ADDENDUM NO. 4
SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

South State Street Manufactured Gas Plant
Remedial Investigation/Feasibility Study

Prepared for

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February 6, 2013

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
City	City of Bellingham, Parks and Recreation Department
CSIA	compound-specific isotope analysis
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
ft	foot or feet
HASP	Health and Safety Plan
Herrenkohl Consulting	Herrenkohl Consulting LLC
MTCA	Model Toxics Control Act
PRT	post-run tubing
PSE	Puget Sound Energy
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RI/FS	remedial investigation and feasibility study
SAP	sampling and analysis plan
SIM	select ion monitoring
SSSMGP	South State Street Manufactured Gas Plant
TWA	time weighted average
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act

1 INTRODUCTION

This document is the fourth addendum to the sampling and analysis plan (SAP) and quality assurance project plan (QAPP) for the South State Street Manufactured Gas Plant (SSSMGP) Site remedial investigation and feasibility study (RI/FS) in Bellingham, Washington. It outlines additional sampling and testing activities proposed for the SSSMGP Site, activities supplementary to work conducted under the August 6, 2010 Work Plan (Herrenkohl Consulting and Landau Associates 2010) based on recommendations in the *Remedial Investigation Interim Data Report* (Herrenkohl Consulting and Landau Associates 2011a) and further discussions with the Washington State Department of Ecology (Ecology).

This addendum provides specific guidance for field and laboratory methodology and quality assurance procedures that will be followed by Herrenkohl Consulting LLC (Herrenkohl Consulting), Landau Associates, and subcontractors. Herrenkohl Consulting and Landau Associates are conducting this work under contract with the City of Bellingham, Parks and Recreation Department (City), with direction from the Ecology Toxics Cleanup Program. The addendum to the SAP and QAPP was prepared in accordance with an Agreed Order and Scope of Work negotiated between the City, Puget Sound Energy (PSE), and Ecology and signed April 30, 2010 (Document No. 7655), and was developed to meet the requirements of an RI/FS as defined by the Washington State Model Toxics Control Act (MTCA) Cleanup Regulation [Washington Administrative Code (WAC) 173-340; Ecology 2007].

Several documents are cited in this addendum. Altogether, these documents are referred to as the Work Plans for the SSSMGP Site RI/FS:

- ***Work Plan*** for the RI/FS of the SSSMGP Site Bellingham, Washington. The Work Plan provides information on existing data for the SSSMGP Site and the sampling strategy and design to meet the data needs for completing the RI/FS. The Work Plan also describes the project management strategy for implementing and reporting RI/FS activities for the Site, including project team responsibilities and schedule.
- ***Sampling and Analysis Plan*** (Appendix B of the Work Plan) for the RI/FS of the SSSMGP Site, Bellingham, Washington. The SAP describes the procedures for conducting field activities and presents the proposed laboratory analyses for samples collected in the field.
- ***Quality Assurance Project Plan*** (QAPP; Appendix C of the Work Plan) for the RI/FS of the SSSMGP Site, Bellingham, Washington. The QAPP describes analytical method reporting limit goals, field and laboratory quality assurance/quality control (QA/QC) requirements and reporting requirements for the RI/FS for the Site.
- ***Project Health and Safety Plan*** (Appendix D of the Work Plan) for the RI/FS of the SSSMGP Site, Bellingham, Washington. The HASP has been prepared in accordance with WAC 173-340-810, applicable Washington Industrial Safety and Health Act (WISHA) regulations, and project requirements. It addresses those activities associated with work to be performed at the Site.

