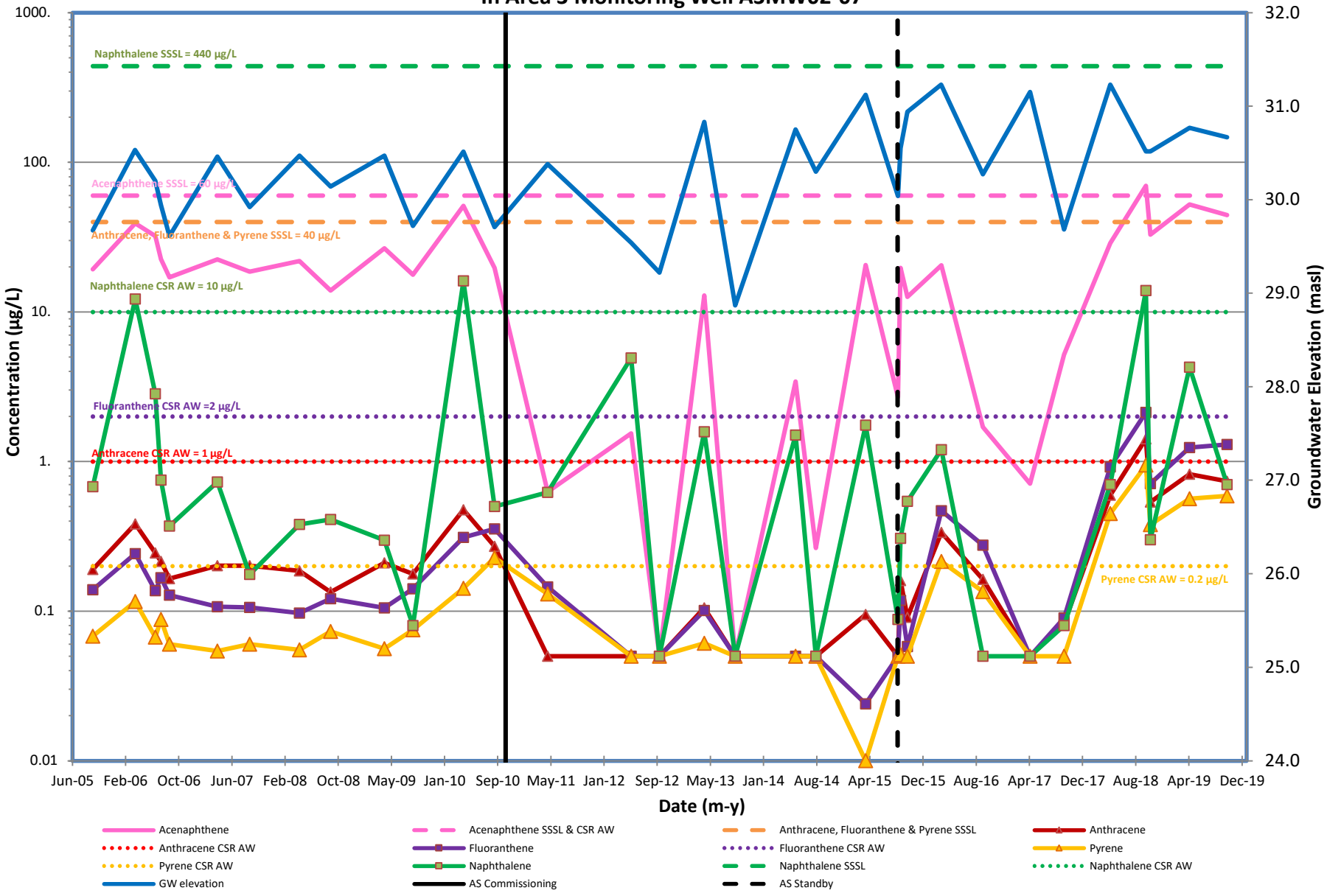
Graph 1: Concentrations of Acridine, Acenaphthene, Benz(a)anthracene, Benzo(a)pyrene, Chrysene, Fluoranthene, Fluorene in Area 3 Monitoring Well U7-10S



Graph 2: Concentrations of Naphthalene, Phenanthrene, Pyrene, and LEPHw in Area 3 Monitoring Well U7-10S

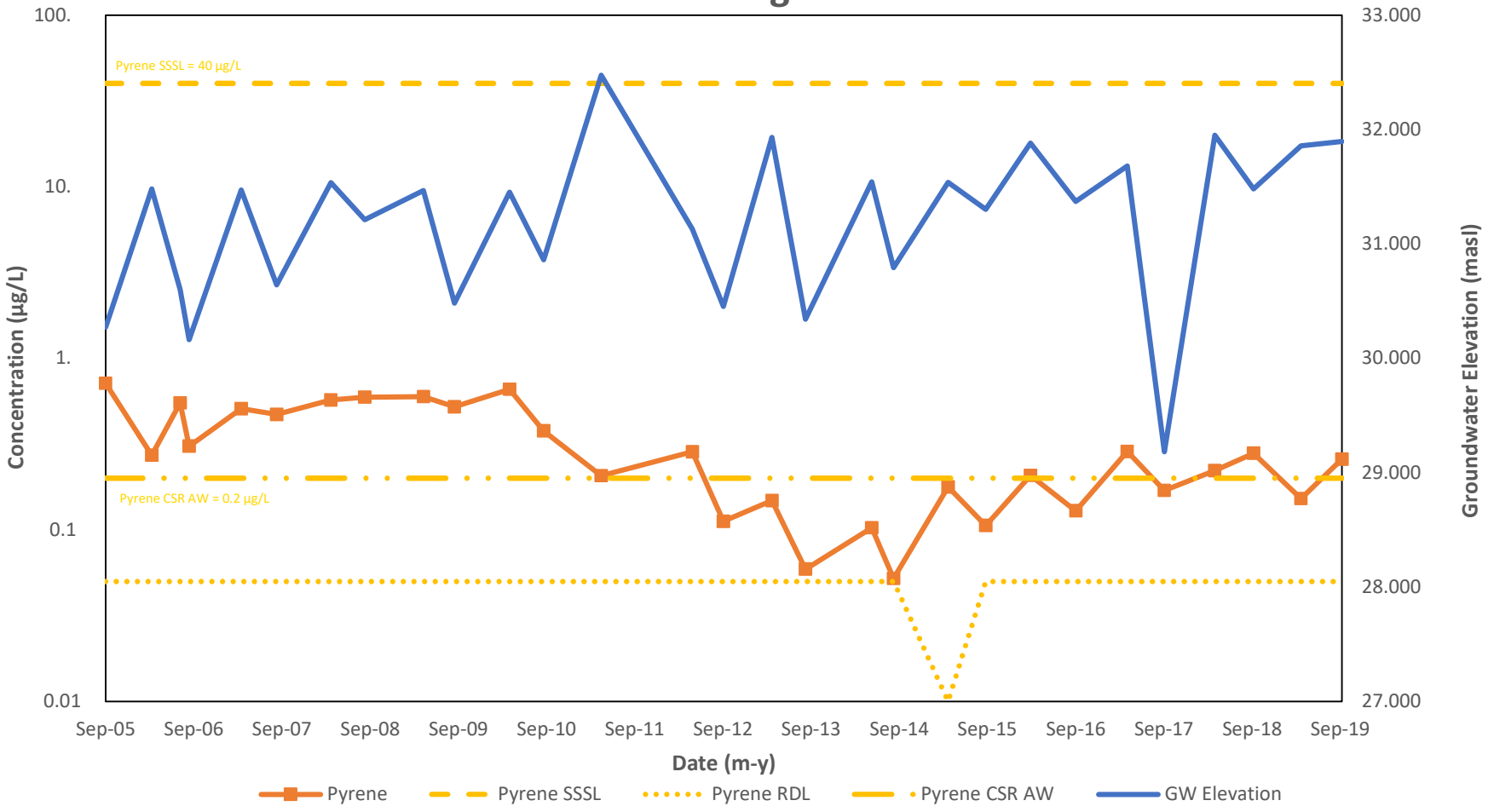


Graph 3: Concentrations of Acenaphthene, Anthracene, Fluoranthene, Naphthalene, and Pyrene In Area 3 Monitoring Well A3MW02-07



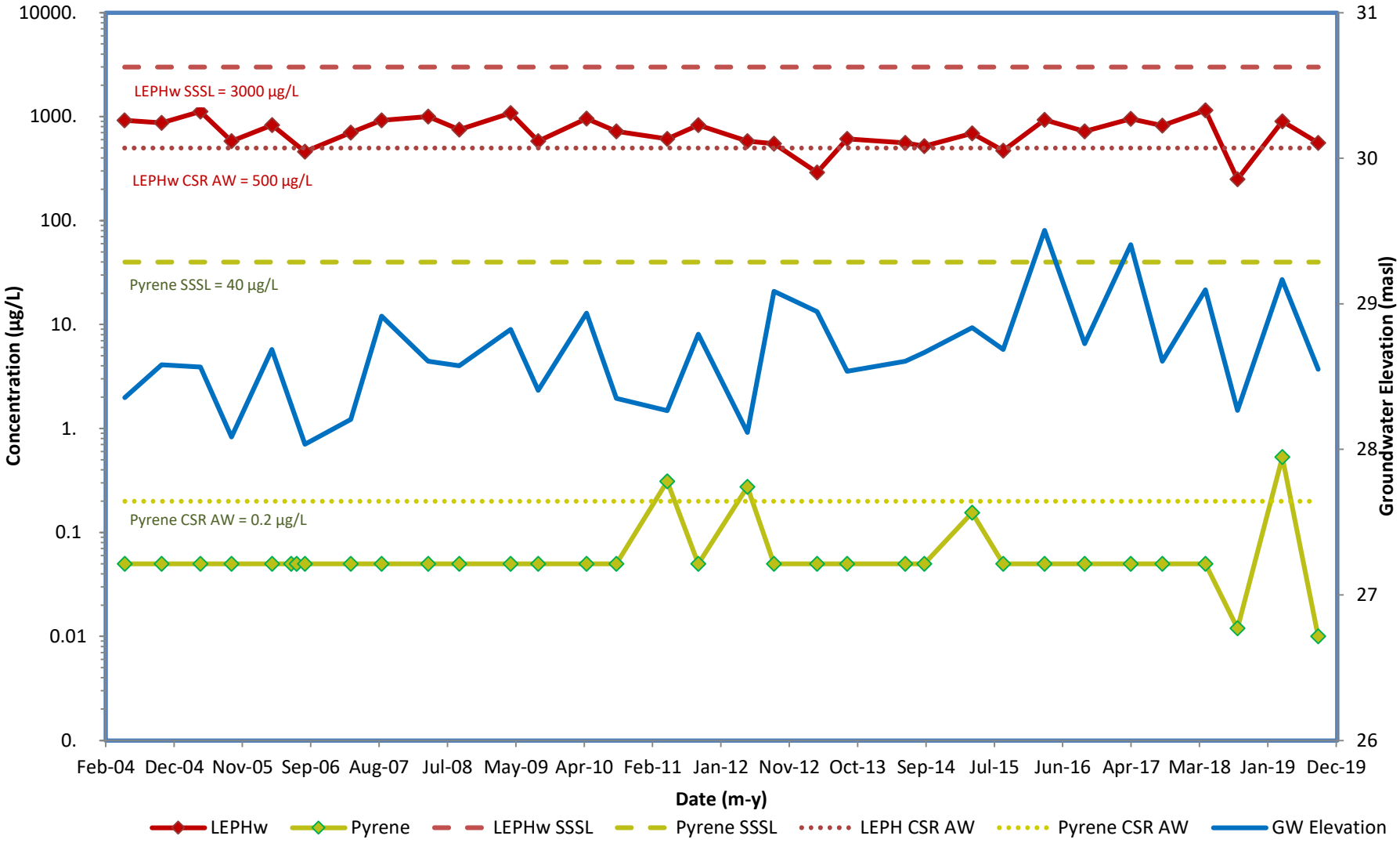
** In the spring of 2015, the laboratory reported detection limit (RDL) was 0.01 µg/L*

Graph 4: Concentrations of Pyrene In Area 3 Monitoring Well A3MW02-08



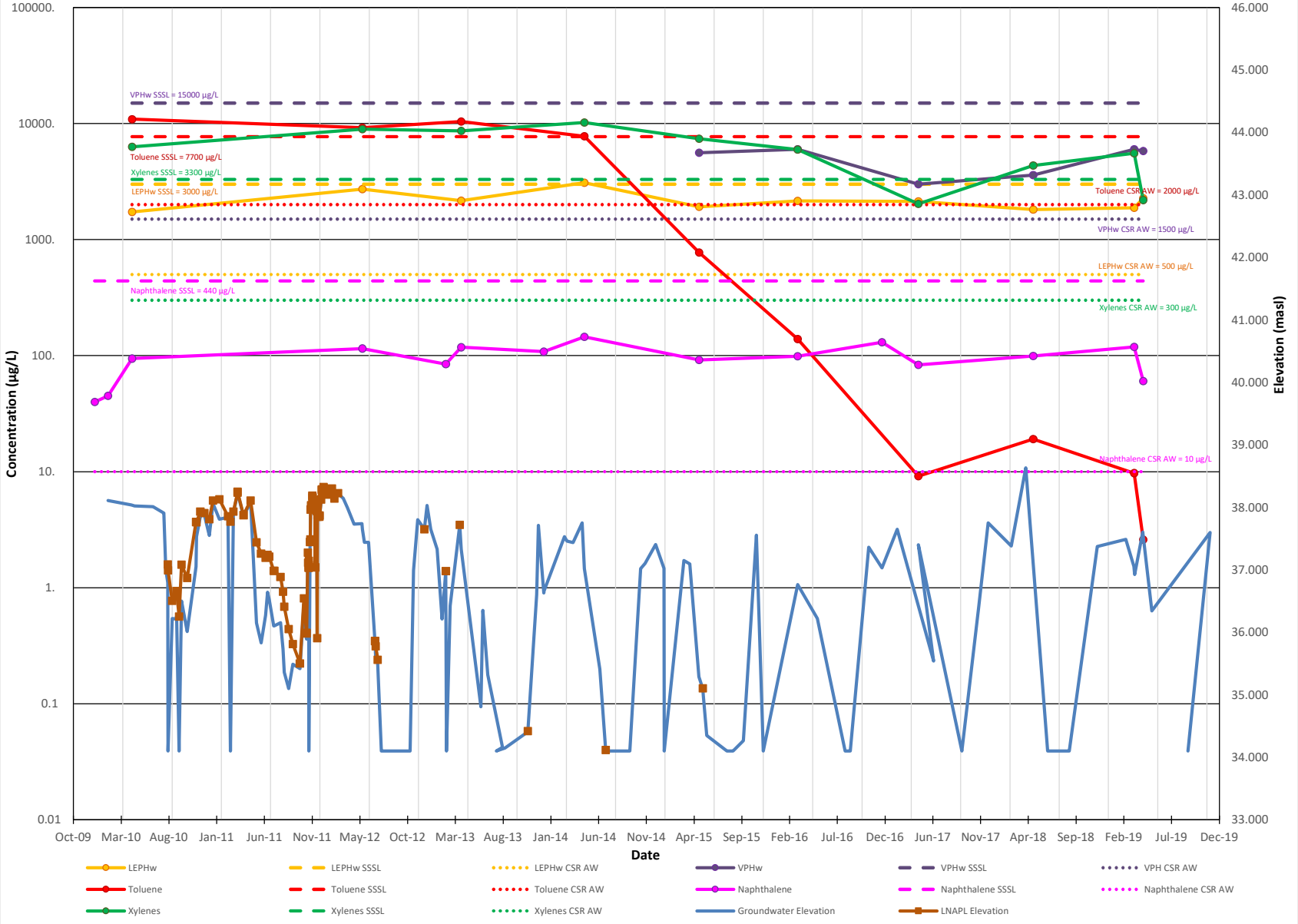
** In the spring of 2015, the laboratory reported detection limit (RDL) was 0.01 µg/L*

Graph 5: Concentrations of LEPHw and Pyrene in Area 3 Monitoring Well A3MW03-02

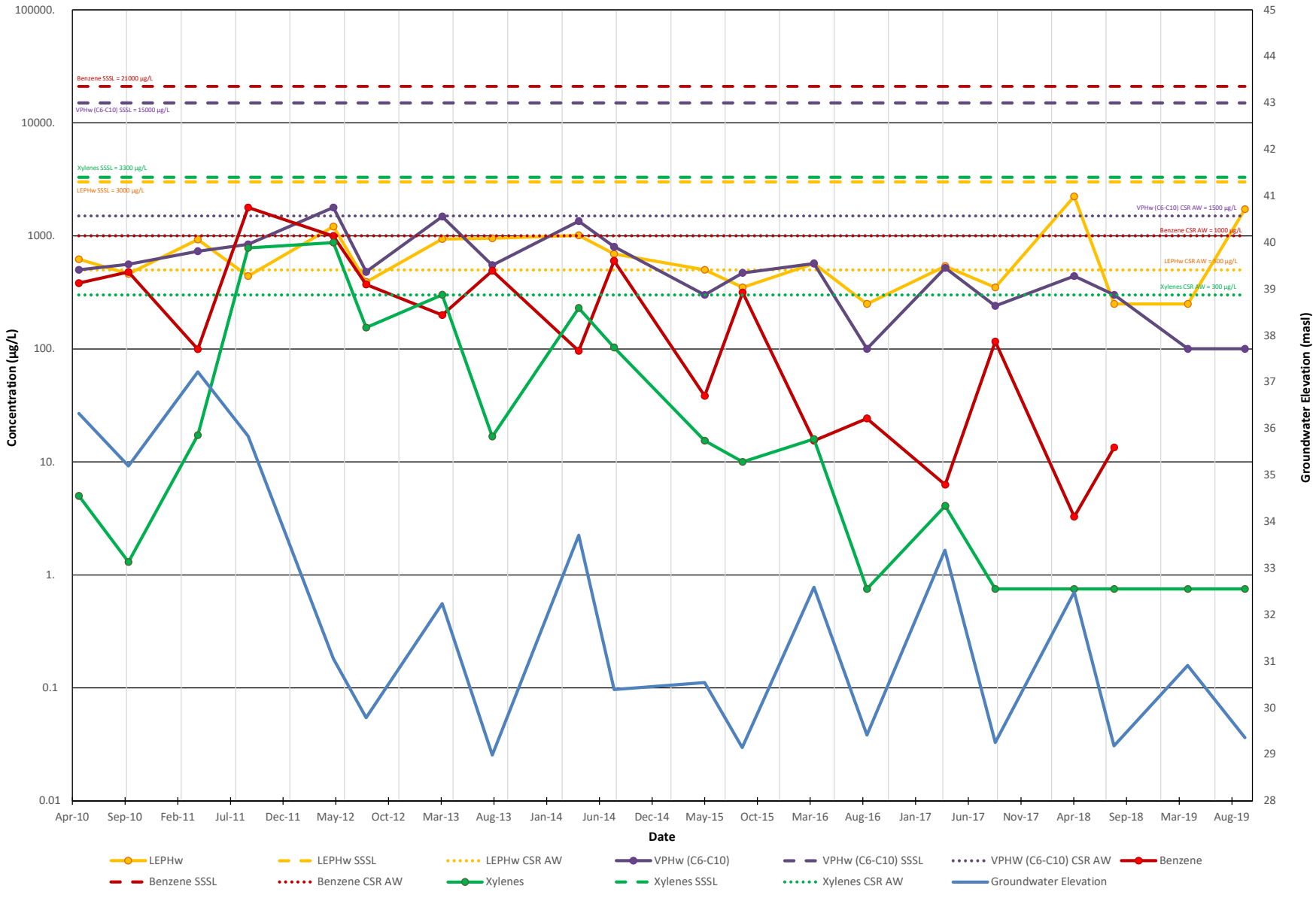


** As of September 2018, the laboratory reported detection limit (RDL) was 0.01 µg/l*

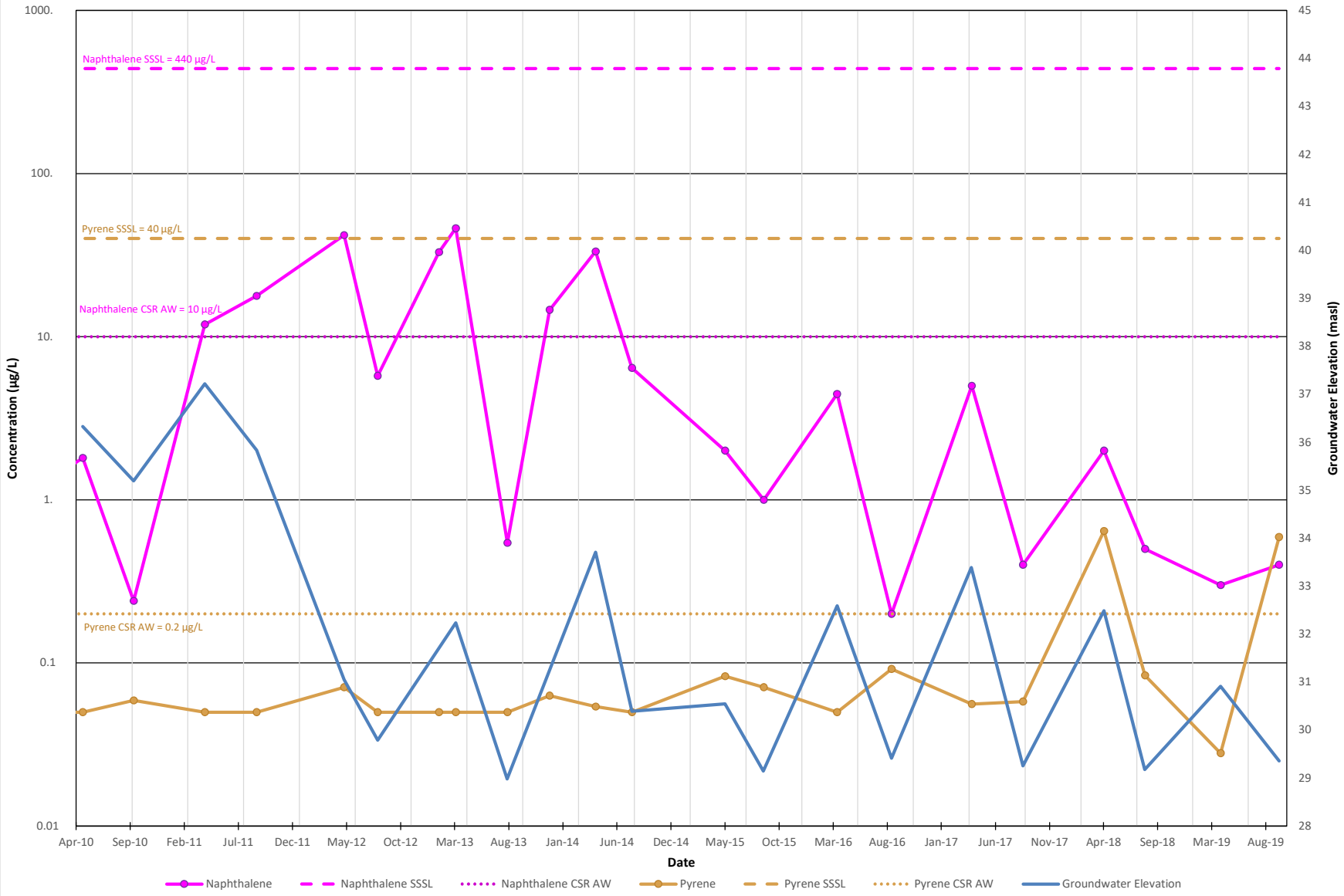
Graph 6: Concentrations of LEPHw, VHw, Toluene, Xylenes, and Naphthalene in Area 2 Monitoring Well A2MW09-11



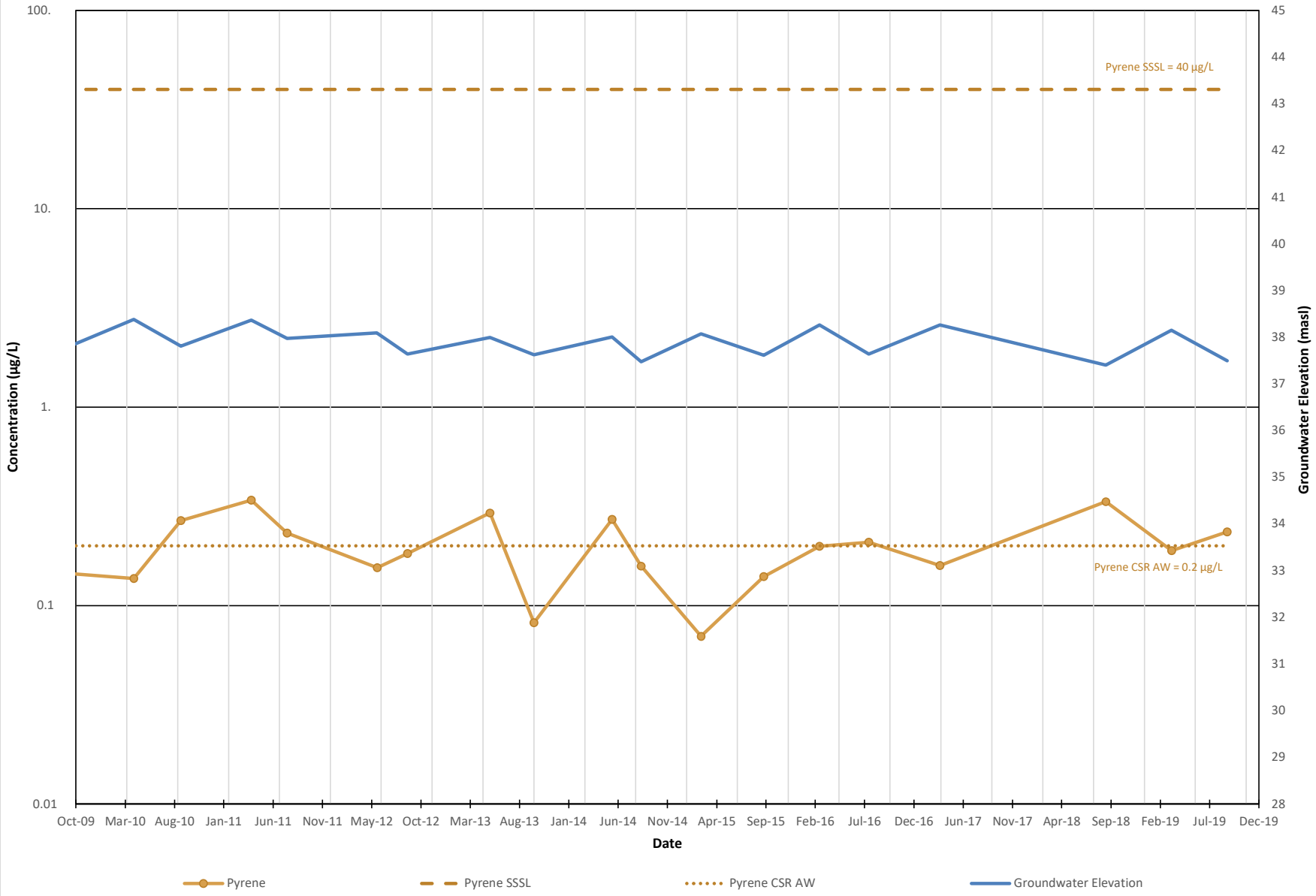
Graph 7: Concentrations of LEPHw, VPHw, Benzene, and Xylenes in Area 2
Monitoring Well A2MW09-06I



Graph 8: Concentrations of Naphthalene and Pyrene in Area 2
Monitoring Well A2MW09-06I

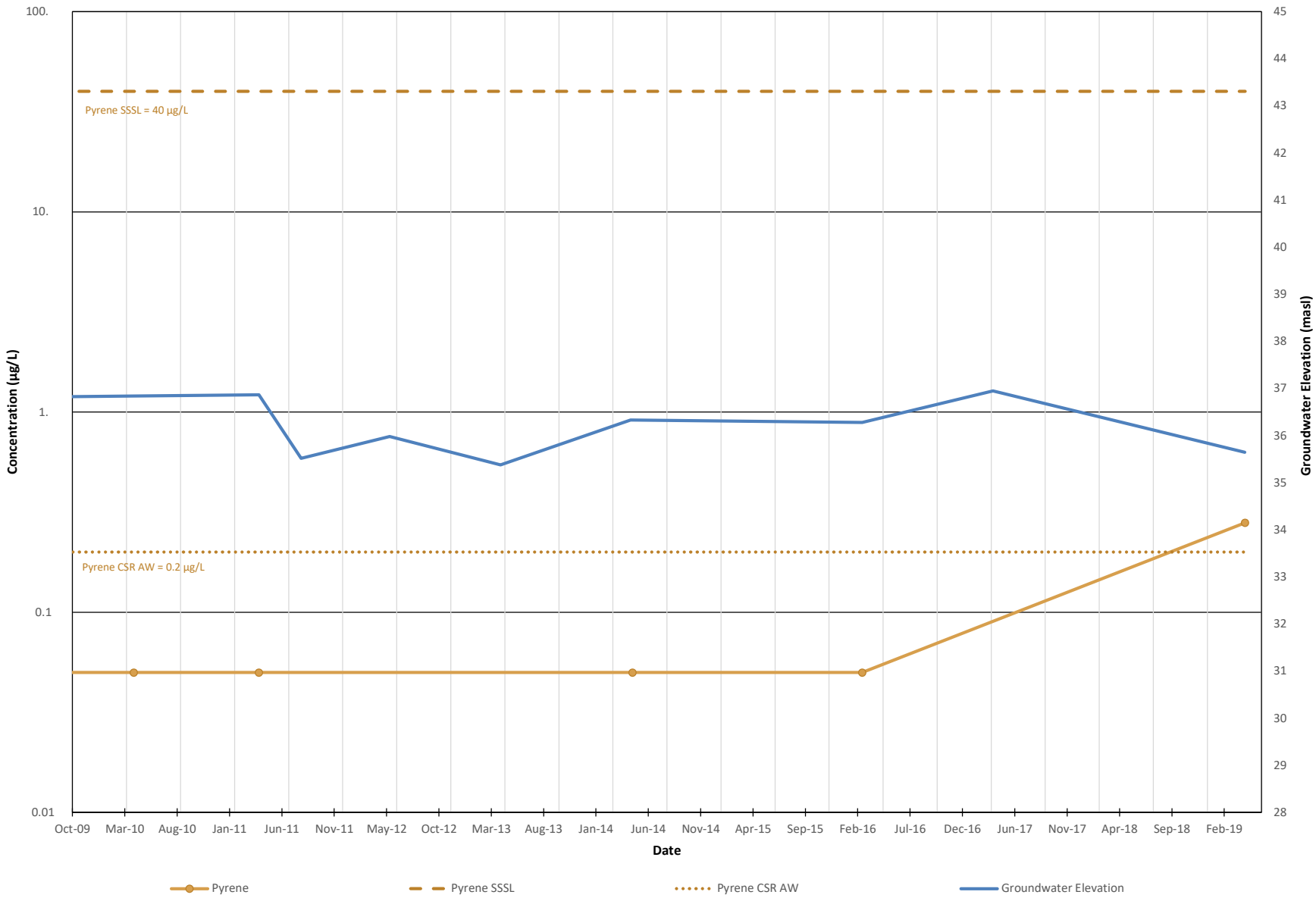


Graph 9: Concentrations of Pyrene in Area 2 Monitoring Well G2-3B

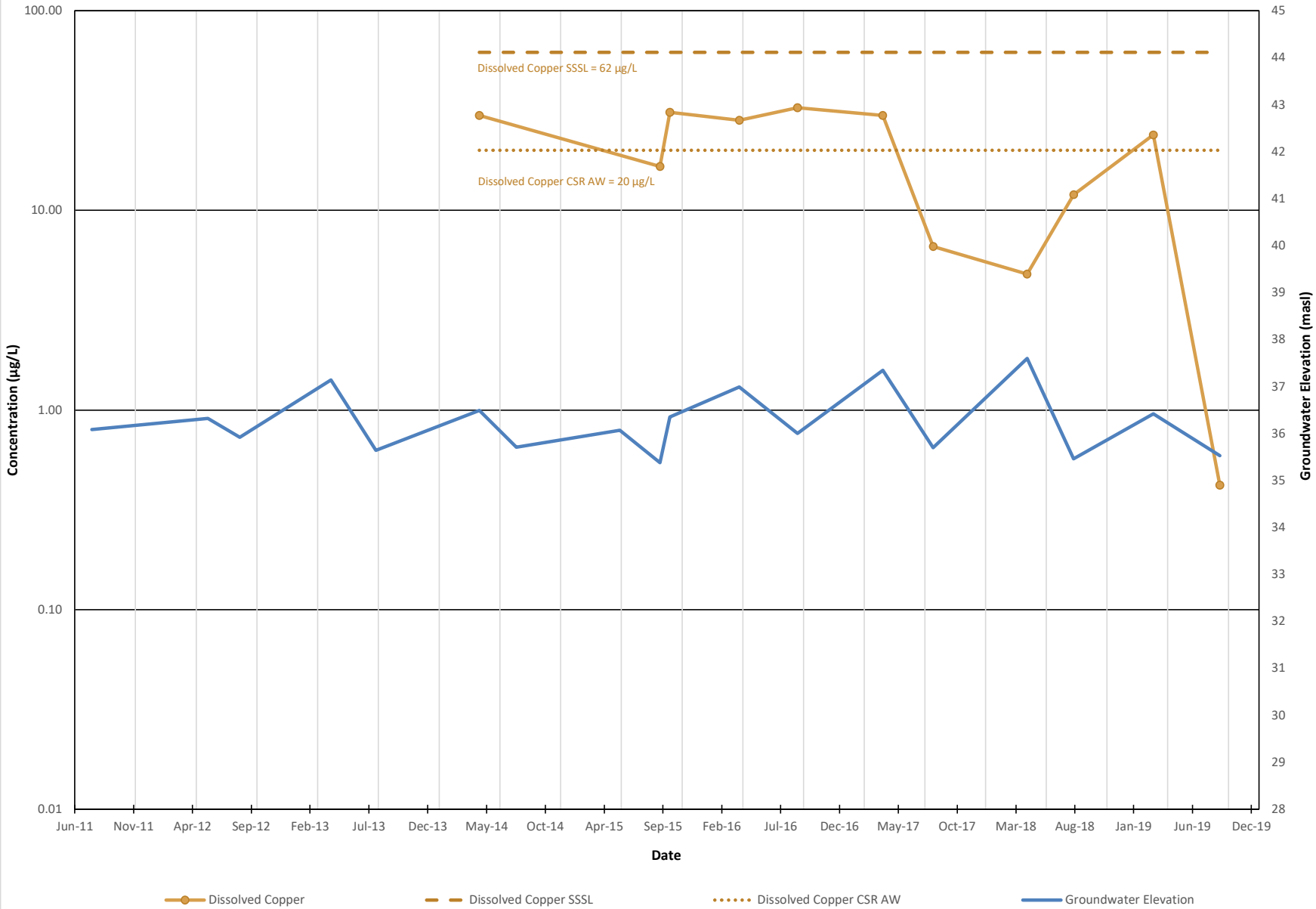


Precipitation data between April 2011 and July 2011 from the Vancouver Harbour CS Weather Station was not available.

Graph 10: Concentrations of Pyrene in Area 2 Monitoring Well PW03-6



Graph 11: Concentrations of Dissolved Copper in Area 2 Monitoring Well MW11-4S



Appendix A- Area 1 and 3 Perimeter Monitoring Program

1 SCOPE OF WORK

In 2019, AECOM completed two groundwater monitoring and sampling events as part of the semi-annual Perimeter Monitoring Program (PMP) in Areas 1 and 3 of the Parkland Burnaby Refinery (Refinery). The planning and execution of the events were scheduled such that one event was completed during the wet season and the other event was completed during the dry season. The dates of the 2019 sampling events are provided in Table 1.

Table 1 - Schedule

Event	Period
Wet Season	March 27 to April 17, 2019
Dry Season	September 19 to September 26, 2019

The Area 1 and Area 3 PMP include the monitoring and sampling (when sufficient water is present) of 32 groundwater monitoring wells. Each well is monitored and sampled in accordance with the field program methods (Appendix E). The monitoring wells included in the 2019 PMP for Areas 1 and 3 are included in Table 2.

Table 2 - Areas 1 and 3 Monitoring Wells Included in the 2019 PMP (Figure 2)

A1-12C	A3MW02-08	G1-1A	G1-7B
A1-12D	A3MW03-01	G1-1B	G1-8
A1-12S	A3MW03-02	G1-1C	NDM97-2
A1-3D	A3MW03-03	G1-2A	NDM97-3
A1-3S	A3MW03-04	G1-2B	U07-10D
A3MW02-05	MW03-07	G1-5	U07-10I
A3MW02-06	U6	G1-6	U07-10S
A3MW02-07	U7	G1-7A	MW17-04

2 MONITORING METHODOLOGY

As part of the PMP, each groundwater monitoring well was monitored for headspace vapours, depth to product if present, depth to water, and total depth of the monitoring well. If sufficient water was present, the following parameters were measured in the field:

- Dissolved oxygen,
- pH and temperature,
- Electrical conductivity, salinity,
- Total dissolved solids (TDS) and,
- Oxidation reduction potential (ORP).

During the 2019 PMP, all 32 monitoring wells were sampled in the wet season. In the dry season sampling event, 30 of the 32 monitoring wells were sampled. Monitoring wells A1-3S and A3MW03-03 both contained insufficient groundwater to sample.

The PMP field monitoring data collected for Areas 1 and 3 monitoring wells for the 2019 PMP and historical perimeter monitoring programs are presented in Table A-1.

3 GROUNDWATER ANALYTICAL RESULTS

Groundwater samples collected as part of the 2019 PMP were analyzed for one or more of the following parameters of concern:

- Petroleum hydrocarbons (PHCs) including one or more of light and heavy extractable petroleum hydrocarbons in water (LEPHw/HEPHw) and/or extractable petroleum hydrocarbons in water ($EPHw_{C10-C19}$/$EPHw_{C19-C32}$),
- Volatile hydrocarbons in water (VHw_{C6-C10}),
- Volatile petroleum hydrocarbons in water (VPHw),
- Benzene/toluene/ethylbenzene/xylenes (BTEX),
- Styrene, and
- Polycyclic aromatic hydrocarbons (PAHs).

The current and historical reported analytical results for groundwater samples from these monitoring wells are presented in Table A-2 and Table A-3. For reference, the laboratory Certificates of Analysis for the 2019 PMP data is provided in Appendix F.

The completed 2019 PMP analytical program for Areas 1 and 3 are summarized in Table 3.

Table 3 - Areas 1 and 3 PMP Analytical Program Summary

	Number of Monitoring Wells Sampled	
Parameter	**Wet Event**	**Dry Event**
LEPHw / HEPHw	14	13*
EPHw	32	30*
BTEX/VPHw/Styrene	32	30*
PAHs	14	13*

Note:

** - discrepancies in number of monitoring wells sampled are due to dry monitoring wells during the dry event; see report for details*

Site-Specific Screening Levels (SSSLs) for select parameters were developed by SLR Consulting Canada Ltd. (SLR), with the support of AECOM, to evaluate potential risks from impacted Site groundwater to Burrard Inlet. Refer to Appendix D for additional information on the development of the SSSLs. The results of the PMP groundwater samples are compared to the SSSLs as well as the Contaminated Sites Regulation (CSR) standards for the protection of marine aquatic life (AW) (CSR standards). In the instance of MW17-4, applicable CSR standards also include the consideration for the protection of freshwater aquatic life. SSSLs represent concentrations which, if exceeded, indicate the need for further assessment/evaluation or remedial action. For those parameters where SSSLs are not available, the CSR standards are used to evaluate the need for further assessment/evaluation or remedial action. A summary of the number of samples containing concentrations of the analyzed parameters above and below the established triggers for further assessment are summarized in Table 4.

Table 4 - Overview of Areas 1 and 3 Groundwater Results

Parameter	Wet Event			Dry Event		
	Result Below RDL	Detectable Result Below SSSLs	Result Above SSSLs	Result Below RDL	Detectable Result Below SSSLs	Result Above SSSLs
LEPHw	12	1	1	11	1	1
EPHw (C10-<C19)	30	1	1	28	1	1
VHw (C6-C10)	30	2	0	27	3	0
VPHw	30	2	0	28	2	0
BTEX	30	2	0	28	2	0
Styrene	32	0	0	30	0	0
PAHs	3	10	1	2	10	1

Note:
RDL= Reported Detection Limit

The reported concentrations for samples collected from 31 of the 32 monitoring wells sampled in Areas 1 and 3 were below the SSSLs. All the reported concentrations above the SSSLs are from the samples collected from monitoring well U07-10S in Area 3.

Concentrations in groundwater samples above the CSR standards, but below the SSSLs for at least one sampling event in 2019 are summarized, by monitoring well, in Table 5.

Table 5 - Summary of Samples below SSSLs, but above the CSR AW Standards

Monitoring Well ID	Parameter Greater Than the CSR AW Standards
U07-10S	Acridine and anthracene
A3MW02-07	Pyrene
A3MW02-08	Pyrene
A3MW03-02	LEPHw, Pyrene

4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

To confirm the integrity and reliability of the data, AECOM field staff followed pre-existing QA/QC protocols during the 2019 PMP. These procedures have resulted in a dataset that achieves the project objectives for monitoring as described in Appendix G.

4.1 Travel Blanks

During the 2019 wet and dry season sampling events, 14 travel blank samples were submitted with groundwater samples and analyzed for BTEX/VPHw, VHw, and styrene. Concentrations for all samples were less than the RDLs, except for TRAVEL BLANK-9, submitted on Sept 25, 2019. The reported concentration of toluene in this blank was 0.89µg/L. Upon receipt of this detection AECOM discussed the result with the lab at which time it was jointly agreed that a possible cause of the detectable concentration is due to sample mishandling or cross-contamination within the batch of samples submitted to the lab, as

the majority of samples submitted in the same batch on September 25 had results below the RDL of 0.75µg/L. The reported analytical results for the travel blanks are presented in the laboratory Certificates of Analysis (COA) provided in Appendix F and summarized at the bottom of Table A-2.

Based on review of the analytical associated with TRAVEL BLANK-9 and consultation with the project laboratory it doesn't appear that the travel blank result affects the findings, conclusions, or recommendations associated with the accompanying analyses. It has also resulted in AECOM's re-enforcement of sample and blank handling procedures, including the review of acceptable labelling pens (i.e. high VOC permanent markers are not permitted).

4.2 Precision

Relative percent differences (RPDs) are presented for duplicate samples in Tables A-2 and A-3.

RPDs were calculated for BTEX/VPHw, Styrene, VHwC6-C10, LEPHw/HEPHw, EPHw$_{C10-C19}$/$_{EPHwC19-C32}$ and PAHs in instances where the reported concentration of the parent and duplicate sample were five times the reported detection limit or greater. The average value was calculated using the absolute RPD numbers. It should be noted that the data set is small for statistical purposes as most reported concentrations were less than the RDLs. During the 2019 wet and dry season sampling events, 10 duplicate samples were collected. Of the samples collected, a total of 12 parameters were suitable for RPD calculation. The average, maximum, and minimum RPDs of the field duplicates are presented in Table 6.

Table 6 - Summary of RPD (%) of Duplicate Analyses

Sample Type	Average RPD (%)	Maximum RPD (%)	Minimum RPD (%)
Groundwater Samples			
Organic Parameters (LEPHw/HEPHw, EPHw, VPHw, VHw, BTEX, Styrene, and PAHs)	18.92	49.3	0.4

The average RPD value of organic parameters (18.92%) indicates a sufficient correlation for duplicate pairings for the entire analytical program. The maximum RPD value of 49.3% was calculated using the reported Fluoranthene concentrations from monitoring well A3MW03-02 and its duplicate sample (DUP-13); both concentrations were below the SSSL.

The BC Environmental Lab Manual (BCELM) provides data quality objectives for recommended laboratory duplicate RPDs[3]. ENV has provided guidance indicating fields RPDs within 1.5 times the laboratory RPDs, as defined in the BCELM, are acceptable[4]. As a result, organic parameters in water therefore have an acceptable field RPD of 45%. Based on this guidance and the above results, the calculated RPDs for organic parameters in groundwater are within acceptable limits; with the exception select PAH parameters (benzo(a)anthracene, fluoranthene, phenanthrene, and pyrene) for parent sample (A3MW03-02) and its duplicate sample (DUP-13) which were greater than 45%. Based on sampling notes for this sampling event it appears that this sample may have contained entrained sediment. Varying amounts of entrained sediment in the parent and duplicate sample is anticipated to be the primary contributing factor for the difference in the select reported PAH parameters. During the dry season sampling event in September this well was again selected for a duplicate sample (DUP-9) due to the RPD's observed during the April event. During this program a clear sample was verified by the field technician and the resulting RPDs between the parent and duplicate sample were acceptable for all parameters calculated. The sediment entrained in the April 2019 samples likely resulted in conservative

[3] British Columbia Environmental Laboratory Manual (2015)
http://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/emre/lab-manual/section-a.pdf
[4] Question #36 from the BC MoE Questions and Answers webpage accessed February 27, 2019.
http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/contaminated-sites/cs_q-a.pdf

reporting of PAH parameters and therefore is not anticipated to change the findings of this report due to the biased high nature of the results.

4.3 Accuracy

Analytical accuracy was confirmed in a review of percent recoveries reported in the laboratory reports. Percent recoveries are obtained when the project laboratory analyzes samples with known concentrations and compares their analytical results to the known concentrations. The laboratory provided percent recoveries for most of the organic parameter analyses. All reported laboratory control spike (LCS) sample recoveries and matrix control spike (MS) sample recoveries were within laboratory quality control (QC) limits, with the exception of 15 samples reported in four laboratory reports (L2250150, L2556470, L2354359, and L2354839). Where the LCS and MS sample recoveries were outside of laboratory QC limits. The associated analytical results did not appear to be affected.

The analytical results are sufficiently accurate for the purposes of this monitoring program.

4.4 Completeness

No samples from either sampling events were invalidated by ALS Environmental due to condition on arrival at the laboratory. All samples were analysed as indicated on the COAs that accompanied the samples.

