6 Site Subareas for RI/FS

This section presents the subareas that were defined in the RI/FS Work Plan (Aspect, 2009a) as having data gaps warranting additional data collection as part of this RI. Definition of the subareas was based on evaluation of the prior 15 years worth of environmental data generated prior to developing the RI/FS Work Plan, as described in Section 6.3 of the RI/FS Work Plan.

The subareas identified have soil, groundwater, and/or soil vapor contamination that represents a potential source for contaminant migration via groundwater or soil gas (air) and is expected to warrant evaluation of remedial action alternatives in the FS or, if appropriate, early interim cleanup actions within the context of the RI/FS process. The Site subareas and their primary contaminant type identified in the RI/FS Work Plan are depicted on Figure 6-1 and described in the following subsections. Each subsection describes each subarea's identified data gaps, and the corresponding data collection conducted during the RI to address the data gaps. Following this section, Section 7 presents the conceptual site model, including contaminant nature/extent/transport and exposure pathways/receptors, for each subarea. Figures depicting the current RI explorations are included in Section 7, where the data for each subarea are discussed.

The RI/FS Work Plan acknowledged that, outside of the defined Site subareas, there is relatively widespread, lower-level soil contamination typical of industrial properties (e.g., oil-range petroleum and cPAHs above unrestricted soil screening levels), and that Fill Unit groundwater throughout the Site has reducing geochemical conditions generating dissolved metals concentrations above groundwater screening levels. Section 7 includes a table and figure depicting data outside of the defined Site subareas.

6.1 Caustic Plume Subarea

This subarea encompasses soil and groundwater impacted by caustic (high pH) and mercury adjacent to the former Chlor-Alkali plant. The extent of soil mercury exceeding a 24 mg/kg soil screening level based on unrestricted direct contact was relatively well defined by the pre-RI activities; however, the downgradient extents of dissolved mercury in groundwater, and the characteristics of its subsurface transport, warranted additional investigation. In addition, limited data existed to assess potential risks to indoor air from mercury in soil vapor under future redevelopment scenarios.

The following specific data gaps were identified for the Caustic Plume subarea in the RI/FS Work Plan (Aspect, 2009a):

1. Document the current dissolved mercury concentrations in Fill Unit groundwater. This includes evaluating potential concentration changes over time at specific wells, and defining the downgradient extent of concentrations above the groundwater screening level.

2. Better understand the fate and transport of dissolved-phase mercury, including the Fill Unit's capacity to neutralize the alkaline pH and thus presumably limit transport of mercury in the aqueous phase.
3. Confirm soil mercury and dissolved mercury concentrations in the Lower Sand unit.
4. Better define the magnitude and spatial distribution of mercury concentrations in soil vapor throughout the Caustic Plume footprint.

The following data collection was conducted during the current RI to address the data gaps:

- Drilling, installation, and development of 22 new Fill Unit monitoring wells and nine soil borings (identified with CP- prefix) to better delineate the spatial extent of dissolved mercury and its attenuation occurring along groundwater flow paths toward the marine water receptors. Thirteen of the new Fill Unit wells were identified in the RI/FS Work Plan. Five of the new wells (CP-MW07 through CP-MW11) and one soil boring (CP-SB01) were installed as part of the Spring 2010 supplemental investigation in accordance with the RI/FS Work Plan Addendum (Aspect, 2010a). Well CP-MW12 was installed in April 2010 based on field data collected during the supplemental investigation, in accordance with a memorandum submitted to and approved by Ecology (Aspect, 2010b). The new Fill Unit wells include:
    - Nine wells aligned along three transects (denoted as Transects A through C), extending to the west and northwest to the Bellingham Bay shoreline, to define dissolved mercury and geochemical trends with downgradient distance from the source area. These wells are labeled CP-MWA1, CP-MWA2, CP-MWA3, CP-MWB1, CP-MWB2, CP-MWB3, CP-MWC1, CP-MWC2, and CP-MWC3.
    - Monitoring well CP-MW01 documents mercury concentrations along the southwestern corner of the caustic plume. Monitoring wells CP-MW02 and CP-MW03 provide intermediate points upgradient of existing wells AMW-1 and Law-1 along the Log Pond shoreline. Monitoring well CP-MW06 provides an additional groundwater monitoring point near the inferred core of the caustic plume.
    - Wells CP-MW07, CP-MW08, and CP-MW09 better delineate the southern and southwestern extent of the caustic plume.
    - Well CP-MW10 provides an additional groundwater monitoring location near the former Wastewater Settling Basin and helps verify the 2009 groundwater quality data from well Law-1.
    - Well CP-MW11 better defines the northeastern extent of the caustic plume, since older wells in that general area are currently in poor condition and not considered reliable for sampling.
    - Well CP-MW12 provides monitoring to assess empirically whether dissolved mercury is migrating to Bellingham Bay within pipe backfill around the City of Bellingham's Cornwall Avenue storm drain line.
    - Wells CP-MW13, CP-MW-14, and CP-MW15 document groundwater quality conditions within the mercury source area.

