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Public Review Draft
Cleanup Action Plan

Former Circle K Site,
Washington

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Prepared for

Washington State
Department of Ecology
Toxics Cleanup Program
3190 160th Avenue SE
Bellevue, Washington 98008-5452

K/J Project No. 1696010.00

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Section 1: Introduction

This draft Cleanup Action Plan (dCAP) describes the proposed remedial action for petroleum hydrocarbons in soil and groundwater at the Former Circle K Station #1461 located at 2350 24th Avenue East in Seattle, King County, Washington (site) (see Figure 1). This dCAP addresses the requirements of the Model Toxics Control Act (MTCA) regulations under Washington Administrative Code (WAC) 173-340 (Ecology 2007). A CAP is a decision document issued by the Washington State Department of Ecology (Ecology) that describes the cleanup standards for a site, the method(s) of cleanup that will be used to achieve these cleanup standards, any other requirements the cleanup must comply with, and the rational for these decisions. WAC 173-340-380 in the MTCA regulation describes the required elements of a CAP.

Site and Project Contact Information

Site and project contact information are summarized below:

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1.1 Purpose of Cleanup Action Plan

As indicated above, the purpose of this report is to satisfy the requirements of WAC 173-340-380. In compliance with these requirements, this dCAP:

- Describes the site.
- Summarizes current site conditions.
- Summarizes the cleanup action alternatives considered in the remedy selection process.
- Describes the selected cleanup action for the site and the rational for selecting this alternative.
- Identifies site-specific cleanup levels and points of compliance for each hazardous substance and medium of concern for the proposed cleanup action.

- Identifies applicable state and federal laws for the proposed cleanup action.
- Identifies residual contamination remaining on the site after cleanup and restrictions on future uses and activities at the site to ensure continued protection of human health and the environment.
- Discusses compliance monitoring requirements.
- Presents the schedule for implementing the CAP.

The draft Remedial Investigation/Feasibility Study (RI/FS, Kennedy/Jenks Consultants 2017a) provides details of site investigation and remediation activities completed to date and a feasibility study, and is the basis for this dCAP.

1.2 Site History and Description

The site is located on the southeastern corner of the intersection of 24th Avenue East and East McGraw Street and is a former Circle K gasoline service station that operated from 1968 to 1990. Four underground gasoline storage tanks (USTs), one pump island, one waste oil UST, and one heating oil UST were located at the site. Historical site features are shown on Figure 2. The site was redeveloped in 1990 and 1991 and two businesses currently operate at the site including a general store (Mont's Market) and a dry cleaner (Jay's Cleaners).

The site is located on Tax Parcel 6788201335 and is zoned for commercial use. According to the King County Department of Assessments, the tax parcel is currently owned by Mr. Kuk Jin Choung and Kathy-Kyung D. Choung. The legal description of the parcel is:

PIKES 2ND ADD TO UNION CITY 1 & 2 LESS E 6 FT; PLAT BLOCK 29, PLAT LOT 1-2

Jay's Cleaners is operated by the Choung family. The Mont's Market space is owned by the Choung family but is leased out and operated by another party.

The site is located in an approximately two-block long commercial area within the Montlake neighborhood of the City of Seattle (City), a primarily residential neighborhood. To the west of the site, 24th Avenue East is a major north-south arterial that is on a King County Transit hybrid-electric bus route. Nearby properties include a public library to the northwest, several restaurants to the south, an antique store to the west, and residential properties to the north and east. An elementary school is located one block west of the site. The Washington Park Arboretum, a 230-acre preserve, is located approximately 700 feet to the east of the site.

The closest water bodies to the site are Portage Bay, approximately 2,100 feet to the northwest; the Montlake Cut, approximately 2,500 feet to the north; and Duck Bay, approximately 1,500 feet to the northeast. Duck Bay is connected to Union Bay, and Union Bay and Portage Bay are connected via the manmade Montlake Cut.

The site and the surrounding area to the east are relatively flat and slopes gently to the east towards the Washington Park Arboretum and Duck Bay. The topography rises immediately west of the site, across 24th Avenue East, where a small hill is present.

According to site maps and Geographic Information System (GIS) information obtained from the City, several underground utility corridors are present near the site (see Figure 2). Seattle Public Utilities (SPU) owns and operates 12-inch and 8-inch-diameter cast iron water distribution mains that run along the eastern side of 24th Avenue East and the northern side of East McGraw Street, as well as an 8-inch-diameter concrete sewer main located just to the north of the site along the center of East McGraw Street. King County owns and operates a 90-inch-diameter reinforced concrete sewer mainline that runs along the center of 24th Avenue East. The King County sewer main flows to the north and the SPU sewer main flows to the east, both by gravity. The site's sanitary sewer is connected to the SPU main along East McGraw Street. According to GeoEngineers (1990), the SPU sewer main is located approximately 12 feet below grade.

1.3 Site Discovery and Initial Remedial and Investigation Activities

In 1989, a leak was discovered in one of the four onsite gasoline USTs. It was estimated that approximately 4,000 to 6,000 gallons of gasoline were released to the subsurface. Following the discovery of the release, all six onsite USTs and the pump island were removed. In addition, approximately 900 cubic yards (cy) of petroleum hydrocarbon-containing soil (PCS) were excavated and removed from the site. Additional remedial and investigation activities were conducted between 1989 and 2006 including 1) Construction and sampling of 16 groundwater monitoring wells, 2) free product [also referred to as light non-aqueous phase liquid (LNAPL)] recovery, 3) groundwater extraction and treatment, 4) soil vapor extraction (SVE), and 5) enhanced fluid recovery (EFR).

1.4 Regulatory Framework

In February 1992, the property owner entered into Consent Decree No. 92-2-08095-8 with Ecology to begin investigation and remediation of petroleum contamination at the site.

In 1994, Ecology conducted a site Hazard Assessment (SHA) for the site. The site ranked 3 out of 5, with 1 being the highest risk and 5 being the lowest risk (Ecology 1994).

A health investigation of the site was reportedly conducted by the Washington State Department of Health in 1995, though the actual investigation report was not available for review in Ecology's files. The health department noted that while the site had a potential impact to public health, it was not of immediate concern due to the lack of any complete human exposure pathways (Washington State Department of Health 1995).

The site has been assigned the following Cleanup Identifications by Ecology:

- Facility Site Identification Number (FSID): 2322
- Cleanup Site Identification Number (CSID): 5089

1.5 Recent Remedial Investigation Activities

In October 2009, Ecology prepared a draft RI/FS report (Ecology 2009) based on the findings of previous investigative activities performed at the site. Kennedy/Jenks Consultants conducted a review of the 2009 report and other previous reports and documents and summarized the information in a Technical Memorandum (Kennedy/Jenks Consultants 2016a), which was submitted to Ecology. To address the data gaps identified in the Technical Memorandum, Kennedy/Jenks Consultants prepared the *Remedial Investigation Sampling and Analysis Work Plan, Former Circle K Site, 2350 24th Avenue East, Seattle, Washington* (Kennedy/Jenks Consultants 2016b) (RI SAP).

Upon Ecology's approval of the RI SAP, additional RI activities were initiated in April 2016. These activities included:

- Collection and laboratory analyses of groundwater samples from accessible monitoring wells in April and December 2016.
- Advancing of 16 direct-push soil borings (KJB-1 through KJB-16) for soil and reconnaissance groundwater sample collection and analyses.
- Drilling and construction of three groundwater monitoring wells (MW-17, MW-18, and MW-19) and nine multi-purpose remediation wells (MW-20, MW-21, and RW-1 through RW-7). Soil samples were collected for laboratory analysis from the monitoring well borings and selected multi-purpose well borings.

