2015 Tier II Commercial Vapor Intrusion Assessment Report
Boeing Auburn Facility
Auburn, Washington

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Prepared for

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Seattle, Washington

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LIST OF ABBREVIATIONS AND ACRONYMS

AirToxics	Eurofins AirToxics Analytical Laboratories
ASTM	ASTM International
Boeing	The Boeing Company
cis-1,2-DCE	cis-1,2-Dichloroethene
CUL	Cleanup Level
°F	Degrees Fahrenheit
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
Facility	Auburn Fabrication Division Facility
ft	Feet/Foot
HVAC	Heating, Ventilating, and Air Conditioning
IAAL	Indoor Air Action Level
L	Liter
$\mu g/m^3$	Micrograms per Cubic Meter
MTCA	Model Toxics Control Act
mph	Miles Per Hour
NW	Northwest
Order	Agreed Order No. DE01HWTRNR-3345
RI	Remedial Investigation
SL	Screening Level
TCE	Trichloroethene
VC	Vinyl Chloride
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

This document presents the results of the 2015 Tier II commercial vapor intrusion assessment completed as part of additional remedial investigation (RI) activities associated with The Boeing Company's (Boeing) Auburn Fabrication Division facility (facility), located at 700 15th Street Southwest in Auburn, Washington. The activities described in this document are part of the ongoing RI for the facility.

Boeing is currently conducting corrective action at the facility. Corrective action requirements are documented in an Agreed Order (Order; No. DE 01HWTRNR-3345) dated August 14, 2002 and the First Amended Agreed Order dated February 21, 2006, both with the Washington State Department of Ecology (Ecology). The Order includes a requirement to conduct an RI of facility contamination impacts both within the facility (on Boeing property) and at downgradient properties (off Boeing property). This document presents the results of vapor intrusion assessments conducted at The Outlet Collection, a commercial building located off Boeing property in Auburn, and at Building 17-70, a building located on Boeing property. The assessment was conducted in accordance with the Tier II Commercial Vapor Intrusion Assessment Work Plan (Work Plan; LAI 2015a). The location of the facility and its immediate vicinity are shown on Figure 1.

1.1 Background

Boeing has been implementing RI activities to characterize the nature and extent of two groundwater plumes: the Area 1 plume (Plume 1) and the western plume (Plume 2), which occur in the upper aquifer beneath the northern portion of the facility and extend off Boeing property to the north and northwest. These plumes are made up of the volatile organic compound (VOC), trichloroethene (TCE) and its breakdown components, cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). The plumes have affected shallow zone groundwater both on and off Boeing property, and VOCs in shallow groundwater have the potential to impact indoor air via the vapor intrusion pathway.

Boeing prepared the 2nd Revised Agency Review Draft Vapor Intrusion Evaluation and Assessment Approach (Vapor Intrusion Assessment report; LAI 2014a) to guide vapor intrusion assessments during the RI. The Vapor Intrusion Assessment report documents the site-wide approach to assessing vapor intrusion risk where shallow zone impacts have been identified near the groundwater plumes both on and off Boeing property. The methods for assessment of vapor intrusion at the facility are based on the tiered approach presented in Ecology's draft vapor intrusion guidance document (Ecology 2009). The assessment process consists of two[1] stages:

1. Tier I assessment – Focuses on determining whether there is a potential vapor intrusion risk based on groundwater and soil gas concentrations and which buildings may potentially be at risk for vapor intrusion. A Tier I assessment does not evaluate individual buildings.

[1] Ecology's guidance presents an additional stage of assessment called a "preliminary assessment". The preliminary assessment for the RI was completed in 2012; and therefore, is not discussed in this document.

2. Tier II assessment – If a potential vapor intrusion risk is identified in an area with overlying structures, a Tier II assessment focuses on evaluating individual structures using additional building-specific sampling such as indoor air, ambient air, and sub-slab soil gas.

A Tier I assessment evaluates VOC concentrations in shallow groundwater or soil gas to determine whether VOCs could pose a vapor intrusion threat to indoor air quality in nearby buildings. Where possible, wells screened near the water table are used for Tier 1 groundwater evaluation because VOCs at the water table have the greatest potential to volatilize into soil gas. A Tier II assessment evaluates specific buildings to determine if VOCs of potential concern are present in indoor air above Model Toxic Control Act (MTCA) cleanup levels (CULs) and if the VOCs are related to vapor intrusion or background sources (Ecology 2009).

An initial Tier I assessment for commercial areas (both on Boeing property and off Boeing property) using existing groundwater water table data was completed and presented in the Vapor Intrusion Assessment report. The results of the initial Tier I assessment indicated that TCE concentrations at the water table do not exceed the commercial groundwater SL; however, VC concentrations in limited commercial areas exceed the VC groundwater screening level (SL) protective of the commercial indoor air CUL. Based on the results of the initial Tier I assessment, additional Tier I assessments that included soil gas sampling were recommended in commercial areas in Algona and Auburn (LAI 2014b); the results of the additional Tier I assessments were presented in the Tier I commercial VI assessment report (LAI 2015b). Groundwater contour figures for the Tier I vapor intrusion assessment were presented in the Work Plan.