TABLE A-1
AREAS 1 AND 3 GROUNDWATER MONITORING DATA
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY

Well ID	Sample ID	Screened Interval (mbgs)	Date Monitored	Total Depth of Well (m from TOC)	Ground Elevation (mASL)[1]	Top of Casing Elevation (TOC, mASL)1	Headspace Vapour Concentration (ppmv)	Depth to Product (m from TOC)	Apparent Product Thickness (mm)	Depth to Water (DTW, m from TOC)	Groundwater Elevation (mASL)[1]	Dissolved Oxygen (mg/L)	pH	Temperature (°C)	Electrical Conductivity (µS/cm)	TDS (g/L)	Salinity (ppt)	ORP (mV)	Observations
A1-12C	A1-12C	5.2-6.7	27-Mar-19	6.550	55.453	55.346	110	nd	na	3.48	51.866	1.64	6.25	12.73	1053.	0.893	0.7	100.3	Cloudy
A1-12C	A1-12C	5.2-6.7	24-Sep-19	6.561	55.453	55.346	5	nd	na	3.373	51.973	0.08	6.19	14.7	708.	0.572	0.44	5.9	Clear
A1-12D	A1-12D	1.7-3.2	27-Mar-19	3.952	55.143	55.029	60	nd	na	1.382	53.647	0.22	6.13	10.99	909.	0.807	0.62	6.8	slightly silty (brown); DUP-07
A1-12D	A1-12D	1.7-3.2	24-Sep-19	3.960	55.143	55.029	65	nd	na	1.07	53.959	0.29	7.24	16.72	1018.	0.786	0.61	-64.1	Clear
A1-12S	A1-12S	0.98-2.48	27-Mar-19	2.364	55.225	55.141	20	nd	na	1.293	53.848	4.76	6.29	11.45	274.	0.241	0.18	105.4	murky; brown colour, sampled on recharge
A1-12S	A1-12S	0.98-2.48	24-Sep-19	2.360	55.225	55.141	20	nd	na	0.758	54.383	3.08	6.78	17.76	647.	0.499	0.38	<7.8	Clear
A1-3D	A1-3D	10.9-15.5	2-Apr-19	15.105	46.105	45.948	5	nd	na	8.484	37.464	7.71	5.67	10.66	567.	0.495	0.37	-0.1	clear with silty particles; sampled on next day, purged + sampled using watera
A1-3D	A1-3D	10.9-15.5	19-Sep-19	15.185	46.105	45.948	15	nd	na	8.583	37.365	6.91	8.98	12.23	494.	0.424	0.32	-20.6	Slightly cloudy (grey); slightly silty
A1-3S	A1-3S	1.1-4.1	10-Apr-19	3.365	46.219	46.121	60	nd	na	3.116	43.005	8.93	6.48	9.13	2411.	2.25	1.83	156.7	clear
A1-3S	ns	1.1-4.1	19-Sep-19	3.371	46.219	46.121	35	nd	na	3.343	42.778	nm	nm	nm	nm	nm	nm	nm	Insufficient water column to sample
A3MW02-05	A3MW02-05	2.4-6.1	9-Apr-19	6.033	33.145	33.042	10	nd	na	2.074	30.968	5.79	6.49	9.46	627.	0.58	0.44	74.9	Clear; slightly yellow tinged; minor orange sediment
A3MW02-05	A3MW02-05	2.4-6.1	26-Sep-19	6.040	33.145	33.042	530	nd	na	2.29	30.752	0.26	7.26	15.59	738.	0.585	0.45	-76.2	Clear
A3MW02-06	A3MW02-06	3.4-6.4	8-Apr-19	6.250	33.191	33.121	10	nd	na	2.671	30.45	<0.03	6.58	11.91	532.	0.461	0.35	645.6	Cloudy; Yellow tinged; sediments present
A3MW02-06	A3MW02-06	3.4-6.4	26-Sep-19	6.266	33.191	33.121	130	nd	na	2.787	30.334	0.05	6.44	16.5	452.8	0.351	0.26	-48.3	Clear
A3MW02-07	A3MW02-07	3.1-6.2	9-Apr-19	5.450	33.453	33.371	85	nd	na	2.601	30.77	<0.01	6.42	11.73	838.	0.729	0.56	705.3	Clear
A3MW02-07	A3MW02-07	3.1-6.2	26-Sep-19	5.481	33.453	33.371	75	nd	na	2.702	30.669	0.28	7.5	15.24	829.	0.662	0.51	-122.9	Clear
A3MW02-08	A3MW02-08	1.5-5.5	9-Apr-19	4.948	33.145	33.072	45	nd	na	1.215	31.857	0.09	6.38	14.26	608.	0.498	0.38	5.2	silty/cloudy
A3MW02-08	A3MW02-08	1.5-5.5	26-Sep-19	4.990	33.145	33.072	120	nd	na	1.175	31.897	0.4	6.96	18.56	738.	0.547	0.41	-100.2	Clear, DUP-10
A3MW03-01	A3MW03-01	1.5-6.1	9-Apr-19	5.479	32.024	31.896	180	nd	na	3.33	28.566	0.34	6.83	10.46	24663.	22.2	21.38	208	Clear, minor sediments
A3MW03-01	A3MW03-01	1.5-6.1	25-Sep-19	5.520	32.024	31.896	45	nd	na	3.95	27.946	1.14	7.06	14.85	37567.	30.29	30.28	-19.6	Clear
A3MW03-02	A3MW03-02	2.3-8.3	9-Apr-19	7.906	33.292	33.185	nd	nd	na	4.018	29.167	<0.02	6.88	11.17	856.	0.756	0.58	798.7	slightly cloudy/silty, some suspended particles; globules present when purging; DUP-13
A3MW03-02	A3MW03-02	2.3-8.3	25-Sep-19	7.928	33.292	33.185	15	nd	na	4.635	28.55	0.55	6.69	15.	1026.	0.826	0.64	-69.5	Clear ; DUP-9
A3MW03-03	A3MW03-03	0.8-6.9	9-Apr-19	4.157	32.972	32.868	25	nd	na	3.952	28.916	4.36	6.77	11.72	603.	0.525	0.4	65	clear; minor orange sediment; sample taken on recharge
A3MW03-03	A3MW03-03	0.8-6.9	26-Sep-19	4.490	32.972	32.868	15	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A3MW03-04	MW03-04	1.5-6.7	8-Apr-19	6.652	33.42	33.316	280	nd	na	4.623	28.693	0.02	6.16	12.23	8999.	0.773	0.59	365.8	sampled on recharge
A3MW03-04	MW03-04	1.5-6.7	26-Sep-19	6.655	33.42	33.316	100	nd	na	4.885	28.431	0.48	7.03	13.69	780.	0.647	0.47	-48.6	Clear
MW03-07	MW03-07	0.6-2.2	2-Apr-19	2.103	34.965	34.874	110	nd	na	1.282	33.592	0.55	6.5	10.74	10461.	9.344	836	145.3	cloudy/opaque
MW03-07	MW03-07	0.6-2.2	25-Sep-19	2.120	34.965	34.874	nd	nd	na	1.296	33.578	0.64	8.31	16.51	3719.	2.886	2.38	-138.8	Clear
G1-1A	G1-1A	3.1-6.1	4-Apr-19	6.004	39.921	39.765	75	nd	na	4.076	35.689	0.06	5.96	11.	1005.	0.892	0.69	174.9	cloudy/opaque and silty
G1-1A	G1-1A	3.1-6.1	23-Sep-19	6.008	39.921	39.765	200	nd	na	3.944	35.821	6.02	6.64	11.57	2256.	1.972	1.59	-61.9	Clear
G1-1B	G1-1B	10.8-12.3	4-Apr-19	12.454	39.634	39.512	nd	nd	na	8.393	31.119	6.06	7.99	14.07	8047.	6.612	5.77	305.5	Cloudy/opaque and silty
G1-1B	G1-1B	10.8-12.3	23-Sep-19	12.440	39.634	39.512	0	nd	na	8.375	31.137	0.03	5.81	14.5	614.	0.501	0.38	-13.1	Clear
G1-1C	G1-1C	19.8-21.3	4-Apr-19	21.333	40.506	40.405	30	nd	na	9.779	30.626	6.37	8.57	13.18	709.	0.595	0.45	167.7	cloudy/opaque and silty
G1-1C	G1-1C	19.8-21.3	23-Sep-19	21.327	40.506	40.405	10	nd	na	9.956	30.449	6.14	8.88	11.24	567.	0.51	0.38	-24.4	Purged dry at 40L; sampled on recharge; Clear
G1-2A	G1-2A	1.8-3.4	28-Mar-19	3.201	34.462	34.352	25	nd	na	1.371	33.172	3.85	7.19	8.8	2004.	1.889	1.51	103.3	slightly silty (grey)
G1-2A	G1-2A	1.8-3.4	24-Sep-19	3.220	34.462	34.352	5	nd	na	1.585	33.172	0.4	7.21	17.71	2246.	1.692	1.35	-31.1	Clear
G1-2B	G1-2B	4.6-6.1	28-Mar-19	6.259	34.398	34.255	30	nd	na	1.203	33.052	1.19	6.95	10.99	11621.	10.31	9.3	80.2	Slighltly silty (brown/orange)
G1-2B	G1-2B	4.6-6.1	24-Sep-19	6.271	34.398	34.255	5	nd	na	1.203	33.052	4.52	8.65	16.6	1999.	1.528	1.21	-17.2	Clear
G1-5	G1-5	9.1-12.2	2-Apr-19	12.608	51.856	51.740	5	nd	na	6.752	44.988	4.07	6.73	15.14	528.	0.423	0.31	161.5	clear; sampled on recharge
G1-5	G1-5	9.1-12.2	19-Sep-19	12.613	51.856	51.740	15	nd	na	6.945	44.795	8.66	7.79	11.93	601.	0.52	0.4	-12.8	Slightly cloudy (grey); slightly silty
G1-6	G1-6	7.9-11	2-Apr-19	10.803	42.280	42.179	15	nd	na	5.469	36.71	0.27	7.33	12.23	614.	0.528	0.4	-23.8	Clear; sampled on recharge; DUP-09
G1-6	G1-6	7.9-11	19-Sep-19	10.811	42.280	42.179	85	nd	na	5.244	36.935	0.38	7.87	11.49	612.	0.536	0.41	-38.4	Clear
G1-7A	G1-7A	0.9-2.4	4-Apr-19	2.709	35.038	34.913	45	nd	na	1.632	33.281	0.05	7.41	8.55	4632.	4.39	3.71	621	clear
G1-7A	G1-7A	0.9-2.4	23-Sep-19	2.680	35.038	34.913	95	nd	na	1.6	33.313	0.57	7.35	16.	2510.	1.956	1.57	79.6	Plurged dry at 18L; sampled on recharge; Clear
G1-7B	G1-7B	6.1-9.1	4-Apr-19	15.420	35.047	34.910	nd	nd	na	3.407	31.503	1.16	8.61	11.92	496.	0.43	0.32	15.7	Clear; sampled on recharge; DUP-11
G1-7B	G1-7B	6.1-9.1	23-Sep-19	15.460	35.047	34.910	10	nd	na	3.485	31.425	0.14	8.43	12.3	388.2	0.333	0.25	-100.8	Clear; DUP-6
G1-8	G1-8	7.0-13.1	3-Apr-19	13.736	34.791	34.663	180	nd	na	2.146	32.517	1.48	8.41	11.37	1190.	1.045	0.82	-60.1	Clear
G1-8	G1-8	7.0-13.1	23-Sep-19	13.750	34.791	34.663	20	nd	na	2.08	32.583	0.78	8.38	12.25	598.	0.514	0.39	-111.2	Clear
NDM97-2	NDM97-2	2.3-5.1	28-Mar-19	5.053	34.825	34.701	20	nd	na	0.523	34.178	0.3	6.87	9.	1280.	1.197	0.94	52.7	Clear
NDM97-2	NDM97-2	2.3-5.1	23-Sep-19	5.050	34.825	34.701	20	nd	na	0.575	34.126	2.63	7.47	14.57	703.	0.571	0.43	-42.3	Clear
NDM97-3	NDM97-3	6.1-9.1	3-Apr-19	9.023	35.003	34.873	210	nd	na	2.914	31.959	0.18	7.37	10.92	7.93	0.703	0.54	62.7	silty; DUP-10
NDM97-3	NDM97-3	6.1-9.1	23-Sep-19	9.075	35.003	34.873	70	nd	na	2.836	32.037	1.77	7.41	12.5	307.5	0.263	0.2	145.6	Clear, small black specs
U07-10D	U07-10D	8.5-10.65	9-Apr-19	10.009	33.164	33.069	nd	nd	na	3.916	29.153	5.08	6.93	11.8	620.	0.538	0.41	69.2	clear
U07-10D	U07-10D	8.5-10.65	25-Sep-19	10.038	33.164	33.069	15	nd	na	3.551	29.518	0.83	8.14	14.66	495.	0.401	0.3	-54.1	Clear
U07-10I	U07-10I	6.65-8.15	9-Apr-19	7.463	33.164	32.993	35	nd	na	3.275	29.718	<0.02	6.91	11.65	828.	0.722	0.56	634.9	clear; minor sediment
U07-10I	U07-10I	6.65-8.15	25-Sep-19	7.478	33.164	32.993	10	nd	na	3.431	29.562	1.08	6.81	15.1	434.3	0.348	0.26	-42.1	Clear
U07-10S	U07-10S	4.7-6.2	9-Apr-19	6.132	33.112	32.950	400	nd	na	4.078	28.872	0.	6.65	11.79	879.	0.764	0.59	717.9	DNAPL at bottom of well (purged);Slightly yellow tinged; minor sediment; sampled for BTEX/VPH, LEPH/HEPH and PAHs
U07-10S	U07-10S	4.7-6.2	10-Apr-19	6.132	33.112	32.950	nd	nd	na	4.149	28.801	0.21	6.26	10.48	899.	0.808	0.62	434.7	DNAPL at bottom of well (purged); water was clear; sheen; globules; sample for VOCs/SVOCs
U07-10S	U07-10S	4.7-6.3	25-Sep-19	6.150	33.112	32.950	470	nd	na	4.305	28.645	0.06	6.12	14.9	709.	0.572	0.43	-22.9	Clear, hc odour
U6	U6	0.9-3.9	8-Apr-19	3.909	32.889	32.789	20	nd	na	0.665	32.124	<0.02	6.4	9.59	86.	0.071	0.06	621.9	sediment; DUP-12
U6	U6	0.9-3.9	26-Sep-19	3.911	32.889	32.789	25	nd	na	0.663	32.126	1.63	6.7	15.75	81.	0.064	0.05	-36.2	Clear
U7	U7	1.2-5.8	8-Apr-19	6.515	32.783	32.618	5	nd	na	1.692	30.926	5	6.85	9.32	229.	0.213	0.16	-36.8	clear, minor sediments
U7	U7	1.2-5.8	26-Sep-19	6.503	32.783	32.618	50	nd	na	0.955	31.663	0.25	6.62	15.9	151.6	0.12	0.09	20.5	Clear
MW17-04	MW17-04	0.8 - 1.5	17-Jul-17	1.360	52.989	52.883	180	nd	na	0.8	52.083	0.86	5.65	15.54	1012.	0.803	0.62	83	Clear
MW17-04	MW17-04	0.8 - 1.5	5-Apr-18	1.283	52.989	52.883	180	nd	na	0.756	52.127	0.46	6.49	8.41	869.	0.827	0.64	-1.2	Clear
MW17-04	MW17-04	0.8 - 1.5	30-Aug-18	1.280	52.989	52.883	230	nd	na	0.851	52.032	1.08	0.28	15.97	1162.	0.912	0.71	22.8	Clear; sampled
MW17-04	MW17-04	0.8 - 1.5	28-Mar-19	1.360	52.989	52.883	95	nd	na	0.823	52.06	0.58	6.34	9.22	1293.	1.188	0.93	-7.8	Clear; sampled on recharge
MW17-04	MW17-04	0.8 - 1.5	24-Sep-19	1.359	52.989	52.883	150	nd	na	0.776	52.107	0.64	7.42	14.8	1367.	1.103	0.86	-32.6	Clear

Abbreviations:

BC	Bailer confirmed
°C	Degree Celsius
DUP	Duplicate
g/L	Grams per litre
L	Litres
m	Metres
mASL	Metres above sea level
mbgs	Metres below ground surface
mg/L	Milligrams per litre
mL	Millilitres
mV	Millivolts
µS/cm	Microsiemens per centimeter
na	Not applicable/ available
nd	Not detected
nm	Not monitored
ns	Not sampled
ORP	Oxidation reduction potential
ppmv	Parts per million by volume
ppt	Parts per thousand
TDS	Total dissolved solids
TOC	Top of casing
---	No observations noted

Notes:

1 Elevations are in Parkland Datum = Geodetic Datum + 91.51 feet (27.895 m)

TABLE A-2
AREAS 1 AND 3 CONCENTRATIONS OF EXTRACTABLE PETROLEUM HYDROCARBONS IN GROUNDWATER
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY
µg/L (ppb)

					LEPHw[3]	HEPHw[3]	EPH w (C10-<C19)[2,3]	EPH w (C19-C32)[3]	VH w (C6-C10)	VPHw	Benzene	Toluene	Ethylbenzene	Xylenes	Styrene	Groundwater Classification
Generic Numerical Water Standards[4]																
CSR	Schedule 3.2 - Freshwater Aquatic Life			(AW)	500[1]	NS	5000[1]	NS	15000[1]	1500[1]	400	5	2000	300[1]	720[1]	
	Schedule 3.2 - Marine Aquatic Life			(AW)	500[1]	NS	5000[1]	NS	15000[1]	1500[1]	1000	2000	2500	300[1]	720[1]	
	Site-Specific Screening Levels (SSSLs)				3000	NS	5000	NS	15000	15000	21000	7700	3200	3300	720	
Well ID	**Sample ID**	**Screened Interval (mbgs)**	**ALS Laboratory Report #**	**Sample Date**												
A1-3D	A1-3D	10.9-15.5	L2253959-1	04-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A1-3D	A1-3D	10.9-15.5	L2350854-1	19-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A1-3S	A1-3S	1.1-4.1	L2256471-1	10-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A1-12S	A1-12S	1.0-2.5	L2250150-1	27-Mar-19	---	---	<250	<250.	<100	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A1-12S	A1-12S	1.0-2.5	L2353321-3	24-Sep-19	---	---	<250	<250.	<100	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A1-12C	A1-12C	5.2-6.7	L2250150-3	27-Mar-19	---	---	<250.	290.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A1-12C	A1-12C	5.2-6.7	L2353321-5	24-Sep-19	---	---	<250.	<250	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A1-12D	A1-12D	1.7-3.2	L2250150-2	27-Mar-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A1-12D	DUP-7	1.7-3.2	L2250150-4	27-Mar-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
QA/QC RPD				27-Mar-19	---	---	---	---	---	---	---	---	---	---	---	
A1-12D	A1-12D	1.7-3.2	L2353321-4	24-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-05	A3MW02-05	2.4-6.1	L2255718-9	09-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-05	A3MW02-05	2.4-6.1	L2354839-6	26-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-06	A3MW02-06	3.4-6.4	L2255046-4	08-Apr-19	<250.	<250.	<250.	<250.	170.	170.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-06	A3MW02-06	3.4-6.4	L2354839-7	26-Sep-19	<250.	<250.	<250.	<250.	<100	<100	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-07	A3MW02-07	3.1-6.2	L2255718-3	09-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-07	A3MW02-07	3.1-6.2	L2354839-2	26-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-08	A3MW02-08	1.5-5.5	L2255718-4	09-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-08	A3MW02-08	1.5-5.5	L2354839-3	26-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW02-08	DUP-10	1.5-5.5	L2354839-8	26-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
QA/QC RPD				26-Sep-19	---	---	---	---	---	---	---	---	---	---	---	
A3MW03-01	A3 MW03-01	1.5-6.1	L2255718-1	09-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW03-01	A3 MW03-01	1.5-6.1	L2354359-1	25-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW03-02	A3 MW03-02	2.3-8.3	L2255718-2	09-Apr-19	900.	<250.	910.	<250.	680.	680.	<0.5	0.97	<0.5	3.5	<0.5	**AW+**
A3MW03-02	DUP-13	2.3-8.3	L2255718-10	09-Apr-19	960.	<250.	970.	<250.	930.	930.	<0.5	0.91	<0.5	3.34	<0.5	**AW+**
QA/QC RPD				09-Apr-19	---	---	---	---	31.1%	31.1%	---	---	---	---	---	
A3MW03-02	A3 MW03-02	2.3-8.3	L2354359-2	25-Sep-19	560.	<250.	570.	<250.	640.	640.	<0.80	0.69	<0.5	1.64	<0.5	**AW+**
A3MW03-02	DUP-9	2.3-8.3	L2354359-7	25-Sep-19	620.	<250.	620.	<250.	610.	610.	<0.80	0.62	<0.5	1.56	<0.5	**AW+**
QA/QC RPD				25-Sep-19	---	---	---	---	4.8%	4.8%	---	---	---	---	---	
A3MW03-03	A3 MW03-03	0.8-6.9	L2255718-8	09-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW03-04	MW03-04	1.5-6.7	L2255046-1	8-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
A3MW03-04	MW03-04	1.5-6.7	L2354839-1	26-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-1A	G1-1A	3.1-6.1	L2253959-2	04-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-1A	G1-1A	3.1-6.1	L2352452-3	23-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-1B	G1-1B	10.8-12.3	L2253959-4	04-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-1B	G1-1B	10.8-12.3	L2352452-1	23-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-1C	G1-1C	19.8-21.3	L2253959-3	04-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-1C	G1-1C	19.8-21.3	L2352452-2	23-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-2A	G1-2A	1.8-3.4	L2250791-2	28-Mar-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-2A	G1-2A	1.8-3.4	L2353321-1	24-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-2B	G1-2B	4.6-6.1	L2250791-3	28-Mar-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-2B	G1-2B	4.6-6.1	L2353321-2	24-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-5	G1-5	9.1-12.2	L2252535-1	02-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-5	G1-5	9.1-12.2	L2350854-3	19-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-6	G1-6	7.9-11	L2252535-2	02-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-6	DUP-09	7.9-11	L2252535-4	02-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
QA/QC RPD				02-Apr-19	---	---	---	---	---	---	---	---	---	---	---	
G1-6	G1-6	7.9-11	L2350854-2	19-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-7A	G1-7A	0.9-2.4	L2253959-5	04-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-7A	G1-7A	0.9-2.4	L2352452-4	23-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-7B	G1-7B	6.1-9.1	L2253959-6	04-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-7B	DUP-11	6.1-9.1	L2253959-7	04-Apr-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
QA/QC RPD				04-Apr-19	---	---	---	---	---	---	---	---	---	---	---	
G1-7B	G1-7B	6.1-9.1	L2352452-5	23-Sep-19	---	---	<250	<250	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-7B	DUP-6	6.1-9.1	L2352452-9	23-Sep-19	---	---	<250	<250	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
QA/QC RPD				23-Sep-19	---	---	---	---	---	---	---	---	---	---	---	
G1-8	G1-8	7.0-13.1	L2253280-2	03-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
G1-8	G1-8	7.0-13.1	L2352452-7	23-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
MW03-07	MW03-07	0.6-2.2	L2252535-3	2-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
MW03-07	MW03-07	0.6-2.2	L2354359-6	25-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
NDM97-2	NDM97-2	2.3-5.1	L2250791-1	28-Mar-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
NDM97-2	NDM97-2	2.3-5.1	L2352452-6	23-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
NDM97-3	NDM97-03	6.1-9.1	L2253280-1	03-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
NDM97-3	DUP-10	6.1-9.1	L2253280-3	03-Apr-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
QA/QC RPD				03-Apr-19	---	---	---	---	---	---	---	---	---	---	---	
NDM97-3	NDM97-03	6.1-9.1	L2352452-8	23-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
U6	U6	0.9-3.9	L2255046-2	08-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
U6	DUP-12	0.9-3.9	L2255046-5	08-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
QA/QC RPD				08-Apr-19	---	---	---	---	---	---	---	---	---	---	---	
U6	U6	0.9-3.9	L2354839-4	26-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	0.63	<0.5	<0.75	<0.5	AW-
U7	U7	1.2-5.8	L2255046-3	8-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
U7	U7	1.2-5.8	L2354839-5	26-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
U07-10S	U07-10S	4.7-6.2	L2255718-7	09-Apr-19	**4660.**	780.	**10400.**	1090.	<100.	<100.	6.24	2.31	7.59	11.4	<0.5	**AW+**
U07-10S	U07-10S	4.7-6.2	L2256470-1	10-Apr-19	---	---	---	---	---	---	9.46	3.53	8.38	12.6	<0.5	AW-

TABLE A-2
AREAS 1 AND 3 CONCENTRATIONS OF EXTRACTABLE PETROLEUM HYDROCARBONS IN GROUNDWATER
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY
µg/L (ppb)

					LEPHw [3]	HEPHw [3]	EPH w (C10-<C19) [2,3]	EPH w (C19-C32) [3]	VH w (C6-C10)	VPHw	Benzene	Toluene	Ethylbenzene	Xylenes	Styrene	Groundwater Classification
Generic Numerical Water Standards [4]																
CSR	Schedule 3.2 - Freshwater Aquatic Life			(AW)	500 [1]	NS	5000 [1]	NS	15000 [1]	1500 [1]	400	5	2000	300 [1]	720 [1]	
	Schedule 3.2 - Marine Aquatic Life			(AW)	500 [1]	NS	5000 [1]	NS	15000 [1]	1500 [1]	1000	2000	2500	300 [1]	720 [1]	
	Site-Specific Screening Levels (SSSLs)				3000	NS	5000	NS	15000	15000	21000	7700	3200	3300	720	
Well ID	**Sample ID**	**Screened Interval (mbgs)**	**ALS Laboratory Report #**	**Sample Date**												
U07-10S	U07-10S	4.7-6.2	L2354359-3	25-Sep-19	**7020.**	300.	**14600.**	360.	150.	<100	23.4	9.22	24.5	30.9	<0.5	**AW+**
U07-10I	U07-10I	6.65-8.15	L2255718-6	09-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
U07-10I	U07-10I	6.65-8.15	L2354359-4	25-Sep-19	<250.	<250.	<250.	<250.	120.	120.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
U07-10D	U07-10D	8.5-10.65	L2255718-5	09-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
U07-10D	U07-10D	8.5-10.65	L2354359-5	25-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
MW17-04	MW17-04	0.8 - 1.5	L2250790-1	28-Mar-19	---	---	<250.	<250.	<100.	<101	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
MW17-04	MW17-04	0.8 - 1.5	L2353320-4	24-Sep-19	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-7	---	L2250150-6	27-Mar-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-8	---	L2250791-4	28-Mar-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-9	---	L2252535-5	02-Apr-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-10	---	L2253280-4	03-Apr-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-11	---	L2253959-8	04-Apr-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-12	---	L2255046-6	08-Apr-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-13	---	L2255718-11	09-Apr-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-14	---	L2256471-2	10-Apr-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-15	---	L2257194-4	11-Apr-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-6	---	L2350854-4	19-Sep-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-7	---	L2352452-10	23-Sep-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-8	---	L2353321-6	24-Sep-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Travel Blank	TRAVEL BLANK-9	---	L2354359-9	25-Sep-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	0.89	<0.5	AW-
Travel Blank	TRAVEL BLANK-10	---	L2354839-9	26-Sep-19	---	---	---	---	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-
Equipment Blank	EB-1		L1668270-4	3-Sep-15	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	---	AW-/NU-
Equipment Blank	EB-2		L1745070-3	15-Mar-16	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	---	AW-/NU-
Equipment Blank	EB-3		L1745070-4	15-Mar-16	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	---	AW-/NU-
Equipment Blank	EB-4		L1746133-4	17-Mar-16	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	---	AW-/NU-
Equipment Blank	EB-5		L1747001-5	21-Mar-16	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	---	AW-/NU-
Equipment Blank	E-BLANK-3		L1917194-8	25-Apr-17	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-/NU-
Equipment Blank	EQUIP BLANK-5		L1919061-4	26-Apr-17	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-/NU-
Equipment Blank	EQUIP BLANK-6		L1919077-2	28-Apr-17	---	---	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	AW-/NU-
Equipment Blank	R-BLANK-1	---	L2250150-5	27-Mar-19	<250	<250	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	AW-
Equipment Blank	R-BLANK-1	---	L2354359-8	25-Sep-19	<250	<250	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	0.87	<0.5	AW-
Reported Detection Limit					250.	250.	250.	250.	100.	100.	0.5	0.5	0.5	0.8	0.5	

Abbreviations:

CSR	Contaminated Sites Regulation (including Stage 12 Amendments, January 2019)
LEPHw	Light extractable petroleum hydrocarbons in water
HEPHw	Heavy extractable petroleum hydrocarbons in water
EPHw	Extractable petroleum hydrocarbons in water
VHw	Volatile hydrocarbons in water
VPHw	Volatile petroleum hydrocarbons in water
MTBE	Methyl tert-butyl ether
QA/QC	Quality assurance / quality control
RPD	Relative percent difference
NS	No standard established for indicated parameter.
mbgs	Metres below ground surface
ppb	Parts per billion
µg/L	Micrograms per litre
<	Sample concentration less than the reported detection limit indicated
---	Sample not analyzed for indicated parameter

	Sample concentration greater than CSR standard for aquatic life (AW).
BOLD	Sample concentration greater than CSR standard for aquatic life (AW) and Site-Specific Screening Levels (SSSLs).
BOLD	Reportable Detection Limit (RDL) raised above the regulatory standard.

Notes:

1 Standards are applicable at all sites, irrespective of water use
2 BC MOE groundwater AW standard (500 µg/L) is for LEPH corrected for PAHs;
EPH (C10<-C19) is LEPH uncorrected for PAHs and therefore conservative.
3 Some LEPH/HEPH and EPH10-19/EPH19-32 results from ALS were affected by laboratory contamination. The former values are available upon request.
4 Criterion concentrations reported in µg/L

TABLE A-3
AREAS 1 AND 3 CONCENTRATIONS OF POLYCYCLIC AROMATIC HYDROCARBONS IN GROUNDWATER
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY
µg/L (ppb)

					Acenaphthene	Acridine	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b+k)fluoranthene	Benzo(b+j+k)fluoranthene [3]	Benzo(ghi)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	1-Methylnaphthalene [4]	2-Methylnaphthalene [4]	Naphthalene	Phenanthrene	Pyrene	Quinoline	Total PAHs [4]	Groundwater Classification
Generic Numerical Water Standards [2]																									
CSR	Schedule 3.2 - Marine and Freshwater Aquati			(AW)	60	0.5	1	1	0.1	NS	NS	NS	1	NS	2	120	NS	NS	NS	10	3	0.2	34	NS	
	Site-Specific Screening Levels (SSSLs)				60	30	40	1	2.8	NS	NS	NS	1	NS	40	120	NS	NS	NS	440	3	40	34	NS	
Well ID	**Sample ID**	**Screened Interval (mbgs)**	**ALS Laboratory Report #**	**Sample Date**																					
A3MW02-05	A3 MW02-05	2.4-6.1	L2255718-9	9-Apr-19	0.083	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
A3MW02-05	A3 MW02-05	2.4-6.1	L2354839-6	26-Sep-19	0.561	<0.030	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	0.015	<0.010	<0.050	<0.050	<0.050	<0.020	0.014	<0.050	0.59	AW-
A3MW02-06	A3 MW02-06	3.4-6.4	L2255046-4	8-Apr-19	2.41	<0.080	<0.070	<0.010	<0.0050	---	<0.015	<0.010	<0.020	<0.0050	0.216	1.22	<0.010	0.827	<0.050	<2.0	0.068	0.144	<0.80	4.9	AW-
A3MW02-06	A3 MW02-06	3.4-6.4	L2354839-7	26-Sep-19	2.11	<0.070	0.058	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.178	0.992	<0.010	0.545	<0.050	<0.70	0.046	0.112	<1.0	4.1	AW-
A3MW02-07	A3MW02-07	3.1-6.2	L2255718-3	9-Apr-19	52.2	<0.090	0.823	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	1.24	23.6	<0.010	1.42	<0.050	4.27	<0.20	0.564	<0.70	84.4	**AW+**
A3MW02-07	A3MW02-07	3.1-6.2	L2354839-2	26-Sep-19	44.4	<0.090	0.738	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	1.3	20.5	<0.010	1.5	<0.050	<0.70	<0.20	0.59	<0.80	69.2	**AW+**
A3MW02-08	A3 MW02-08	1.5-5.5	L2255718-4	9-Apr-19	2.62	<0.020	0.103	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.236	1.33	<0.010	0.124	<0.050	0.646	0.037	0.152	<0.050	5.26	AW-
A3MW02-08	A3MW02-08	1.5-5.5	L2354839-3	26-Sep-19	4.3	<0.030	0.13	<0.020	0.006	---	<0.015	<0.010	<0.010	<0.0050	0.41	1.86	<0.010	0.161	<0.050	0.733	0.048	0.258	<0.060	7.93	**AW+**
A3MW02-08	DUP-10	1.5-5.5	L2354839-8	26-Sep-19	4.44	<0.030	0.132	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.407	1.93	<0.010	0.166	<0.050	0.743	0.049	0.257	<0.080	8.14	**AW+**
QA/QC RPD				26-Sep-19	3.2%	---	1.5%	---	---	---	---	---	---	---	0.7%	3.7%	---	---	---	1.4%	---	0.4%	---	2.6%	
A3MW03-02	A3 MW03-02	2.3-8.3	L2255718-2	9-Apr-19	2.28	<0.07	<0.2	0.088	0.029	---	0.059	<0.01	0.059	<0.005	0.736	2.27	0.01	53.1	0.17	<2.	2.28	0.531	<4.	61.6	**AW+**
A3MW03-02	DUP-13	2.3-8.3	L2255718-10	9-Apr-19	1.69	<0.050	<0.10	0.055	0.019	---	0.04	<0.01	0.04	<0.0050	0.445	1.89	<0.010	54.7	0.139	<2.0	1.44	0.327	<4.0	60.7	**AW+**
QA/QC RPD				9-Apr-19	29.7%	---	---	46.2%	---	---	---	---	---	---	49.3%	18.3%	---	3.0%	---	---	45.2%	47.6%	---	1.5%	
A3MW03-02	A3 MW03-02	2.3-8.3	L2354359-2	25-Sep-19	1.03	<0.050	0.020	<0.010	<0.0050		<0.015	<0.010	<0.010	<0.0050	<0.010	1.12	<0.010	19.1	0.067	0.695	0.170	<0.010	<4.0	22.2	AW-
A3MW03-02	DUP-9	2.3-8.3	L2354359-7	25-Sep-19	1.37	<0.050	<0.030	<0.010	<0.0050		<0.015	<0.010	<0.010	<0.0050	<0.010	1.33	<0.010	28.2	0.081	<1.0	0.189	<0.010	<3.0	31.2	AW-
QA/QC RPD				25-Sep-19	28.3%	---	---	---	---	---	---	---	---	---	---	17.1%	---	38.5%	---	---	10.6%	---	---	33.7%	
A3MW03-03	A3MW03-03	0.8-6.9	L2255718-8	9-Apr-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
A3MW03-04	MW03-04	1.5-6.7	L2255046-1	8-Apr-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
A3MW03-04	MW03-04	1.5-6.7	L2354839-1	26-Sep-19	0.012	<0.010	<0.010	<0.010	<0.0050		<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
G1-1A	G1-1A	3.1-6.1	L2253959-2	4-Apr-19	<0.010	<0.010	<0.010	<0.010	0.006	---	<0.015	<0.020	<0.010	<0.0050	0.017	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	0.018	<0.050	<0.11	AW-
G1-1A	G1-1A	3.1-6.1	L2352452-3	23-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW03-07	MW03-07	0.6-2.2	L2252535-3	2-Apr-19	<0.010	<0.020	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	0.037	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW03-07	MW03-07	0.6-2.2	L2354359-6	25-Sep-19	<0.010	<0.020	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	0.071	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
U6	U6	0.9-3.9	L2255046-2	8-Apr-19	<0.01	<0.01	<0.01	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
U6	DUP-12	0.9-3.9	L2255046-5	8-Apr-19	<0.01	<0.01	<0.01	<0.01	<0.02	---	<0.015	<0.01	<0.01	<0.005	0.013	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	0.013	<0.05	<0.11	AW-
QA/QC RPD				8-Apr-19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
U6	U6	0.9-3.9	L2354839-4	26-Sep-19	<0.010	<0.010	0.043	<0.010	<0.0050		<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
U7	U7	1.2-5.8	L2255046-3	8-Apr-19	<0.010	<0.010	0.011	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
U7	U7	1.2-5.8	L2354839-5	26-Sep-19	<0.010	<0.010	0.016	<0.010	<0.0050		<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
U07-10S	U07-10S	4.7-6.2	L2255718-7	9-Apr-19	**655.**	**<20**	24.	**27.7**	**6.96**	---	32.7	1.61	**7.7**	0.541	**157.**	**219.**	2.24	309.	477.	**4510.**	**363.**	**116.**	<0.60	6920.	**AW+**
U07-10S	U07-10S	4.7-6.2	L2354359-3	25-Sep-19	**683.**	13.	**<20**	**1.54**	0.479	---	0.932	0.112	0.955	0.0379	**32.3**	**240.**	0.148	334.	568.	**6370.**	**268.**	21.6	<5.0	8550.	**AW+**
U07-10I	U07-10I	6.65-8.15	L2255718-6	9-Apr-19	0.049	<0.010	0.016	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.026	0.039	<0.010	0.078	<0.050	<0.070	0.093	0.018	<0.050	0.32	AW-
U07-10I	U07-10I	6.65-8.15	L2354359-4	25-Sep-19	0.154	<0.010	0.013	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	0.038	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.40	<0.41	AW-
U07-10D	U07-10D	8.5-10.65	L2255718-5	9-Apr-19	0.256	<0.010	<0.030	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.013	0.176	<0.010	<0.050	<0.050	<0.050	0.047	<0.010	<0.050	0.49	AW-
U07-10D	U07-10D	8.5-10.65	L2354359-5	25-Sep-19	0.854	<0.010	0.024	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.013	0.483	<0.010	<0.050	<0.050	0.063	<0.020	<0.010	<0.050	1.44	AW-
Equipment Blank	R-BLANK-1		L2250150-5	27-Mar-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
Equipment Blank	R-BLANK-1		L2354359-8	25-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
Reported Detection Limit					0.01	0.01	0.01	0.01	0.005	0.015	0.015	0.01	0.01	0.005	0.01	0.01	0.01	0.01	0.01	0.05	0.02	0.01	0.05	0.065	

Abbreviations:

CSR	Contaminated Sites Regulation (including Stage 12 Amendments, January 2019)
NS	No standard established for indicated parameter
QA/QC	Quality assurance / quality control
RPD	Relative percent difference
mbgs	Metres below ground surface
µg/L	Micrograms per litre
ppb	Parts per billion
<	Sample concentration less than the reported detection limit indicated
---	Sample not analyzed for indicated parameter
	Sample concentration greater than CSR standard for aquatic life (AW).
BOLD	Sample concentration greater than CSR standard for aquatic life (AW) and Site-Specific Screening Levels (SSSLs).
BOLD	Reportable Detection Limit (RDL) raised above the regulatory standard.

Notes

1. CSR AW standards apply to both freshwater and marine receiving environments
2. Criterion concentration reported in µg/L
3. Beginning 2018 the analysis of Benzo(b+j)fluoranthene has been replaced with Benzo(b+j+k)fluoranthene
4. Lab analysis of 1-Methylnaphthalene, 2-Methylnaphthalene and Total PAH's first began to be reported in 2018

Appendix B - Area 2 Perimeter Monitoring Program

1 SCOPE OF WORK

In 2019, AECOM completed two groundwater monitoring and sampling events as part of the semi-annual Perimeter Monitoring Program (PMP) in Area 2 of the Parkland Burnaby Refinery (Refinery). The planning and execution of the events were timed such that one event was completed during the wet season and the other event was completed during the dry season. The dates of the 2019 sampling events are provided in Table 1.

Table 1 - Schedule

Event	Period
Wet Season	March 18 to April 17, 2019
Dry Season	September 9 to 17, 2019

The Area 2 PMP included the monitoring and sampling (when sufficient water was present) of 39 groundwater monitoring wells. Each well was monitored and sampled in accordance with the field program methods for this program (Appendix E). During the 2019 PMP, 6 wells were not sampled during the wet season event due to insufficient groundwater. During the dry season event, 22 monitoring wells could not be sampled due to insufficient groundwater.

The monitoring wells included in the 2019 PMP for Area 2 are included in Table 2.

Table 2 - Area 2 Monitoring Wells Included in the 2019 PMP, (Figure 3)

G2-3B	PW03-1A[2]	PW03-6[2]	MW02-04[1,2]	A2MW09-11[2]	MW11-3D
G2-3C	PW03-1B[2]	U8[2]	MW03-02[2]	A2MW09-12[2]	MW11-4I
G2-9A	PW03-2A[2]	U9[2]	MW03-03[1,2]	A2MW09-13[2]	MW11-4D
G2-9B	PW03-2B[2]	WS2-D	A2MW09-05I	A2MW09-14[1,2]	MW11-4S
G2-10	PW03-3[2]	WS2-D2	A2MW09-06I	A2MW09-15[1,2]	
G2-11A	PW03-4[2]	MW02-02[2]	A2MW09-06S[1,2]	MW11-3S	
G2-11B	PW03-5[2]	MW02-03[2]	A2MW09-10[1,2]	MW11-3I	

Notes:

1. Well could not be sampled during the Wet Sampling Event (March/April) due to insufficient groundwater.

2. Well could not be sampled during the Dry Sampling Event (September) due to insufficient groundwater.

1.1 MONITORING METHODOLOGY

As part of the PMP, each groundwater monitoring well was monitored for headspace vapour, depth to product (if present), depth to water, and total depth of the monitoring well. If sufficient water was present the following parameters were measured in the field (current and historical data are provided in Table B-1):

- Dissolved Oxygen,

- pH and temperature,
- Electrical conductivity, salinity,
- Total dissolved solids (TDS), and,
- Oxidation reduction potential (ORP).

The field monitoring data collected for Area 2 monitoring wells are presented in Table B-1.

2 GROUNDWATER ANALYTICAL RESULTS

Groundwater samples collected as part of the 2019 PMP were analyzed for one or more of the following parameters of concern:

- Petroleum hydrocarbons (PHCs) including one or more of light and heavy extractable petroleum hydrocarbons in water (LEPHw/HEPHw) and/or extractable petroleum hydrocarbons in water ($EPHw_{C10-C19}$/$EPHw_{C19-C32}$),
- Volatile hydrocarbons in water (VHwC6-C10),
- Volatile petroleum hydrocarbons in water (VPHw),
- Benzene/toluene/ethylbenzene/xylenes (BTEX),
- Styrene,
- Methyl tert-butyl ether (MTBE),
- Polycyclic aromatic hydrocarbons (PAHs), and,
- Dissolved metals.

The current and historical reported analytical results for groundwater samples from these monitoring wells are presented in Tables B-2 through Table B-4. For reference, the 2019 laboratory Certificates of Analysis for the 2019 PMP data is provided in Appendix F.

The completed 2019 PMP analytical program for Area 2 is summarized in Table 3.

Table 3 - Area 2 PMP Analytical Program Summary

	Number of Monitoring Wells Sampled	
Parameter	**Wet Event**	**Dry Event**
LEPHw/HEPHw	33	17*
PAHs	33	17*
BTEX/VPHw/Styrene	33	17*
MTBE	7	7
Dissolved Metals	1	1

Note:

** - discrepancies in number of monitoring wells sampled are due to dry monitoring wells during the dry event; see report for details*

Site-Specific Screening Levels (SSSLs) for select parameters were developed by SLR Consulting Canada Ltd. (SLR), with the support of AECOM, to evaluate potential risks from impacted Site

groundwater to Burrard Inlet. Refer to Appendix D for additional information on the development of the SSSLs. The results of the PMP groundwater samples are compared to the SSSLs as well as the Contaminated Sites Regulation (CSR) standards for the protection of marine aquatic life (AW) (CSR standards). SSSLs represent a concentration above which will indicate the need for further assessment/evaluation or remedial action. For those parameters where SSSLs are not available, the CSR standards will be the basis to evaluate the need for further assessment or remedial action. A summary of the number of samples containing concentrations of the analyzed parameters above and below the established triggers for further assessment are summarized in Table 4.

Table 4 - Overview of Area 2 Groundwater Results

Parameter	Wet Event			Dry Event		
	Result Below RDL	Detectable Result Below SSSLs	Result Above SSSLs	Result Below RDL	Detectable Result Below SSSLs	Result Above SSSLs
LEPHw	32	1	0	15	2	0
EPHw (C10-C19)	32	1	0	15	2	0
PAHs	21	12	0	7	10	0
BTEX	28	4	1	14	3	0
VHw (C6-C10)	31	2	0	16	1	0
VPHw	31	2	0	16	1	0
Styrene	33	0	0	17	0	0
MTBE	2	5	0	1	6	0
Dissolved Metals	0	1	0	0	1	0

Note:
RDL= Reported Detection Limit

Reported concentrations in groundwater samples above the SSSLs and CSR standards applicable at the Refinery for at least one sampling event in 2019 are summarized, by well, in Table 5 and Figure 4 (Main Report).

Table 5 - Summary of Samples with Concentrations Above the Site Standards

Monitoring Well ID	Parameter Greater Than the CSR AW Standards	Parameters Greater Than the SSSLs
A2MW09-11	LEPHw, VPHw and Naphthalene	Xylenes
A2MW09-06I	LEPHw and Pyrene	-

Monitoring Well ID	Parameter Greater Than the CSR AW Standards	Parameters Greater Than the SSSLs
G2-3B	Pyrene	-
PW03-6	Pyrene	-
MW11-4S	Copper	-

2.1 Area 2 MTBE Remediation Area

The remediation of MTBE in Area 2 is considered complete (AECOM, 2017). In 2017, sampling activities in the vicinity of this dormant system were reduced to five groundwater monitoring wells (G2-9A, G2-9B, G2-10, WS2-D, and WS2-D2). These monitoring wells are screened across the water table and provide appropriate coverage to monitor groundwater. Ongoing sampling of the five wells continue to support MTBE (and PHC) monitoring of the area. An additional two wells (G2-3B and G2-3C), were added as part of the 2018 PMP, included MTBE analysis due to their proximity to the remediated MTBE area. The concentrations of MTBE reported in samples collected during the 2019 PMP were generally consistent with concentrations reported in 2017 and 2018 samples. None of the MTBE reported concentrations were greater than the CSR AW standard in 2019.

3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

To confirm the integrity and reliability of the data, AECOM field staff followed pre-existing QA/QC protocols during the 2019 PMP. These procedures have resulted in a high-quality dataset that is representative of the groundwater quality and achieves the project objectives for monitoring as described in Appendix G.

3.1 Travel Blanks

During the 2019 wet and dry season events, thirteen travel blank samples were submitted with groundwater samples and analyzed for BTEX/VPHw, VHw_{C6-C10}, and styrene. One travel blank (TRAVEL BLANK-05), submitted on March 25, 2019, was additionally analyzed for MTBE. Concentrations for all samples were less than the RDLs. The reported analytical results for the travel blanks are represented in the laboratory Certificates of Analysis provided in Appendix F and summarized in Table B-2.

3.2 Equipment Blanks

During the 2019 wet season sampling event, one equipment blank was submitted with groundwater samples and analyzed for BTEX/VPHw, styrene, VHwC6-C10, LEPHw/HEPHw, and $EPHw_{C10-C19}$/$EPHw_{C19-C32}$. Concentrations in the sample were less than the RDLs and the CSR AW standards, the reported analytical results for the equipment blank is presented in the laboratory Certificates of Analysis provided in Appendix F and summarized in Table B-2.

3.3 Precision

Relative percent differences (RPDs) are presented for duplicate samples in Tables B-2, and B-3.

