# TECHNICAL MEMORANDUM

LANDAU ASSOCIATES

TO: Carl Bach, The Boeing Company, and Allison Crowley, Seattle City Light

FROM: Kathryn Hartley and Kristy J. Hendrickson, P.E.

DATE: October 12, 2015

RE: **ADDENDUM NO. 3**
**NORTH BOEING FIELD/GEORGETOWN STEAM PLANT SITE**
**REMEDIAL INVESTIGATION/FEASIBILITY STUDY**
**SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN**
**SEATTLE, WASHINGTON**

This technical memorandum presents Addendum No. 3 to the North Boeing Field/Georgetown Steam Plant Site (NBF/GTSP) Remedial Investigation/Feasibility Study (RI/FS) Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP; Leidos 2014). Soil gas samples were collected from the NBF/GTSP site as part of Phase I RI investigation activities. Based on those results, Boeing plans to evaluate occupant exposure and other factors at the buildings adjacent to vapor points where volatile organic compounds (VOCs) were detected in soil gas near buildings at a concentration greater than five times the shallow soil gas screening level (Attachment 1) to determine what additional steps may be needed regarding the vapor intrusion pathway. Evaluation may include collection of sub-slab vapor and/or indoor air samples or ambient air samples. The SAP/QAPP and associated addenda did not include procedures for collection and analysis of sub-slab samples, indoor air samples, or ambient air samples; these procedures are included in this addendum. The following sections provide information regarding the collection of sub-slab soil gas, indoor air, and ambient air samples. Two methods are provided for sub-slab soil gas sampling. The method used at a given location will depend on site conditions and slab thickness. Sample locations and sampling methods will be provided to and approved by the Washington State Department of Ecology (Ecology) prior to the field investigation.

## Sub-Slab Soil Gas Sampling Device Installation

Sub-slab soil gas sampling will be initiated by drilling a hole through the concrete floor slab, inserting a sample collection device, and sealing the hole around the sample collection device so that ambient air cannot enter the subsurface. A sample point may be constructed in one of two ways, either by inserting a Cox-Colvin Vapor Pin™ (Vapor Pin) of approximately 3 inches in length into the hole, or by placing a vapor implant into the hole and sealing the hole with hydrated bentonite. The sections below describe the installation process for both the Vapor Pin and the vapor implant. The installation sections are followed by a description of the sampling protocol, which is the same for both installation types.

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Sub-slab soil gas samples will be collected from just beneath or within a slab from a 5/8-inch or 1-inch diameter hole. The hole will be drilled with a handheld rotary hammer style drill[1]. Immediately following coring, field staff will insert a photoionization detector (PID) into the drilled hole to quickly check for VOCs, and will proceed with installing the sample point to minimize the introduction of soil gas into indoor air as described below:

- **Cox-Colvin Vapor Pin -** Vapor Pins are comprised of a barbed, stainless-steel sample point fitted with an inert, compressible, silicon sleeve. Each Vapor Pin will be installed using a hammer and specialized installation tool to drive the Vapor Pin into a ⅝-inch-diameter vertical hole within the slab. Driving the Vapor Pin into the hole compresses the sleeve, creating a seal between the sample point and slab surface. Typically, slabs are thicker than 3 inches, so the bottom of the Vapor Pin will rest within the slab, above underlying soil. After the Vapor Pin is installed, the end with a hose barb is exposed at the ground surface. A fitted cap will be attached to the barb to allow the sub-slab soil gas to equilibrate without exposure to ambient air. A flush-mounted installation will be used for locations where multiple sampling events are anticipated.
- **Vapor Implant -** Vapor implants are typically installed in a 1-inch-diameter vertical hole within the slab; larger holes may be used, but are not anticipated for this sampling event. Vapor implants comprise a porous sampling tip and sample tubing placed in the core hole. Teflon or Nylaflow® tubing may be used as sample tubing. The porous sampling tip will extend 1 to 2 inches below the bottom of the slab. The void space around the sampling tip will be backfilled with drilling grade silica sand up to the bottom of the slab. Granular bentonite (bentonite) will be used to seal the annular space between the sample tubing and the slab within the hole. Two to 3 inches of dry bentonite will be placed on top of the silica sand. Tap water will be used to hydrate the top 1 inch of bentonite. Care will be taken to avoid getting water into the silica sand layer. Once the top layer of bentonite is hydrated, additional bentonite will be added and hydrated in 1- to 2-inch lifts until the bentonite is within ½ inch of the top of the slab. A flush-mounted installation will be used for locations where multiple sampling events are anticipated. The tubing will be secured with a valve and the core will be capped between sampling events.

## Sub-Slab Soil Gas Sample Collection

The sample point will be left undisturbed for a minimum of 2 hours after installation (CalEPA 2015) to allow for the soil gas to equilibrate. To prevent the sample point from being tampered with or damaged, a small safety cone will be placed over the sampling assembly during the equilibration period[2]. If the sample point will not be sampled immediately following the equilibration period, the flush-mount cap will be replaced to prevent the sample point from being tampered with or damaged between sampling events.