Two buildings (The Outlet Collection in Auburn and Building 17-70 on Boeing property[2]) were selected to proceed directly to Tier II evaluation (LAI 2015a) based on the results of the initial Tier I assessment. The rationale for conducting Tier II vapor intrusion assessments at The Outlet Collection and Building 17-70 were presented in the Work Plan. The results of the Tier II vapor intrusion assessments at The Outlet Collection and Building 17-70 are presented in this report.

[2] Although Boeing property at the site is considered industrial, Building 17-70 primarily houses offices; therefore, groundwater near Building 17-70 was evaluated using commercial groundwater SLs.

2.0 COMMERCIAL VAPOR INTRUSION SCREENING CRITERIA

Commercial indoor air, soil gas, and groundwater SLs for the constituents of concern were presented in the Work Plan (LAI 2015a). TCE and VC are the primary chemicals being evaluated as constituents of concern because of their concentrations in groundwater relative to their toxicity and lower SLs. Although there are presently no MTCA indoor air CULs (and thus, no vapor intrusion groundwater or soil gas SLs) for cis-1,2-DCE, this constituent was included as an analyte because it is an intermediate breakdown product of TCE and has been detected in groundwater at the water table surface.

Commercial SLs were developed for TCE and VC in shallow groundwater and soil gas based on Modified MTCA Method B values for indoor air[3]. Both carcinogenic (excess cancer risk) and non-carcinogenic effects (hazard index) were evaluated when developing indoor air SLs; carcinogenic values, based on a 1 in 1,000,000 (1×10^{-6}) excess cancer risk, were the most conservative for a commercial setting for TCE and VC (LAI 2015b).

Indoor Air Action Levels (IAALs)[4] were also developed for TCE and VC. There are two types of IAALs: sub-chronic (short-term exposure), which are concentration-based IAALs and chronic (long-term exposure), which are risk-based IAALs. A short-term exposure IAAL was developed for only one compound, TCE, based on an EPA Region 10 publication (EPA 2012) that identified potential non-carcinogenic risk to a developing fetus; short-term exposure IAALs are not derived from MTCA. The short-term exposure IAAL for TCE is applicable to commercial buildings where women of childbearing age work or visit for extended periods[5]. A long-term, risk-based IAAL was established based on chronic exposure and a cumulative potential cancer risk of 1 in 100,000 (1×10^{-5}) for both TCE and VC.

The commercial indoor air, soil gas, and groundwater SLs and indoor air IAALs were approved by Ecology (Ecology 2015), and used to evaluate the results of the Tier II commercial vapor intrusion assessment (Section 3.0). SLs and IAALs are presented on the Table 1.

[3] Indoor air values calculated using Modified MTCA Method B formulas for commercial areas are considered SLs rather than CULs because MTCA does not contain a provision for use of commercial CULs.

[4] The IAAL value is a sub-chronic, non-carcinogenic indoor air action level from the U.S. Environmental Protection Agency (EPA) Region 10 (EPA 2012). VC does not have an IAAL.

[5] The short-term exposure IAAL is based on an 8-hour workday, 260 days per year, which eliminates the assumption that there is a 2-week absence during the year (EPA 2012).

3.0 TIER II COMMERCIAL VAPOR INTRUSION ASSESSMENT

Sampling procedures for soil gas and groundwater are summarized in Section 3.1. Specific sampling activities and results for The Outlet Collection and Building 17-70 are summarized in sections 3.2 and 3.3, respectively.

3.1 Sampling Procedures

Building surveys were conducted at The Outlet Collection and Building 17-70 to collect relevant information and identify sampling locations; the findings of the building surveys and investigation approaches were described in the Work Plan. Information obtained during the individual building surveys is summarized in Section 3.2 (The Outlet Collection) and Section 3.3 (Building 17-70).

Collection of sub-slab soil gas, indoor air, and ambient air samples was conducted in accordance with the Work Plan. Sub-slab soil gas samples were collected with 1-liter (L) Summa (vacuum) canisters[6] fitted with flow controllers calibrated by the laboratory to a flow rate not to exceed 200 milliliters per minute. Time-weighted average indoor air and ambient air samples were collected with 6-L Summa canisters fitted with 10-hour flow controllers. The samples were submitted to Eurofins AirToxics analytical laboratory (AirToxics) to measure the concentrations of TCE, VC, and cis-1,2-DCE using EPA Method TO-15 (sub-slab soil gas samples) and EPA Method TO-15 low-level (indoor air and ambient air samples).

Leak test procedures were implemented as part of the sub-slab soil gas sampling to check for potential ambient air leaks that could compromise soil-gas sample results. The leak test procedures are outlined in detail in the Work Plan but generally consisted of placing a shroud over the sample point and Summa canister and maintaining helium in the shroud throughout the sample collection period. To evaluate the results of the helium leak test, sub-slab samples were analyzed by AirToxics to measure the concentrations of helium using ASTM International (ASTM) Method ASTM D-1946.