- For the 13 new Fill Unit monitoring well locations installed in Fall 2009, analyzed one sample of saturated soil from within the well's screened interval depth for total mercury to provide correlation of saturated soil and dissolved mercury concentrations. In addition, analyzed one sample of unsaturated soil from borings CP-MWA1, CP-MWA2, CP-MWB1, CP-MWB2, CP-MWC1, CP-MWC2, and CP-MW06 for total mercury to further characterize the distribution of mercury in unsaturated soils and allow for correlation of mercury concentrations in soil and collocated soil vapor.
- Drilling, installation, and development of two new Lower Sand Unit monitoring wells (CP-MW04 and CP-MW05) to evaluate potential for downward migration of mercury from the Fill Unit through the Tidal Flat Aquitard into the Lower Sand Unit. The new Lower Sand Unit wells were installed in assumed "worst-case" locations with respect to mercury contamination in the overlying Fill Unit: CP-MW04 adjacent to the former 72 Catch Basin, and CP-MW05 within the footprint of the former Wastewater Settling Basin. Soil samples were also collected and analyzed for total mercury across the entire depth of each deep boring to provide a detailed vertical profile of soil mercury concentrations through the Fill Unit, Tidal Flat Aquitard, and into the Lower Sand Unit in these locations.
- During Fall 2009 and Spring 2010, conducted dry season and wet season sampling and analysis of groundwater from the 21 new monitoring wells plus twelve existing Fill Unit monitoring wells (AMW-1, Law-1, EMW-14S, EMW-2S, AMW-2, EMW-19S, AMW-3, EMW-1S, EMW-4S, EMW-15S, EMW-7S, and EMW-8S) and existing Lower Sand Unit wells EMW-28D and EMW-29D to define the current distribution of groundwater pH and dissolved mercury in both aquifers. Conducted supplemental groundwater sampling and analysis of selected monitoring wells within and around the mercury source area in December 2010.
- In addition to dissolved mercury and field parameters during those two sampling events, analyzed groundwater samples from 17 Fill Unit wells for a suite of water quality parameters including major cations, major anions, alkalinity, redox pairs (sulfate/sulfide and nitrate/nitrite), and total dissolved solids (TDS) to provide information on geochemical conditions and support potential subsequent geochemical modeling efforts, if warranted. The additional water quality analyses were conducted for samples from the nine new transect monitoring wells, plus wells AMW-2, AMW-3, CP-MW06, EMW-2S, EMW-14S, and EMW-19S, within the inferred higher concentration portion of the plume, as well as CP-MW03 and Law-1 aligned along a potential northern groundwater flowpath toward the Log Pond. During the Spring 2010 sampling event, analysis for dissolved organic carbon (DOC) was added for groundwater samples from wells CP-MWA1, CP-MWB1, CP-MWB2, and CP-MWB3.
- Submitted a sample of saturated Fill Unit soil (aquifer matrix) from four wells positioned along the inferred dissolved mercury transport pathway for petrographic analysis of aquifer matrix mineralogy. Subsequently submitted a sample of Fill Unit aquifer matrix from within the former Wastewater Settling Basin that contained a high mercury concentration, and an unfiltered sample of groundwater from well CP-MWA1, which contained high dissolved mercury concentration and a relatively large

quantity of dark-colored suspended solids. The purpose of the petrographic analyses was to identify the framework mineralogy of the fill material interacting with dissolved mercury, including minerals that may dissolve, precipitate, or complex with mercury along the inferred transport pathway. The mineralogical determinations were made using qualitative x-ray diffraction (XRD) and thin-section petrography. Scanning electron microscopy (SEM) was also conducted to provide qualitative spot chemical analysis and produce elemental mercury maps. The suspended solids filtered from the CP-AMW1 groundwater sample were analyzed using XRD and SEM. The petrography work was conducted by MWH Americas Inc., using Colorado School of Mines' laboratory instrumentation. A copy of MWH Americas' report for the petrography assessment is included in Appendix D.

- Hydraulic conductivity (K) testing (slug testing) of the nine new Fill Unit transect monitoring wells, as well as the two new Lower Sand Unit wells. K estimates were also available for some of these wells using tidal study data, as described in Section 4.2.2.

