Phase II Vapor Intrusion Summary (Winter-Spring 2014) Algona, Washington

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Prepared for

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INTRODUCTION

Volatile[1] organic compounds (VOCs) related to industrial manufacturing have been found in shallow groundwater in the northeastern portion of residential Algona. It is believed that the VOCs originated from The Boeing Company's manufacturing facility (Boeing facility) located at 700 15th Street SW, Auburn, Washington. Boeing is actively investigating the presence of the VOCs in northern Algona, and in particular the residential neighborhood, as part of a larger remedial investigation. The remedial investigation will identify where any contamination is, how far it has moved, and the most effective way to clean it up. The remedial investigation is overseen and directed by the Washington State Department of Ecology (Ecology) under a Washington State law called the Model Toxics Control Act. The locations of residential Algona and the Boeing facility are shown on Figure 1.

As part of the remedial investigation activities in residential Algona, Boeing is evaluating potential risks to human health related to VOCs in shallow groundwater (near the ground surface). If human health is found to be at risk due to VOC contamination from Boeing's facility, Boeing will be responsible for reducing the contamination to a level that is protective of human health. Boeing collected samples from shallow groundwater and compared the levels of chemicals in those samples to levels that Ecology determined protective of human health. The results from this sampling are summarized in the section below titled "Algona Shallow Groundwater Data."

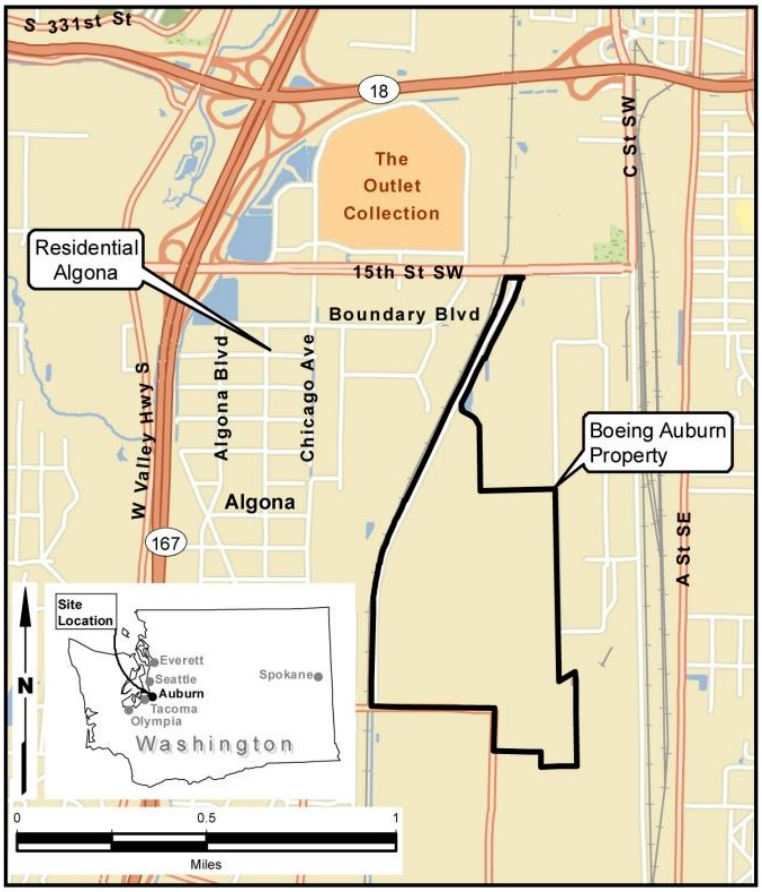

Figure 1: Area Map

One way that VOCs in shallow groundwater can impact human health is through vapor intrusion. Vapor intrusion occurs when chemicals in the groundwater move as vapor upward through the soil and

[1] These compounds are called "volatile" because VOCs can evaporate under normal atmospheric conditions.

into indoor air. The discovery of VOCs in the shallowest groundwater (approximately 5 to 10 feet below the ground surface) was in the northeastern portion of residential Algona, which led to a residential vapor intrusion assessment (or study); the study area is shown on Figure 2. Figure 2 also shows where VOC concentrations in shallow groundwater are high enough to potentially impact indoor air through vapor intrusion (green area).