3.2 The Outlet Collection

The Outlet Collection is a privately owned shopping mall with approximately 130 leased spaces. It is located in an area where VC groundwater water table data exceed commercial vapor intrusion SLs. TCE does not exceed commercial vapor intrusion groundwater SLs at the water table near The Outlet Collection. At this building, Tier II evaluation was proposed primarily for efficiency and to minimize business disruption potentially resulting from additional Tier I Assessment.

[6] The sampling and laboratory procedures for using Summa canisters are presented in the Work Plan (Landau Associates 2015a), in the current draft sampling and analysis plan (Landau Associates 2013a), and in the quality assurance project plan (Landau Associates 2013b).

A building survey was conducted on November 13, 2014 by Ecology and Landau Associates, Inc. (LAI: on behalf of Boeing); detailed findings of the building survey were presented in the Work Plan. Key findings from the building survey include:

- The building has only one level (main level) where all leased spaces are located and business operations take place. The only subgrade spaces are two underground tunnels used for deliveries and emergency egress.
- The building has slab-on-grade floor construction.
- The building is reportedly under positive pressure and the Heating, Ventilating, and Air Conditioning (HVAC) system intakes are located on the roof of the building
- Floor penetrations that can provide conduits for vapor intrusion were concentrated in utility rooms and several sumps were located in the underground tunnels.

3.2.1 Field Investigation Activities

The field investigation at The Outlet Collection was completed in two phases. The initial sampling event was completed on April 27 and April 28, 2015. Repeat sampling was conducted at select locations on June 4, 2015 to further investigate the results of the initial sampling event.

As presented in the Work Plan, co-located indoor air and sub-slab soil gas samples were collected in two sprinkler riser rooms and a hallway on the main floor of the building, and indoor air samples (only) were collected in the two underground tunnels. Sub-slab samples were not collected in the tunnels due to the likelihood that the water table is at or near the bottom of the slab. According to building as-built drawings, sumps at the ends of the tunnels extend 4.5 feet (ft) below the tunnels' concrete floor slab and rest on a 2-ft-thick reinforced concrete pad. The sumps collect water from floor drains in the tunnels and appear to discharge to the building's sanitary sewer system. The sump pumps reportedly run frequently during the wet season. The tunnels reportedly do not have groundwater intrusion issues; however, groundwater could be a contributing source of water in the sumps in addition to drainage from the tunnel floor drains.

Sampling locations were chosen to minimize potential background source interference due to chemical use and storage at the shopping mall and recent renovations, which may contribute off-gassing chemicals, and to avoid access and potential business interference issues associated with tenant spaces. The locations were also distributed such that they provided geographic coverage on the north, south, and west sides of The Outlet Collection, the area where shallow zone VC concentrations exceed groundwater SLs (LAI 2015b). These locations are also expected to represent worst-case conditions for indoor air due to the presence of floor penetrations, floor drains, and cracks in the slab, which may provide preferential pathways. The sampling locations are shown on Figure 2.

The two underground tunnels, herein termed the "east tunnel" and "west tunnel", are used for delivery and emergency egress, and were observed during the building survey and sampling visits to be generally unoccupied. There are two sumps containing sump pumps at the ends of each underground tunnel (four sumps total). Elevators are also located near the sumps at both ends of each tunnel and connect the tunnels to the main level. During the initial sampling event, one indoor air sample was collected in each tunnel at the sump closest to the center of the building. The sumps are covered by lids bolted to the floor but there are small openings in the lid that appear to be for electrical connections to the sump pumps. The sample tubing was directed at openings in the lids. Air in the tunnels' breathing space was not sampled during the initial sampling event. Tunnel, sump, and elevator locations are shown on Figure 2, along with the sampling locations.

As noted in the Work Plan, each of the underground tunnels have separate HVAC systems; standard operating procedure for the tunnel HVAC systems at The Outlet Collection at the time of the initial sampling was reportedly to only run the HVAC system during business hours. All HVAC systems serving The Outlet Collection, including the tunnels, have inlets on the roof; therefore, one ambient air sample was collected on the roof near an HVAC intake.

Repeat sampling was conducted in the east tunnel on June 4, 2015 to further investigate the results of the initial sampling event. The objective of the repeat sampling event was to verify the east tunnel sample results from the initial sampling event (discussed below in Section 3.2.2), and determine if vapor intrusion is impacting air in the breathing space.

Weather conditions during the initial sampling event were similar to the repeat sampling event. The weather conditions during the initial sampling event on April 27, 2015 included an average temperature of 62.3 degrees Fahrenheit (° F), humidity at 73 percent, and wind speed at 1 mile per hour (mph) from the northwest (NW). Weather conditions during the repeat sampling event included an average temperature of 61.3° F, humidity at 68 percent, and wind speed at 2 mph from the NW.

During the repeat sampling event, a sample was collected from the east tunnel near the sump closest to the center of the mall with the air intake tubing placed at the sump opening near the floor, as it was during the initial sampling event. Samples were also collected in the breathing zone near the sump and in the breathing zone about halfway down the east tunnel. Sample intake tubing for breathing zone samples was placed approximately 5 ft above the floor, to represent the breathing space of a standing person. An ambient air sample was collected from the roof, near the HVAC intake for the east tunnel. Following the initial sampling, The Outlet Collection modified their operating procedures and began continuous operation of the tunnel HVAC systems, rather than only operating during business hours. Sampling locations for the repeat sampling event are presented on Figure 2.