Figure 3 shows additional RI and previous investigation soil boring and groundwater monitoring/multi-purpose remediation well locations.

1.5.1 2017 Bioremediation Pilot Study

To provide field treatability study data/information to support the evaluation of remedial alternatives, a bioremediation pilot test was conducted at the site to assess the effectiveness of enhancing biodegradation of dissolved petroleum hydrocarbons in groundwater. The pilot test was conducted in general accordance with the *Pilot Study Work Plan* (Kennedy/Jenks Consultants 2017b) submitted to Ecology on 4 February 2017.

The 7-day bioremediation pilot test was performed in March 2017 by ETEC Environmental Technologies, LLC, of Washougal, Washington, using eight of the monitoring and multi-purpose wells (MW-19, MW-20, MW-21, RW-2, RW-3, RW-4, RW-5, and RW-7). The pilot test involved extraction of groundwater from the onsite monitoring/multi-purpose remediation wells and injection of solutions (surfactants and amendments prepared aboveground using this extracted groundwater and potable water) back into the onsite wells. The objective of the injection and extraction process was to establish a recirculation system onsite to effectively distribute bio-augmentation products to hydrocarbon impacted areas. The pilot study included the following steps: (1) extracting groundwater from selected onsite wells, (2) mixing the extracted groundwater and tap water with surfactant, (3) injecting approximately 4,500 gallons of the surfactant solution into the subsurface, and (4) injecting approximately 3,120 gallons of bio-

augmentation nutrient solution (consisting of extracted groundwater, macronutrients, and a bacterial consortium) into the subsurface.

The pilot study demonstrated that, although site hydraulic conditions are not ideal, a groundwater recirculation system could be effectively established to support implementation of a bioremediation system. The following observations were made during the pilot study:

- Injection pressures for amendment injections ranged from less than 1 to 8 pounds per square inch (psi) with an average injection rate of approximately 1.3 gallons per minute (gpm) per well.

- Surfactant solution was observed in extraction well RW-3, located approximately 12 feet away from injection well RW-2, after approximately 800 gallons of groundwater were extracted (from RW-3) and approximately 700 gallons of surfactant solution were injected over a time period of approximately 1 day. Surfactant solution was observed in extraction well RW-4, located equidistant and approximately 20 feet away from injection wells RW-2 and MW-21, after approximately 1,200 gallons of groundwater were extracted (from RW-4) and after the total volume of 4,500 gallons of surfactant solution was injected and approximately 3 days after the injection was initiated. Based on these observations, the permeability of the saturated zone is conducive to accepting solution injections.

- Extraction flow rates ranged from 0.2 to 0.3 gpm per well throughout the pilot study.

- Extraction well pumping cycles were adjusted during the initial portion of the pilot test to allow for sufficient recharge between cycles and avoid dry pump operation.

Groundwater monitoring was performed at multiple monitoring and extraction wells used during the pilot study in May 2017, approximately 2 months following the pilot study. A preliminary evaluation of these data indicate that in general, constituent concentrations decreased on the western side of the site and increased or were consistent with previous results in the central portion of the site. Constituent concentrations would be expected to increase with the addition of surfactant and is an indication that the solution was distributed through the saturated zone during and following the pilot study.

Section 2: Site Characterization

This section includes a brief description of the site geology and hydrogeology, a summary of the nature and extent of site contamination, and applicable points of compliance and cleanup levels. The RI/FS (Kennedy/Jenks Consultants 2017a) presents a more comprehensive description of this information.

2.1 Geology and Hydrogeology

Based on a review of boring logs generated during the RI activities conducted in 2016/2017 and previous investigations (primarily from GeoEngineers 1990), three generalized stratigraphic units are identified at the site, as summarized below:

- Silt – Typically encountered from the ground surface (i.e., beneath pavement and subgrade fill) to depths of approximately 2 to 8 feet bgs, but extends to greater depth (up to approximately 13 feet bgs) in the northern portion of the site. The unit is generally described as soft to stiff, brown to gray, silt to sandy silt, locally with gravel and/or organics.

- Sand/silt – Typically encountered below the silt layer to depths of approximately 17 to 22 feet bgs, and typically described as gray to brown, fine sand, silty fine sand, or sandy silt locally containing cobbles. The unit is described as loose, medium dense, dense, and very dense with vertical and lateral variation. This unit may locally include the uppermost, possibly weathered, portion of the underlying glacial till unit.

- Till – Typically encountered below the sand/silt starting at approximately 17 to 22 feet bgs and generally described as gray silt, silty sand, or sandy silt with sand and gravel. The till unit is typically described as dense to very dense, hard to very hard, or stiff to very stiff, as indicated during drilling by increased drilling pressure and significant increases in blow counts required to drive split-spoon soil samplers.

None of the site monitoring/multi-purpose remediation wells or soil borings has been advanced through the till unit; however, a well installed by Landau Associates near site well MW-4 in 2013 (Landau 2013) was advanced to approximately 90 feet bgs (the well was part of an investigation for a separate site, Montlake Neighborhood Former Dry Cleaner, located west of the Former Circle K site). The log for the 2013 Landau well (designated MW-3, see Figure 4) shows the upper contact with the till at 18 feet bgs, dense (unweathered) till at 30 feet bgs, and gray fine to medium sand beneath (or possibly interbedded with) the till from approximately 80 to 90 feet bgs.

The depth to shallow groundwater at the site ranges from 3 to 12 feet bgs, based on water levels measured from April to December 2016. This zone of shallow groundwater appears to be perched on top of the Till unit. Although a seasonal water table fluctuation of a foot or less was generally observed near the former UST area during the April and December 2016 monitoring event, a fluctuation nearly 6 feet was recorded at northernmost monitoring well MW-11. It should be noted that site wells MW-17 through MW-21 were completed in August and September 2016 and were therefore, were only included in the December 2016 monitoring event.

Previous reports have indicated that the hydraulic gradient and presumed direction of groundwater flow is towards the northeast and that while the onsite recovery system was operating in from 1989 to 2000, a stable cone of depression was located near the recovery well. Following shutdown of the recovery system, water levels measured in August 2006 (EA Engineering 2006) suggest that the groundwater flow direction was generally southeast, towards the former UST area, on the northern portion of the site. No monitoring wells were present on the southern portion of the site in 2006. Deeper groundwater units are not expected to be impacted by the gasoline release at this site, and have not been evaluated as part of the site investigation activities.

2.2 Nature and Extent of Impacted Soil

Gasoline-range organics (GRO) and benzene are the primary contaminants of concern (COCs) in soil at the site. Figure 3 shows GRO and benzene concentrations detected in soil, as well as the estimated lateral extent of the area in which GRO and benzene concentrations exceed Ecology's Model Toxics Control Act (MTCA) Method A clean up levels for unrestricted land use (soil CULs). The soil CULs for GRO and benzene are 30 mg/kg and 0.03 mg/kg, respectively. In addition to benzene the other aromatic gasoline constituents, toluene, ethylbenzene, and xylenes were also detected above MTCA Method A CULs in soil. Based on analytical results and field observations, the vertical extent of GRO concentrations exceeding the soil CUL appear to be generally limited to the zone from 8 to 20 feet bgs. The lateral and vertical extents of benzene, toluene, ethylbenzene, and xylenes concentrations that exceed the soil CUL appear to be coincided with the distribution of GRO; therefore, targeting the zone in which GRO concentrations exceed soil CULs for remediation will also address cleanup of the aromatic gasoline constituents.