The first phase of the study (Phase I) began in the summer of 2013 and concluded in the early fall of 2013. The results from Phase I of the study were published in the *Phase I Vapor Intrusion Summary* in January 2014.

The second phase of the study (Phase II) began in January of 2014 and concluded in the early spring of 2014. The results from Phase II were used to verify the results from Phase I of sampling and to see if winter and early spring conditions (such as groundwater being closer to the ground surface) influence the occurrence of vapor intrusion in the residential vapor intrusion study area. This summary report provides background information on vapor intrusion, explains why the study occurred, provides information on sampling, and shares results from both the Phase I and Phase II sampling. Specific objectives include: 1) to identify if there are VOCs present in the homes situated over the study area, 2) If VOCs are found, to identify whether the source is likely attributable to vapor intrusion, and 3) if VOCs are detected, to assess whether the concentrations are high enough to pose a health risk.

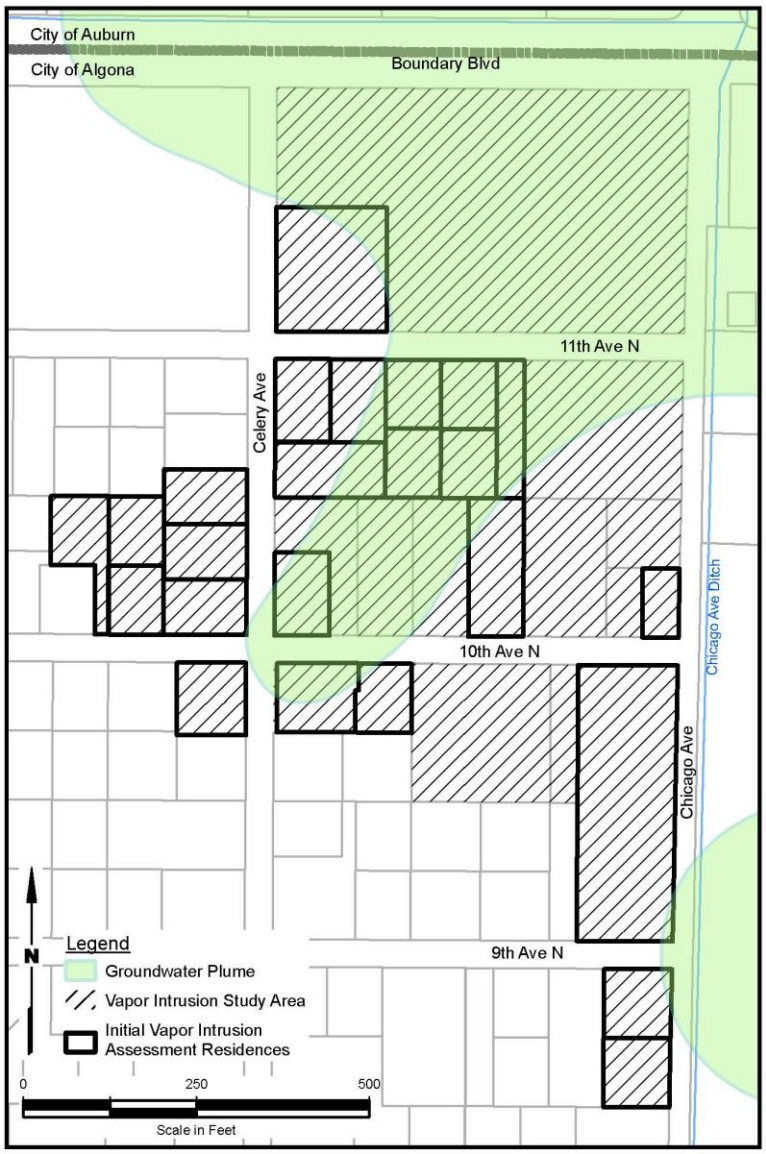

Figure 2: Residential Vapor Intrusion Study Area

Generally, the results from the first and second phases of the vapor intrusion study indicate that no action is needed at this time to reduce the potential for exposure in any home. The overall findings indicate that vapor intrusion cannot be identified as the source of the limited detections of trichloroethene (TCE) at homes in the study area and, when detected, concentrations were at levels below those expected to cause harmful health effects. Additional monitoring wells will be installed in the residential and commercial areas of Algona to help monitor VOC concentrations in shallow groundwater on a regular basis. If conditions in the shallow groundwater change and VOC concentrations increase significantly, there may be additional vapor intrusion studies conducted.

BACKGROUND

TCE[2] was historically used and stored at the Boeing facility. The chemical was used as early as the 1960s and as late as the mid-1980s. During its use at the facility, some of the TCE leaked into the groundwater.

TCE belongs to a group of VOCs called "chlorinated solvents" and can naturally break down into other chemicals, including cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), and vinyl chloride. The breakdown products listed above were included in the vapor intrusion study sampling.

The area of TCE-impacted groundwater is called a plume and the plume usually moves with the natural flow of groundwater. Groundwater beneath the Boeing Auburn facility flows to the northwest, so the shallow plume is located to the northwest in areas that include northeastern residential Algona. The location of the groundwater plume is determined by collecting groundwater samples at permanent sampling points (monitoring wells) or at temporary sampling points (borings). The plume has three dimensions, which means concentrations of the chemicals can vary horizontally (length and width, as shown on Figure 3) and with depth below the ground surface. Figure 3 shows the approximate area of the shallow portion of the groundwater plume, based on the most recent complete set of groundwater samples. Only chemicals that are close to the surface, such as chemicals in shallow groundwater, can impact the air above ground.

[2] A detailed summary of TCE was published by the Agency for Toxic Substances and Disease Registry (ATSDR): http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=173&tid=30. Trichloroethylene and trichloroethene are the same chemical.

In December 2012, additional groundwater monitoring wells were installed in the northeastern portion of residential Algona. Samples taken from these wells determined that TCE and its breakdown chemicals were present in the shallow groundwater and that the concentrations exceeded project-wide screening levels set by Ecology.[3] The sample results were shared with Ecology and the City of Algona in January 2013. The City of Algona worked with Ecology, the Washington State Department of Health (Department of Health), and Boeing to organize a public meeting for the citizens of Algona where the results were explained. The public meeting was held in mid-February 2013.