RPDs were calculated for BTEX/VPHw, Styrene, VHwC6-C10, LEPHw/HEPHw, $EPHw_{C10-C19}$/$_{EPHwC19-C32}$, PAHs, and MTBE in instances where the concentrations were five times the reported detection limit or greater. The average and median values were calculated using the absolute RPD numbers. It should be noted that the data set is small for statistical purposes as most reported concentrations were less than the RDLs. During the 2019 wet and dry season sampling events, 10 duplicates samples were collected. Of

the samples collected, a total of 17 parameters were suitable for RPD calculations. The average, median, maximum, and minimum RPDs of the field duplicates are presented below:

Table 6 - Relative Percent Differences (RPDs) of Duplicate Analyses

Sample Type	Average RPD (%)	Median RPD (%)	Maximum RPD (%)	Minimum RPD (%)
Groundwater Samples				
Organic Parameters (LEPHw/HEPHw, EPHw, VPHw, VHw, BTEX, MTBE, and PAHs)	5.7	4.4	21.9	0.0

The average RPD value of organic parameters (5.7%) indicates a good correlation for duplicate pairings for the entire analytical program. The maximum RPD value of 21.9% was calculated using the reported benzene concentration from well A2MW09-11 and its corresponding duplicate (DUP-02), collected in March 2019.

The British Columbia Ministry of Environment and Climate Change Strategy has provided guidance indicating that field RPDs[5] within 1.5 times the laboratory RPDs as defined in the BC Environmental Laboratory Manual[6] are acceptable. Therefore, acceptable field RPDs of 45% or below are acceptable for organic parameters. Based on this guidance and the above results, the calculated RPDs for organic parameters in groundwater are within acceptable limits; therefore, they do not add uncertainty to the findings of the monitoring program.

3.4 Accuracy

Analytical accuracy was confirmed in a review of percent recoveries reported in the laboratory reports. Percent recoveries are obtained when the project laboratory analyzes samples with known concentrations and compares their analytical results to the known concentrations. The laboratory provided percent recoveries for most the organic parameter analyses. All reported laboratory control spike (LCS) sample recoveries were within laboratory quality control (QC) limits or were outside of laboratory QC limits but associated results were not affected. Matrix control spike (MS) recovery could not be accurately calculated for barium, calcium or magnesium in the sample collected from MW11-4S on March 18, 2019; however, of these parameters only barium has an associated standard and the result (42.2 µg/L) is 2 orders of magnitude below the CSR AW standard. MS recovery could also not be accurately calculated for calcium, magnesium, selenium and sodium in the sample collected from MW11-4S on September 9, 2019; only selenium has an associated standard, the result was below the detection limit. None of the MS recovery results are believed to affect the quality or completeness of the data.

It is AECOM's opinion that the analytical results are valid with respect to accuracy. The reported analytical results are presented in the laboratory Certificates of Analysis (COA) provided in Appendix F.

3.5 Completeness

No samples from either sampling events were invalidated by ALS Canada Ltd., the project laboratory. Completeness for the 2019 program was therefore 100%.

[5] British Columbia Environmental Laboratory Manual (2015) https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-environmental-laboratory-manual

[6] BC ENV, 2015. British Columbia Environmental Laboratory Manual - Section A: Laboratory Quality Assurance / Quality Control: 2015. Victoria, BC. https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/emre/lab-manual/section-a.pdf

TABLE B-1
AREA 2 GROUNDWATER MONITORING DATA
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY

Well ID	Sample ID	Screened Interval (mbgs)	Date Monitored	Total Depth of Well (m from TOC)	Ground Elevation (mASL) [1]	Top of Casing Elevation (TOC, mASL) [1]	Headspace Vapour Concentration (ppmv)	Depth to Product (m from TOC)	Apparent Product Thickness (mm)	Depth to Water (DTW, m from TOC)	Groundwater Elevation (mASL) [1]	Dissolved Oxygen (mg/L)	pH	Temperature (°C)	Electrical Conductivity (µS/cm)	TDS (g/L)	Salinity (ppt)	ORP (mV)	Observations
G2-3B	G2-3B	10.1-13.1	21-Mar-19	10.389	45.86	45.742	nd	nd	na	7.594	38.148	1.97	6.18	14.12	441	0.361	0.27	-26.9	Slightly silty
G2-3B	G2-3B	10.1-13.1	12-Sep-19	11.271	45.86	45.742	5	nd	na	8.248	37.494	0.35	6.7	15.13	453	0.363	0.27	3.3	Slightly cloudy
G2-3C	G2-3C	18.3-22.9	21-Mar-19	21.010	45.82	45.717	nd	nd	na	7.543	38.174	2.05	6.47	13.99	413	0.339	0.25	-35.1	Clear
G2-3C	G2-3C	18.3-22.9	17-Sep-19	20.951	45.82	45.717	nd	nd	na	8.110	37.607	5.99	7.09	13.52	591	0.492	0.37	-15.1	Cloudy, some organic debris
G2-9A	G2-9A	6.1-9.1	21-Mar-19	9.068	44.51	44.639	nd	nd	na	7.407	37.232	1.05	6.02	13.24	279	0.234	0.17	37	slightly cloudy (grey)
G2-9A	G2-9A	6.1-9.1	12-Sep-19	9.100	44.51	44.639	15	nd	na	8.207	36.432	0.73	3.46	13.74	378	0.314	0.23	173	Clear
G2-9B	G2-9B	18.9-21.9	20-Mar-19	21.774	44.52	44.681	10	nd	na	7.718	36.963	9.33	6.95	14.19	362	0.296	0.22	-22.7	Clear
G2-9B	G2-9B	18.9-21.9	12-Sep-19	21.818	44.52	44.681	nd	nd	na	8.493	36.188	3	3.73	12.54	366	0.312	0.23	161.1	Bailed 3x well volume, clear
G2-10	G2-10	4.9-6.4	21-Mar-19	6.118	45.16	45.349	nd	nd	na	3.643	41.706	0.25	5.28	11.02	335	0.297	0.22	-33.8	silty; slightly orange tinged
G2-10	G2-10	4.9-6.4	17-Sep-19	6.130	45.16	45.349	140	nd	na	4.720	40.629	2.01	6.7	12.09	380	0.328	0.25	5.6	clear
G2-11A	G2-11A	4.6-6.1	26-Mar-19	6.009	5.48	50.341	110	nd	na	5.563	44.778	1.98	6.21	12.28	1639	1.407	1.12	-14.1	Clear; PAHs bottles sampled on recharge; DUP-06
G2-11A	G2-11A	4.6-6.1	17-Sep-19	6.010	5.48	50.341	10	nd	na	5.538	44.803	1.04	6.56	13.56	3141	2.613	2.14	-7.9	Clear;
G2-11B	G2-11B	7.0-8.5	26-Mar-19	8.387	50.54	50.347	nd	nd	na	5.646	44.701	1.13	6.2	12.49	1569	1.341	1.05	62.7	Clear
G2-11B	G2-11B	7.0-8.5	17-Sep-19	8.402	50.54	50.347	10	nd	na	5.703	44.644	1.22	7.36	12.59	1403	1.196	0.94	-40.2	Clear; DUP-4
PW03-1A	PW03-1A	2.4-4.0	26-Mar-19	4.030	38.27	38.159	100	nd	na	3.825	34.334	1.53	6.06	9.76	120	0.11	0.08	67.4	very silty/cloudy; sampled on recharge
PW03-1A	ns	2.4-4.0	17-Sep-19	4.050	38.27	38.159	100	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	dry, silt on probe
PW03-1B	ns	1.1-3.7	26-Mar-19	3.078	38.20	38.129	5	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
PW03-1B	ns	1.1-3.7	27-Mar-19	3.073	38.20	38.129	5	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; second sampling attempt of 2019 wet season PMP
PW03-1B	PW03-1B	1.1-3.7	16-Apr-19	3.073	38.20	38.129	nm	nd	na	1.642	36.487	8.12	4.32	8.73	33	0.033	0.02	234.2	Clear
PW03-1B	ns	1.1-3.7	17-Sep-19	3.091	38.20	38.129	35	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
PW03-2A	ns	1.8-4.6	26-Mar-19	4.468	37.82	37.644	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
PW03-2A	ns	1.8-4.6	27-Mar-19	4.464	37.82	37.644	5	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	'Dry; second sampling attempt of 2019 wet season PMP
PW03-2A	PW03-2A	1.8-4.6	16-Apr-19	4.457	37.82	37.644	nm	nd	na	3.265	34.379	1.63	4.13	9.53	70	0.064	0.05	281.4	Clear; issues with RKI Eagle, could not monitor for headspace vapour
PW03-2A	ns	1.8-4.6	17-Sep-19	4.467	37.82	37.644	100	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
PW03-2B	PW03-2B	1.1-3.7	26-Mar-19	3.150	37.88	37.809	95	nd	na	2.880	34.929	7.52	6.45	9.19	350	0.326	0.24	58.8	very silty/cloudy
PW03-2B	ns	1.1-3.7	17-Sep-19	3.152	37.88	37.809	65	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	dry, silt on probe
PW03-3	PW03-3	1.2-4.1	26-Mar-19	4.192	39.21	39.162	30	nd	na	3.582	35.580	0.9	5.84	10	219	0.2	0.15	5.8	slightly silty (brown+grey)
PW03-3	PW03-3	1.2-4.1	17-Sep-19	4.155	39.21	39.162	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dr, silt on probe
PW03-4	ns	1.8-4.0	26-Mar-19	3.838	37.17	37.028	nd	nd	na	3.804	33.224	nm	nm	nm	nm	nm	nm	nm	Dry
PW03-4	ns	1.8-4.0	27-Mar-19	3.838	37.17	37.028	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	'Dry; second sampling attempt of 2019 wet season PMP
PW03-4	PW03-4	1.8-4.0	16-Apr-19	3.848	37.17	37.028	nm	nd	na	2.770	34.258	8.48	6.18	9.28	145	0.134	0.1	233.1	Very silty; issues with RKI Eagle, could not monitor for headspace vapour
PW03-4	ns	1.8-4.0	17-Sep-19	3.857	37.17	37.028	nm	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
PW03-5	PW03-5	7.6-8.5	26-Mar-19	8.461	37.79	37.647	nd	nd	na	6.834	30.813	0.82	6.34	11.21	262	0.232	0.17	40.2	slightly silty (light brown); DUP-05
PW03-5	ns	7.6-8.5	17-Sep-19	8.468	37.79	37.647	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry, silt on probe
PW03-6	ns	1.1-3.15	26-Mar-19	2.831	38.31	38.141	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
PW03-6	ns	1.1-3.15	27-Mar-19	2.847	38.31	38.141	5	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; second sampling attempt of 2019 wet season PMP
PW03-6	PW03-6	1.1-3.15	16-Apr-19	2.832	38.31	38.141	nm	nd	na	2.493	35.648	8.11	5.01	9.3	52	0.048	0.03	195.5	Silty; sampled on recharge
PW03-6	ns	1.1-3.15	17-Sep-19	2.845	38.31	38.141	nm	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
U8	U8	3.22-6.22	21-Mar-19	6.230	38.49	39.205	25	nd	na	5.232	33.973	2.29	3.97	11.73	46	0.04	0.03	-29	clear
U8	ns	3.22-6.22	10-Sep-19	15.224	38.49	39.205	15	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	dry
U9	U9	3.3-6.3	21-Mar-19	6.280	38.59	39.424	15	nd	na	6.080	33.344	1.43	5.4	11.99	42	0.036	0.03	137.6	silty; orange tinged
U9	U9	3.3-6.3	10-Sep-19	6.212	38.59	39.424	5	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
MW02-02	MW02-02	1.2-4.3	19-Mar-19	5.221	41.24	42.258	5	nd	na	4.640	37.618	5.95	5.94	10.78	357	0.318	0.24	-26.3	clear; well cap was missing, replaced
MW02-02	ns	1.2-4.3	10-Sep-19	5.222	41.24	42.258	nm	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry, silt on probe
MW02-03	MW02-03	1.5-4.6	19-Mar-19	6.053	41.43	41.387	100	nd	na	4.903	36.484	0.93	4.76	11.28	261	0.231	0.17	-22.4	clear; slightly orange tinged
MW02-03	ns	1.5-4.6	10-Sep-19	6.055	41.43	41.387	5	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry, silt on probe
MW02-04	ns	1.5-4.6	19-Mar-19	6.022	41.71	41.685	45	nd	na	5.803	35.882	nm	nm	nm	nm	nm	nm	nm	tried to sample; insufficient water
MW02-04	ns	1.5-4.6	27-Mar-19	6.016	41.71	41.685	nd	nd	na	5.907	35.778	nm	nm	nm	nm	nm	nm	nm	tried to sample; insufficient water; second sampling attempt of 2019 wet PMP

TABLE B-1
AREA 2 GROUNDWATER MONITORING DATA
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY

Well ID	Sample ID	Screened Interval (mbgs)	Date Monitored	Total Depth of Well (m from TOC)	Ground Elevation (mASL) [1]	Top of Casing Elevation (TOC, mASL) [1]	Headspace Vapour Concentration (ppmv)	Depth to Product (m from TOC)	Apparent Product Thickness (mm)	Depth to Water (DTW, m from TOC)	Groundwater Elevation (mASL) [1]	Dissolved Oxygen (mg/L)	pH	Temperature (°C)	Electrical Conductivity (µS/cm)	TDS (g/L)	Salinity (ppt)	ORP (mV)	Observations
MW02-04	ns	1.5-4.6	16-Apr-19	6.012	41.71	41.685	nm	nd	na	5.803	35.882	nm	nm	nm	nm	nm	nm	nm	tried to sample; insufficient water; third sampling attempt of 2019 wet PMP; issues with RKI Eagle, could not monitor for headspace vapour
MW02-04	ns	1.5-4.6	10-Sep-19	6.014	41.71	41.685	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry, silt on probe
MW03-02	MW03-02	3.7-7.6	20-Mar-19	8.635	40.79	41.756	80	nd	na	7.400	34.356	1.93	5.14	10.42	125	0.113	0.08	0	clear
MW03-02	ns	3.7-7.6	10-Sep-19	8.619	40.79	41.756	nm	nd	na	8.563	33.193	nm	nm	nm	nm	nm	nm	nm	Dry
MW03-03	ns	6.1-13.7	19-Mar-19	13.922	44.65	45.392	65	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
MW03-03	ns	6.1-13.7	27-Mar-19	13.920	44.65	45.392	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; second sampling attempt of 2019 wet season PMP
MW03-03	ns	6.1-13.7	16-Apr-19	13.908	44.65	45.392	nm	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; third sampling attempt of 2019 wet season PMP; issues with RKI Eagle, could not monitor for headspace vapour
MW03-03	ns	6.1-13.7	10-Sep-19	13.936	44.65	45.392	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-05I	MW09-05I	9.18-10.68	26-Mar-19	11.400	38.67	39.32	nd	nd	na	6.883	32.437	0.32	6.31	10.51	289	0.26	0.19	63.2	Silty; slightly cloudy; sampled on recharge; sampled for NSA+Methane; DUP-04
A2MW09-05I	MW09-05I	9.18-10.68	10-Sep-19	11.432	38.67	39.32	10	nd	na	9.231	30.089	0.29	6.83	13.08	317	0.266	0.2	25.1	Clear, HC odour; DUP-2
A2MW09-06S	ns	2.44-5.44	26-Mar-19	6.150	38.36	39.049	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-06S	ns	2.44-5.44	27-Mar-19	6.128	38.36	39.049	5	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; second sampling attempt of 2019 wet season PMP
A2MW09-06S	ns	2.44-5.44	16-Apr-19	6.121	38.36	39.049	nm	nd	na	5.974	33.075	nm	nm	nm	nm	nm	nm	nm	Insufficient water water to sample; third sampling attempt of 2019 wet season PMP; issues with RKI Eagle, could not monitor for headspace vapour
A2MW09-06S	ns	2.44-5.44	10-Sep-19	6.134	38.36	39.049	15	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-06I	MW09-06I	9.33-10.83	26-Mar-19	11.565	38.59	39.366	90	nd	na	8.454	30.912	0.41	6.37	10.42	239	0.215	0.16	-55.7	Clear
A2MW09-06I	MW09-06I	9.33-10.83	10-Sep-19	11.597	38.59	39.366	nd	nd	na	10.006	29.360	0.46	7.16	14.62	279	0.226	0.17	-105.8	Clear
A2MW09-10	ns	2.22-5.22	21-Mar-19	6.086	38.98	39.835	40	nd	na	6.036	33.799	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-10	ns	2.22-5.22	27-Mar-19	6.078	38.98	39.835	15	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; second sampling attempt of 2019 wet season PMP
A2MW09-10	ns	2.22-5.22	16-Apr-19	6.056	38.98	39.835	nm	nd	na	5.973	33.862	nm	nm	nm	nm	nm	nm	nm	Insufficient water water to sample; third sampling attempt of 2019 wet season PMP; issues with RKI Eagle, could not monitor for headspace vapour
A2MW09-10	ns	2.22-5.22	10-Sep-19	6.075	38.98	39.835	350	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-11	A2MW09-11	2.05-5.05	19-Mar-19	6.068	39.13	40.162	640	nd	na	3.103	37.059	0.5	5.83	9.82	268	0.246	0.18	-39.9	Clear; Strong hydrocarbon odour; orange stain on tubing; DUP-02
A2MW09-11	A2MW09-11	2.05-5.05	21-Mar-19	6.065	39.13	40.162	890	nd	na	3.235	36.927	0.32	6.33	9.89	277	0.253	0.19	-39.8	Sheen especially on BTEX vial; hydrocarbon odour; sampled for methane and NSA
A2MW09-11	A2MW09-11	2.05-5.05	17-Apr-19	6.056	39.13	40.162	nd	nd	na	2.553	37.609	0.72	5.36	9.92	189	0.172	0.13	50.1	Clear; second sample of 2019 wet season PMP
A2MW09-11	ns	2.05-5.05	10-Sep-19	6.092	39.13	40.162	9% LEL	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-12	A2MW09-12	2.14-5.14	19-Mar-19	6.080	39.62	40.561	5	nd	na	3.663	36.898	7.3	5.55	10.74	43	0.039	0.03	173.9	Clear
A2MW09-12	A2MW09-12	2.14-5.14	21-Mar-19	6.083	39.62	40.561	10	nd	na	3.924	36.637	6.3	4.7	10.85	43	0.038	0.03	2.9	Clear, sample for methane + NSA
A2MW09-12	ns	2.14-5.14	10-Sep-19	6.068	39.62	40.561	5	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-13	A2MW09-13	2.02-5.02	19-Mar-19	6.037	41.54	42.575	nd	nd	na	5.178	37.397	9.05	4.86	10.47	39	0.035	0.02	9.7	silty; slightly orange tinged
A2MW09-13	ns	2.02-5.02	10-Sep-19	6.032	41.54	42.575	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-14	ns	2.03-5.03	19-Mar-19	6.117	41.07	42.164	25	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-14	ns	2.03-5.03	27-Mar-19	6.108	41.07	42.164	25	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; second sampling attempt of 2019 wet season PMP
A2MW09-14	ns	2.03-5.03	16-Apr-19	6.106	41.07	42.164	nm	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; third sampling attempt of 2019 wet season PMP; issues with RKI Eagle, could not monitor for headspace vapour
A2MW09-14	ns	2.03-5.03	10-Sep-19	6.108	41.07	42.164	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-15	ns	1.35-4.35	19-Mar-19	5.465	40.23	41.448	10	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
A2MW09-15	ns	1.35-4.35	27-Mar-19	5.479	40.23	41.448	35	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; second sampling attempt of 2019 wet season PMP
A2MW09-15	ns	1.35-4.35	16-Apr-19	5.473	40.23	41.448	nm	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry; third sampling attempt of 2019 wet season PMP; issues with RKI Eagle, could not monitor for headspace vapour
A2MW09-15	ns	1.35-4.35	10-Sep-19	5.482	40.23	41.448	nd	nd	na	nd	na	nm	nm	nm	nm	nm	nm	nm	Dry
MW11-3S	MW11-3S	5.0-8.0	18-Mar-19	8.047	42.68	42.59	nd	nd	na	5.162	37.428	1.34	4.87	11.58	394	0.345	0.26	-36.3	Clear
MW11-3S	MW11-3S	5.0-8.0	09-Sep-19	8.129	42.68	42.59	115	nd	na	6.728	35.862	1.52	5.62	12.7	612	0.52	0.39	81.6	slightly cloudy
MW11-3I	MW11-3I	11.0-12.5	18-Mar-19	12.152	42.68	42.58	nd	nd	na	5.273	37.307	1.02	5.44	11.82	373	0.324	0.24	-59.5	Clear
MW11-3I	MW11-3I	11.0-12.5	09-Sep-19	12.207	42.68	42.58	10	nd	na	7.082	35.498	0.44	7.04	12.17	448	0.386	0.29	-95.3	Clear
MW11-3D	MW11-3D	18.5-20	18-Mar-19	20.506	42.68	42.59	nd	nd	na	6.610	35.980	1.04	6.18	12.06	704	0.608	0.46	-51.4	Clear
MW11-3D	MW11-3D	18.5-20	09-Sep-19	20.652	42.68	42.59	10	nd	na	7.789	34.801	0.23	6.55	13.07	741	0.623	0.48	52.9	Clear
MW11-4S	MW11-4S	5 - 8.0	18-Mar-19	7.922	41.89	41.89	nd	nd	na	5.473	36.417	1.23	5.33	11.34	815	0.717	0.55	-56.3	Clear
MW11-4S	MW11-4S	5 - 8.0	9-Sep-19	7.915	41.89	41.89	15	nd	na	6.360	35.530	4.12	7.04	11.25	861	0.759	0.58	-15.8	Clear
MW11-4I	MW11-4I	11.0-12.5	18-Mar-19	12.302	41.89	41.82	nd	nd	na	6.323	35.497	0.24	5.29	11.54	808	0.707	0.54	-56.9	Clear; DUP-01
MW11-4I	MW11-4I	11.0-12.5	9-Sep-19	12.225	41.89	41.82	nd	nd	na	7.283	34.537	0.81	6.91	11.74	853	0.742	0.57	-34.2	clear

TABLE B-1
AREA 2 GROUNDWATER MONITORING DATA
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY

Well ID	Sample ID	Screened Interval (mbgs)	Date Monitored	Total Depth of Well (m from TOC)	Ground Elevation (mASL) [1]	Top of Casing Elevation (TOC, mASL) [1]	Headspace Vapour Concentration (ppmv)	Depth to Product (m from TOC)	Apparent Product Thickness (mm)	Depth to Water (DTW, m from TOC)	Groundwater Elevation (mASL) [1]	Dissolved Oxygen (mg/L)	pH	Temperature (°C)	Electrical Conductivity (µS/cm)	TDS (g/L)	Salinity (ppt)	ORP (mV)	Observations
MW11-4D	MW11-4D	18.5-20	18-Mar-19	20.522	41.89	41.9	nd	nd	na	6.908	34.992	0.62	5.13	11.35	784	0.693	0.53	-57.4	Clear
MW11-4D	MW11-4D	18.5-20	9-Sep-19	20.490	41.89	41.9	nd	nd	na	7.850	34.050	1.11	6.98	11.39	820	0.72	0.55	-34.9	clear; DUP-1
WS2-D	WS2-D	4.6-7.6	25-Mar-19	7.708	40.34	40.256	25	nd	na	4.478	35.778	5	5.03	10.85	82	0.074	0.05	250.9	Clear
WS2-D	WS2-D	4.6-7.6	12-Sep-19	7.724	40.34	40.256	10	nd	na	6.662	33.594	4.69	6.85	11.44	78	0.068	0.05	18.3	Clear
WS2-D2	WS2-D2	10.7-12.2	25-Mar-19	11.936	40.34	40.317	25	nd	na	5.523	34.794	1.09	7.05	11.33	210	0.185	0.14	115.6	Clear; DUP-03
WS2-D2	WS2-D2	10.7-12.2	12-Sep-19	11.821	40.34	40.317	5	nd	na	7.240	33.077	0.73	7.02	12.05	160	0.139	0.1	66.1	Clear; DUP-03

Abbreviations:

BC	Bailer confirmed
° c	Degree Celsius
DUP	Duplicate
g/L	Grams per litre
L	Litre
m	Metres
mASL	Metres above sea level
mbgs	Metres below ground surface
mg/L	Milligrams per litre
mm	Millimetres
mV	Millivolts
µS/cm	Microsiemens per centimetre
na	Not available/applicable
nd	Not detected
nm	Not monitored
ns	Not sampled
ORP	Oxidation reduction potential
ppmv	Parts per million by volume
ppt	Parts per thousand
TDS	Total dissolved solids
TOC	Top of casing
---	No observations noted

Notes:

1 Elevations are in Parkland Datum - Geodetic Datum + 91.51 feet (27.895 m)

TABLE B-2
AREA 2 CONCENTRATIONS OF PETROLEUM HYDROCARBONS IN GROUNDWATER
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY
µg/L (ppb)

					LEPHw [3]	HEPHw [3]	EPHw (C10-C19) [2,3]	EPHw (C19-C32) [3]	VHw (C6-C10)	VPHw	Benzene	Toluene	Ethylbenzene	Xylenes	Styrene	MTBE	Groundwater Classification
Generic Numerical Water Standards [4]																	
CSR	Schedule 3.2 - Marine Aquatic Life			(AW)	500	NS	5000[1]	NS	15000[1]	1500	1000	2000	2500	300	720	4400	
	Site-Specific Screening Levels (SSSLs)				3000	NS	5000	NS	15000	15000	21000	7700	3200	3300	NS	NS	
Well ID	**Sample ID**	**Screened Interval (mbgs)**	**ALS Laboratory Report #**	**Sample Date**													
G2-3B	G2-3B	10.1-13.1	L2247729-4	21-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	30.3	AW-
G2-3B	G2-3B	10.1-13.1	L2346508-3	12-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	26.8	AW-
G2-3C	G2-3C	18.3-22.9	L2247729-3	21-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	12.2	AW-
G2-3C	G2-3C	18.3-22.9	L2349075-1	17-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	11.3	AW-
G2-9A	G2-9A	6.1-9.1	L2247729-1	21-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	2.26	AW-
G2-9A	G2-9A	6.1-9.1	L2346508-4	12-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	1.96	AW-
G2-9B	G2-9B	18.9-21.9	L2247147-2	20-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	---	AW-
G2-9B	G2-9B	18.9-21.9	L2346508-5	12-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	1.62	AW-
G2-10	G2-10	4.9-6.4	L2247729-5	21-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	<0.5	AW-
G2-10	G2-10	4.9-6.4	L2349075-2	17-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	<0.5	AW-
G2-11A	G2-11A	4.6-6.1	L2249476-6	26-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	0.99	<0.5	<0.5	<0.75	<0.5	---	AW-
G2-11A	DUP-06	4.6-6.1	L2249476-10	26-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	0.95	<0.5	<0.5	<0.75	<0.5	---	AW-
QA/QC RPD				26-Mar-19	---	---	---	---	---	---	---	---	---	---	---	---	
G2-11A	G2-11A	4.6-6.1	L2349075-3	17-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	1.74	<0.5	<0.5	<0.75	<0.5	---	AW-
G2-11B	G2-11B	7.0-8.5	L2249476-7	26-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	0.93	<0.5	<0.5	<0.75	<0.5	---	AW-
G2-11B	G2-11B	7.0-8.5	L2349075-4	17-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	0.86	<0.5	<0.5	<0.75	<0.5	---	AW-
G2-11B	DUP-04	7.0-8.5	L2349075-5	17-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	0.92	<0.5	<0.5	<0.75	<0.5	---	AW-
QA/QC RPD				17-Sep-19	---	---	---	---	---	---	---	---	---	---	---	---	
PW03-1A	PW03-1A	2.4-4.0	L2249476-11	26-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
PW03-1B	PW03-1B	1.1-3.7	L2259103-2	16-Apr-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
PW03-2A	PW03-2A	1.8-4.6	L2259103-3	16-Apr-19	<250	<250	<250	<250	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
PW03-2B	PW03-2B	1.1-3.7	L2249476-3	26-Mar-19	<250	<250	<250	<250	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
PW03-3	PW03-3	1.2-4.1	L2249476-4	26-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
PW03-4	PW03-4	1.8-4.0	L2259103-4	16-Apr-19	<250	<250	<250	<250	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
PW03-5	PW03-5	7.6-8.5	L2249476-5	26-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
PW03-5	DUP-05	7.6-8.5	L2249476-9	26-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
QA/QC RPD				26-Mar-19	---	---	---	---	---	---	---	---	---	---	---	---	
PW03-6	PW03-6	1.1-3.0	L2259103-1	16-Apr-19	<250	<250	<250.	<250	<100.	<100	<0.5	<1	<0.5	<0.75	<0.5	---	AW-
U8	U8	3.22-6.22	L2247729-2	21-Mar-19	<250	<250	<250.	<250	<100	<100	<0.5	<1	<0.5	<0.75	<0.5	---	AW-
U9	U9	3.3-6.3	L2247729-6	21-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	9.14	<0.5	0.78	<0.75	<0.5	---	AW-
MW02-02	MW02-02	1.2-4.3	L2246339-2	19-Mar-19	<250	<250	<250	<250	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
MW02-03	MW02-03	1.5-4.6	L2246339-1	19-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW03-02	MW03-02	3.7-7.6	L2247147-1	20-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
A2 MW09-05I	A2 MW09-05I	9.18-10.68	L2249476-2	26-Mar-19	<250.	<250.	<250.	<250.	170.	170.	<1.	<0.5	<0.5	<0.75	<0.5	---	AW-
A2 MW09-05I	DUP-04	9.18-10.69	L2249476-8	26-Mar-19	<250.	<250.	<250.	<250.	160.	160.	<1.	<0.5	<0.5	<0.75	<0.5	---	AW-
QA/QC RPD				26-Mar-19	---	---	---	---	---	---	---	---	---	---	---	---	
A2 MW09-05I	A2 MW09-05I	9.18-10.68	L2344655-1	10-Sep-19	350.	<250.	350.	<250.	780.	590.	181.	2.14	5.03	10.3	<0.5	---	AW-
A2 MW09-05I	DUP-2	9.18-10.69	L2344655-3	10-Sep-19	320.	<250.	320.	<250.	630.	430.	183.	2.1	4.91	10.3	<0.5	---	AW-
QA/QC RPD				10-Sep-19	---	---	---	---	21.3%	---	1.1%	---	2.4%	0.0%	---	---	
A2 MW09-06I	MW09-06I	9.33-10.83	L2249476-1	26-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	---	<0.5	<0.5	<0.75	<0.5	---	AW-
A2 MW09-06I	MW09-06I	9.33-10.83	L2344655-2	10-Sep-19	1720.	1340.	1720.	1340.	<100.	<100.	---	<0.50	<0.50	<0.75	<0.50	---	**AW+**
A2MW09-11	A2MW09-11	2.05-5.05	L2246339-5	19-Mar-19	1880.	<250.	2000	<250	13300	6000.	118.0	9.73	1580	**5540.**	<0.5	---	**AW+**
A2MW09-11	DUP-02	2.05-5.05	L2246339-6	19-Mar-19	1940.	<250.	2060	<250	14100	6300.	147	9.84	1720	**5960.**	<0.5	---	**AW+**
QA/QC RPD				19-Mar-19	3.1%	---	3.0%	---	5.8%	4.9%	21.9%	1.1%	8.5%	7.3%	---	---	
MW09-11	MW09-11	2.05-5.05	L2259932-1	17-Apr-19	2270.	560.	2330.	560	8560	5800	38	3	565	2190	<2.5	---	**AW+**
A2MW09-12	MW09-12	2.14-5.14	L2246339-4	19-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
A2MW09-13	MW09-13	2.02-5.02	L2246339-3	19-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
WS2-D	WS2-D	4.6-7.6	L2248814-1	25-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	<0.5	AW-
WS2-D	WS2-D	4.6-7.6	L2346508-1	12-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	1.96	AW-
WS2-D2	WS2-D2	10.7-12.2	L2248814-2	25-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	113.	AW-
WS2-D2	DUP-03	10.7-12.2	L2248814-3	25-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	119.	AW-
QA/QC RPD				25-Mar-19	---	---	---	---	---	---	---	---	---	---	---	5.2%	
WS2-D2	WS2-D2	10.7-12.2	L2346508-2	12-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	155.	AW-
WS2-D2	DUP-03	10.7-12.2	L2346508-6	12-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.45	<0.5	<0.75	<0.5	161.	AW-
QA/QC RPD				12-Sep-19	---	---	---	---	---	---	---	---	---	---	---	3.8%	
MW11-3S	MW11-3S	5.00-8.00	L2245599-4	18-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-3S	MW11-3S	5.00-8.00	L2343824-1	9-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-3I	MW11-3I	11-12.5	L2245599-5	18-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-3I	MW11-3I	11-12.5	L2343824-2	9-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-3D	MW11-3D	18.5-20	L2245599-6	18-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-3D	MW11-3D	18.5-20	L2343824-3	9-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-4S	MW11-4S	5.00-8.00	L2245599-1	18-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-4S	MW11-4S	5.00-8.00	L2343824-4	09-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-4I	MW11-4I	11-12.5	L2245599-2	18-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-4I	DUP-01	11-12.5	L2245599-7	18-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
QA/QC RPD				18-Mar-19	---	---	---	---	---	---	---	---	---	---	---	---	
MW11-4I	MW11-4I	11-12.5	L2343824-5	9-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-4D	MW11-4D	18.5-20	L2245599-3	18-Mar-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-

TABLE B-2
AREA 2 CONCENTRATIONS OF PETROLEUM HYDROCARBONS IN GROUNDWATER
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY
µg/L (ppb)

					LEPHw [3]	HEPHw [3]	EPHw (C10-C19) [2,3]	EPHw (C19-C32) [3]	VHw (C6-C10)	VPHw	Benzene	Toluene	Ethylbenzene	Xylenes	Styrene	MTBE	Groundwater Classification
Generic Numerical Water Standards [4]																	
CSR	Schedule 3.2 - Marine Aquatic Life			(AW)	500	NS	5000 [1]	NS	15000 [1]	1500	1000	2000	2500	300	720	4400	
	Site-Specific Screening Levels (SSSLs)				3000	NS	5000	NS	15000	15000	21000	7700	3200	3300	NS	NS	
Well ID	**Sample ID**	**Screened Interval (mbgs)**	**ALS Laboratory Report #**	**Sample Date**													
MW11-4D	MW11-4D	18.5-20	L2343824-6	9-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
MW11-4D	DUP-1	18.5-20	L2343824-7	9-Sep-19	<250.	<250.	<250.	<250.	<100.	<100.	<0.5	<0.5	<0.5	<0.75	<0.5	---	AW-
QA/QC RPD				9-Sep-19	---	---	---	---	---	---	---	---	---	---	---	---	
Equipment Blank	R_BLANK-2		L2259932-2	17-Apr-19	<250	<250	<250	<250	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-01		L2245599-8	18-Mar-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-02		L2246339-7	19-Mar-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-03		L2247147-3	20-Mar-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-04		L2247729-7	21-Mar-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-05		L2248814-4	25-Mar-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	<0.50	AW-
Travel Blank	TRAVEL BLANK-06		L2249476-12	26-Mar-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-16		L2259103-5	16-Apr-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-17		L2259932-3	17-Apr-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-1		L2343824-8	9-Sep-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-2		L2344655-4	10-Sep-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-3		L2346508-7	12-Sep-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-4		L2349075-6	17-Sep-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Travel Blank	TRAVEL BLANK-5		L2350015-4	18-Sep-19	---	---	---	---	<100	<100	<0.50	<0.50	<0.50	<0.75	<0.50	---	AW-
Reported Detection Limit					250	250	250	250	100	100	0.5	0.5	0.5	0.75	0.5	0.5	

Abbreviations:

CSR	Contaminated Sites Regulation (including Stage 12 amendments, January 2019)
EPH_W	Extractable petroleum hydrocarbons in water
$LEPH_W$	Light extractable petroleum hydrocarbons in water
$HEPH_W$	Heavy extractable petroleum hydrocarbons in water
MTBE	Methyl tert-butyl ether
VH	Volatile hydrocarbons
VPH_W	Volatile petroleum hydrocarbons in water
QA/QC	Quality Assurance/Quality Control
RPD	Relative percent difference
NS	No standard established for indicated parameter
mbgs	Metres below ground surface
µg/L	Micrograms per litre
ppb	Parts per billion
<	Sample concentration less than the detection limit indicated.
---	Sample not analyzed for indicated parameter or not calculated.

	Sample concentration greater than CSR standard for aquatic life (AW).
BOLD	Sample concentration greater than CSR standard for aquatic life (AW) and Site-Specific Screening Levels (SSSLs).
BOLD	Reportable Detection Limit (RDL) raised above the regulatory standard.

Notes:

1 CSR Standards are applicable at all sites, irrespective of water use
2 BC MoE groundwater AW standard (500 µg/L) is for LEPH corrected for PAHs;
EPHW (C10-C19) is LEPH uncorrected for PAHs and therefore conservative.
3 Some LEPH/HEPH and EPH10-19/EPH19-32 results from ALS were affected by laboratory contamination. The former values are available upon request.
4 Criterion concentration in µg/L.

Notes:

1 CSR Standards are applicable at all sites, irrespective of water use
2 BC MoE groundwater AW standard (500 µg/L) is for LEPH corrected for PAHs;
EPHW (C10-C19) is LEPH uncorrected for PAHs and therefore conservative.
3 Some LEPH/HEPH and EPH10-19/EPH19-32 results from ALS were affected by laboratory contamination. The former values are available upon request.
4 Criterion concentration in µg/L.

TABLE B-3
AREA 2 CONCENTRATIONS OF POLYCYCLIC AROMATIC HYDROCARBONS IN GROUNDWATER
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY
µg/L (ppb)

					Acenaphthene	Acridine	Anthracene	Benz(a)anthracene	Benzo(e)pyrene	Benzo(b+k)fluoranthene[3]	Benzo(b+j+k)fluoranthene[3]	Benzo(ghi)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	1-Methylnaphthalene[4]	2-Methylnaphthalene[4]	Naphthalene	Phenanthrene	Pyrene	Quinoline	Total PAHs[4]	Groundwater Classification
Generic Numerical Water Standards[2]																								
CSR	Schedule 3.2 - Marine Aquatic Life			(AW)[1]	60	0.5	1	1	0.1	NS	NS	NS	1	NS	2	120	NS	NS	NS	10	3	0.2	34	NS	
	Site Specific Screening Levels				60	30	40	1	2.8	NS	NS	NS	1	NS	40	120	NS	NS	NS	440	3	40	34	NS	
Well ID	**Sample ID**	**Screened Interval**	**ALS Laboratory Report #**	**Sample Date**																				
G2-3B	G2-3B	10.1-13.1	L2247729-4	21-Mar-19	0.04	<0.080	<0.050	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.021	0.082	<0.010	<0.050	<0.050	<0.050	<0.020	0.189	<0.050	0.33	AW-
G2-3B	G2-3B	10.1-13.1	L2346508-3	12-Sep-19	0.013	<0.060	<0.030	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.022	0.026	<0.010	<0.050	<0.050	0.057	<0.020	0.235	<0.050	0.35	**AW+**
G2-3C	G2-3C	18.3-22.9	L2247729-3	21-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
G2-3C	G2-3C	18.3-22.9	L2349075-1	17-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
G2-9A	G2-9A	6.1-9.1	L2247729-1	21-Mar-19	<0.010	<0.020	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	0.072	<0.050	<0.11	AW-
G2-9A	G2-9A	6.1-9.1	L2346508-4	12-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	0.053	<0.020	0.031	<0.050	<0.11	AW-
G2-9B	G2-9B	18.9-21.9	L2247147-2	20-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
G2-9B	G2-9B	18.9-21.9	L2346508-5	12-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
G2-10	G2-10	4.9-6.4	L2247729-5	21-Mar-19	<0.010	<0.20	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.024	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	0.136	<0.050	<0.23	AW-
G2-10	G2-10	4.9-6.4	L2349075-2	17-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
G2-11A	G2-11A	4.6-6.1	L2249476-6	26-Mar-19	<0.020	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.01	<0.01	<0.005	<0.01	0.03	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
G2-11A	DUP-06	4.6-6.1	L2249476-10	26-Mar-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
QA/QC RPD				26-Mar-19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
G2-11A	G2-11A	4.6-6.1	L2349075-3	17-Sep-19	0.019	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	0.025	<0.010	0.066	<0.050	<0.10	<0.020	<0.010	<0.050	<0.14	AW-
G2-11B	G2-11B	7.0-8.5	L2249476-7	26-Mar-19	<0.01	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
G2-11B	G2-11B	7.0-8.5	L2349075-4	17-Sep-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.06	<0.02	<0.01	<0.05	<0.11	AW-
G2-11B	DUP-4	7.0-8.5	L2349075-5	17-Sep-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
QA/QC RPD				17-Sep-19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PW03-1A	PW03-1A	2.4-4.0	L2249476-11	26-Mar-19	<0.01	<0.02	<0.01	<0.01	<0.005	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
PW03-1B	PW03-1B	1.1-3.7	L2259103-2	16-Apr-19	<0.010	<0.010	<0.010	0.014	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	0.068	<0.010	<0.010	<0.050	<0.050	<0.050	0.045	0.051	<0.050	0.18	AW-
PW03-2A	PW03-2A	1.8-4.6	L2259103-3	16-Apr-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
PW03-2B	PW03-2B	1.1-3.7	L2249476-3	26-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
PW03-3	PW03-3	1.2-4.1	L2249476-4	26-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
PW03-4	PW03-4	1.8-4.0	L2259103-4	16-Apr-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
PW03-5	PW03-5	7.6-8.5	L2249476-5	26-Mar-19	<0.010	<0.01	<0.010	<0.010	<0.0050	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
PW03-5	DUP-05	7.6-8.5	L2249476-9	26-Mar-19	<0.01	<0.010	<0.01	<0.01	<0.005	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
QA/QC RPD				26-Mar-19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PW03-6	PW03-6	1.1-3.7	L2259103-1	16-Apr-19	0.013	<0.010	<0.060	0.101	0.0215	---	0.053	0.019	0.064	<0.0050	0.445	0.147	<0.010	<0.050	<0.050	<0.050	0.897	0.28	<0.050	2.02	**AW+**
U8	U8	3.22-6.22	L2247729-2	21-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
U9	U9	3.3-6.3	L2247729-6	21-Mar-19	0.027	<0.050	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.040	<0.0050	<0.010	0.027	<0.010	1.2	0.744	2.3	<0.020	0.038	<0.070	4.34	AW-
MW02-02	MW02-02	1.2-4.3	L2246339-2	19-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW02-03	MW02-03	1.5-4.6	L2246339-1	19-Mar-19	0.019	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	0.017	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW03-02	MW03-02	3.7-7.6	L2247147-1	20-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
A2MW09-05I	MW09-05I	9.18-10.68	L2249476-2	26-Mar-19	<0.3	<0.01	<0.04	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	0.459	<0.01	0.201	<0.05	<0.8	<0.02	0.019	<0.8	<1.2	AW-
A2MW09-05I	DUP-04	9.18-10.68	L2249476-8	26-Mar-19	<0.30	<0.010	<0.040	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	0.453	<0.01	0.232	<0.050	<0.80	<0.020	0.019	<0.90	<1.2	AW-
QA/QC RPD				26-Mar-19	---	---	---	---	---	---	---	---	---	---	---	1.3%	---	---	---	---	---	---	---	---	---
A2MW09-05I	MW09-05I	9.18-10.68	L2344655-1	10-Sep-19	0.373	<0.09	<0.05	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	0.392	<0.01	4.45	1.21	<2.	0.108	0.02	<0.8	6.6	AW-
A2MW09-05I	DUP-2	9.18-10.68	L2344655-3	10-Sep-19	0.347	<0.07	<0.05	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	0.404	<0.01	4.13	1.12	<2.	0.099	0.018	<0.7	6.1	AW-
QA/QC RPD				10-Sep-19	7.2%	---	---	---	---	---	---	---	---	---	---	3.0%	---	7.5%	7.7%	---	---	---	---	7.9%	
A2MW09-06I	MW09-06I	9.33-10.83	L2249476-1	26-Mar-19	<0.080	<0.060	<0.030	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	0.172	<0.010	0.091	<0.050	<0.30	<0.020	0.028	<0.30	<0.45	AW-
A2MW09-06I	MW09-06I	9.33-10.83	L2344655-2	10-Sep-19	0.116	<0.40	<0.070	<0.020	<0.0050	---	<0.015	<0.010	<0.050	<0.0050	0.086	0.164	<0.010	0.154	0.059	<0.40	<0.070	0.592	<0.30	1.17	**AW+**
A2MW09-11	MW09-11	2.05-5.05	L2246339-5	19-Mar-19	0.397	<0.1	<0.04	<0.01	<0.005	---	<0.015	<0.01	<0.03	<0.005	<0.02	0.514	<0.01	29.5	46.1	119.	0.281	0.1	<3.	196.	**AW+**
A2MW09-11	DUP-02	2.05-5.05	L2246339-6	19-Mar-19	0.413	<0.2	<0.04	<0.01	<0.005	---	<0.015	<0.01	<0.04	<0.005	<0.02	0.532	<0.01	31.6	47.3	117.	0.297	0.113	<2.	197.	**AW+**
QA/QC RPD				19-Mar-19	4.0%	---	---	---	---	---	---	---	---	---	---	3.4%	---	6.9%	2.6%	1.7%	5.5%	12.2%	---	0.5%	
A2MW09-11	MW09-11	2.05-5.05	L2259932-1	17-Apr-19	0.563	<0.03	<0.06	<0.02	<0.008	---	<0.015	<0.01	<0.03	<0.005	<0.03	0.724	<0.01	25.4	40.9	60.3	0.445	0.192	<4.	129.	**AW+**
A2MW09-12	MW09-12	2.14-5.14	L2246339-4	19-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
A2MW09-13	MW09-13	2.02-5.02	L2246339-3	19-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	0.01	<0.050	<0.11	AW-
WS2-D	WS2-D	10.7-12.2	L2248814-1	25-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
WS2-D	WS2-D	10.7-12.2	L2346508-1	12-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
WS2-D2	WS2-D2	10.7-12.2	L2248814-2	25-Mar-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
WS2-D2	DUP-03	10.7-12.2	L2248814-3	25-Mar-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
QA/QC RPD				25-Mar-19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WS2-D2	WS2-D2	10.7-12.2	L2346508-2	12-Sep-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
WS2-D2	DUP-03	10.7-12.3	L2346508-6	12-Sep-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
QA/QC RPD				12-Sep-19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MW11-3S	MW11-3S	5.00-8.00	L2245599-4	18-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW11-3S	MW11-3S	5.00-8.00	L2343824-1	09-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	0.056	<0.020	<0.010	<0.050	<0.11	AW-
MW11-3I	MW11-3I	11-12.5	L2245599-5	18-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW11-3I	MW11-3I	11-12.5	L2343824-2	09-Sep-19	<0.020	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.020	<0.0050	0.067	0.012	<0.010	<0.050	0.075	<0.20	0.024	0.042	<0.050	<0.22	AW-
MW11-3D	MW11-3D	18.5-20	L2245599-6	18-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW11-3D	MW11-3D	18.5-20	L2343824-3	09-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	0.053	<0.20	<0.020	<0.010	<0.050	<0.22	AW-
MW11-4S	MW11-4S	5.00-8.00	L2245599-1	18-Mar-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW11-4S	MW11-4S	5.00-8.00	L2343824-4	09-Sep-19	<0.010	<0.010	<0.010	<0.010	<0.0050	---	<0.015	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.020	<0.010	<0.050	<0.11	AW-
MW11-4I	MW11-4I	11-12.5	L2245599-2	18-Mar-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
MW11-4I	DUP-01	11-12.5	L2245599-7	18-Mar-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
QA/QC RPD			---	18-Mar-19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MW11-4I	MW11-4I	11-12.5	L2343824-5	09-Sep-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	0.087	<0.02	<0.01	<0.05	<0.11	AW-
MW11-4D	MW11-4D	18.5-20	L2245599-3	18-Mar-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.02	<0.01	<0.05	<0.11	AW-
MW11-4D	MW11-4D	18.5-20	L2343824-6	09-Sep-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	<0.05	0.052	<0.02	<0.01	<0.05	<0.11	AW-
MW11-4D	DUP-1	18.5-20	L2343824-7	09-Sep-19	<0.01	<0.01	<0.01	<0.01	<0.005	---	<0.015	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.05	0.053	<0.2	<0.02	<0.01	<0.05	<0.22	AW-
QA/QC RPD				09-Sep-19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Reported Detection Limit					0.01	0.01	0.01	0.01	0.005	0.015	0.015	0.01	0.01	0.005	0.01	0.01	0.01	0.05	0.05	0.05	0.02	0.01	0.05	0.11	

Abbreviations:

CSR	Contaminated Sites Regulation (including Stage 12 amendments, January 2019)
NS	No standard established for indicated parameter
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percent Difference
mbgs	Metres below ground surface
µg/L	Micrograms per litre
ppb	Parts per billion
<	Sample concentration less than the reported detection limit indicated
---	Sample not analyzed for indicated parameter

Notes:

1 CSR AW standards apply to both freshwater and marine receiving environments
2 Criterion concentration reported in µg/L
3 Beginning 2018 the analysis of Benzo(b+j)fluoranthene has been replaced with Benzo(b+j+k)fluoranthene
4 Lab analysis of 1-Methylnaphthalene, 2-Methylnaphthalene and Total PAH's first began to be reported in 2018

	Sample concentration greater than CSR standard for aquatic life (AW).
BOLD	Sample concentration greater than CSR standard for aquatic life (AW) and Site-Specific Screening Levels (SSSLs).
BOLD	Reportable Detection Limit (RDL) raised above the regulatory standard.