The Work Plan described an environmental investigation designed to meet the data needs for completing the RI/FS. Data collected in that investigation were summarized in the Interim Data Report (Herrenkohl Consulting and Landau Associates 2011a). An evaluation of that data resulted in the identification of remaining data gaps and recommendations for additional investigation activities to fulfill the data needs for completing the RI/FS. Some of those additional investigation activities were conducted in July 2011, February 2012, and October 2012 in accordance with *Addendums No. 1, No. 2 and No. 3, Sampling and Analysis Plan and Quality Assurance Project Plan*, respectively (SAP Addendums 1, 2, and 3, Herrenkohl Consulting and Landau Associates 2011b,c and 2012). Sampling and testing completed in accordance with Addendum 1 included laboratory analysis of some archived soil and sediment samples, additional soil vapor sampling, and a bivalve reconnaissance within the pocket beach area of the Site. For Addendum 2, soil and sediment borings were drilled and monitoring wells installed at four additional locations (HS/MW-46, HS/MW-53, HS/MW-54 and HS/MW-55) to further delineate contamination associated with the Site and define the Site boundary[1]. For Addendum 3, soil borings were drilled (GP-56 and GP-57) to further delineate soil and groundwater contamination associated with the Site and define the Site boundary.

1.1 PURPOSE AND APPROACH

Based on our review of previous data collected in support of the RI/FS and discussions with Ecology, additional sampling and testing is warranted to evaluate whether vapor intrusion is a complete and significant exposure pathway at a residential property adjacent to the Site. Benzene, which is the primary driver for potential risks associated with vapor intrusion at the site based on detected concentrations, has been detected in the three sampling locations adjacent to the southwest Site boundary (SV-25, SV-49, and SV-50).

To evaluate vapor intrusion as a potential exposure pathway at the Spinnaker Reach Condominiums, two crawl space air samples will be collected from the northeast end of the crawl space of the condominium building, as close to the Site boundary as possible. One sample location (CA-01) will be located somewhat centrally within the crawl space of the condominium unit and directly southwest of GP-25, at the location of highest detected benzene concentrations in soil vapor adjacent to the southwest Site boundary. A second sample location (CA-02) will be in the easternmost corner of the crawl space of the condominium unit. The placement of CA-02 will indicate air concentrations with the least influence by any possible ventilation at the daylighted portion of the crawl space (the crawl space in the Site-adjacent condominium building unit daylights at two locations along the northwest face of the Spinnaker Reach Condominiums). To minimize the potential that ventilation will affect air quality conditions in the crawl space, the access door will be opened only when entering the crawl space to initiate sampling, to confirm the proper functioning of the sampling equipment, and to terminate sample collection. By

[1] For the purpose of this document, the term "boundary" refers to the Preliminary SSSMGP Site Boundary as set out in Exhibit A to the 2010 Agreed Order. The Preliminary SSSMGP Site Boundary may not encompass the full lateral extent of contamination associated with the former MGP. The final Site boundary will be based on the full extent of contamination and could be larger or smaller than that originally identified in Exhibit A of the Agreed Order.

minimizing the time the access door is opened, and not using any mechanical ventilation equipment for the crawl space, effects on crawl space air quality are expected to be negligible. Both proposed sample locations, shown on Figure 1 will be analyzed for total concentration of benzene.

To provide background concentrations in ambient air, one ambient air sample will also be collected outside of the Spinnaker Reach Condominium (station AA-01). This sample will be collected from the north corner of the fence between the Site and the condominium property[2]. This proposed sample location is also shown on Figure 1. Sample AA-01 will also be analyzed for total concentration of benzene. The concentration of benzene in ambient air will be considered the baseline air quality condition. Potential air quality impacts to crawl space air, if any, that may be attributed to vapor intrusion will be estimated by subtracting benzene concentrations detected in ambient air from those detected in crawl space air.

Benzene is a common component in a number of household and commercial chemical products and can therefore be commonly detected in residential indoor air. Given the relatively low concentrations of benzene in soil vapor from the adjacent Site boundary and the distance between those sample locations and the condominium building, the results may be inconclusive. For example, if benzene exceeds indoor air cleanup levels at either of the two crawl space air sample locations, it would be unclear whether the benzene detected in crawl space air is related to vapor intrusion from subsurface contamination at the Site, or background indoor air concentrations related to indoor chemical use at the condominium building (an indoor source). However, the isotope profile of benzene from Site-related subsurface contamination would likely be different than the profile of possible indoor air sources, making measurement of the isotope profile a useful tool for source differentiation.