3.2.2 Sampling Results

None of the chemicals of concern (i.e., TCE, VC, or cis-1,2-DCE) were detected in the sub-slab and indoor air samples collected on the main level (hallway and sprinkler riser rooms), the indoor air samples collected in the west tunnel, or the ambient air sample. Helium was also not detected in the sub-slab samples, which indicates that an effective seal was achieved and the sample train had no leaks during sub-slab sampling. Sampling results are presented in Table 2.

During the initial sampling event, TCE was detected in the indoor air sample collected near the sump opening in the east tunnel at a concentration of 11 micrograms per cubic meter (µg/m^3); none of the other chemicals of concern (i.e., VC or cis-1,2-DCE) were detected in the sample. The detected concentration of TCE is greater than the indoor air SL of 1.9 µg/m^3, and the short-term IAAL of 8.4 µg/m^3. The calculated hazard index for the sample is 1.8, which is greater than the target hazard index of 1.0. The calculated potential cancer risk of 6x10-6 for the initial east tunnel indoor air sample is less than the risk IAAL for carcinogenic effects (potential cancer risk of 1x10-5).

Separate indoor air SLs were calculated for the tunnel using an alternate exposure scenario more typical of individuals who may be passing through the tunnel infrequently. The generic exposure scenario used to calculate commercial indoor air SLs assumes continuous exposure over the course of every work shift; however, exposure to air in the tunnel would generally be far less, since it is used only for ingress and egress related to deliveries and potential emergencies. The alternate exposure scenario for the tunnel assumes a person might spend an average of 15 minutes per day in the tunnel. The TCE indoor air SL for the tunnel exposure scenario is 58 µg/m^3. The concentration detected in the east tunnel (11 µg/m^3) is well below the calculated indoor air SL for the tunnel. Calculation of the alternate SL for the tunnel exposure scenario is shown in Appendix A, Table A-1.

A repeat sampling event was conducted to confirm the east tunnel results from the initial sampling. The repeat sampling included collection of indoor air samples near the east tunnel sump opening, the breathing zone near the sump, the breathing zone approximately halfway down the tunnel, and an ambient air sample. None of the chemicals of concern were detected in the samples collected during the repeat sampling event, including the indoor air sample collected near the east tunnel sump opening. Results from the repeat sampling event are presented in Table 2.

3.2.3 Discussion

None of the constituents of concern were detected in indoor air samples collected from The Outlet Collection's main level (i.e., two sprinkler riser rooms and the hallway), or in sub-slab soil gas beneath the main level. The results indicate vapor intrusion does not appear to be occurring in the main level of the building and there is no indication that VI is a concern. TCE was detected at concentrations above the commercial indoor air SLs in the sample collected near the east tunnel sump during the initial sampling event; however, it did not exceed the risk IAAL. None of the other chemicals of concern were detected in the initial east tunnel sample. Subsequent samples at various locations throughout the tunnel did not detect TCE or any other constituents of concern. TCE does not appear to be a health concern in the tunnel.

The potential for worker exposure within the tunnels was evaluated in accordance with the Work Plan. As noted in Section 3.2.1, the tunnels were observed to be generally unoccupied. The tunnels are intended for use as emergency egress and transport of items for delivery; therefore, workers do not occupy the tunnels on a full-time basis. The TCE concentration initially detected in the east tunnel was above the commercial SL protective of personnel working full-time in the tunnel; however, it did not exceed the SL developed based on a more typical exposure scenario for the tunnel. Additionally, the initial sample was collected at floor level (not typical of the breathing zone); subsequent samples collected in the breathing zone did not detect TCE.

As discussed in Section 1.1, TCE is not detected at concentrations above the commercial groundwater SLs in groundwater at the water table site-wide. Additionally, TCE is generally not detected in water table groundwater samples near The Outlet Collection. VC detections in groundwater at the water table were the trigger for additional vapor intrusion testing at The Outlet Collection. Since TCE was not detected in water table groundwater samples near The Outlet Collection, groundwater may not be the source of the TCE detection in the east tunnel. The tunnel is used to transport merchandise, maintenance equipment, and other products that may contain one or more background sources of TCE.

In summary, the concentration of TCE detected in the initial sample near the east tunnel sump does not exceed the SLs developed based on a typical exposure for the tunnel. Additionally, the source of TCE may have been related to background sources rather than vapor intrusion. Based on the concentrations and source information, no further investigation is proposed at The Outlet Collection.

3.3 Building 17-70

Building 17-70 is a Boeing building located directly north of Buildings 17-07 and 17-12 where indoor air and sub-slab gas sampling have already been completed (LAI 2012)[7]. Ecology's vapor intrusion guidance contains a "100 ft rule," which requires that areas within 100 ft of groundwater exceeding vapor intrusion SLs should be included in a vapor intrusion assessment. As presented in the Work Plan, the south end of Building 17-70 is at the edge of the 100- ft boundary line of the area where groundwater exceeds the commercial groundwater SLs; therefore, Building 17-70 was identified for a Tier II assessment. Sampling activities and results are discussed in the following sections.