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[1] Some coring debris will remain at the bottom of the boring; therefore, drilling should extend beneath the bottom of the slab by approximately 4 to 6 inches to expose the soil before installing the Vapor Pin or Implant. Sub-slab conditions (such as site-specific construction features) may require shallower drilling beneath the sub-slab, which will be evaluated at each sample location and/or in each building prior to installation of the sample collection device. A broom and dust pan or shop vacuum will be used to collect coring debris deposits on the ground surface; a shop vacuum will be used only to clear the hole prior to breakthrough of the floor slab or after installation of the sample collection device.

[2] Applicable field sampling procedures for sub-slab vapor sampling are presented in *Vapor Intrusion Pathway: A Practical Guideline* (ITRC 2007), and *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology 2009). Procedures in this work plan are generally consistent with these two guidance documents, except where the CalEPA 2015 document is followed.

Each sub-slab sample will be collected in a 1-liter (L) Summa (vacuum) canister fitted with a flow controller. The flow controller will be calibrated by the laboratory to a flow rate not to exceed 200 milliliters per minute. Sub-slab soil gas samples will be collected in accordance with either the sample collection method identified in Section 2.3.3 of the SAP/QAPP, or the sample collection method identified below. The sample collection method identified below requires a small footprint and may be used in buildings or areas where space is restricted and a smaller sample setup is desired.

After the equilibration period is complete:

a. Turn on the helium detector and zero-out the instrument to read a helium concentration of 0 parts per million (ppm).

b. Attach sample tubing. Teflon or Nylaflow tubing is acceptable. If using a Vapor Pin, install new connection tubing (Masterflex® or other acceptable connection tubing) on the barb of the Vapor Pin and connect it to the sample tubing. If using a vapor implant, the sample tubing connected to the porous implant should be long enough to almost reach the intake of the Summa canister.

c. Purge the sample train. Connect the end of the sample tubing to port 1 of a 3-way stop cock valve and connect a large graduated syringe to port 3 of the 3-way valve A (port 2 is left open for discharge). Purge 3 volumes of air from the sample train by placing the valve so that port 2 (discharge) is closed and extracting the required volume of air with the graduated syringe; turn the valve so port 1 (sample tubing) is closed and push the extracted air out of the syringe through port 2. Leave port 1 of the valve closed.

d. Connect a short length of sample tubing to port 2 of the 3-way valve and connect the other end of the tubing to the summa canister using a swagelok fitting. Turn the valve so port 3 (syringe) is closed and disconnect the syringe. Leave port 3 closed for the remainder of the sampling.

e. Place the shroud over the sample point, tubing, and Summa canister.

f. Connect the helium tank to the shroud from the exterior of the shroud and ensure that all connections are tight. Place the helium detector inside the shroud. Only ultra-pure helium should be used. Balloon grade helium can contain other contaminants and is not acceptable for use in sampling.

g. Attach the shroud lid to the shroud. Release one burst of helium into the shroud.

h. Concentrations should be at least two orders of magnitude above the lower detection limit of the helium detector (for example, if the lower detection limit is 25 ppm, the concentration in the shroud should be at least 2500 ppm). It is expected that helium concentrations will peak and begin to fall. Maintain concentrations inside the shroud at, at least, two orders of magnitude above the lower detection limit. If concentrations fall near or below that concentration, add another short burst of helium to maintain the minimum concentration.

i. Using the attached gloves, open the Summa canister valve to begin collecting the sample.

j. Record helium concentration and time at the start of sampling and at the end of sampling. If the sampling period is longer than 5 minutes, record one additional reading approximately halfway through the sample period. Record the lowest concentration of helium during sample period.

k. Once the vacuum gauge on the Summa canister reaches 0 inches of mercury (in. Hg), remove the shroud lid and close the valve on the Summa canister itself. Ensure the Summa canister valve is closed prior to disconnecting it from the well to prevent accidental entrance of remnant low-level helium from the shroud into the Summa canister.

l. After collecting the required samples at each location, the sample point assembly will be removed and the slab hole patched with quick-set concrete to reseal the concrete slab. Alternatively, the sample point assembly will be left in place and covered to allow for collection of additional samples.

Where sub-slab soil gas samples are co-located with indoor air samples, potential impacts to the indoor air samples related to sub-slab soil gas must be considered. The sub-slab sample must be collected either at least 1 day before the indoor air sample is set up or any time after the indoor air sampling is completed.

**Indoor Air Sampling**

Indoor air samples will be 8-hour, TWA samples. The TWA samples will be collected using integrated passive air samplers consisting of a 6-L laboratory-certified evacuated Summa canister. Each Summa canister will be equipped with a pressure gauge and a calibrated critical orifice air flow controller.

Canister inlet valve heights will be about 3 to 3½ ft to approximate a sitting receptor in an office setting. 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.