- Analysis of total mercury in soil vapor samples collected from 22 locations spanning a range of soil and groundwater mercury concentrations. In late September 2009, vapor samples were collected from vapor probes immediately adjacent to Fill Unit monitoring wells CP-MWA1, CP-MWB1, CP-MWC1, CP-MWA2, CP-MWC2, CP-MW01, CP-MW02, CP-MW03, and CP-MW06. A vapor probe was also installed adjacent to well CP-MWB2, but shallow perched water persisted in the probe after being pumped out several times, which prevented vapor sample collection. In late March 2010, four additional soil vapor samples (CP-VP01, CP-VP02, CP-VP03, and CP-VP04) were collected to better delineate the extent of elevated mercury soil vapor concentrations, in accordance with the RI/FS Work Plan Addendum. During the second phase of the interim action pre-design investigation (February 2011), six shallow soil vapor probes (CP-VP05 through CP-VP10) were installed and sampled to further refine the extent of elevated mercury soil vapor in the mercury source area. Also analyzed mercury concentrations in ambient indoor air within the Cell Building and an outdoor background location during February 2011 (CP-AA01 and BG-AA01, respectively). Finally, in October 2011, three additional vapor probes (CP-VP-11, CP-VP12, and CP-VP13) were sampled beneath and adjacent to the Cell Building. Frontier Geosciences, under subcontract to Aspect, conducted the soil vapor sampling and laboratory analysis. The Frontier Geosciences reports detailing the soil vapor sampling and analysis is included as Appendix E.

6.2 Confined Nearshore Fill/Chemfix Subarea

Elevated soil mercury concentrations occur within the western portion of the Confined Nearshore Fill/Chemfix subarea, where mercury-containing wastewater was historically discharged from the former Chlor-Alkali plant – directly to the Whatcom Waterway between 1965-1970, and then into a Wastewater Settling Basin between 1970-1980. Elevated soil mercury concentrations also exist in the chemically stabilized Chemfix material, which is contained and capped within the southern portion of the subarea.

Based on the pre-RI information, groundwater quality data was inadequate to confidently address protection of the Log Pond and Whatcom Waterway via potential groundwater

transport of dissolved mercury from soil areas containing elevated mercury. The pre-RI data indicate that mercury soil vapor concentrations from the stabilized Chemfix material are below the unrestricted air screening level, so this is not an exposure pathway of concern.

The following data collection was conducted during the current RI to address the data gaps:

- Drilling, installation, and development of two new Fill Unit monitoring wells (CF-MW01 and CF-MW02) immediately downgradient of the Chemfix material.
- Conducted dry season and wet season sampling and analysis of groundwater from new Fill Unit wells CF-MW01, CF-MW02, CP-MW03, CP-MW10, and CP-MW11, existing Fill Unit wells EMW-7S, EMW-8S, EMW-10S, EMW-14S, EMW-20S, Law-1, as well as Lower Sand Unit wells CP-MW05 and EMW-29D. Several of these wells overlap with characterization of the Caustic Plume subarea, as described above, but are located within the footprint of the Confined Nearshore Fill/Chemfix subarea. The groundwater samples were analyzed for dissolved mercury and field parameters. Groundwater samples from some of the wells were also analyzed for TPH for characterization of the Million Gallon Tanks subarea, as described in Section 6.5.
- Based on elevated dissolved mercury concentrations detected in well Law-1 during Fall 2009/Spring 2010 sampling events, additional sampling for mercury in soil and Fill Unit groundwater was completed at the following new locations as part of the interim action pre-design investigation in December 2010:
    - L1-MW01, completed within about 5 feet of the existing well Law-1 to verify conditions there;
    - L1-MW02, west of Law-1, located within the Salt Storage Pad area, west of the 1974 dredge fill (Nearshore Confined Fill);
    - L1-MW03, located east of Law-1 and within the silty soil berm constructed to confine the 1974 dredge fill.
    - L1-MW04 and L1-MW05, located upgradient of Law-1, within the footprint of the former Wastewater Settling Basin where elevated soil mercury concentrations are documented at depth.
- Groundwater samples collected in December 2010 from the new wells and four existing monitoring wells (AMW-01, CP-MW03, CP-MW10, and Law-1), and a new intertidal wellpoint immediately downgradient of Law-1 (L1-WP1), were analyzed for dissolved mercury, sulfide, sulfate, DOC, dissolved iron and manganese, alkalinity, TDS, and field parameters.
- During the second phase investigation of interim action pre-design investigation (February 2011), two new intertidal wellpoints (L1-WP2 and L1-WP3) and monitoring well L1-MW06 were installed. Groundwater samples were collected from wells Law-1, L1-MW01, L1-MW02, L1-MW03, and L1-MW06, and wellpoints L1-WP1, L1-WP2, and L1-WP3.

6.3 Stormwater Swale Subarea

The RI/FS Work Plan did not identify data gaps for the Stormwater Swale subarea, located south of the former Chlor-Alkali plant. However, after subsequent evaluation and discussion with Ecology during implementation of the RI, it was decided that additional soil sampling and analysis was warranted to confidently delineate lateral and vertical extents of soil mercury in this area.