3.3.1 Field Investigation Activities

A building survey was conducted on November 12, 2014 by LAI (on behalf of Boeing). Detailed findings of the building survey were presented in the Work Plan (LAI 2015a). As described in the Work Plan, there are multiple types of slab-on-grade floor construction in the southern portion of the building. The southeastern portion of the building rests on a sandwich slab (polystyrene foam sandwiched between an upper concrete slab and a lower mud slab), which is not conducive to sub-slab sampling procedures. The western side of the building is closer to the 100 ft boundary and the groundwater flow direction is northwest, away from the southeastern quarter; therefore, sample locations were not identified in the southeastern portion of the building (LAI 2015b). Sample locations were identified in the southwestern end of the building nearest to the well with groundwater concentrations exceeding commercial groundwater SLs[8]. The foundation type in the southwestern

[7] Indoor air results were below reporting limits for all constituents at Building 17-07 and 17-12.
[8] VC was detected in AGW152 in December 2014 at a concentration of 3.4 micrograms per liter.

portion of the building is primarily slab-on-grade. Co-located indoor air and sub-slab soil gas samples were collected in room W-6 and room 13A11 in accordance with the Work Plan.

There are multiple HVAC systems for the building, and the air intakes for the HVAC systems serving rooms W-6 and 13A11 are both on the roof. The HVAC intake serving room W-6 is located close to the building edge and outside of the safety perimeter for roof work; therefore, the ambient air sample was collected from the roof near the HVAC system intake for room 13A11.

The indoor air and ambient air samples were collected on April 20, 2015; the sub-slab soil-gas samples were collected on April 21, 2015. The sampling locations are presented on Figure 3.

3.3.2 Sampling Results

None of the chemicals of concern (i.e., TCE, VC, or cis-1,2-DCE) were detected in the sub-slab soil gas samples, indoor air samples, or the ambient air sample at concentrations greater than the laboratory reporting limits. Helium was not detected in the sub-slab gas samples, which confirms that an effective surface seal was achieved and the sample train had no leaks during sub-slab sampling. The laboratory analytical data are summarized in Table 3.

3.3.3 Discussion

The constituents of concern were not detected in Building 17-70. Vapor intrusion does not appear to be occurring; therefore, no further investigation is proposed at Building 17-70.

4.0 CONCLUSIONS

Tier II vapor intrusion assessments were conducted at The Outlet Collection (off Boeing property) and Building 17-70 (on Boeing property). TCE was detected in one indoor air sample collected from a subsurface tunnel at The Outlet Collection. The absence of TCE in nearby water table groundwater samples and further investigation of the tunnel, including repeat sampling, suggests that the detection may have been related to an unidentified background source. Additionally, the concentration of TCE in the original sample does not exceed the indoor air SL calculated for the tunnel, but more significantly, repeat sampling did not detect TCE in the breathing zone. Contaminants of concern were not detected at Building 17-70.

Based on the results from the two assessments, no mitigation is necessary to reduce exposure and no additional indoor air sampling is recommended at either building. Boeing will continue to monitor shallow groundwater (from the water table) concentrations to determine if additional vapor intrusion assessments are necessary in the future.

5.0 USE OF THIS REPORT

This report has been prepared for the exclusive use of The Boeing Company for specific application to the Auburn Fabrication Division remedial investigation. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following environmental key staff.