TABLE B-4
AREA 2 CONCENTRATIONS OF DISSOLVED METALS IN GROUNDWATER
SEMI-ANNUAL PERIMETER MONITORING PROGRAM
PARKLAND BURNABY REFINERY
µg/L (ppb)

					pH	Temperature (°C)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Hardness (mg/L CaCO3)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium (+6)	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Sodium	Thallium	Titanium	Uranium	Vanadium	Zinc	Groundwater Classification
Generic Numerical Water Standards[1]																																			
CSR	Schedule 3.2 - Marine Aquatic Life			(AW)	NS	NS	NS	NS	NS	NS	2500	125	5000	1000	12000	15	NS	15	40	20	NS	20	NS	NS	0.25	10000	83	20	15	NS	3	1000	85	NS	100	NS
	Site-Specific Screening Levels (SSSLs)				NS	NS	NS	NS	NS	NS	2500	125	5000	1000	12000	90	NS	500	1100	62	NS	1400	NS	NS	NS	10000	750	20	NS	NS	3	NS	1000	NS	900	NS
Well ID	**Sample ID**	**Screened Interval (mbgs)**	**ALS Laboratory Report #**	**Sample Date**																															
MW11-4S	MW11-4S	5 - 8.0	L2245599-1	18-Mar-19	5.33	11.34	815.	1.23	---	15.	<0.10	0.59	42.2	<0.10	33.	0.13	18400.	0.2	11.6	23.9	627.	<0.05	4870.	1780.	---	0.097	10.3	0.099	<0.01	222000.	0.027	<0.3	0.047	<0.5	10.8	**AW+**
MW11-4S	MW11-4S	5 - 8.0	L2343824-4	09-Sep-19	4.12	11.25	861.	4.12	---	1.9	0.1	0.29	48.4	<0.10	25.	0.092	22800.	<0.10	0.6	0.42	22.	<0.050	6800.	186.	---	0.108	3.31	<0.050	<0.010	96100.	<0.010	<0.30	<0.010	<0.50	3.2	AW-
Reported Detection Limit					---	---	---	---	0.5	1.	0.1	0.1	0.1	0.1	10.	0.005	50.	0.1	0.1	0.2	10.	0.05	5.	0.1	0.01	0.05	0.5	0.05	0.01	50.	0.01	0.3	0.01	0.5	1.	

Abbreviations:

CSR	Contaminated Sites Regulation (including Stage 12 amendments, January 2019)
NS	No standard established for indicated parameter.
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percent Difference
mbgs	Metres below ground surface
µg/L	Micrograms per litre
ppb	Parts per billion
<	Sample concentration less than the detection limit indicated.
---	Sample not analyzed for indicated parameter.

Notes:

1 Criterion concentration in µg/L

	Sample concentration greater than CSR standard for aquatic life (AW).
BOLD	Sample concentration greater than CSR standard for aquatic life (AW) and Site-Specific Screening Levels (SSSLs).
BOLD	Reportable Detection Limit (RDL) raised above the regulatory standard.

Appendix C Perimeter Extraction System Operations and Performance

1 OVERVIEW

The Perimeter Extraction System (PES) is a line of closely spaced extraction wells along the Area 2 northern fence line of the Parkland Burnaby Refinery (Refinery). The pumps located in PES wells extract total fluids with the intent to depress the groundwater table and preclude the off-site migration of light non-aqueous phase liquid (LNAPL) and dissolved phase petroleum hydrocarbons (PHCs) in groundwater that originate from the Area 2 LNAPL plume. The total fluids are collected by a network of top loading pneumatic pumps to ensure that LNAPL is preferentially collected and removed from each extraction well.

The PES consists of pneumatic pumps equipped with an internal float which provide on demand extraction of total fluids from the well. Compressed air is supplied to the PES pumps by a dedicated air compressor equipped with a dryer unit. The discharge of each pump is connected to a common discharge header by flexible nylon tubing. Each pump cycle is recorded by a cycle counter affixed to the pump-dedicated air supply. The discharge header drains to a centralized oil water separator (OWS) and eventually to the Refinery process water treatment system. To control biofoul accumulation, the PES includes a sequestering agent dosing system which supplies the sequestering agent to each pump intake through pressure compensating drippers.

Additional PES information is summarized by component in Table 1 below.

Table 1 PES Component Summary

System Component	Number of Components	Description
Pneumatic Pump	40	QED Environmental Systems AP4 / AP4+ AutoPump
Air Compressor System		
1. Air Compressor	1	Ingersoll Rand UP6-30-125 operated at approximately 110 pounds per square inch (psi).
2. Dryer Unit	1	Ingersoll Rand Desiccant Dryer HL Series Model HP120PH00AA operated at a dew point of -40°F
Oil / Water Separator		
3. Oil / Water Separator	1	Ecologix Environmental System Oil Water Separator with HD Q-PAC coalescing plates. Single wall 12 gauge stainless steel construction.
4. NAPL Storage Container (Lube Cube)	1	Containment Solutions 60 gallon 10 gauge steel single wall construction.
5. Flow Meter	1	Area-Velocity Flow Meter – Model AVFM 5.0
Sequestering System		
1. Chemical Dosing Pump	1	LMI Milton Roy Chemical Metering Pump Model E731-312SI
2. Sequestering Agent	1	LineClear 50 Blended Phosphonate/Maleic Homopolymers/Stabilizer stored in 275 gallon poly tote with a 360 gallon secondary containment spill pallet.
3. Line-Charging Pump	1	Oberdorfer Chemsteel Model R104 Stainless Steel Sealed Rotary Gear pump.
4. Pressure Compensating Drippers	40	Netafim Woodpecker Pressure Compensating (WPC) with CNL. Pressure range of 14.5 to 58 psi.

This report has been prepared to fulfil the annual reporting requirements as outlined in the Operation, Monitoring, and Maintenance Plan prepared by AECOM Canada Limited (AECOM) in January 2016.

2 OPERATION

The primary system operation activities performed by AECOM are:

- Semi-monthly monitoring of the pumping performance and water level at each active extraction well;
- Semi-monthly monitoring of the sequestering dosing system including pump conditions and remaining chemical volumes;
- Pump replacement and performance troubleshooting;
- Quarterly monitoring of groundwater monitoring wells in the vicinity of the PES;
- Quarterly effluent characterization program; and,
- Coordination of the preventative maintenance program.

A summary of the observations and activities are provided in the following sections.

2.1 Semi Monthly Extraction Pump Monitoring

Semi-monthly monitoring was completed throughout 2019.

On a semi-monthly basis, the depth to pump intake and the depth to water were monitored at each active extraction well to monitor drawdown in the well as the key indicator of PES performance and reliability. Since 2018, a water column greater than one meter above any pump intake was the trigger for troubleshooting and / or replacement, prior to 2018 the trigger was 3 m. The trigger was adjusted in 2018 to improve field response to underperforming pumps and therefore improve the PES performance.

If after monitoring there is greater than 1m of water column above a pump, troubleshooting is conducted. If the pump does not function following troubleshooting it is removed and replaced with a working pump from the spare pump inventory. If the pump functions following troubleshooting but subsequent monitoring demonstrated poor reliability, the pump was also replaced with a functioning spare pump. As an indicator of PES reliability, the average water column above a pump's intake was evaluated over each quarter and on an annual basis.

This information is summarized in Table 2 below.

Table 2 - Summary of Average Water Column Above Active Extraction Pumps

	Number of Extraction Wells*				
Average Water Column Above Pump Intake	**January - March (Q1)**	**April - June (Q2)**	**July-September (Q3)**	**October to December (Q4)**	**January - December (Annual Average)**
>3m	3	1	0	1	0
<3m to >1m	5	4	0	8	6
<1m	32	35	40	31	34

* Indicates the number of PES extraction wells with the average water column height calculated over the period indicated

Despite instances throughout each quarter where an average water column of greater than three meters was observed due to reduced pump performance, the pump replacement approach was effective at maintaining the average annual water column less than 3m above the pump at all 40 extraction wells throughout 2019. The reliability of the entire PES is further demonstrated by an average annual water column above the pump intake of less than 1 meter at 34 of the 40 extraction wells. The six locations with an average annual water column between 1-3 m above the pump intake include UEIB-18, UEIB-19, UEIB-27, UEIB-43, UEIB-55, and UEIB-56. Five locations are in the eastern section of the PES and one location is in the western section of the PES. In all instances these wells are outside of the known LNAPL plume in Area 2. For field troubleshooting purposes their location outside of the LNAPL plume makes these locations lower priority for pump replacement and therefore more likely candidates for field repair and on-going monitoring to evaluate pump reliability which may therefore result in increased instances of submerged pump intakes while reliability is being assessed. In the instance of UEIB-55, the pump has become stuck in the well and cannot be removed for maintenance since October 2019. UEIB-55 is already a replacement pump and well for the original extraction well UEIB-31 which had also become stuck in the well and could not be removed for maintenance.

Based on troubleshooting activities reduced reliability is generally attributed to a combination of factors including insufficient compressed air supply, biofouling, and pump wear and tear. Ongoing troubleshooting efforts and maintenance activities are summarized in Section 3 of this appendix.

2.2 Quarterly Groundwater Level Monitoring

Groundwater levels in the nearby monitoring wells were monitored quarterly throughout 2019. The water level measurements along with semi-monthly extraction well data were used to evaluate the influence of the hydraulic barrier along the northern perimeter of the Refinery. The quarterly monitoring events were completed in February, May, August, and November 2019. The quarterly monitoring data and extraction pump data measured along the upper bench is illustrated on Figures C-1 through C-4. Groundwater contouring based on groundwater elevations measured in nearby monitoring wells is illustrated on Figures C-5 through C-8.

The following bullets summarize key groundwater level observations and include relevant comparison to PES operational performance or modifications.

- In 2019, groundwater elevations along the Upper and Lower Benches remained generally below the 2012 baseline elevations across the entire PES, which indicates that the limited periods of individual pump underperformance summarized in Table 2 are not anticipated to have a widespread affect on the PES performance.
- It is typical during wet periods of the year (e.g. first and fourth quarters) to see a perched water table in the overlying alluvium / colluvium while underlying wells screened in the till are more stable throughout the year. In both instances the contouring and particle path analyses indicate hydraulic capture is generally maintained across the PES.
- Of the six extraction wells which were identified as having an average annual water column greater than one meter (but less than 3m), none had downgradient monitoring wells where the sample concentrations exceeded the CSR AW standards.

2.3 Total Fluid and Effluent Extraction Rates

Total fluid extraction rates were determined on a pump-by-pump basis as follows:

$$Total\ Fluid\ Extraction\ Rate\ (by\ well) = \frac{\#\ of\ pump\ cycles \times average\ volume\ per\ cycle}{elapsed\ time}$$

The number of pump cycles were recorded from the pump-dedicated cycle counter, along with the date and time, during each semi-monthly monitoring event and the average volume per cycle for each pump was re-evaluated quarterly.

The average pump volume per cycle was estimated as follows:

- Discharge total fluids collected by each pump into an empty 208 litre (L) drum.
- Record the cycle counter at the beginning and end of each test to determine the total number of pump cycles.
- Measure and calculate the volume of water within the drum.
- Divide the total volume in the drum by the number of pump cycles.

Based on the method summarized above the PES collected an estimated 40,544 cubic meters (m^3) of total fluid in 2019.

In addition to verifying the volume, the surface of the water in each drum is visually inspected for the presence of LNAPL or sheen. In 2019, measurable levels of LNAPL were not observed; however, sheen or small globules of LNAPL were routinely observed on the water surface in the drum at two extraction wells (UEIB-45 and UEIB-54). On a quarter-by-quarter basis, additional extraction wells (UEIB-32, UEIB-33, UEIB-46, and UEIB-53) were identified as LNAPL contributors based on analytical and fluid collection data. To support LNAPL collection estimation, it was assumed that the presence of sheen or globules in a drum test represents 0.01% NAPL, by volume, of total fluids collected by that pump. Note that prior to November 22, 2012, this observation was estimated to represent 0.1% NAPL. A summary of the total fluids and LNAPL removed by the PES, by year, is listed in Table 3.

Table 3 Summary of Total Fluids and NAPL Removed by the PES

Year	Total Fluids Collected	Estimated NAPL Collected
2019	40,544 m^3	~ 167L[2]
2018	32,402 m^3	~ 190 L[2]
2017	38,642 m^3	~ 210 L[2]
2016[1]	33,369 m^3	~ 200 L[2]
2015[1]	43,218 m^3	~ 240 L[2]
2014[1]	54,213 m^3	~ 500 L[2]
2013[1]	48,491 m^3	~ 300 L[2]

Year	Total Fluids Collected	Estimated NAPL Collected
2012[1]	40,159m^3	~ 500 L[2]
2011	12,900 m^3	~21,700 L[3]

Notes:

[1] - Historically reported volumes have been corrected in this report to include only the total fluids collected by the PES. Previous totals also include total fluids collected by pumps located in EX-1 to EX-4, and U2-4.

[2] - NAPL Extracted = 0.01% x the total volume of water collected from an extraction well during a quarter where NAPL or sheen was observed during the drum test for that extraction well.

[3] - NAPL Extracted = 0.1% x the total volume of water collected from an extraction well during a quarter where NAPL or sheen was observed during the drum test for that extraction well.

Estimated flow rates and LNAPL collection rates for all active extraction wells since 2012 are provided in Table C-1.

3 MAINTENANCE

In 2018 the approach to pump maintenance was reduced from a semi-annual to an annual maintenance program. In place of the spring preventative maintenance program a pump removal standard operating procedure (SOP) was developed and a spare pump inventory was maintained. The SOP permitted the removal of the pumps by AECOM field representatives rather than coordinating with a pump maintenance sub-contractor. This reduced the period of time underperforming pumps remained in service. Once removed, the pumps were sent off site for refurbishment and returned to the Refinery to replenish the spare pump inventory. Pump refurbishment typically includes the inspection and cleaning of the pneumatic pump and replacement of worn parts as needed to maintain reliable pump operation.

In addition to pump maintenance, the extraction wells are redeveloped on an annual schedule and the header line is flushed on a bi-annual schedule. The extraction wells are flushed by introducing clean water from a nearby hydrant into the top of the well casing while simultaneously removing water from the bottom of the well to collect sediment and sludge that may accumulate in the well and sand annulus. This is completed in an effort to maintain good hydraulic communication between the extraction well and surrounding subsurface. The header line is similarly flushed with firewater and drained to the Refinery's water treatment system.

A summary of the major maintenance and notable troubleshooting performed in 2019 is provided in the bulleted list below.

- In February 2019, the line charging pump for the PES sequestering system was rebuilt. Following the reinstallation of the line charging pump in May 2019, the PES sequestering system was recommissioned using the clean water source identified in 2018. The system was winterized in October 2019.
- A total of eight pumps were removed during 2019 and replaced with refurbished spare pumps apart from the annual maintenance program completed in October 2019.
- In May 2019 corrosion was identified on the sequestering system secondary containment drainage valve. This drainage valve was replaced with stainless steel parts in May 2019
- In June 2019 a drainage port was added to the bottom of the OWS allowing for the removal of settle solids.
- In July 2019 a stainless steel hose was added to the Lube Cube Drainage port allowing for drainage into the refinery's water treatment ponds.

- During July 2019, the semi-annual cleaning of the OWS and its coalescing media, annual redevelopment of the active PES extraction wells, and flushing of the PES header were completed.
- During September 2019, the exhaust mufflers for the PES air compressor were replaced by Parkland's maintenance department.
- The annual pump maintenance program was performed on in October of 2019. Pumps within extraction wells UEIB-15 and UEIB-27 were replaced with refurbished spare pumps. The second annual cleaning of the OWS and its coalescing media and header flushing was also completed during this time.
- In October and November 2019 attempts were made to remove the pump from extraction well UEIB-55 but it could not be removed. Although the pump was not providing acceptable drawdown it continued to cycle and efforts to remove the pump were suspended.

4 PERFORMANCE ASSESSMENT

The performance of the PES is evaluated on a quarterly basis using the data collected from the semi-monthly system monitoring events, quarterly groundwater monitoring program, effluent characterization activities, and system maintenance. Part of the performance evaluation includes the preparation of groundwater contour drawings and particle flow paths. These contours are developed using Surfer 13 by Golden Software. The groundwater data and contour maps are then reviewed to assess the performance of the PES in conjunction with the PES pump operating data over that quarter. The groundwater contour drawings prepared following each quarterly monitoring program are provided as Figures C-5 through C-8. Further discussion of the hydraulic capture is provided in Section 4.1.

As indicated in Sections 2.1 and 2.2, the hydraulic drawdown across the majority of the PES was reliable and sustained throughout 2019. In the instances where drawdown in select wells were flagged during system monitoring the pumps were promptly removed for inspection and replaced to minimize the duration of reduced drawdown. An indication of the success of the pump exchange is that the average annual water column did not exceed 3 m above the pump intake in any of the active PES wells despite there being instances throughout each quarter where select wells had an average water column of greater than 3 m. Additionally, there was one quarter where the average water column in all wells did not exceed one meter. This is the first instance since the PES was installed.

When the water column above the pump intake was averaged over 2019 for each well, an average water column greater than one but less than three meters was observed in six of the forty wells. All of those wells were located outside of the known NAPL plume.

4.1 Capture Assessment

The capture zone assessment is based on data collected during the quarterly monitoring programs in 2019 and the groundwater contouring and flow paths presented in Figures C-5 through C-8. As part of the assessment, it is important to note the hydraulic conductivities for the PES area range from 5×10^{-6} meters per second (m/s) to 1×10^{-10} m/s with a geometric mean of 5×10^{-7} m/s (URS 2013a). Based on this information, the estimated time required for groundwater to travel from the PES to the Parkland property boundary under non-pumping conditions is six months (URS 2013b).

The following notes provide justification of the contours, data selection, and flow path interpretation.

- Information resolution is based on the available monitoring points. In some areas, there is a denser well network than others. Overall, the monitoring well locations are generally sufficient to interpret flow and capture.
- A constant head boundary of 28.8 m (Parkland Datum) has been added to the contour to represent Burrard Inlet. The constant head boundary was created within the intertidal shoreline. (*Note Parkland Datum = Geodetic Datum + 27.895m*)

- Monitoring wells that are seasonally dry have been removed from the contour.
- In areas with a dense well network, preference is given to monitoring wells screened in the till layer during the winter months. The monitoring wells screened in the till layer will be less susceptible to the presence of a seasonal perched water table and represent the stratigraphic layer where NAPL has been historically encountered.
- The groundwater flow paths are initiated from approximately 35 m upgradient of the PES and generally orthogonal to the groundwater contours. In some instances, the flow paths were smoothed based on the interpretation of an AECOM engineer/hydrogeologist.

The 2019 capture assessment is summarized in the following notes:

- Hydraulic capture was generally maintained across the entire PES for 2019.
- In the first quarter (Q1), illustrated on Figure C-5, the contouring and particle path analyses demonstrates adequate capture is maintained despite reduced drawdown observed in the vicinity of UEIB-43. The implementation of continuous pump maintenance and replacement between the annual pump maintenance program allowed for consistent PES reliability.
- In the second quarter (Q2), illustrated on Figure C-6, the contouring and particle path analysis demonstrated hydraulic control was maintained. During this quarter, UEIB-43 was the only pump indicated in Table 1 to have a greater than three meter water column above the pump. The reduced drawdown in this well did not impact the contouring as illustrated by the particle path analyses. Hydraulic capture is believed to have been maintained by the adjacent extraction wells.
- In the third quarter (Q3), illustrated on Figure C-7, reliable hydraulic capture is observed across the PES. During this quarter the average water column above all of the PES extraction well pumps was less than 1m.
- In the fourth quarter (Q4), illustrated on Figure C-8, the contouring and particle path analyses demonstrated hydraulic control was maintained across the length of the PES. During this quarter unreliable drawdown was observed in six extraction wells (UEIB-19, UEIB-23, UEIB-24, UEIB-27, UEIB-55, and UEIB-56) but groundwater extraction from the remaining system and adjacent monitoring wells is believed to have maintained good capture based on the monitoring results.
- Although the drawdown in UEIB-55 (the westernmost PES extraction well) is above the site trigger for the PES this does not affect the ability of the PES to preclude the offsite migration of LNAPL and dissolved phase hydrocarbons for the following reasons:
    - The hydraulic capture of UEIB-55 is not within or down gradient of the Area 2 LNAPL plume;
    - The groundwater within the capture radius of UEIB-55 is unlikely to contain concentrations of dissolved phase hydrocarbons above the applicable site standards due to the reported concentration of extractable petroleum hydrocarbons (EPH), and volatile petroleum hydrocarbons (VPH) below the reported laboratory detection limit in all quarterly effluent samples since its installation in October 2017 except for one instance in September 2018 where a EPH_{c19-32} result of 720 ug/L was reported.

Based on the available monitoring information summarized above the PES operating was reliable throughout 2019.

5 Summary

Based on groundwater monitoring data and system operational data, the PES continued to intercept and prevent the off-site migration of LNAPL. Additionally, the PES will continue to intercept and prevent the off-site migration of LNAPL with or without a functioning pump in UEIB-55 which has become stuck in the extraction well and can not be removed for maintenance.

The dissolved phase hydrocarbons along the northern perimeter of Area 2 are further evaluated in the Section 9.0 of the main report.

A **West** — **A'** **East**

Upper Bench

West Section | Central Section | East Section

2.80 gpm	1.26 gpm	0.45 gpm	0.39 gpm	0.24 gpm	0.12 gpm	0.06 gpm	0.23gpm	0.59 gpm	0.11 gpm	0.10 gpm	0.40 gpm	0.20 gpm	No Data Available	0.17 gpm	0.06 gpm	0.16 gpm	0.55 gpm	0.13 gpm	0.02 gpm	1.25 gpm	0.21 gpm	0.16 gpm	0.63 gpm	0.38 gpm	0.78 gpm	0.83 gpm	0.28 gpm	3.54 gpm	1.48 gpm	0.60 gpm	0.09 gpm	1.03 gpm	0.14 gpm	0.79 gpm	3.44 gpm	0.66 gpm	1.36 gpm	0.49 gpm	0.32 gpm
MW11-8S/I/D	UEIB-43	A2-7D	UEIB-42	U2-1	UEIB-41	UEIB-40	UEIB-39	U2-2	UEIB-38	UEIB-37	UEIB-36	MW11-9I	UEIB-35	G2-5	UEIB-34	UEIB-44	MW11-6S/I/D	UEIB-33	UEIB-32	UEIB-12	UEIB-51	SPT-3	G2-2WT	UEIB-52	UEIB-13	UEIB-53	G2-2B	UEIB-54	UEIB-45	UEIB-5	MW11-10I	A2MW09-01	UEIB-46	UEIB-47	UEIB-48	MW10-03I/D	A2MW09-02	UEIB-49	UEIB-50	MW03-01
UEIB-15	UEIB-16	UEIB-17	MW11-1S/I/D	UEIB-18	UEIB-19	UEIB-56	MW11-2S/I/D	UEIB-21	UEIB-22	MW11-11S/I	MW11-12S/I	UEIB-23	G2-1C	G2-1B	UEIB-24	G2-1A	UEIB-25	UEIB-26	UEIB-27	UEIB-28	UEIB-29	MW02-07	UEIB-30	UEIB-55	MW11-3S/I/D	MW11-4S/I/D													
ND	ND	ND	ND	ND	ND	ND	ND	DC	DC	DC	DC	DC	DC	DC	DC	DC	DC	DC	DC	DC	DC	ND	ND	ND	ND	DC	DC	DC	DC	DC	ND	ND	ND	ND	ND	DC	ND	ND	ND

Elevation in Feet (metres) Parkland Datum

(50) (45) (40) (35) (30) (25) (20) (15)

160 150 140 130 120 110 100 90 80 70 60 50 40

G2-2WT (Feb. 25)

UEIB-14 (Feb. 25)

UEIB-12 (Feb. 25)

SPT-3 (Feb. 25)

UEIB-13 (Feb. 25)

MW11-10I (Feb. 20)

(50) (100) (150) (200) (250) (300) (350) (400) (450)

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500

Distance in Feet (metres)

LEGEND:

Fill

Alluvium/colluvium

Till

Extraction Well

Well Screen

Static Groundwater Elevation, January 23, 2012

Pumping Groundwater Elevation, February 19, 20, 21, 2019

Dry

Extraction Pump

Fluid Extraction Rate Average 0.17 gpm

NAPL Detected in 2019 (most recent date)

Well ID

NS = No Sample Collected in February 2019

ND = February 2019 Reported Concentrations of EPH10-19, EPH19-32, and VPH below Reported Detection Limits

DC = February 2019 Reported Concentrations of EPH10-19, EPH19-32, or VPH Detected

ABBREVATIONS:
gpm US gallons per minute

NOTE: NAPL not shown on the UEIB well was detected in the nearby monitoring well as indicated.

Horizontal Scale
feet: 0 50 100
metres: 0 20 40

Vertical Scale
feet: 0 10 20
metres: 0 5 10

AECOM

UPPER BENCH EXTRACTION WELL AND GROUNDWATER ELEVATIONS FOR FEBRUARY 2019

Perimeter Extraction System - First Quarter 2019 Performance Assessment
Area 2 - Parkland Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

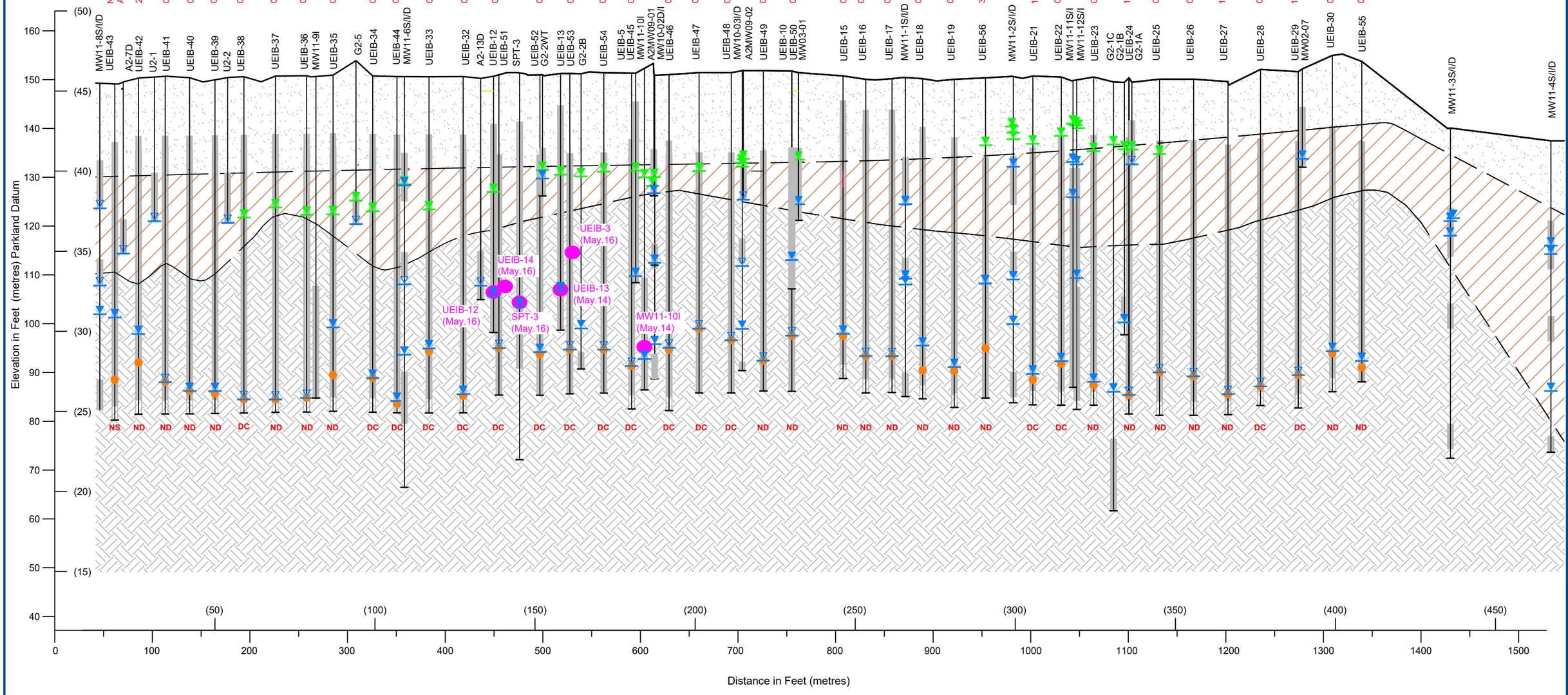
DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2020	60601146	NT	0	FIGURE C-1

FILE NAME: \\CABNY1FP001\prod\1686\Projects\URS-CHEVRON\60601146 2019 Perimeter Monitoring\400-Technical\2019 Annual PMP Report\Figures\FIG_C-1 - Q1_Monitoring-Extraction Wells Location & GW Elevation February 2019 -20200318-60601146-Parkland Ref.dwg

A West — A' East

Upper Bench

West Section | Central Section | East Section



LEGEND:

Fill

Alluvium/colluvium

Till

Extraction Well

Well Screen

Static Groundwater Elevation, January 23, 2012

Pumping Groundwater Elevation, May 13, 14, 15, 2019

Dry

Extraction Pump

Fluid Extraction Rate Average 0.17 gpm

NAPL Detected in 2019 (most recent date)

Well ID

NS = No Sample Collected in May 2019

ND = May 2019 Reported Concentrations of EPH10-19, EPH19-32, and VPH below Reported Detection Limits

DC = May 2019 Reported Concentrations of EPH10-19, EPH19-32, or VPH Detected

ABBREVIATIONS:
gpm US gallons per minute

NOTE: NAPL not shown on the UEIB well was detected in the nearby monitoring well as indicated.

* Flow rate determined from May 14th, 2019 data only.

Horizontal Scale
feet: 0 50 100
metres: 0 20 40

Vertical Scale
feet: 0 10 20
metres: 0 5 10

AECOM

UPPER BENCH EXTRACTION WELL AND GROUNDWATER ELEVATIONS FOR MAY 2019

Perimeter Extraction System - Second Quarter 2019 Performance Assessment
Area 2 - Parkland Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

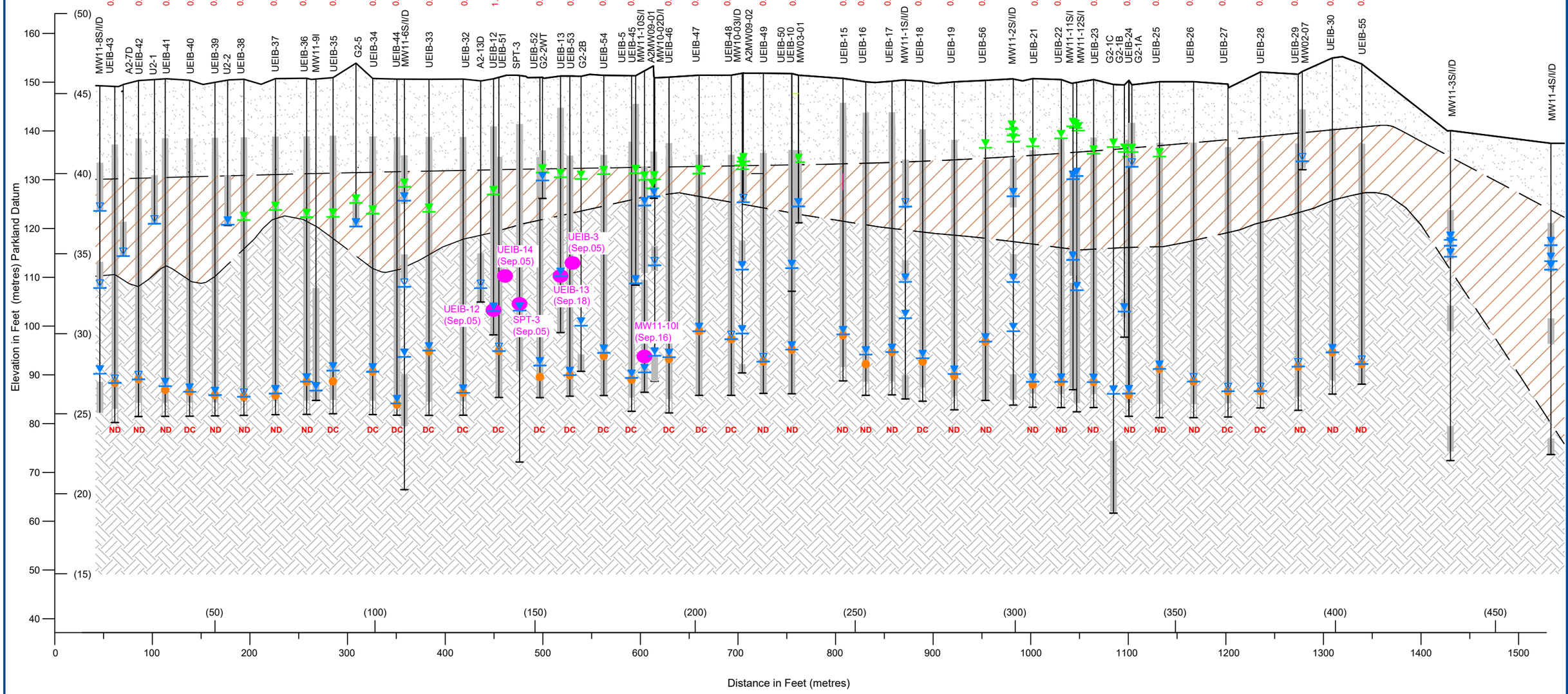
DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2020	60601146	NT	0	FIGURE C-2

FILE NAME: \\CABNY1FP001\prod\1686\Projects\URS-CHEVRON\60601146 2019 Perimeter Monitoring\400-Technical\2019 Annual PMP Report\Figures\FIG_C-2 - Q2_Monitoring-Extraction Wells Location & GW Elevation May 2019 -20200318-60601146-Parkland Ref.dwg

A West — A' East

Upper Bench

West Section | Central Section | East Section



LEGEND:

Fill

Alluvium/colluvium

Till

Extraction Well

Well Screen

Static Groundwater Elevation, January 23, 2012

Pumping Groundwater Elevation, September 16, 2019

Dry

Extraction Pump

Fluid Extraction Rate Average 0.17 gpm

NAPL Detected in 2019 (most recent date)

Well ID

NS = No Sample Collected in August 2019

ND = August 2019 Reported Concentrations of EPH10-19, EPH19-32, and VPH below Reported Detection Limits

DC = August 2019 Reported Concentrations of EPH10-19, EPH19-32, or VPH Detected

ABBREVATIONS:
gpm US gallons per minute

NOTE: NAPL not shown on the UEIB well was detected in the nearby monitoring well as indicated.

Horizontal Scale
feet: 0 50 100
metres: 0 20 40

Vertical Scale
feet: 0 10 20
metres: 0 5 10

AECOM

UPPER BENCH EXTRACTION WELL AND GROUNDWATER ELEVATIONS FOR SEPTEMBER 2019

Perimeter Extraction System - Third Quarter 2019 Performance Assessment
Area 2 - Parkland Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2020	60601146	NT	0	FIGURE C-3

FILE NAME: \\CABNY1FP001\prod\1686\Projects\URS-CHEVRON\60601146 2019 Perimeter Monitoring\400-Technical\2019 Annual PMP Report\Figures\FIG_C-3 - Q3_Monitoring-Extraction Wells Location & GW Elevation September 2019 -20200318-60601146-Parkland Ref.dwg

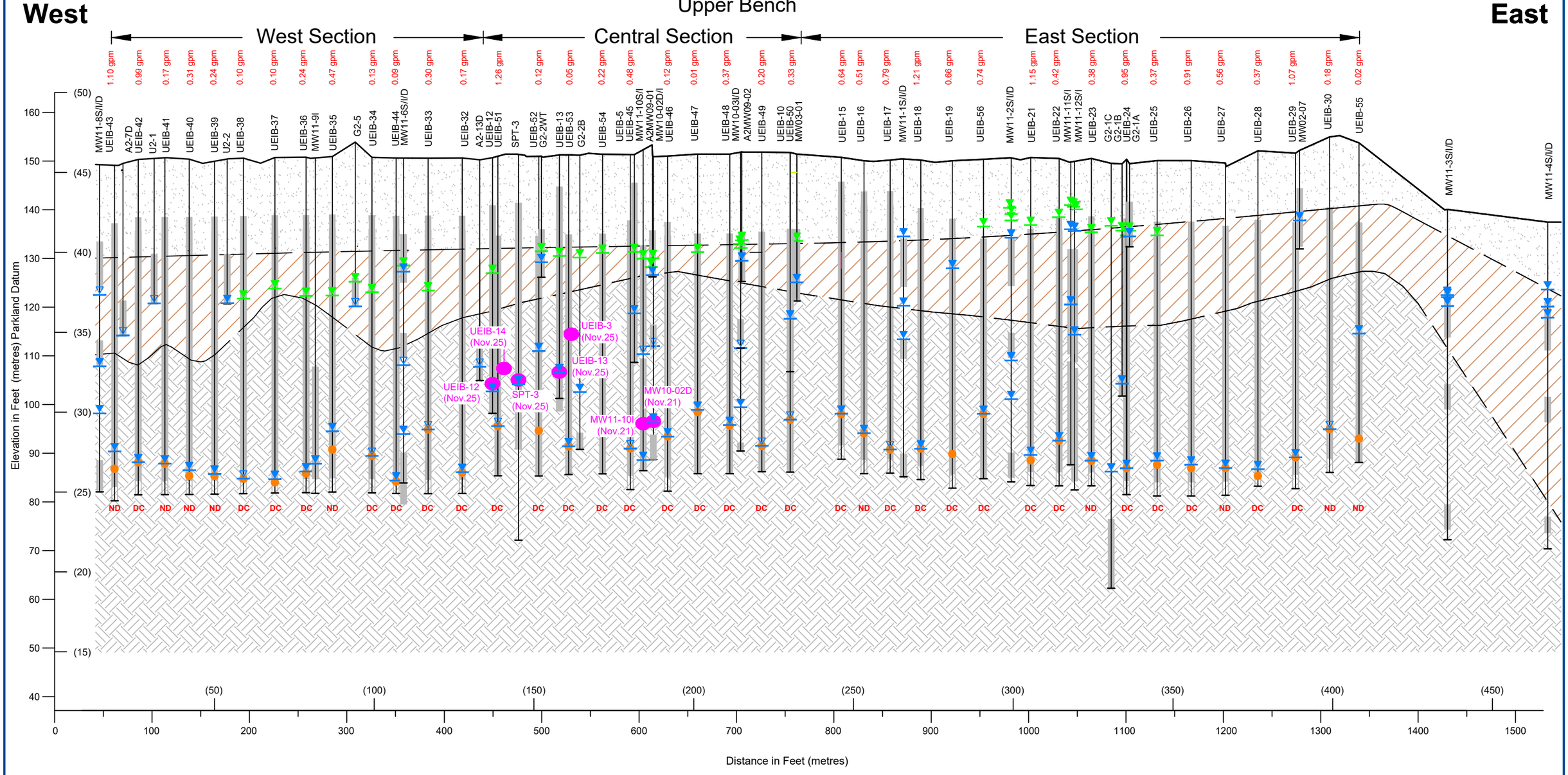
A West — A' East

Upper Bench

West Section | Central Section | East Section

Elevation in Feet (metres) Parkland Datum

Distance in Feet (metres)



LEGEND:

Fill

Alluvium/colluvium

Till

Extraction Well

Well Screen

Static Groundwater Elevation, January 23, 2012

Pumping Groundwater Elevation, November 20, 2019

Dry

Extraction Pump

Fluid Extraction Rate Average 0.17 gpm

NAPL Detected in 2019 (most recent date) — Well ID

NS = No Sample Collected in November 2019

ND = November 2019 Reported Concentrations of EPH10-19, EPH19-32, and VPH below Reported Detection Limits

DC = November 2019 Reported Concentrations of EPH10-19, EPH19-32, or VPH Detected

ABBREVATIONS:
gpm US gallons per minute

NOTE: NAPL not shown on the UEIB well was detected in the nearby monitoring well as indicated.