In accordance with the RI/FS Work Plan Addendum (Aspect, 2010a), the following data collection was conducted during the current RI to address the data gap:

- Collected soil samples for total mercury analysis at nine additional locations around the perimeter of the Stormwater Swale to better define the lateral and vertical extent of soil mercury within and around it. The explorations included:
    - Six hand-augered borings (SW-HA01 through SW-HA06) to depths of 1 foot around the perimeter of the swale to define the lateral extent of soil mercury.
    - Three deeper soil borings to define vertical extent of elevated soil mercury in areas where elevated mercury in near-surface soils were not vertically bounded during pre-RI sampling. The borings included SW-SB01 and MG-MW02 to depths of 9 feet, and SW-SB02 to a depth of 15 feet. Boring MG-MW02 was completed primarily to address potential groundwater TPH impacts from the adjacent Million Gallon Tanks; however, because of proximity to the Stormwater Swale, soil samples collected from it during drilling were analyzed for soil mercury to further assess lateral and vertical soil mercury extents.

6.4 Laurel Street Pipe Rack Subarea

Elevated soil mercury concentrations remain in this area as a result of disposal of mercury-containing debris from the former Chlor-Alkali plant. Additional information was required to better define the lateral and vertical extents of mercury-impacted soil, and to sufficiently address protection of surface water via groundwater transport of dissolved mercury. The pre-RI data indicate that mercury soil vapor concentrations from the subarea's soils are below the unrestricted air screening level, so this is not an exposure pathway of concern.

The RI/FS Work Plan (Aspect, 2009a) identified the following specific data gaps for the Laurel Street Pipe Rack subarea:

1. Better document the lateral and vertical extent of elevated soil mercury concentrations, to allow refined evaluation of soil volumes requiring cleanup.
2. Document TCLP mercury concentrations for the impacted soil to confirm whether it might designate as characteristic dangerous waste, if excavated.
3. Document the current dissolved mercury concentrations in Fill Unit groundwater within and immediately downgradient of the impacted soil area.

The following data collection was conducted during the RI to address the data gaps:

- Sampled soils for total mercury analysis to depths of approximately 18 feet in eight soil borings (PR-SB02 through PR-SB06, and PR-MW01 through PR-MW03), to delineate the lateral and vertical extents of soil mercury. In accordance with the RI/FS Work Plan, borings PR-MW01 and PR-SB02 through PR-SB05 were completed early in the Fall 2009 field effort, with rush laboratory turnaround for soil mercury results. Based on the lab results, borings PR-SB06 and PR-MW02 were added during the same mobilization to delineate the lateral extent of soil mercury. In accordance with the RI/FS Work Plan Addendum, boring PR-MW03 was advanced in March 2010 to better delineate the vertical extent of soil mercury within the location of highest soil mercury concentrations based on pre-RI data. The 40 soil samples collected from the eight borings were analyzed for total mercury, and the two Fall 2009 samples with highest total mercury concentrations were also analyzed for leachable mercury by the TCLP analysis.

- Installed and developed Fill Unit monitoring wells in the PR-MW01, PR-MW02, and PR-MW03 borings.

- Conducted dry season and wet season sampling and analysis of groundwater from the new Fill Unit wells PR-MW01 and PR-MW02, plus existing Fill Unit well EMW-13S; groundwater from new well PR-MW03 was also sampled during the wet season event in Spring 2010. The groundwater samples were analyzed for dissolved mercury and field parameters.

6.5 Million Gallon Tanks Subarea

Grossly contaminated soil adjacent to former Tank 2 was removed in a 2006 independent cleanup action. With the subsequent removal of the tanks, additional information was required to better define the extent of petroleum-impacted soil and to sufficiently address protection of surface water via groundwater transport of petroleum hydrocarbons. The RI/FS Work Plan (Aspect, 2009a) identified the following specific data gaps for the Million Gallon Tanks subarea:

1. Better document the lateral and vertical extent of TPH and associated cPAHs in soils around Tank 2, to allow evaluation of soil volumes potentially requiring cleanup.

2. Calculate a Site-specific risk-based TPH concentration protective of groundwater quality and direct contact under unrestricted and industrial Site uses.

3. Determine the lateral extent of petroleum hydrocarbons in groundwater adjacent to the Tanks.

The following data collection was conducted during the RI to address the data gaps:

- Conducted sampling and analysis of soils to depths of about 18 feet in seven borings (MG-SB04 through MG-SB10) surrounding and in the center of the Former Tank 2, and on the east side of Tank 1 where some visual evidence of petroleum was noted in test pits during the 2006 cleanup action. The 32 soil samples were analyzed for diesel- and oil-range petroleum hydrocarbons and PAHs.

