

REMEDIAL INVESTIGATION SAMPLING AND ANALYSIS PLAN

Former PQ Corporation Site
Tacoma, Washington

Prepared for: Port of Tacoma

Project No. 120051-001 • June 17, 2013



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Acronyms

Aspect	Aspect Consulting, LLC
AST	above-ground storage tank
ASTM	American Society for Testing and Materials
BETX	benzene, ethylbenzene, toluene and xylenes
CLARC	Cleanup Level and Risk Calculation
CLP	Contract Laboratory Program
COC	chain of custody
COPEC	chemicals of potential ecological concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	conceptual site model
DQO	data quality objectives
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
ESA	Environmental Site Assessment
HDPE	high density polyethylene
IDW	investigation-derived waste
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MDL	method detection limit
mg/kg	milligrams/kilograms
mg/L	milligrams per liter
MS	matrix spike
MS/MDS	matrix spike duplicate
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
ORP	oxidation-reduction potential
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl

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PCE	perchloroethylene
PID	photoionization detector
Port	Port of Tacoma
PQL	practical quantitation limit
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SAP	Sampling Analysis Plan
Site	Former PQ Corporation Site
SMS	Sediment Management Standards
SOP	standard operating procedure
SVOC	semivolatile organic compounds
TCE	trichloroethylene
TDS	total dissolved solids
TEE	Terrestrial Ecological Evaluation
TPH	total petroleum hydrocarbons
TSS	total suspended solids
UST	underground storage tank
VCP	Voluntary Cleanup Program
VI	vapor intrusion
VOC	volatile organic compound
WAC	Washington Administrative Code

1 Introduction

Aspect Consulting, LLC (Aspect) has prepared this Sampling and Analysis Plan (SAP) on behalf of the Port of Tacoma (Port) to guide the remedial investigation (RI) for the Former PQ Corporation Site (Site) located at 1114 and 1202 Taylor Way in Tacoma, Washington (Figure 1). PQ Corporation operated a sodium silicate liquefaction facility on the Site between the early 1940s and 2009. A release of hazardous substances has been documented at the Site, and the Site is listed in Ecology's database of Confirmed or Suspected Contaminated Sites (Facility Site ID 68592738). The Port enrolled the Site into the Washington State Department of Ecology (Ecology) Voluntary Cleanup Program (VCP) during December 2012 (VCP ID SW1269; Ecology, 2012).

The following sections present the objectives of this SAP as well as an overview of its organization.

1.1 Objectives

The Port intends to complete a remedial investigation/feasibility study (RI/FS) for the Site as required by the Model Toxics Control Act (MTCA). The RI/FS will be conducted to document the nature and extent of contamination, and define and evaluate cleanup alternatives for identified contamination. The SAP documents the sample collection, handling, and analysis procedures to be used for the RI.

The specific objectives of the SAP are to:

- Summarize relevant information from the prior environmental investigations;
- Identify data gaps with respect to potential contaminant sources, migration, and exposure pathways; and
- Define a scope of work for the RI to address the identified data gaps. Following completion of the scope of work defined here, additional data collection may be warranted to define the nature and extent of contamination for the purposes of identifying cleanup alternatives in the FS. Additional RI data collection, if needed, will be documented in an addendum to this SAP or by other means.

1.2 Organization

The remaining sections of the SAP are organized as follows:

- **Section 2—Property History and Environmental Setting** describes the Site location and zoning, operational history, and environmental setting.
- **Section 3—Previous Environmental Investigations** summarizes previous investigations. Data gaps from the prior investigations are also identified.
- **Section 4—Preliminary Conceptual Site Model (CSM)** identifies likely contaminant release and transport mechanisms and exposure pathways. The preliminary CSM is based on previous environmental investigations and will be updated during the completion of the RI. The preliminary CSM also includes a

terrestrial ecological evaluation (TEE) to identify potential ecological concerns and terrestrial wildlife exposure pathways.

- **Section 5—Data Gaps and Proposed Data Collection** summarizes data gaps in the prior environmental investigation/cleanup information and other historical information. This section also proposes the RI data collection methods to address the identified data gaps.
- **Section 6—References** lists documents used or referenced in this SAP.

Appendices to the SAP include:

- **Appendix A—Historical Photographs** provides several aerial and oblique aerial photographs of the Site.
- **Appendix B—Field Sampling Plan** provides the collection and handling methods for soil, sediment, and groundwater samples.
- **Appendix C—Quality Assurance Project Plan (QAPP)** provides analytical laboratory requirements for quality assurance/quality control (QA/QC) procedures.

Aspect will prepare under separate cover a site-specific Health and Safety Plan (HSP) for field investigation activities.

2 Property History and Environmental Setting

This section presents a brief overview of the Site including location, operational history and current Site conditions, and hydrogeologic setting.

2.1 Property Location and Zoning

The Site is located on the Blair-Hylebos peninsula, approximately 2½ miles northeast of downtown Tacoma, Washington, within Section 26 of Township 21, Range 03 (Figure 1). The Site consists of two contiguous tax parcels at 1114 Taylor Way (parcel #2275200260) and 1202 Taylor Way (parcel #0321263016), totaling approximately 5.7 acres of land (Figure 2). A stormwater pond occupies the southern portion of both parcels; the stormwater pond represents waters of the United States (U.S.) regulated under the Clean Water Act.

The parcels adjoining the Site to the west, south, and east are owned by the Port. The northern Site boundary is formed by Taylor Way. Parcels immediately north of Taylor way are also owned by the Port, with the exception of two small parcels northwest of the Site, which are owned by the City of Tacoma.

The entire Blair-Hylebos peninsula, including the Site and adjacent parcels, is zoned Port Maritime and Industrial (PMI). Zoning in the vicinity of the Site is consistent with the MTCA definition of industrial property:

- "Industrial properties" means properties that are or have been characterized by, or are to be committed to, traditional industrial uses such as processing or manufacturing of materials, marine terminal and transportation areas and facilities, fabrication, assembly, treatment, or distribution of manufactured products, or storage of bulk materials, that are either:
 - Zoned for industrial use by a city or county conducting land use planning under chapter 36.70A RCW (Growth Management Act); or
 - For counties not planning under chapter 36.70A RCW (Growth Management Act) and the cities within them, zoned for industrial use and adjacent to properties currently used or designated for industrial purposes.

The Port intends to maintain the Site for industrial use consistent with its zoning; therefore, the Site meets the definition of an industrial property under MTCA.

2.2 Operational History

The Site operated as a sodium silicate liquefaction facility from the early 1940s until 2009. Demolition of the facility began in 2008, conducted by PRS Group Inc. The parcel located at 1114 Taylor Way is currently being used for heavy equipment storage, while the 1202 Taylor Way parcel is currently under lease to a propane delivery service.

The Site is located in an area that was reclaimed from the former tidflats of Commencement Bay using dredged material in the early 1900s. The Site was first

developed by the PQ Corporation in 1941 and operated as a sodium silicate liquefaction facility.

Operations mainly occurred on the eastern parcel (1202 Taylor Way). During operations, solid sodium silicate arrived to the western side of the facility via railcar. The solid material was dissolved in a central boiler to produce liquid sodium silicate, which was transferred to storage tanks if it met specifications. Liquid product that did not meet specifications was sent to correction tanks where it was treated with water and/or sodium hydroxide and/or liquid sodium silicate. The liquid sodium silicate product left the facility via railcar on the eastern side of the facility (Figure 2).

Operations were conducted in 11 buildings (Figure 2). Production occurred in the furnace building which housed the furnace, batch mixing hoppers, conveyors, and the boiler. The boiler was initially fueled by Bunker C fuel oil, but was converted to natural gas at an unknown time. Raw materials were stored in a warehouse to the north of the furnace. Equipment was stored in a building to the west of the furnace building, and product storage tanks were located to the east. Small parts and equipment maintenance and repair were conducted in a maintenance shop located on the southeastern portion of the property.

Sodium silicate is considered non-toxic, although high-concentration solutions of sodium silicate and water can be alkaline (pH 11–12) (PQ Corporation, 2013). Leaded gasoline, Bunker C fuel oil (for boiler), machinery oils, and naphtha-based cleaning solvents were utilized as part of regular facility operations (Floyd|Snider, 2007a).

Most of the operational areas were paved with concrete or asphalt. Stormwater from the paved area was collected and discharged to the stormwater pond along the southern property boundary via an outfall. Historical photographs from 1946 and 1952 (Appendix A, Figures A.3 and A.5) show active placement of fill material from the 1202 Taylor Way parcel into the topographically lower area immediately south. This area of recent fill is referred to as the “probable fill” in ERM (2010), and is the area where the southern fence line juts out to the southwest (Figure 2).

The 1114 Taylor Way parcel to the west is unpaved and is currently used for heavy equipment storage. The parcel was formerly leased to an individual for storage of railroad-related emergency services equipment (Floyd|Snider, 2007a).

The PQ Corporation continued operations for a brief period after the property was purchased by the Port on March 27, 2008 (Pierce County Assessor, 2013).

2.3 Surface Conditions

The Site is located, on the Blair-Hylebos peninsula between the Hylebos Waterway (approximately 9,000 feet to the north) and the Blair Waterway (approximately 1,200 feet to the southwest). Commencement Bay is located approximately 4,300 feet to the northwest of the property.

The ground surface on the property is generally flat and currently unpaved, with surface grade at an elevation of approximately 8 to 10 feet above mean sea level (ERM, 2010). However, the eastern parcel, where the primary industrial operations occurred, was mostly paved prior to the demolition of the operations facilities. A steep 3- to 4-foot slope

drops down to the stormwater pond covering the southern portions of the 1114 and 1202 Taylor Way parcels.

The pond collects stormwater runoff from the Site and surrounding parcels. Historically, stormwater discharged to the pond via an outfall when the property was paved. This outfall was formerly permitted under National Pollutant Discharge Elimination System (NPDES) Industrial Permit No. SO3000330 (Parametrix, 2009). A second outfall of unknown function was observed on the north edge of the pond during the Parametrix Site visit in 2009 (Parametrix, 2009).

Since removal of pavement, stormwater generated on the property still discharges to the pond, although a larger portion now infiltrates through the gravel surface. Stormwater collects in a stormwater pond in the western portion of the wetland that discharges to a small catchment basin, from which it drains to the Hylebos Waterway.

2.4 Geologic and Hydrogeologic Conditions

The general geologic setting of the property is in Tacoma Tideflats, which is comprised of dredged fill material above a thick (greater than 200 feet) sequence of stratified deltaic deposits that ultimately overlie Vashon glacial deposits (Hart Crowser, 1974). The underlying native deltaic deposits consist of sand and silty sand with interbedded silts and peat. The fill was historically dredged to deepen the waterways (Blair, Hylebos, etc.) and placed in the current upland; therefore, the fill and native materials may appear similar unless the fill also contains debris.

Previous investigations identified a lobe of debris fill located on the south edge of the Site (Figure 2). Test pits and soil borings from this lobe contained waste that included burnt trash, brick, cans, glass, charred timbers, and gelatinous beige-gray-white material presumed to be sodium silicate. Outside of the recent debris-fill lobe, sodium silicate material without other debris was also found in two of three test pits completed on the western parcel. Black silty fine sand interpreted as dredged fill has been encountered to depths of 12 to 15 feet below ground surface (bgs).

Regional groundwater flow across the Blair-Hylebos peninsula is generally semi-radial, flowing towards the nearest waterway with a groundwater divide within the middle of the long axis of the peninsula. Groundwater flow diverges from the divide toward the Hylebos Waterway on the north and the Blair Waterway on the south.

Regional information indicates the presence of multiple hydrostratigraphic units within the combined fill and underlying deltaic deposits. For example, a data report for a site located within about ¼ mile northwest of the Site references 15-foot, 25-foot, and 50-foot aquifer zones (GeoEngineers, 2010). The water table within the fill is present at depths of about 3 feet bgs within the debris-fill area on the south end of the Site. Groundwater elevation data collected from the existing monitoring wells within the debris-fill area confirm that groundwater locally flows to the south-southwest, into the adjacent stormwater pond at the south end of the Site (ERM, 2010). However, groundwater elevation data are not available for the majority of the Site, and the Site is located several hundred feet closer to the Hylebos Waterway than the Blair Waterway. There is insufficient information available to draw broad conclusions about the direction of groundwater flow across most of the Site. However, water level data from a clustered

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shallow and deep monitoring well pair (MW-5S and MW-5D; Figure 2) confirm a downward vertical hydraulic gradient between the debris fill (screen midpoint depth of 5 feet bgs) and underlying native deposits (screen midpoint depth 22.5 feet bgs) (ERM, 2010).

A municipal water supply well, approximately 900 feet deep, is located between the Site and the Hylebos Waterway, at 1171 Taylor Way.

3 Previous Environmental Investigations

This section summarizes previous environmental investigations conducted at the Site. The approximate locations of features described below are indicated on Figure 2. At the end of this section, the existing analytical data are compared against preliminary screening levels to identify preliminary constituents of potential concern for the Site.

3.1 Phase I ESA (Floyd|Snider, 2007a)

In July 2007, Floyd|Snider conducted a Phase I Environmental Site Assessment (ESA) for the PQ Corporation property, in accordance with the American Society for Testing and Materials (ASTM) Standard E1527-05 (Floyd|Snider, 2007a). Potential environmental issues identified in the Phase I are as follows:

- Gasoline undergrounds storage tank (UST) removed without documentation in 1978; located just north of the former “Diesel & Kerosene Storage Shed”.
- Unknown source of fill used to elevate the 1114 Taylor Way parcel (Figure 2). Without the source of fill being known, the Phase 1 ESA indicated the potential for it to be contaminated with ASARCO slag or other “industrial contaminated material”, based on similar situations at other sites in the Tacoma Tidelands.

3.2 Phase II ESA (Floyd|Snider, 2007b)

In August 2007, Floyd|Snider conducted a Phase II ESA at the PQ Corporation property (Floyd|Snider, 2007b). The gasoline UST issue identified during the Phase I ESA was further investigated as follows:

- Four soil and four grab groundwater samples were collected from four borings completed in the reported vicinity of the gasoline UST removed in 1978; however, the borings were not completed in the location of the former gasoline UST identified in the Phase I. No gasoline-range total petroleum hydrocarbons (TPH) or benzene, toluene, ethylbenzene, xylenes (BTEX) were detected.

3.3 Site Investigation (Parametrix, 2009)

In November 2009, Parametrix conducted a limited Site investigation following the closure of the PQ Corporation facility and the Port’s purchase of the property. Soil and groundwater samples were collected from six test pits, and shallow sediment cores were collected at three locations near identified outfalls within the stormwater pond along the southern property boundary.

Test pits were completed in two areas of the Site: (1) south of the former “Diesel & Kerosene Storage Shed” within the 1202 Taylor Way parcel, and (2) in the central portion of the 1114 Taylor Way parcel. Chemical sampling results from the explorations were as follows:

- **1202 Taylor Way Parcel:** Soil and grab groundwater samples from the three test pits completed in the “Diesel & Kerosene Storage Shed” area (TP-1, TP-2, and

TP-3) were analyzed for TPH (gasoline, diesel, and oil ranges), BTEX, polycyclic aromatic hydrocarbons (PAHs), total (unfiltered) priority pollutant metals, and polychlorinated biphenyls (PCBs). In soil, gasoline-range TPH, cadmium, and mercury concentrations detected in one or more samples from the test pits exceeded MTCA industrial soil cleanup levels. Carcinogenic PAHs (cPAHs) and PCBs were detected in multiple soil samples but at concentrations below industrial soil cleanup levels. One or more grab samples of groundwater collected from the test pits had detected concentrations of total cadmium, chromium, copper, lead, mercury, zinc, and cPAHs exceeding MTCA Method A cleanup levels. Floating separate-phase petroleum was reported on the shallow groundwater in test pits TP-1 and TP-2; diesel-/oil-range TPH concentrations in groundwater samples from these two test pits exceeded the 0.5 milligrams per liter (mg/L) MTCA groundwater cleanup level. Groundwater pH measured in the three test pits ranged from 8.5 to 9.9.