2.3 Nature and Extent of Impacted Groundwater

GRO and benzene are also the primary COCs in groundwater at the site. In general, benzene concentrations exceed the groundwater CUL in the same locations as the GRO concentrations. Figure 4 shows the estimated lateral extent of the area in which GRO and benzene concentrations in groundwater exceed Ecology's MTCA Method A clean up levels (groundwater CULs). The groundwater CULs for GRO and benzene are 800 micrograms per liter (µg/L) and 5 µg/L, respectively. None of the fuel additives (1,2-dichloroethane, 1,2-dibromoethane, and Methyl tert butyl ether) were detected in the monitoring well groundwater samples analyzed for these compounds (samples collected from wells MW-20 and MW-21). No LNAPL was observed in any of the monitoring wells during either the April or December 2016 monitoring events.

Although residual concentrations of COCs are high, the recent groundwater monitoring results indicate that the dissolved petroleum hydrocarbon plume at the site is either stable or potentially diminishing in size. Source remediation and ongoing processes that have contributed to mitigating the spread of dissolved petroleum hydrocarbon concentrations in groundwater include:

- Removal of the USTs in 1989, including excavation of petroleum contaminated soil.
- Past remedial efforts including groundwater extraction, operation of the SVE system, and LNAPL recovery.

- Natural attenuation processes such as biodegradation, dispersion, dilution, sorption and volatilization.

2.4 Vapor Intrusion Assessment

Kennedy/Jenks Consultants conducted an initial (Tier 1) assessment of the potential for vapor intrusion (VI) into the main site structure and adjacent residences following the methods described in the EPA's *Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites* (EPA 2015). The results of the Tier 1 assessment are presented in the RI/FS (Kennedy/Jenks Consultants 2017a) and are summarized as follows:

- The occupied on-property commercial structure is within the lateral VI inclusion zone based on the maximum benzene, toluene, and xylene concentrations detected in groundwater near the building.

- Although groundwater at the site is typically encountered about 10 feet bgs adjacent to the building, exceeding EPA's vertical groundwater separation distance criterion of 6 feet for bio-attenuation of petroleum hydrocarbons, the presence of underground utilities could provide a preferential pathway(s) for soil vapors to enter the onsite building. Consequently, the VI pathway into the onsite structure is considered potentially complete pending further characterization of preferential vapor pathways.

- The potential for VI into nearby residential structures appears to be very low based upon the separation distance of the soil and groundwater contamination to such structures; however, in the absence of additional sampling at the residential properties to confirm subsurface conditions, the VI pathway for off-property residential areas must be regarded as potentially complete.

[Note: In addition to possible VI conduits, potentially explosive conditions could be created within sewer lines if substantial concentrations of gasoline vapors from proximal contaminated soil and groundwater were to accumulate.]

2.4.1 Points of Compliance

The points of compliance, based on the potential chemical exposure routes, are those points where cleanup levels established for the site shall be achieved.

The points of compliance for site media were established as follows:

- **Soil**: Based on WAC 173-340-740, the point of compliance for soil is as follows:
  - Throughout the site for protection of groundwater.
  - From the ground surface to the depth of shallow groundwater for possible VI.
  - From the ground surface to a depth of 15 feet below grade for protection of humans based on direct contact.

- **Groundwater**: In accordance with WAC 173-340-720(8), throughout the site from the uppermost saturated zone to the lowest depth potentially affected by site contaminants. [Note: This is regarded as a conservative approach, as no potable water supply wells were identified within a 0.25-mile radius of the site, based on a search of the Ecology Well Log database.]

- **Air**: In accordance with WAC 174-340-750 (6), in ambient air throughout the site.

2.5 Conceptual Site Exposure Model

A conceptual site exposure model (CSEM) was developed in the RI/FS based on the findings of recent and historical remedial investigation and remedial action activities. The CSEM is summarized below and is presented graphically on Figure 5.

The primary source of the COCs is the former USTs located on the northern end of the site. The USTs were removed in 1990. The primary release mechanism is considered to be a release of approximately 4,000 to 6,000 gallons of gasoline from the USTs discovered in 1989. Soil and groundwater impacted by the gasoline release are secondary sources.

Contaminant transport appears to have been mainly limited by (1) the volume of the gasoline released, (2) the relatively slow groundwater seepage velocities inferred for the site based on the saturated media and hydraulic gradients, and (3) natural attenuation processes. As previously discussed**,** the onsite groundwater gradient and flow direction are variable with a slight gradient to the north/northeast towards monitoring well MW-4. To the north and west of the site, there appears to be a stronger hydraulic gradient primarily to the south and southeast, respectively, generally towards the site. Groundwater movement may be influenced by recharge from the south (generally upgradient), preferential flow along utility corridors, and altered flow in the vicinity of the former UST excavation area where gravel was used for backfill material. Spreading of the gasoline dissolved-phase hydrocarbon (and possibly LNAPL) after the release along with advection and dispersion of dissolved petroleum hydrocarbons in groundwater appear to be the major transport mechanism for COCs.

Potential transport processes between sources and exposure media may include (but are not limited to) the following:

- Direct release to media.

- Leaching from soil to groundwater in water-bearing zones.

- Partitioning of dissolved volatile COCs in groundwater into soil vapor.

- Vertical vapor movement through the soil column (e.g., infiltration into buildings/indoor air) from impacted soil and groundwater.

Potential exposure pathways for the site include direct contact for soil and groundwater, leaching (soil to groundwater), and VI to receptors in the onsite structure. Potential exposure pathways are shown on Figure 5 and identified below.

- Soil direct contact and/or ingestion for construction and utility workers.
- Groundwater direct contact and/or ingestion by construction and utility workers.
- Vapor inhalation by construction and utility workers.
- VI into the on-property and off property buildings by occupants and visitors.

A search of water wells within a 0.25-mile radius of the site was conducted using Ecology's Well Log database and no water wells were identified in the search. City water supplies are available in this area of the site; consequently, consumption of groundwater is not classified as a reasonably potentially complete exposure pathway.

Section 3: Proposed Cleanup Action

3.1 Cleanup Standards

This section (1) identifies the COCs to be addressed by the cleanup and (2) describes the cleanup levels for the environmental media that need to be addressed by the cleanup and the basis for these levels. The objective of the cleanup action is to reduce potential risks to human health and the environment. Because the Site is zoned as "Neighborhood-Commercial", the proposed soil cleanup standards must be protective of unrestricted land use.

The COCs for soil and groundwater are GRO and the aromatic gasoline constituents including benzene, toluene, ethylbenzene, and xylene (BTEX). The COC for potential VI are benzene, toluene, and xylene.

Specific risk-based cleanup objectives include:

- Reduce the potential for human contact with soil and groundwater containing COCs at concentrations that exceed the selected cleanup levels.
- Protect groundwater quality by addressing the source of hydrocarbons to the extent required to limit their mobility in the environment.
- Prevent VI into nearby residential homes and commercial workspaces.

The proposed cleanup levels include:

- **Soil:** MTCA Method A soil CULs for unrestricted land use based on WAC 173-340-740 and/or obtained from Ecology's CLARC database. For those compounds where MTCA Method A levels may not be available, soil cleanup levels will be based on MTCA Method B values.
- **Groundwater:** MTCA Method A groundwater CULs for fuel components (GRO and BTEX constituents) based on WAC 173-340-740 and/or obtained from Ecology's CLARC database. For those compounds where MTCA Method A levels may not be available, groundwater cleanup levels will be based on MTCA Method B values.
- **Vapor Intrusion:** CULs will be based on MTCA Method B groundwater screening levels for the vapor intrusion pathway obtained from Ecology's CLARC database.