Horizontal Scale
feet: 0 50 100
metres: 0 20 40

Vertical Scale
feet: 0 10 20
metres: 0 5 10

AECOM

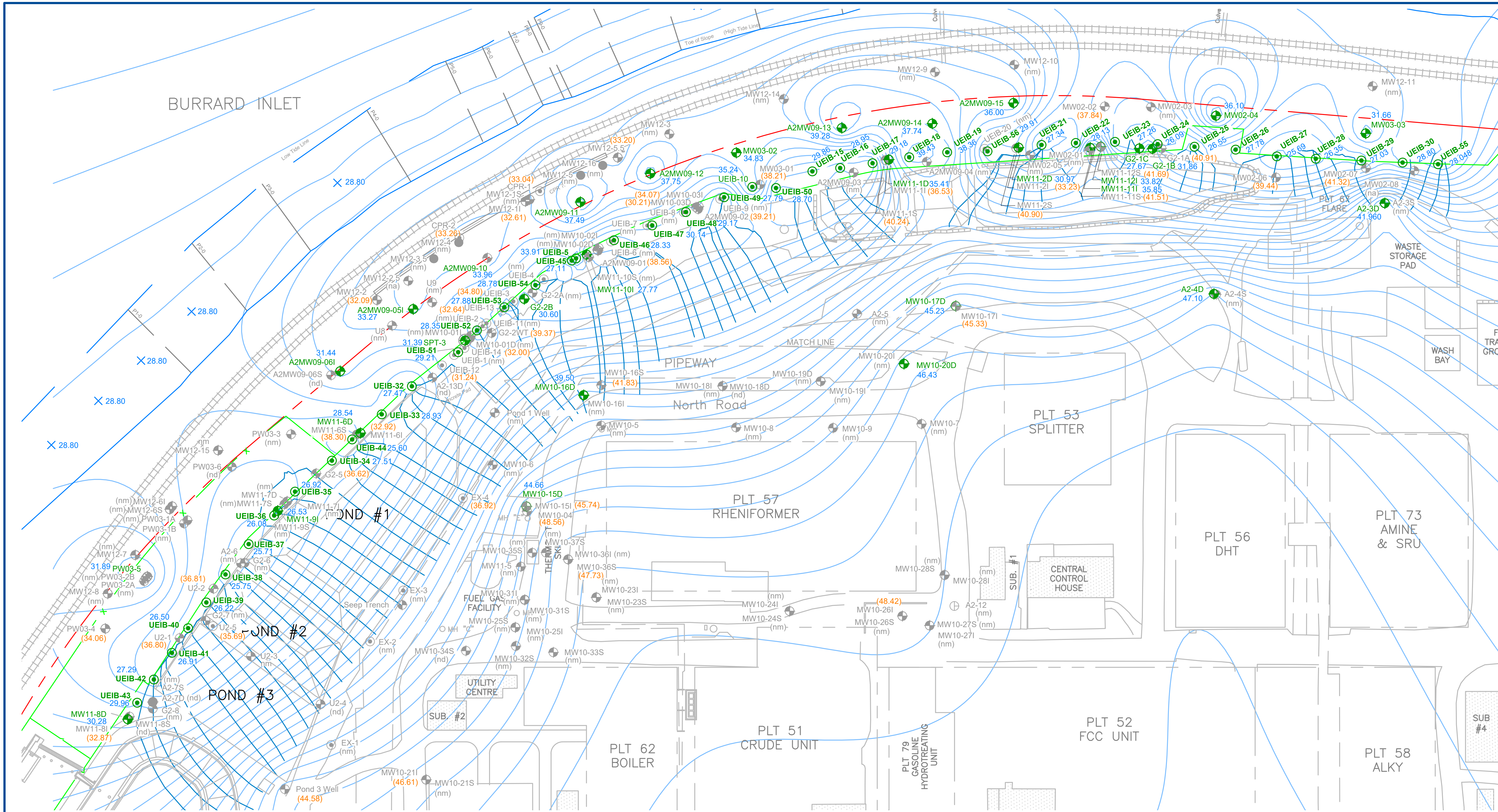
UPPER BENCH EXTRACTION WELL AND GROUNDWATER ELEVATIONS FOR NOVEMBER 2019

Perimeter Extraction System - Fourth Quarter 2019 Performance Assessment
Area 2 - Parkland Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2020	60601146	NT	0	FIGURE C-4

FILE NAME: \\CABNY1FP001\prod\1686\Projects\URS-CHEVRON\60601146 2019 Perimeter Monitoring\400-Technical\2019 Annual PMP Report\Figures\FIG_C-4 - Q4_Monitoring-Extraction Wells Location & GW Elevation September 2019 -20200320-60601146-Parkland Ref.dwg



LEGEND:

Property Line		Extraction Well		Groundwater Elevation (m) not used to extrapolate contours	(40.14)
Fence Line		Groundwater Flow		Mean Tide Elevation Point	
Foreshore Sampling Transect		Groundwater Contour (m) (Interval 1.0 metres)		Well used in Groundwater Contouring	
Monitoring Well		Groundwater Elevation (m) February 2019	32.49		

ABBREVIATIONS:

na	not available
nd	non-detect (dry well)
nm	not measured/not in program

GRID NORTH
N
W E
S

metres
0 20 40

AECOM

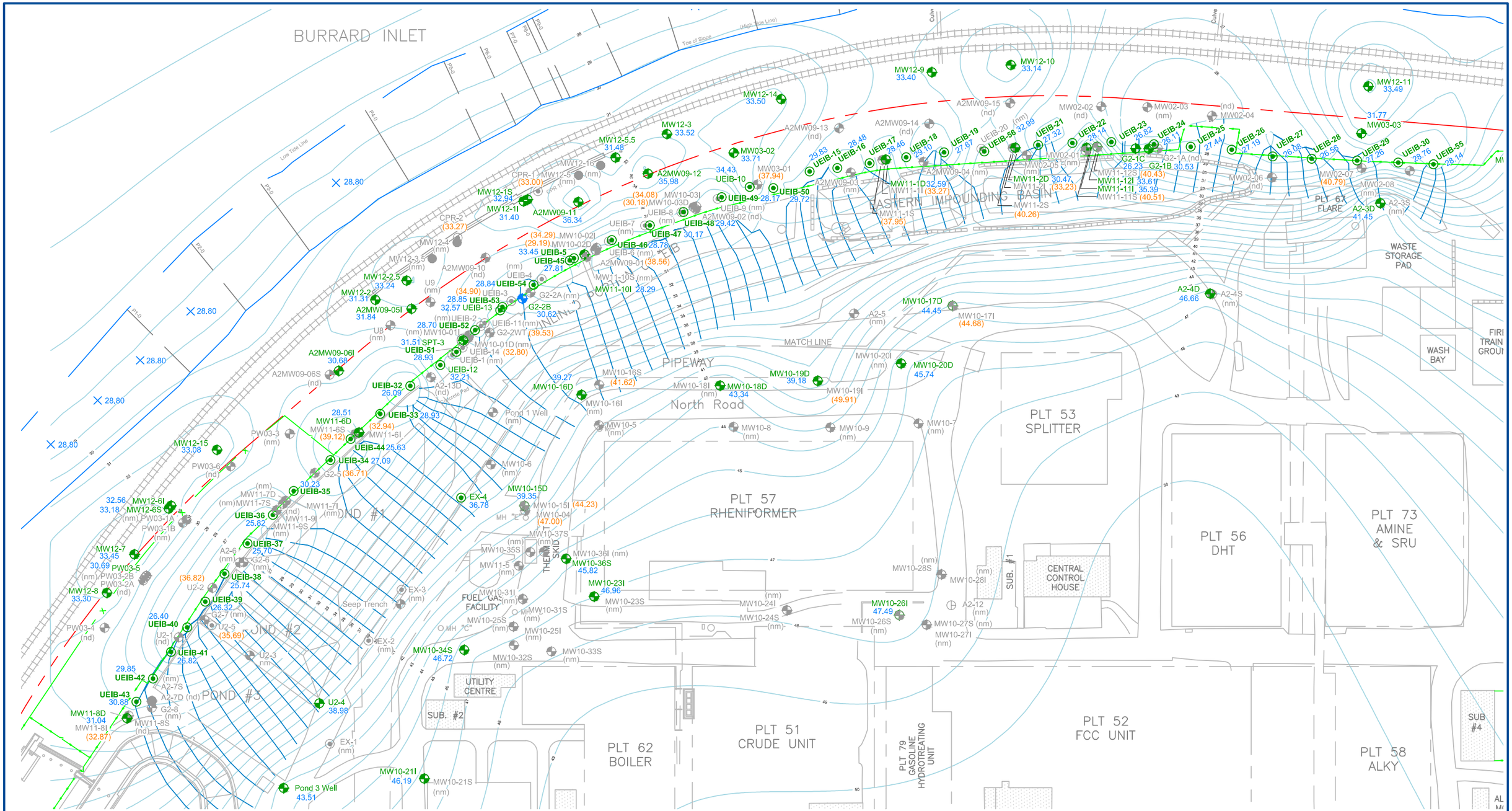
PERIMETER EXTRACTION SYSTEM GROUNDWATER ELEVATIONS AND CONTOURS - February 2019

Perimeter Extraction System - First Quarter 2019 Performance Assessment
Area 2 - Parkland Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
March 2019	60599888	TS	0	FIGURE C-5

FILE NAME: C:\Users\beckerj\appdata\local\temp\AcPublish_749932\20190415 Fig05 TILL LAYER_JVB.dwg



LEGEND:

- Property Line
- Fence Line
- Foreshore Sampling Transect
- Monitoring Well
- Extraction Well
- Groundwater Flow
- Groundwater Contour (m) (Interval 1.0 metres)
- Groundwater Elevation (m) April and May 2019 — 32.49
- Groundwater Elevation (m) not used to extrapolate contours — (40.14)
- Mean Tide Elevation Point
- Well used in Groundwater Contouring

ABBREVIATIONS:

na	not available
nd	non-detect (dry well)
nm	not measured/not in program

GRID NORTH

N W E S

metres 0 20 40

AECOM

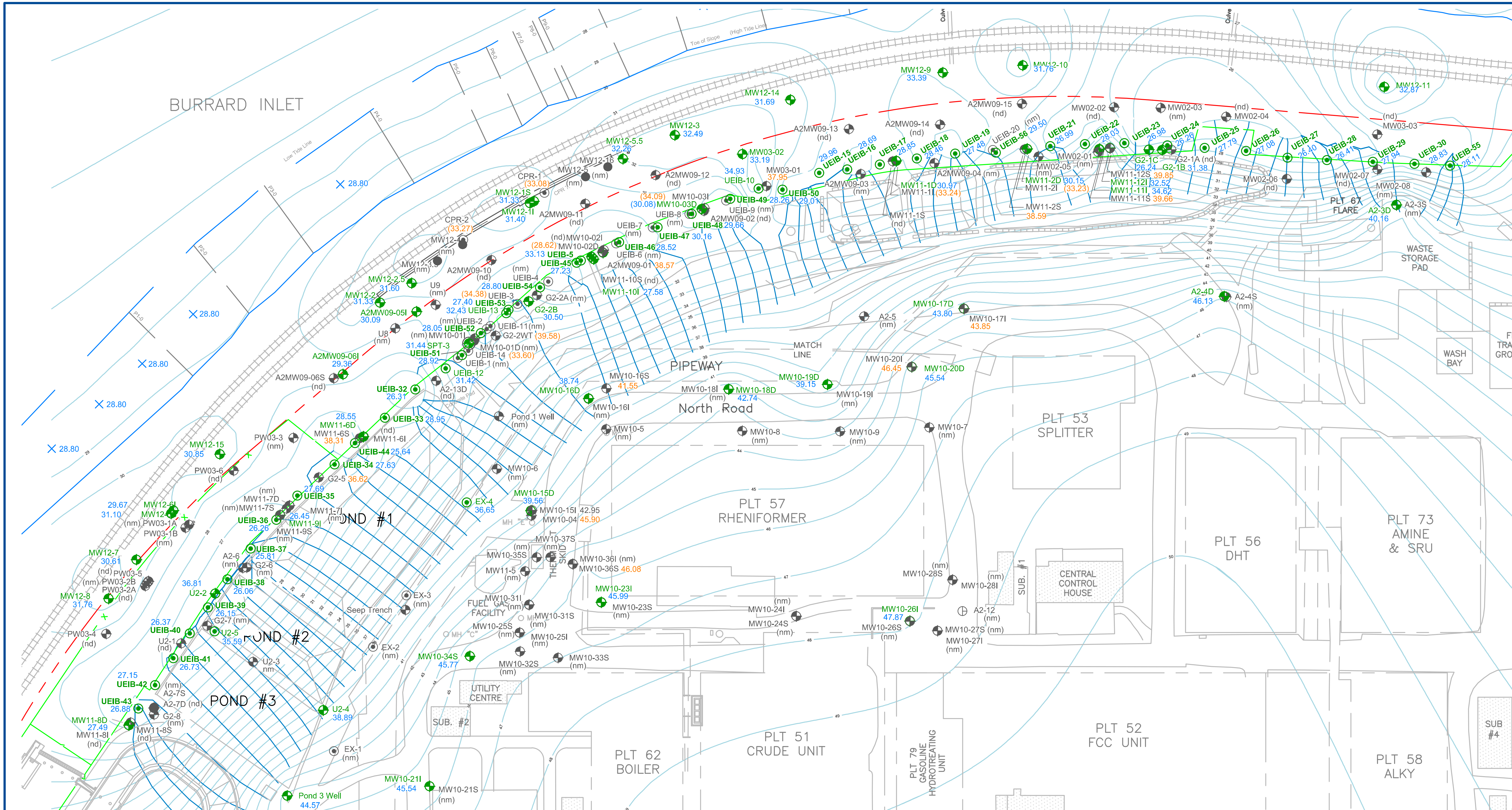
PERIMETER EXTRACTION SYSTEM GROUNDWATER ELEVATIONS AND CONTOURS - May 2019

Perimeter Extraction System - Second Quarter 2019 Performance Assessment
Area 2 - Parkland Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
July 2019	60599888	NT	0	FIGURE C-6

FILE NAME: \\cabny1fp001\prod\1686\Projects\URS-CHEVRON\60599888 2019 Remediation Systems Operation\400-Technical\Q2- Update\Figures\20190705 Fig05 TILL LAYER_JVB.dwg



LEGEND:

Property Line	(red line)	Extraction Well	(symbol)	Groundwater Elevation (m) not used to extrapolate contours	(40.14)
Fence Line	(green line with x)	Groundwater Flow	(blue line)	Mean Tide Elevation Point	X
Foreshore Sampling Transect	(grey line)	Groundwater Contour (m) (Interval 1.0 metres)	(light blue line)	Well used in Groundwater Contouring	(symbols)
Monitoring Well	(symbols)	Groundwater Elevation (m) September 2019 used to extrapolate contours	32.49		

ABBREVIATIONS:
- na — not available
- nd — non-detect (dry well)
- nm — not measured/not in program

GRID NORTH
N W E S

metres
0 20 40

AECOM

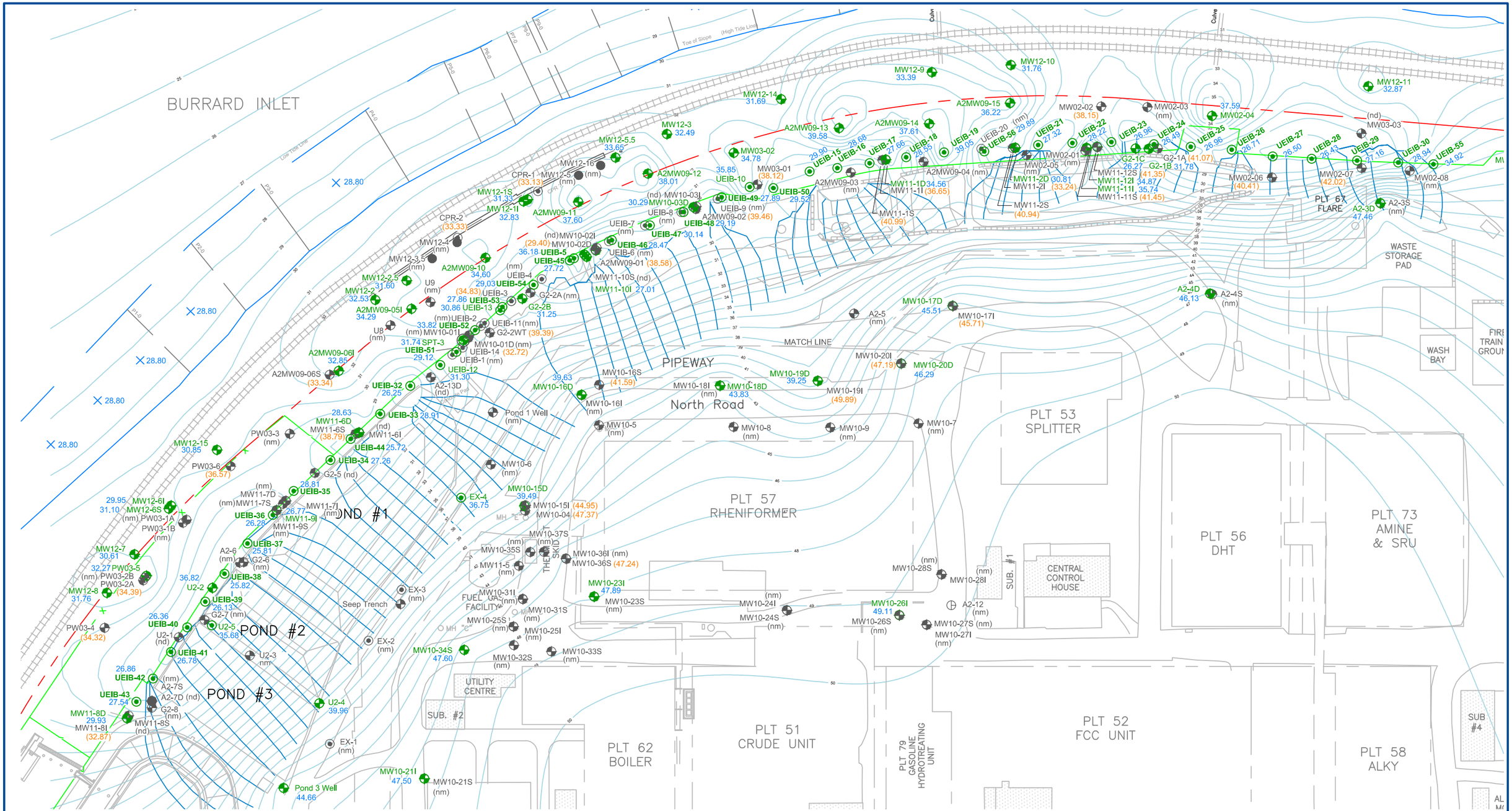
PERIMETER EXTRACTION SYSTEM GROUNDWATER ELEVATIONS AND CONTOURS - September 2019

Perimeter Extraction System - Third Quarter 2019 Performance Assessment
Area 2 - Parkland Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
October 2019	60599888	NT	0	FIGURE C-7

FILE NAME: \\cabny1fp001\prod\1686\Projects\URS-CHEVRON\60599888 2019 Remediation Systems Operation\400-Technical\Q3- Update\Figures\20191023 FIG05 TILL LAYER_Q3_JVB.dwg



LEGEND:

- Property Line
- Fence Line
- Foreshore Sampling Transect
- Monitoring Well
- Extraction Well
- Groundwater Flow
- Groundwater Contour (m) (Interval 1.0 metres)
- Groundwater Elevation (m) November 2019 used to extrapolate contours — 32.49
- Groundwater Elevation (m) not used to extrapolate contours — (40.14)
- Mean Tide Elevation Point
- Well used in Groundwater Contouring

ABBREVIATIONS:

na	not available
nd	non-detect (dry well)
nm	not measured/not in program

GRID NORTH

N W E S

metres

0 20 40

AECOM

PERIMETER EXTRACTION SYSTEM GROUNDWATER ELEVATIONS AND CONTOURS - NOVEMBER 2019

Perimeter Extraction System - Fourth Quarter 2019 Performance Assessment
Area 2 - Parkland Refinery, Burnaby, BC

PARKLAND REFINING (B.C.) LTD.

DATE:	PROJECT NO.:	DRAWN BY:	REVISION NO.:	DRAWING NO.:
January 2020	60599888	NT	0	FIGURE C-8

FILE NAME: \\cabny1fp001\prod\1686\Projects\URS-CHEVRON\60599888 2019 Remediation Systems Operation\400-Technical\Q4 - Update\Figures\2020-01-17_FIG05 TILL LAYER_Q4_JVB_v2.dwg

TABLE C-1
SUMMARY OF EXTRACTION RATES - PERIMETER EXTRACTION SYSTEM
PARKLAND BURNABY REFINERY

Extraction Well	July 25, 2012					November 22, 2012					December 19, 2012						February 14, 2013						June 6, 2013					
	Total Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extraction Rate[5] (L/day)	Total Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extraction Rate[5] (L/day)	Total Fluids Extracted (m^3)	Fluid Extraction Rate (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	Total Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	Total Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)
UEIB-1[1]	78	N/A	N/A	2,680	N/A	78	N/A	N/A	2,680	N/A	78	N/A	N/A	2,680	0.00	N/A	78	N/A	N/A	2,680	0.00	N/A	78	N/A	N/A	2,680	0.00	N/A
UEIB-2[2]/UEIB-52[14]	158	0.05	0.01	1,578	0.09	158	0.00	0.00	1,578	0.00	164	0.10	0.02	1,578	0.00	0.00	179	0.26	0.05	1,578	0.00	0.00	201	0.20	0.04	1,578	0.00	0.00
UEIB-3/UEIB-53[14]	442	0.00	0.00	4,465	0.20	446	0.03	0.01	4,465	0.00	452	0.18	0.03	4,465	0.00	0.00	466	0.24	0.04	4,465	0.00	0.00	491	0.23	0.04	4,465	0.00	0.00
UEIB-4/UEIB-54[14]	308	0.00	0.00	154	0.13	308	0.00	0.00	154	-	309	0.02	0.00	154	0.00	0.00	311	0.05	0.01	154	0.00	0.00	315	0.04	0.01	154	0.00	0.00
UEIB-5[8]	358	0.62	0.11	184	0.22	358	N/A	N/A	184	N/A	358	N/A	N/A	184	0.00	N/A	358	N/A	N/A	184	0.00	N/A	358	N/A	N/A	184	0.00	N/A
UEIB-6[9]	209	0.50	0.09	6,025	0.16	209	N/A	N/A	6,025	N/A	209	N/A	N/A	6,025	0.00	N/A	209	N/A	N/A	6,025	0.00	N/A	209	N/A	N/A	6,025	0.00	N/A
UEIB-7/UEIB-47[14]	292	0.00	0.00	5,644	0.17	293	0.01	0.00	5,644	0.00	294	0.03	0.01	5,644	0.00	0.00	295	0.02	0.00	5,644	0.00	0.00	298	0.02	0.00	5,644	0.00	0.00
UEIB-8/UEIB-48[14]	1,108	0.40	0.07	0.00	0.00	1,108	0.00	0.00	0.00	0.00	1,123	0.17	0.03	0.00	0.00	0.00	1,151	0.50	0.09	0.00	0.00	0.00	1,180	0.25	0.05	0.00	0.00	0.00
UEIB-9/UEIB-49[14]	1,651	0.27	0.05	0.00	0.00	1,657	0.05	0.01	0.00	0.00	1,669	0.19	0.03	0.00	0.00	0.00	1,706	0.65	0.12	0.00	0.00	0.00	1,780	0.67	0.12	0.00	0.00	0.00
UEIB-10[4]/UEIB-50[14]	792	0.22	0.04	0.00	0.00	792	0.04	0.01	0.00	0.00	792	0.04	0.01	0.00	0.00	0.00	792	N/A	N/A	0.00	0.00	N/A	792	N/A	N/A	0.00	0.00	N/A
UEIB-11[3]	10	N/A	N/A	0.00	N/A	10	N/A	N/A	0.00	N/A	10	N/A	N/A	0.00	0.00	N/A	10	N/A	N/A	0.00	0.00	N/A	10	N/A	N/A	0.00	0.00	N/A
UEIB-14[1,4]/UEIB-51[14]	85	0.00	0.00	825	0.11	85	N/A	N/A	825	N/A	85	0.00	0.00	825	0.00	N/A	85	0.00	0.00	825	0.00	0.00	85	0.00	0.00	825	0.00	0.00
UEIB-15	1,013	5.31	0.97	0.00	0.00	1,282	4.62	0.85	0.00	0.00	1,415	4.78	0.88	0.00	0.00	0.00	1,674	4.46	0.82	0.00	0.00	0.00	2,205	4.78	0.88	0.00	0.00	0.00
UEIB-16	416	0.12	0.02	0.00	0.00	543	1.99	0.36	0.00	0.00	714	5.35	0.98	0.00	0.00	0.00	975	4.03	0.74	0.00	0.00	0.00	1,467	4.44	0.81	0.00	0.00	0.00
UEIB-17	309	1.16	0.21	0.00	0.00	499	2.17	0.40	0.00	0.00	602	3.60	0.66	0.00	0.00	0.00	752	2.13	0.39	0.00	0.00	0.00	1,071	2.87	0.53	0.00	0.00	0.00
UEIB-18	553	2.19	0.40	0.00	0.00	894	3.22	0.59	0.00	0.00	1,009	3.97	0.73	0.00	0.00	0.00	1,224	3.66	0.67	0.00	0.00	0.00	1,669	4.01	0.74	0.00	0.00	0.00
UEIB-19	1,232	5.23	0.96	0.00	0.00	2,040	4.75	0.87	0.00	0.00	2,372	11.26	2.07	0.00	0.00	0.00	2,614	4.87	0.89	0.00	0.00	0.00	2,821	3.65	0.67	0.00	0.00	0.00
UEIB-20/UEIB-56[14]	2,093	10.25	1.88	0.00	0.00	3,021	7.25	1.33	0.00	0.00	3,235	7.46	1.37	0.00	0.00	0.00	3,466	4.65	0.85	0.00	0.00	0.00	4,827	12.85	2.36	0.00	0.00	0.00
UEIB-21	1,672	7.94	1.46	0.00	0.00	2,863	10.45	1.92	0.00	0.00	3,179	10.89	2.00	0.00	0.00	0.00	3,883	11.76	2.16	0.00	0.00	0.00	3,908	N/A	N/A	0.00	0.00	N/A
UEIB-22	619	1.53	0.28	0.00	0.00	823	2.25	0.41	0.00	0.00	889	2.31	0.42	0.00	0.00	0.00	1,020	2.21	0.41	0.00	0.00	0.00	1,318	2.69	0.49	0.00	0.00	0.00
UEIB-23	429	0.37	0.07	0.00	0.00	478	0.71	0.13	0.00	0.00	490	0.57	0.10	0.00	0.00	0.00	545	1.25	0.23	0.00	0.00	0.00	739	1.75	0.32	0.00	0.00	0.00
UEIB-24	1,426	8.78	1.61	0.00	0.00	2,808	10.32	1.89	0.00	0.00	3,100	10.42	1.91	0.00	0.00	0.00	3,559	8.20	1.50	0.00	0.00	0.00	4,188	7.84	1.44	0.00	0.00	0.00
UEIB-25	446	5.47	1.00	0.00	0.00	1,361	3.87	0.71	0.00	0.00	1,486	4.18	0.77	0.00	0.00	0.00	1,732	4.40	0.81	0.00	0.00	0.00	2,194	4.16	0.76	0.00	0.00	0.00
UEIB-26	459	1.95	0.36	0.00	0.00	854	4.53	0.83	0.00	0.00	1,023	5.29	0.97	0.00	0.00	0.00	1,329	5.46	1.00	0.00	0.00	0.00	1,704	3.38	0.62	0.00	0.00	0.00
UEIB-27	883	5.10	0.94	0.00	0.00	1,494	7.91	1.45	0.00	0.00	1,494	0.01	0.00	0.00	0.00	0.00	1,494	0.00	0.00	0.00	0.00	0.00	2,074	7.53	1.38	0.00	0.00	0.00
UEIB-28	834	0.91	0.17	0.00	0.00	1,166	2.78	0.51	0.00	0.00	1,322	5.29	0.97	0.00	0.00	0.00	1,670	6.20	1.14	0.00	0.00	0.00	2,190	4.69	0.86	0.00	0.00	0.00
UEIB-29	1,415	7.80	1.43	0.00	0.00	2,232	6.74	1.24	0.00	0.00	2,520	7.72	1.42	0.00	0.00	0.00	3,091	10.19	1.87	0.00	0.00	0.00	3,656	4.36	0.80	0.00	0.00	0.00
UEIB-30	542	1.88	0.35	0.00	0.00	1,304	8.92	1.64	0.00	0.00	1,459	7.25	1.33	0.00	0.00	0.00	1,722	4.71	0.86	0.00	0.00	0.00	2,375	6.01	1.10	0.00	0.00	0.00
UEIB-31/UEIB-55[14]	577	3.35	0.61	0.00	0.00	974	2.98	0.55	0.00	0.00	1,067	3.31	0.61	0.00	0.00	0.00	1,203	2.44	0.45	0.00	0.00	0.00	1,496	2.65	0.49	0.00	0.00	0.00
UEIB-32	1,762	8.70	1.60	0.00	0.00	2,105	3.44	0.63	0.00	0.00	2,219	5.09	0.93	0.00	0.00	0.00	2,404	3.31	0.61	9	9.26	0.17	2,679	2.47	0.45	23	13.75	0.12
UEIB-33	1,379	0.00	0.00	0.00	0.00	1,379	0.01	0.00	0.00	0.00	1,379	0.00	0.00	0.00	0.00	0.00	1,379	0.00	0.00	0.00	0.00	0.00	1,820	3.97	0.73	0.00	0.00	0.00
UEIB-34	1,167	2.34	0.43	0.00	0.00	1,296	1.17	0.21	0.00	0.00	1,401	3.06	0.56	0.00	0.00	0.00	1,618	3.89	0.71	0.00	0.00	0.00	2,257	5.74	1.05	0.00	0.00	0.00
UEIB-35	1,171	5.67	1.04	0.00	0.00	1,759	4.20	0.77	0.00	0.00	1,858	3.80	0.70	0.00	0.00	0.00	2,191	5.95	1.09	0.00	0.00	0.00	4,191	18.01	3.30	0.00	0.00	0.00
UEIB-36	722	2.24	0.41	0.00	0.00	937	1.95	0.36	0.00	0.00	1,080	4.29	0.79	0.00	0.00	0.00	1,756	12.08	2.22	0.00	0.00	0.00	2,239	4.35	0.80	0.00	0.00	0.00
UEIB-37 [6]	285	1.52	0.28	0.00	0.00	353	0.26	0.05	0.00	0.00	359	0.24	0.04	0.00	0.00	0.00	394	0.75	0.14	0.00	0.00	0.00	721	2.95	0.54	0.00	0.00	0.00
UEIB-38	72	0.87	0.16	0.00	0.00	174	0.97	0.18	0.00	0.00	217	1.77	0.32	0.00	0.00	0.00	312	1.70	0.31	0.00	0.00	0.00	490	1.60	0.29	0.00	0.00	0.00
UEIB-39 [6]	420	2.14	0.39	0.00	0.00	627	1.85	0.34	0.00	0.00	702	2.64	0.48	0.00	0.00	0.00	813	1.98	0.36	0.00	0.00	0.00	1,034	1.99	0.36	0.00	0.00	0.00
UEIB-40 [6]	176	0.90	0.16	0.00	0.00	402	1.62	0.30	0.00	0.00	483	2.69	0.49	0.00	0.00	0.00	650	2.82	0.52	0.00	0.00	0.00	925	2.48	0.45	0.00	0.00	0.00
UEIB-41 [6]	308	1.14	0.21	0.00	0.00	601	3.97	0.73	0.00	0.00	764	6.28	1.15	0.00	0.00	0.00	857	1.63	0.30	0.00	0.00	0.00	1,413	5.06	0.93	0.00	0.00	0.00
UEIB-42 [6]	395	2.08	0.38	0.00	0.00	1,377	12.35	2.27	0.00	0.00	1,730	13.89	2.55	0.00	0.00	0.00	2,539	14.45	2.65	0.00	0.00	0.00	3,808	11.44	2.10	0.00	0.00	0.00
UEIB-43	1,085	6.60	1.21	0.00	0.00	1,775	8.47	1.55	0.00	0.00	1,972	8.60	1.58	0.00	0.00	0.00	2,716	14.39	2.64	0.00	0.00	0.00	4,012	12.32	2.26	0.00	0.00	0.00
UEIB-44	548	3.39	0.62	0.00	0.00	800	2.37	0.43	0.00	0.00	883	3.16	0.58	0.00	0.00	0.00	1,045	2.90	0.53	8	8.13	0.15	1,215	1.53	0.28	17	8.49	0.08
UEIB-45 [8]	566	9.49	1.74	57	1.39	1,544	8.10	1.49	106	0.46	1,779	9.01	1.65	106	0.00	0.24	2,147	6.56	1.20	106	0.00	0.00	2,878	6.59	1.21	142	36.58	0.33
UEIB-46 [9]	69	1.58	0.29	0.00	0.00	185	0.96	0.18	0.00	0.00	247	1.82	0.33	0.00	0.00	0.00	328	1.08	0.20	0.00	0.00	0.00	402	0.67	0.12	7.76	7.76	0.05
CPR-1 [11]	1,505	1.36	0.25	49	0.12	1,548	0.48	0.09	53	0.05	1,895	2.80	0.51	53	0	0.00	2,102	4.61	0.85	109	55.68	0.88	2,232	4.08	0.75	131	22.49	0.15
CPR-2 [11]	143	0.02	0.00	14	0.03	143	0.00	0.00	14	0.00	143	0.00	0.00	14	0	0.00	161	0.23	0.04	31	16.92	0.00	313	1.82	0.33	31	0.00	0.18
EX-1 [11]	5,169	2.31	0.42	N/A	N/A	5,208	0.15	0.03	N/A	N/A	5,313	1.79	0.33	N/A	NA	N/A	5,433	2.01	0.37	N/A	NA	N/A	5,564	1.49	0.27	N/A	NA	N/A
EX-2 [11]	524	0.22	0.04	N/A	N/A	524	0.01	0.00	N/A	N/A	532	0.14	0.03	N/A	NA	N/A	540	0.14	0.03	N/A	NA	N/A	554	0.14	0.03	N/A	NA	N/A
EX-3 [11]	1,979	0.79	0.14	N/A	N/A	1,987	0.03	0.01	N/A	N/A	2,005	0.31	0.06	N/A	NA	N/A	2,024	0.32	0.06	N/A	NA	N/A	2,057	0.32	0.06	N/A	NA	N/A
EX-4 [11]	501	0.14	0.03	N/A	N/A	502	0.01	0.00	N/A	N/A	506	0.06	0.01	N/A	NA	N/A	509	0.07	0.01	N/A	NA	N/A	516	0.06	0.01	N/A	NA	N/A
U2-5 [11]	503	0.01	0.00	N/A	N/A	503	0.00	0.00	N/A	N/A	503	0.00	0.00	N/A	NA	N/A	503	0.00	0.00	N/A	NA	N/A	503	0.00	0.00	N/A	NA	N/A
Total	40,859	125	22	21,674	2.62	55,866	138	25	21,728	0.51	60,888	166	30	21,728	0	0.24	70,014	163	30	21,818	90	1.19	87,523	168	31	21,907	89	0.91

Abbreviations:

UK - Unknown (not enough data).
NAPL - Non-Aqueous Phase Liquids
PHC - Petroleum Hydrocarbons
m - Metres
L - Litres
Kg - Kilograms
gpm - Gallons per minute

Notes

1. UEIB-1 operated from August 5, 2010 to March 17, 2011. On March 17, UEIB-1 was replaced with UEIB-14.
2. UEIB-2 operated from August 5 to 25, 2010 and continuously since February 1, 2011.
3. UEIB-11 operated from August 25, 2010 to February 1, 2011.
4. UEIB-10 operated from December 2010 to July 2012. In July 2012, UEIB-10 was replaced with UEIB-32. On December 17, 2015, pump in UEIB-14 was moved to UEIB-10.
5. NAPL extraction rate measured as total NAPL extracted since previous measuring event.
6. No pump tests done before July 2012. Assumed rate of 0.90 L/count.
7. Pumps UEIB-32 to UEIB-44 not started until September 27, 2011. Rates listed for those pumps are taken from measurements completed from September 27 to October 24, 2011. Due to this exception, cummulative extracted fluids and NAPL were not calculated.
8. Pump operated in UEIB-5 until June 2012, then it was moved into UEIB-45.
9. Pump operated in UEIB-6 until June 2012, then it was moved into UEIB-46.
10. Extraction rate values calculated from change in counter readings between June 21 to June 27.
11. For November 22, 2012 Summary Table results, CPR-(1,2), EX-(1,2,3,4) and U2-5 data was collected on Oct.22,24, 2012.
12. Transducer Data - during rebound testing, all pumps were shut off from Oct.11-12, 2011 to Mar.14-22, 2012 with the exception of test pumps (UEIB-5,6,22,23,35 and 36).
13. Fluid extraction rate based on the average of the last five measurements.
14. A replaced well was installed to replace the shallow extraction well. The AP4 pump was swapped from the shallow well to the deep well and installed in the week of October 2, 2017

TABLE C-1
SUMMARY OF EXTRACTION RATES - PERIMETER EXTRACTION SYSTEM
PARKLAND BURNABY REFINERY

Extraction Well	September 26, 2013								December 20, 2013							
	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate[13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate[13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)
	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	0.00	N/A	NA	78	N/A	N/A	N/A	2,680	NA	N/A	NA
UEIB-2[2]/UEIB-52[14]	210	9	0.08	0.01	1,578	0.00	0.00	0.03	219	9	0.14	0.03	1,578	0.00	0.00	0.03
UEIB-3/UEIB-53[14]	506	15	0.13	0.02	4,465	0.00	0.00	0.04	525	18	0.26	0.05	4,465	0.00	0.00	0.91
UEIB-4/UEIB-54[14]	319	4	0.04	0.01	154	0.00	0.00	0.01	321	1	0.03	0.01	154	0.00	0.00	0.00
UEIB-5[8]	358	N/A	N/A	N/A	184	0.00	N/A	NA	358	N/A	N/A	N/A	184	NA	N/A	NA
UEIB-6[9]	209	N/A	N/A	N/A	6,025	0.00	N/A	NA	209	N/A	N/A	N/A	6,025	NA	N/A	NA
UEIB-7/UEIB-47[14]	307	9	0.08	0.01	5,644	0.00	0.00	0.03	307	0	0.00	0.00	5,644	0.00	0.00	0.00
UEIB-8/UEIB-48[14]	1,190	10	0.09	0.02	0.00	0.00	0.00	0.03	1,190	0	0.00	0.00	0.00	0.00	0.00	0.00
UEIB-9/UEIB-49[14]	1,811	31	0.27	0.05	0.00	0.00	0.00	0.09	1,836	24	0.24	0.04	0.00	0.00	0.00	0.07
UEIB-10[4]/UEIB-50[14]	792	N/A	N/A	N/A	0.00	0.00	N/A	N/A	792	N/A	N/A	N/A	0.00	0.00	N/A	N/A
UEIB-11[3]	10	N/A	N/A	N/A	0.00	0.00	N/A	N/A	10	N/A	N/A	N/A	0.00	0.00	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	86	0	0.00	0.00	825	0.00	0.00	0.00	86	0	0.00	0.00	825	0.00	0.00	0.00
UEIB-15	2,499	294	2.20	0.40	0.00	0.00	0.00	0.06	2,816	317	4.03	0.74	0.00	0.00	0.00	0.06
UEIB-16	1,731	263	2.31	0.42	0.00	0.00	0.00	0.14	2,076	346	4.40	0.81	0.00	0.00	0.00	0.19
UEIB-17	1,218	147	1.50	0.27	0.00	0.00	0.00	0.14	1,531	313	4.20	0.77	0.00	0.00	0.00	0.31
UEIB-18	1,908	239	2.09	0.38	0.00	0.00	0.00	0.36	2,235	327	8.63	1.58	0.00	0.00	0.00	3.39
UEIB-19	3,091	270	2.39	0.44	0.00	0.00	0.00	0.62	3,149	59	0.01	0.00	0.00	0.00	0.00	7.27
UEIB-20/UEIB-56[14]	5,609	782	6.91	1.27	0.00	0.00	0.00	1.62	6,199	589	11.53	2.12	0.00	0.00	0.00	12.82
UEIB-21	3,988	80	0.60	0.11	0.00	0.00	0.00	0.55	4,410	423	11.12	2.04	0.00	0.00	0.00	30.56
UEIB-22	1,477	158	1.40	0.26	0.00	0.00	0.00	0.36	1,670	193	2.44	0.45	0.00	0.00	0.00	3.82
UEIB-23	1,048	309	2.74	0.50	0.00	0.00	0.00	0.89	1,088	40	0.52	0.09	0.00	0.00	0.00	3.13
UEIB-24	4,402	213	1.18	0.22	0.00	0.00	0.00	0.61	5,069	667	7.61	1.40	0.00	0.00	0.00	14.60
UEIB-25	2,532	338	2.99	0.55	0.00	0.00	0.00	0.10	2,883	351	4.96	0.91	0.00	0.00	0.00	0.84
UEIB-26	1,877	173	1.58	0.29	0.00	0.00	0.00	0.06	2,074	197	2.48	0.45	0.00	0.00	0.00	0.75
UEIB-27	2,598	525	4.64	0.85	0.00	0.00	0.00	0.99	3,057	459	7.25	1.33	0.00	0.00	0.00	5.74
UEIB-28	2,268	78	0.58	0.11	0.00	0.00	0.00	0.21	2,293	25	0.05	0.01	0.00	0.00	0.00	6.19
UEIB-29	4,331	675	5.96	1.09	0.00	0.00	0.00	1.94	4,925	594	6.53	1.20	0.00	0.00	0.00	14.17
UEIB-30	2,612	238	2.10	0.39	0.00	0.00	0.00	0.68	2,914	302	4.52	0.83	0.00	0.00	0.00	8.39
UEIB-31/UEIB-55[14]	1,679	182	1.61	0.30	0.00	0.00	0.00	0.52	1,849	170	1.92	0.35	0.00	0.00	0.00	5.32
UEIB-32	2,786	107	0.93	0.17	23.01	0.00	0.00	1.41	2,875	89	1.11	0.20	28.40	5.39	0.05	37.77
UEIB-33	2,247	427	3.71	0.68	11.23	11.23	0.16	1.70	3,038	791	10.44	1.92	54.26	43.03	0.38	12.11
UEIB-34	2,579	323	2.81	0.52	0.00	0.00	0.00	0.08	2,803	224	2.72	0.50	0.00	0.00	0.00	0.73
UEIB-35	6,057	1,866	16.23	2.98	0.00	0.00	0.00	5.38	7,304	1,247	13.70	2.51	0.00	0.00	0.00	21.00
UEIB-36	2,870	631	5.49	1.01	0.00	0.00	0.00	0.18	3,023	153	1.76	0.32	0.00	0.00	0.00	0.84
UEIB-37 [6]	1,021	300	2.61	0.48	0.00	0.00	0.00	0.86	1,438	417	4.98	0.91	0.00	0.00	0.00	4.14
UEIB-38	550	60	0.52	0.10	0.00	0.00	0.00	0.02	618	68	0.88	0.16	0.00	0.00	0.00	0.19
UEIB-39 [6]	1,197	163	1.47	0.27	0.00	0.00	0.00	0.47	1,321	124	1.55	0.28	0.00	0.00	0.00	3.80
UEIB-40 [6]	1,097	173	1.57	0.29	0.00	0.00	0.00	0.50	1,295	197	2.58	0.47	0.00	0.00	0.00	3.73
UEIB-41 [6]	1,819	405	3.80	0.70	0.00	0.00	0.00	1.17	2,406	588	6.95	1.27	0.00	0.00	0.00	6.92
UEIB-42 [6]	4,493	685	3.97	0.73	0.00	0.00	0.00	1.97	4,493	0	0.00	0.00	0.00	0.00	0.00	12.93
UEIB-43	4,945	933	6.96	1.28	0.00	0.00	0.00	2.69	5,197	253	4.06	0.74	0.00	0.00	0.00	14.95
UEIB-44	1,294	79	0.68	0.13	18.71	2.10	0.03	0.27	1,359	65	0.79	0.14	23.17	4.46	0.04	4.73
UEIB-45 [8]	3,381	503	4.41	0.81	155.86	13.76	0.20	3.50	3,910	529	6.53	1.20	188.11	32.25	0.28	27.15
UEIB-46 [9]	478	76	0.67	0.12	10.17	2.42	0.03	0.54	533	55	0.76	0.14	10.17	0.00	0.00	3.81
CPR-1 [11]	2,345	114	1.67	0.31	132	1.24	0.15	0.33	2,412	67	0.43	0.08	135	2.43	0.08	6.94
CPR-2 [11]	320	8	0.85	0.16	32	0.38	0.00	0.02	326	5	0.04	0.01	32	0.00	0.00	0.94
EX-1 [11]	5,648	84	1.12	0.21	N/A	NA	N/A	N/A	5,730	82	0.85	0.16	N/A	NA	N/A	N/A
EX-2 [11]	563	8	0.12	0.02	N/A	NA	N/A	N/A	570	7	0.08	0.02	N/A	NA	N/A	N/A
EX-3 [11]	2,082	25	0.30	0.06	N/A	NA	N/A	N/A	2,091	9	0.15	0.03	N/A	NA	N/A	N/A
EX-4 [11]	520	5	0.06	0.01	N/A	NA	N/A	N/A	527	6	0.05	0.01	N/A	NA	N/A	N/A
U2-5 [11]	503	N/A	-	0.00	N/A	NA	N/A	N/A	503	N/A	-	0.00	N/A	NA	N/A	N/A
Total	99,539	12,017	103	19	21,938	31	0.58	31.20	109,942	10,403	136	25	22,025	88	0.84	281.21

Extraction Well	March 26, 2014								June 24-25 and July 7, 2014							
	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate[13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate[13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)
	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	NA	78	N/A	N/A	N/A	2,680	N/A	N/A	NA
UEIB-2[2]/UEIB-52[14]	234	14	0.16	0.03	1,578	0.00	0.00	0.04	248	15	0.15	0.03	1,578	0.00	0.00	5.49
UEIB-3/UEIB-53[14]	561	36	0.38	0.07	4,465	0.00	0.00	0.10	595	34	0.38	0.07	4,465	0.00	0.00	12.80
UEIB-4/UEIB-54[14]	334	13	0.17	0.03	154	0.00	0.00	0.04	346	12	0.13	0.02	153.92	0.00	0.00	4.58
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	NA	358	N/A	N/A	N/A	184	N/A	N/A	NA
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	NA	209	N/A	N/A	N/A	6,025	N/A	N/A	NA
UEIB-7/UEIB-47[14]	311	4	0.04	0.01	5,644	0.00	0.00	0.01	315	4	0.05	0.01	5,644	0.00	0.00	1.64
UEIB-8/UEIB-48[14]	1,220	30	0.31	0.06	0.00	0.00	0.00	0.09	1,274	54	0.59	0.11	0.00	0.00	0.00	0.05
UEIB-9/UEIB-49[14]	1,904	68	0.78	0.14	0.00	0.00	0.00	0.20	1,970	66	0.96	0.18	0.00	0.00	0.00	24.78
UEIB-10[4]/UEIB-50[14]	792	N/A	N/A	N/A	0.00	N/A	N/A	N/A	792	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-11[3]	10	N/A	N/A	N/A	0.00	N/A	N/A	N/A	10	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	86	1	0.01	0.00	825	0.00	0.00	0.00	90	4	0.04	0.01	825	0.00	0.00	1.51
UEIB-15	3,033	217	1.12	0.21	0.00	0.00	0.00	0.04	3,152	119	0.84	0.15	0.00	0.00	0.00	0.10
UEIB-16	3,536	1,460	18.42	3.38	0.00	0.00	0.00	0.80	4,053	516	4.68	0.86	0.00	0.00	0.00	0.18
UEIB-17	1,869	338	2.94	0.54	0.00	0.00	0.00	0.33	2,057	188	0.72	0.13	0.00	0.00	0.00	0.11
UEIB-18	2,593	357	2.42	0.44	0.00	0.00	0.00	0.54	2,826	233	2.31	0.42	0.00	0.00	0.00	87.34
UEIB-19	3,519	370	3.17	0.58	0.00	0.00	0.00	0.85	4,013	493	5.02	0.92	0.00	0.00	0.00	0.63
UEIB-20/UEIB-56[14]	6,510	312	2.52	0.46	0.00	0.00	0.00	0.65	6,667	157	1.70	0.31	0.00	0.00	0.00	0.12
UEIB-21	5,065	655	8.26	1.52	0.00	0.00	0.00	4.54	6,581	1,516	4.12	0.76	0.00	0.00	0.00	10.51
UEIB-22	1,979	309	3.14	0.58	0.00	0.00	0.00	0.71	2,293	315	2.94	0.54	0.00	0.00	0.00	0.18
UEIB-23	1,465	376	4.72	0.87	0.00	0.00	0.00	1.08	1,946	482	4.54	0.83	0.00	0.00	0.00	0.51
UEIB-24	5,429	360	3.72	0.68	0.00	0.00	0.00	1.04	5,439	10	0.10	0.02	0.00	0.00	0.00	0.04
UEIB-25	3,317	434	3.99	0.73	0.00	0.00	0.00	0.13	3,317	0	0.76	0.14	0.00	0.00	0.00	0.00
UEIB-26	4,486	2,413	32.98	6.05	0.00	0.00	0.00	0.87	4,783	297	3.32	0.61	0.00	0.00	0.00	0.64
UEIB-27	3,563	506	4.96	0.91	0.00	0.00	0.00	0.95	3,918	355	3.48	0.64	0.00	0.00	0.00	1.44
UEIB-28	2,307	14	0.20	0.04	0.00	0.00	0.00	0.04	2,428	121	1.64	0.30	0.00	0.00	0.00	0.26
UEIB-29	5,604	679	7.07	1.30	0.00	0.00	0.00	1.96	5,937	334	2.57	0.47	0.00	0.00	0.00	125.08
UEIB-30	3,162	248	2.60	0.48	0.00	0.00	0.00	0.71	3,167	5	0.96	0.18	0.00	0.00	0.00	0.02
UEIB-31/UEIB-55[14]	2,157	308	4.68	0.86	0.00	0.00	0.00	0.89	2,545	388	3.97	0.73	0.00	0.00	0.00	145.55
UEIB-32	2,966	91	0.79	0.14	39.34	10.94	0.13	1.19	3,071	105	1.17	0.21	44.62	5.27	0.04	2.65
UEIB-33	3,792	753	7.34	1.35	54.26	0.00	0.00	3.01	3,792	0	0.16	0.03	54.26	0.00	0.00	0.00
UEIB-34	3,057	253	2.70	0.49	0.00	0.00	0.00	0.07	3,472	415	4.28	0.79	0.00	0.00	0.00	0.73
UEIB-35	7,997	692	6.66	1.22	0.00	0.00	0.00	1.99	8,328	331	3.68	0.67	0.00	0.00	0.00	0.39
UEIB-36	3,264	242	2.75	0.50	0.00	0.00	0.00	0.07	3,498	234	2.60	0.48	0.00	0.00	0.00	87.70
UEIB-37 [6]	1,892	454	4.83	0.89	0.00	0.00	0.00	1.31	2,207	315	3.49	0.64	0.00	0.00	0.00	118.09
UEIB-38	713	96	1.00	0.18	0.00	0.00	0.00	0.03	802	89	0.81	0.15	0.00	0.00	0.00	33.34
UEIB-39 [6]	1,572	251	2.80	0.51	0.00	0.00	0.00	0.72	1,750	178	1.97	0.36	0.00	0.00	0.00	66.76
UEIB-40 [6]	1,617	322	3.53	0.65	0.00	0.00	0.00	0.93	1,904	288	3.19	0.59	0.00	0.00	0.00	107.96
UEIB-41 [6]	2,871	464	5.14	0.94	0.00	0.00	0.00	1.34	3,100	229	2.80	0.51	0.00	0.00	0.00	85.86
UEIB-42 [6]	4,577	83	1.19	0.22	0.00	0.00	0.00	0.24	4,843	266	2.96	0.54	0.00	0.00	0.00	99.85
UEIB-43	6,242	1,044	10.87	1.99	0.00	0.00	0.00	3.01	6,533	291	8.10	1.49	0.00	0.00	0.00	109.31
UEIB-44	1,432	73	0.67	0.12	23.87	0.69	0.01	0.25	1,584	153	1.69	0.31	30.01	6.14	0.05	0.78
UEIB-45 [8]	4,713	803	8.40	1.54	255.22	67.10	0.80	5.58	5,294	581	5.23	0.96	337.72	82.50	1.33	4535.09
UEIB-46 [9]	662	129	1.44	0.26	10.17	0.00	0.00	0.93	812	150	1.65	0.30	10.17	0.00	0.00	0.75
CPR-1 [11]	2,806	393	3.49	0.64	155	20.58	0.17	1.13	2,969	163	2.87	1	155	0.00	0.00	61.23
CPR-2 [11]	377	51	0.45	0.08	34	2.55	0.03	0.15	386	9	0.27	0	35	0.46	0.00	3.43
EX-1 [11]	5,779	49	0.69	0.13	N/A	N/A	N/A	N/A	5,888	109	1.13	0	N/A	N/A	N/A	N/A
EX-2 [11]	576	6	0.09	0.02	N/A	N/A	N/A	N/A	591	15	0.15	0	N/A	N/A	N/A	N/A
EX-3 [11]	2,124	33	0.46	0.08	N/A	N/A	N/A	N/A	2,177	54	0.62	0	N/A	N/A	N/A	N/A
EX-4 [11]	534	7	0.08	0.01	N/A	N/A	N/A	N/A	541	6	0.07	0	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	125,755	15,813	174	32	22,127	102	1.14	38.55	135,456	9,700	95	17	22,222	94	1.43	5737.47

Abbreviations:

UK - Unknown (not enough data).