To help evaluate whether the benzene, if detected in crawl space air at concentrations exceeding indoor air cleanup levels, has a different isotope profile than benzene detected in Site soil vapor, additional sample volume will be collected from the two crawl space sampling locations and held for possible analysis using compound specific isotope analysis (CSIA). In the event that the benzene concentration in either crawl space air sample exceeds indoor air cleanup levels, then the sample with the highest concentration will be analyzed using CSIA.

[2] Ambient air samples are often collected upwind of the building being investigated to improve the likelihood that the sample is representative of outdoor air that is being circulated indoors through the building's HVAC system. For the following reasons the effects of ambient air conditions are expected to be much more gradual than at many buildings (i.e., ambient air concentrations are expected to influence crawl space air concentrations over a period of days or weeks, not hours): 1) there is no HVAC system with an outdoor air intake point for the building; 2) the likelihood of direct ventilation (e.g., open windows) to indoor air is very low during the heating season; 3) there is no direct air exchange between indoor air and crawl space air; and 4) there is no direct ventilation between crawl space air and ambient air. These building-specific conditions make wind direction a much less pertinent consideration during the proposed sampling event; therefore, the ambient air sampling location has been based on the following considerations: 1) distance from other known sources (e.g., vehicle exhaust in parking areas on the southeast side of the building); 2) proximity to the portion of the building being sampled; and 3) relative security of the sampling location.

A soil vapor sample – to be collected at a later date only if the indoor air cleanup level is exceeded – will be collected from the Site and analyzed using CSIA. The contingent soil vapor sample would be collected at the location and depth interval adjacent to the southwest Site boundary with the highest benzene detection in previous sampling (GP-25, 6-8 ft below ground surface). The additional Site soil vapor CSIA sample would be collected using direct-push drilling and post-run tubing (PRT) equipment and methods utilized for soil vapor sampling as described in the SAP and Addendum 1 of the SAP, and would require an additional mobilization of personnel and equipment.

1.2 PRELIMINARY BUILDING RECONNAISSANCE

A preliminary reconnaissance of the condominium building's crawl space was conducted November 30, 2012. Representatives of the City, PSE, and Ecology participated in the reconnaissance, identifying conditions of interest to support the preparation of this SAP addendum. The condominiums are a collection of individual buildings; the building reconnaissance was focused on the building adjacent to the Site (Building No. 3).

The footprint of Building No. 3 is approximately 40 feet by 80 feet; the short side is parallel to the Site and the long side is parallel to the Burlington Northern Santa Fe railroad tracks. The bottom floor of the condominium building is constructed as a daylight basement. The floor on the southeast side of the building is 5 feet below ground surface. The ground surface slopes down toward the northwest; the floor on the northwest side of the building is approximately 1.5 feet above ground surface.

The building is constructed on concrete stem-wall footings, continuous around the crawl space without any in-built ventilation points. The crawl space height is 30 inches and spans the full building footprint. The base of the crawl space is earthen, with plastic sheeting covering as a vapor retardant. The condominium floors are constructed directly on top of the concrete stem-wall footings and consist of ½-inch plywood subfloor beneath 1½-inch lightweight concrete flooring. The crawl space is accessible through two small plywood portals on the northwest side of the building. The plywood portals are solid, screwed tight shut, and do not provide ventilation except in a very limited capacity when open to provide access; even when open, the access portals are protected from wind effects by the presence of landscaped shrubs. There are no other ventilation points in the crawl space.

No preferential pathways for vapor migration were observed during the reconnaissance. The building has no sumps or elevator shafts extending into the subsurface. The four utility connections observed in the crawl space are sealed and do not provide for significant advective air flow between the crawl space and indoor air. The building does not have a central heating, ventilation and air-conditioning (HVAC) system. Each condominium unit is heated with electric wall heaters.

Based on the observations of the building reconnaissance, there are no building conditions that would lead to an expectation of preferential vapor migration from the subsurface to crawl space

air, or from crawl space air to indoor air. The crawl space has very limited air exchange, and chemical concentrations in crawl space air are more likely to be associated with long-term molecular diffusion than short-term advective air flow. For the purposes of the vapor intrusion assessment, the default approach will be to conservatively assume that there is no attenuation of contaminant concentrations between crawl space air and indoor air (Ecology 2009).