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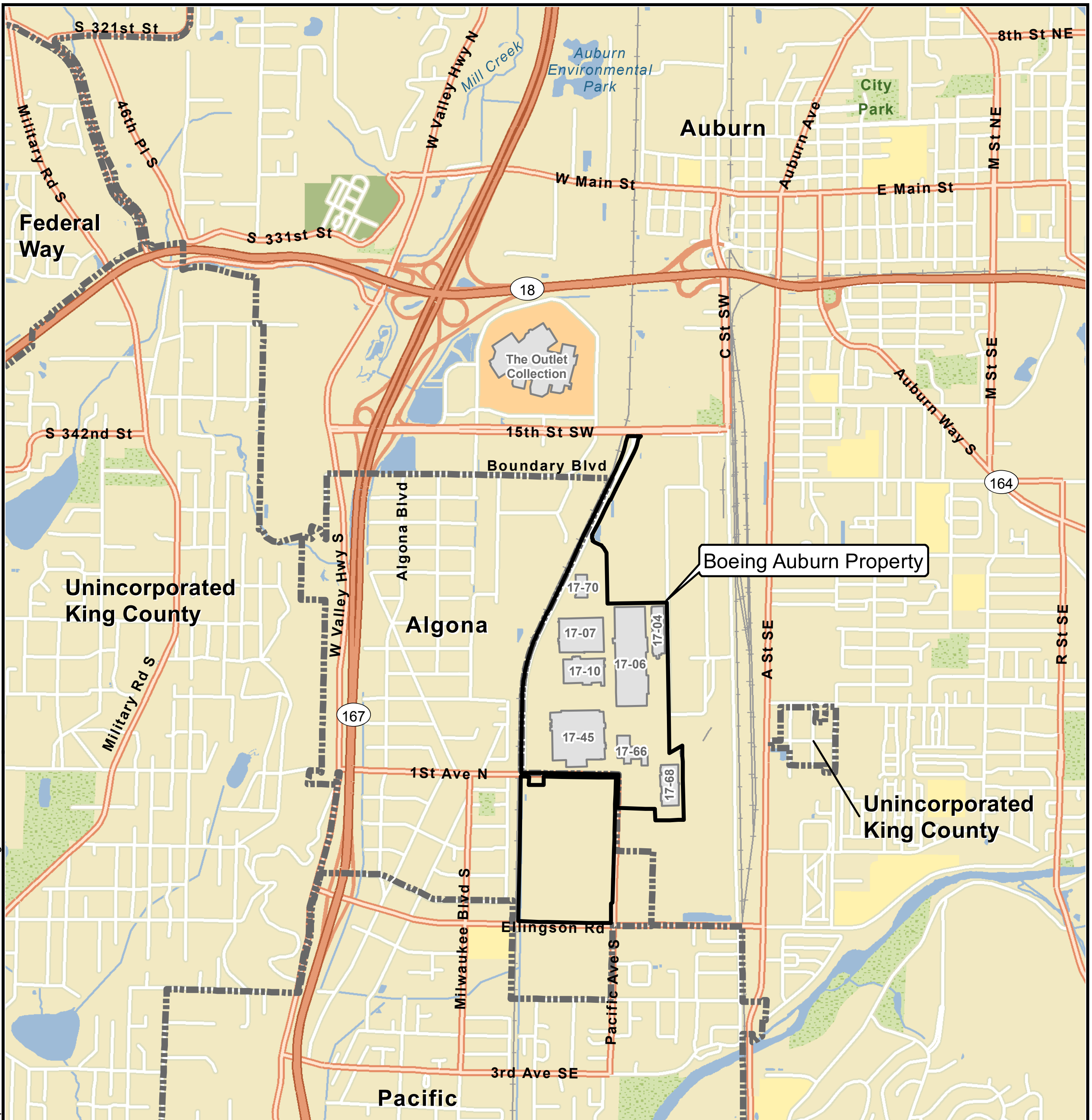

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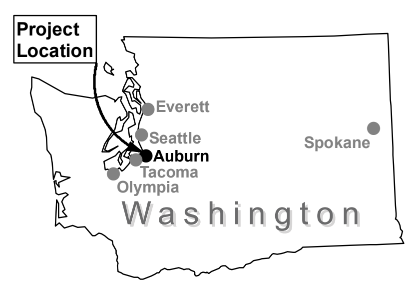

Data Source: Esri 2012

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Landau Associates

Boeing Auburn Auburn, Washington	**Vicinity Map**	Figure 1

Note

1. An ambient air sample was collected from the roof near an HVAC intake on the roof during initial and repeat sampling. Approximate locations of the roof samples are shown.
2. Indoor air samples are identified by the IA prefix. Sub-slab vapor samples are identified by the SSV prefix. Ambient air samples are identified by the AA prefix.
3. Rooms with bare concrete slab are generally janitorial closets, electrical rooms, fire riser rooms, storage rooms, and hallways.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 120 240
Scale in Feet