- **1114 Taylor Way Parcel:** No samples were collected for chemical analysis from the three test pits on the 1114 Taylor Way parcel (TP-4, TP-5, and TP-6); however, groundwater pH was measured in each pit. A layer of presumed sodium silicate material was observed in test pits TP-4 and TP-6 at depths of 1 to 2 feet bgs. Groundwater pH measured in the three test pits ranged from 7.0 to 9.2.

Three shallow cores were advanced to observe sediment within the bottom of the stormwater pond (Figure 2: WS-1, WS-2, and WS-3). WS-1 was completed near the facility's stormwater outfall 001. WS-2 was completed near an outfall for boiler blowdown water or other process waters from PQ Corporation's operations. WS-3 was completed west of WS-2. A layer of presumed sodium silicate material was observed in each of the three sediment cores, at thicknesses ranging from 10 to 24 inches. The measured pH of the sediment was 10.5, 10.1, and 7.8 at WS-1, WS-2, and WS-3, respectively. A petroleum-like odor was observed in the WS-1 core; therefore, a sediment sample from that core was submitted for diesel-/oil-range TPH analysis. The detected 450 milligram per kilogram (mg/kg) TPH concentration in the WS-1 sediment sample was below the 2,000 mg/kg industrial soil cleanup level.

3.4 Site Characterization Report (ERM, 2010)

As a follow up to the Parametrix investigation, ERM conducted a focused Site investigation on behalf of PQ Corporation, including collection of soil and groundwater samples from six monitoring wells located near the "Diesel & Kerosene Storage Shed". Soil and groundwater samples were analyzed for TPH (gasoline, diesel, and oil ranges), BTEX, PAHs, and metals.

A summary of soil samples collected from the six locations is presented below:

- Sample MW-2S exceeded MTCA industrial soil cleanup levels for gasoline-range TPH and total xylenes. Other exceedances were not reported for petroleum hydrocarbons or BTEX.
- Soil samples did not exceed MTCA industrial soil cleanup levels for total cPAHs.

- Soil samples from MW-1S, MW-2S, MW-5S, and MW-5D exceeded Ecological Indicator Soil Concentrations (EISC) for Protection of Terrestrial Plants and Wildlife for total chromium, lead, and zinc.

A summary of groundwater samples collected from the six monitoring wells is presented below:

- A groundwater sample from MW-5S exceeded the MTCA Method A groundwater cleanup level for oil-range petroleum hydrocarbons.
- Groundwater samples from MW-2S and MW-5S exceeded MTCA Method A groundwater cleanup levels for benzo(a)pyrene and total cPAHs.
- Groundwater samples from MW-1S, MW-2S, MW-3S, MW-4S, MW-5S, and MW-5D exceeded MTCA Method A groundwater cleanup levels for arsenic (dissolved).
- Groundwater samples from MW-1S, MW-3S, and MW-5D exceeded MTCA Method A groundwater cleanup levels for total chromium (dissolved).

The groundwater samples were submitted for analysis of dissolved metals (field filtered) and total metals (not field filtered). ERM (2010) states that the field filtering of groundwater samples was deficient, since the analytical laboratory reported the filtered samples to be turbid and visually indistinguishable from non-filtered samples.

Based on the ERM (2010) groundwater data from the debris-fill area, the shallow fill aquifer zone has higher concentrations of petroleum-related contaminants than the deeper intermediate aquifer zone, but metals concentrations are comparable in the two aquifer zones. The presence of petroleum hydrocarbons in groundwater can further reduce the groundwater oxidation-reduction potential (ORP), which can facilitate metals transport.

3.5 Summary of Existing Soil and Groundwater Analytical Data

Tables 1 and 2 provide statistical summaries of the existing soil and groundwater data from the Parametrix (2009) and ERM (2010) investigations, with the analytical data from the debris-fill area of the Site. The Parametrix (2009) groundwater samples were collected from test pits. Because the test pits with groundwater samples (TP-1, TP-2, TP-3) were in the area where groundwater data from monitoring wells are available, the 2009 test pit groundwater data will not be used quantitatively in the RI. Tables 1 and 2 provide, for soil and groundwater data respectively, the following information for each analyte in the respective matrix: the numbers of sample locations, analyses, and detections; maximum detection; preliminary screening level to be applied in the RI; numbers of detections greater than the preliminary screening level (exceedances); and numbers of non-detects with an analytical detection limit greater than the preliminary screening level. For soil, the data are compared separately to preliminary screening levels for humans and ecological receptors (terrestrial wildlife) under an industrial site use. The groundwater data are compared against preliminary screening levels protective of human and ecological receptors. Section 4.3 describes derivation of the preliminary screening levels.

Constituents detected at concentrations greater than preliminary screening levels, either human health or ecological, within the debris-fill area soil and groundwater are as follows:

Soil

- Gasoline-range petroleum hydrocarbons;
- Total xylenes; and
- Cadmium, chromium, lead, mercury, and zinc.

For soil samples, constituents with analytical detection limits greater than preliminary screening levels included selenium and benzene.

Groundwater

- Oil-range petroleum hydrocarbons;
- cPAHs;
- Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc; and
- pH.

For groundwater samples, constituents with analytical detection limits greater than preliminary screening levels included cadmium, lead, mercury, silver, thallium, benzene, and cPAHs.

4 Preliminary Conceptual Site Model

The following sections present a preliminary CSM, including potential contaminant release and transport mechanisms, exposure pathways, and receptors. The CSM helps identify data gaps in the existing characterization data, as well as define applicable regulatory screening levels. Figure 3 is an illustration of the preliminary CSM to accompany the narrative below. This preliminary CSM will be updated in the RI report to incorporate additional information collected under this SAP.

4.1 Contaminant Release and Transport

The Site was operated by the PQ Corporation as a sodium silicate liquefaction facility between the early 1940s and 2009. During that time, Bunker C fuel oil, waste oil, solvents, kerosene, diesel, gasoline, and sodium silicate materials were used and stored on the Site. Potential sources for identified contamination in the debris-fill area include the following:

- Debris fill of unknown origin placed on the south end of the Site from the 1940s until sometime in the 1960s; and
- Fuel storage, including the gasoline UST that was removed in 1978, as well as diesel and kerosene storage.

Impacts to groundwater can potentially result from leaching from the debris fill and/or historical fuel releases. Water level data indicate shallow groundwater is flowing toward the stormwater pond, which may result in impacts to pond sediments and surface water. Stormwater runoff can also carry soil contaminants to the stormwater pond. Release of petroleum can reduce groundwater ORP, which in turn can increase mobility of metals in the groundwater. In addition, there is a downward hydraulic gradient at the Site, resulting in the potential for downward transport of groundwater contamination.

In addition to impacts identified in the debris-fill area, historical plant operations have the potential for releases to the environment. These operations include the following:

- Above-ground storage of Bunker C fuel oil;
- Conveyance of Bunker C fuel oil to the boiler;
- Former Maintenance Shop operations, including the use of a solvent-based parts washer and storage of waste oil; and
- Wastewater discharge from the sodium silicate liquefaction process.

If volatile organic compounds (VOCs) are present in Site soil or groundwater, they can be transported into vadose zone soil gas and then into indoor air (future occupied structures) or outdoor air on the Site. Disturbance of contaminated soil can generate contaminated dust, which can pose an inhalation risk.

Stormwater and process wastewater generated on the Site was historically conveyed to the stormwater pond via outfall(s). Residual sodium silicate and boiler blowdown water has elevated pH and was discharged to the stormwater pond. The sodium silicate was also

observed in test pits at other locations on the Site, including on the 1114 Taylor Way parcel.

While the Site is not located on the marine shoreline, impacts to marine surface water are possible via two transport pathways:

1. **Via conveyance of contaminated stormwater:** A catch basin collecting surface water from the stormwater pond discharges to the Hylebos Waterway; and
2. **Via migration of contaminated groundwater:** The direction of groundwater flow across much of the Site has not been determined, so the migration of potentially impacted groundwater and subsequent discharge to the Hylebos and/or Blair Waterways cannot be discounted.

4.2 Exposure Pathways and Receptors

An exposure pathway describes the mechanisms by which human or ecological exposure to contaminants can occur assuming no remedial action or protective control is in place. An exposure pathway is considered complete if a human or ecological receptor can be exposed to a contaminant via that pathway. Assuming a future industrial land use, potential pathways for receptors to be exposed to contaminants in Site soil, groundwater, surface water, and sediment are outlined below.

4.2.1 Soil

Current and future potentially complete exposure pathways for soil include the following:

- Industrial workers (including construction worker) dermal contact with or incidental ingestion of contaminated soils;
- Industrial workers (including construction worker) inhalation of indoor or outdoor air contaminated by vapor intrusion of volatile contaminants in vadose zone soil;
- Terrestrial wildlife contacting contaminated soils; and
- Terrestrial wildlife consuming soil invertebrates that have accumulated bioaccessible contaminants from the soil.

In addition to these pathways, contaminants in soil can leach to groundwater, acting as a secondary source; therefore, the soil-to-groundwater pathway is considered in areas where there is a potentially complete groundwater exposure pathway.

4.2.2 Groundwater

As discussed further in Section 4.3.1, Site groundwater is not used for drinking water and is not a practicable future source of drinking water; therefore, potable use of on-Site groundwater is not considered a potentially complete exposure pathway for the Site. However, there is a deep municipal water supply well located north of the Site.

Current and future potentially complete exposure pathways for groundwater include the following:

- Construction workers contacting contaminated groundwater during excavation or other construction-related activities;

- Industrial workers (including construction worker) inhalation of indoor or outdoor air contaminated by vapor intrusion of volatile contaminants in shallow groundwater;
- Ecological receptors (benthic, aquatic) direct exposure to groundwater contaminants discharged to the sediment bioactive zone or surface water; and
- Higher-trophic-level organisms (ecological or human) consuming ecological receptors contaminated by groundwater discharges to the sediment bioactive zone or surface water.

4.2.3 Surface Water and Sediment

Current and future potentially complete exposure pathways for surface water and sediment, whether in the Hylebos or Blair Waterways or more likely the stormwater pond, include the following:

- Ecological receptors (benthic, aquatic) direct exposure to contaminants in sediment bioactive zone or surface water; and
- Higher-trophic-level organisms (ecological or human) consuming ecological receptors contaminated by exposure to surface water or sediment.

4.3 Preliminary Screening Levels

This section describes the numerical screening levels against which constituent concentration data for environmental media will be compared for the purpose of identifying constituents of potential concern during the RI. The screening levels applied in the RI will not necessarily represent cleanup levels for the Site. Additional information may be collected during the RI/FS to support selection of cleanup levels and/or remediation levels. Cleanup levels will not be set at concentrations less than area background concentrations¹; however, background concentrations have not been determined.

The following sections describe the derivation of environmental media screening levels to be applied in the RI.

4.3.1 Groundwater Screening Levels

The Site is located within the Tacoma Tideflats industrial area, and it is proposed that shallow groundwater within the Site is classified as nonpotable.

Because drinking water is not a practicable future use for shallow groundwater at the Site, groundwater screening levels for the RI are the most stringent criterion based on protection of the adjacent surface water and vapor intrusion (VI) to future structures (indoor air) on the Site. For arsenic, groundwater screening levels are not set lower than the 5 µg/L MTCA Method A groundwater cleanup level based on background. In addition, because there are no surface water criteria for petroleum mixtures (TPH), MTCA Method A groundwater cleanup levels will be applied as the groundwater screening criteria for TPH. Note that the individual constituents comprising TPH mixtures (VOCs, PAHs, etc.) are also analyzed for, and have their own surface water-

¹ Concentrations consistently present in the vicinity of the site but unrelated to releases from the site (WAC 173-340-200).

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based and VI-based groundwater screening levels. If off-Site groundwater contaminant transport is confirmed, assessment of potential for impacts to the neighboring deep municipal water supply well will be conducted in the RI (e.g., applying drinking water screening levels).

Groundwater screening levels protective of surface water incorporate MTCA surface water cleanup levels including criteria from applicable state and federal laws. For protection of surface water quality, screening levels are the most stringent of the following aquatic life criteria and human health criteria for consumption of aquatic organisms under state and federal laws:

1. MTCA standard Method B surface water cleanup levels based on human consumption of fish (human health only);
2. Washington State Water Quality Standards;
3. Federal National Recommended Water Quality Criteria pursuant to Section 304(a) of the Clean Water Act; and
4. The Federal National Toxics Rule (NTR; 40 CFR 131.36).

Groundwater is known to discharge to the stormwater pond south of the Site; therefore, aquatic life water quality criteria for freshwater are applied. However, since the stormwater pond eventually discharges to the Hylebos Waterway, and Site groundwater may discharge directly to the Hylebos and/or Blair Waterways, marine water quality criteria are also considered for purposes of developing preliminary screening levels. For each constituent, the most conservative water quality criterion is chosen as the preliminary groundwater screening level.

Volatilization of contaminants in shallow groundwater can represent a potential risk for VI to future structures (indoor air) or outdoor ambient air. For the purposes of the RI, conservative (“Tier 1”) groundwater VI screening levels are obtained from Table B-1 of Appendix B to Ecology’s guidance for evaluating soil vapor intrusion (Ecology, 2009); however, values for trichloroethylene (TCE) and tetrachloroethylene (PCE) have been updated based on updated air cleanup levels published in Ecology’s Cleanup Levels and Risk Calculations Database (CLARC) on September 26, 2012. Air concentrations protective of indoor air are more stringent than those for outdoor air; therefore, Ecology’s guidance includes groundwater screening levels based on indoor air only.

The standard point of compliance for groundwater cleanup levels is throughout Site. If it is not practicable to meet groundwater cleanup levels throughout the Site, Ecology may approve a conditional point of compliance for groundwater.

For volatile groundwater contaminants that can pose a VI risk, protectiveness is achieved by meeting VI-based groundwater cleanup levels throughout Site groundwater, or wherever structures would be built on grade in the future. Therefore, for VI protection, the groundwater point of compliance is throughout the shallow aquifer.

Because Site groundwater’s highest beneficial use is discharge to surface water, protectiveness of that beneficial use is dependent on meeting surface water criteria at the

points of groundwater discharge to the adjacent surface water body (i.e., groundwater conditional point of compliance at surface water interface).

For the purposes of the RI, the standard point of compliance will be assumed, and data from each well will be compared against preliminary groundwater screening levels protective of both VI and surface water protection. However, to inform the evaluation of remedial alternatives in the FS, evaluations of groundwater contaminant nature and extent relative to surface water protection will focus on data from monitoring wells located adjacent to the surface water body. As part of the RI/FS, more detailed evaluation of groundwater contaminant natural attenuation occurring between monitoring wells and the point of discharge to surface water (point of exposure) may be conducted.

4.3.2 Soil Screening Levels

Because the Site qualifies as an industrial property under MTCA (refer to Section 2.1), the soil data will be evaluated relative to soil screening levels for industrial land use. The industrial soil screening levels are the most stringent of MTCA Method C soil cleanup levels and Method A industrial soil cleanup levels.

The point of compliance for direct contact with soil extends to 15 feet below grade, based on a reasonable maximum depth of excavation and assumed placement of excavated soils at the surface where contact occurs. Therefore, for soil screening levels based on direct contact, the soil point of compliance is to a depth of 15 feet. For soil screening levels based on groundwater protection, the soil point of compliance is all depths, above and below the water table.

4.3.3 Terrestrial Ecological Evaluation (TEE)

The Site does not qualify for any of the four primary TEE exclusions defined under WAC 173-340-7491. Areas of higher quality habitat are present near the Site, including regulated wetlands that are designated by the City of Tacoma as a "Habitat Zone". As such, there is the potential for wildlife receptors to be attracted to the Site and be exposed to contaminated soil. For these reasons, a site-specific evaluation is required under the TEE process.