2 FIELD SAMPLING AND TESTING METHODS

The environmental investigation activities described herein will be completed in early 2013. Field investigation and laboratory analysis methods described in the SAP and QAPP will be used for the additional investigation, except for activities that warrant the use of new or modified methods. This section presents only those field sampling and laboratory testing methods that are not contained in the SAP and QAPP or that deviate from the methods described therein. Table 1 presents an air and vapor sampling matrix, identifying sample collection and analysis details for each sample described herein.

2.1 CRAWL SPACE AND AMBIENT AIR INVESTIGATION

Crawl space and ambient air samples will be collected from two locations (CA-01 and CA-02) in the crawl space at the northeast end of the Spinnaker Reach Condominiums building and one location (AA-01) at the north corner of the fence between the Site and the condominium boundary (Figure 1). This section describes sampling and analysis procedures that differ from those described in the SAP and QAPP.

In addition to the sampling and analysis procedures described below, the vapor intrusion assessment will also include a discussion of precipitation, barometric pressure, temperature, wind direction and wind speed observed in Bellingham during the two-week period leading up to, and including, the sampling event. Sampling will not be conducted during the approach of a significant high-pressure system.

2.1.1 Crawl Space and Ambient Air Sample Collection for Total Concentration of Benzene

One integrated passive air sampler system, consisting of a 6-liter Summa canister, evacuated to a vacuum pressure of 25 to 30 inches Hg by the Air Toxics, Ltd., will be used to collect a 24-hour, time weighted average (TWA) sample at each location. This sample interval is considered representative of continuous residential exposure scenarios. Each canister will be equipped with a pressure gauge and a calibrated critical orifice air flow controller for collection of the TWA samples. Canisters at sample locations CA-01 and CA-02 will be placed upright in the crawl space so their inlet valves are near the top of the vertical clearance in the 30-inch crawl space; additional sample volume will be collected for potential CSIA as discussed in Section 2.2. The canister at sample location AA-01 will be attached to the top of the fence so the inlet valve is approximately 5 feet above the ground surface representative of typical adult breathing space. Canisters will be clearly labeled with signs indicating the purpose of the canisters and that the canisters are not to be interfered with or moved.

Prior to beginning sample collection, field personnel will confirm the vacuum pressure of the canisters is between 25 to 30 inches Hg. After the inlet valves are opened and the start time is recorded, canister pressures will be checked within 1 to 2 hours, and two additional times during the 24-hour sampling period, to evaluate whether air flow controllers are functioning properly.

Observed hourly pressure loss greater than approximately 2 inches Hg will be indicative of a faulty flow controller. Any canisters observed to have a faulty flow controller will be replaced with a backup canister and flow controller. A final vacuum pressure reading greater than ambient (i.e., zero inches Hg) indicates a valid sample; however, canister closure will be targeted for 5 inches Hg to provide a margin of safety.

At the end of the 24-hour sample period, the inlet valves will be closed and final canister pressure will be recorded. Pressure gauges and air flow controllers will be removed, the inlets will be capped, and canisters will be held in accordance with sample custody procedures discussed in the SAP.

2.1.2 Laboratory Analyses

Crawl space air and ambient air samples will be analyzed only for benzene, which is the primary driver for potential risks associated with vapor intrusion on the Site based on concentrations detected during previous sampling events at the Site. Samples will be analyzed for benzene using modified U.S. Environmental Protection Agency (EPA) Method TO-15 with select ion monitoring (SIM) on 3-day turnaround time to provide enough time for contingent analysis by CSIA, which is discussed below.

2.2 COMPOUND-SPECIFIC ISOTOPE ANALYSIS (CSIA) INVESTIGATION

If benzene is detected in either crawl space sample at a concentration exceeding the indoor air cleanup level for benzene, the additional sample volume from the sample location with the highest benzene concentration will be analyzed by CSIA. The contingent Site-related soil vapor sample would then also be collected and analyzed using CSIA. This section describes the sampling and analysis procedures that differ from those described in the SAP and QAPP.