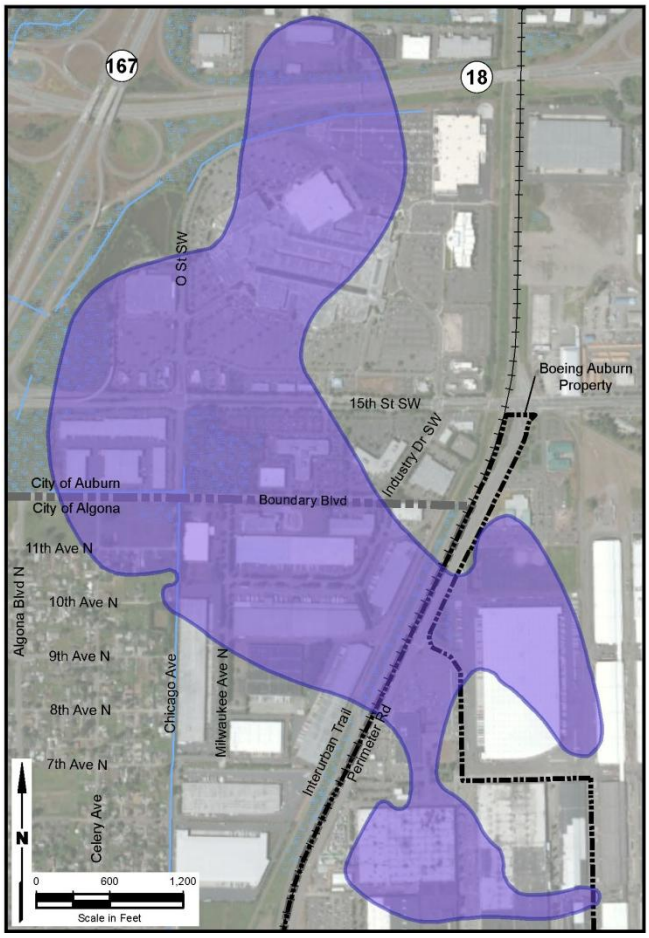

Figure 3: Shallow Zone TCE Plume

In order to further understand the extent of shallow groundwater contamination in residential Algona, the next step of the investigation was to collect multiple shallow groundwater samples covering northern and some portions of southern residential Algona. To expedite the data collection process, borings were used instead of installing monitoring wells. The borings were drilled and sampled in April 2013. The sample results were used to determine the area where vapor intrusion could occur in homes, also called the "study area." The results of the April 2013 groundwater sampling investigation and the vapor intrusion assessment study area were presented to City of Algona officials and their technical consultant, ICF International (ICF), for review. Ecology hosted a second public meeting in June 2013 to speak with community members and to address their concerns. Subsequently, Phase I of the vapor intrusion study began in June 2013 and was conducted through the fall of 2013; Phase II of the vapor intrusion study began in January 2014 and was conducted into the spring of 2014.

[3] In November 2012, Ecology formally set the project's residential vapor intrusion screening levels for shallow groundwater. These screening levels were developed consistent with the U.S. Environmental Protection Agency's standards and the Washington State Model Toxics Control Act. They are used to indicate if chemical concentrations in shallow groundwater could result in potentially harmful levels in indoor air from vapor intrusion.

VAPOR INTRUSION – WHAT IS IT?

When a chemical is released and comes in contact with groundwater, that chemical can travel with the natural flow of groundwater. Some types of chemicals, such as VOCs, can easily evaporate and become vapors, meaning the chemical leaves the shallowest groundwater and enters air between the soil particles. These vapors can travel through the soil and enter buildings directly above the location of the chemical; this is called vapor intrusion. Once in a building, the vapors can potentially build up and affect air quality and the health of the building's occupants. Figure 4 shows the steps that chemicals must take for vapor intrusion to occur in a home, from groundwater to indoor air.