The field program described in Section 5 will support completion of a site-specific TEE. Terrestrial wildlife receptors may be exposed to chemical contamination associated with Site soil or exposed stormwater pond sediment via direct contact and/or consumption of contaminated prey. Stormwater pond sediment in areas inundated by water may support benthic communities that provide a prey resource for terrestrial wildlife. The sampling and analysis for the stormwater pond sediment, adjacent soil, and eastern fence line soil will provide sufficient data to refine the list of chemicals of potential ecological concern and to characterize potential chemical exposure to terrestrial wildlife from the exposure pathways present at the Site.

Wildlife soil indicator chemical concentrations from TEE Table 749-3 will be applied as the primary line of evidence to screen Site soils and exposed and inundated stormwater pond sediment to determine the chemicals of potential ecological concern (COPEC) for the TEE. Because the stormwater pond sediments are likely to have different physiochemical properties than lake or river sediment, Washington State freshwater sediment criteria may or may not accurately predict toxicity to benthos inhabiting the

stormwater pond. For the purpose of screening chemicals of potential concern, the freshwater Sediment Management Standards (SMS) criteria (WAC 173-204) will be applied as a secondary line of evidence to screen inundated and exposed pond sediment. If a chemical in a stormwater pond sediment sample exceeds the freshwater SMS criteria, but not the TEE soil wildlife indicator chemical concentration, that chemical will be retained as a COPEC and its potential risk addressed in the TEE.

As part of the TEE, field water quality parameters will be collected at three locations in the stormwater pond. Because the stormwater pond contains waters of the State of Washington, pH will be compared to the aquatic life water quality criteria for freshwater screening levels. Aquatic life water quality criteria are not listed for other field parameters.

5 Data Gaps and Proposed Data Collection

This section presents areas of environmental concern and data gaps identified during the process of developing this SAP. For each area, additional data collection is proposed to address the data gaps. Section 5.1 provides an overview of sampling and analysis procedures common to the individual investigation areas. Sections 5.2 through 5.6 provide details on the proposed investigation approach for each area, and Section 5.7 describes site-wide hydrogeologic data collection.

5.1 Sampling and Analysis Overview

To sufficiently characterize the Site for the purposes of a MTCA-compliant RI/FS, soil and groundwater sampling at 11 monitoring well locations (MW-6S through MW-16S) and soil sampling within the Test Trench are identified on Figure 2. The sampling characterizes shallow soil and groundwater within the shallowest water-bearing zone across the Site. Table 3 provides the rationale for each sampling location.

Each monitoring well boring will be advanced using a direct-push drill rig, with collection of a continuous² soil core to a depth of approximately 15 feet. Two soil samples will be collected from each boring: one above the water table (approximately 1 to 2 feet bgs), and one at the water table observed during drilling (expected approximately 3 to 4 feet bgs). A deeper sample of saturated soil (approximately 6 to 7 feet bgs) will also be archived (frozen) for subsequent chemical analysis, if warranted, based on results from the shallower samples. Soil sample depths can be adjusted based on field observations, including field screening for the presence of volatile organic vapors.

The test trench is intended to assess the presence of potential subsurface fuel pipelines and potential petroleum releases associated with a pipeline or historical boiler operation. Up to five soil samples will be collected from the proposed trenching, based on field observations.

Aspect proposes to analyze³ the 27 planned soil samples for the following constituents:

- Metals including arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc by EPA Methods 6010/7471;
- VOCs by EPA Method 8260;
- Gasoline-, diesel-, and oil-range petroleum hydrocarbons by Methods NWTPH-Gx and NWTPH-Dx; and
- PAHs by EPA Method 8270 SIM.

If warranted, the archived deeper soil samples will be analyzed for specific analytes to be determined based on results from the shallower soil samples.

² Continuous sampling is subject to soil recovery within each core.

³ Analyses to be performed by Analytical Resources Inc. of Tukwila, Washington, as described in Appendix C.

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The monitoring wells will be constructed from 2-inch PVC casing, with 10-foot well screens placed similar to those in the six existing “shallow” monitoring wells on the Site (e.g., 3 to 13 feet bgs). In addition to the monitoring wells, a permanent staff gauge will be installed in the stormwater pond to serve as a monitoring point for surface water levels.

- Following installation of the new monitoring wells and the staff gauge, the entire groundwater and surface water monitoring network will be surveyed under the supervision of a licensed Washington State Land surveyor. The monitoring network will be surveyed in a common datum at a horizontal accuracy of 0.1 foot and a vertical accuracy of 0.01 foot.

Groundwater samples will be collected from the entire groundwater monitoring network (11 new plus six existing wells) in a single event. To confirm the results of the initial sampling round, a second round of groundwater sampling and analysis will be repeated approximately 3 months later.

We propose to analyze each groundwater sample for the following constituents:

- Field parameters including depth to water, temperature, pH, specific electric conductance, dissolved oxygen, and oxidation/reduction potential (ORP);
- Dissolved metals including arsenic, cadmium, chromium, copper, lead, nickel, and zinc by EPA Methods 200.8;
- Dissolved mercury by a modified (low level) EPA Method 7470;
- VOCs by EPA 8260;
- Gasoline-, diesel-, and oil-range petroleum hydrocarbons by Methods NWTPH-Gx and NWTPH-Dx;
- Low-level PAHs by EPA Method 8270 SIM; and
- Total Suspended Solids (TSS) by Method SM2540D.

To characterize the nature and extent of potential Site-related chemical contamination within and adjacent to the stormwater pond, 25 sediment core stations will be distributed across eight transects within the pond for visual observation and logging. A subset of these sediment cores (12 samples) will be submitted for chemical analysis. In addition, six surface soil samples will be collected along the north edge of the stormwater pond, and one sample will be collected on the eastern fence line to characterize potential exposure to terrestrial wildlife (Figure 2). Where standing water is present at the time of the field investigation, conventional water quality parameters will be measured at three locations.

We propose to analyze each of the 12 stormwater pond sediment samples and seven soil samples for the following constituents:

- Metals including arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc by EPA Methods 6010/7471;
- VOCx by EPA Method 8260;
- Gasoline-, diesel-, and oil-range petroleum hydrocarbons by Methods NWTPH-Gx and NWTPH-Dx;

- PAHs by EPA Method 8270 SIM; and
- In addition, stormwater pond sediment samples will be analyzed for Total Organic Carbon by EPA (1986) and total sulfides by Plumb (1981).

The analytical data collected during this investigation will be independently validated for data quality by Pyron Environmental, Inc., compiled into a project database, and then uploaded to Ecology's Environmental Information Management (EIM) database.

The validated analytical data will be evaluated relative to appropriate MTCA and SMS screening levels for the industrial Site. The evaluation will include comparison of data to screening benchmarks for protection of terrestrial wildlife receptors to support evaluation of chemicals of potential ecological concern.

The rationale for additional data collection is presented by area in the following subsections. Figure 2 shows an overview of the proposed explorations described in this section. Appendix B details the field procedures to be followed during the proposed data collection. Additional information on laboratory analytical methods and quality control is provided in the QAPP, included as Appendix C.

5.2 Southern Debris-Fill Area

Soil within the southern lobe of identified debris fill (Debris-Fill Area, Figure 2), located south of the Former Boiler House, is known to contain elevated levels of gasoline-range TPH, total xylenes, total chromium, lead, and zinc. Groundwater within this lobe of debris fill is known to contain elevated levels of oil-range petroleum hydrocarbons, benzo(a)pyrene, total cPAHs, arsenic, and total chromium. The northern extent of the contaminated debris fill has not yet been delineated in the vicinity of the Former General and Pipe Storage area, and the Former Boiler House area has not yet been delineated (Ecology, 2013).

Potential sources of the contamination in this debris fill include the "Diesel & Kerosene Storage Shed" area and possibly the former Bunker C fuel oil AST (No. 15), as identified from a 1991 Site layout plan provided by PQ Corporation during the Floyd|Snider (2007a) Phase I investigation. The specific location of the former Bunker C fuel oil AST has never been identified; however, an unknown tank matching the general size of the Bunker C fuel oil AST is visible in this debris-fill area in the mid-1950s, 1965, 1969, and 1973 historical aerial photos. The location of the unknown tank is depicted on Figure 2.

The proposed data collection for this area is as follows:

- Advance and sample soil from two soil borings (MW-15S and MW-16S) adjacent to the identified debris-fill area. Two soil samples and an archive soil sample will be collected from each boring at the general depth intervals identified in Section 5.1 for the chemical analyses outlined in that section; and
- Complete the new borings as monitoring wells, and collect groundwater samples from them and existing monitoring wells in the vicinity of the debris-fill area (MW-1S, MW-2S, MW-3S, MW-4S, MW-5S, and MW-5D) for the chemical analyses identified in Section 5.1.

5.3 Former Fuel ASTs and Former Boiler House

The Former Fuel Oil Tank, identified as AST No. 20 on Figure 2, was used to store fuel for the boiler. In addition to AST No. 20, the existence of a Bunker C fuel oil AST (No. 15) was identified but not located during the Phase I assessment. Aspect expects that the AST would have been located west of the Former Boiler House, near the railroad tracks that were used to import raw materials and supplies, and it is possible that AST No. 15 is the same location as the Former Fuel Oil Tank (AST No. 20). Pipelines, presumed subsurface, would have conveyed the stored fuel to the Former Boiler House for burning.

The proposed data collection for this area is as follows:

- Complete a long test trench(es) in the vicinity of the Former Boiler House to observe for presence of potential subsurface fuel pipelines, and, if encountered, uncover and document their full extent. Using a small excavator, the test trench will be advanced to a depth of approximately 4 feet bgs. The trench will start near the Former Fuel Oil Tank (AST No. 20). If a subsurface fuel pipeline is encountered, the test trench will be adjusted from that shown on Figure 2 to uncover and observe the fuel pipeline's full length, if possible. Analyze up to five soil samples from the test trench for diesel- and oil-range hydrocarbons based on field observations.
- Advance and sample soil from one soil boring (MW-9S) at the location of the Former Fuel Oil Tank (AST No. 20). Collect two soil samples and an archive soil sample from each boring at the general depth intervals identified in Section 5.1 for the chemical analyses outlined in that section.
- Complete the boring as a monitoring well, and collect a groundwater sample from it for the chemical analyses identified in Section 5.1.

5.4 Ancillary Storage and Maintenance Buildings

Former buildings, ancillary to the main manufacturing operation, include the following:

- Former Maintenance Shop, which is known to have had a waste oil tank and a solvent-based parts washer;
- Former Oil Shed; and
- Former Garage.

The proposed data collection for these areas is as follows:

- Advance and sample soil from four soil borings located within the areas occupied by the former ancillary buildings: MW-6S and MW-7S (Former Maintenance Shop with waste oil tank), MW-8S (Former Oil Shed), and MW-10S (Former Garage). Collect two soil samples and an archive soil sample from each boring at the general depth intervals identified in Section 5.1 for the chemical analyses outlined in that section; and
- Complete the new borings as monitoring wells, and collect groundwater samples from them for the chemical analyses identified in Section 5.1.

5.5 Shallow Fill Soils

The source of the shallow fill (approximately 5 feet or less) at the Site is unknown. The fill is observed to be primarily sand, but containing occurrences of sodium silicate, refractory brick, and other non-native materials. Fill outside the debris-fill area has not been investigated beyond field observations. The Phase I investigation (Floyd|Snider, 2007a) noted that the 1114 Taylor Way parcel appears higher in grade than the 1202 Taylor Way parcel, and that the source and age of the 1114 Taylor Way fill is unknown. The determination of groundwater flow direction was also considered when planning the data collection to address shallow fill soils (Section 5.7)

The proposed data collection for this area is as follows:

- Advance and sample soil from four soil borings (MW-11S, MW-12S, MW-13S, and MW-14S) in the northern and western parts of the Site. Collect two soil samples and an archive soil sample from each boring at the general depth intervals identified in Section 5.1 for the chemical analyses outlined in that section; and
- Complete the borings as monitoring wells, and collect a groundwater sample from them for the chemical analyses identified in Section 5.1.

5.6 Stormwater Pond

Previous Site investigations identified the presence of sodium silicate deposits in the stormwater pond, with a hydrocarbon odor noted in one core location. Additional characterization planned in the stormwater pond and adjacent area will support development of a MTCA-compliant TEE.

The proposed data collection to support the TEE is as follows:

- Collect sediment cores at 25 stations distributed across a series of eight transects, each of which span the full northeast-southwest width of the pond. Transects will be spaced 75 feet apart in the vicinity of identified debris fill and 150 feet apart elsewhere. At all stations, the cores will be manually advanced to a depth of about 3 feet, if possible, using a hand-coring device, and visually inspected and logged.
- Collect sediment samples for chemical analysis from a subset of eight core locations in the vicinity of the probable fill area. Two to three samples will be collected from these locations, based on distinct stratigraphic units and/or observations of potential contamination. Up to 12 sediment samples will be submitted for laboratory analysis as described in Section 5.1, with the remainder archived (frozen). If warranted, based on the results of the initial testing, the archived deeper sediment samples will be tested for specific analytes (to be determined) based on the results from the shallower samples.
- At three locations with standing water in the stormwater pond, field-measure conventional water quality parameters, including pH, conductivity, dissolved oxygen, and ORP.

- Collect surface soil samples at six locations north of the stormwater pond boundary and at one location on the eastern fence line to characterize potential exposure to terrestrial wildlife. These soil sampling locations north of the stormwater pond boundary are placed in line with other transect locations. Submit each of the seven soil samples for laboratory analysis of the analytes described in Section 5.1.

5.7 Hydrogeologic Data Collection

Groundwater elevation data has been collected only from the existing monitoring wells within the debris-fill area. These data confirm groundwater locally flowing to the south-southwest into the adjacent stormwater pond at the south end of the Site (ERM, 2010). However, regional groundwater flow across the Blair-Hylebos peninsula is generally semi-radial, with a groundwater divide within the middle of the peninsula. This divide causes groundwater to flow toward the Hylebos Waterway on the north and the Blair Waterway on the south. The Site is located several hundred feet closer to the Hylebos Waterway than the Blair Waterway, suggesting that groundwater flow near the debris-fill area is not representative of the groundwater flow direction across the entire Site.

The proposed data collection to document groundwater flow direction beneath the Site is as follows:

- Install a staff gauge in the stormwater pond to provide a surface water level control point; and
- During each groundwater sampling event (3 months apart), collect water level measurements from each surveyed monitoring well and from the pond staff gauge, and use that water level elevation data to produce groundwater elevation contour maps.