- Analyzed two soil samples containing higher TPH concentrations for extractable petroleum hydrocarbons (EPH) analysis, to allow for calculation of risk-based soil cleanup levels based on direct contact and leaching to groundwater, in accordance with MTCA.

- In accordance with the RI/FS Work Plan Addendum, drilled, installed, and developed two new Fill Unit monitoring wells: MG-MW02 located due south of the former Tank 2 to assess potential groundwater petroleum impacts in that direction and better define local groundwater flow directions; and MG-MW03 located downgradient (north) of Tank 2 to assess continuity of groundwater TPH between the Tank 2 location and further downgradient wells.

- Conducted dry season and wet season sampling and analysis of Fill Unit groundwater from new wells CF-MW01 and CF-MW02 and existing wells MG-MW01, EMW-6S, EMW-12S, and EMW-16S. For the Spring 2010 (wet season) groundwater sampling event, wells MG-MW02, MG-MW03, EMW-7S, EMW-8S, EMW-18S, and EMW-20S were added for sampling and analysis to better define the downgradient extent of groundwater TPH from the tanks area, in accordance with the RI/FS Work Plan Addendum. The groundwater samples were analyzed for TPH, TSS, and field parameters, and, for wells other than EMW-7S, EMW-8S, EMW-18S, and EMW-20S, for PAHs.

- As per the RI/FS Work Plan Addendum, the Spring 2010 groundwater samples from wells MG-MW01, EMW-12S, EMW-16S, MG-MW03, CF-MW01, CF-MW02, EMW-7S, and EMW-8S were also submitted to Ecology's Manchester Laboratory for analysis of petroleum biomarkers. Biomarkers (e.g., steranes, terpanes) provide detailed information on the origin of the petroleum product and are more resistant to degradation than other petroleum components, so can be useful in chemically fingerprinting petroleum releases. The goal for conducting the petroleum biomarker analyses was to better define the continuity and migration of groundwater contamination from the Million Gallon Tanks subarea. Ecology's report of its findings (Ecology, 2010b) is presented in Appendix G.

- In the first phase of interim action pre-design investigation (December 2010), eight additional soil borings (MG-SB11 through MG-SB16, MG-MW04 and MG-MW05) were installed, with MG-MW04 and MG-MW05 completed as monitoring wells. Soil and groundwater sampling for petroleum hydrocarbons was conducted.

- In a second phase of interim action pre-design investigation (February 2011), four soil vapor probes (MG-VP01 through MG-VP04) were installed and sampled for petroleum hydrocarbons at locations based on the collective soil and groundwater data.

- In November 2012, porewater samples were collected from shallow intertidal sediment locations (MG-PW-01 and MG-PW-02) at the downgradient edge of the subarea, to assess whether TPH in groundwater was reaching surface water at concentrations of concern.

6.6 Bunker C Tank Subarea

The previous sampling documented the presence of light non-aqueous phase liquid (LNAPL) on the water table, and petroleum-impacted soil at distance from the former Bunker C storage tank in this subarea. Subsurface pipelines conveyed the fuel from the storage tank to the former steam plant located west of the former storage tank. Additional information was required to better define the extent of petroleum-impacted soil in the area, including along the waterway bulkhead, and to sufficiently address protection of the Whatcom Waterway via groundwater transport of petroleum hydrocarbons. The RI/FS Work Plan (Aspect, 2009a) identified the following specific data gaps for the Bunker C Tank subarea:

1. Better document the lateral extent of Bunker C and associated cPAHs in soil, to allow refined evaluation of soil volumes requiring cleanup.
2. Calculate a Site-specific risk-based concentration for the Bunker C protective of groundwater quality and direct contact under unrestricted and industrial Site uses.
3. Confirm the lateral extent of separate-phase and dissolved-phase petroleum hydrocarbons in groundwater.
4. Assess geotechnical and structural (bulkhead) considerations for conducting soil excavation adjacent to the waterway, if necessary.

The following data collection was conducted during the current RI to address the data gaps:

- Sampled and analyzed soil to depths of 15 to 22 feet in ten soil borings (BC-SB03 through BC-SB10, BC-MW02, and BC-MW03) to assess vertical and lateral extents of Bunker C in soil. The 48 soil samples were analyzed for diesel- and oil-range petroleum hydrocarbons and PAHs.
- Analyzed four soil samples containing higher TPH concentrations for EPH analysis, to allow for calculation of risk-based soil cleanup levels based on direct contact and leaching to groundwater, in accordance with MTCA.
- Installed and developed Fill Unit monitoring wells in the BC-MW02 and BC-MW03 borings, to document groundwater quality along inferred potential locations of Fill Unit groundwater discharge to the waterway: BC-MW02 just north-northwest of the former Bunker C tank and BC-MW03 east-northeast of it.
- Conducted dry season and wet season sampling and analysis of groundwater from Fill Unit wells BC-MW01, BC-MW02, and BC-MW03. During the Fall 2009 (dry season) sampling event, a thin accumulation of LNAPL was present in BC-MW01; therefore, a groundwater sample was not collected from this well, in accordance with the RI/FS Work Plan. A groundwater sample was collected from it in Spring 2010. The groundwater samples were analyzed for TPH, PAHs, TSS, and field parameters. Because elevated dissolved metals were detected in the Fall 2009 groundwater sample collected from BC-MW02 (for characterization of the Acid Area, described below), dissolved metals analyses were also added for the