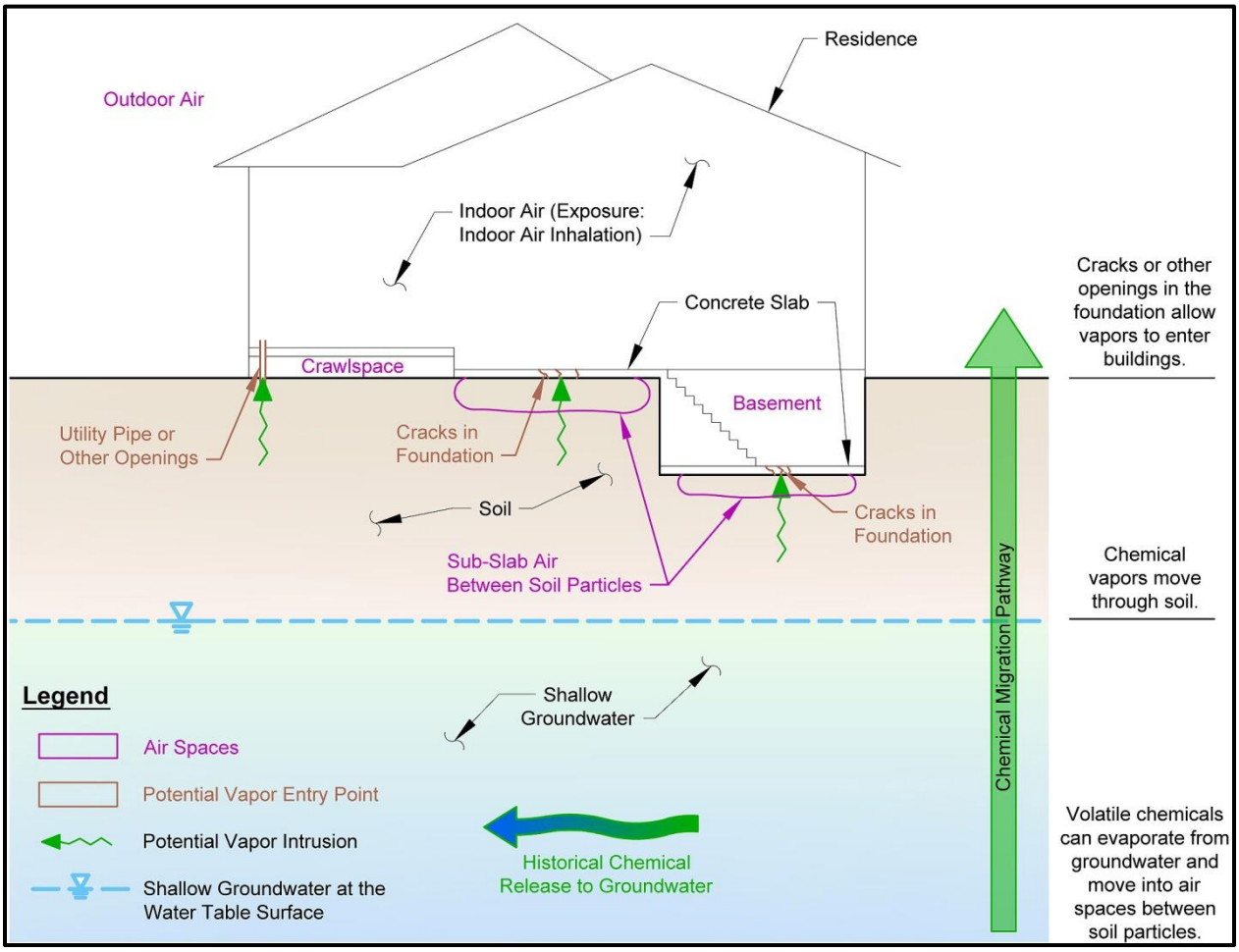

Figure 4: Vapor Intrusion Conceptual Model

How vapors can enter a building varies based on the building's foundation. The chance that the vapors will enter the building also varies based on the condition of the foundation. For example, cracks in a building's slab may allow vapors to enter a building more easily. In homes with crawlspaces, vapors may enter through the crawlspace.

ALGONA SHALLOW GROUNDWATER DATA

The April 2013 investigation included collection of shallow groundwater samples from 49 locations throughout northern and parts of southern residential Algona. The samples were tested for VOCs, including TCE and its breakdown products (trans-1,2-DCE, cis-1,2-DCE, and vinyl chloride). The chemical concentration data were compared to Ecology-approved, residential Algona-specific groundwater preliminary concern levels (herein termed Algona screening criteria).[4] The Algona screening criteria are chemical-specific, health-protective values that represent the concentrations above which shallow groundwater could theoretically result in unacceptable VOC concentrations in indoor air through vapor intrusion. A number of exposure elements are factored into calculating the Algona screening criteria, which are designed to be very conservative and err on the side of caution to ensure protection of human health.

ALGONA RESIDENTIAL VAPOR INTRUSION STUDY AREA