The proposed CULs are presented in Table 1. MTCA Method A or Method B (when a Method A CUL is not available) CULs for unrestricted land uses are proposed as part of the cleanup standards for this site. These standards are protective of human exposure via direct contact pathway and are protective of groundwater and surface water.

Groundwater CULs selected for the site are based on a combination of MTCA Method A groundwater for fuel components (GRO and BTEX). MTCA Method A groundwater CULs for

GRO and BTEX were selected for fuel components because they are the most applicable and protective standards for gasoline-range hydrocarbon compounds (including BTEX).

3.2 Applicable and Relevant and Appropriate Requirements

Action-specific Applicable and Relevant and Appropriate Requirements (ARARs) for the cleanup action are presented in Table 2.

3.3 Selected Remedial Alternative

The RI/FS report (Kennedy/Jenks Consultants 2017a) presented five remedial alternatives to address petroleum hydrocarbon contamination at the site and evaluated these alternatives using the requirements and expectations established in MTCA (WAC 173-340-360).

The preferred remedial action for the site includes a combination Alternative 5 (*In Situ* Bioremediation) to address impacted site saturated soil and groundwater and Alternative 2 [Soil Vapor Extraction (SVE)] to enhance remediation of the vadose zone and mitigate potential VI. Of the alternatives evaluated, Alternative 5 provides the shortest estimated timeframe for completion and the highest potential to permanently attain soil and groundwater cleanup levels. However, Alternative 5 would not fully address the unsaturated zone and may not mitigate the VI pathway. The combination of Alternative 5 and Alternative 2 is the most projective of human health and the environment and best addresses the remedial action objectives. The proposed components of *in situ* bioremediation and SVE systems are shown on Figures 6 and 7, respectively.

Alternative 5 involves injection of a low-concentration surfactant solution followed by injection and recirculation of a combination of extracted groundwater and amendments (i.e., a cultured bacteria consortium and macronutrients) into the target cleanup area to stimulate biodegradation of GRO and BTEX in the saturated zone (including smear zone soils). Following desorption from the soil matrix, the petroleum hydrocarbons are mobilized by the surfactant solution in groundwater and drawn toward the recirculation system extraction wells where groundwater brought to the surface is treated with granular activated carbon (GAC), mixed with amendments and injected back into the subsurface to enhance biodegradation. With full implementation (including installation of a semi-permanent system), Alternative 5 is expected to be effective in reducing petroleum hydrocarbon concentrations in the target treatment zone saturated soil and groundwater to below CULs. Groundwater monitoring will be performed to assess the effectiveness of the bioremediation and to evaluate groundwater quality for compliance with cleanup standards.

Alterative 2 involves the construction of several onsite SVE wells and connection of these wells to subsurface piping connected to aboveground blower/vapor treatment equipment. The system will be operated until evaluation of extracted vapor monitoring results indicates that the concentration of volatile petroleum hydrocarbon in soil gas has decline appreciably and the VI pathway is ln longer potentially complete exposure pathway. After initial operation of the SVE system and removal of adequate volatile petroleum hydrocarbons from soil that could partition into soil vapor, further operation of SVE system may be periodic (i.e., pulsed) to help optimize its performance. Due to the urban and residential nature of the surrounding area, it is anticipated that treatment of extracted soil vapor (vapor phase GAC) will be required prior to

atmospheric discharge. Specific extracted soil vapor treatment and discharge requirements will be determined during the design/permitting process.

Section 4: Cleanup Action Rationale

The selected cleanup action will be designed to accomplish the following:

Protect Human Health and the Environment - SVE provides petroleum hydrocarbon mass removal from the unsaturated zone (prevents leaching to groundwater) and mitigates potential migration of vapor phase petroleum hydrocarbons into on-property and surrounding structures. Bioremediation degrades to byproducts petroleum hydrocarbon mass within the smear/saturated zone reducing the partitioning of volatile petroleum hydrocarbon constituents into soil gas and decreasing dissolved phase hydrocarbon contamination to below groundwater CULs. The existing asphalt pavement cover and possibly a future deed restriction (if needed) would prevent direct human contact with impacted media.

Comply with Cleanup Standards per WAC 173-340-700 through 760 – The combination of *in situ* bioremediation and SVE will be designed to achieve CULs throughout the site for soil, groundwater, and air as identified in Section 3.

Comply with Applicable State and Federal Laws per WAC 173-340-710 – The cleanup action will comply with relevant laws and requirements as required in WAC 173-340-710. A temporary deed restriction may be required while the cleanup is being implemented to prevent potential human exposure to contaminants during any necessary onsite excavation or subgrade utility work.

Provide Compliance Monitoring per WAC 173-340-410 – To assess treatment effectiveness and progress to cleanup goals, quarterly groundwater confirmation monitoring will be conducted until cleanup standards are met. Groundwater sample analysis will include GRO, BTEX, and natural attenuation parameters. Extracted soil vapors will be monitored using field instruments and periodic laboratory analyses to assess the effectiveness of the SVE system in attaining cleanup goals and to assess the effectiveness of the vapor treatment equipment.

Use Permanent Solutions to the Maximum Extent Practicable per WAC 173-340-360(3) – MTCA defines a permanent solution as a cleanup action in which cleanup standards of WAC 173-340-700 through 173-340-760 can be met without further action being required at the site, or any other site involved with the cleanup action, other than the approved disposal of any residue from the treatment of hazardous substances (WAC 173-340-200). The selected cleanup action is considered permanent according to this definition. [Note: Even if GAC containing the adsorbed petroleum hydrocarbons from the SVE system are shipped offsite for management, it is anticipated that the GAC will be regenerated using a processed that destroys the desorbed petroleum hydrocarbons.]

Long-Term Effectiveness – Long-term effectiveness [WAC 173-340-360(3)(iv)] is measured in terms of the magnitude of residual risk and the adequacy and reliability of the cleanup action. Contaminant mass removal will be accomplished through long-term operation of *in situ* bioremediation and SVE systems, thereby reducing the residual risk to acceptable levels.

Confirmational monitoring will be used to demonstrate the long-term effectiveness of the cleanup action.

Short-Term Effectiveness – Short-term effectiveness [WAC 173-340-360(3)(v)] considers how the cleanup action will affect human health and the environment during implementation and prior to achievement of cleanup standards. The cleanup action will involve drilling and trenching that will disrupt PCS and create the potential for producing fugitive dust and/or organic vapors. Risks will be present for construction workers due to potential contact with petroleum-affected media during installation of multi-purpose remediation wells, and remediation system piping and electrical conduits. All unacceptable risks of this nature will be mitigated through the implementation of proper construction procedures including the use of personal protective equipment and dust control measures.

For SVE, it is estimated that soil CULs will be attained within 10 years (likely sooner). SVE alone will not fully address impacted groundwater. It is estimated that soil and groundwater CULs will be attained within approximately 3 to 5 years with full implementation of an *in situ* bioremediation system. Short-term risk during the operation and maintenance (O&M) of the remediation systems will be mitigated through the implementation of a site-specific health and safety plan.

Ability to be Implemented – Implementation of the selected cleanup action involves conventional technologies that have a demonstrated track record. Adequate offsite facilities, services, and materials are available to implement the selected cleanup action. Cleanup actions related construction activities would be easier to perform during the dry weather; however, with some extra effort, they can be conducted during rainy weather. The installation of the remediation systems will require management of onsite traffic to maintain access to the operating businesses.