NAPL - Non-Aqueous Phase Liquids

PHC - Petroleum Hydrocarbons

m - Metres

L - Litres

Kg - Kilograms

gpm - Gallons per minute

TABLE C-1
SUMMARY OF EXTRACTION RATES - PERIMETER EXTRACTION SYSTEM
PARKLAND BURNABY REFINERY

Extraction Well	September 29-30, 2014							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13]		Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
			(m^3/day)	(gpm)				
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	NA
UEIB-2[2]/UEIB-52[14]	256	8	0.05	0.01	1,578	0.00	0.00	1.84
UEIB-3/UEIB-53[14]	605	10	0.07	0.01	4,465	0.00	0.00	2.37
UEIB-4/UEIB-54[14]	353	6	0.02	0.00	153.92	0.00	0.00	1.56
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	NA
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	NA
UEIB-7/UEIB-47[14]	316	0.2	0.00	0.00	5,644	0.00	0.00	0.06
UEIB-8/UEIB-48[14]	1,299	25	0.01	0.00	0.00	0.00	0.00	6.00
UEIB-9/UEIB-49[14]	2,020	50	0.44	0.08	0.00	0.00	0.00	0.03
UEIB-10[4]/UEIB-50[14]	792	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-11[3]	10	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	91	0.3	0.00	0.00	825	0.00	0.00	0.07
UEIB-15	3,616	464	2.05	0.38	0.00	0.00	0.00	0.23
UEIB-16	4,679	626	1.65	0.30	0.00	0.00	0.00	153.36
UEIB-17	2,257	200	2.57	0.47	0.00	0.00	0.00	49.04
UEIB-18	3,002	177	1.93	0.35	0.00	0.00	0.00	0.50
UEIB-19	4,301	288	0.99	0.18	0.00	0.00	0.00	70.61
UEIB-20/UEIB-56[14]	7,003	336	4.09	0.75	0.00	0.00	0.00	0.28
UEIB-21	6,924	343	5.70	1.05	0.00	0.00	0.00	83.85
UEIB-22	2,557	264	2.70	0.49	0.00	0.00	0.00	0.37
UEIB-23	2,453	507	6.03	1.11	0.00	0.00	0.00	0.22
UEIB-24	5,548	109	1.37	0.25	0.00	0.00	0.00	0.02
UEIB-25	3,598	281	3.75	0.69	0.00	0.00	0.00	68.80
UEIB-26	4,961	178	1.97	0.36	0.00	0.00	0.00	43.56
UEIB-27	4,412	493	8.08	1.48	0.00	0.00	0.00	0.93
UEIB-28	2,547	119	1.97	0.36	0.00	0.00	0.00	29.13
UEIB-29	6,185	248	2.95	0.54	0.00	0.00	0.00	60.68
UEIB-30	3,409	242	3.37	0.62	0.00	0.00	0.00	0.06
UEIB-31/UEIB-55[14]	3,942	1,397	21.77	3.99	0.00	0.00	0.00	341.95
UEIB-32	3,177	105	1.04	0.19	44.62	0.00	0.00	0.66
UEIB-33	3,808	16	0.28	0.05	54.26	0.00	0.00	0.12
UEIB-34	3,952	480	4.48	0.82	24.02	24.02	0.26	0.13
UEIB-35	8,401	74	0.02	0.00	0.00	0.00	0.00	4.87
UEIB-36	3,833	335	3.51	0.64	16.77	16.77	0.23	82.08
UEIB-37[6]	3,359	1,152	17.29	3.17	0.00	0.00	0.00	282.08
UEIB-38	810	8	0.09	0.02	0.00	0.00	0.00	1.98
UEIB-39[6]	1,921	171	1.58	0.29	0.00	0.00	0.00	0.09
UEIB-40[6]	2,168	264	3.68	0.67	0.00	0.00	0.00	0.13
UEIB-41[6]	4,721	1,621	3.26	0.60	0.00	0.00	0.00	0.47
UEIB-42[6]	5,083	240	2.53	0.46	0.00	0.00	0.00	0.14
UEIB-43	7,879	1,346	10.70	1.96	0.00	0.00	0.00	329.40
UEIB-44	1,714	130	1.25	0.23	42.96	12.95	0.18	1.77
UEIB-45[8]	6,477	1,182	10.69	1.96	455.95	118.23	1.53	5659.44
UEIB-46[9]	937	124	1.18	0.22	10.17	0.00	0.00	0.59
CPR-1[11]	2,970	1	0.02	0	155	0.06	0.00	0.28
CPR-2[11]	386	0	0.00	0	35	0.00	0.00	0.00
EX-1[11]	5,947	59	0.71	0	N/A	N/A	N/A	N/A
EX-2[11]	599	9	0.11	0	N/A	N/A	N/A	N/A
EX-3[11]	2,200	22	0.28	0	N/A	N/A	N/A	N/A
EX-4[11]	544	3	0.04	0	N/A	N/A	N/A	N/A
U2-5[11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	149,167	13,712	136	25	22,394	172	2.21	7279.78

Extraction Well	December 15-17, 2014							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13]		Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
			(m^3/day)	(gpm)				
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	NA
UEIB-2[2]/UEIB-52[14]	280	24.3	0.34	0.06	1,578	0.00	0.00	0.12
UEIB-3/UEIB-53[14]	633	27.5	0.38	0.07	4,465	0.00	0.00	0.46
UEIB-4/UEIB-54[14]	383	30.4	0.47	0.09	153.92	0.00	0.00	1.38
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	NA
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	NA
UEIB-7/UEIB-47[14]	320	4.7	0.07	0.01	5,644	0.00	0.00	0.14
UEIB-8/UEIB-48[14]	1,345	46.3	0.58	0.11	2.83	2.83	0.04	0.13
UEIB-9/UEIB-49[14]	2,104	84.3	1.05	0.19	0.00	0.00	0.00	0.02
UEIB-10[4]/UEIB-50[14]	792	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-11[3]	10	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	92	1.1	0.02	0.00	825	0.00	0.00	0.13
UEIB-15	4,442	826.0	11.46	2.10	0.00	0.00	0.00	0.74
UEIB-16	5,294	615.0	9.58	1.76	0.00	0.00	0.00	0.63
UEIB-17	2,444	187.0	2.02	0.37	0.00	0.00	0.00	0.15
UEIB-18	3,374	371.9	4.25	0.78	0.00	0.00	0.00	0.30
UEIB-19	4,308	7.3	0.13	0.02	0.00	0.00	0.00	0.02
UEIB-20/UEIB-56[14]	7,584	581.4	4.32	0.79	0.00	0.00	0.00	0.51
UEIB-21	7,647	723.5	8.90	1.63	0.00	0.00	0.00	3.51
UEIB-22	3,322	764.7	9.77	1.79	0.00	0.00	0.00	2.41
UEIB-23	4,145	1,692.0	24.26	4.45	0.00	0.00	0.00	2.93
UEIB-24	5,820	272.1	2.48	0.46	0.00	0.00	0.00	0.19
UEIB-25	4,126	527.8	7.16	1.31	0.00	0.00	0.00	0.55
UEIB-26	5,425	463.4	0.67	0.12	0.00	0.00	0.00	0.90
UEIB-27	5,512	1,100.7	12.45	2.28	0.00	0.00	0.00	7.02
UEIB-28	2,864	317.3	3.98	0.73	0.00	0.00	0.00	0.75
UEIB-29	6,621	435.6	3.30	0.60	0.00	0.00	0.00	0.22
UEIB-30	3,844	434.7	4.89	0.90	0.00	0.00	0.00	0.31
UEIB-31/UEIB-55[14]	3,947	5.2	0.03	0.01	0.00	0.00	0.00	0.16
UEIB-32	3,315	138.2	1.53	0.28	44.62	0.00	0.00	1.14
UEIB-33	3,968	160.7	2.07	0.38	54.26	0.00	0.00	0.74
UEIB-34	4,337	385.2	3.40	0.62	40.07	16.06	0.20	2.68
UEIB-35	8,891	489.3	7.17	1.31	0.00	0.00	0.00	14.86
UEIB-36	4,193	359.6	3.04	0.56	33.16	16.39	0.20	0.11
UEIB-37[6]	3,926	566.8	5.70	1.05	0.00	0.00	0.00	6.35
UEIB-38	810	-	0.08	0.01	0.00	0.00	0.00	0.00
UEIB-39[6]	2,142	221.0	2.60	0.48	0.00	0.00	0.00	0.11
UEIB-40[6]	2,493	325.2	3.77	0.69	0.00	0.00	0.00	0.10
UEIB-41[6]	5,132	410.7	3.74	0.69	0.00	0.00	0.00	12.47
UEIB-42[6]	5,666	582.8	6.74	1.24	0.00	0.00	0.00	0.10
UEIB-43	8,870	991.8	9.22	1.69	0.00	0.00	0.00	30.13
UEIB-44	1,714	0.3	0.00	0.00	42.98	0.01	0.00	0.01
UEIB-45[8]	7,018	541.4	5.38	0.99	501.07	45.12	0.58	391.41
UEIB-46[9]	1,111	174.0	2.27	0.42	10.17	0.00	0.00	1.53
CPR-1[11]	3,330	359.4	4.67	0.86	170	14.88	0.18	10.92
CPR-2[11]	494	107.9	1.44	0.26	35	0.00	0.00	3.28
EX-1[11]	6,049	102.7	1.07	0.20	N/A	N/A	N/A	N/A
EX-2[11]	616	16.9	0.19	0.03	N/A	N/A	N/A	N/A
EX-3[11]	2,272	72.5	0.82	0.15	N/A	N/A	N/A	N/A
EX-4[11]	549	5.6	0.06	0.01	N/A	N/A	N/A	N/A
U2-5[11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	164,724	15,556	178	33	22,489	95	1.20	499.60

Extraction Well	February 24-25, 2015							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13]		Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
			(m^3/day)	(gpm)				
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	NA
UEIB-2[2]/UEIB-52[14]	303	23.1	0.25	0.05	1,578	0.00	0.00	0.07
UEIB-3/UEIB-53[14]	648	15.0	0.13	0.02	4,465	0.00	0.00	0.05
UEIB-4/UEIB-54[14]	390	6.8	0.06	0.01	153.92	0.00	0.00	0.02
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	NA
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	NA
UEIB-7/UEIB-47[14]	323	3.2	0.04	0.01	5,644	0.00	0.00	0.01
UEIB-8/UEIB-48[14]	1,431	85.8	1.03	0.19	6.80	3.97	0.07	0.14
UEIB-9/UEIB-49[14]	2,159	55.0	0.58	0.11	0.00	0.00	0.00	0.01
UEIB-10[4]/UEIB-50[14]	792	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-11[3]	10	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	93	1.7	0.02	0.00	825	0.00	0.00	0.01
UEIB-15	5,558	1,116.2	8.90	1.63	0.00	0.00	0.00	0.68
UEIB-16	5,298	4.4	0.01	0.00	0.00	0.00	0.00	0.00
UEIB-17	2,819	375.0	2.18	0.40	0.00	0.00	0.00	1.17
UEIB-18	3,788	413.9	5.72	1.05	0.00	0.00	0.00	0.96
UEIB-19	4,343	34.8	0.44	0.08	0.00	0.00	0.00	0.05
UEIB-20/UEIB-56[14]	8,094	510.0	6.01	1.10	0.00	0.00	0.00	0.40
UEIB-21	8,362	714.7	6.83	1.25	0.00	0.00	0.00	4.29
UEIB-22	3,477	155.0	1.92	0.35	0.00	0.00	0.00	0.48
UEIB-23	4,598	452.7	5.76	1.06	0.00	0.00	0.00	0.64
UEIB-24	5,979	158.4	11.55	2.12	0.00	0.00	0.00	0.10
UEIB-25	4,672	546.5	3.69	0.68	0.00	0.00	0.00	0.78
UEIB-26	5,524	99.1	4.68	0.86	0.00	0.00	0.00	0.38
UEIB-27	6,042	529.4	1.41	0.26	0.00	0.00	0.00	3.07
UEIB-28	3,191	326.5	10.18	1.87	0.00	0.00	0.00	1.00
UEIB-29	7,007	386.4	3.88	0.71	0.00	0.00	0.00	0.10
UEIB-30	4,403	559.4	7.80	1.43	0.00	0.00	0.00	0.29
UEIB-31/UEIB-55[14]	3,993	46.2	3.10	0.57	0.00	0.00	0.00	0.01
UEIB-32	3,442	127.5	1.46	0.27	44.62	0.00	0.00	1.03
UEIB-33	4,276	307.4	3.46	0.63	54.26	0.00	0.00	1.87
UEIB-34	4,703	365.8	4.35	0.80	40.07	0.00	0.00	0.56
UEIB-35	9,479	588.5	6.57	1.21	0.00	0.00	0.00	0.33
UEIB-36	4,326	132.7	1.57	0.29	33.16	0.00	0.00	0.04
UEIB-37[6]	4,443	517.1	5.87	1.08	0.00	0.00	0.00	0.74
UEIB-38	810	0.0	0.00	0.00	0.00	0.00	0.00	0.00
UEIB-39[6]	2,396	254.2	2.96	0.54	0.00	0.00	0.00	0.47
UEIB-40[6]	2,793	299.2	3.33	0.61	0.00	0.00	0.00	0.19
UEIB-41[6]	5,440	308.6	3.54	0.65	0.00	0.00	0.00	0.52
UEIB-42[6]	6,620	953.8	11.00	2.02	0.00	0.00	0.00	0.24
UEIB-43	9,694	824.1	9.74	1.79	0.00	0.00	0.00	2.57
UEIB-44	1,732	18.0	0.33	0.06	42.98	0.00	0.00	0.13
UEIB-45[8]	7,738	719.9	8.87	1.63	557.72	56.65	0.82	19.39
UEIB-46[9]	1,232	121.2	1.36	0.25	10.17	0.00	0.00	0.76
CPR-1[11]	3,558	228.4	3.00	0.55	170	0.00	0.00	0.71
CPR-2[11]	586	92.6	1.22	0.22	35	0.00	0.00	0.29
EX-1[11]	6,137	87.6	1.15	0.21	N/A	N/A	N/A	N/A
EX-2[11]	630	13.7	0.18	0.03	N/A	N/A	N/A	N/A
EX-3[11]	2,326	54.2	0.71	0.13	N/A	N/A	N/A	N/A
EX-4[11]	554	4.6	0.05	0.01	N/A	N/A	N/A	N/A
U2-5[11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	177,362	12,638	157	29	22,550	61	0.89	44.55

Extraction Well	May 26-28, 2015							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13]		Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
			(m^3/day)	(gpm)				
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	NA
UEIB-2[2]/UEIB-52[14]	317	13.5	0.09	0.02	1,578	0.00	0.00	0.65
UEIB-3/UEIB-53[14]	653	4.9	0.00	0.00	4,465	0.00	0.00	0.24
UEIB-4/UEIB-54[14]	391	0.7	0.00	0.00	153.92	0.00	0.00	0.03
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	324	0.9	0.00	0.00	5,644	0.00	0.00	0.04
UEIB-8/UEIB-48[14]	1,467	36.1	0.20	0.04	6.80	0.00	0.00	1.75
UEIB-9/UEIB-49[14]	2,222	63.3	0.57	0.10	0.00	0.00	0.00	0.02
UEIB-10[4]/UEIB-50[14]	792	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-11[3]	10	N/A	N/A	N/A	0.00	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	94	0.5	0.00	0.00	825	0.00	0.00	0.02
UEIB-15	6,305	747.3	7.69	1.41	0.00	0.00	0.00	0.28
UEIB-16	5,299	0.3	0.01	0.00	0.00	0.00	0.00	0.00
UEIB-17	2,873	53.7	0.73	0.13	0.00	0.00	0.00	2.61
UEIB-18	4,272	483.9	5.71	1.05	0.00	0.00	0.00	0.20
UEIB-19	4,355	12.1	0.21	0.04	0.00	0.00	0.00	0.59
UEIB-20/UEIB-56[14]	8,837	743.0	6.33	1.16	0.00	0.00	0.00	0.77
UEIB-21	8,850	488.3	6.69	1.23	0.00	0.00	0.00	2.52
UEIB-22	3,824	347.6	3.99	0.73	0.00	0.00	0.00	0.55
UEIB-23	4,942	344.2	4.88	0.90	0.00	0.00	0.00	0.15
UEIB-24	6,894	915.1	8.88	1.63	0.00	0.00	0.00	44.50
UEIB-25	4,965	293.0	3.21	0.59	0.00	0.00	0.00	0.35
UEIB-26	8,175	2,651.4	46.00	8.44	0.00	0.00	0.00	128.95
UEIB-27	6,540	498.7	4.46	0.82	0.00	0.00	0.00	1.34
UEIB-28	3,494	303.3	2.31	0.42	0.00	0.00	0.00	0.15
UEIB-29	7,706	698.6	5.00	0.92	0.00	0.00	0.00	0.24
UEIB-30	4,750	346.8	2.90	0.53	0.00	0.00	0.00	0.21
UEIB-31/UEIB-55[14]	4,160	167.0	0.09	0.02	0.00	0.00	0.00	8.12
UEIB-32	3,544	102.0	1.06	0.19	44.62	0.00	0.00	0.57
UEIB-33	4,458	182.5	1.40	0.26	54.26	0.00	0.00	0.76
UEIB-34	4,970	266.4	2.75	0.50	40.07	0.00	0.00	0.04
UEIB-35	9,896	416.5	3.77	0.69	0.00	0.00	0.00	20.26
UEIB-36	4,392	66.4	1.07	0.20	33.16	0.00	0.00	3.23
UEIB-37[6]	4,521	77.2	0.72	0.13	0.00	0.00	0.00	3.76
UEIB-38	810	0.0	0.00	0.00	0.00	0.00	0.00	0.00
UEIB-39[6]	2,518	121.5	1.34	0.25	0.00	0.00	0.00	0.02
UEIB-40[6]	2,946	153.3	1.63	0.30	0.00	0.00	0.00	7.46
UEIB-41[6]	5,653	213.2	2.33	0.43	0.00	0.00	0.00	10.37
UEIB-42[6]	7,210	590.5	8.12	1.49	0.00	0.00	0.00	28.72
UEIB-43	9,760	65.8	0.00	0.00	0.00	0.00	0.00	3.20
UEIB-44	1,821	88.5	0.93	0.17	42.98	0.00	0.00	0.29
UEIB-45[8]	8,450	711.5	7.39	1.35	632.50	74.78	0.95	667.34
UEIB-46[9]	1,299	66.8	0.53	0.10	10.17	0.00	0.00	0.40
CPR-1[11]	3,680	122.5	1.22	0.22	170	0.00	0.00	5.96
CPR-2[11]	610	23.8	0.2	0.04	35	0.00	0.00	1.16
EX-1[11]	6,239	101.9	0.97	0.18	N/A	N/A	N/A	N/A
EX-2[11]	646	16.1	0.14	0.03	N/A	N/A	N/A	N/A
EX-3[11]	2,378	52.1	0.36	0.07	N/A	N/A	N/A	N/A
EX-4[11]	559	4.7	0.05	0.01	N/A	N/A	N/A	N/A
U2-5[11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	190,019	12,657	146	27	22,624	75	0.95	947.83

Abbreviations:

UK - Unknown (not enough data).
NAPL - Non-Aqueous Phase Liquids
PHC - Petroleum Hydrocarbons
m - Metres
L - Litres
Kg - Kilograms
gpm - Gallons per minute

TABLE C-1
SUMMARY OF EXTRACTION RATES - PERIMETER EXTRACTION SYSTEM
PARKLAND BURNABY REFINERY

Extraction Well	August 11-13, 2015								November 16-19, 2015								February 1-3, 2016								May 30,31 June 8, 9, and 15, 2016							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	317	0.1	0.00	0.00	1,578	0.00	0.00	0.00	326	9.3	0.12	0.02	1,578	0.00	0.00	0.18	340	14.0	0.17	0.03	1,578	0.00	0.00	0.20	350	9.6	0.09	0.02	1,578	0.00	0.00	0.16
UEIB-3/UEIB-53[14]	653	0.0	0.00	0.00	4,465	0.00	0.00	0.00	660	7.5	0.12	0.02	4,465	0.00	0.00	0.15	672	11.4	0.14	0.03	4,465	0.00	0.00	0.16	675	3.0	0.01	0.00	4,465	0.00	0.00	0.05
UEIB-4/UEIB-54[14]	391	0.0	0.00	0.00	154	0.00	0.00	0.00	391	0.4	0.01	0.00	154	0.00	0.00	0.01	392	1.1	0.01	0.00	154	0.00	0.00	0.02	393	0.5	0.00	0.00	154	0.00	0.00	0.01
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A	358	N/A	N/A	N/A	184	N/A	N/A	N/A	358	N/A	N/A	N/A	184	N/A	N/A	N/A	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	324	0.1	0.00	0.00	5,644	0.00	0.00	0.00	327	2.8	0.04	0.01	5,644	0.00	0.00	0.05	329	1.6	0.02	0.00	5,644	0.00	0.00	0.01	330	0.8	0.01	0.00	5,644	0.00	0.00	0.01
UEIB-8/UEIB-48[14]	1,467	0.2	0.00	0.00	6.80	0.00	0.00	0.01	1,512	45.0	0.40	0.07	6.80	0.00	0.00	0.09	1,618	106.3	1.27	0.23	6.80	0.00	0.00	1.53	1,713	95.0	0.97	0.18	6.80	0.00	0.00	0.08
UEIB-9/UEIB-49[14]	2,255	32.3	0.30	0.06	0.00	0.00	0.00	1.04	2,337	82.8	1.02	0.19	0.00	0.00	0.00	0.01	2,419	81.3	0.89	0.16	0.00	0.00	0.00	2.69	2,483	64.5	0.64	0.12	0.00	0.00	0.00	0.07
UEIB-10[4]/UEIB-50[14]	792	N/A	N/A	N/A	0.00	N/A	N/A	N/A	793	1.5	0.00	0.00	0.00	0.00	0.00	0.03	803	10.1	0.11	0.02	0.00	0.00	0.00	0.14	811	7.7	0.09	0.02	0.00	0.00	0.00	0.13
UEIB-11[3]	10	N/A	N/A	N/A	0.00	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	94	0.2	0.00	0.00	825	0.00	0.00	0.01	95	0.8	0.01	0.00	825	0.00	0.00	0.02	95	N/A	N/A	N/A	825	N/A	N/A	N/A	95	N/A	N/A	N/A	825	N/A	N/A	N/A
UEIB-15	7,443	1,137.6	2.62	0.48	0.00	0.00	0.00	0.14	7,540	97.5	2.31	0.42	0.00	0.00	0.00	0.08	7,709	168.7	2.42	0.44	0.00	0.00	0.00	0.03	7,891	182.0	1.37	0.25	0.00	0.00	0.00	0.03
UEIB-16	5,313	14.6	0.23	0.04	0.00	0.00	0.00	0.47	5,379	65.2	0.54	0.10	0.00	0.00	0.00	1.25	5,707	328.6	4.00	0.73	0.00	0.00	0.00	4.63	5,951	243.9	2.11	0.39	0.00	0.00	0.00	4.13
UEIB-17	3,149	276.3	4.87	0.89	0.00	0.00	0.00	9	3,524	375.0	2.62	0.48	0.00	0.00	0.00	7.21	3,875	350.9	3.83	0.70	0.00	0.00	0.00	4.95	4,000	125.0	1.63	0.30	0.00	0.00	0.00	2.12
UEIB-18	4,795	523.2	4.92	0.90	0.00	0.00	0.00	0.20	5,147	352.1	4.67	0.86	0.00	0.00	0.00	6.77	5,568	420.7	4.48	0.82	0.00	0.00	0.00	5.93	5,939	370.8	3.55	0.65	0.00	0.00	0.00	6.28
UEIB-19	5,232	876.8	3.61	0.66	0.00	0.00	0.00	28.16	5,589	356.8	1.34	0.25	0.00	0.00	0.00	0.40	5,798	209.0	2.63	0.48	0.00	0.00	0.00	0.19	6,053	254.9	2.55	0.47	0.00	0.00	0.00	0.18
UEIB-20/UEIB-56[14]	9,712	874.6	8.34	1.53	0.00	0.00	0.00	0.40	10,734	1,022.7	10.62	1.95	0.00	0.00	0.00	1.12	11,244	510.1	5.17	0.95	0.00	0.00	0.00	0.44	11,766	521.6	5.87	1.08	0.00	0.00	0.00	0.07
UEIB-21	9,623	772.1	8.51	1.56	0.00	0.00	0.00	3.47	10,243	620.2	7.15	1.31	0.00	0.00	0.00	1.62	10,371	128.1	2.21	0.40	0.00	0.00	0.00	0.16	10,371	0.0	0.00	0.00	0.00	0.00	0.00	0
UEIB-22	3,981	157.2	1.37	0.25	0.00	0.00	0.00	0.05	4,203	221.1	2.58	0.47	0.00	0.00	0.00	0.27	4,494	291.4	3.12	0.57	0.00	0.00	0.00	0.47	4,735	240.7	2.30	0.42	0.00	0.00	0.00	0.37
UEIB-23	5,381	438.4	4.31	0.79	0.00	0.00	0.00	14.08	5,609	228.5	2.26	0.41	0.00	0.00	0.00	4.39	5,948	339.3	4.08	0.75	0.00	0.00	0.00	4.79	6,100	151.3	1.38	0.25	0.00	0.00	0.00	2.56
UEIB-24	7,546	652.4	3.45	0.63	0.00	0.00	0.00	20.95	7,974	428.2	4.91	0.90	0.00	0.00	0.00	8.24	8,325	351.2	3.37	0.62	0.00	0.00	0.00	4.95	8,617	291.7	3.22	0.59	0.00	0.00	0.00	4.94
UEIB-25	5,177	211.8	2.12	0.39	0.00	0.00	0.00	6.80	5,377	199.5	2.35	0.43	0.00	0.00	0.00	3.84	5,733	356.8	4.59	0.84	0.00	0.00	0.00	5.03	6,134	401.0	4.11	0.75	0.00	0.00	0.00	6.79
UEIB-26	8,339	164.1	1.61	0.30	0.00	0.00	0.00	5.27	8,628	289.1	3.78	0.69	0.00	0.00	0.00	5.56	9,030	401.3	4.41	0.81	0.00	0.00	0.00	5.66	9,304	274.3	2.79	0.51	0.00	0.00	0.00	4.65
UEIB-27	6,739	198.9	2.15	0.40	0.00	0.00	0.00	0.39	7,005	265.4	3.18	0.58	0.00	0.00	0.00	0.68	7,381	376.4	3.16	0.58	0.00	0.00	0.00	1.60	7,570	188.4	1.86	0.34	0.00	0.00	0.00	0.57
UEIB-28	3,594	99.9	1.22	0.22	0.00	0.00	0.00	3.21	3,749	155.2	2.24	0.41	0.00	0.00	0.00	2.98	4,111	361.8	4.74	0.87	0.00	0.00	0.00	0.31	4,472	360.7	3.80	0.70	0.00	0.00	0.00	6
UEIB-29	7,983	277.7	1.55	0.28	0.00	0.00	0.00	0.24	8,405	421.1	4.56	0.84	0.00	0.00	0.00	0.16	8,665	260.7	2.21	0.40	0.00	0.00	0.00	3.68	8,840	174.4	1.96	0.36	0.00	0.00	0.00	2.95
UEIB-30	5,006	256.1	3.30	0.61	0.00	0.00	0.00	8.23	5,011	5.3	0.01	0.00	0.00	0.00	0.00	0.06	5,024	12.4	0.18	0.03	0.00	0.00	0.00	0.00	5,113	89.1	0.97	0.18	0.00	0.00	0.00	2
UEIB-31/UEIB-55[14]	4,237	76.9	0.74	0.14	0.00	0.00	0.00	2.47	4,455	218.1	2.52	0.46	0.00	0.00	0.00	4.19	4,667	211.4	2.29	0.42	0.00	0.00	0.00	2.98	4,667	0.0	0.00	0.00	0.00	0.00	0.00	0.00
UEIB-32	3,619	74.5	0.75	0.14	44.62	0.00	0.00	0.44	3,695	76.6	0.92	0.17	44.62	0.00	0.00	0.52	3,803	107.7	1.24	0.23	44.62	0.00	0.00	0.57	3,901	97.8	1.07	0.20	44.62	0.00	0.00	0.41
UEIB-33	4,528	69.3	0.69	0.13	54.26	0.00	0.00	0.37	4,718	190.0	2.70	0.50	54.26	0.00	0.00	0.67	5,039	321.2	3.76	0.69	54.26	0.00	0.00	0.91	5,228	188.9	1.82	0.33	54.26	0.00	0.00	0.64
UEIB-34	5,150	180.5	1.62	0.30	40.07	0.00	0.00	0.03	5,270	119.9	0.98	0.18	40.07	0.00	0.00	0.01	5,376	106.1	1.19	0.22	40.07	0.00	0.00	0.02	5,447	71.1	0.71	0.13	40.07	0.00	0.00	1
UEIB-35	10,162	266.0	2.64	0.48	0.00	0.00	0.00	8.54	10,419	257.1	3.24	0.59	0.00	0.00	0.00	0.04	10,964	545.2	6.42	1.18	0.00	0.00	0.00	7.69	11,335	371.5	3.74	0.69	0.00	0.00	0.00	6.29
UEIB-36	4,463	71.0	0.82	0.15	33.16	0.00	0.00	2.28	4,579	115.5	1.19	0.22	33.16	0.00	0.00	2.22	4,591	12.3	0.16	0.03	33.16	0.00	0.00	0.17	4,591	0.0	0.00	0.00	33.16	0.00	0.00	0.00
UEIB-37 [6]	4,607	86.3	0.94	0.17	0.00	0.00	0.00	2.77	4,664	56.8	0.66	0.12	0.00	0.00	0.00	1.09	4,747	82.9	0.93	0.17	0.00	0.00	0.00	1.17	4,797	50.2	0.49	0.09	0.00	0.00	0.00	0.85
UEIB-38	814	3.5	0.05	0.01	0.00	0.00	0.00	0.11	852	37.7	0.42	0.08	0.00	0.00	0.00	0.73	901	49.5	0.56	0.10	0.00	0.00	0.00	0.70	942	40.5	0.42	0.08	0.00	0.00	0.00	0.69
UEIB-39 [6]	2,619	101.5	1.02	0.19	0.00	0.00	0.00	3.26	2,700	80.6	1.01	0.19	0.00	0.00	0.00	1.55	2,867	166.9	2.00	0.37	0.00	0.00	0.00	2.35	2,980	113.6	1.13	0.21	0.00	0.00	0.00	1.92
UEIB-40 [6]	3,080	133.8	1.34	0.25	0.00	0.00	0.00	4.30	3,213	133.7	1.60	0.29	0.00	0.00	0.00	2.57	3,345	131.5	1.44	0.26	0.00	0.00	0.00	1.85	3,501	155.9	2.02	0.37	0.00	0.00	0.00	0.03
UEIB-41 [6]	5,872	218.1	2.35	0.43	0.00	0.00	0.00	7.00	6,090	218.2	2.61	0.48	0.00	0.00	0.00	4.20	6,398	308.5	3.59	0.66	0.00	0.00	0.00	4.35	6,404	5.5	0.06	0.01	0.00	0.00	0.00	0.09
UEIB-42 [6]	7,883	673.1	6.75	1.24	0.00	0.00	0.00	21.62	8,471	587.8	7.03	1.29	0.00	0.00	0.00	11.31	9,225	754.2	8.40	1.54	0.00	0.00	0.00	10.64	9,958	732.2	8.04	1.48	0.00	0.00	0.00	12.40
UEIB-43	9,828	67.6	0.89	0.16	0.00	0.00	0.00	2.17	10,403	575.5	5.22	0.96	0.00	0.00	0.00	11.07	10,700	296.7	3.70	0.68	0.00	0.00	0.00	4.18	11,035	334.6	2.78	0.51	0.00	0.00	0.00	5.67
UEIB-44	1,893	71.8	0.69	0.13	42.98	0.00	0.00	0.34	1,942	49.0	0.53	0.10	42.98	0.00	0.00	0.94	1,992	50.2	0.59	0.11	42.98	0.00	0.00	0.16	2,041	49.4	0.54	0.10	42.98	0.00	0.00	0.15
UEIB-45 [8]	8,982	532.4	6.14	1.13	688.13	55.63	0.71	223.96	9,386	403.6	4.46	0.82	728.20	40.07	0.42	116.51	9,820	434.1	4.89	0.90	762.56	34.36	0.45	70.45	10,240	420.6	4.53	0.83	817.36	54.80	6.87	79.88
UEIB-46 [9]	1,354	55.2	0.52	0.10	10.17	0.00	0.00	0.17	1,437	83.2	0.93	0.17	10.17	0.00	0.00	0.39	1,550	112.8	1.23	0.23	10.17	0.00	0.00	0.52	1,600	49.8	0.35	0.06	10.17	0.00	0.00	0.61
CPR-1 [11]	3,688	7.5	0.10	0.02	170	0.00	0.00	0.01	3,803	115.5	2.21	0.41	177	6.15	0.18	0.03	4,333	529.8	3.88	0.71	177	0.00	0.00	7.47	4,347	14.1	0.07	0.01	203.60	27.09	0.47	0.24
CPR-2 [11]	610	0.0	0.0	0.00	35	0.00	0.00	0.00	641	31.4	0.6	0.11	36	1.57	0.04	0.60	720	79.0	0.67	0.12	36	0.00	0.00	1.11	720	0.0	0.00	0.00	40.17	3.95	0.07	0.00
EX-1 [11]	6,327	87.9	0.91	0.17	N/A	N/A	N/A	N/A	6,441	113.8	1.30	0.24	N/A	N/A	N/A	N/A	6,558	117.5	1.28	0.24	N/A	N/A	N/A	N/A	6,640	81.8	0.86	0.16	N/A	N/A	N/A	N/A
EX-2 [11]	658	11.9	0.13	0.02	N/A	N/A	N/A	N/A	676	18.2	0.22	0.04	N/A	N/A	N/A	N/A	699	22.4	0.25	0.05	N/A	N/A	N/A	N/A	718	19.4	0.21	0.04	N/A	N/A	N/A	N/A
EX-3 [11]	2,427	48.1	0.49	0.09	N/A	N/A	N/A	N/A	2,506	79.2	0.99	0.18	N/A	N/A	N/A	N/A	2,603	97.2	1.13	0.21	N/A	N/A	N/A	N/A	2,651	47.8	0.53	0.10	N/A	N/A	N/A	N/A
EX-4 [11]	562	3.5	0.04	0.01	N/A	N/A	N/A	N/A	566	4.3	0.05	0.01	N/A	N/A	N/A	N/A	571	5.0	0.05	0.01	N/A	N/A	N/A	N/A	576	4.3	0.05	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	199,824	9,805	84	15	22,680	56	0.71	381.84	208,643	8,819	98	18	22,728	48	0.64	203.83	218,278	9,635	107	20	22,762	34	0.45	164.89	225,178	6,900	71	13	22,848	86	7.41	154.85

Abbreviations:

UK - Unknown (not enough data).
NAPL - Non-Aqueous Phase Liquids
PHC - Petroleum Hydrocarbons
m - Metres
L - Litres
Kg - Kilograms
gpm - Gallons per minute

TABLE C-1
SUMMARY OF EXTRACTION RATES - PERIMETER EXTRACTION SYSTEM
PARKLAND BURNABY REFINERY

Extraction Well	August 29-31, 2016							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	Fluid Extraction Rate [13] (gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	356	5.9	0.05	0.01	1,578	0.00	0.00	0.04
UEIB-3/UEIB-53[14]	675	NA	0.01	0.00	4,465	N/A	N/A	N/A
UEIB-4/UEIB-54[14]	394	1.2	0.02	0.00	154	0.00	0.00	0.01
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	330	0.7	0.01	0.00	5,644	0.00	0.00	0.00
UEIB-8/UEIB-48[14]	1,742	28.8	0.09	0.02	6.80	0.00	0.00	0.19
UEIB-9/UEIB-49[14]	2,530	46.3	0.45	0.08	0.00	0.00	0.00	0.05
UEIB-10[4]/UEIB-50[14]	819	8.5	0.10	0.02	0.00	0.00	0.00	0.06
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	95	N/A	N/A	N/A	825	N/A	N/A	N/A
UEIB-15	8,671	780.1	12.38	2.27	0.00	0.00	0.00	0.15
UEIB-16	6,163	211.8	2.58	0.47	0.00	0.00	0.00	1.37
UEIB-17	4,131	130.8	1.18	0.22	0.00	0.00	0.00	0.85
UEIB-18	6,201	262.2	2.90	0.53	0.00	0.00	0.00	1.69
UEIB-19	6,422	369.2	4.74	0.87	0.00	0.00	0.00	0.19
UEIB-20/UEIB-56[14]	12,223	457.3	4.66	0.86	0.00	0.00	0.00	2.96
UEIB-21	10,633	262.3	6.36	1.17	0.00	0.00	0.00	1.70
UEIB-22	4,794	59.8	0.28	0.05	0.00	0.00	0.00	0.35
UEIB-23	6,150	50.1	0.36	0.07	0.00	0.00	0.00	0.32
UEIB-24	9,061	443.7	5.45	1.00	0.00	0.00	0.00	2.87
UEIB-25	6,379	244.4	2.15	0.39	0.00	0.00	0.00	1.58
UEIB-26	9,522	218.1	2.23	0.41	0.00	0.00	0.00	1.41
UEIB-27	8,076	506.7	7.09	1.30	0.00	0.00	0.00	1.54
UEIB-28	4,706	234.1	2.07	0.38	0.00	0.00	0.00	1.51
UEIB-29	9,642	802.4	10.53	1.93	0.00	0.00	0.00	5.19
UEIB-30	5,160	46.8	0.42	0.08	0.00	0.00	0.00	0.30
UEIB-31/UEIB-55[14]	4,667	0.0	0.00	0.00	0.00	0.00	0.00	0.00
UEIB-32	3,986	85.4	0.89	0.16	44.62	0.00	0.00	0.38
UEIB-33	5,341	113.7	0.99	0.18	54.26	0.00	0.00	0.41
UEIB-34	5,521	74.0	0.93	0.17	40.07	0.00	0.00	0.48
UEIB-35	11,605	269.5	2.75	0.50	0.00	0.00	0.00	1.74
UEIB-36	4,592	1.3	0.02	0.00	33.16	0.00	0.00	0.01
UEIB-37 [6]	4,847	50.1	0.57	0.10	0.00	0.00	0.00	0.32
UEIB-38	980	38.4	0.44	0.08	0.00	0.00	0.00	0.25
UEIB-39 [6]	3,018	37.7	0.30	0.05	0.00	0.00	0.00	0.24
UEIB-40 [6]	3,682	181.4	1.93	0.35	0.00	0.00	0.00	1.17
UEIB-41 [6]	6,643	239.5	3.05	0.56	0.00	0.00	0.00	1.55
UEIB-42 [6]	10,600	642.8	6.81	1.25	0.00	0.00	0.00	4.15
UEIB-43	11,035	0.4	0.01	0.00	0.00	0.00	0.00	0.00
UEIB-44	2,082	40.5	0.42	0.08	42.98	0.00	0.00	0.14
UEIB-45 [8]	10,695	454.7	2.85	0.52	866.97	49.61	0.54	17.23
UEIB-46 [9]	1,671	71.0	1.12	0.21	12.47	2.30	0.03	0.32
CPR-1 [11]	4,349	1.3	0.00	0.00	203.60	0.00	0.00	0.01
CPR-2 [11]	720	0.0	0.00	0.00	40.17	0.00	0.00	0.00
EX-1 [11]	6,709	68.6	0.82	0.15	N/A	N/A	N/A	N/A
EX-2 [11]	732	14.4	0.15	0.03	N/A	N/A	N/A	N/A
EX-3 [11]	2,678	26.8	0.28	0.05	N/A	N/A	N/A	N/A
EX-4 [11]	579	3.7	0.04	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	232,765	7,587	90	17	22,900	52	0.56	52.73

Extraction Well	November 14, 16, and 17, 2016							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	Fluid Extraction Rate [13] (gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	365	9.8	0.14	0.03	1,578	0.00	0.00	0.04
UEIB-3/UEIB-53[14]	675	NA	0.01	0.00	4,465	N/A	N/A	N/A
UEIB-4/UEIB-54[14]	399	5.4	0.07	0.01	154	0.00	0.00	0.02
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	332	1.5	0.02	0.00	5,644	0.00	0.00	0.00
UEIB-8/UEIB-48[14]	1,793	50.4	0.79	0.14	6.80	0.00	0.00	0.01
UEIB-9/UEIB-49[14]	2,574	44.7	0.59	0.11	0.00	0.00	0.00	0.19
UEIB-10[4]/UEIB-50[14]	831	11.9	0.16	0.03	0.00	0.00	0.00	0.05
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	95	N/A	N/A	N/A	825	N/A	N/A	N/A
UEIB-15	9,013	342.0	4.28	0.79	0.00	0.00	0.00	0.13
UEIB-16	6,430	267.4	2.97	0.55	0.00	0.00	0.00	1.15
UEIB-17	4,686	555.5	8.65	1.59	0.00	0.00	0.00	2.38
UEIB-18	6,568	367.4	4.66	0.86	0.00	0.00	0.00	0.25
UEIB-19	6,574	152.4	0.54	0.10	0.00	0.00	0.00	0.65
UEIB-20/UEIB-56[14]	12,384	160.3	-	0.00	0.00	0.00	0.00	0.69
UEIB-21	11,282	649.1	9.14	1.68	0.00	0.00	0.00	2.43
UEIB-22	5,009	214.7	3.43	0.63	0.00	0.00	0.00	0.36
UEIB-23	6,268	118.4	1.78	0.33	0.00	0.00	0.00	0.51
UEIB-24	9,339	278.3	2.83	0.52	0.00	0.00	0.00	1.19
UEIB-25	6,578	199.7	2.43	0.45	0.00	0.00	0.00	0.86
UEIB-26	9,857	334.9	4.94	0.91	0.00	0.00	0.00	0.15
UEIB-27	8,225	148.5	0.06	0.01	0.00	0.00	0.00	0.22
UEIB-28	4,978	272.3	2.72	0.50	0.00	0.00	0.00	0.30
UEIB-29	10,612	969.7	12.47	2.29	0.00	0.00	0.00	4.16
UEIB-30	5,445	285.6	4.10	0.75	0.00	0.00	0.00	1.22
UEIB-31/UEIB-55[14]	4,667	0.0	0.00	0.00	0.00	0.00	0.00	0.00
UEIB-32	4,079	93.1	1.28	0.23	44.62	0.00	0.00	0.80
UEIB-33	5,489	148.1	1.97	0.36	54.26	0.00	0.00	0.40
UEIB-34	5,618	96.6	1.24	0.23	40.07	0.00	0.00	0.01
UEIB-35	11,914	309.2	4.10	0.75	0.00	0.00	0.00	1.33
UEIB-36	4,689	96.6	1.27	0.23	33.16	0.00	0.00	0.41
UEIB-37 [6]	4,908	61.3	0.79	0.14	0.00	0.00	0.00	0.26
UEIB-38	1,038	58.1	0.79	0.14	0.00	0.00	0.00	0.25
UEIB-39 [6]	3,022	3.8	0.05	0.01	0.00	0.00	0.00	0.02
UEIB-40 [6]	3,813	131.0	1.50	0.28	0.00	0.00	0.00	0.56
UEIB-41 [6]	8,580	1,937.0	4.26	0.78	0.00	0.00	0.00	8.31
UEIB-42 [6]	11,114	513.9	6.46	1.19	0.00	0.00	0.00	4.01
UEIB-43	11,071	35.8	0.51	0.09	0.00	0.00	0.00	0.15
UEIB-44	2,166	84.6	1.22	0.22	42.98	0.00	0.54	0.41
UEIB-45 [8]	10,995	300.0	3.84	0.70	893.55	26.58	0.34	6.63
UEIB-46 [9]	1,774	103.1	1.37	0.25	16.23	3.76	0.05	1.09
CPR-1 [11]	4,363	14.2	0.17	0.03	203.60	0.00	0.00	0.06
CPR-2 [11]	1,050	329.1	3.87	0.71	40.17	0.00	0.00	1.41
EX-1 [11]	6,760	50.9	0.60	0.11	N/A	N/A	N/A	N/A
EX-2 [11]	772	39.6	0.47	0.09	N/A	N/A	N/A	N/A
EX-3 [11]	2,713	35.5	0.42	0.08	N/A	N/A	N/A	N/A
EX-4 [11]	583	3.2	0.04	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	242,650	9,885	103	19	22,930	30	0.93	43.09