The vapor intrusion study includes areas near wells or borings where VOCs were detected in shallow groundwater at higher concentrations than the Algona screening criteria. The Department of Health and Ecology requested that a few additional homes be included in the study area because the homes appeared to have basements (an uncommon feature in Algona home construction) and were relatively close to a boring where chemicals were detected in shallow groundwater. There were 24 homes identified on the properties within the study area (see Figure 2).[5] These households were offered vapor intrusion sampling, paid for by Boeing and conducted by Boeing's contractor (Landau Associates), to determine if vapor intrusion was occurring in the home.[6]

BUILDING SURVEY VISITS

Before vapor intrusion-related air sampling occurred at a home, a building survey was completed. The purpose of the building survey was to gather information about the building's foundation and construction, identify potential background sources of chemicals that could impact the air sample results (explained in the next section, Vapor Intrusion Sampling), collect relevant information about the occupants during an interview with the occupant(s), identify potential sampling locations, and describe the sampling process to the residents. A representative from Landau Associates and a representative from

[4] The preliminary concern levels (PCLs, referred to herein as the Algona screening criteria) are currently being used in Algona instead of the residential vapor intrusion screening levels for shallow groundwater because groundwater in Algona is very close to the ground surface. The Algona screening criteria are more protective of human health than the project-wide screening levels.