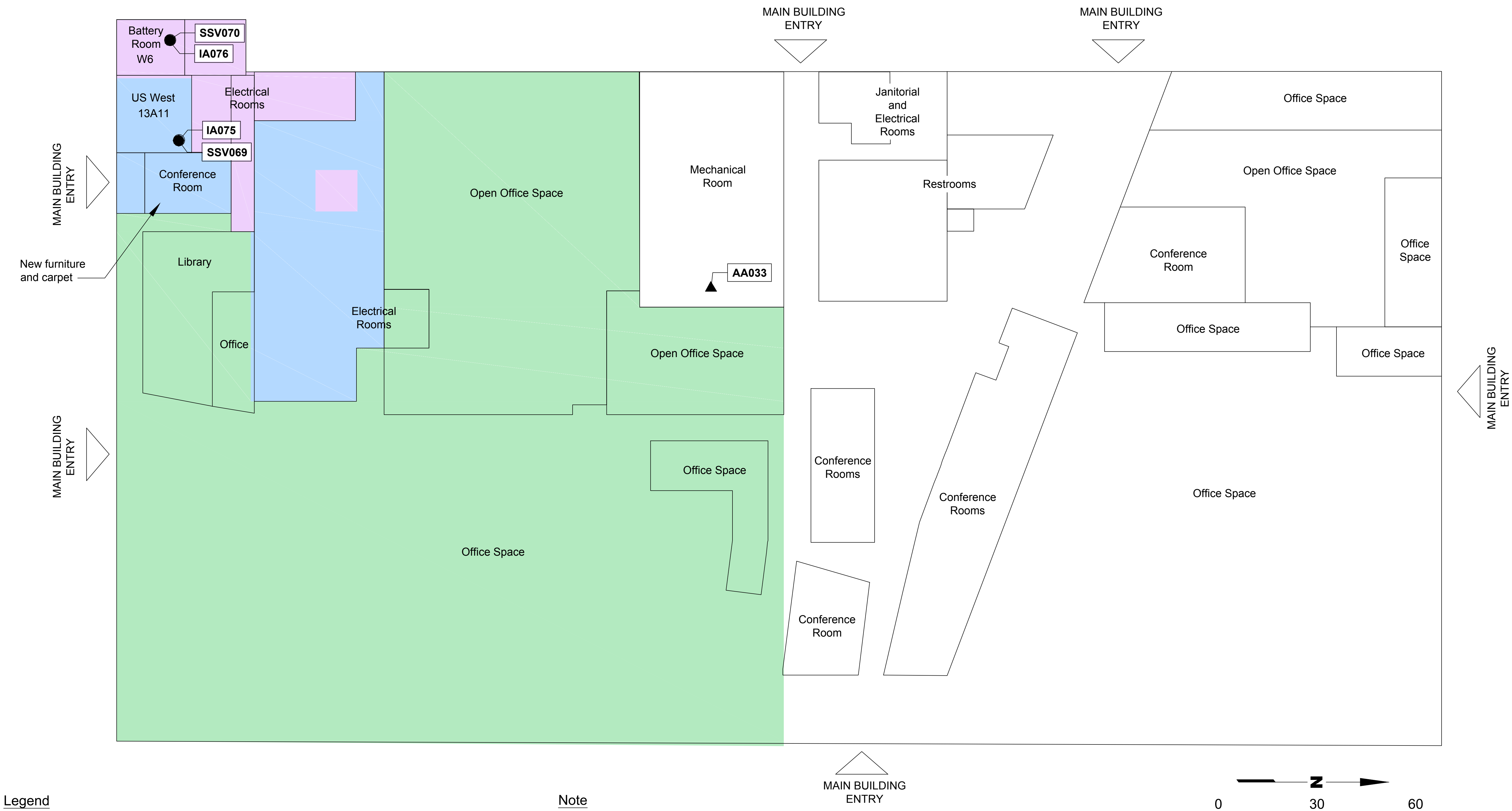
Source: Glimcher, 2014;

Landau Associates

Boeing Auburn
Auburn, Washington

The Outlet Collection
Indoor Air and Sub-Slab
Vapor Sampling Locations

Figure
2



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SCALE IN FEET

Legend

- ● Co-located Sub-Slab Soil Vapor and Indoor Air Sample Location.
- ▲ Ambient Air Sample Location (On Roof).
- (green) Top Concrete Slab Rests on Polystyrene Foam Which Rests on Slab-on-Grade Base.
- (blue) Raised Floor with Removable Panels Above Slab-on-Grade Base.
- (pink) Slab-on-Grade

Note

1. An ambient air sample was collected from the roof near an HVAC intake.
2. Building layout and interior features simplified for clarity. For additional building construction, utility, and office space layout details, see the Tier II Commercial Vapor Intrusion Assessment Work Plan (Landau Associates 2015).
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

Boeing Auburn Auburn, Washington	**Commercial Boeing Building 17-70 Indoor Air and Sub-Slab Soil Vapor Sampling Locations**	Figure 3

Table 1
Commercial Vapor Intrusion Screening and Indoor Air Action Level Criteria
Boeing Auburn

Constituent of Concern	Indoor Air (μg/m^3) [a]				Screening Levels Protective of Modified MTCA Method B Indoor Air SLs	
	Modified MTCA Method B [b]	EPA Region 10 Value	MTCA	Tunnel Scenario MTCA Modified Method B	Soil Gas (μg/m^3)	Groundwater (μg/L) [d]
	SL (Carc)	IAAL Sub-Chronic (Non-Carc)[c]	IAAL Chronic Exposure Cumulative Excess Cancer Risk	SL (Carc)	SL (Carc)	SL (Carc)
TCE	1.9	8.4	1×10^{-5}	58	63	7.9
VC	0.85	--		--	28	1.0

Carc = Carcinogenic
EPA = U.S. Environmental Protection Agency
IAAL = Indoor Air Action Level
μg/m^3 = Micrograms per Cubic Meter
μg/L = Micrograms per Liter
MTCA = Model Toxics Control Act
Non-Carc = Non-carcinogenic
SL = Screening Level
TCE = Trichloroethene
VC = Vinyl Chloride

a = Indoor air screening criteria is be applied to indoor air samples, crawl space, and basement air samples, and ambient air samples.
b = Method for calculating modified MTCA Method B air SLs for commercial land use was defined by Washington State Department of Ecology (Ecology) in their comments to the draft vapor intrusion data report.
c = The sub-chronic non-carcinogenic indoor air action level comes from the EPA Region 10 (EPA 2012). Ecology has requested that Boeing apply this value as an IAAL When air sampling is conducted where a woman of child bearing age works or visits regularly. Once EPA Office of Solid Waste and Emergency Response determines an official value, the EPA Region 10 sub-chronic value will be replaced.
d = The Henry's Law constant used to calculate the shallow groundwater screening level assumes a temperature of 13 degrees Celsius per the U.S. temperature map provided by EPA. Online Tools for Site Assessment Calculation for Henry's Law Constants.