Extraction Well	Feburary 20, 21, and 22, 2017							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	Fluid Extraction Rate [13] (gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	380	14.1	0.15	0.03	1,578	0.00	0.00	0.05
UEIB-3/UEIB-53[14]	675	NA	0.01	0.00	4,465	N/A	N/A	N/A
UEIB-4/UEIB-54[14]	408	8.8	0.06	0.01	154	0.00	0.00	0.03
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	333	0.9	0.01	0.00	5,644	0.00	0.00	0.00
UEIB-8/UEIB-48[14]	1,889	96.0	1.07	0.20	6.80	0.00	0.00	0.10
UEIB-9/UEIB-49[14]	2,621	46.5	0.48	0.09	0.00	0.00	0.00	0.15
UEIB-10[4]/UEIB-50[14]	846	14.7	0.16	0.03	0.00	0.00	0.00	0.05
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	95	N/A	N/A	N/A	825	N/A	N/A	N/A
UEIB-15	9,479	465.7	5.43	1.00	0.00	0.00	0.00	0.20
UEIB-16	6,996	565.5	5.50	1.01	0.00	0.00	0.00	1.82
UEIB-17	5,168	481.8	3.76	0.69	0.00	0.00	0.00	1.55
UEIB-18	7,015	446.2	4.87	0.89	0.00	0.00	0.00	1.44
UEIB-19	7,097	522.3	5.44	1.00	0.00	0.00	0.00	1.68
UEIB-20/UEIB-56[14]	12,384	-	-	0.00	0.00	0.00	0.00	0.00
UEIB-21	12,218	935.4	8.50	1.56	0.00	0.00	0.00	1.13
UEIB-22	5,254	245.0	2.95	0.54	0.00	0.00	0.00	0.30
UEIB-23	6,562	294.1	3.76	0.69	0.00	0.00	0.00	0.95
UEIB-24	9,414	74.9	0.07	0.01	0.00	0.00	0.00	0.02
UEIB-25	6,815	236.2	2.54	0.47	0.00	0.00	0.00	0.76
UEIB-26	10,400	543.6	5.46	1.00	0.00	0.00	0.00	0.24
UEIB-27	8,451	226.1	2.69	0.49	0.00	0.00	0.00	0.71
UEIB-28	5,157	178.9	1.48	0.27	0.00	0.00	0.00	0.09
UEIB-29	11,376	764.6	5.47	1.00	0.00	0.00	0.00	2.46
UEIB-30	5,983	538.0	6.07	1.11	0.00	0.00	0.00	0.00
UEIB-31/UEIB-55[14]	4,667	-	0.00	0.00	0.00	0.00	0.00	0.00
UEIB-32	4,160	80.6	0.75	0.14	44.62	0.00	0.00	0.46
UEIB-33	5,809	320.1	3.36	0.62	54.26	0.00	0.00	0.84
UEIB-34	5,646	28.4	0.38	0.07	40.07	0.00	0.00	0.01
UEIB-35	12,276	362.0	3.58	0.66	0.00	0.00	0.00	1.16
UEIB-36	4,807	117.8	1.02	0.19	33.16	0.00	0.00	0.38
UEIB-37 [6]	4,963	54.5	0.50	0.09	0.00	0.00	0.00	0.18
UEIB-38	1,067	28.8	0.19	0.04	0.00	0.00	0.00	0.09
UEIB-39 [6]	3,530	508.4	7.60	1.39	0.00	0.00	0.00	1.64
UEIB-40 [6]	3,953	139.8	1.34	0.25	0.00	0.00	0.00	0.03
UEIB-41 [6]	8,757	176.5	2.10	0.38	0.00	0.00	0.00	0.57
UEIB-42 [6]	11,470	356.1	2.92	0.53	0.00	0.00	0.00	0.07
UEIB-43	11,912	841.3	10.77	1.98	0.00	0.00	0.00	2.71
UEIB-44	2,242	75.9	0.51	0.09	42.98	0.00	0.00	0.25
UEIB-45 [8]	11,444	449.3	5.13	0.94	933.44	39.89	0.41	11.83
UEIB-46 [9]	1,891	117.5	1.32	0.24	16.23	0.00	0.00	0.78
CPR-1 [11]	4,439	75.6	1.13	0.21	203.60	0.00	0.00	0.24
CPR-2 [11]	1,260	210.3	2.21	0.41	40.17	0.00	0.00	0.68
EX-1 [11]	6,826	66.6	0.66	0.12	N/A	N/A	N/A	N/A
EX-2 [11]	826	53.8	0.58	0.11	N/A	N/A	N/A	N/A
EX-3 [11]	2,764	50.8	0.52	0.10	N/A	N/A	N/A	N/A
EX-4 [11]	588	5.2	0.06	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	253,469	10,819	113	21	22,970	40	0.41	35.63

Extraction Well	June 12-14, 2017							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	Fluid Extraction Rate [13] (gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	392	12.5	0.11	0.02	1,578	0.00	0.00	0.08
UEIB-3/UEIB-53[14]	675	NA	NA	NA	4,465	N/A	N/A	N/A
UEIB-4/UEIB-54[14]	413	5.2	0.02	0.00	154	0.00	0.00	0.03
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	335	1.8	0.02	0.00	5,644	0.00	0.00	0.01
UEIB-8/UEIB-48[14]	1,976	87.8	0.75	0.14	6.80	0.00	0.00	0.04
UEIB-9/UEIB-49[14]	2,675	54.3	0.50	0.09	0.00	0.00	0.00	0.34
UEIB-10[4]/UEIB-50[14]	867	20.6	0.19	0.03	0.00	0.00	0.00	0.13
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	95	N/A	N/A	N/A	825	N/A	N/A	N/A
UEIB-15	10,223	743.9	7.19	1.32	0.00	0.00	0.00	0.13
UEIB-16	7,093	97.7	0.85	0.16	0.00	0.00	0.00	0.62
UEIB-17	5,390	222.0	3.09	0.57	0.00	0.00	0.00	1.40
UEIB-18	7,482	467.9	4.21	0.77	0.00	0.00	0.00	2.96
UEIB-19	7,550	453.1	4.30	0.79	0.00	0.00	0.00	0.35
UEIB-20/UEIB-56[14]	12,384	-	-	0.00	0.00	0.00	0.00	0.00
UEIB-21	12,837	619.7	6.79	1.25	0.00	0.00	0.00	0.60
UEIB-22	7,155	1,900.6	2.40	0.44	0.00	0.00	0.00	1.94
UEIB-23	6,789	227.0	1.42	0.26	0.00	0.00	0.00	1.44
UEIB-24	9,504	90.3	1.27	0.23	0.00	0.00	0.00	0.57
UEIB-25	7,078	263.7	2.64	0.48	0.00	0.00	0.00	1.67
UEIB-26	10,725	324.1	2.87	0.53	0.00	0.00	0.00	0.04
UEIB-27	9,086	635.5	8.85	1.62	0.00	0.00	0.00	1.38
UEIB-28	5,333	175.9	1.05	0.19	0.00	0.00	0.00	0.48
UEIB-29	11,636	259.5	3.41	0.63	0.00	0.00	0.00	1.64
UEIB-30	6,577	593.4	5.65	1.04	0.00	0.00	0.00	3.75
UEIB-31/UEIB-55[14]	4,667	-	0.00	0.00	0.00	0.00	0.00	0.00
UEIB-32	4,281	120.5	1.10	0.20	44.62	0.00	0.00	0.84
UEIB-33	6,078	268.8	2.31	0.42	54.26	0.00	0.00	3.72
UEIB-34	5,694	48.3	0.48	0.09	40.07	0.00	0.00	0.03
UEIB-35	12,577	300.8	2.83	0.52	0.00	0.00	0.00	0.04
UEIB-36	4,937	130.0	1.04	0.19	33.16	0.00	0.00	0.82
UEIB-37 [6]	5,037	74.5	0.59	0.11	0.00	0.00	0.00	0.47
UEIB-38	1,093	26.2	0.37	0.07	0.00	0.00	0.00	0.17
UEIB-39 [6]	3,937	407.0	1.39	0.26	0.00	0.00	0.00	2.57
UEIB-40 [6]	4,087	133.8	1.30	0.24	0.00	0.00	0.00	0.85
UEIB-41 [6]	8,961	203.8	1.89	0.35	0.00	0.00	0.00	1.29
UEIB-42 [6]	11,932	461.4	4.73	0.87	0.00	0.00	0.00	0.08
UEIB-43	13,068	1,156.0	11.73	2.15	0.00	0.00	0.00	7.31
UEIB-44	2,317	74.7	0.71	0.13	42.98	0.00	0.00	0.23
UEIB-45 [8]	12,038	594.2	5.75	1.06	1,000.33	66.89	0.59	28.44
UEIB-46 [9]	2,013	121.7	1.17	0.21	16.23	0.00	0.00	2.46
CPR-1 [11]	4,507	68.9	0.54	0.10	203.60	0.00	0.00	0.44
CPR-2 [11]	1,480	220.4	2.20	0.40	40.17	0.00	0.00	1.39
EX-1 [11]	6,909	82.6	0.83	0.15	N/A	N/A	N/A	N/A
EX-2 [11]	868	42.4	0.42	0.08	N/A	N/A	N/A	N/A
EX-3 [11]	2,810	45.8	0.46	0.08	N/A	N/A	N/A	N/A
EX-4 [11]	593	5.2	0.05	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	265,312	11,844	99	18	23,037	67	0.59	67.00

Abbreviations:

UK - Unknown (not enough data).
NAPL - Non-Aqueous Phase Liquids
PHC - Petroleum Hydrocarbons
m - Metres
L - Litres
Kg - Kilograms
gpm - Gallons per minute

TABLE C-1
SUMMARY OF EXTRACTION RATES - PERIMETER EXTRACTION SYSTEM
PARKLAND BURNABY REFINERY

Extraction Well	September 12-14, 2017								December 4-7, 2017							
	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate [13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate [13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)
	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	392	0.0	0.00	0.00	1,578	0.00	0.00	0.00	435	43.1	0.69	0.13	1,578	0.00	0.00	0.30
UEIB-3/UEIB-53[14]	675	NA	NA	NA	4,465	N/A	N/A	N/A	696	21.8	0.33	0.06	4,465	0.00	0.00	1.13
UEIB-4/UEIB-54[14]	413	0.0	0.00	0.00	154	0.00	0.00	0.00	457	43.5	0.44	0.08	154	0.00	0.00	1.23
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	335	0.1	0.00	0.00	5,644	0.00	0.00	0.00	340	5.5	0.11	0.02	5,644	0.00	0.00	0.29
UEIB-8/UEIB-48[14]	1,976	-	-	0.00	6.80	0.00	0.00	0.00	2,098	121.5	1.80	0.33	6.80	0.00	0.00	0.21
UEIB-9/UEIB-49[14]	2,695	19.7	0.18	0.03	0.00	0.00	0.00	0.67	2,760	65.1	0.87	0.16	0.00	0.00	0.00	3.38
UEIB-10[4]/UEIB-50[14]	869	2.1	0.02	0.00	0.00	0.00	0.00	0.07	925	56.0	0.89	0.16	0.00	0.00	0.00	0.01
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	95	N/A	N/A	N/A	825	N/A	N/A	N/A	95	N/A	N/A	N/A	825	N/A	N/A	N/A
UEIB-15	10,385	162.8	2.18	0.40	0.00	0.00	0.00	0.02	10,579	193.3	2.65	0.49	0.00	0.00	0.00	0.03
UEIB-16	7,356	262.4	3.35	0.61	0.00	0.00	0.00	8.98	7,633	276.7	3.43	0.63	0.00	0.00	0.00	14.38
UEIB-17	5,514	124.3	1.13	0.21	0.00	0.00	0.00	4.25	5,847	332.5	5.10	0.94	0.00	0.00	0.00	17.28
UEIB-18	7,738	256.0	2.27	0.42	0.00	0.00	0.00	8.76	8,355	616.0	8.36	1.53	0.00	0.00	0.00	32.03
UEIB-19	7,724	174.1	1.69	0.31	0.00	0.00	0.00	5.96	7,990	266.7	3.85	0.71	0.00	0.00	0.00	2.26
UEIB-20/UEIB-56[14]	12,384	N/A	N/A	0.00	0.00	0.00	0.00	N/A	12,384	N/A	N/A	0.00	0.00	0.00	0.00	N/A
UEIB-21	13,407	569.7	5.53	1.01	0.00	0.00	0.00	0.22	13,889	482.2	6.52	1.20	0.00	0.00	0.00	0.37
UEIB-22	7,244	89.5	0.86	0.16	0.00	0.00	0.00	3.06	7,413	169.2	2.58	0.47	0.00	0.00	0.00	0.18
UEIB-23	6,819	29.4	0.34	0.06	0.00	0.00	0.00	1.01	6,855	36.7	0.48	0.09	0.00	0.00	0.00	1.91
UEIB-24	9,677	172.8	2.07	0.38	0.00	0.00	0.00	5.91	9,942	265.1	3.33	0.61	0.00	0.00	0.00	13.78
UEIB-25	7,263	184.2	2.12	0.39	0.00	0.00	0.00	6.30	7,441	178.3	2.29	0.42	0.00	0.00	0.00	9.27
UEIB-26	10,844	119.6	1.34	0.25	0.00	0.00	0.00	4.09	10,991	147.0	2.11	0.39	0.00	0.00	0.00	7.64
UEIB-27	9,660	574.1	6.72	1.23	0.00	0.00	0.00	1.06	11,202	1,541.7	26.03	4.78	0.00	0.00	0.00	4.46
UEIB-28	5,351	17.8	0.24	0.04	0.00	0.00	0.00	0.00	5,446	95.4	1.46	0.27	0.00	0.00	0.00	0.12
UEIB-29	11,662	25.6	0.29	0.05	0.00	0.00	0.00	0.88	11,987	325.3	3.06	0.56	0.00	0.00	0.00	16.91
UEIB-30	6,922	345.1	3.91	0.72	0.00	0.00	0.00	11.81	6,992	70.2	1.29	0.24	0.00	0.00	0.00	3.65
UEIB-31/UEIB-55[14]	4,668	1.1	0.00	0.00	0.00	0.00	0.00	0.04	4,733	65.5	0.90	0.16	0.00	0.00	0.00	3.40
UEIB-32	4,358	77.0	0.95	0.17	44.62	0.00	0.00	0.50	4,423	65.2	0.83	0.15	44.62	0.00	0.00	0.46
UEIB-33	6,155	77.0	0.82	0.15	54.26	0.00	0.00	6.17	6,275	119.3	1.88	0.34	54.26	0.00	0.00	0.43
UEIB-34	5,761	66.7	0.81	0.15	40.07	0.00	0.00	0.05	7,599	1,838.0	1.12	0.21	40.07	0.00	0.00	0.42
UEIB-35	12,655	77.7	0.82	0.15	0.00	0.00	0.00	2.66	12,775	120.5	1.61	0.29	0.00	0.00	0.00	6.27
UEIB-36	5,055	117.8	1.38	0.25	33.16	0.00	0.00	4.03	5,163	108.9	1.30	0.24	33.16	0.00	0.00	5.66
UEIB-37 [6]	5,071	34.1	0.37	0.07	0.00	0.00	0.00	1.17	5,103	31.9	0.41	0.08	0.00	0.00	0.00	1.66
UEIB-38	1,127	34.4	0.40	0.07	0.00	0.00	0.00	1.18	1,168	40.5	0.52	0.10	0.00	0.00	0.00	2.11
UEIB-39 [6]	3,998	60.9	0.66	0.12	0.00	0.00	0.00	2.08	4,097	98.7	1.36	0.25	0.00	0.00	0.00	5.13
UEIB-40 [6]	4,166	79.0	0.89	0.16	0.00	0.00	0.00	0.01	4,227	61.1	0.75	0.14	0.00	0.00	0.00	0.02
UEIB-41 [6]	9,091	130.7	1.51	0.28	0.00	0.00	0.00	4.47	9,250	159.0	2.13	0.39	0.00	0.00	0.00	8.27
UEIB-42 [6]	12,181	249.0	2.96	0.54	0.00	0.00	0.00	0.10	12,637	456.1	6.16	1.13	0.00	0.00	0.00	0.06
UEIB-43	14,187	1,118.8	13.13	2.41	0.00	0.00	0.00	38.27	15,056	869.4	10.95	2.01	0.00	0.00	0.00	45.20
UEIB-44	2,356	38.8	0.45	0.08	42.98	0.00	0.00	0.14	2,390	34.5	0.43	0.08	42.98	0.00	0.00	0.15
UEIB-45 [8]	12,623	584.9	6.90	1.27	1,062.25	61.93	0.69	182.97	13,018	394.3	4.74	0.87	1,103.64	41.39	0.49	360.75
UEIB-46 [9]	2,073	59.7	0.60	0.11	16.23	0.00	0.00	0.23	2,109	36.4	0.52	0.10	16.23	0.00	0.00	0.19
CPR-1 [11]	4,508	0.1	0.00	0.00	203.60	0.00	0.00	0.00	4,710	202.8	2.91	0.53	203.60	0.00	0.00	10.54
CPR-2 [11]	1,480	0.0	0.00	0.00	40.17	0.00	0.00	0.00	1,514	33.6	0.48	0.09	40.17	0.00	0.00	1.74
EX-1 [11]	6,974	65.0	0.74	0.14	N/A	N/A	N/A	N/A	7,034	60.2	0.76	0.14	N/A	N/A	N/A	N/A
EX-2 [11]	883	15.0	0.18	0.03	N/A	N/A	N/A	N/A	924	41.2	0.56	0.10	N/A	N/A	N/A	N/A
EX-3 [11]	2,831	21.0	0.25	0.04	N/A	N/A	N/A	N/A	2,871	40.3	0.54	0.10	N/A	N/A	N/A	N/A
EX-4 [11]	596	3.0	0.03	0.01	N/A	N/A	N/A	N/A	599	3.3	0.04	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	271,354	6,041	68	12	23,099	62	0.69	307.11	281,587	10,233	119	22	23,140	41	0.49	583.27

Extraction Well	March 26-29, 2018								June 12-18, 2018							
	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate [13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate [13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)
	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	538	102.7	1.05	0.19	1,578	0.00	0.00	0.54	609	70.8	0.53	0.10	1,578	0.00	0.00	0.22
UEIB-3/UEIB-53[14]	739	42.2	0.43	0.08	4,468	2.38	0.02	1.80	769	30.1	0.27	0.05	4,470	2.79	0.02	0.28
UEIB-4/UEIB-54[14]	525	68.2	0.61	0.11	158	3.90	0.03	3.01	580	54.9	0.32	0.06	163	5.00	0.06	8.54
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	355	14.5	0.15	0.03	5,644	0.00	0.00	0.12	362	7.3	0.06	0.01	5,644	0.00	0.00	1.17
UEIB-8/UEIB-48[14]	2,238	140.4	1.43	0.26	6.80	0.00	0.00	0.09	2,386	147.8	2.01	0.37	6.80	0.00	0.00	0.02
UEIB-9/UEIB-49[14]	2,862	101.8	1.04	0.19	0.00	0.00	0.00	0.84	3,390	528.4	0.83	0.15	0.00	0.00	0.00	5.31
UEIB-10[4]/UEIB-50[14]	1,035	109.7	1.13	0.21	0.00	0.00	0.00	0.01	1,129	94.1	0.90	0.17	0.00	0.00	0.00	15
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	95	N/A	N/A	N/A	825	N/A	N/A	N/A	95	0.0	0.00	0.00	825	0.00	0.00	0.00
UEIB-15	11,000	420.9	4.38	0.80	0.00	0.00	0.00	3.49	11,320	320.6	2.55	0.47	0.00	0.00	0.00	0
UEIB-16	8,030	397.0	4.13	0.76	0.00	0.00	0.00	3.29	8,398	368.0	2.69	0.49	0.00	0.00	0.00	59.26
UEIB-17	6,222	375.4	3.91	0.72	0.00	0.00	0.00	3.11	6,300	77.9	0.67	0.12	0.00	0.00	0.00	13
UEIB-18	8,601	246.9	2.57	0.47	0.00	0.00	0.00	0.09	8,945	343.5	5.90	1.08	0.00	0.00	0.00	55.31
UEIB-19	8,501	510.4	5.32	0.98	0.00	0.00	0.00	0.48	8,897	396.5	3.04	0.56	0.00	0.00	0.00	0.18
UEIB-20/UEIB-56[14]	12,384	N/A	N/A	0.00	0.00	0.00	0.00	N/A	12,439	55.7	1.28	0.24	0.00	0.00	0.00	0.02
UEIB-21	14,419	529.7	5.52	1.01	0.00	0.00	0.00	0.51	14,914	494.8	2.27	0.42	0.00	0.00	0.00	0.14
UEIB-22	7,759	345.8	3.60	0.66	0.00	0.00	0.00	0.39	8,012	252.5	0.95	0.17	0.00	0.00	0.00	0.59
UEIB-23	6,946	90.7	0.94	0.17	0.00	0.00	0.00	0.75	7,053	106.9	1.22	0.22	0.00	0.00	0.00	17.21
UEIB-24	10,343	400.6	4.17	0.77	0.00	0.00	0.00	3.32	10,941	597.7	7.16	1.31	0.00	0.00	0.00	96.25
UEIB-25	7,680	238.8	2.49	0.46	0.00	0.00	0.00	0.06	7,915	235.0	1.91	0.35	0.00	0.00	0.00	37.84
UEIB-26	11,321	330.3	3.44	0.63	0.00	0.00	0.00	0.13	11,491	169.5	1.07	0.20	0.00	0.00	0.00	27.30
UEIB-27	11,615	412.5	4.33	0.80	0.00	0.00	0.00	0.22	12,052	437.7	3.80	0.70	0.00	0.00	0.00	70.48
UEIB-28	5,770	323.7	3.40	0.62	0.00	0.00	0.00	0.41	6,026	256.5	1.64	0.30	0.00	0.00	0.00	0.37
UEIB-29	11,992	4.9	0.05	0.01	0.00	0.00	0.00	0.04	12,141	149.4	3.60	0.66	0.00	0.00	0.00	0.60
UEIB-30	7,329	336.6	3.00	0.55	0.00	0.00	0.00	2.79	7,576	247.9	0.42	0.08	0.00	0.00	0.00	39.92
UEIB-31/UEIB-55[14]	4,842	108.9	0.97	0.18	0.00	0.00	0.00	0.90	4,953	111.1	0.70	0.13	0.00	0.00	0.00	17.88
UEIB-32	4,507	84.1	0.86	0.16	44.62	0.00	0.00	0.54	4,586	79.7	0.55	0.10	44.62	0.00	0.00	0.47
UEIB-33	6,584	309.6	3.16	0.58	54.26	0.00	0.00	1.37	6,784	200.0	1.25	0.23	54.26	0.00	0.00	4.32
UEIB-34	7,719	120.0	1.22	0.22	40.07	0.00	0.00	0.05	7,747	27.4	0.13	0.02	40.07	0.00	0.00	4.41
UEIB-35	12,980	204.4	2.08	0.38	0.00	0.00	0.00	0.04	13,300	320.3	2.92	0.54	0.00	0.00	0.00	0.05
UEIB-36	5,318	154.9	1.58	0.29	33.16	0.00	0.00	1.28	5,428	109.7	1.09	0.20	33.16	0.00	0.00	17.66
UEIB-37 [6]	5,163	60.1	0.61	0.11	0.00	0.00	0.00	0.50	5,207	43.8	0.38	0.07	0.00	0.00	0.00	7.05
UEIB-38	1,259	91.5	0.92	0.17	0.00	0.00	0.00	0.76	1,328	68.3	0.63	0.12	0.00	0.00	0.00	11.00
UEIB-39 [6]	4,310	213.3	2.15	0.40	0.00	0.00	0.00	1.77	4,452	141.6	1.03	0.19	0.00	0.00	0.00	22.79
UEIB-40 [6]	4,243	15.8	0.16	0.03	0.00	0.00	0.00	0.13	4,337	94.4	1.65	0.30	0.00	0.00	0.00	15.20
UEIB-41 [6]	9,585	334.9	3.38	0.62	0.00	0.00	0.00	2.77	9,862	276.4	2.66	0.49	0.00	0.00	0.00	44.51
UEIB-42 [6]	13,233	596.7	6.03	1.11	0.00	0.00	0.00	4.94	13,705	471.3	4.63	0.85	0.00	0.00	0.00	75.90
UEIB-43	15,949	892.2	9.17	1.68	0.00	0.00	0.00	7.39	16,779	829.9	11.08	2.03	0.00	0.00	0.00	133.64
UEIB-44	2,439	49.3	0.50	0.09	42.98	0.00	0.00	0.20	2,499	59.4	0.61	0.11	42.98	0.00	0.00	0.11
UEIB-45 [8]	13,489	471.0	4.81	0.88	1,157.13	53.50	0.48	12.31	13,834	345.7	3.95	0.72	1,188.43	31.30	0.38	1033.01
UEIB-46 [9]	2,186	76.8	0.78	0.14	20.55	4.32	0.04	1.95	2,286	100.2	0.89	0.16	29.92	9.37	0.11	0.34
CPR-1 [11]	4,920	209.6	2.47	0.45	203.60	0.00	0.00	1.74	4,944	24.4	0.08	0.01	203.60	0.00	0.00	3.92
CPR-2 [11]	1,574	60.4	0.62	0.11	40.17	0.00	0.00	0.50	1,577	2.6	0.03	0.01	40.17	0.00	0.00	0.41
EX-1 [11]	7,109	75.2	0.76	0.14	N/A	N/A	N/A	N/A	7,127	18.0	0.74	0.14	N/A	N/A	N/A	N/A
EX-2 [11]	964	39.7	0.41	0.07	N/A	N/A	N/A	N/A	974	9.4	0.39	0.07	N/A	N/A	N/A	N/A
EX-3 [11]	2,923	52.6	0.52	0.10	N/A	N/A	N/A	N/A	2,937	13.6	0.52	0.10	N/A	N/A	N/A	N/A
EX-4 [11]	604	4.6	0.05	0.01	N/A	N/A	N/A	N/A	608	4.0	0.04	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	291,356	9,769	100	18	23,204	64	0.57	64.65	300,150	8,794	81	15	23,253	48	0.58	1841.44

Abbreviations:

UK - Unknown (not enough data).
NAPL - Non-Aqueous Phase Liquids
PHC - Petroleum Hydrocarbons
m - Metres
L - Litres
Kg - Kilograms
gpm - Gallons per minute

TABLE C-1
SUMMARY OF EXTRACTION RATES - PERIMETER EXTRACTION SYSTEM
PARKLAND BURNABY REFINERY

Extraction Well	Sept 4-6, 2018							
	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate [13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)
	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	630	21.2	0.21	0.04	1,578	0.00	0.00	0.08
UEIB-3/UEIB-53[14]	785	16.5	0.20	0.04	4,471	0.72	0.01	0.06
UEIB-4/UEIB-54[14]	611	31.1	0.27	0.05	166	2.92	0.04	17.01
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	362	0.2	0.00	0.00	5,644	0.00	0.00	0.03
UEIB-8/UEIB-48[14]	2,466	80.3	0.74	0.14	6.80	0.00	0.00	0.02
UEIB-9/UEIB-49[14]	3,460	70.4	0.71	0.13	0.00	0.00	0.00	0.02
UEIB-10[4]/UEIB-50[14]	1,184	55.8	0.54	0.10	0.00	0.00	0.00	9.50
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	95	0.0	0.00	0.00	825	0.00	0.00	0.00
UEIB-15	11,399	78.3	0.59	0.11	0.00	0.00	0.00	0.01
UEIB-16	8,547	149.0	1.50	0.27	0.00	0.00	0.00	25.38
UEIB-17	6,317	16.7	0.23	0.04	0.00	0.00	0.00	2.84
UEIB-18	9,191	246.0	2.59	0.47	0.00	0.00	0.00	41.88
UEIB-19	9,122	224.6	5.92	1.09	0.00	0.00	0.00	38.25
UEIB-20/UEIB-56[14]	12,585	145.4	1.58	0.29	0.00	0.00	0.00	24.75
UEIB-21	15,245	331.2	3.50	0.64	0.00	0.00	0.00	56.40
UEIB-22	8,049	37.8	0.47	0.09	0.00	0.00	0.00	6.43
UEIB-23	7,121	68.2	0.69	0.13	0.00	0.00	0.00	11.62
UEIB-24	11,232	291.1	3.17	0.58	0.00	0.00	0.00	49.56
UEIB-25	8,079	164.2	1.85	0.34	0.00	0.00	0.00	27.95
UEIB-26	11,605	114.1	1.36	0.25	0.00	0.00	0.00	19.42
UEIB-27	12,133	80.9	1.13	0.21	0.00	0.00	0.00	0.01
UEIB-28	6,134	108.0	1.08	0.20	0.00	0.00	0.00	0.19
UEIB-29	12,476	334.7	3.73	0.68	0.00	0.00	0.00	56.99
UEIB-30	7,580	3.0	0.00	0.00	0.00	0.00	0.00	0.51
UEIB-31/UEIB-55[14]	5,001	48.3	0.74	0.14	0.00	0.00	0.00	0.03
UEIB-32	4,656	69.5	0.69	0.13	44.62	0.00	0.00	0.41
UEIB-33	6,848	63.9	0.68	0.12	54.26	0.00	0.00	1.01
UEIB-34	7,783	36.1	0.01	0.00	40.07	0.00	0.00	6.15
UEIB-35	13,548	248.2	2.67	0.49	0.00	0.00	0.00	0.03
UEIB-36	5,511	83.2	0.85	0.16	33.16	0.00	0.00	14.17
UEIB-37 [6]	5,244	37.2	0.42	0.08	0.00	0.00	0.00	6.33
UEIB-38	1,394	65.7	0.81	0.15	0.00	0.00	0.00	0.01
UEIB-39 [6]	4,461	9.6	0.00	0.00	0.00	0.00	0.00	1.64
UEIB-40 [6]	4,501	163.9	1.85	0.34	0.00	0.00	0.00	0.02
UEIB-41 [6]	10,026	164.1	1.70	0.31	0.00	0.00	0.00	27.94
UEIB-42 [6]	14,083	378.3	3.50	0.64	0.00	0.00	0.00	64.42
UEIB-43	17,560	781.7	8.59	1.58	0.00	0.00	0.00	133.10
UEIB-44	2,541	42.7	0.50	0.09	42.98	0.00	0.00	0.11
UEIB-45 [8]	14,207	372.6	3.81	0.70	1,222.16	33.73	0.43	920.95
UEIB-46 [9]	2,345	58.7	0.55	0.10	35.40	5.48	0.07	0.36
CPR-1 [11]	4,961	16.2	0.21	0.04	203.60	0.00	0.00	2.76
CPR-2 [11]	1,578	0.9	0.01	0.00	40.17	0.00	0.00	0.15
EX-1 [11]	7,127	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-2 [11]	974	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-3 [11]	2,937	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-4 [11]	611	3.0	0.03	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	305,462	5,312	60	11	23,296	43	0.54	1568.51

Extraction Well	Nov 19-21, 2018							
	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate [13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)
	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	667	36.7	0.59	0.11	1,578	0.00	0.00	0.19
UEIB-3/UEIB-53[14]	804	18.7	0.26	0.05	4,471	0.00	0.00	0.22
UEIB-4/UEIB-54[14]	651	40.5	0.63	0.12	169	3.04	0.04	80.57
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	366	4.3	0.06	0.01	5,644	0.00	0.00	0.46
UEIB-8/UEIB-48[14]	2,785	318.5	6.78	1.24	6.80	0.00	0.00	34.02
UEIB-9/UEIB-49[14]	3,525	64.3	0.81	0.15	0.00	0.00	0.00	0.01
UEIB-10[4]/UEIB-50[14]	1,238	53.9	0.67	0.12	0.00	0.00	0.00	5.76
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	98	3.0	0.04	0.01	825	0.00	0.00	0.02
UEIB-15	11,582	183.6	2.66	0.49	0.00	0.00	0.00	19.61
UEIB-16	8,699	152.4	1.91	0.35	0.00	0.00	0.00	16.28
UEIB-17	6,483	166.6	2.62	0.48	0.00	0.00	0.00	17.80
UEIB-18	9,613	422.5	5.23	0.96	0.00	0.00	0.00	45.13
UEIB-19	9,777	655.3	7.57	1.39	0.00	0.00	0.00	0.23
UEIB-20/UEIB-56[14]	13,047	462.2	7.03	1.29	0.00	0.00	0.00	0.13
UEIB-21	15,708	463.4	6.22	1.14	0.00	0.00	0.00	0.68
UEIB-22	8,215	165.7	2.54	0.47	0.00	0.00	0.00	0.38
UEIB-23	7,149	28.2	0.39	0.07	0.00	0.00	0.00	3.01
UEIB-24	11,525	293.6	3.84	0.70	0.00	0.00	0.00	31.37
UEIB-25	8,256	176.9	2.20	0.40	0.00	0.00	0.00	18.90
UEIB-26	11,868	263.3	4.12	0.76	0.00	0.00	0.00	0.13
UEIB-27	12,909	775.6	12.97	2.38	0.00	0.00	0.00	0.68
UEIB-28	6,326	191.8	3.14	0.58	0.00	0.00	0.00	0.05
UEIB-29	12,891	415.6	6.07	1.11	0.00	0.00	0.00	44.40
UEIB-30	7,664	84.7	1.78	0.33	0.00	0.00	0.00	9.05
UEIB-31/UEIB-55[14]	5,108	106.9	1.70	0.31	0.00	0.00	0.00	11.42
UEIB-32	4,723	66.8	0.93	0.17	44.62	0.00	0.00	0.47
UEIB-33	6,963	114.5	1.88	0.34	54.26	0.00	0.00	1.39
UEIB-34	7,802	19.0	0.39	0.07	40.07	0.00	0.00	0.02
UEIB-35	13,756	207.5	2.66	0.49	0.00	0.00	0.00	0.05
UEIB-36	5,935	423.8	9.33	1.71	33.16	0.00	0.00	45.27
UEIB-37 [6]	5,266	21.7	0.21	0.04	0.00	0.00	0.00	2.31
UEIB-38	1,435	41.2	0.45	0.08	0.00	0.00	0.00	0.01
UEIB-39 [6]	4,514	52.2	1.01	0.19	0.00	0.00	0.00	5.58
UEIB-40 [6]	4,638	137.0	1.69	0.31	0.00	0.00	0.00	0.02
UEIB-41 [6]	10,171	145.3	1.88	0.35	0.00	0.00	0.00	15.52
UEIB-42 [6]	14,305	221.4	2.00	0.37	0.00	0.00	0.00	23.65
UEIB-43	18,469	909.1	12.19	2.24	0.00	0.00	0.00	0.32
UEIB-44	2,578	36.7	0.41	0.08	42.98	0.00	0.00	0.25
UEIB-45 [8]	14,439	231.7	2.75	0.50	1,245.63	23.47	0.31	88.50
UEIB-46 [9]	2,394	49.4	0.66	0.12	39.87	4.47	0.06	1.34
CPR-1 [11]	5,172	211.5	2.95	0.54	203.60	0.00	0.00	22.60
CPR-2 [11]	1,664	86.5	1.25	0.23	40.17	0.00	0.00	9.24
EX-1 [11]	7,127	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-2 [11]	974	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-3 [11]	2,937	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-4 [11]	614	3.5	0.04	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	313,989	8,527	125	23	23,327	31	0.40	557.03

Extraction Well	Feb 19-21, 2019							
	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate [13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)
	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	724	57.1	0.90	0.17	1,578	0.00	0.00	0.09
UEIB-3/UEIB-53[14]	823	19.5	0.31	0.06	4,471	0.00	0.00	0.29
UEIB-4/UEIB-54[14]	707	55.7	0.87	0.16	176	7.26	0.08	4.99
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	373	6.8	0.10	0.02	5,644	0.00	0.00	0.00
UEIB-8/UEIB-48[14]	3,137	352.1	6.83	1.25	6.80	0.00	0.00	0.13
UEIB-9/UEIB-49[14]	3,597	72.1	1.12	0.21	0.00	0.00	0.00	0.01
UEIB-10[4]/UEIB-50[14]	1,293	55.0	0.87	0.16	0.00	0.00	0.00	1.00
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	98	0.0	0.00	0.00	825	0.00	0.00	0.00
UEIB-15	11,796	214.3	3.41	0.63	0.00	0.00	0.00	3.90
UEIB-16	8,840	140.6	2.07	0.38	0.00	0.00	0.00	2.56
UEIB-17	6,747	263.5	4.23	0.78	0.00	0.00	0.00	4.79
UEIB-18	9,924	310.4	4.54	0.83	0.00	0.00	0.00	0.12
UEIB-19	9,880	103.1	1.52	0.28	0.00	0.00	0.00	0.06
UEIB-20/UEIB-56[14]	14,119	1,072.3	19.27	3.54	0.00	0.00	0.00	0.66
UEIB-21	16,210	501.6	8.06	1.48	0.00	0.00	0.00	0.09
UEIB-22	8,423	207.7	3.26	0.60	0.00	0.00	0.00	0.25
UEIB-23	7,179	29.9	0.48	0.09	0.00	0.00	0.00	0.54
UEIB-24	11,876	350.4	5.60	1.03	0.00	0.00	0.00	6.37
UEIB-25	8,350	94.5	0.74	0.14	0.00	0.00	0.00	1.72
UEIB-26	12,163	294.8	4.31	0.79	0.00	0.00	0.00	5.36
UEIB-27	14,109	1,200.7	18.75	3.44	0.00	0.00	0.00	21.84
UEIB-28	6,576	249.8	3.60	0.66	0.00	0.00	0.00	0.31
UEIB-29	13,372	480.6	7.40	1.36	0.00	0.00	0.00	8.74
UEIB-30	7,845	181.1	2.66	0.49	0.00	0.00	0.00	3.29
UEIB-31/UEIB-55[14]	5,228	120.0	1.75	0.32	0.00	0.00	0.00	2.18
UEIB-32	4,797	74.2	1.09	0.20	44.62	0.00	0.00	1.10
UEIB-33	7,116	153.4	2.19	0.40	54.26	0.00	0.00	4.51
UEIB-34	7,843	41.8	0.59	0.11	40.07	0.00	0.00	0.02
UEIB-35	13,971	215.8	3.20	0.59	0.00	0.00	0.00	0.04
UEIB-36	6,021	85.6	1.24	0.23	33.16	0.00	0.00	1.56
UEIB-37 [6]	5,287	21.2	0.31	0.06	0.00	0.00	0.00	0.39
UEIB-38	1,478	43.8	0.66	0.12	0.00	0.00	0.00	0.80
UEIB-39 [6]	4,603	89.6	1.31	0.24	0.00	0.00	0.00	1.63
UEIB-40 [6]	4,779	140.8	2.11	0.39	0.00	0.00	0.00	2.56
UEIB-41 [6]	10,331	160.5	2.46	0.45	0.00	0.00	0.00	2.92
UEIB-42 [6]	14,734	429.7	6.86	1.26	0.00	0.00	0.00	7.82
UEIB-43	19,518	1,048.9	15.25	2.80	0.00	0.00	0.00	19.08
UEIB-44	2,614	35.5	0.53	0.10	42.98	0.00	0.00	0.08
UEIB-45 [8]	14,625	186.4	2.99	0.55	1,258.20	12.57	0.14	36.73
UEIB-46 [9]	2,441	46.5	0.72	0.13	42.95	3.08	0.03	0.19
CPR-1 [11]	5,437	264.9	3.84	0.70	203.60	0.00	0.00	4.82
CPR-2 [11]	1,706	41.7	1.32	0.24	40.17	0.00	0.00	0.76
EX-1 [11]	7,127	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-2 [11]	974	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-3 [11]	2,937	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-4 [11]	618	3.4	0.05	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	323,506	9,517	149	27	23,350	23	0.25	154.32

Extraction Well	May 13-15, 2019							
	Total Fluids Extracted	Quarter Fluids Extracted	Fluid Extraction Rate [13]		Total NAPL Extracted	NAPL Extracted (quarterly basis)	NAPL Extraction Rate[5]	PHC Mass Extracted (quarterly basis)
	(m^3)	(m^3)	(m^3/day)	(gpm)	(L)	(L)	(L/day)	(Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	784	60.0	0.73	0.13	1,578	0.00	0.00	0.06
UEIB-3/UEIB-53[14]	846	22.6	0.28	0.05	4,472	1.13	0.01	1.12
UEIB-4/UEIB-54[14]	765	58.4	0.73	0.13	182	5.84	0.07	3.26
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	381	7.7	0.10	0.02	5,644	0.00	0.00	0.00
UEIB-8/UEIB-48[14]	3,265	128.4	1.55	0.28	6.80	0.00	0.00	0.10
UEIB-9/UEIB-49[14]	3,684	87.1	1.08	0.20	0.00	0.00	0.00	0.88
UEIB-10[4]/UEIB-50[14]	1,407	113.9	1.35	0.25	0.00	0.00	0.00	1.15
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	186	88.1	2.04	0.37	825	0.00	0.00	0.79
UEIB-15	12,008	211.8	2.43	0.45	0.00	0.00	0.00	2.15
UEIB-16	9,000	160.8	1.76	0.32	0.00	0.00	0.00	1.63
UEIB-17	6,963	215.8	1.85	0.34	0.00	0.00	0.00	2.19
UEIB-18	10,254	330.3	3.75	0.69	0.00	0.00	0.00	3.35
UEIB-19	9,949	68.0	0.88	0.16	0.00	0.00	0.00	0.69
UEIB-20/UEIB-56[14]	15,641	1,521.3	18.93	3.47	0.00	0.00	0.00	15.42
UEIB-21	16,684	473.8	5.54	1.02	0.00	0.00	0.00	0.15
UEIB-22	8,535	112.6	0.99	0.18	0.00	0.00	0.00	0.44
UEIB-23	7,228	48.3	0.61	0.11	0.00	0.00	0.00	0.49
UEIB-24	12,390	514.2	6.05	1.11	0.00	0.00	0.00	5.21
UEIB-25	8,617	267.3	4.42	0.81	0.00	0.00	0.00	2.71
UEIB-26	12,351	187.6	2.66	0.49	0.00	0.00	0.00	1.90
UEIB-27	14,910	800.7	9.38	1.72	0.00	0.00	0.00	8.11
UEIB-28	6,732	156.5	1.96	0.36	0.00	0.00	0.00	0.19
UEIB-29	13,858	486.5	5.69	1.04	0.00	0.00	0.00	0.05
UEIB-30	7,956	110.8	1.35	0.25	0.00	0.00	0.00	1.12
UEIB-31/UEIB-55[14]	5,349	120.4	1.72	0.32	0.00	0.00	0.00	1.22
UEIB-32	4,862	64.8	0.81	0.15	44.62	0.00	0.00	0.37
UEIB-33	7,258	141.5	1.76	0.32	54.26	0.00	0.00	2.06
UEIB-34	7,905	62.0	0.78	0.14	40.07	0.00	0.00	0.06
UEIB-35	14,197	225.6	2.55	0.47	0.00	0.00	0.00	2.29
UEIB-36	6,129	108.6	1.37	0.25	33.16	0.00	0.00	1.10
UEIB-37 [6]	5,318	31.0	0.38	0.07	0.00	0.00	0.00	0.31
UEIB-38	1,541	63.0	0.78	0.14	0.00	0.00	0.00	0.02
UEIB-39 [6]	4,715	111.9	1.53	0.28	0.00	0.00	0.00	1.13
UEIB-40 [6]	4,971	192.6	2.40	0.44	0.00	0.00	0.00	1.95
UEIB-41 [6]	10,578	246.2	3.07	0.56	0.00	0.00	0.00	2.49
UEIB-42 [6]	15,752	1,018.1	10.92	2.00	0.00	0.00	0.00	10.32
UEIB-43	19,589	70.4	0.00	0.00	0.00	0.00	0.00	0.71
UEIB-44	2,659	45.1	0.55	0.10	42.98	0.00	0.00	0.17
UEIB-45 [8]	14,900	274.7	3.08	0.57	1,303.51	45.31	0.17	5.41
UEIB-46 [9]	2,491	49.6	0.61	0.11	42.95	0.00	0.00	0.27
CPR-1 [11]	5,492	55.5	0.69	0.13	203.60	0.00	0.00	0.56
CPR-2 [11]	1,706	0.1	0.00	0.00	40.17	0.00	0.00	0.00
EX-1 [11]	7,127	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-2 [11]	974	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-3 [11]	2,937	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-4 [11]	622	3.9	0.05	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	332,624	9,117	109	20	23,402	52	0.25	83.61

Abbreviations:

UK - Unknown (not enough data).
NAPL - Non-Aqueous Phase Liquids
PHC - Petroleum Hydrocarbons
m - Metres
L - Litres
Kg - Kilograms
gpm - Gallons per minute