[5] There were initially 23 homes. An additional home was constructed inside the study area during the study period, bringing the total to 24 homes.

[6] Ecology and/or Ecology's consultant, Aspect Consulting, also attended a number of sampling appointments.

Ecology or Ecology's consultant, Aspect Consulting, attended each building survey. The City of Algona's environmental technical consultant, ICF, attended building surveys at the residents' request. A work plan for each individual home was then created based on the building survey. The work plans were reviewed by Ecology, the Department of Health, and ICF.

Although only 15 of the 24 homes chose to participate in the sampling,[7] the homes that were sampled included a variety of types from all sections of the study area, including:

- Manufactured home with crawlspace and attached slab-on-grade garage
- Manufactured home with a crawlspace
- Stick-built home with slab-on-grade foundation or attached garage
- Stick-built home with a crawlspace
- Stick-built home with a basement.

Fewer homes chose to participate in the second phase of the study (7 participants) than the first phase of the study (14 participants). However, the homes that did participate in the second phase of the study were spread across the study area and included a variety of home construction types.

VAPOR INTRUSION SAMPLING

Once each home's work plan was approved by Ecology, air sampling was done to evaluate if chemical vapors from groundwater were entering the home. This can be difficult to evaluate, as these chemicals are also found in common household products such as paints, solvents, and cleaning products. These interfering household products, called background sources, can release chemical vapors as well, which can impact the air samples collected and affect indoor air quality even if vapor intrusion is not occurring. Residents were asked to remove these types of products from their homes at least 48 hours prior to sampling, with assistance from Landau Associates if desired, and were asked to refrain from using them during the sampling period.

Figure 5: 6-liter Summa canister

Air samples were collected over 24 hours using Summa canisters (Figure 5). Summa canisters are stainless steel vacuum canisters that collect air at a set rate. The number of samples collected at a home varied based on building type (illustrated on Figure 4), but a typical set of air samples included:

[7] Six of the 24 homes chose to participate in both phases of sampling; 8 of the 24 homes chose to participate in Phase I sampling only; and 1 of the 24 homes chose to participate in Phase II sampling only.

- An air sample from the crawlspace or basement, if present. Of the types of air samples collected, crawlspace or basement air samples are closest to shallow groundwater.
- An indoor air sample from a commonly occupied first floor room. If multiple first-floor rooms are commonly occupied, an indoor air sample was collected from each commonly occupied room. Additional samples were sometimes collected from upper-level floors at a resident's request; however, collecting samples from the first floor is more important as vapors must travel through the first-floor rooms to arrive at the upper-level rooms.
- An ambient (outdoor) air sample to determine if there was an outdoor source of contaminants during collection of the indoor air samples. Chemical use outside of the home, or at nearby businesses or homes, can release vapors into the ambient air. The ambient air can then enter a home and affect indoor air quality even if vapor intrusion is not occurring. Placement of the ambient air sample location was based on the observed wind direction at the start of sampling and placed upwind of the home.

If the building had a concrete slab, a sub-slab vapor sample may have been collected. Sub-slab vapor sampling helps determine if vapors are accumulating beneath the slab of a building. Sub-slab vapor sampling involves collection of a vapor sample from the air spaces between the soil particles beneath a concrete slab; vapor samples are collected in the same type of container as air samples. Similar to crawlspace air samples, sub-slab vapor samples are collected closer to shallow groundwater than indoor air samples. The sub-slab vapor sample takes approximately 30 minutes to collect and can be collected only if conditions are appropriate (i.e., groundwater levels are not too high).