Table 2
The Outlet Collection Analytical Results
Tier II Commercial Vapor Intrusion Sampling
Boeing Auburn

	AA034 Roof 1504515A-04A 4/27/2015	AA035 Roof 1506116-01A 6/4/2015	IA077 Hallway 1504515A-05A 4/27/2015	IA078 East Tunnel Sump 1504515A-01A 4/27/2015	IA079 West Fire Room 1504515A-06A 4/27/2015	IA080 West Tunnel Sump 1504515A-02A 4/27/2015	IA081 South Fire Room 1504515A-03A 4/27/2015	IA082 East Tunnel Hallway Breathing Zone 1506116-04A 6/4/2015	IA083 East Tunnel Sump 1506116-03A 6/4/2015	IA084 East Tunnel Sump Breathing Zone 1506116-02A 6/4/2015
VOLATILES (µg/m3)										
Method EPA TO-15										
cis-1,2-Dichloroethene	0.69 U	0.65 U	0.66 U	0.64 U	0.63 U	0.66 U	0.66 U	0.60 U	0.64 U	0.61 U
Trichloroethene	0.94 U	0.89 U	0.89 U	**11**	0.85 U	0.89 U	0.89 U	0.81 U	0.87 U	0.83 U
Vinyl chloride	0.45 U	0.42 U	0.42 U	0.41 U	0.41 U	0.42 U	0.42 U	0.38 U	0.41 U	0.40 U
HELIUM (%)										
Method ASTM D-1946	--	--	--	--	--	--	--	--	--	--

	SSV071 South Fire Room 1504515B-07A 4/28/2015	SSV072 West Fire Room 1504515B-08A 4/28/2015	SSV073 Hallway 1504515B-09A 4/28/2015	IA Short-Term IAAL	IA Modified MTCA Method B SL	Soil Gas SL Protective of Modified MTCA Method B Air
VOLATILES (µg/m3)						
Method EPA TO-15						
cis-1,2-Dichloroethene	3.9 U	3.9 U	3.9 U	--	--	--
Trichloroethene	5.3 U	5.2 U	5.2 U	8.4	1.9	63
Vinyl chloride	2.5 U	2.5 U	2.5 U	--	0.85	28
HELIUM (%)						
Method ASTM D-1946	0.10 U	0.098 U	0.098 U	--	--	--

-- = Not applicable
AA = Ambient Air
Bold = Detected compound.
Box = Exceeds screening criteria
IA = Indoor Air
IAAL = Indoor Air Action Levels
MTCA = Model Toxics Control Act
µg/m3 = micrograms per cubic meter
SL = Screening Level
SSV = Sub-slab Soil Vapor
U = Indicates the compound was not detected at the reported concentration.

Table 3
Building 17-70 Analytical Data
Tier II Commercial Vapor Intrusion Sampling
Boeing Auburn

	Bldg 17-70 AA033 Roof 1504384A-01A 4/20/2015	Bldg 17-70 IA075 Room 13A11 1504384A-02A 4/20/2015	Bldg 17-70 IA076 Room W6 1504384A-03A 4/20/2015	Bldg 17-70 SSV069 Room 13A11 1504384B-04A 4/21/2015	Bldg 17-70 SSV070 Room W6 1504384B-05A 4/21/2015	IA Short-term IAAL	IA Modified MTCA Method B SL	Soil Gas SL Protective of Modified MTCA Method B Air
VOLATILES (µg/m^3) **Method EPA TO-15**								
cis-1,2-Dichloroethene	0.69 U	0.66 U	0.59 U	4.1 U	4.1 U	--	--	--
Trichloroethene	0.94 U	0.90 U	0.81 U	5.5 U	5.6 U	8.4	1.9	63
Vinyl chloride	0.45 U	0.43 U	0.38 U	2.6 U	2.7 U	--	0.85	28
HELIUM (%)								
Method ASTM D-1946	--	--	--	0.10 U	0.10 U	--	--	--

-- = Not applicable
AA = Ambient Air
IA = Indoor Air
IAAL = Indoor Air Action Level
MTCA = Model Toxics Control Act
µg/m^3 = micrograms per cubic meter
SL = Screening Level
SSV = Sub-slab Soil Vapor
U = Indicates the compound was not detected at the reported concentration.

APPENDIX A

Tunnel Exposure Scenario Screening Level Calculation

Table A-1
Utility Tunnel Modified Method B Carcinogenic Risk Screening Levels for TCE
Vapor Intrusion Assessment
Boeing Auburn

Constants from MTCA Equation 750-2 for carcinogens

RISK	=	1.E-06	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=	0.0144	Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)*
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	0.010416667	Exposure frequency (15 minutes/day)

Equation: (a) SL_{IA} (µg/m^3)=

$$\frac{RISK \times ABW \times AT \times UCF}{CPF \times BR \times ABS \times ED \times EF}$$

MTCA Equation 750-2

Solve: (a) SL_{IA} (µg/m3)= **58**

* CPF_i provided by Ecology via Email May 18, 2015