Cleanup Cost – Of the five remedial alternatives evaluated, the estimated cleanup cost for Alternative 2 (SVE) was the lowest and Alternative 5 (*in situ* bioremediation) was the next to highest (Kennedy/Jenks Consultants 2017a) and considerably lower that Alternative 1 (excavation and offsite disposal). However, if design, construction, and operation of the both the SVE and *in situ* bioremediation systems are implemented simultaneously, cost efficiencies may be realized. Consequently, the overall costs of construction of the combined alternatives should be less than is estimated for the individual systems.

Consideration of Public Concerns – This CAP will be provided to the public for a 30-day comment period. Ecology will consider public comments received and prepare a summary of responses.

Section 5: Cleanup Action Work Elements

5.1 Engineering Plans and Specifications Preparation

Engineering plans and specifications will be prepared during a remedial design phase to provide details adequate to support the implementation of the cleanup action and to serve as a basis for contractor bidding. The remediation work will be bid in accordance with Ecology's current contractor procurement process.

5.2 Permitting and Public Notice

Ecology will coordinate with relevant federal, state, and local agencies regarding permits needed for the cleanup action. In most cases, Ecology is not required to obtain permits, but will need to meet the substantive requirements of the permits.

Public notice and participation will be provided in accordance with WAC 173-340-600. The CAP will be available for public review and comment. The comment period will be a minimum of 30 days, and a public meeting will be held upon a request by 10 or more persons.

5.3 Construction Mobilization

The following activities are projected to be part of the construction mobilization:

- Prepare plans, including Health and Safety Plan, Remedial Action Work Plan, City of Seattle construction permits, Puget Sound Clean Air Agency air discharge permit, traffic control plan, etc., and waste profiling and designation.
- Provide notifications to property owner and place signs at the site announcing the planned construction activities for the community.
- Mobilize equipment and materials to the site. Install temporary construction fencing as necessary to prevent access to work areas while maintaining access to the businesses operating onsite.

5.4 Phases of Work

A project construction sequence has been prepared to present the phases of work involved in implementing the selected cleanup action. These phases are summarized as follows:

- Phase 1 – Drill and complete additional multi-purpose and SVE wells.
- Phase 2 – Construct the SVE and *in situ* bioremediation systems, including trenching and installation of vaults, piping, and electrical conduits; construction excavation backfilling and resurfacing; and installation of bioremediation and SVE system aboveground equipment inside of an onsite shelter.

- Phase 3 – Testing and startup of both systems. This includes confirmational and performance monitoring, as required, including:
    - Tests to confirm the zones of influence of SVE wells and the influence of variable extraction rates on zones of influence.
    - Pumping and injection tests to confirm the extent of groundwater mounding and depression resulting from operation of the multi-purpose vertical remediation wells and horizontal remediation wells.
    - Design and implementation of monitoring programs to confirm the subsurface responses to operation of the SVE and groundwater injection/extraction systems, including:
        - Observation of perimeter monitoring wells and probes to assess conditions at the property lines.
        - Testing of geochemical indicator parameters to assess effectiveness of the groundwater remediation system.

Section 6: Compliance Monitoring

A Compliance Monitoring Plan (CMP) as specified in WAC 173-340-410 will be prepared as part of the remedial design phase. A Sampling and Analysis Plan (SAP) meeting the requirements of WAC 173-340-820 will be included in the CMP. The SAP will identify soil, groundwater, and extracted soil vapor sampling frequencies and analytical tests to be performed during cleanup activities (protection monitoring) and for the duration of the compliance period (confirmational monitoring).

6.1 Protection Monitoring

Health and safety measures are required for those individuals working at and visiting the site who may reasonably be expected to come into contact with contaminants (1) during clean up action construction or (2) during operation of the remediation systems (e.g., contaminants extracted and brought to the surface by the bioremediation and SVE systems). The construction contractor will prepare a site Health and Safety Plan. Health and safety measures, including any protection monitoring necessary during construction activities, will be described in the Health and Safety Plan. A separate Health and Safety Plan will be prepared for use during remediation system O&M activities.

6.2 Performance Monitoring

Performance monitoring will be conducted at system startup and periodically during long-term O&M.

SVE system sampling and chemical analyses will be performed to estimate contaminant mass removal, assess treatment performance (including verifying vapor mitigation), and satisfy air discharge requirements.

Bioremediation system sampling and chemical analyses will be performed to estimate contaminant mass reduction and assess bioremediation system performance.

Quality assurance/quality control (QA/QC) samples will be collected and analyzed during O&M activities and evaluated for conformance with the data quality objectives (DQOs).

6.3 Confirmation Monitoring

The CMP will identify the specific requirements for future groundwater monitoring activities at the site. Monitoring well locations, sampling methods, analyses to be performed and sampling frequency will be identified in the CMP. At a minimum, groundwater confirmation monitoring will be conducted to evaluate groundwater cleanup progress until cleanup standards are met. Groundwater samples will be analyzed for GRO, BTEX, and natural attenuation parameters. Initially, groundwater confirmation sampling will be conducted on a quarterly basis. The groundwater confirmation sampling frequency may be adjusted based on long-term monitoring results.

6.4 Soil Disposal Profiling

The disposal facility selected to receive PCS generated during system construction will require analytical data for disposal profiling purposes. The remediation contractor will be responsible for collecting samples, obtaining the appropriate laboratory data for profiling, and coordinating with the disposal facility for PCS disposal.

References

The following is list of references used in the preparation of this CAP.

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Tables

TABLE 1

SUMMARY OF PROPOSED SOIL AND GROUNDWATER CLEANUP LEVELS
FORMER CIRCLE K SITE
Seattle, Washington

Chemicals of Concern (COCs)	Soil CULs	Groundwater CULs	CUL Basis[(a)]
Total Petroleum Hydrocarbon (TPH)-Gasoline	100 mg/kg (w/o benzene) **30 mg/kg** (with benzene)	1,000 µg/L (w/o benzene) **800 µg/L** (with benzene)	MTCA Method A[(b)]
Benzene	**0.03 mg/kg** / 18.2 mg/kg	**5 µg/L /** 0.795 µg/L	MTCA Method A / MTCA Method B
Toluene	**7 mg/kg** / 6400 mg/kg	**1,000 µg/L /** 640 µg/L	MTCA Method A / MTCA Method B
Ethylbenzene	**6 mg/kg** / 8000 mg/kg	**700 µg/L** / 800 µg/L	MTCA Method A / MTCA Method B
Xylenes	**9 mg/kg** / 16000 mg/kg	**1,000 µg/L** / 1,600 µg/L	MTCA Method A / MTCA Method B
Methyl-tert-butyl ether (MTBE)	**0.1 mg/kg** / 556 mg/kg	**20 µg/L** / 24.3 µg/L	MTCA Method A / MTCA Method B
1,2-dibromomethane (EDB)	**0.005 mg/kg** / 0.5 mg/kg	**0.01 µg/L** / 0.0219 µg/L	MTCA Method A / MTCA Method B
1,2-dichoroethane (EDC)	(MTCA A n/a) / **11 mg/kg**	**5 µg/L /** 0.481 µg/L	MTCA Method A / MTCA Method B
Lead	**250 mg/kg** / (MTCA B n/a)	**15 µg/L** / (MTCA B n/a)	MTCA Method A / MTCA Method B

Notes:

(a) Model Toxics Control Act (MTCA) Method A/B cleanup levels (CULs) based on the following:
- Method A (Soil unrestricted land use) - Washington State Administrative Code (WAC) 173-340-740 Table 740-1.
- Method A (Groundwater) - WAC 173-340-720 Table 720-1.
- Method B (Soil and Groundwater) - Cleanup Levels and Risk Calculation (CLARC) (Accessed January 2017).