6 References

- Ecology, 2009, Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action, Review Draft, October 2009, Ecology Publication No. 09-09-047.
- Ecology, 2011, Early Notice Letter Regarding Release of Hazardous substances at the Former PQ Corporation (site name), located 1202 Taylor Way, Tacoma, Washington 98421, Facility Site Identification Number: 68592738.
- Ecology, 2012, Voluntary Cleanup Program Acceptance Letter – Site SW1269. December 19, 2012.
- Ecology, 2013, “RE: draft Overview of Sampling and Analysis Plan, Former PQ Corporation Site”, Email message to Steve Germiot and Scott Rose from Hans Qiu, February 28.
- ERM, 2010, Site Characterization Report, Former PQ Corporation Plant, Prepared for PQ Corporation, December 20.
- Floyd|Snider, 2007a, Phase I Environmental Site Assessment, PQ Corporation, Tacoma, Washington, Prepared for Port of Tacoma, July 13.
- Floyd|Snider, 2007b, Phase II Environmental Site Assessment, PQ Corporation, Tacoma, Washington, Prepared for Port of Tacoma, August 28.
- GeoEngineers, 2010, Final Report, 721 East Alexander Avenue and Adjacent Properties Data Summary, Tacoma, Washington, January 25, 2010.
- Hart-Crowser and Associates, Incorporated, 1974, Geology of the Port of Tacoma, Prepared for the Port of Tacoma.
- Parametrix, 2009, Re: PQ Corporation Tacoma Plant, Prepared for Port of Tacoma, November 17.
- Pierce County Assessor, 2013, Pierce County Assessor-Treasurer Electronic Property Information Profile [online]. Retrieved April 12, 2013 from:
<http://epip.co.pierce.wa.us/cfapps/atr/epip/sales.cfm?parcel=2275200260> and
<http://epip.co.pierce.wa.us/cfapps/atr/epip/sales.cfm?parcel=0321263016>
- Plumb, R. H. Jr. 1981, Procedure for Handling and Chemical Analysis of Sediment and Water Samples, Technical Report EPA/CE-81-1, U.S. Environmental Protection Agency and U.S. Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.
- PQ Corporation, 2013, Typical Property Data for PQ Liquid Sodium Silicates, Bulletin 17-2A.
- U.S. Environmental Protection Agency (EPA), 1986, Method 9060: Total Organic Carbon, Test Procedures for Solid Waste, 3rd ed, SW-846, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

Limitations

Work for this project was performed for the Port of Tacoma (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

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Table 1 - Soil Data Comparison to Preliminary Screening Levels

120051 Former PQ Corporation Site

Analyte	Number of Sample Locations	Number of Analyses	Number of Detections	Maximum Detection	Units	Preliminary Human Health Soil Screening Levels			Preliminary Terrestrial Wildlife Soil Screening Levels		
						Preliminary Industrial Soil Screening Level	Number of Detections > Screening Level	Number of Non-Detects with Detection Limit > Screening Level	Preliminary Wildlife Soil Screening Level	Number of Detections > Screening Level	Number of Non-Detects with Detection Limit > Screening Level
Total Petroleum Hydrocarbons (TPH)											
Gasoline Range Hydrocarbons	9	12	6	150	mg/kg	30	4	0	5000	0	0
Diesel Range Hydrocarbons	9	12	7	270	mg/kg	2000	0	0	6000	0	0
Oil Range Hydrocarbons	9	12	10	1100	mg/kg	2000	0	0	---	---	---
Metals											
Antimony	9	13	5	1.6	mg/kg	1400	0	0	---	---	---
Arsenic	9	13	8	20	mg/kg	20	0	0	132	0	0
Beryllium	9	13	0	NA	mg/kg	7000	0	0	---	---	---
Cadmium	9	13	7	5.5	mg/kg	2	2	0	14	0	0
Chromium (Total)	9	13	13	160	mg/kg	2000	0	0	67	7	0
Copper	9	13	13	135	mg/kg	140000	0	0	217	0	0
Lead	9	13	13	660	mg/kg	1000	0	0	118	7	0
Mercury	9	13	11	9	mg/kg	2	3	0	5.5	1	0
Methylmercury	2	2	2	0.0017	mg/kg	350	0	0	0.4	0	0
Nickel	9	13	13	256	mg/kg	70000	0	0	980	0	0
Selenium	9	13	0	NA	mg/kg	18000	0	0	0.3	0	13
Silver	9	13	0	NA	mg/kg	18000	0	0	---	---	---
Thallium	9	13	0	NA	mg/kg	---	---	---	---	---	---
Zinc	9	13	13	1140	mg/kg	1100000	0	0	360	6	0
Volatile Organic Compounds (VOC)											
Benzene	9	12	1	0.0061	mg/kg	0.03	0	5	---	---	---
Ethylbenzene	9	12	2	1.2	mg/kg	6	0	0	---	---	---
Toluene	9	12	1	1.1	mg/kg	7	0	0	---	---	---
m,p-Xylenes	6	7	2	9.3	mg/kg	---	---	---	---	---	---
o-Xylene	6	7	2	4.5	mg/kg	700000	0	0	---	---	---
Total Xylenes	9	12	2	14	mg/kg	9	1	0	---	---	---

Table 1 - Soil Data Comparison to Preliminary Screening Levels

120051 Former PQ Corporation Site

Analyte	Number of Sample Locations	Number of Analyses	Number of Detections	Maximum Detection	Units	Preliminary Human Health Soil Screening Levels			Preliminary Terrestrial Wildlife Soil Screening Levels		
						Preliminary Industrial Soil Screening Level	Number of Detections > Screening Level	Number of Non-Detects with Detection Limit > Screening Level	Preliminary Wildlife Soil Screening Level	Number of Detections > Screening Level	Number of Non-Detects with Detection Limit > Screening Level
Polycyclic Aromatic Hydrocarbons (PAHs)											
Acenaphthene	9	12	4	0.048	mg/kg	210000	0	0	---	---	---
Acenaphthylene	9	12	4	0.036	mg/kg	---	---	---	---	---	---
Anthracene	9	12	6	0.063	mg/kg	1100000	0	0	---	---	---
Benzo(g,h,i)perylene	9	12	10	0.29	mg/kg	---	---	---	---	---	---
Dibenzofuran	6	7	0	NA	mg/kg	3500	0	0	---	---	---
Fluoranthene	9	12	9	0.45	mg/kg	140000	0	0	---	---	---
Fluorene	9	12	4	0.23	mg/kg	140000	0	0	---	---	---
Phenanthrene	9	12	8	0.61	mg/kg	---	---	---	---	---	---
Pyrene	9	12	9	0.54	mg/kg	110000	0	0	---	---	---
1-Methylnaphthalene	6	7	2	0.075	mg/kg	4500	0	0	---	---	---
2-Methylnaphthalene	6	7	2	0.076	mg/kg	14000	0	0	---	---	---
Naphthalene	9	12	6	0.44	mg/kg	5	0	0	---	---	---
Total Naphthalenes	3	5	4	0.7	mg/kg	---	---	---	---	---	---
Benz(a)anthracene	9	12	9	0.22	mg/kg	180	0	0	---	---	---
Benzo(a)pyrene	9	12	8	0.22	mg/kg	2	0	0	12	0	0
Benzo(b)fluoranthene	9	12	9	0.26	mg/kg	180	0	0	---	---	---
Benzo(k)fluoranthene	9	12	8	0.2	mg/kg	1800	0	0	---	---	---
Chrysene	9	12	9	0.37	mg/kg	18000	0	0	---	---	---
Dibenzo(a,h)anthracene	9	12	5	0.082	mg/kg	18	0	0	---	---	---
Indeno(1,2,3-cd)pyrene	9	12	8	0.22	mg/kg	180	0	0	---	---	---
Total cPAHs TEQ	9	12	10	0.32	mg/kg	2	0	0	12	0	0
Polychlorinated Biphenyls (PCBs)											
Aroclor 1016	3	5	0	NA	mg/kg	250	0	0	---	---	---
Aroclor 1221	3	5	0	NA	mg/kg	---	---	---	---	---	---
Aroclor 1232	3	5	0	NA	mg/kg	---	---	---	---	---	---
Aroclor 1242	3	5	0	NA	mg/kg	---	---	---	---	---	---
Aroclor 1248	3	5	1	0.074	mg/kg	---	---	---	---	---	---
Aroclor 1254	3	5	2	0.11	mg/kg	66	0	0	---	---	---
Aroclor 1260	3	5	2	0.053	mg/kg	66	0	0	---	---	---
Total PCBs	3	5	2	0.24	mg/kg	10	0	0	---	---	---

Note: Screening levels are described in Section 4.3.

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6/17/2013

V:\120051 Port of Tacoma PQ Corporation Site\Deliverables\SAP\Ecology Review Draft 6-17-13\Tables 1 and 2 - Summary of Existing Data

Table 1

Remedial Investigation Sampling and Analysis Plan

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Table 2 - Groundwater Data Comparison to Preliminary Screening Levels

120051 Former PQ Corporation Site

Analyte	Total or Dissolved Metals	Number of Sample Locations	Number of Analyses	Number of Detections	Maximum Detection	Units	Preliminary Groundwater Screening Level	Number of Detections > Screening Level	Number of Non-Detects with Detection Limit > Screening Level
Total Petroleum Hydrocarbons (TPH)									
Gasoline Range Hydrocarbons		6	6	2	80	ug/L	800	0	0
Diesel Range Hydrocarbons		6	6	2	330	ug/L	500	0	0
Oil Range Hydrocarbons		6	6	2	900	ug/L	500	1	0
Metals									
Antimony	Dissolved	6	6	4	5.1	ug/L	5.6	0	0
Antimony	Total	6	6	5	7.6	ug/L	5.6	1	0
Arsenic	Dissolved	6	6	6	35	ug/L	5	6	0
Arsenic	Total	6	6	6	34	ug/L	5	6	0
Beryllium	Dissolved	6	6	1	1	ug/L	32	0	0
Beryllium	Total	6	6	1	1.3	ug/L	32	0	0
Cadmium	Dissolved	6	6	2	0.66	ug/L	0.25	2	4
Cadmium	Total	6	6	2	0.85	ug/L	0.25	2	4
Chromium (Total)	Dissolved	6	6	6	93	ug/L	57	2	0
Chromium (Total)	Total	6	6	6	170	ug/L	57	4	0
Copper	Dissolved	6	6	6	91	ug/L	3.1	6	0
Copper	Total	6	6	6	96	ug/L	3.1	6	0
Lead	Dissolved	6	6	6	260	ug/L	0.54	6	0
Lead	Total	6	6	3	290	ug/L	0.54	3	3
Mercury	Dissolved	6	6	0	NA	ug/L	0.012	0	6
Mercury	Total	6	6	2	2.7	ug/L	0.012	2	4
Nickel	Dissolved	6	6	3	18	ug/L	8.2	2	0
Nickel	Total	6	6	3	38	ug/L	8.2	2	0
Selenium	Dissolved	6	6	0	NA	ug/L	5	0	0
Selenium	Total	6	6	1	3.3	ug/L	5	0	0
Silver	Dissolved	6	6	0	NA	ug/L	0.32	0	6
Silver	Total	6	6	0	NA	ug/L	0.32	0	6
Thallium	Dissolved	6	6	0	NA	ug/L	0.24	0	6
Thallium	Total	6	6	0	NA	ug/L	0.24	0	6
Zinc	Dissolved	6	6	3	260	ug/L	32	2	0
Zinc	Total	6	6	3	290	ug/L	32	2	0

Table 2 - Groundwater Data Comparison to Preliminary Screening Levels

120051 Former PQ Corporation Site

Analyte	Total or Dissolved Metals	Number of Sample Locations	Number of Analyses	Number of Detections	Maximum Detection	Units	Preliminary Groundwater Screening Level	Number of Detections > Screening Level	Number of Non-Detects with Detection Limit > Screening Level
Volatile Organic Compounds (VOC)									
Benzene		6	6	0	NA	ug/L	1.2	0	6
Ethylbenzene		6	6	0	NA	ug/L	530	0	0
Toluene		6	6	0	NA	ug/L	1300	0	0
m,p-Xylenes		6	6	0	NA	ug/L	670	0	0
o-Xylene		6	6	0	NA	ug/L	960	0	0
Polycyclic Aromatic Hydrocarbons (PAHs)									
Acenaphthene		6	6	2	0.83	ug/L	640	0	0
Acenaphthylene		6	6	1	0.045	ug/L	---	---	---
Anthracene		6	6	2	0.063	ug/L	8300	0	0
Benzo(g,h,i)perylene		6	6	4	0.066	ug/L	---	---	---
Dibenzofuran		6	6	2	0.095	ug/L	---	---	---
Fluoranthene		6	6	2	0.23	ug/L	130	0	0
Fluorene		6	6	2	0.33	ug/L	1100	0	0
Phenanthrene		6	6	3	0.4	ug/L	---	---	---
Pyrene		6	6	2	0.28	ug/L	830	0	0
1-Methylnaphthalene		6	6	2	3.4	ug/L	---	---	---
2-Methylnaphthalene		6	6	2	2.5	ug/L	---	---	---
Naphthalene		6	6	6	5.7	ug/L	360	0	0
Benz(a)anthracene		6	6	2	0.048	ug/L	0.0028	2	4
Benzo(a)pyrene		6	6	2	0.023	ug/L	0.0028	2	4
Benzo(b)fluoranthene		6	6	2	0.035	ug/L	0.0028	2	4
Benzo(k)fluoranthene		6	6	1	0.026	ug/L	0.0028	1	5
Chrysene		6	6	2	0.11	ug/L	0.0028	2	4
Dibenzo(a,h)anthracene		6	6	0	NA	ug/L	0.0028	0	6
Indeno(1,2,3-cd)pyrene		6	6	0	NA	ug/L	0.0028	0	6
Total cPAHs TEQ		6	6	6	0.037	ug/L	0.0028	6	0
Field Parameters									
Dissolved Oxygen		6	6	6	1.26	mg/L	---	---	---
ORP		6	6	6	-86	mVolts	---	---	---
pH		6	6	6	10.1	pH Units	6.5 - 8.5	5	0
Specific Conductance		6	6	6	2492	us/cm	---	---	---
Temperature		6	6	6	20.23	deg C	---	---	---

Note: Screening levels are described in Section 4.3.

Aspect Consulting

6/17/2013

V:\120051 Port of Tacoma PQ Corporation Site\Deliverables\SAP\Ecology Review Draft 6-17-13\Tables 1 and 2 - Summary of Existing Data

Table 2

Remedial Investigation Sampling and Analysis Plan

Page 2 of 2

Table 3 - Proposed Soil and Groundwater Sampling Locations

120051 Former PQ Corporation Site

Location	Purpose (Area Being Characterized)
MW-6S	Soil and groundwater at Former Waste Oil Tank
MW-7S	Soil and groundwater at Former Maintenance Shop
MW-8S	Soil and groundwater at Former Oil Shed
MW-9S	Soil and groundwater at Former Fuel Oil Tank (AST No. 20)
MW-10S	Soil and groundwater at Former Garage
MW-11S	General fill and groundwater on north side of main operational area
MW-12S	General fill and groundwater in center of Site
MW-13S	General fill and groundwater adjacent to stormwater wetland on southwest side of Site
MW-14S	General fill and groundwater on west side of Site
MW-15S	General fill and groundwater adjacent to Probable Fill area
MW-16S	Soil and groundwater at Former Boiler House
Test Trench	Soil within Former Boiler House with potential subsurface fuel pipeline



GIS Path: I:\projects_81\Port of Tacoma\Parcel_114_Cleanup_120051\WorkArea\Fig1_SiteVicinityMap.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 | Date Saved: 4/24/2013 | User: hovelace | Print Date: 4/24/2013