Spring 2010 groundwater samples from BC-MW01 and BC-MW03 to assess the extent and potential source of elevated dissolved metals observed in BC-MW02.

- In the first phase of interim action pre-design investigation (December 2010), twelve additional soil borings (BC-SB11 through BC-SB20, BC-MW04, and BC-MW05) were installed, with BC-MW04 and BC-MW05 completed as monitoring wells. Soil and groundwater sampling for petroleum hydrocarbons was conducted.
- In a second phase of interim action pre-design investigation (February 2011), four soil vapor probes (BC-VP01 through BC-VP04) were installed and sampled for petroleum hydrocarbons at locations based on the collective soil and groundwater data.

No data were collected during the current RI specifically to assess geotechnical and/or bulkhead issues that may affect the cleanup approach for the Bunker C subarea. Geotechnical work being conducted as part of the Whatcom Waterway remedial design work will be factored into the development and evaluation of remedial alternatives for the Bunker C Tank subarea, as appropriate, during the FS and/or pre-design efforts for a potential interim remedial action.

6.7 Acid Plant Subarea

Pre-RI investigations documented acidic pH and elevated dissolved metals concentrations in groundwater downgradient of the former Acid Plant, where sulfuric acid was produced for use in the pulping process. Additional information was required to sufficiently address protection of the Waterway via groundwater transport of dissolved metals. The RI/FS Work Plan (Aspect, 2009a) identified the following specific data gaps for the Acid Plant subarea:

1. Better document the lateral extent and potential seasonal fluctuation of the low pH and dissolved metals concentrations in groundwater to the north, along the shoreline, and on the east where the former Pulp and Tissue Mill buildings prevented installation of monitoring wells during the 2004 Phase II Environmental Assessment.
2. Document whether soils in the former Acid Plant represent a potential ongoing source of acidity to the Fill Unit groundwater.
3. Better understand the fate and transport of dissolved-phase metals, including the Fill Unit's capacity to neutralize the acidic pH and thus presumably limit transport of metals in the aqueous phase.

The following data collection was conducted during the current RI to address the data gaps:

- Drilling, installation, and development of five new monitoring wells (AA-MW01 through AA-MW05) to define the lateral extent of low pH and associated dissolved metals in groundwater in this subarea. Wells AA-MW01 and AA-MW02 were installed along the waterway shoreline to assess dissolved metals concentrations approaching discharge to the Whatcom Waterway. Wells A-

MW03 and AA-MW05 were intended to define the eastern and western extents of the impacted groundwater. Well AA-MW04 was installed within the footprint of the former Acid Plant to define conditions within the acidic source area.

- Conducted soil sampling and analysis to a depth of 12 feet during drilling of AA-MW04, to assess whether soils within the former Acid Plant Area represent a potential ongoing source of acidic leaching. The four soil samples were analyzed for soil pH and total metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc).

- Conducted dry season and wet season sampling and analysis of Fill Unit groundwater from the following monitoring wells: new Acid Area wells (AA-MW01 through AA-MW04), new well BC-MW02 in the Bunker C Tank area, and existing wells GF-MW01, FH-MW01, GF-MW02, LB-MW01, and TS-MW01. During the Spring 2010 groundwater sampling event, wells BC-MW01 and BC-MW03, within the Bunker C Tank subarea, were added. The groundwater samples were analyzed for dissolved metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc) and field parameters.

- In addition, analyzed groundwater samples from wells AA-MW01, AA-MW02, AA-MW04, GF-MW02, and FH-MW01 for a suite of water quality parameters including major cations, major anions, alkalinity, redox pairs (sulfate/sulfide and nitrate/nitrite), and TDS to provide information on geochemical conditions and support potential subsequent geochemical modeling efforts, if warranted for assessment of remedial technologies in the FS.

6.8 Lignin Plant Well LP-MW01 Subarea

Groundwater from existing Lignin Plant monitoring well LP-MW01 was sampled in dry and wet seasons for VOCs to verify concentrations of chlorinated solvent VOCs detected in 2004 at concentrations above groundwater screening levels. The dry season groundwater sample was collected during the first round of Site-wide groundwater level measurements, prior to the start of other soil and groundwater quality sampling activities at the Site. Chlorinated solvents were detected in the sample at concentrations above groundwater screening levels. Therefore, in accordance with the RI/FS Work Plan, additional soil and groundwater sampling and analysis was performed to delineate the extent of chlorinated solvent impacts. This information was conveyed to Ecology prior to proceeding with the additional investigation (Aspect, 2009b).