2.2.1 Crawl Space CSIA Sample Collection

Crawl space samples for CSIA will be collected using two adsorbent tubes per location, specially prepared by the University of Oklahoma for isotope profiling of carbon in benzene. A single low-volume sampling pump, equipped with a flow-splitter, will be attached to the downstream side of each pair of adsorbent sampling tubes so that the sample will be collected into both adsorbent tubes in parallel. This low-volume sampling pump will be used to collect air at a rate of 100 mL/min per sampling tube (i.e., the total flow rate will be set at 200 mL/min). Each set of sampling tubes will be sampled for a collection volume of 40 liters, with an approximate sampling time of 400 minutes.

After the sample has been collected, the adsorbent tubes will be placed in a laboratory-prepared sample container. The container will be labeled with the sample identification number and stored in a cooler with ice in accordance with sample custody procedures discussed in the SAP. The sample will be shipped overnight and submitted to the University of Oklahoma laboratory on hold, pending the crawl space air sample results for total concentration of benzene.

2.2.2 Soil Vapor CSIA Sample Collection

The Site-related soil vapor sample for CSIA will be collected only if benzene is detected in crawl space air samples at concentrations exceeding the indoor air cleanup level. This sample will be collected from 6-8 feet below ground surface (bgs) at previous sample location GP-25/SV-25 using a limited access, track-mounted, direct push drilling rig and PRT tooling setup; if groundwater is encountered at a shallower depth than 6 ft bgs, then the sample interval will be modified to a depth immediately above the water level. Sampling procedures will follow those described in the SAP and Addendum No. 1 to the SAP/QAPP until the sample adsorbent tubes are attached to the sample tubing; at this point, the sampling procedures in Section 2.2.1 will be followed.

2.2.3 Laboratory Analyses

Crawl space air and soil vapor CSIA samples collected in adsorbent tubes will be sent to the University of Oklahoma for laboratory analysis of the isotope profile of carbon in benzene using CSIA. If analyzed, isotope profile results will be completed on a 3 to 4-week turnaround time.

3 REFERENCES

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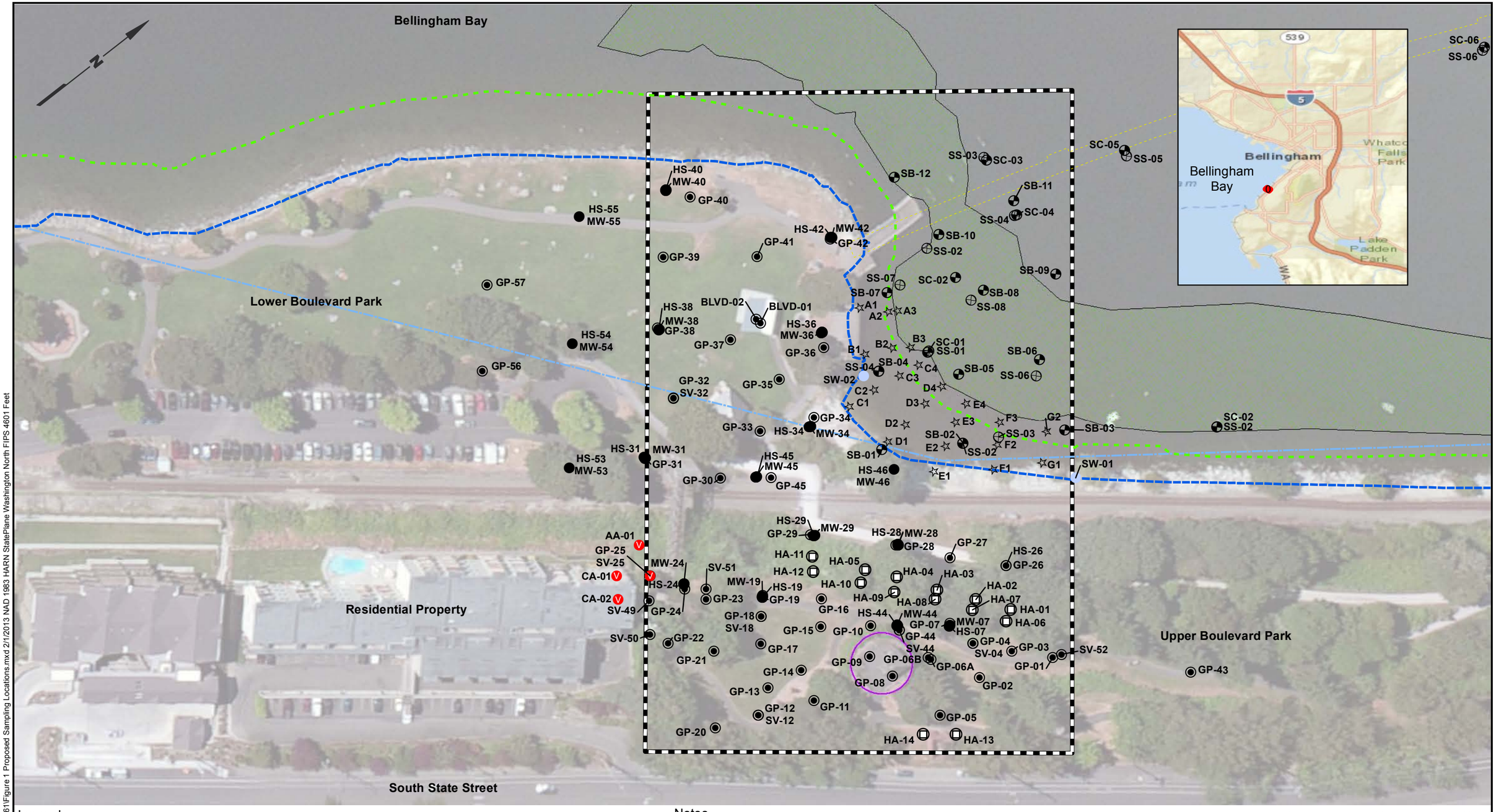