Site Vicinity Map
 Former PQ Corporation Site
 Tacoma, Washington

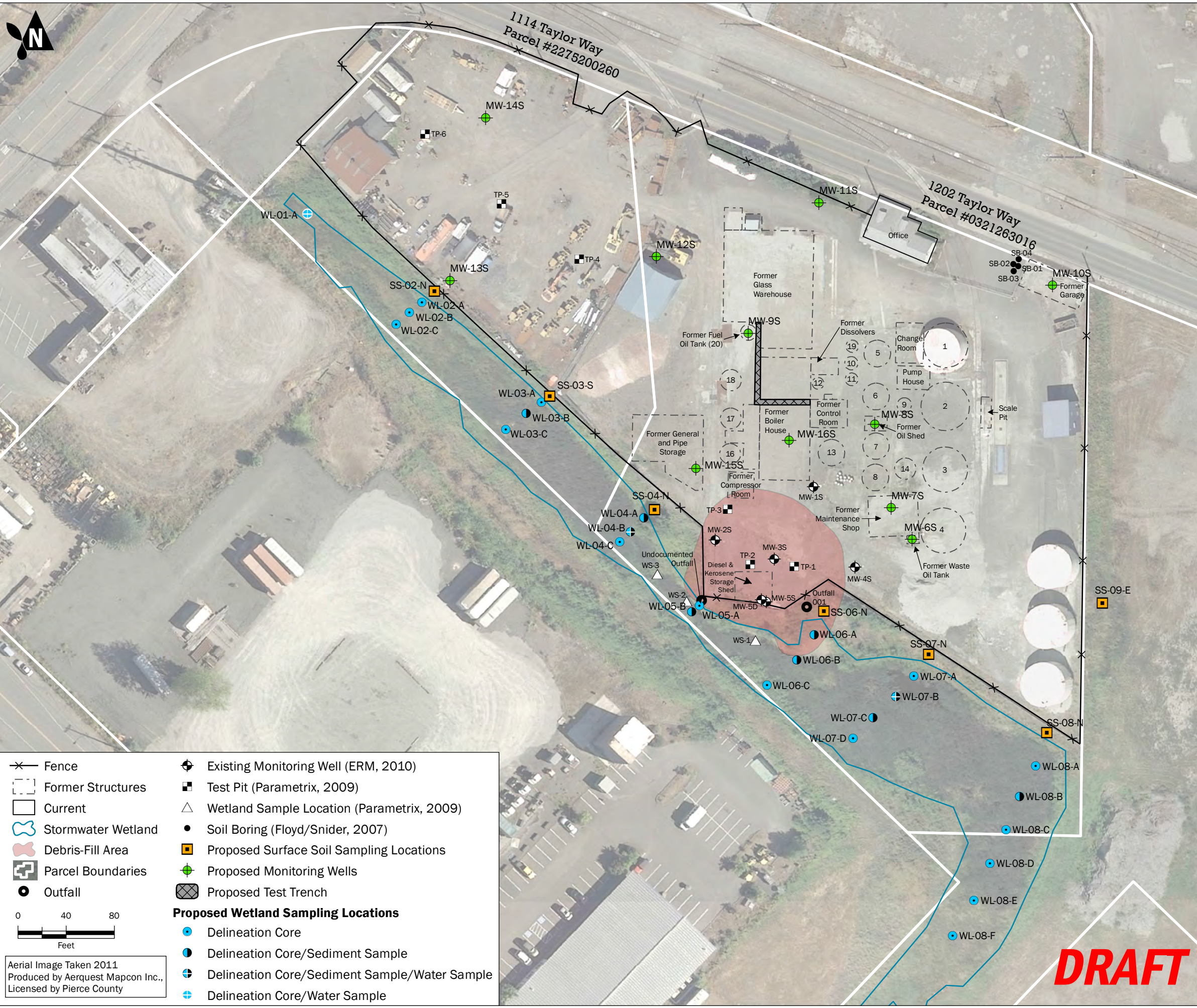
DRAFT



APR-2013
 PROJECT NO.
 120051

BY:
 HRL
 REV BY:

FIGURE NO.
1



Aboveground Storage Tanks (Floyd/Snider, 2007)	
ASTID Number	Former Contents
1, 2, 3, 4	Sodium Silicate
5, 6, 7	Sodium Silicate
8	Sodium Silicate
9	Process Water
10, 11, 12	Sodium Silicate
13	Cooling Process Water
14	Sodium Silicate
15 (Removed <2007)	Bunker C Fuel Oil
16	Sand
17	Soda Ash
18	Sand
19	Sodium Silicate
20	Fuel Oil

✂ Fence
 [Dashed Box] Former Structures
 [Solid Box] Current
 [Blue Wavy Line] Stormwater Wetland
 [Red Shaded Area] Debris-Fill Area
 [Black Line] Parcel Boundaries
 ● Outfall

⚓ Existing Monitoring Well (ERM, 2010)
 [Black Square] Test Pit (Parametrix, 2009)
 △ Wetland Sample Location (Parametrix, 2009)
 ● Soil Boring (Floyd/Snider, 2007)
 [Orange Square] Proposed Surface Soil Sampling Locations
 [Green Circle] Proposed Monitoring Wells
 [Cross-hatched Box] Proposed Test Trench

Proposed Wetland Sampling Locations
 ● Delineation Core
 ● Delineation Core/Sediment Sample
 ● Delineation Core/Sediment Sample/Water Sample
 ● Delineation Core/Water Sample

0 40 80
 Feet

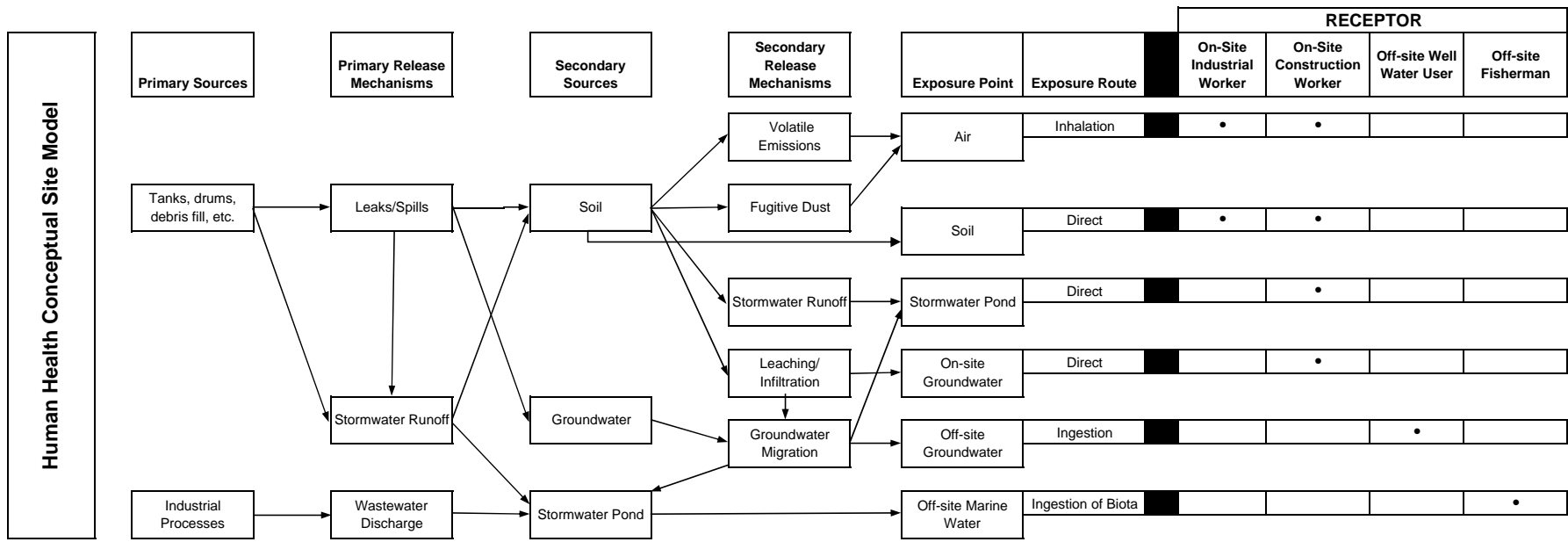
Aerial Image Taken 2011
 Produced by Aerquest Mapcon Inc.,
 Licensed by Pierce County

**Site Features
and Proposed Explorations**
 Former PQ Corporation Site
 Tacoma, Washington

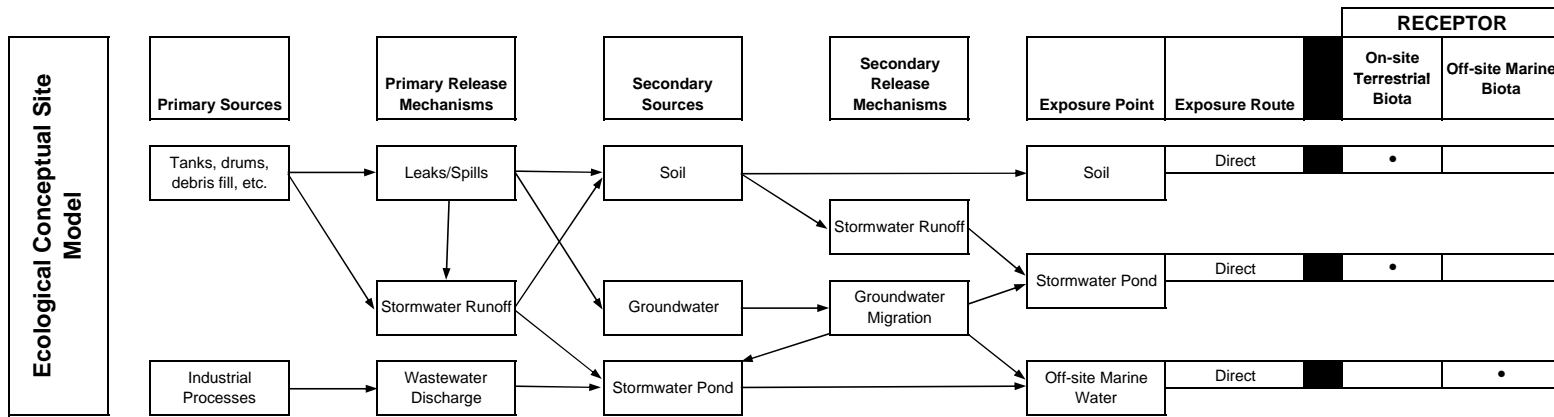
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	APR-2013	BY: HRL	FIGURE NO. 2
	PROJECT NO. 120051	REV BY: ---	

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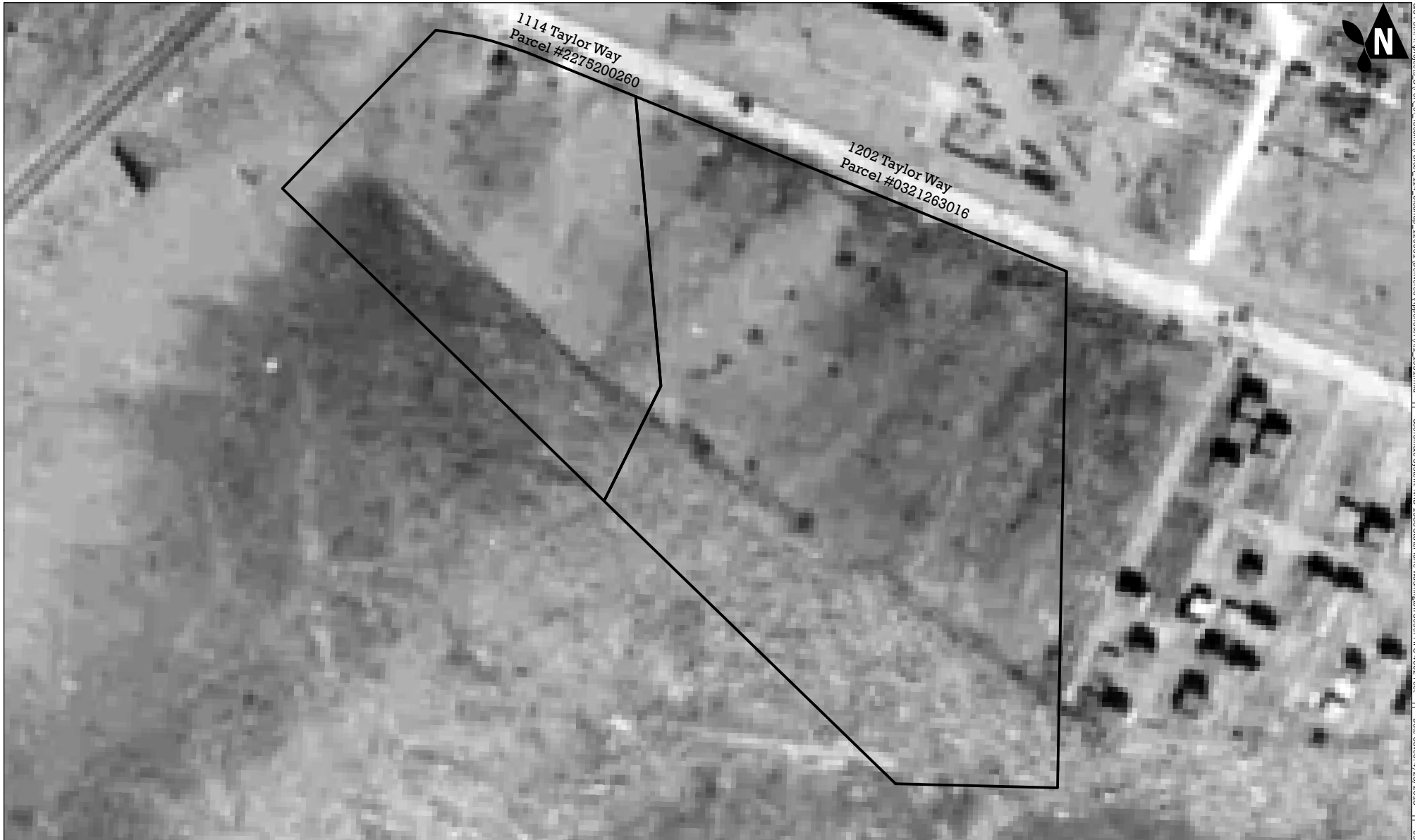
Notes: "Direct" human exposure can include dermal contact and incidental ingestion.



Notes: "Direct" ecological exposure can include dermal contact and ingestion, with screening levels addressing potential bioaccumulation.

APPENDIX A

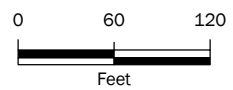
Historical Photographs



SIS Path: I:\projects_8\Part of Tacoma Parcel_114_Cleanup_120051\Deliverables\Appendix A.1_1931.mxd | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | Date Saved: 4/23/2013 | User: hnowton | Print Date: 4/24/2013



Present Day (2013)
Parcel Boundaries



1931 Aerial Photograph Source: Phase I Investigation EDR Report, Floyd|Snider, 2007a

Former PQ Corporation Site
Tacoma, Washington




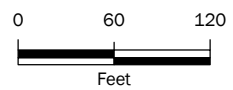
APR-2013	BY: DFR / HRL	FIGURE NO. A.1
PROJECT NO. 120051	REV BY: ---	



1114 Taylor Way
Parcel #2275200260

1202 Taylor Way
Parcel #0321263016

 Present Day (2013)
Parcel Boundaries



1946 Aerial Photograph
Source: Phase I Investigation
EDR Report, Floyd|Snider, 2007a

Former PQ Corporation Site
Tacoma, Washington

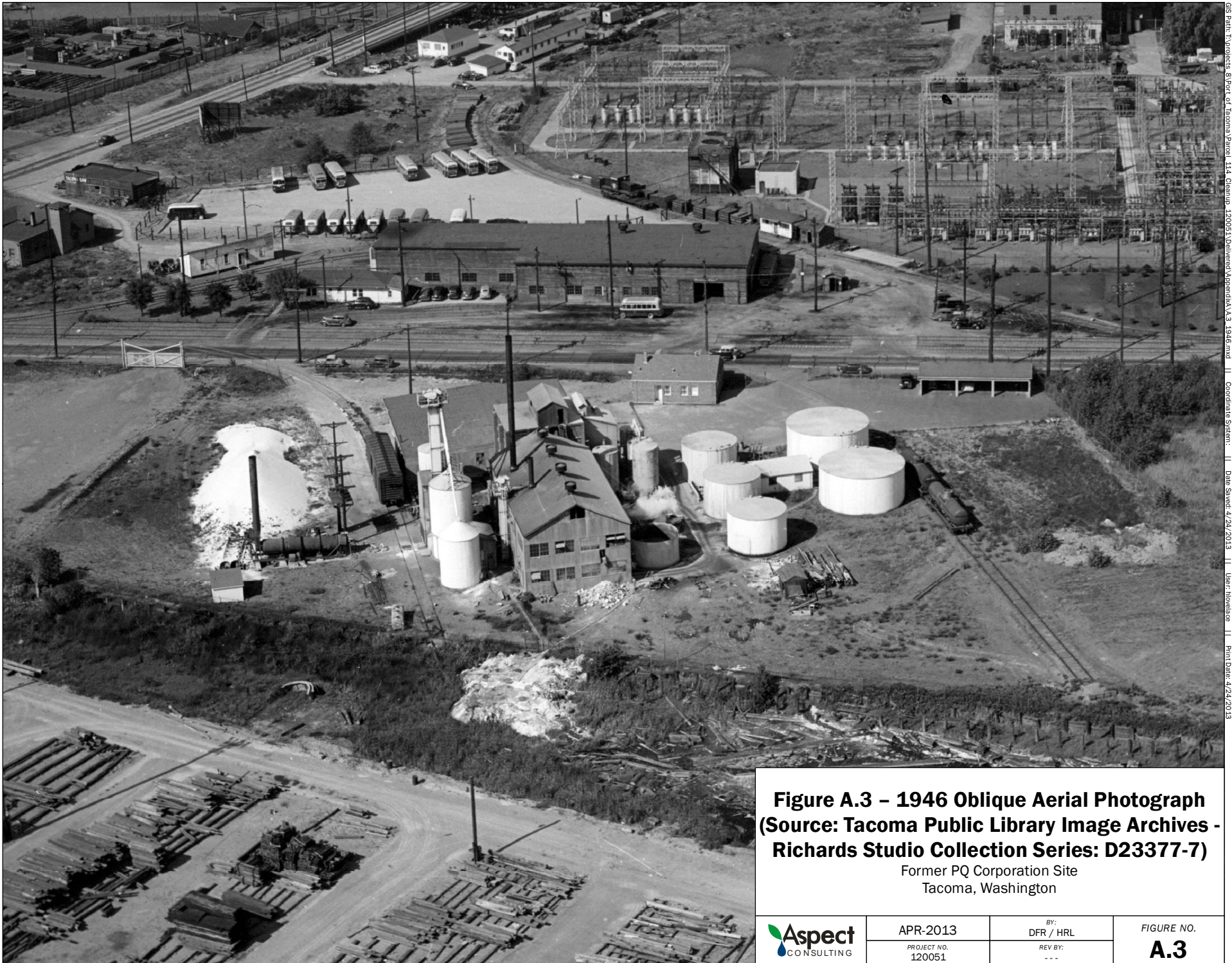


APR-2013
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120051

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FIGURE NO.
A.2

GIS Point: T:\Projects_8\Part of Tacoma Parcel_114_Cleanup_120051\Deliverables\Appendix A.2_1946.mxd | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | Date Shared: 4/24/2013 | User: thavelos | Print Date: 4/24/2013



GIS Path: I:\Projects_8\Part of Tacoma Parcel_114 Cleanup_120051\Delivered\Appendix A.3_1946.mxd | Coordinate System: | Date Saved: 4/24/2013 | User: hlowe@ce | Print Date: 4/24/2013

**Figure A.3 – 1946 Oblique Aerial Photograph
 (Source: Tacoma Public Library Image Archives -
 Richards Studio Collection Series: D23377-7)**

Former PQ Corporation Site
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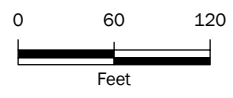
FIGURE NO.