TABLE C-1
SUMMARY OF EXTRACTION RATES - PERIMETER EXTRACTION SYSTEM
PARKLAND BURNABY REFINERY

Extraction Well	August 6-8, 2019								October 3 - January 7th, 2019/2020							
	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)	Total Fluids Extracted (m^3)	Quarter Fluids Extracted (m^3)	Fluid Extraction Rate [13] (m^3/day)	(gpm)	Total NAPL Extracted (L)	NAPL Extracted (quarterly basis) (L)	NAPL Extraction Rate[5] (L/day)	PHC Mass Extracted (quarterly basis) (Kg)
UEIB-1[1]	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A	78	N/A	N/A	N/A	2,680	N/A	N/A	N/A
UEIB-2[2]/UEIB-52[14]	897	113.4	0.81	0.15	1,578	0.00	0.00	0.55	957	59.3	0.64	0.12	1,578	0.00	0.00	0.17
UEIB-3/UEIB-53[14]	876	30.5	0.19	0.03	4,474	1.52	0.01	0.98	901	24.4	0.25	0.05	4,475	1.22	0.01	1.58
UEIB-4/UEIB-54[14]	1,050	284.6	2.49	0.46	210	28.46	0.24	91.01	1,166	116.4	1.18	0.22	222	11.64	0.12	5.83
UEIB-5[8]	358	N/A	N/A	N/A	184	N/A	N/A	N/A	358	N/A	N/A	N/A	184	N/A	N/A	N/A
UEIB-6[9]	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A	209	N/A	N/A	N/A	6,025	N/A	N/A	N/A
UEIB-7/UEIB-47[14]	386	5.2	0.02	0.00	5,644	0.00	0.00	0.00	394	8.2	0.08	0.01	5,644	0.00	0.00	0.01
UEIB-8/UEIB-48[14]	3,487	221.1	1.45	0.27	6.80	0.00	0.00	0.08	3,689	202.7	2.03	0.37	6.80	0.00	0.00	0.24
UEIB-9/UEIB-49[14]	3,827	143.3	0.99	0.18	0.00	0.00	0.00	4.48	3,933	105.7	1.10	0.20	0.00	0.00	0.00	0.02
UEIB-10[4]/UEIB-50[14]	1,634	226.4	1.54	0.28	0.00	0.00	0.00	7.07	1,805	171.3	1.80	0.33	0.00	0.00	0.00	0.05
UEIB-11[3]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UEIB-14[1,4]/UEIB-51[14]	1,099	912.8	4.26	0.78	825	0.00	0.00	7.03	1,777	678.1	6.85	1.26	825	0.00	0.00	3.49
UEIB-15	12,259	251.0	1.37	0.25	0.00	0.00	0.00	7.84	12,588	328.2	3.46	0.64	0.00	0.00	0.00	0.16
UEIB-16	9,226	226.0	1.57	0.29	0.00	0.00	0.00	7.06	9,510	283.2	2.79	0.51	0.00	0.00	0.00	2.44
UEIB-17	7,106	143.0	0.69	0.13	0.00	0.00	0.00	4.47	7,549	443.4	4.33	0.80	0.00	0.00	0.00	0.82
UEIB-18	10,627	372.6	2.33	0.43	0.00	0.00	0.00	0.13	11,304	677.9	6.62	1.21	0.00	0.00	0.00	0.17
UEIB-19	10,103	154.5	0.74	0.14	0.00	0.00	0.00	4.83	10,467	363.8	3.62	0.66	0.00	0.00	0.00	1.11
UEIB-20/UEIB-56[14]	16,473	832.3	4.35	0.80	0.00	0.00	0.00	26.00	16,860	387.0	4.01	0.74	0.00	0.00	0.00	0.11
UEIB-21	17,216	532.8	3.43	0.63	0.00	0.00	0.00	16.65	17,848	631.4	6.27	1.15	0.00	0.00	0.00	0.76
UEIB-22	8,608	73.0	0.31	0.06	0.00	0.00	0.00	2.28	8,840	231.6	2.29	0.42	0.00	0.00	0.00	0.23
UEIB-23	7,359	131.2	0.84	0.15	0.00	0.00	0.00	4.10	7,576	217.2	2.06	0.38	0.00	0.00	0.00	1.87
UEIB-24	13,132	742.3	5.33	0.98	0.00	0.00	0.00	23.19	13,632	499.4	5.20	0.95	0.00	0.00	0.00	0.12
UEIB-25	9,105	487.6	3.65	0.67	0.00	0.00	0.00	0.12	9,276	170.6	2.01	0.37	0.00	0.00	0.00	0.06
UEIB-26	12,773	422.2	2.80	0.51	0.00	0.00	0.00	13.19	13,264	490.8	4.96	0.91	0.00	0.00	0.00	0.17
UEIB-27	15,337	427.2	2.78	0.51	0.00	0.00	0.00	0.11	15,615	277.3	3.03	0.56	0.00	0.00	0.00	2.39
UEIB-28	6,907	174.4	1.26	0.23	0.00	0.00	0.00	0.27	7,115	208.9	2.02	0.37	0.00	0.00	0.00	0.25
UEIB-29	14,574	715.6	4.98	0.91	0.00	0.00	0.00	22.36	15,155	581.5	5.81	1.07	0.00	0.00	0.00	0.90
UEIB-30	8,009	52.8	0.30	0.05	0.00	0.00	0.00	1.65	8,116	106.8	1.00	0.18	0.00	0.00	0.00	0.92
UEIB-31/UEIB-55[14]	5,620	270.9	1.80	0.33	0.00	0.00	0.00	8.46	5,620	0.6	0.11	0.02	0.00	0.00	0.00	0.01
UEIB-32	4,981	119.3	0.80	0.15	50.58	5.96	0.04	14.66	5,070	89.1	0.92	0.17	55.04	4.46	0.05	0.48
UEIB-33	7,398	139.9	0.85	0.16	54.26	0.00	0.00	3.45	7,567	169.1	1.64	0.30	54.26	0.00	0.00	1.96
UEIB-34	8,027	121.7	0.83	0.15	40.07	0.00	0.00	0.09	8,117	89.8	0.68	0.13	40.07	0.00	0.00	0.11
UEIB-35	14,556	358.9	2.77	0.51	0.00	0.00	0.00	0.11	14,798	242.3	2.59	0.47	0.00	0.00	0.00	2.09
UEIB-36	6,324	194.8	1.31	0.24	33.16	0.00	0.00	6.08	6,454	129.9	1.32	0.24	33.16	0.00	0.00	0.04
UEIB-37 [6]	5,405	87.3	0.63	0.12	0.00	0.00	0.00	2.73	5,456	50.9	0.52	0.10	0.00	0.00	0.00	0.01
UEIB-38	1,635	93.2	0.73	0.13	0.00	0.00	0.00	2.91	1,687	52.7	0.55	0.10	0.00	0.00	0.00	0.02
UEIB-39 [6]	5,024	309.0	2.31	0.42	0.00	0.00	0.00	9.65	5,136	111.8	1.30	0.24	0.00	0.00	0.00	0.96
UEIB-40 [6]	5,214	242.5	1.68	0.31	0.00	0.00	0.00	0.03	5,380	166.5	1.68	0.31	0.00	0.00	0.00	1.44
UEIB-41 [6]	10,903	325.0	1.99	0.37	0.00	0.00	0.00	10.15	10,987	84.3	0.94	0.17	0.00	0.00	0.00	0.73
UEIB-42 [6]	16,051	298.6	2.39	0.44	0.00	0.00	0.00	9.33	16,601	550.3	5.40	0.99	0.00	0.00	0.00	0.10
UEIB-43	20,349	760.6	4.45	0.82	0.00	0.00	0.00	23.77	20,928	578.7	6.01	1.10	0.00	0.00	0.00	4.99
UEIB-44	2,734	75.1	0.53	0.10	42.98	0.00	0.00	1.06	2,781	47.6	0.50	0.09	42.98	0.00	0.00	0.95
UEIB-45 [8]	15,332	432.1	1.73	0.32	1,315.15	11.64	0.37	12.32	15,602	269.7	2.64	0.48	1,342.13	26.97	0.28	21.14
UEIB-46 [9]	2,571	80.7	0.50	0.09	42.95	0.00	0.00	0.27	2,636	64.7	0.65	0.12	42.95	0.00	0.00	0.25
CPR-1 [11]	5,515	22.4	0.02	0.00	203.60	0.00	0.00	0.70	5,785	269.7	2.54	0.47	203.60	0.00	0.00	2.33
CPR-2 [11]	1,708	1.8	0.00	0.00	40.17	0.00	0.00	0.06	1,764	56.3	0.51	0.09	40.17	0.00	0.00	0.49
EX-1 [11]	7,127	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,127	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-2 [11]	974	N/A	N/A	N/A	N/A	N/A	N/A	N/A	974	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-3 [11]	2,937	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,937	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EX-4 [11]	628	6.0	0.04	0.01	N/A	N/A	N/A	N/A	633	4.9	0.05	0.01	N/A	N/A	N/A	N/A
U2-5 [11]	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A	503	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	344,239	11,616	74	14	23,450	48	0.66	351.29	354,533	10,294	104	19	23,494	44	0.46	61.96

Abbreviations:
UK - Unknown (not enough data).
NAPL - Non-Aqueous Phase Liquids
PHC - Petroleum Hydrocarbons
m - Metres
L - Litres
Kg - Kilograms
gpm - Gallons per minute

Appendix D Regulatory Context and SSSLs

1 REGULATORY CONTEXT FOR PERIMETER GROUNDWATER MONITORING PROGRAM

The British Columbia provincial *Environmental Management Act* (EMA) was brought into force on July 8, 2004. The applicable regulations under the EMA are the Contaminated Sites Regulation (CSR) and the Hazardous Waste Regulation (HWR). Federal environmental legislation applicable to Burrard Inlet adjacent to the Site includes the *Fisheries Act*.

1.1 Fisheries Act

The Fisheries Act, administered by the Fisheries and Oceans Canada (DFO), prohibits the discharge of a deleterious substance to an aquatic environment and is enforced by Environment and Climate Change Canada, Fisheries and Oceans Canada (DFO), and the British Columbia Ministry of the Environment and Climate Change Strategy (ENV). Deleterious substances are defined as any substance that, if added to any water, would degrade or alter its quality such that it could be harmful to fish, fish habitat or the use of fish by people and therefore includes contaminants regulated by the CSR.

1.2 Contaminated Sites Regulation

The ENV has established standards for evaluating contamination and associated remediation requirements in the CSR. The CSR came into effect April 1, 1997 and provides a framework to investigate, assess, and remediate contaminated sites in BC. Twelve amendments to the CSR have been completed since 1997, with the most recent being the Stage 12, which came into effect on January 24, 2019.

The CSR is simplified into four new schedules:

- Schedule 3.1 – Part 1, Matrix Numerical Soil Standards;
- Schedule 3.1 – Part 2, Generic Numerical Soil Standards to Protect Human Health;
- Schedule 3.1 – Part 3, Generic Numerical Soil Standards to Protect Ecological Health;
- Schedule 3.2, Generic Numerical Water;
- Schedule 3.3, Generic Numerical Vapour Standards; and
- Schedule 3.4, Generic Numerical Sediment Standards.

1.3 Soil

Under the CSR, there are three types of numerical remediation soil standards.

1. The Generic Numerical Standards refer to concentrations of specific substances in soil, for a particular land or water use.
2. Matrix Numerical Standards are applied for some substances in soil, taking into account site-specific factors such as proximity to a watercourse, likelihood of human ingestion, and use of land for livestock rearing.
3. Site-Specific Numerical Standards involve the generation of a soil standard for a specific site, based on ENV protocols.

Sites are considered contaminated if any parameter exceeds the numerical standard for the applicable use at the property.

1.4 Groundwater

The Site is zoned for heavy industrial use. The following is a discussion of the applicable groundwater standards at the Site. Water quality standards are classified into four levels, based on the use of the water:

- AW - Aquatic life (freshwater and/or marine/estuarine);
- IW - Irrigation;
- LW - Livestock watering; and
- DW - Drinking water.

Based on the surrounding site use neither irrigation nor livestock watering standards apply at the Site.

Additionally, numeric water standards for the generic petroleum hydrocarbon (PHC) parameters "volatile hydrocarbon in water" ($VH_{WC6-C10}$) and "extractable petroleum hydrocarbons in water" ($EPHw_{C10-C19}$) are applicable at all sites regardless of water use.

ENV requires specific analysis for light extractable petroleum hydrocarbons in water (LEPHw) in support of Certificates and Determinations and will not consider $EPHw_{C10-C19}$ analyses appropriate for assessing LEPHw contamination. At low concentrations EPHw is used as an indicator test for LEPHw. LEPHw concentrations are based on $EPHw_{C10-C19}$ concentrations minus the six polycyclic aromatic hydrocarbon (PAH) compounds (acenaphthene, acridine, anthracene, fluorene, naphthalene, and phenanthrene). The six PAH compounds are reported separately.

1.4.1 Applicability of Drinking Water Standards

Under ENV guidance, drinking water standards are applicable at all sites unless they are determined to be not applicable using Protocol 21 (ENV 2017), or an exemption is granted by the ENV.

A letter requesting a drinking water standards exemption for Area 2 of the Refinery was submitted to ENV on December 19, 2011 and re-submitted on November 9, 2012. The drinking water exemption was provided by the ENV on May 15, 2017.

To determine whether drinking water applies to Areas 1 and 3, the drinking water flowcharts at the end of Protocol 21 (Figures 1 and 4 in the Protocol) were reviewed in which Area 3 was assessed separately from Area 1. This approach was implemented in the 2015 and 2016 PMP and PES Monitoring Report which determined that drinking water does not apply to any of the areas of the Parkland Burnaby Refinery (AECOM, 2017).

A copy of the drinking water exemption response-letter prepared by ENV for Area 2, as well as the Area 1 and Area 3 assessments, have been included at the end of this Appendix.

1.4.2 Applicability of Aquatic Life Standards

The nearest surface water downgradient of the Site is Burrard Inlet, located approximately 10 m to the north of Areas 1 and 3, and 40 m north of Area 2. Assessment of the Site's hydrogeology and potential pathways for groundwater contamination, using the available data from numerous soil and groundwater investigations, indicated that CSR standards for the protection of marine aquatic life (AW) are applicable at the Site[7]. Rainbow Creek a freshwater waterbody is located within close vicinity to MW17-04, as a result, this well was also compared against freshwater (FW) aquatic life standards. This is the only well in the PMP required to be screened against FW AW standards.

[7] http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/protocols/protocol_21.pdf

1.4.3 Groundwater Site-Specific Screening Levels

The Site-Specific Screening Levels (SSSLs) were first introduced in the Report on the 2015 and 2016 Perimeter Monitoring Program and Perimeter Extraction System, Chevron Burnaby Refinery, Burnaby British Columbia (AECOM 2017). SSSLs for select parameters were developed by SLR Consulting Canada Ltd. (SLR), with the support of Parkland and AECOM, to evaluate potential risks resulting from impacted Site groundwater to Burrard Inlet. The SSSLs were based on the CSR Stage 10 Omnibus Amendments in addition to the Updated Screening Levels (USLs) and Risk-Based Management Targets (RBMTs) developed for application along the Foreshore downslope of Area 2 of the Refinery[8]. Upon the release of the Stage 11 and 12 Housekeeping Amendment, the SSSLs were reviewed by AECOM. The CSR AW standards for parameters which have SSSLs did not change between Stage 10, Stage 11 and Stage 12 Amendments; therefore, AECOM does not recommend modifying the existing SSSLs. The measured groundwater concentrations from the monitoring wells investigated during this program were compared against the Site wide SSSLs. In the event an SSSL was not available for a certain parameter, the groundwater concentrations were also compared against the CSR AW (marine, and freshwater for MW17-04 only). For parameters with SSSLs, the SSSLs were considered the prevailing standard and are recognized as the basis for remedial action by Parkland.

The groundwater SSSLs for the Parkland Refinery monitoring wells located in Areas 1, 2 and 3 are summarized in Table 1 below. The supporting rationale are presented in Section 2.0

Table 1: Groundwater Site-Specific Screening Levels (SSSLs)

PCOC Group	PCOC	SSSL (µg/L)	Source	Comment
PHCs	LEPHw	3000	RBMT x 10	
	VPHw	15000	RBMT x 10	
	$EPHw_{(C10-C19)}$	5000	BC CSR AW Standard	
	$VHw_{(C6-C10)}$	15000	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Benzene	21000	RBMT x 10	
	Ethylbenzene	3200	RBMT x 10	
	Styrene	720	BC CSR AW Standard	
	Toluene	7700	RBMT x 10	
	Xylenes	3300	RBMT x 10	
PAHs	Acenaphthene	60	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Acridine	30	USL x 10	
	Anthracene	40	USL x 10	
	Benz[a]anthracene	1	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Benzo[a]pyrene	2.8	RBMT x 10	
	Chrysene	1	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Fluoranthene	40	USL x 10	
	Fluorene	120	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Naphthalene	440	RBMT x 10	

[8] The SSSLs were partially derived from the Stage 10 Omnibus Amendment. Upon release of the Stage 11 Housekeeping Amendment, these SSSLs were reassessed to determine if any updates were warranted. AECOM concluded no further updates are required at this time.

PCOC Group	PCOC	SSSL (µg/L)	Source	Comment
	Phenanthrene	3	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Pyrene	40	USL x 10	
	Quinoline	34	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
Metals	Antimony	2500	BC CSR AW Standard	
	Arsenic	125	BC CSR AW Standard	
	Barium	5000	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Beryllium	1000	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Boron	12000	BC CSR AW Standard	
	Cadmium	90	USL x 10	
	Chromium	500	USL x 10	
	Cobalt	1100	USL x 10	
	Copper	62	RBMT x 10	
	Lead	1400	USL x 10	
	Molybdenum	10000	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Nickel	750	USL x 10	
	Selenium	20	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Thallium	3	USL x 10	BC CSR AW Standard adopted as same value as USL x 10
	Uranium	1000	USL x 10	
	Zinc	900	RBMT x 10	

BC CSR refers to the BC CSR, Stage 12 Amendments, Schedule 3.2 – AW Standard for the Protection of Aquatic Life.

2 SITE-SPECIFIC SCREENING LEVEL RATIONALE

This section outlines the rationale for the selection of the SSSLs for groundwater for the Perimeter Monitoring Program for Areas 1, 2 and 3 of the Refinery. The sources of values used to derive the SSSLs are presented in Section 2.1 and the approach followed to obtain the SSSLs is described in Section 2.2.

2.1 Sources of SSSLs

The sources of SSSLs included:

- USLs for Foreshore Monitoring (SLR 2013a and 2013b);
- RBMTs for the Seep Area along the Foreshore Downslope of East Impounding Basin (SLR 2014a and 2014b); and
- The BC CSR, Stage 10 (Omnibus) Amendments, Schedule 3.2 – AW Standard for the Protection of Aquatic Life.

2.2 Updated Screening Levels

The USLs were used as part of the Foreshore Monitoring Plan to evaluate porewater and surface water samples collected in the foreshore downslope of Area 2 of the Refinery. The USLs were presented to BC ENV in two memoranda prepared by SLR: Updated Screening Levels for Foreshore Monitoring and Updated Screening Levels for Foreshore Monitoring - Addendum, dated May 9, 2013 and June 6, 2013, respectively. The USLs were based on the BC Approved Water Quality Guidelines (AWQG) for the protection of marine aquatic life, the Burrard Inlet Water Quality Objectives (BIWQOs), the Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life, and the Federal Interim Groundwater Quality Guidelines (FIGQG) for Federal Contaminated Sites (Meridian 2012). The rationale supporting each proposed USL was provided in the SLR memoranda (2013a and 2013b). Upon review, BC ENV confirmed that the selected screening levels were satisfactory to the Ministry (BC MoE 2013).

The USLs were used to evaluate potential contaminants of concern (PCOCs) in the porewater and seawater along the foreshore in the vicinity of the seeps and at a reference location, to assess the performance of the Interim Remedial Action (IRA), and, to support the selection of PCOCs for the Human Health and Ecological Risk Assessments completed for the foreshore downslope of Area 2 (SLR 2016).

2.2.1 Risk-Based Management Targets

RBMTs were derived by SLR for PCOCs associated with the seeps observed in the foreshore area downslope of the East Impounding Basin (EIB) in Area 2 at the Parkland Refinery in Burnaby, BC. The PCOCs for which RBMTS were derived were selected based on the final porewater and surface water PCOCs retained in the Human Health and Ecological Risk Assessment (HHERA) for the protection of marine aquatic life (SLR 2014a). PCOCs for which RBMTs were proposed included light extractable petroleum hydrocarbons in water (LEPHw), volatile petroleum hydrocarbons in water (VPHw), benzene, toluene, ethylbenzene, xylenes (BTEX), benzo(a)pyrene, naphthalene, copper, and zinc. RBMTs were developed to be protective of aquatic plants and invertebrates at the community level and fish at the population level and were defined as the concentrations of PCOC in porewater below which the ecological function of aquatic plants and invertebrates and the viability of local fish population can be maintained. Literature sources reviewed in the derivation of the RBMTs for aquatic receptors included:

- Technical supporting documents published by BC MoE as part of the BC AWQG.
- Technical supporting documents published by CCME as part of the Canadian Environmental Quality Guidelines for the protection of aquatic life.
- Technical supporting document published by the US EPA to support the Ambient Water Quality Guidelines.
- Toxicity values developed by other jurisdictions such as the Atlantic Risk Based Corrective Action (RBCA) and the European Union.
- Scientific peer review articles such as McGrath and DiToro (2009).
- Grey literature including ecological risk assessment reports prepared by environmental consultants focusing on projects completed in British Columbia.

Preferences were given to chronic sublethal toxicity data (e.g., EC20) for reproduction and growth, if available, when selecting the RBMTs. The rationale supporting the RBMTs is provided by SLR (2014a and 2014b).

The RBMTs were proposed in the context of the final remedy for the seeps, as a risk management tool, to determine whether porewater PCOCs can adversely impact aquatic life upon discharge in the foreshore (i.e. downgradient of the remedial measure) and to assess the performance of the final remedy in the foreshore cross-gradient and downgradient of the seeps. The RBMTs were deemed adequate by BC MoE (MoE, 2014).

2.2.2 Regulatory Context for the RBMTs

The CSR under the EMA is the principal regulatory document defining requirements for contaminated sites management in British Columbia. The CSR came into effect on April 1, 1997 and has been amended several times, most recently on January 24, 2019 with the Stage 12 Housekeeping Amendment. The EMA and CSR have provisions for both numerical standards and risk-based standards approaches to managing site contamination.

CSR standards are not available for porewater/groundwater quality assessment for monitoring wells located within 10 m of the high water mark of the aquatic receiving environment. The CSR AW standards apply to porewater/groundwater wells at distances greater or equal to 10 m from the high water mark of receiving environment, based on the assumption that groundwater will be diluted at least 10-fold from its initial concentration in the remaining 10 m before entering the aquatic receiving environment (BC MoE 2017). The BC Water Quality Guidelines (WGQs) apply to high water mark of the aquatic receiving environment.

As part of the Foreshore Monitoring Program implemented by URS (2012a, 2012b, and 2012c) (now AECOM), porewater results for samples collected from monitoring wells installed within the intertidal area have been compared to USLs for the protection of marine aquatic life. As indicated in Section 2.2, these benchmarks were presented to BC MoE in two memoranda prepared by SLR (2013a and 2013b) and upon review; BC MoE confirmed that the selected screening levels were satisfactory to the Ministry.

If the CSR AW standards cannot be met at distances greater or equal to 10 m from the high water mark of the receiving environment and the BC WQGs (i.e., USLs for foreshore monitoring in this case) cannot be met for monitoring wells located within 10 m of the high water mark of the aquatic receiving environment, BC MoE, the Technical Guidance 15 – Concentration Limits for the Protection of Aquatic Receiving Environments (BC MoE 2017) allows an alternative risk-based approach which shows that:

- The 10-fold dilution of substance concentrations in groundwater occurs before the water enters the aquatic receiving environment;
- Groundwater quality meets a site-specific risk-based standard with a protection level appropriate for aquatic receiving environments (i.e., EC20); or
- Substance concentrations in groundwater do not represent an unacceptable risk to aquatic life as revealed by a detailed ecological risk assessment.

According to the above, the RBMTs were used to determine whether porewater PCOCs presented an unacceptable risk to aquatic life upon discharge to the foreshore.

2.3 Derivation of SSSLs for Monitoring Wells in Areas 1, 2 and 3

The following approach was used to select the SSSLs for monitoring wells located in Areas 1, 2 and 3 of the Parkland Burnaby Refinery:

- The RBMT values were multiplied by 10 to obtain SSSLs to screen groundwater monitoring wells located greater than 10 m from the foreshore high water mark. This approach was followed for LEPHw, VPHw, BTEX, styrene, benzo(a)pyrene, naphthalene, copper, and zinc.
- In the absence of RBMTs, the USL values were multiplied by 10 to obtain SSSLs to screen groundwater monitoring wells located greater than 10 m from the foreshore high water mark. This approach was followed for acenaphthene, acridine, anthracene, benz(a)anthracene, fluoranthene, fluorene, phenanthrene, pyrene, quinoline, barium, beryllium, cadmium, chromium, cobalt, lead, molybdenum, nickel, selenium, thallium, titanium, and uranium. Note that several of the SSSLs derived using this approach are equal to the BC CSR Schedule 3.2 – Generic Numerical Water Standards for the Protection of Aquatic Life. In these instances, the CSR Schedule 3.2 AW Standards were adopted as the SSSLs. PCOCs for which the USL multiplied by 10 was equal to the

CSR AW standard included: VHw (C6-C10), acenaphthene, benz(a)anthracene, chrysene, fluorene, phenanthrene, quinoline, barium, beryllium, molybdenum, selenium, and thallium.

- The BC CSR, Schedule 3.2 – AW Standard for the Protection of Aquatic Life was selected when it was higher than the RBMT x 10 and/or USL x 10. This approach was followed for antimony, arsenic, and boron.

2.4 Additional SSSLs Development Considerations

The USLs and RBMTs were originally derived for porewater and surface water in the Seep Area along the Foreshore down slope of East Impounding Basin in Area 2 of the Refinery. These USLs and RBMTs are the basis for SSSLs which are currently applied to Areas 1, 2 and 3. The justification for the application of the SSSLs for Areas 1 and 3 is based on the following:

- The USLs and RBMTs were derived for PHCs, PAHs and metals. These represent the same PCOCs for the entire Refinery. Additionally, the PHC sources are similar for the three areas.
- A sensitive site designation was attributed to the foreshore down slope of Area 2 for the purpose of deriving the USLs and RBMTs. The receptors of concerns considered as part of the selection of USLs and RBMTs included aquatic plants, benthic invertebrates and fish (including federally or provincially listed fish). The sensitive site designation and aquatic receptors of concern selected for the foreshore down slope of Area 2 are considered to be protective of the aquatic species residing in aquatic habitat downslope of Area 1 and Area 3. The foreshore down gradient of Area 1 and Area 3 includes a wharf and the slope to Burrard Inlet is stabilized with rip-rap, which extends into the foreshore and intertidal environments (URS 2007). Aquatic plants, benthic invertebrates and fish considered receptors of concern in the area of the foreshore down slope of Areas 1 and 3 were also considered receptors of concern for the foreshore down slope of Area 2.

3 DRINKING WATER EXEMPTION ASSESSMENT

A drinking water exemption was obtained from ENV in 2017 for Area 2. A letter requesting a drinking water standards exemption for Area 2 of the Refinery was submitted to the ENV on December 19, 2011 and re-submitted on November 9, 2012. The drinking water exemption was provided by the ENV on May 15, 2017. A copy of the ENV response-letter is included at the end of this Appendix.

To assess the applicability of the CSR drinking water standards for Areas 1 and 3, the drinking water flowcharts at the end of Protocol 21 (Figures 1 and 4) were completed for each area. The assessment is shown in Table 2 for Area 3 and Tables 3 and 4 for Area 1.

Based on the Protocol 21 Assessment, drinking water does not apply for Area 1 and 3 of the Parkland Burnaby Refinery.

Table 2: Drinking Water Use Application in Area 3

Protocol 21 Flowchart Question	**Answer:**
Current Drinking Water Use	
Q1. Is water at or near the site currently used for drinking water?	No. There are no drinking water wells located within 500m of the Site. Drinking water in Burnaby, BC is supplied by the municipality.
Future Drinking Water Use	
Q1. Is the site located within filled former marine or estuarine foreshore?	Yes.
Conclusion	Future DW use does not apply to Area 3.

Table 3: Drinking Water Use Application in Area 1

Protocol 21 Flowchart Question	**Answer:**
Current Drinking Water Use	
Q1. Is water at or near the site currently used for drinking water?	No. There are no wells located within 500m of the Site. Drinking water in Burnaby, BC is supplied by the municipality from GVRD surface water reservoirs (Seymour, Capilano and Coquitlam watersheds) far removed from the Site.
Future Drinking Water Use	
Q1. Is the site located within filled former marine or estuarine foreshore?	No.
Q2. Is the aquifer confined and protected by a natural confining barrier?	No.
Q3. Does drinking water use apply to an underlying aquifer?	No. See bedrock aquifer table below.
Q4. Does the unconfined aquifer have a bulk hydraulic conductivity > 10-6 m/s or a yield ≥1.3 L/min or is the aquifer mapped in the BC Water Resource Atlas?	No. The unconfined aquifer has a bulk hydraulic conductivity < 10^{-6} m/s based on a pumping test in Area 2. Yes. The yield in Area 2 till is ≥1.3 L/min (URS, 2012). No. The site is not an aquifer mapped in the BC Water Resource Atlas.
Q5. Is the unconfined aquifer comprised only of imported fill or present only seasonally or is the average saturated thickness ≤2m?	Yes, the average saturated thickness in the unconsolidated material (i.e. non-bedrock) is less than 2 meters. To evaluate this, 10 borehole logs and well monitoring data across Area 1 were reviewed. The depth to bedrock ranged from 0.8 to 5 meters below grade. The average depth to water (measured seasonally over more than 10 years) ranged from 0.9 to 4.9 meters below grade. The average saturated thickness in the unconsolidated material ranged from 0 to 3.2 meters with an average saturated thickness over the 10 locations of 1.1 meters[9].
Conclusion	Future DW use does not apply to the unconsolidated non-bedrock groundwater in Area 1.

[9] Borehole logs/monitoring wells used in assessment: A1-9S/D, A1-12S/D, A1-11A/B, A1-7S/D, A1MW02-03, NDP97-1, A1-6, A1-5, A1-3S/D and A1-4S/D. Depth to bedrock based on borehole logs. Average depth to water based on regular monitoring (over multiple seasons) completed since 2004.

Table 4: Drinking Water Use Application in Area 1 Bedrock

Protocol 21	Answer:
Current Drinking Water Use	
Q1. Is water in the bedrock at or near your site currently being used for drinking purposes?	No. There are no wells located within 500m of the Site. Drinking water in Burnaby, BC is supplied by the municipality. See above
Future Drinking Water Use	
Q1. Is a bedrock aquifer mapped in the BC Water Resource Atlas?	No.
Q2. Do soil or groundwater containing substances at concentrations above standards protective of drinking water extend to the bedrock surface?	Yes.
Does in-situ bedrock investigations on the site or within 500 m show a bulk hydraulic conductivity >10-6 m/s and a yield ≥1.3 L/min?	No. Well yield is less than 1.3 L/min. To evaluate this, Well yield was calculated at 3 locations screened in the sand and siltstone in Area 1. Well yield ranged from 0.1 to 0.8 L/min
Conclusion	Future DW use does not apply to Area 1.

4 REFERENCES

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BRITISH COLUMBIA

File: 26250-20/6726
Site: 6726

May 15, 2017

Mr. Chris Boys
Chevron Canada Limited
355 Willingdon Avenue
Burnaby, BC V5C 1X4

Dear Mr Boys:

Re: Drinking Water Exemption Request, Area 2, Chevron Burnaby Refinery, 5201 Penzance Drive, Burnaby, BC

The Ministry of Environment (Ministry) has reviewed the following technical report prepared by SLR Consulting (Canada) and additional correspondence from AECOM Canada Consulting submitted in support of your application for a determination of no drinking water use at Area 2 Chevron Refinery in Burnaby, British Columbia (the Site):

- *Drinking Water Standards Exemption Request, Chevron Burnaby Refinery, Area 2, 5201 Penzance Drive, Burnaby BC dated November 20, 2012 prepared by SLR Consulting (Canada)*
- *Additional information contained in an email from AECOM Canada dated Sept 1, 2016*
- *Additional information contained in a letter to the ministry from AECOM Canada dated March 17, 2017*

The legal description of the Site to which this water use determination applies is:

- Block F, Plan 13496, District Lot 188/189, Group 1 Land District, Except Plan RP13504 (PCL 3) & RP13238 (PCL 1) & B/L A37751 & 49497, 6238-0691, 5804-0588, 9999-5286, 0250-5620)

The Site is depicted in attached Figure 1 for reference.

Ministry of Environment Land Remediation Section
Environmental Emergencies and Land Remediation
Environmental Protection Division
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Victoria BC V8W 9M1
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Section 12(5) of the Contaminated Sites Regulation (CSR) specifies the water uses that may apply at sites in BC, including aquatic life, drinking, irrigation and livestock watering water uses, as well as the factors a Director must consider in determining current and reasonable potential future water uses at a site. Protocol 21 provides criteria for determining current and reasonable potential future water uses at specific sites.

Where drinking water use has been determined to apply at a site under Protocol 21 and site circumstances indicate that it is unlikely or unreasonable to anticipate that water would be used for drinking, a site-specific water use determination may be sought from the Director. Protocol 21, Appendix 1 "Director's Decision Framework for Site-Specific Determinations of Water Use" outlines a multiple-lines-of-evidence approach for seeking a Director's determination of no drinking water use at a specific site.

The letter request and additional documentation provided by SLR and AECOM for a Water Use Determination provides the following rationale to support that drinking water use should not apply to the groundwater at the Site:

- *The geometric mean hydraulic conductivity for the native till based on the pumping tests is 3 x 10^{-7} m/s within this unit.*
- *The geometric mean hydraulic conductivity for the native till based on slug tests is: 9 x 10^{-7} m/s.*
- *Based on the nearest* [~700 m to 1 km away; Area 1 of the Chevron Refinery] *available bedrock hydrogeological data ... has bulk hydraulic conductivity less than 1 x 10^{-6} m/s, and a yield less than 1.3 L/min* [yield calculations ranged from 0.1 L/min to 0.8 L/min]*...the bedrock below Area 2 of the Refinery is not a viable aquifer.*
- There are no mapped aquifers at the Site, according to the Water Resources Atlas.
- *The site and down gradient Canadian Pacific Railway (CPR) property have been subject to heavy industrial usage since the mid 1900s and will continue to be so into the foreseeable future. Chevron has operated a refinery on the site since approximately 1954;*
- *The Burrard Inlet shoreline is approximately 30 m northwest (downgradient) of the site boundary and forms the northern boundary of the CPR lands;*
- *Because of the close proximity of marine waters to the site and the long past and continued use of the site for heavy industrial purposes into the future, it is unlikely that groundwater beneath the site or the CPR lands containing their main rail line into Vancouver would be used for drinking water;*
- *The land use for those lands abutting the site to the east, south, and west are park or green space, residential areas, or roadway rights-of-way;*
- *All residential areas are south of the site and are significantly higher in elevation (upgradient);*
- *The residential areas are serviced by Municipal water supply and the aquifer below these areas is not classified as a drinking water aquifer;*

- *There are no current drinking water wells, points of diversion, or mapped aquifers within 500 m of the site;*
- *There is no indication of contaminant migration to the south from contaminated areas at the site; and*
- This exemption would be similar to *the DW exemptions granted by the MoE for Site 8071 in New Westminster and Site 8467 in Port Alberni.*

On the basis of the arguments and supporting information provided by SLR and AECOM, I concur with the conclusion that potential future use of the groundwater underlying the Site for drinking water is unlikely for the following reasons:

- Hydraulic response and pumping tests indicate that the bulk hydraulic conductivity of the alluvium, glacial till formation is less than $1x10^{-6}$ m/s.
- Hydraulic response tests conducted in wells within 1 km of the site indicate that the bulk hydraulic conductivity of the native bedrock is less than $1x10^{-6}$ m/s and a maximum calculated yield of 0.8 L/min.
- There are no mapped aquifers below the Site according to the Water Resource Atlas.
- There are no current drinking water uses within 500 m of the Site and Site drinking water is serviced by a municipality that is not sourced from groundwater.
- The Site is located approximately 30 m from the marine foreshore and Site groundwater discharges to the marine environment.
- The Site has a long history of heavy industrial use. The Site will continue for heavy industrial purposes into the future.

Therefore, I hereby determine that drinking water use does not apply at the Site. I also confirm that aquatic life water use (marine) does apply.

This decision is based on the most recent information available to the ministry regarding the above referenced site. The ministry, however, makes no representation or warranty as to the accuracy or completeness of this information.

Please contact Lavinia Zanini at 604-582-5348 (lavinia.zanini@gov.bc.ca) if you require clarification regarding this letter.

Sincerely,

Amy Sloma, P. Eng.
For Director, *Environmental Management Act*

Attachment: Figure 1

cc: Mike Gill, AECOM Canada Consulting
Lucy Hewlett, Ministry of Environment, Victoria
Catherine Schachtel, CSAP Society

Figure 1. Chevron Burnaby Refinery, Area 2 (blue)

Appendix E Field Program and Methods

The majority of monitoring wells included in the Perimeter Monitoring Program (PMP) are completed in low permeability, fine-grained formation material (e.g., sandy silt). Due to this material, groundwater recharge is typically slow, and samples are more likely to be turbid in comparison with monitoring wells constructed in coarse-grained materials. Excess suspended solids in groundwater samples may result in false positive detections of dissolved polycyclic aromatic hydrocarbons (PAHs), light and heavy extractable petroleum hydrocarbons in water (LEPHw/HEPHw) or extractable petroleum hydrocarbons in water ($EPHw_{C10-C19}$/$EPHw_{C19-C32}$). As a result, a selection of purging and sampling techniques is critical for the collection of high-quality, reliable groundwater analytical data. AECOM Canada Ltd. (AECOM) has developed site-specific field procedures and documentation requirements for the Parkland Refining (B.C.) Limited (Parkland) Burnaby Refinery PMP. The selected field methods are similar to the Ministry of Environment & Climate Change Strategy (BC ENV), formerly known as Ministry of Environment (MoE), British Columbia Field Sampling Manual (2013) and are consistent with AECOM protocols described in the following subsections.

MONITORING WELL PURGING METHOD

The method of groundwater purging and sampling is dependent upon the depth of groundwater table below the ground surface. For depths to groundwater less than 8 meters (m), purging and sampling were conducted using a peristaltic pump. For depths to groundwater greater than 8 m, purging was conducted using a dedicated bailer or Waterra™ tubing and foot valve. Prior to purging, the time of day and tide condition (for Area 3), monitoring well headspace vapour concentration levels, depth to water, and total depth of the monitoring well were recorded at each location. Field observations, field measurements, and other details related to monitoring, well purging, and sampling were recorded by AECOM field staff and presented in Tables A-1 and B-1.

Monitoring well headspace vapour concentration levels were measured using a photoionization detector (RKI Eagle) operated in methane elimination mode immediately after removing the cap from the monitoring well. Depth to water was measured using an oil/water interface meter, which was decontaminated with amended water[10] between monitoring wells to prevent cross contamination.

For monitoring wells where the groundwater table is within 8 m of the ground surface, water was pumped from the monitoring well at a low flow rate (i.e., up to 0.5 litres per minute [L/min]) using a peristaltic pump connected to a well-dedicated length of ¼-inch high/low-density polyethylene tubing. The intake of the tubing was placed in the middle of the screened section of the monitoring well to obtain representative samples and to minimize the disturbance and subsequent entrainment of silt located at the bottom of the monitoring well. During purging, field parameters including pH, temperature, electrical conductivity, total dissolved solids, salinity, oxidation redox potential, and dissolved oxygen were measured. Purging continued until field parameters stabilized and at least one well volume had been removed[11], or until the well was purged dry.

For monitoring wells where the groundwater table is greater than 8 m from the ground surface, purging was conducted using a dedicated bailer, or Waterra™ tubing equipped with a foot valve. While purging with a bailer/Waterra™, water is removed from near the top of the water column to minimize disturbance of potential sediment located at the bottom of the monitoring well; purging was conducted until at least three well volumes had been removed, or until the monitoring well was dry.

Regardless of the purging method, if the monitoring well was purged dry, it was left to recharge overnight and sampled directly thereafter without additional purging.

All purge water was disposed of as prescribed by current environmental regulations and Parkland Refinery protocols.

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[10] Amended water is a 0.5% solution of Liquinox and distilled water.

[11] Studies have demonstrated that when purging at low flow rates, formation water is accessed in less than three (3) well volumes, and frequently between one to two (1 to 2) well volumes (Puls, R.W. and Michael J. Barcelona 1996. Ground Water Issue: Low-Flow (Minimal Drawdown) Ground Water Sampling Procedures, USEPA, Washington, DC).

MONITORING WELL SAMPLING METHOD

When groundwater recharge was sufficient to purge and sample using a peristaltic pump, a lower flow rate (i.e., up to 0.5 L/min) was used to minimize entrainment of silt and losses of volatile constituents in the sample. When using a bailer, WaterraTM tubing, or when the well was purged/sampled dry, groundwater levels were allowed to recover enough to collect the remaining sample set.

Sample containers and preservatives are listed by chemical constituent to be analyzed, below:

1. $EPHw_{C10-C19}$/$EPHw_{C19-C32}$, LEPHw/HEPHw, and/or PAHs: two 250 millilitre (mL) amber glass bottles, no filtering, sodium bisulphate [$NaH(SO_4)$] preservative;
2. BTEX, VPHw, and/or MTBE: two 40 mL clear glass purge and trap vials, no filtering, and NaH(SO4) preservative; and
3. Dissolved metals: one 125mL plastic container, field filtering, and nitric acid (HNO3) preservative.

Sample containers were filled completely to minimize headspace within the sample bottles. When sampling for volatile petroleum hydrocarbons, the sampler used purge and trap vials to reduce the potential of having headspace present in the sample containers. All bottles were placed immediately in coolers containing icepacks and transported at the end of the day using Chain of Custody (COC) protocols to ALS Environmental (ALS) of Burnaby, BC. All samples were submitted, extracted, and analysed within the required holding time for each parameter. Groundwater samples from Areas 1 and 3 monitoring wells and Area 2 monitoring wells were submitted under separate COC forms.

POTENTIAL TIDAL EFFECTS

To minimize potential biases in groundwater data quality due to tidal effects, AECOM sampled the monitoring wells in Area 3 over the period of an out-going or ebb tide cycle. Based on the locations of the remaining perimeter monitoring wells and Site hydrogeology, the tidal effect on the remaining monitoring wells is understood to be negligible. Thus, tide conditions were not considered when monitoring and sampling wells outside Area 3.

ANALYTICAL TESTING PROGRAM

Based on the letter entitled, Chevron Refinery Well Monitoring Program, submitted to the MoE (now BC ENV) on October 31, 2003, samples are analyzed for EPHw, rather than LEPHw/HEPHw, for samples where historical reported EPHw concentrations are below the Contaminated Sites Regulation (CSR) standards for the protection of marine life aquatic life (AW). This allows for the collection of groundwater quality data necessary for the assessment of key contaminants of concern, while minimizing unnecessary data collection and budget expenditure. LEPHw/HEPHw analysis was performed where the potential contaminants of concern include PAHs or where historical EPHw concentrations approached or exceeded the CSR AW standards.

QUALITY ASSURANCE

To evaluate the accuracy and reproducibility of the groundwater sampling results, AECOM collected approximately one field duplicate per every ten samples. Each data set included at least one duplicate for every constituent analyzed, or where one constituent is analysed repeatedly, a number equal to approximately 10% of the total number of analyses.

Appendix F Laboratory Analytical Data (on USB located on the back cover of the report)

Appendix G Quality Assurance and Quality Control Protocols

DATA QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

In order to assure the integrity and defensibility of the data collected, rigorous QA/QC protocols were implemented for the collection, identification, storage, shipment and documentation of the samples. Standard operating procedures (SOPs) for sample collection and storage, equipment decontamination, and sample chain of custody protocols were followed. Groundwater samples were collected using sampling techniques presented in Appendix E. The use of these methods confirmed the quality, soundness, and defensibility of the data obtained. The laboratory analytical data, once generated, was also proofed for inconsistencies and anomalies. Field duplicates, trip blanks, and equipment blanks were collected for QA/QC purposes.

FIELD DUPLICATE SAMPLES

Field duplicate samples are two identical samples that are submitted to the laboratory with no indication that they are the same. The analysis of field duplicate samples provides an indication of the total precision of the sampling and analysis process. Field duplicate samples were collected and analyzed at a rate of approximately 10% of samples for a given analytical suite.

TRIP BLANKS

Trip blanks are samples of clean deionized and distilled (Reagent Grade Type II) water that are prepared in the laboratory, taken to the field, retained on Site throughout sample collection, returned to the laboratory, and analyzed with the environmental samples. The QA/QC review identifies trip blanks with detections of target analytes and evaluates the effect of the detections on associated sample results for possible cross-contamination during transport.

EQUIPMENT BLANKS

Equipment blanks are samples taken by pouring clean deionized and distilled (Reagent Grade Type II) water, prepared in the laboratory, over the surface of the decontaminated interface probe used during the program and into laboratory provided sample containers. The decontamination method used is the same as outlined in the SOP. These samples are transported and analyzed with the environmental samples to the laboratory. The QA/QC review identifies equipment blanks with detections of target analytes and evaluates the effect of the detections on associated sample results for possible cross-contamination due to equipment contamination.

ANALYTICAL DATA INTERPRETATION

To confirm the quality of the laboratory analytical data, precision, accuracy, and completeness were considered.

PRECISION

Precision measures the reproducibility of repetitive measurements and is usually expressed in terms of imprecision. It is strictly defined as the degree of mutual agreement among multiple independent measurements as the result of repeated application of the same process under similar conditions.

Analytical precision is a measurement of the variability associated with the duplicate (i.e., two) or replicate (i.e., more than two) analyses of the same sample in the laboratory, and is determined by the analysis of matrix spike (MS) duplicate or laboratory duplicate samples.

Total precision is a measurement of the variability associated with the entire sampling and analysis process. It is determined by the analysis of duplicate or replicate field samples and incorporates any variability introduced by the analytical procedure, sample collection and handling procedures, and matrix factors. Precision data must be interpreted by taking into consideration these possible sources of variability.

Duplicate field samples were collected, and duplicate spiked or unspiked samples were analyzed to assess analytical precision. The results were assessed using the relative percent difference (RPD) between duplicate measurements. The equation used to calculate RPD for duplicate samples is:

$$RPD = \frac{(A - B)}{(\frac{A + B}{2}} * 100\%$$

where:

A = analytical result

B = duplicate result

Note that for RPDs the result can be a positive or a negative value. RPDs are often presented as absolute RPDs, in which case the absolute value of the RPD is reported, always resulting in a positive number. Reporting the absolute RPD results in a reduction in information, since, for instance, if a duplicate sample consistently returned higher results than the original sample, all RPD values would be negative and it may be an indication of a precision problem. In this case, if absolute RPD was reported, no indication would be forthcoming.

Total precision was determined by collecting field duplicate samples. These samples were collected and analyzed at a rate of approximately 10% of total samples for each analytical suite.

Analytical precision will be determined in the laboratory by running matrix spike/matrix spike duplicate (MS/MSD) pairs, or by running laboratory duplicate analyses. These samples will be analyzed at a rate of approximately 5% for each analytical suite.

ACCURACY

Accuracy is a statistical measurement of correctness and includes components of random error (e.g., variability due to imprecision) and systematic error (e.g., bias). Therefore, accuracy reflects the total error associated with a measurement. A measurement is accurate when the reported value does not differ beyond acceptable limits from the true value or known concentration of the spike or standard. Acceptance criteria are indicated in the individual standardized analytical methods.

Analytical accuracy is typically measured by determining the percent recovery of known target analytes that are spiked into a field sample (i.e., a surrogate or matrix spike), or reagent water (i.e., laboratory control sample [LCS] or blank spike) before extraction at known concentrations. Percent recovery (% REC) is calculated as:

$$\%\ REC = \frac{A}{B} * 100\%$$

where:

A = obtained value

B = true value

Analytical accuracy was determined in the laboratory by running MS samples or laboratory control samples. These samples were analyzed at a minimum rate of 5% for each analytical suite.

COMPLETENESS

Completeness for this investigation was defined as the percentage of valid analytical results. Results made uncertain due to missed hold times, improper calibration, blank contamination, or poor calibration verification results would be deemed invalid. Results that may be flagged due to matrix effects are not considered invalid. Completeness for projects should exceed 90%. Completeness is calculated by:

$$Completeness = \frac{A}{B} * 100\%$$

where:

A = number of valid analytical results

B = total number of analytical results