(b) Tabulated values for MTCA Method B CULs are not available for total petroleum hydrocarbon (TPH)-gasoline. Evaluation of risk-based CULs for TPH may be performed, if needed, including analysis of TPH fractions using Ecology Methods for volatile petroleum hydrocarbons (VPH).

MTCA Method A values used as cleanup standards. Where MTCA Method A is not available, the lowest MTCA Method B value is used.

mg/kg = milligrams per kilogram
µg/L = micrograms per liter
Bold values denote the lower of the listed MTCA Method A and B cleanup levels.

TABLE 2

POTENTIAL ACTION-SPECIFIC APPLICABLE, RELEVANT, AND APPROPRIATE REQUIREMENTS (ARARs)
FORMER CIRCLE K SITE
Seattle, Washington

Federal/State Citation	ALTERNATIVE 2 Soil Vapor Extraction	ALTERNATIVE 5 *In Situ* Bioremediation
Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES)	Applicable for groundwater treatment and discharge.	
Safe Drinking Water Act (National Primary and Secondary Drinking Water Regulations)	The remedial actions are being completed to reduce chemical concentrations in soil and groundwater to MTCA Method A (unrestricted use) cleanup levels.	
Resource Conservation and Recovery Act (RCRA)	Waste generated during the remedial action will be characterized and disposed per RCRA, as implemented by the State of Washington Danger Waste Regulations (WAC 173-303).	
Clean Air Act, as Amended	Applicable for vapor treatment and discharge; production of air emissions.	
National Historic Preservation Act, Archeological Resources Protect (36 CFR 800)	Historically significant archeological resources are not known to be present at the site. Historically significant properties will not be disturbed by any remedial action proposed.	
Occupational Safety and Health Act (29 CFR 1910)	Site activities will be performed under appropriate Occupation Safety and Health Act standards and WISHA requirements.	
Standards Applicable to Transporters of Hazardous Waste (29 CFR 107, 29 CRF 171)	Hazardous waste, if any, generated at the site will be characterized/waste profiled as required to determine packaging, handling, and transportation requirements.	
STATE or LOCAL		
Dangerous Waste Regulations (WAC 173-303)	Waste generated during the remedial action will be characterized and disposed per RCRA, as implemented by the State of Washington Danger Waste Regulations (WAC 173-303).	
Model Toxics Control Act (MTCA) (WAC 173-340)	Applicable to all aspects of the project. Each remedial alternative would be completed in accordance with MTCA regulations.	
State Clean Air Act (RCW 70.94)	Applicable for vapor treatment and discharge; production of air emissions.	
Washington Industrial Safety and Health Act (WISHA) (WAC 296-62)	Site activities will be performed under appropriate Washington Industrial and Safety and Health Act standards.	
Water Pollution Control Act (RCW 90.48)	Applicable for discharge of effluents from remediation activities.	
Water Quality Standards for Groundwater of the State of Washington (WAC 173-200)	The remedial actions are being completed to reduce chemical concentrations in groundwater to MTCA Method A (unrestricted use) cleanup levels.	
Underground Injection Control (WAC 173-218)	Applicable for chemical oxidation and bioremediation recirculation systems.	
Maximum Environmental Noise Levels (WAC 173-60)	Relevant depending on remedial action.	
Minimum Standards for Construction and Maintenance of Wells (WAC 173-160)	Soil borings and well construction to be completed in accordance with these regulations.	
State Environmental Policy Act (SEPA) (WAC 197-11)	Applicable to each alternative.	

TABLE 2

POTENTIAL ACTION-SPECIFIC APPLICABLE, RELEVANT, AND APPROPRIATE REQUIREMENTS (ARARs)
FORMER CIRCLE K SITE
Seattle, Washington

Federal/State Citation	ALTERNATIVE 2 Soil Vapor Extraction	ALTERNATIVE 5 *In Situ* Bioremediation
Puget Sound Clean Air Regulatory Requirements	Applicable for vapor treatment and discharge; production of air emissions.	
Land Development Standards (SBC)	Compliance with substantive conditions of local permits; storm water regulations, demolition, clearing, and grading.	
Building and Construction (SBC)	Compliance with substantive conditions of local building codes; building permits.	

Notes:

ARARs = Applicable, relevant, and appropriate requirements
CFR = Code of Federal Regulations
WAC = Washington Administrative Code
RCW = Revised Code of Washington
SBC = Seattle Building Code

Figures

Path: Q:\Projects\2016\1696010.00 WA DOE Circle K Site Assessment\GIS\Events\RI Figures\Figure1_VicinityMap.mxd ©2017 Kennedy/Jenks Consultants

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap

Legend

Site Location

N

0 200 400

Scale: Feet

Note:
1. All locations are approximate.

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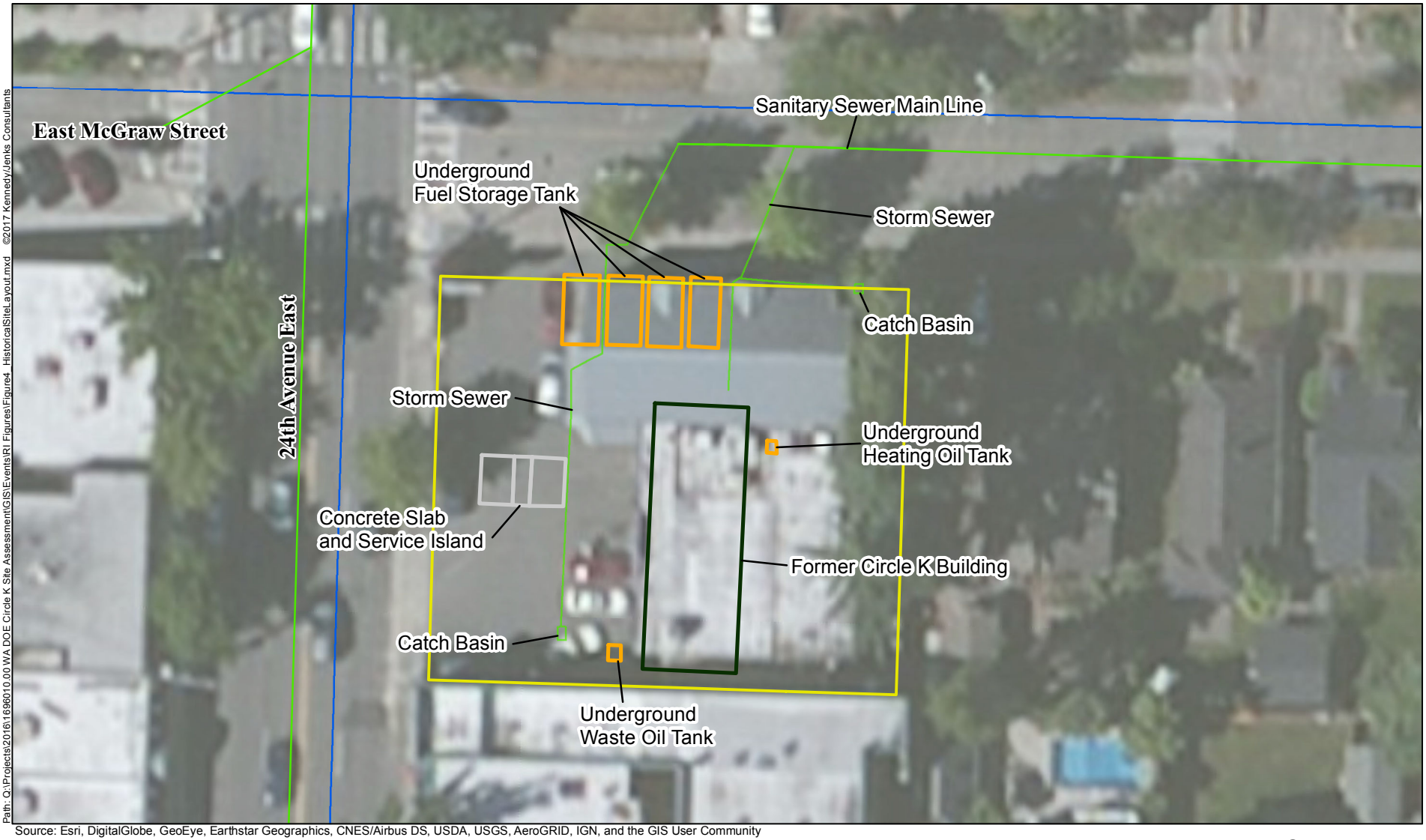
Former Circle K Site
Seattle, Washington