A.3



SIS Path: T:\projects_8\Part of Tacoma Parcel_114_Cleanup_120051\Deliverables\Appendix A.4_1950.mxd | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | Date Shared: 4/24/2013 | User: hnovelov | Print Date: 4/24/2013

 Present Day (2013)
Parcel Boundaries



1950 Aerial Photograph
Source: Phase I Investigation
EDR Report, Floyd|Snider, 2007a

Former PQ Corporation Site
Tacoma, Washington



APR-2013	BY: DFR / HRL	FIGURE NO. A.4
PROJECT NO. 120051	REV BY: ---	



GIS Path: I:\projects_8\Part of Tacoma Parcel_114_Cleanup_120051\Delivered\Appendix A.5_1952.mxd | Coordinate System: | Date Saved: 4/24/2013 | User: howellc | Print Date: 4/24/2013

Figure A.5 – 1952 Oblique Aerial Photograph
(Source: Tacoma Public Library Image Archives -
Richards Studio Collection Series: A68307-1)

Former PQ Corporation Site
 Tacoma, Washington



APR-2013

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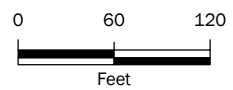
FIGURE NO.

A.5



GIS Path: I:\Projects_8\Part of Tacoma Parcel_114_Cleanup_120051\Deliverables\Appendix A.G_1965.mxd | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | Date Saved: 4/24/2013 | User: hnovelton | Print Date: 4/24/2013

 Present Day (2013)
Parcel Boundaries



1965 Aerial Photograph
Source: Phase I Investigation
EDR Report, Floyd|Snider, 2007a


Former PQ Corporation Site
Tacoma, Washington

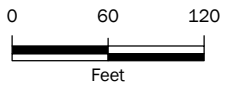


APR-2013	BY: DFR / HRL	FIGURE NO. A.6
PROJECT NO. 120051	REV BY: ---	



SIS Path: I:\Projects_8\Part of Tacoma Parcel_114 Cleanup_120051\Deliverables\Appendix A.7_1989.mxd | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | Date Shared: 4/24/2013 | User: hnovelko | Print Date: 4/24/2013

 Present Day (2013)
Parcel Boundaries



1969 Aerial Photograph
Source: Phase I Investigation
EDR Report, Floyd|Snider, 2007a

Former PQ Corporation Site
Tacoma, Washington



APR-2013

PROJECT NO.
120051

BY:
DFR / HRL


REV BY:

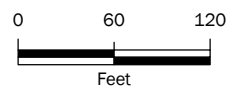
FIGURE NO.

A.7




GIS Path: E:\Projects_8\Part of Tacoma Parcel_114 Cleanup_120051\Deliverables\Appendix A.8_1973.mxd | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 feet | Date Saved: 4/24/2013 | User: thowles | Print Date: 4/24/2013

 Present Day (2013)
Parcel Boundaries




1973 Aerial Photograph
Source: Phase I Investigation
EDR Report, Floyd|Snider, 2007a

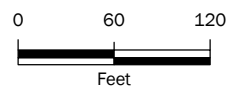
Former PQ Corporation Site
 Tacoma, Washington

	APR-2013	BY: DFR / HRL	FIGURE NO. A.8
	PROJECT NO. 120051	REV BY: ---	




GIS Path: I:\Projects_8\Part of Tacoma Parcel_114 Cleanup_120051\Deliverables\Appendix A.9_1989.mxd | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | Date Saved: 4/24/2013 | User: hnovales | Print Date: 4/24/2013

 Present Day (2013) Parcel Boundaries



1989 Aerial Photograph
Source: Phase I Investigation
EDR Report, Floyd|Snider, 2007a


Former PQ Corporation Site
 Tacoma, Washington

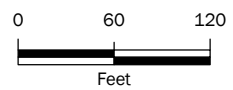
	APR-2013	BY: DFR / HRL	FIGURE NO. A.9
	PROJECT NO. 120051	REV BY: ---	



1114 Taylor Way
Parcel #2275200260

1202 Taylor Way
Parcel #0321263016

 Present Day (2013)
Parcel Boundaries



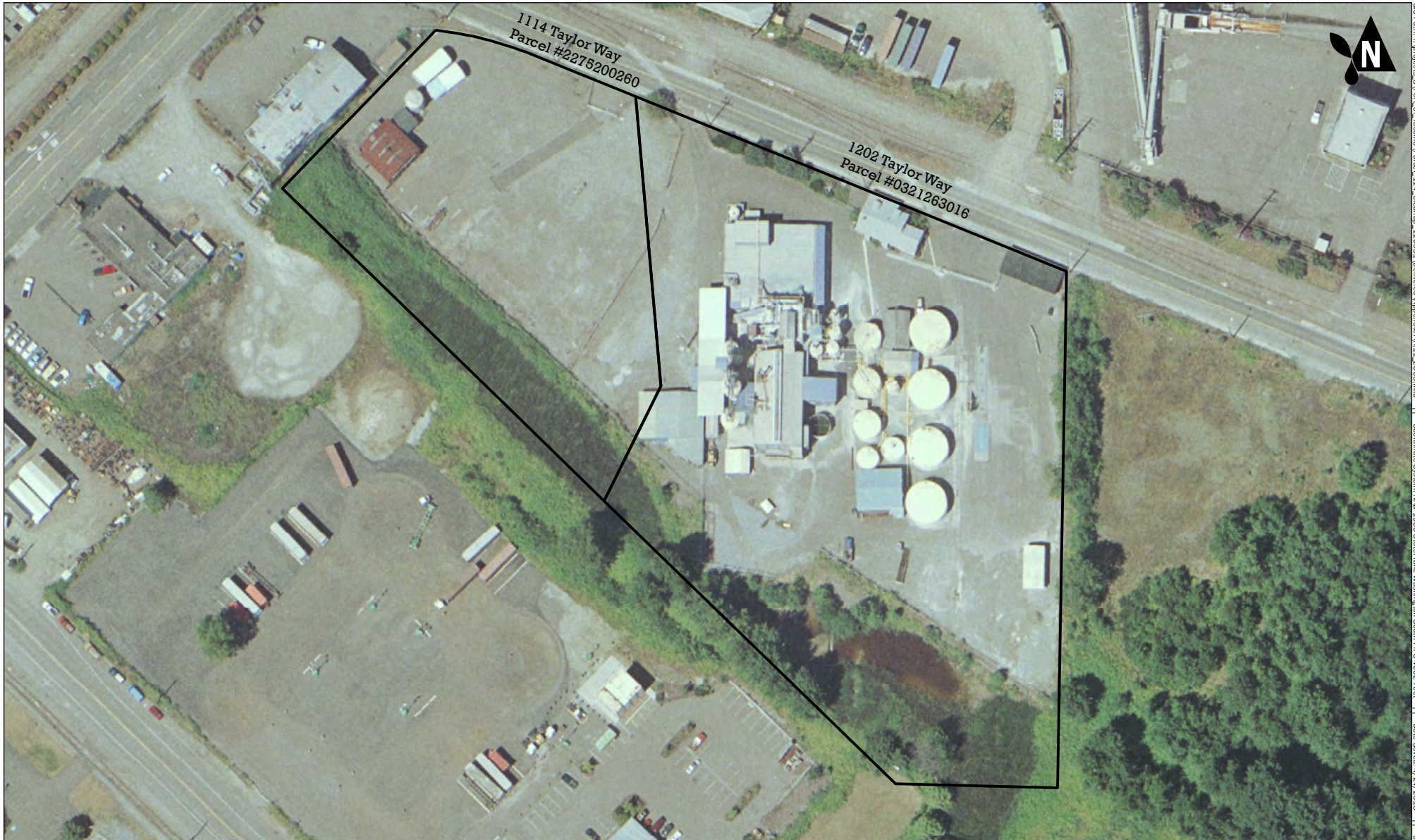
1996 Aerial Photograph
Source: Phase I Investigation
EDR Report, Floyd|Snider, 2007a

Former PQ Corporation Site
Tacoma, Washington




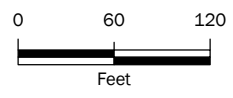
APR-2013	BY: DFR / HRL	FIGURE NO. A.10
PROJECT NO. 120051	REV BY: ---	

SIS Path: E:\Projects_8\Part of Tacoma Parcel_114_Cleanup_120051\Deliverables\Appendix A.10_1996.aerial | Coordinates System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | Date Saved: 4/24/2013 | User: thovibee | Print Date: 4/24/2013




GIS Path: T:\Projects_8\Part of Tacoma Parcel_114 Cleanup_120051\Deliverables\Appendix A.11_2005.mxd || Coordinates System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 4/29/2013 || User: hnovotice || Print Date: 4/24/2013

 Present Day (2013)
 Parcel Boundaries



2005 Aerial Photograph
Source: Phase I Investigation
EDR Report, Floyd|Snider, 2007a
 Former PQ Corporation Site
 Tacoma, Washington

	APR-2013	BY: DFR / HRL	FIGURE NO. A.11
	PROJECT NO. 120051	REV BY: ---	

APPENDIX B

Field Procedures Summary

1 Introduction

This Field Procedures Summary describes field sampling and Quality Control (QC) procedures to be followed during the RI/FS data collection. Section 5 of the Sampling and Analysis Plan (SAP) describes the locations and rationale for the proposed sampling and analyses. Additional information on laboratory analytical methods and QC are provided in the Quality Assurance Project Plan (QAPP), included as Appendix C of this SAP. It is the responsibility of the project personnel performing or overseeing the sampling and analysis activities to adhere to the requirements of the SAP and QAPP.

1.1 Purpose of the Field Procedures

The purpose of this Field Procedures Summary is to ensure that field sample collection, handling, and analysis conducted during the environmental assessment will generate data to meet project-specific data quality objectives (DQOs) in accordance with MTCA requirements (WAC 173-340-350). The Summary includes requirements for sampling activities such as sampling frequency and location, analytical testing, documentation, and quality assurance/quality control (QA/QC) for compliance monitoring and waste characterization.

2 Soil Borings and Soil Sampling

Soil sampling will be conducted during execution of the environmental assessment to assess the nature and extent of soil contamination at the Site. The specific soil sample locations, depths, and chemical analyses are provided in Section 5 of the SAP. The following subsections detail the procedures for soil sample collection, handling, identification, and sample QA/QC.

Aspect will subcontract with a Washington-licensed resource protection well driller to complete soil borings in accordance with requirements of Chapter 173-160 WAC. Soil borings will be advanced using direct push drill rig (i.e., Geoprobe).

Soil borings will be sampled on a continuous basis. Each boring will be advanced to collect samples at depth intervals specified in the Work Plan or as determined by field screening. The direct push drilling method provides continuous cores of soil, depending on soil recovery, returned within disposable 1.5-inch-diameter plastic liners (4-foot or 5-foot lengths). The liners are sliced longitudinally and opened to access the soil core.

2.1 Soil Sample Collection and Handling Procedures

Irrespective of drilling or excavation method, a geologist from Aspect will oversee the drilling activities and preparation of a geologic log for each of the explorations completed. The field representative will visually classify the soils in accordance with

ASTM Method D 2488 and record soil descriptions, field screening results, and other relevant details (e.g., staining, debris, odors, etc.) on the boring log form. If samples are collected for chemical analysis, the sample ID and depth will also be recorded on the log.

In addition to soil classification, the field representative will screen each soil sample using a PID to monitor for the presence of volatile organic compounds (VOCs).

All soil samples to be submitted for VOC analyses will be collected in accordance with EPA Method 5035A. The soil aliquot for VOC analysis will be collected from the undisturbed soil sample core using a laboratory-supplied modified disposable plastic syringe as required by the 5035A method, and placed in pre-weighed laboratory supplied vials.

For all other analyses, the soil samples will be removed from the sampler using a stainless steel spoon and placed in a stainless steel bowl for homogenization with the stainless steel spoon. Gravel-sized material greater than approximately 0.5 inch will be removed from the sample during mixing. A representative aliquot of the homogenized soil will be placed into certified-clean jars supplied by the analytical laboratory.

Surface soil samples (near the wetland) will be collected from the corner of a square measuring 1 square meter. Roughly equal volumes of sediment from the 0 to 10 cm layer will be collected from each corner using a stainless steel trowel or similar utensil and homogenized in a stainless steel bowl.

Trench explorations will be completed with a small rubber tracked excavator. Test trenches will be completed until refusal, or a depth of 4 feet is encountered, whichever occurs first. Soils will be classified as described above, and representative samples of soil from the excavator bucket will be screened using a PID. Soil samples will be collected from the excavator bucket and homogenized as described above. If Bunker C conveyance utilities are found during test trenching, the pipes will be removed from the excavation and characterized for appropriate disposition.

QC soil samples (e.g., field duplicates, rinsate blanks, and trip blanks) will be collected at the respective frequencies prescribed in Section 4 of the QAPP (Appendix C).

All borings will be completed as monitoring wells as described in Section 3 of this Appendix.

2.2 Soil Sample Identification

Each soil sample collected for chemical analysis will be assigned a unique sample identification number including the boring number and the depth from which the sample was collected. For example, the soil sample collected from boring MW-10S at a depth of 7 to 8 feet below ground surface (bgs) would be identified as MW-10S-7-8.

3 Monitoring Well Installation and Development

3.1 Monitoring Well Installation

All borings will be completed as groundwater monitoring wells. The monitoring wells will be constructed by a state-licensed resource protection well driller and in accordance with Chapter 173-160 WAC. An Aspect field geologist will oversee and document installation of each monitoring well, including completion of an As-Built Well Completion Diagram.