During the Fall 2009 field effort, six soil borings (LP-SB09 through –SB14) were advanced in locations surrounding existing well LP-MW01. During drilling, the recovered soil was field screened for the presence of VOCs using a PID. Three soil samples were collected from each boring, one at a depth of 1 to 2 feet, one straddling the water table, and one from a few feet below the water table. One groundwater grab sample was also collected from each boring. The soil and groundwater samples were analyzed for VOCs. VOC concentrations in the six groundwater samples were below screening levels. One VOC, PCE, was detected in two soil samples from one boring (LP-SB11) at concentrations slightly above its screening level, which is based on leaching to groundwater for VI protection. However, PCE was not detected in groundwater sample,

or the deeper soil sample collected below the water table, from the boring. Based on the data, no additional investigation, beyond the wet season groundwater sampling at LP-MW01, was warranted in accordance with RI/FS Work Plan (Aspect, 2009a).

6.9 Miscellaneous Constituents, Site-Wide

Outside of the Site subareas, there is relatively widespread, lower-level soil contamination typical of industrial properties (e.g., oil-range TPH, cPAHs, and some metals above unrestricted soil screening levels). In addition, groundwater in the Fill Unit throughout the Site has reducing geochemical conditions conducive to the mobilization of dissolved metals in groundwater. The following subsections describe miscellaneous constituents for which additional RI data collection was conducted across the Site in accordance with the RI/FS Work Plan (Aspect, 2009a).

6.9.1 Miscellaneous Groundwater Metals Exceedances

One or more dissolved metals were detected in pre-RI groundwater samples from five wells at concentrations exceeding respective groundwater screening levels. These wells (EMW-12S, EMW-16S, LP-MW01, LW-MW01, and SC-MW02) are located outside the subareas discussed previously for which groundwater quality sampling and analysis for metals were proposed (e.g., the Acid Plant subarea). In addition, dissolved hexavalent chromium was reported in the EMW-16S sample at a concentration above its groundwater screening level, but the available information indicates it was an analytical artifact (Section 6.2.2 of Aspect, 2009a). To verify the dissolved metals concentrations for the purpose of assessing protection of the Whatcom Waterway, the wells EMW-12S, EMW-16S, LP-MW01, LW-MW01, and SC-MW02 were sampled and analyzed twice (wet and dry seasons) for dissolved metals (arsenic, cadmium, total chromium, hexavalent chromium, copper, lead, mercury, nickel, and zinc) and field parameters.

6.9.2 Dioxins/Furans in Site Soils

The pre-RI data indicate the presence of dioxins/furans in Fill Unit soil at concentrations above the unrestricted soil screening level but below the industrial soil screening level. Although a high concentration source is not apparent, three additional soil samples collected across the Site were analyzed for dioxins/furans to further assess the extent and range of concentrations in soil.

To help bound the lateral extent of dioxins/furans detected at pre-RI boring BH-SB02, analysis for dioxins/furans was conducted for a soil sample from soil boring BC-SB03, located about 90 feet south of BH-SB02. To provide a spatial distribution of data across the Site, dioxins/furans analyses were also conducted for soil samples collected from boring PR-MW01 on the north side of the Laurel Street Pipe Rack subarea, and boring CP-MW03 on the north side of the Caustic Plume subarea.

6.10 Stormwater Conveyance System

The Site includes operational and historical stormwater conveyance systems. Notably, the City's Laurel Street stormwater pipe conveys off-Site stormwater through the center of the Site, beneath Laurel Street, to a City outfall on the Whatcom Waterway. A subsurface pipe conveys Site stormwater along the same general alignment beneath Laurel Street, but at shallower depth (on top of the City's pipeline), to a pump station at the Waterway.

From the pump station, the Site stormwater is pumped beneath the Waterway to the ASB for treatment and discharge under a NPDES permit. In addition, immediately south of the Site, a City stormwater pipe conveys off-Site stormwater to a City outfall on the "elbow beach" at the western terminus of Cornwall Avenue.

Where the storm drain piping occurs below the water table, permeable pipe bedding and backfill surrounding the pipe can provide a preferential conduit for groundwater flow. A data gap identified in the RI/FS Work Plan was to determine whether stormwater conveyance pipelines beneath the Site represent potential preferential conduits for groundwater flow and contaminant transport to the Waterway. In accordance with the RI/FS Work Plan, the following tiered assessment process outlined below was conducted to address the data gap.