The TWA Summa canisters will be evacuated to a vacuum pressure of 25 to 30 in. Hg by the laboratory. A final vacuum pressure reading greater than ambient (i.e., 0 in. Hg) indicates a valid sample; however, canister closure will be targeted for a vacuum pressure of 5 in. Hg to provide a margin of safety. Canister pressures will be checked within 1 to 2 hours after beginning sampling to evaluate whether air flow controllers are functioning properly. Observed hourly pressure losses greater than one-tenth of the initial pressure will be considered 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.

**Ambient Air Sampling**

Ambient air sample locations will be 8-hour, TWA samples. The sample will be collected using a 6-L laboratory-certified evacuated Summa canister. The Summa canister will be equipped with a pressure gauge and a calibrated critical orifice air flow controller for collection of the TWA samples. Canister inlet valves will be placed on the roof of the building, near HVAC inlets where feasible.

The background sample Summa canisters will be evacuated to a vacuum pressure of 25 to 30 in. Hg by the laboratory. A final vacuum pressure reading greater than ambient (i.e., 0 in. Hg) indicates a valid sample; however, canister closure will be targeted for a vacuum pressure of 5 in. Hg to provide a safety margin. Canister pressure will be checked within 1 to 2 hours after beginning sampling to evaluate whether the air flow controller is functioning properly. Observed hourly pressure losses greater than one-tenth of the initial pressure will be considered indicative of a faulty flow controller. If the canister is observed to have a faulty flow controller, it will be replaced with a backup canister and flow controller.

Atmospheric conditions during the sampling period including temperature, barometric pressure, wind direction, wind speed, and precipitation totals, will be recorded using a combination of publicly available meteorological data from a nearby weather station. Observations will be recorded both at the beginning and at the end of the sample period.

## Sample Container Handling and Analysis

Summa canisters will be handled, labeled, and analyzed in accordance with Section 2.3.4 of the SAP/QAPP.

## REFERENCES

CalEPA. 2015. *Advisory – Active Soil Gas Investigations*. Department of Toxic Substances Control, Los Angeles Regional Water Quality Control Board, San Francisco Regional Water Quality Control Board. California Environmental Protection Agency. July.

Ecology. 2009. *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action, Review DRAFT*. Toxics Cleanup Program, Washington State Department of Ecology. Publication No. 09-09-047. October.

ITRC. 2007. *Vapor Intrusion Pathway: A Practical Guideline*. Interstate Technology and Regulatory Council. January.

Leidos (formerly SAIC). 2014. *North Boeing Field/Georgetown Steam Plant Site, Remedial Investigation/Feasibility Study, Final Sampling and Analysis Plan and Quality Assurance Project Plan*. Prepared for Toxics Cleanup Program, Northwest Regional Office, Washington State Department of Ecology, Bellevue, Washington. April.

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Attachment 1: NBF Soil Gas Concentrations and Screening Level Exceedances

ATTACHMENT 1

# NBF Soil Gas Concentrations and Screening Level Exceedances

## NBF Soil Gas Concentrations and Screening Level Exceedances

| Chemicals Exceeding Screening Levels | MTCA Method B Indoor Air CUL ($ug/m^3$) | Shallow Soil Gas Screening Level, AF=0.03 ($ug/m^3$) | Deep Soil Gas Screening Level, AF=0.01 ($ug/m^3$) | Soil Gas Detected Concentrations ($ug/m^3$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | VP01 Building 3-323 | VP02 Buildings 3-334 & 3-323 | VP03 Building 3-333 | VP04 Building 3-335 | VP05 Building 3-335 | VP06 Building 3-324 | VP07 Building 3-353 | VP08 Building 3-800 | VP09 Building 3-801 |
| Benzene | 0.321 | 10.7 | 32.1 | | | | 0.73 | 0.85 | | 0.82 J | 28 | |
| Chloroform | 0.109 | 3.62 | 10.9 | 4.8 | **26** | 3.4 | 3.3 | 11 | 2.9 | | 12 | 5.1 |
| PCE | 9.62 | 321 | 962 | | 16 | 2.8 | 6.5 | 83 | 20 | | **2,100** | 19 |
| TCE | 0.370 | 12.3 | 37.0 | | 27 | | | | | | 14 | 13 |
| Maximum Exceedance Factor (compared to Shallow SL): | | | | 1.3 | **7.2** | < 1 | < 1 | 3.0 | < 1 | < 1 | **6.5** | 1.4 |

AF = Attenuation Factor

SL = Screening Level

Concentrations in black are detected below Ecology's SLs; blank cells are non-detected values.

Concentrations in orange exceed Ecology's shallow soil gas SLs.

Concentrations in red exceed Ecology's deep soil gas SLs (although none of the vapor points are deep, these SLs are used to present the degree of exceedance).

Bold values have exceedance factors more than 5x Ecology's shallow soil gas SLs.

Method B indoor air CULs and Ecology's SLs for shallow (sub-slab) and deep (≥15 feet bgs) soil gas are derived from CLARC, 9/1/2015.

Note: The shallow soil gas AF of 0.03 is the same as the EPA (2015) recommended AF for sub-slab and near-source exterior soil gas results.