New monitoring wells will be constructed with 2-inch-diameter, threaded Schedule 40 PVC blank casing and preplaced slotted. Well screens will be 0.010-inch (10-slot) or 0.020-inch slot (20-slot) slotted screen 10 feet in length. An artificial filter pack consisting of 10/20 silica sand will be pre-packed around the well screen, and an annular seal consisting of bentonite chips will be placed above the filter pack. A concrete surface seal will be set at grade for each new monitoring well. Each well cap will be vented with a small hole. The finished monitoring wells will be protected with a steel flush-mount monument embedded in the concrete surface seal.

3.2 Monitoring Well Development

Following installation, each new monitoring well will be developed using a downhole submersible pump to remove fine-grained material from inside the well casing and filter pack to the extent practical, and to improve hydraulic communication between the well screen and the surrounding water-bearing formation. Each well will be developed until visual turbidity is reduced to minimal levels or until a maximum of 10 casing volumes of water has been removed.

4 Groundwater Sampling

Groundwater samples will be collected and handled in accordance with the procedures described below:

- The locking well cap will be removed and the depth-to-groundwater will be measured from the surveyed location to the nearest 0.01 foot using an electronic water level measuring device. The depth to the bottom of the monitoring well will also be measured to evaluate siltation of the monitoring. The water level indicator will be decontaminated between wells.
- Each monitoring well will be purged at a low-flow rate less than 0.5 liter per minute using a peristaltic pump and dedicated tubing (polyethylene tubing with a short length of silicon tubing through the pump head). The tubing intake will be placed just below the center of the saturated section of well screen. The well will then be purged at flow rates less than 0.5 liter per minute, and the field parameters temperature, pH, electrical conductance, dissolved oxygen, and

oxidation-reduction potential (ORP) will be monitored using a YSI meter and flow-through cell, or equivalent. These field parameters will be recorded at 2 to 4 minute intervals throughout well purging until they stabilize. Stabilization is defined as three successive readings where the parameter values vary by less than 10% (or 0.5 mg/L dissolved oxygen if the readings are below 1 mg/L). However, no more than three well casing volumes will be purged prior to groundwater sample collection. At least one turbidity measurement will be made before collecting the sample.

- If the monitoring well is completely dewatered during purging, samples will be collected when sufficient recharge has occurred to allow filling of all sample containers.
- Once purging is complete, the groundwater samples will be collected using the same low flow rate directly into laboratory-supplied sample containers. Samples for dissolved metals analyses will be filtered using an in-line 0.45 µm filter; at least one-half liter of water will be purged through the filter prior to sample collection.
- QC groundwater samples (e.g., field duplicates and trip blanks) will be collected at the respective frequencies prescribed in Section 4 of the QAPP (Appendix C).
- Following sampling, the wells cap and monument cap will be secured. Each well's dedicated tubing will be left in the well casing for subsequent sampling events. Any damaged or defective well caps or monuments will be noted, and scheduled for replacement, if necessary.

4.1 Groundwater Sample Identification

Each groundwater sample will be assigned a unique sample identification number include the well number and the 6-digit date on which the sample was collected. For example, a groundwater sample collected from monitoring well MW-10S on May 30, 2013, would be identified as MW-10S-053013.

5 Wetland Sediment Sampling

This section addresses the sample collection, processing, and handling procedures for wetland sediment core samples and surface soil samples

5.1 Sediment Core Sample Collection

Collection of wetland sediment core samples will be conducted using hand operated push core or similar core collection equipment. The hand core device utilizes a three foot stainless steel core barrel fitted with a polycarbonate liner and includes a core catcher in the nose of the core barrel to minimize loss of any part of the sample during sample retrieval. Sediment sampling is conducted by pushing the coring device vertically into the sediment using handles on the head assembly. Core samples can be collected from

exposed surface sediments or from sediments in shallow water. Following sediment penetration, the hand corer works by creating a partial vacuum which holds the sample in place. As the coring device is pulled up, a polyurethane flutter valve on the head seals the sampler. The core catcher helps prevent wash-out from the bottom.

5.2.1 Sediment Core Sample Identification

Each core sample will be assigned a unique sample identification number including the core sample location, sediment core sampling intervals, and the 6-digit date on which the sample was collected. For example, a wetland sediment core sample collected from wetland core location WL-02-B from the 0-25centimeter depth interval, on May 30, 2013, would be identified as WL-02-B-0-25-053013.

5.2.2 Core Collection

Sediment cores will be collected at each wetland location using a hand corer or similar device. The corer will use polycarbonate liners inside a rigid external tube approximately 2 inches in diameter. The coring device will be pushed manually into the bottom to its maximum length of 3 feet or to refusal.

Recovered cores will be processed, and samples will be created at a separate core processing location. The following procedure will be used to decontaminate core sample tubes prior to use:

- Rinse and pre-clean with potable water
- Wash and scrub in a solution of laboratory-grade, non-phosphate-based soap and potable water
- Rinse with potable water
- Rinse with distilled water
- Seal both ends of each core tube with aluminum foil

The core tube caps will be removed immediately prior to placement into the coring device. Care will be taken during sampling to avoid contact of the sample tube with potentially contaminated surfaces. Extra sample tubes will be available during sampling operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used. Core collection forms and field notes of all core samples will be maintained as samples are collected. The following information will be included in the documentation:

- Location of each station as determined by a handheld differential GPS;
- Date and time of collection of each sediment core sample;
- Names of field supervisor and person(s) collecting and handling the sample;
- Observations made during sample collection including: weather conditions, complications, and other details associated with the sampling effort;
- The sample station identification;
- Penetration depth;

- Recovery for each core based on physical measurement of sediment in the recovered core; and
- Qualitative notation of apparent resistance of sediment column to coring.

5.2.3 Core Processing and Handling Procedures

This section describes core processing, sample containers, and subsampling procedures. The core processing station will be located at a separate location either on-site or off-site. Transported cores will be handled consistent with American Society for Testing and Materials (ASTM) procedures (ASTM D 4220) and stored upright in the ARI refrigerators until processed.

All working surfaces and instruments will be thoroughly cleaned and decontaminated, and covered with aluminum foil to minimize outside contamination between sampling stations. Disposable gloves will be discarded after processing each station and replaced prior to handling decontaminated instruments or work surfaces.

Sample containers will be kept in packaging as received from the analytical laboratory until use; a sample container will be withdrawn only when a sample is to be collected and will be returned to a cooler containing completed samples.

The steps for processing the samples are listed below:

- Sediment from within each core will be extruded from the core using a plunger-like device by pushing the cored material from the bottom of the core. Sediment from within the core will be extruded onto an aluminum foil tray to expose the full length of the core. Alternatively, the polycarbonate core liner will be cut longitudinally along the sides of the core using power shears so that the core can be opened to expose the sediment.
- Using a clean, stainless steel spatula or spoon, fill two pre-labeled, 2-ounce (oz) volatile organic compounds (VOC) containers from the inner portion (no contact with any work surface or equipment) of the sample core (described below).
- Using a clean, stainless steel spoon, fill a pre-labeled 120-milliliter (ml) total sulfides container with between 50 and 60 grams of sample material (described below).
- Record the description of the core sample on a core log form for the following parameters as appropriate and present:
 - Sample recovery (depth in feet of penetration and length of recovered sediment)
 - Physical soil description in accordance with ASTM procedures (ASTM D 2488 and ASTM D 2487 - Unified Soil Classification System) including soil type, density and consistency of soil, and color
 - Visual stratification, structure, and texture
 - Odor (e.g., hydrogen sulfide, petroleum, etc.)
 - Vegetation and debris

- Biological activity (e.g., detritus or presence of organisms)
- Any other distinguishing characteristics or features
- Using a clean spoon, place sample material from the desired core interval into a cleaned stainless steel bowl, homogenize using a stainless steel spoon until uniform in color and texture.
- Using a clean, stainless steel spoon, completely fill pre-labeled sample containers as indicated in Table C-1 for the remaining analyses.
- Thoroughly check all sample containers for proper identification, analysis type, and lid tightness.
- Pack each container carefully to prevent breakage and place inside of a cooler with ice for storage at the proper temperature (4 ± 2 degrees Celsius [$^{\circ}\text{C}$] for all samples).

At a minimum, each sample label will include the following information:

- Project name and number
- Sample identifier
- Date of collection
- Initials of field personnel responsible for sample collection
- Analyses required
- Preservative (if applicable)

Subsampling – Volatile Organic Compounds

The subsample for VOCs will be collected immediately upon extrusion (prior to sample characterization) from the desired core sample interval and placed into two 2-oz glass containers. To reduce potential outside contamination from working surfaces and loss of volatile compounds to be analyzed, this sample will be taken from a portion of the sample core that has not been exposed to working surfaces. Subsample material will be collected along the entire length of the representative core section and transferred to the two 2-oz glass containers. Each glass container will be filled completely with sample sediment, allowing no headspace. Samples will be stored in the dark at $4^{\circ} \pm 2^{\circ} \text{C}$.

Subsampling – Total Sulfides

The total sulfides subsample will be collected immediately after the VOC sample is collected. Exposure to air must be held to a minimum, and the sample should be kept moist to minimize oxidation. A complete sample will require between 50 and 60 grams of material. Subsample material will be collected along the entire length of the representative core section, transferred to 120-ml glass container, fixed with 5 ml of 2 *Normal* (N) zinc acetate, capped, and shaken vigorously. The sample label will clearly indicate the addition of zinc acetate preservative. Samples will be stored in the dark at $4^{\circ} \pm 2^{\circ} \text{C}$.

6 Sample Custody and Field Documentation

6.1 Sample Custody

Upon collection of samples in the field, samples will be placed upright in a cooler. Ice or blue ice will be placed in each cooler to meet sample preservation requirements. Inert cushioning material will be placed in the remaining space of the cooler as needed to limit movement of the sample containers. If the sample coolers are being shipped, not hand carried, to the laboratory, the chain of custody (COC) form will be placed in waterproof bag taped to the inside lid of the cooler for shipment.

After collection, samples will be maintained in Aspect's custody until formally transferred to the analytical laboratory. For purposes of this work, custody of the samples will be defined as follows.

- In plain view of the field representatives;
- Inside a cooler that is in plain view of the field representative; or
- Inside any locked space such as a cooler, locker, car, or truck to which the field representative has the only immediately available key(s).

A COC record provided by the laboratory will be initiated at the time of sampling for all samples collected. The record will be signed by the field representative and others who subsequently take custody of the sample. Couriers or other professional shipping representatives are not required to sign the COC form; however, shipping receipts will be collected and maintained as a part of custody documentation in project files. A copy of the COC form with appropriate signatures will be kept by Aspect's project manager.

Upon sample receipt, the laboratory will fill out a cooler receipt form to document sample delivery conditions. A designated sample custodian will accept custody of the shipped samples and will verify that the chain of custody form matches the samples received. The laboratory will notify as soon as possible the Aspect project manager of any issues noted with the sample shipment or custody.

6.2 Field Documentation

While conducting field work, the field representative will document pertinent observations and events on field forms specific to each activity (e.g., boring log form, as-built well completion form, well development form, groundwater sampling form, etc.) and/or in a field notebook, and, when warranted, provide photographic documentation of specific sampling efforts. Field notes will include a description of the field activity, sample descriptions, and associated details such as the date, time, and field conditions.

7 Hydrogeologic Data Collection

7.1 Groundwater Level Monitoring

Depth-to-groundwater measurements will be conducted in the wells using an electric well sounder, graduated to 0.01 foot.

7.2 Wetland Surface Water Measurement

Surface water measurements will be collected to a resolution of 0.01 foot from a staff gauge to be installed in the stormwater wetland.

8 Exploration Surveying

Horizontal coordinates for each soil and wetland sediment sampling location will be recorded using hand-held GPS with real-time differential correction. The horizontal coordinates and elevations of the wetland staff gauge and monitoring wells included in the assessment will be surveyed by a licensed surveyor relative to a common horizontal and vertical datum. Staff gauge reference point and monitoring well top-of-casing elevations will be surveyed to the nearest 0.01 foot, and horizontal coordinates to the nearest 0.1 foot, or better. Each well will be surveyed at the marked spot on the top of the PVC well casing from which depth-to-water measurements are collected.

9 Decontamination and Investigative-Derived Waste Management

All non-disposable sampling equipment (stainless steel spoons and bowls) will be decontaminated before collection of each sample. The decontamination sequence consists of a scrub with a detergent (Alconox) solution, followed by tap water (potable) rinse, and finished with thorough spraying with deionized or distilled water.

Investigation-derived waste (IDW) water generated during equipment decontamination and monitoring will be placed in labeled DOT-approved drums and disposed of appropriately at a permitted off-site disposal facility.

Soil cuttings from borings and disposable personal protective equipment (PPE) will be placed in labeled DOT-approved drums pending the analytical results to determine appropriate disposal. The drums will be temporarily consolidated in the on-site, profiled based on available analytical data, and disposed of appropriately at a permitted off-site disposal facility.

Documentation for off-site disposal of IDW will be maintained in the project file.

APPENDIX C

Quality Assurance Project Plan

1 Introduction

This Quality Assurance Project Plan (QAPP) identifies quality control (QC) procedures and criteria required to ensure that data collected during the remedial investigation are of known quality and acceptable to achieve project objectives. Specific protocols and criteria are also set forth in this QAPP for data quality evaluation, upon the completion of data collection, to determine the level of completeness and usability of the data. It is the responsibility of the project personnel performing or overseeing the sampling and analysis activities to adhere to the requirements of the Sampling and Analysis Plan and this QAPP.

1.1 Purpose of the QAPP

As stated in Ecology's Guidelines for Preparation of Quality Assurance Project Plans for Environmental Studies (Ecology Publication No. 04-03-030, July 2004), specific goals of this QAPP is to:

- Focus project manager and project team to factors affecting data quality during the planning stage of the project;
- Facilitate communication among field, laboratory, and management staff as the project progresses;
- Document the planning, implementation, and assessment procedures for QA/QC activities for the investigation;
- Ensure that the data quality objectives (DQOs) are achieved; and
- Provide a record of the project to facilitate final report preparation.

DQOs dictate sampling and analysis designs and sample collection procedures are presented in the Interim Action Plan and SAP. The DQOs for the project include both qualitative and quantitative objectives, which define the appropriate type of data, and specify the tolerable levels of potential decision errors that will be used as a basis for establishing the quality and quantity of data needed to support the environmental assessment. To ensure that the DQOs are achieved, this QAPP details aspects of data collection including analytical methods, QA/QC procedures, and data quality reviews. This QAPP describes both quantitative and qualitative measures of data to ensure that the DQOs are achieved. DQOs dictate data collection rationale, sampling and analysis designs that are presented in the SAP, and sample collection procedures that are also presented in the SAP.

2 Analytical Methods and Reporting Limits

Analytical methodologies applied to the analyses of samples collected during the opportunistic interim action are in accordance with the following documents:

- USEPA SW Methods - USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, December 1996.
- USEPA Method 7470A, Revision 1: Mercury in Liquid Waste (Manual Cold Vapor Technique, Office of Water, U.S. Environmental Protection Agency, September 1994.
- USEPA Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983 and updates.
- Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 20th Edition, 1995.
- Ecology (Washington State Department of). 1997. *Analytical Methods for Petroleum Hydrocarbons*. Publication No. ECY 97-602. June 1997.

Table C-1 lists the laboratory analytical methods for soil and groundwater analyses to be performed, along with samples containers, preservation, and analytical holding times for each analysis.

The analytical method detection limit (MDL) is the minimum concentration of a compound that can be measured and reported with a 99% confidence that the analyte concentration is greater than zero; MDLs are established by the laboratory using prepared samples, not samples of environmental media. The analytical reporting limit (RL) is defined as the lowest concentration at which a chemical can be accurately and reproducibly quantified, within specified limits of precision and accuracy, for a given environmental sample. The RL can vary from sample to sample depending on sample size, sample dilution, matrix interferences, moisture content, and other sample-specific conditions. Operationally, it is equivalent to the concentration of the lowest calibration standard (at a minimum) in the initial calibration curve. In accordance with MTCA, the RL is equivalent to a practical quantitation limit (PQL) which cannot be greater than 10 times the MDL.