Site Location and Vicinity Map

K/J 1696010*00

Figure 1



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Former Building
- Former Pump Island
- Former Tank
- Parcel Boundary
- Sewer Line
- Water Line

Notes:

1. All locations are approximate.
2. Sewer and water line locations are based on available site information and not appropriate for construction purposes.
3. Former feature locations georeferenced from *Report of Geotechnical Services Subsurface Contamination Study and Remedial Action Monitoring Circle K Facility 1461 Seattle, Washington* 6 March 1990 by GeoEngineers.

N

0 20 40

Scale: Feet

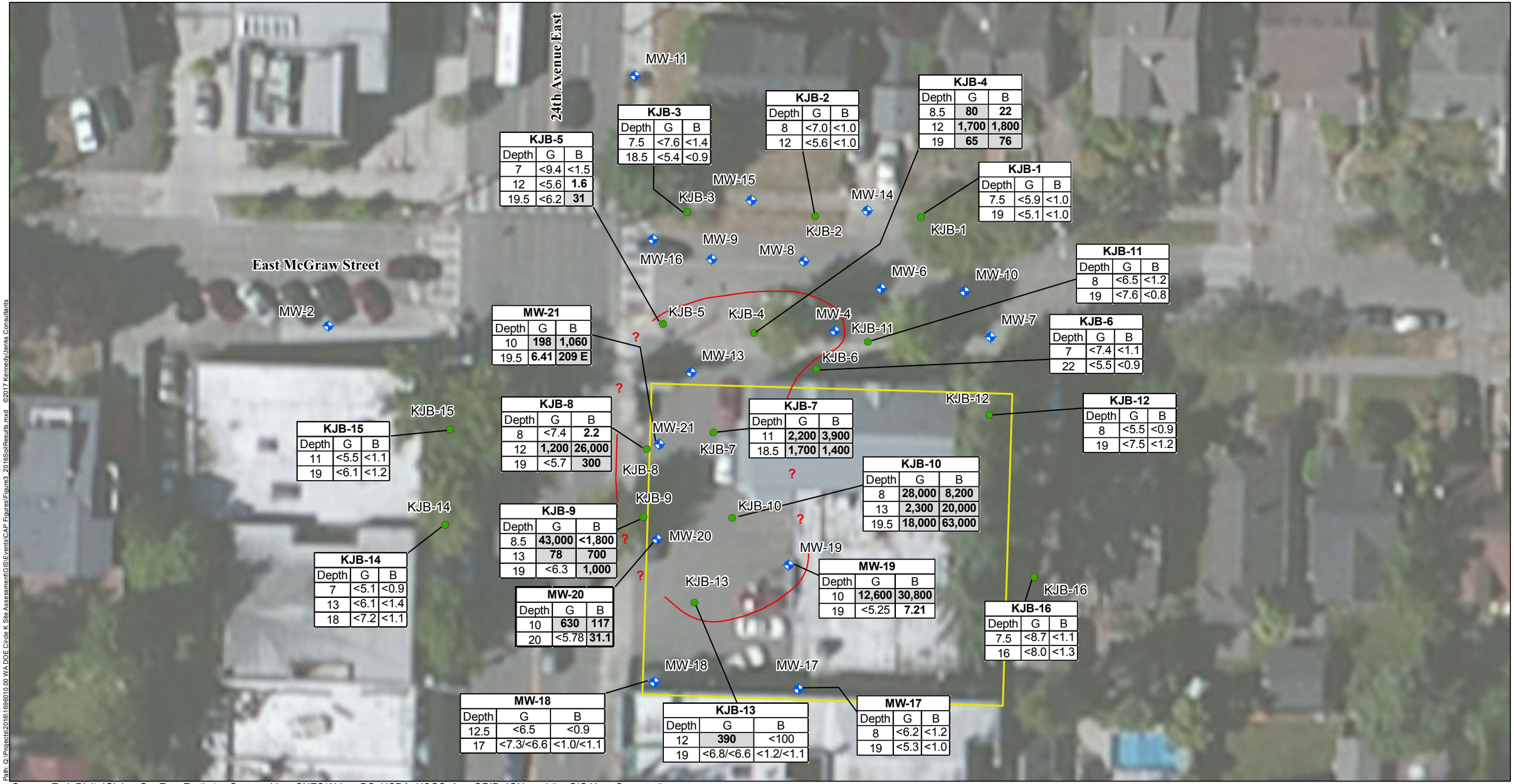
Kennedy/Jenks Consultants

Former Circle K Site
Seattle, Washington

Historical Site Features

1696010*00

Figure 2



KJB-5		
Depth	G	B
7	<9.4	<1.5
12	<5.6	**1.6**
19.5	<6.2	**31**

KJB-3		
Depth	G	B
7.5	<7.6	<1.4
18.5	<5.4	<0.9

KJB-2		
Depth	G	B
8	<7.0	<1.0
12	<5.6	<1.0

KJB-4		
Depth	G	B
8.5	**80**	**22**
12	**1,700**	**1,800**
19	**65**	**76**

KJB-1		
Depth	G	B
7.5	<5.9	<1.0
19	<5.1	<1.0

KJB-11		
Depth	G	B
8	<6.5	<1.2
19	<7.6	<0.8

MW-21		
Depth	G	B
10	**198**	**1,060**
19.5	**6.41**	**209 E**

KJB-6		
Depth	G	B
7	<7.4	<1.1
22	<5.5	<0.9

KJB-15		
Depth	G	B
11	<5.5	<1.1
19	<6.1	<1.2

KJB-8		
Depth	G	B
8	<7.4	**2.2**
12	**1,200**	**26,000**
19	<5.7	**300**

KJB-7		
Depth	G	B
11	**2,200**	**3,900**
18.5	**1,700**	**1,400**

KJB-12		
Depth	G	B
8	<5.5	<0.9
19	<7.5	<1.2

KJB-10		
Depth	G	B
8	**28,000**	**8,200**
13	**2,300**	**20,000**
19.5	**18,000**	**63,000**

KJB-14		
Depth	G	B
7	<5.1	<0.9
13	<6.1	<1.4
18	<7.2	<1.1

KJB-9		
Depth	G	B
8.5	**43,000**	**<1,800**
13	**78**	**700**
19	<6.3	**1,000**

MW-20		
Depth	G	B
10	**630**	**117**
20	<5.78	**31.1**

MW-19		
Depth	G	B
10	**12,600**	**30,800**
19	<5.25	**7.21**

KJB-16		
Depth	G	B
7.5	<8.7	<1.1
16	<8.0	<1.3

MW-18		
Depth	G	B
12.5	<6.5	<0.9
17	<7.3/<6.6	<1.0/<1.1

KJB-13		
Depth	G	B
12	**390**	<100
19	<6.8/<6.6	<1.2/<1.1

MW-17		
Depth	G	B
8	<6.2	<1.2
19	<5.3	<1.0

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Monitoring Well
- Soil Boring
- Parcel Boundary
- Approximate Extent of Gasoline-Range Organics/Benzene in Soil above MTCA Method A Cleanup Levels

Boring ID → MW-17
Sample Depth in feet → Depth 8 | G <6.2 | B <1.2; Depth 19 | G <5.3 | B <1.0

All concentrations in mg/kg.
Concentrations are bolded where detected.
Shaded concentrations are above the MTCA Method A cleanup level.