Y:\Projects\015015\060\061\Figure 1 Proposed Sampling Locations.mxd 2/1/2013 NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet

Legend

- Proposed Addendum 4 Sample Locations
- Bivalve Sample Locations
- GeoProbe (and Soil Vapor if Indicated)
- Hand Auger
- Monitoring Well
- Sediment Boring
- Surface Sediment
- Stormwater
- Existing Gas Holder Tank
- Mean Lower Low Water (Elev = 0)
- Mean High Tide
- Inner Harbor Line
- Proposed Over Water Walkway
- Site Boundary
- Eelgrass Survey

Notes

1. CA = Crawl Space Air AA= Ambient Air SV = Soil Vapor
2. Re-sampling of SV-25 is dependent on indoor air results.
3. Horizontal Datum: NAD 83 (HARN), U.S. Survey Feet.
4. Vertical Datum: Mean Lower Low Water (MLLW), Feet.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 80 160

Scale in Feet

Data Sources: BergerABAM, 2010: Steele and Assoc, 2011; ESRI World Imagery.

LANDAU ASSOCIATES

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Proposed Addendum 4
Air Sampling Locations and
Previous Investigation Locations

Figure
1

Table 1. Air and Vapor Sampling Matrix.

Sample Type	Sample ID	Quantity	Volume (L)	Flow Rate (mL/min)	Time (min)	Time (hr)	Container Type	Analysis	Analyte	Laboratory to Analyze	Notes
Crawl Space Air	CA-01	1	6	0.41	1440	24	Summa Canister	TO-15	benzene	Air Toxics	3 day TAT
	CA-01-CSIA	2	40	100	400	6.7	Absorbent Tube	CSIA	C in benzene	U of O	HOLD
	CA-02	1	6	0.41	1440	24	Summa Canister	TO-15	benzene	Air Toxics	3 day TAT
	CA-02-CSIA	2	40	100	400	6.7	Absorbent Tube	CSIA	C in benzene	U of O	HOLD
Ambient Air	AA-01	1	6	0.41	1440	24	Summa Canister	TO-15	benzene	Air Toxics	3 day TAT
Soil Vapor	SV-25	2	40	100	400	6.7	Absorbent Tube	CSIA	C in benzene	U of O	Potential

U of O = University of Oklahoma

TAT = Turn Around Time

CA = Crawl Space Air

AA = Ambient Air

SV = Soil Vapor