6.10.1 First Tier

The first tier of the assessment included field observations of stormwater catch basins and/or outfalls that are fed by on-Site pipelines positioned at or below the dry season water table. Flow from the outfalls during the dry season, when there has been no appreciable precipitation for the preceding week or more, is likely attributable to groundwater inflow.

A pair of dry-season inspections in September and October 2009 documented that on-Site pipelines contained no water. Comparison of the pipe invert elevations to groundwater elevations indicates these drains are generally above the water table. The City's Laurel Street drain is more deeply buried and extends below the water table. The dry weather inspections did document minimal flow (3 to 4 gpm) coming out of the slip-lined pipe at the Laurel Street outfall (roughly equal flows from center of slip-lined pipe and from between slip lining and outer drain structure). The discharge was pretty constant at early and late low tides, and was brackish.

That information, and groundwater elevation mapping (Section 4.2.2), suggests that groundwater locally enters the Laurel Street pipe alignment. Therefore, additional observations (second tier) were continued on the Laurel Street pipe, in accordance with the Work Plan.

6.10.2 Second Tier

The second tier of the assessment involved measuring flow volumes at accessible upstream and downstream points in the pipeline to estimate gain or loss of flow across the pipe length, attributable to inflow from groundwater or outflow to groundwater.

The second tier observations were conducted on the Laurel Street stormwater piping and consisted of inspections at both the outfall at Whatcom Waterway and at the upstream (and off-Site) manholes adjacent to Cornwall Avenue. Two inspections were conducted in May 2010, both following moderate rainfall events over the course of a few consecutive days. Both inspections occurred during the rising limb of low-tide conditions, where the tidal water surface was below the invert of the outfall and sufficient time had passed to minimize the effect of tidal water flow from within the outfall.

The first inspection occurred on May 4 following a rainfall event of 0.77 inches over three consecutive days and measured approximated flow of 0.07 cfs at the Laurel Street outfall. Observation of flow upstream of the Mill Site (south side of Cornwall Avenue)

indicated there was no visual difference in flow compared to the flow at the outfall. There was no visual indication of flow in the annular space between the slip-lined 22-inch diameter outfall pipe (where flow measurements were taken) and the wood-stave carrier pipe.

The second inspection occurred on May 28 following a rainfall event of 1.45 inches over nearly four days and measured approximated flow of 0.24 cfs upstream of the Mill Site and 0.20 to 0.27 cfs at the outfall. The range of flows at the outfall was calculated using a variety of flow measurements that were not available at the upstream location. Flow was also observed in the annular space between the outfall and the carrier pipe. A measurement of this flow was not possible with the methods used on the outfall itself; however, the flow was estimated at one-tenth the amount discharged from the outfall itself.

The two inspections indicated that the flow rate in the Laurel Street outfall was similar at the upstream (coming from off-Site) and downstream (at the outfall) ends of the Site. The presence of flow in the annular space between the slip-lined outfall and the wood-stave carrier pipe is believed to be groundwater from on-Site sources.

Note that no exceedances of groundwater screening levels have been detected in Site monitoring wells located nearest the sewer line (EMW-13S, PR-MW01, PR-MW02, EMW-18S, AP-MW01, AA-MW03, GF-MW01) during 2004, 2009, or 2010 groundwater monitoring events (data presented in Section 7).

The collective information indicates that the Laurel Street storm drain alignment is a local conduit for Fill Unit groundwater flow, but not a conduit for contaminant migration, to the Whatcom Waterway. In addition, a portion of the water exiting the drain at the outfall is from off-Site sources. As a result, the third tier of the assessment identified in the RI/FS Work Plan (sampling and chemical analysis) was not conducted.

Whatcom Waterway

Law-1 Area

Nearshore Confined Fill Subarea

Chemfix Area

Caustic Plume Subarea

Million Gallon Tanks Subarea (Tank 2)

Stormwater Swale Subarea

Laurel St. Pipe Rack Subarea

Acid Plant Subarea

Bunker C Tank Subarea

Lignin Plant (LP-MW01) Subarea

FORMER BULKHEAD

"ENCOGEN NW" 160 MW CO-GENERATION PLANT

CORNWALL AVENUE

LAUREL STREET

Site Subarea Boundary

Other Area

Subarea Contaminant:

- Mercury
- Other Metals
- Petroleum
- Chlorinated Solvents

0 100 200 400 600 800 Feet

MILL NORTH / TRUE NORTH (45°)

Aspect CONSULTING

Site Subareas for RI/FS

GP West Site RI/FS
Bellingham, WA

DATE: Apr 2013	PROJECT NO. 070188
DESIGNED BY: SJG	
DRAWN BY: PPW	FIGURE NO. 6-1
REVISED BY: PPW	

Path: T:\projects_8\Port_of_Bellingham\Delivered\RI\Final\6-1 SiteSubareas_RIFS.mxd