3 Data Quality Objectives

Data quality objectives (DQOs), including indicators for precision, accuracy, representativeness, comparability, and completeness (PARCC parameters), and data RLs are dictated by the data quality objectives, project requirements, and intended uses of the data. For this project, the analytical data must be of sufficient technical quality to determine whether contaminants are present and, if present, whether their concentrations are above or below applicable screening criteria based on protection of human health and the environment.

An assessment of data quality is based upon quantitative (precision, accuracy, and completeness) and qualitative (representativeness and comparability) data quality indicators. Definitions of these parameters and the applicable QC procedures are presented below.

3.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared with their average values. Analytical precision is measured through matrix spike/matrix spike duplicate (MS/MSD) samples and laboratory control samples/laboratory control sample duplicate (LCS/LCSD) for organic analysis and through laboratory duplicate samples for inorganic analyses.

Analytical precision is quantitatively expressed as the relative percent difference (RPD) between the LCS/LCSD, MS/MSD, or lab duplicate pairs and is calculated with the following formula:

$$RPD (\%) = 100 \times \frac{|S - D|}{(S + D)/2}$$

where:

S = analyte concentration in sample

D = analyte concentration in duplicate sample

Analytical precision measurements will be carried out at a minimum frequency of 1 per 20 samples for each matrix sampled, or one per laboratory analysis group. Laboratory precision will be evaluated against laboratory quantitative RPD performance criteria provided with the lab's analytical data report. If the control criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. The RPD will be evaluated during data review and validation. The data reviewer will note deviations from the specified limits and will comment on the effect of the deviations on reported data.

3.2 Accuracy

Accuracy measures the closeness of the measured value to the true value. The accuracy of chemical test results is assessed by "spiking" samples with known standards (surrogates, blank spikes, or matrix spikes) and establishing the average recovery. Accuracy is quantified as the percent recovery (%R). The closer the %R is to 100%, the more accurate the data.

Surrogate recovery will be calculated as follows:

$$\text{Recovery (\%)} = \frac{MC}{SC} \times 100$$

where:

SC = spiked concentration

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MC = measured concentration

MS percent recovery will be calculated as follows:

$$\text{Recovery (\%)} = \frac{MC - USC}{SC} \times 100$$

where:

SC = spiked concentration

MC = measured concentration

USC = unspiked sample concentration

Accuracy measurements on MS samples will be carried out at a minimum frequency of one in 20 samples per matrix analyzed. Blank spikes will also be analyzed at a minimum frequency of one in 20 samples per matrix analyzed. Surrogate recoveries for organic compounds will be determined for each sample analyzed for respective compounds. Laboratory accuracy will be evaluated against the lab's quantitative matrix spike and surrogate spike recovery performance criteria as provided with the lab's analytical data report. If the control criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. Percent recoveries will be evaluated during data review and validation, and the data reviewer will comment on the effect of the deviations on the reported data.

3.3 Representativeness

Representativeness measures how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the matrix sampled. The Interim Action Plan sampling plan design, sampling techniques, and sample handling protocols (e.g., homogenizing, storage, preservation, and use of duplicates and blanks) have been developed to ensure representative samples. Sampling locations for interim action activities are described in the main body of the Interim Action Plan. The field sampling procedures are described in the SAP and included as Appendix A of the Interim Action Plan.

3.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This goal will be achieved through the use of standard techniques to collect samples, USEPA-approved standard methods to analyze samples, and consistent units to report analytical results. Data comparability also depends on data quality. Data of unknown quality cannot be compared.

3.5 Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid. Results will be considered valid if the precision, accuracy, and representativeness

objectives are met and if RLs are sufficient for the intended uses of the data. Completeness is calculated as follows:

$$\text{Completeness (\%)} = \frac{V}{P} \times 100$$

where:

V = number of valid measurements

P = number of measurements taken

Valid and invalid data (i.e., data qualified with the R flag [rejected]) will be identified during data validation. The target completeness goal for this project is 95 percent.

4 Quality Control Procedures

Field and laboratory QC procedures are outlined below.

4.1 Field Quality Control

Beyond use of standard sampling protocols defined in the SAP, field QC procedures include maintaining the field instrumentation used. Field instruments (e.g., PID for evaluating presence of VOCs in soil samples, and the YSI meter for measuring field parameters during groundwater sampling) are maintained and calibrated regularly in accordance with manufacturer recommendations prior to use.

In addition, field QC is accomplished through the analysis of controlled samples that are introduced to the laboratory from the field. Field duplicates and trip blanks will be collected and submitted for analysis as described below.

Field Duplicates

Field duplicate samples are used to check for sampling and analysis reproducibility; however, the field duplicate sample results included variability introduced during both field sampling and laboratory preparation and analysis, and EPA data validation guidance provides no RPD control limits for field duplicate samples. Field duplicate samples will be collected at a frequency of 5 percent (1 per 20 samples – not including QA samples) of the field samples for each matrix and analytical method, but not less than one duplicate per sampling event per matrix.

Trip Blank

Trip blank samples will be used to monitor possible VOC cross contamination occurring during sample transport of samples to be analyzed for VOCs or gasoline-range TPH. Trip blank samples are prepared and supplied by the laboratory using organic-free reagent-grade water into a VOC vial prior to the collection of field samples. The trip blank sample vials are placed with and accompany the VOC and petroleum gasoline samples through the entire transporting process. Trip blank samples will be prepared and analyzed

for the full suite of VOCs (if required). One trip blank will be collected for each soil sampling round and each groundwater sampling round where VOC analysis is conducted.

4.2 Laboratory Quality Control

The laboratories' analytical procedures must meet requirements specified in the respective analytical methods or approved laboratory standard operating procedures (SOPs), e.g., instrument performance check, initial calibration, calibration check, blanks, surrogate spikes, internal standards, and/or labeled compound spikes. The laboratory QC procedures used for this project will consist of the following at a minimum:

- Instrument calibration and standards as defined in the laboratory standard operating procedures (SOPs);
- Laboratory method blank measurements at a minimum frequency of 5% or one per 20 samples; and
- Accuracy and precision measurements as defined above, at a minimum frequency of 5% or one per 20 samples per matrix.

The laboratory's QA officers are responsible for ensuring that the laboratory implements the internal QC and QA procedures detailed in Analytical Resources, Incorporated's Quality Assurance Manual.

5 Corrective Actions

If routine QC audits by the laboratory result in detection of unacceptable conditions or data, actions specified in the laboratory standard operating procedures (SOPs) will be taken. Specific corrective actions are outlined in each SOP used and can include the following:

- Identifying the source of the violation;
- Reanalyzing samples if holding time criteria permit;
- Resampling and analyzing;
- Evaluating and amending sampling and analytical procedures; and/or
- Accepting but qualifying data to indicate the level of uncertainty.

If unacceptable conditions occur, the laboratory will contact Aspect's project manager to discuss the issues and determine the appropriate corrective action. Corrective actions taken by the laboratory during analysis of samples for this project will be documented by the laboratory in the case narrative associated with the affected samples.

In addition, the project data quality manager will review the laboratory data generated for this investigation to ensure that project DQOs are met. If the review indicates that non-conformances in the data have resulted from field sampling or documentation procedures

or laboratory analytical or documentation procedures, the impact of those non-conformances on the overall project data usability will be assessed. Appropriate actions, including re-sampling and/or re-analysis of samples may be recommended to the project manager to achieve project objectives.

6 Data Reduction, Quality Review, and Reporting

All data will undergo a QA/QC evaluation at the laboratory which will then be reviewed by the Aspect database manager. Initial data reduction, evaluation, and reporting at the laboratory will be carried out as described in the appropriate analytical protocols. Quality control data resulting from methods and procedures described in this document will also be reported.

6.1 Minimum Data Reporting Requirements

The following sections describe the minimum data reporting requirements necessary to allow proper data quality review (as described in Section 6.2) and analytical data documentation.

Sample Receipt. Cooler receipt forms will be filled out for all sample shipments to document problems in sample packaging, chain of custody, and sample preservation.

Reporting. For each analytical method run, analytes for each sample will be reported as a detected concentration or as less than the specific RL. Solid data will be reported on a dry weight basis except that from gas chromatograph-mass spectrometry (GC-MS) methods (EPA Method 8260 and EPA Method 8270). The laboratories will report dilution factors for each sample as well as date of extraction (if applicable), date of analysis, extraction method, any cleanup methods performed, and confirmation results where required. The laboratory will also report any corrective actions taken if unacceptable conditions or data are detected.

Internal Quality Control Reporting. Internal quality control samples will be analyzed at the rates specified in the applicable analytical method.

- **Laboratory Method Blanks.** Analytes will be reported for each laboratory blank. Non-blank sample results shall be designated as corresponding to a particular laboratory blank in terms of analytical batch processing.
- **Surrogate Spike Samples.** Surrogate spike recoveries will be reported with organic reports where appropriate. The report shall also specify the control limits for surrogate spike results as well as the spiking concentration. Spike recoveries outside of specified control limits (as defined in the laboratory SOP) will result in the sample being rerun.
- **Laboratory Duplicate and/or Matrix Spike Duplicate Pairs.** Relative percent differences will be reported for duplicate pairs relative to analyte/matrix-specific control limits defined in the laboratory SOP.

- **Laboratory Control Samples (LCS).** LCS recoveries will be reported for organic analyses. LCS results and control limits will be reported with the corresponding sample data.

6.2 Data Quality Verification and Validation

Reported analytical results will be qualified by the laboratory to identify QC concerns in accordance with the specifications of the analytical methods. Additional laboratory data qualifiers may be defined and reported by the laboratory to more completely explain QC concerns regarding a particular sample result. All data qualifiers will be defined in the laboratory's narrative reports associated with each case.

Pyron Environmental, Inc. will conduct an independent data validation for all chemical data submitted by the analytical laboratories during the investigation. The independent data validation will be EPA Level III equivalent, following the guidance documents below:

- USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, January 2010, USEPA 540/R-10/011.
- USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, June 2008, USEPA-540-R-08-01.

The data validation will examine and verify the following parameters against the method requirements and laboratory control limits:

- Sample management and holding times;
- Laboratory and field blank results;
- Detection and reporting limits;
- Laboratory replicate results;
- MS/MSD results;
- LCS and/or standard reference material results;
- Field duplicate results;
- Surrogate spike recovery (organic analyses only);
- Inter-element interference check (ICP analyses only); and
- Serial dilution (metals only).

Data qualifiers will be assigned based on outcome of the data validation. Data qualifiers are limited to and defined as follows:

- U - The analyte was analyzed for but was determined to be non-detect above the reported sample quantitation limit, or the quantitation limit was raised to the concentration found in the sample due to blank contamination.
- J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- UJ - The analyte was not detected above the reported quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R - The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence or absence of the analyte cannot be verified.
- DNR - Do not report from this analysis; the result for this analyte is to be reported from an alternative analysis.

In cases of multiple analyses (such as an un-diluted and a diluted analysis) performed on one sample, the optimal result will be determined and only the determined result will be reported for the sample.

The scope and findings of the data validation will be documented in a Data Validation Report(s) included as an appendix to the investigation report.

7 Preventative Maintenance Procedures and Schedules

Preventative maintenance in the laboratory will be the responsibility of the laboratory personnel and analysts. This maintenance includes routine care and cleaning of instruments and inspection and monitoring of carrier gases, solvents, and glassware used in analyses. Details of the maintenance procedures are addressed in the respective laboratory SOPs.

Precision and accuracy data are examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance will be performed when an instrument begins to change as indicated by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet one or another of the method-specific QC criteria.

Maintenance and calibration of instruments used in the field for sampling (e.g., PID for evaluating presence of VOCs in soil samples, and the YSI meter for measuring field parameters during groundwater sampling) will be conducted regularly in accordance with manufacturer recommendations prior to use.

8 Performance and System Audits

The Aspect project manager has responsibility for reviewing the performance of the laboratory QA program. This will be achieved through regular contact with the analytical laboratory's project manager. To ensure comparable data, all samples of a given matrix to be analyzed by each specified analytical method will be processed consistently by the same analytical laboratory.

9 Data and Records Management

Records will be maintained documenting all activities and data related to field sampling and chemical analyses.

9.1 Field Documentation

The Aspect project manager will ensure that the field team receives the final approved version of this QAPP, the site health and safety plan, and the SAP prior to the initiation of field activities. Field documents will be maintained in the project file.

9.2 Analytical Data Management

Raw data received from the analytical laboratory will be reviewed, entered into a computerized database, and verified for consistency and correctness. The database will be updated based on data review and independent validation if necessary.

Information regarding whether concentrations represent total phase (unfiltered samples) or dissolved phase (filtered samples) will be compiled and stored in the database. Data will be submitted to Ecology's Environmental Information Management (EIM) database once all data have been reviewed and validated.

10 References

USEPA, 2008, Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, June 2008, USEPA-540-R-08-01.

USEPA, 2010, Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, January 2010, USEPA 540/R-10/011.

Table C-1 - Analytical Methods, Sample Containers, Preservation, and Holding Times

Sample Matrix	Analytical Parameter	Analytical Method	Sample Container	No. Containers	Preservation Requirements	Holding Time
Soil and Sediment	Gasoline Range TPH	NWTPH-Gx	Method 5035A, 40-ml vials	4	4°C ±2°C, Freeze within 48 hours to <-7°C	14 days
	Diesel & Motor Oil Range TPH	NWTPH-Dx/SW846 Method 3630 (Silica Gel Cleanup)	4 ounce jar	1	4°C ±2°C	14 days for extraction; 40 days for analysis
	Soil VOCs	Method 8260 B	Method 5035A, 40-ml vials	4	4°C ±2°C, Freeze within 48 hours to <-7°C	14 days
	Sediment VOCs	Method 8260 B	2 ounce jar	2	Zero head space/4°C ±2°C	14 days
	PAHs	Method 8270-SIM	4 ounce jar	1	4°C ±2°C	14 days for extraction; 40 days for analysis
	Total Metals other than Hg	Method 200.8	4 ounce jar	1	4°C ±2°C	6 months
	Total Sulfides	Plumb (1981)	4 ounce jar	1	5 ml 2N ZnAc/Dark/4°C ±2°C	7 days
	Total Organic Carbon	Method 9060 (EPA, 1986)	4 ounce jar	1	4°C ±2°C	28 days
	Total Mercury	Method 7471	4 ounce jar	1	4°C ±2°C	28 days
	SVOCs	Method 8270D	4 ounce jar	1	4°C ±2°C	14 days for extraction; 40 days for analysis
	PCBs	Method 8082A	4 ounce jar	1	4°C ±2°C	NA
pH	Method 9045C	4 ounce jar	1	4°C ±2°C	28 days	
Water	Gasoline Range TPH	Method NWTPH-Gx	40-mL VOA Vials	3	4°C ±2°C, HCl pH < 2	14 days
	Diesel & Motor Oil Range TPH	NWTPH-Dx/SW846 Method 3630 (Silica Gel Cleanup)	500-mL Amber Glass	1	4°C ±2°C	7 days for extraction, 40 days for analysis
	VOCs	Method 8260	40-mL VOA Vials	3	4°C ±2°C, 1 with HCl pH < 2, 2	14 days for analysis
	Low-level PAHs	Method 8270-SIM-LL	1-L Amber Glass	1	4°C ±2°C	7 days for extraction, 40 days for analysis
	SVOCs	Method 8270D	1-L Amber Glass	1	4°C ±2°C	7 days for extraction, 40 days for analysis
	Dissolved Metals other than Hg	Method 200.8	500-mL HDPE	1	4°C ±2°C, HNO3 pH < 2 (after filtration)	180 days
	Dissolved Mercury	Method 7470-LL	500-mL HDPE	1	4°C ±2°C, HNO3 pH < 2 (after filtration)	28 days
	TSS	SM2540D	500-mL HDPE	1	4°C ±2°	7 days