Notes:
1. All locations are approximate.
2. mg/kg = milligrams per kilogram.
3. G = gasoline-range organics.
4. B = benzene.

N

0 15 30

Scale: Feet

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Former Circle K Site
Seattle, Washington

2016 Soil Boring Soil Sample Results

K/J 1696010*00

Figure 3

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Legend

- Monitoring Well
- Landau Monitoring Well
- Water Line
- Sewer Line
- Parcel Boundary
- Extent of GRO and/or BTEX concentrations exceeding MTCA Method A CULs in Groundwater

Notes:

1. All locations are approximate.
2. Groundwater samples were collected 7-8 December 2016 from monitoring wells.
3. NS = not sampled.
4. µg/L = micrograms per liter.
5. GRO = Gasoline-Range Organics.
6. BTEX = Benzene, Toluene, Ethylbenzene, Total Xylenes.

N

0 15 30

Scale: Feet

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Former Circle K Site
Seattle, Washington

Estimated Extent of GRO and BTEX Contamination December 2016

K/J 1696010*00

Figure 4

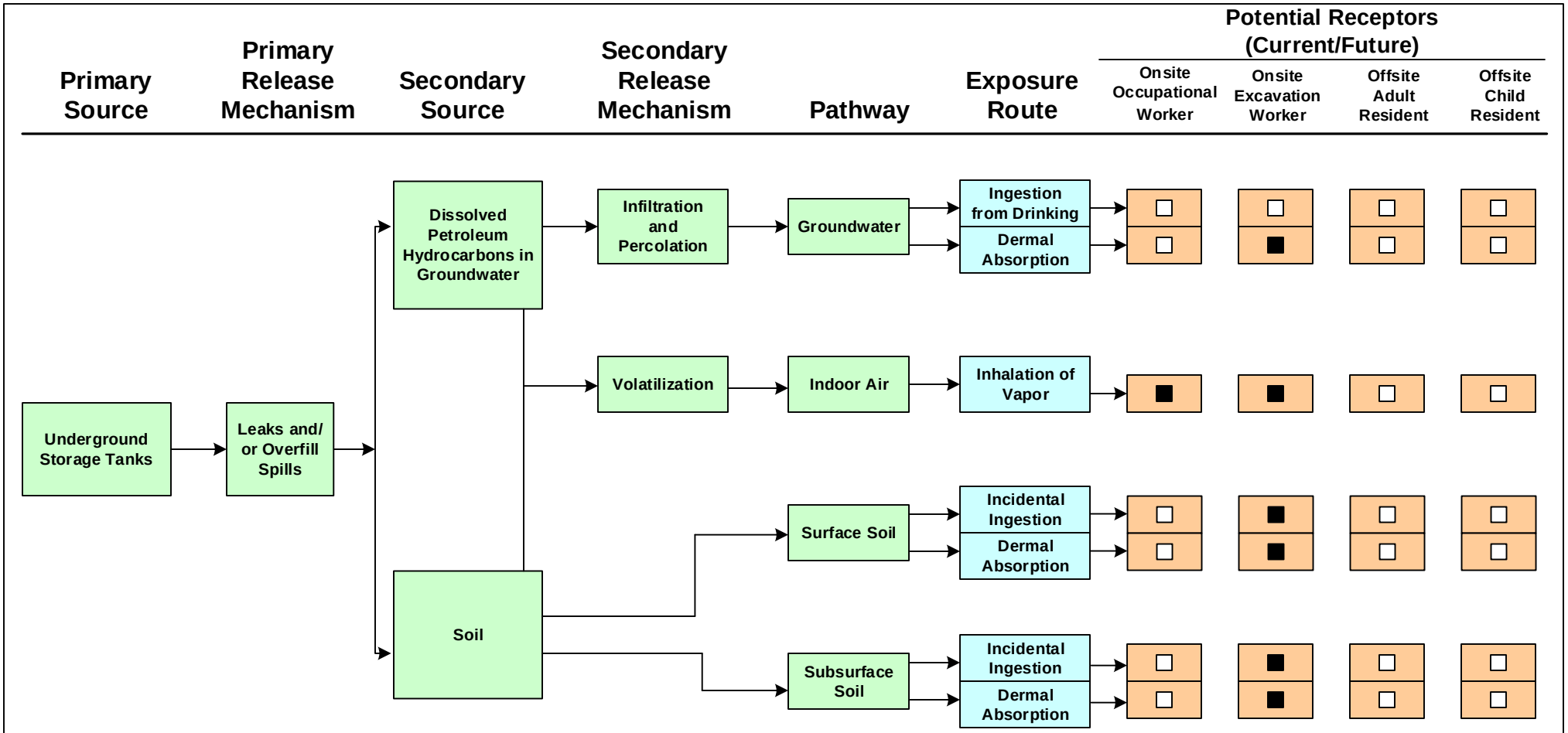

Figure depicts a preliminary assessment of potential exposure pathways.

Legend:

■ Potentially complete exposure pathway.

□ Incomplete exposure pathway.

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Former Circle K Site
Seattle, Washington

Conceptual Site Exposure Model

K/J 1696059*00

Figure 5

Path: Q:\Projects\2016\1696010.00 WA DOE Circle K Site Assessment\GIS\Events\CAP Figures\Figure6_Alternative2and3.mxd ©2017 Kennedy/Jenks Consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Proposed Vapor Extraction Well
- Remediation Well
- Monitoring Well
- Abandoned Well
- Landau Monitoring Well
- Boring
- Landau Boring
- Sewer Line
- Water Line
- Estimated Radius of Influence for Soil Vapor Extraction Wells
- Proposed Treatment System Location
- Approximate Extent of Gasoline-Range Organics/Benzene in Soil above MTCA Method A Cleanup Levels
- Parcel Boundary

Notes:

1. All locations are approximate.
2. Sewer and water line locations are based on available site information and not appropriate for construction purposes.

N

0 12.5 25

Scale: Feet

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Former Circle K Site
Seattle, Washington

Alternative 2: Soil Vapor Extraction

K/J 1696010*00

Figure 6

Path: Q:\Projects\2016\1696010.00 WA DOE Circle K Site Assessment\GIS\Events\FigureC_Alternative4.mxd ©2017 Kennedy/Jenks Consultants

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Proposed Multi-Purpose Remediation Well
- RW-7 Existing Multi-Purpose Remediation Well
- Monitoring Well
- Soil Boring
- Soil Boring Location with Gasoline-Range Organics above the MTCA Method A Cleanup Level for Soil
- Possible Future Horizontal Well
- Estimated Gasoline-Range Organics Isoconcentration (>1,000 µg/L)
- Estimated Gasoline-Range Organics Isoconcentration (>50,000 µg/L)

Note:
1. All locations are approximate.
2. µg/L = micrograms per liter.

N

0 12.5 25

Scale: Feet

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Former Circle K Site
Seattle, Washington

Alternative 4: In Situ Chemical Oxidation and Alternative 5: In Situ Bioremediation

K/J 1696010*00

Figure 7