Samples collected using Summa canisters were analyzed for TCE and related breakdown chemicals trans-1,2-DCE, cis-1,2-DCE,[8] and vinyl chloride. The results are the average concentrations of the chemicals over the sample period.

Figure 6: Passive Diffusive Radiello Sampler

A select number of homes were sampled for TCE in indoor air and crawlspace air with Radiello® samplers (Figure 6) in addition to Summa canisters. The Department of Health asked that Boeing use the Radiello samplers at a small number of homes (three or four) in areas where TCE was detected in the nearest well or boring at a concentration greater than the Algona screening criteria. The Radiello samplers are a type of passive diffusive sampler, meaning the TCE passes through a membrane and is absorbed by special media that can be analyzed by

[8] There are currently no known health risks associated with inhaling cis-1,2-DCE, but its presence in indoor air is a useful indicator that it may be present in underlying groundwater.

laboratory instruments. This technology allows a sample to be collected over 21 days and the results are the average concentrations of TCE over 3 weeks.

HOW SAMPLE RESULTS ARE REPORTED AND EVALUATED

Air sampling results were compared to indoor air action levels. These are levels that Ecology set to show which chemical concentrations may pose a health concern if a person was exposed for a certain period of time. If chemicals are detected at levels greater than their indoor air action levels, it means further action may need to be taken at the home if vapor intrusion is the cause. Additional testing is often needed to determine the source of a chemical detected in indoor air. If chemicals are detected at levels below their indoor air action levels, they are considered safe.

There are two types of indoor air action levels:

- Short-term exposure
- Long-term exposure.

Detections higher than a short-term exposure limit require immediate action because there could be immediate health risks to certain individuals. Detections higher than a long-term exposure limit but lower than a short-term exposure limit indicate that there are no immediate health risks, but action is required to reduce long-term exposure levels if they are related to vapor intrusion.

Sample results are reported by laboratories as numeric concentration values. Laboratory analyses have a minimum concentration that the laboratory instruments can detect; these are called laboratory detection limits. The detection limits must be lower than all applicable screening criteria. The laboratory used for the study met this requirement.

STUDY RESULTS AND WHAT THEY MEAN

During each phase of the study, homeowners and/or tenants (if applicable) of the sampled homes received their results and a letter describing what the results meant approximately 1 month after the last sample was collected from the home. A summary of Phase I and Phase II study results from all 15 homes is provided in Table 1.

Of the 15 homes tested, eight had no detected concentrations of any of the chemicals of concern. The remaining seven homes had one or more detections, and TCE was the only chemical detected. Five of the seven homes had TCE in the living space. Of those five, one also had it in the crawlspace, one home had it only in the crawlspace, and one home had it only in sub-slab vapor.

To determine if any of the detections of TCE were likely linked to vapor intrusion, the entire data set at each home was considered: sub slab sampling, crawlspace, indoor air, and outdoor air in terms of the pattern and concentrations. The findings from each home's data set are summarized below.

Summary of TCE Detections in Living Spaces

- TCE was detected below indoor air action levels in the basement bedroom of one home during Phase II sampling. The detection was right at the laboratory instrument's detection limit, which was well below the indoor air action levels. TCE was not detected in the two other samples collected from the basement at the same time, including one sample collected from a sump penetrating the floor of the basement. There were also no detections in this home during Phase I sampling. Based on the results of this study, vapor intrusion does not appear to be the likely source of the detection and no further action is required at this time to reduce the potential for exposure in this home.

- One home had TCE detections in three of its Phase I samples: two indoor air samples and one ambient air sample. TCE concentrations in all indoor air samples were below the indoor air action levels, which means they are not expected to cause harmful health effects and no action was needed to reduce exposure in the home. The highest concentration of TCE was found in the ambient air sample. A sub-slab soil vapor sample was also collected at this home and TCE was not detected in soil vapor, indicating that vapor intrusion is not likely to have contributed to the detections in indoor air. Based on the test results, it was determined that the TCE detected in the indoor air samples was coming from outdoor air. With Ecology approval, an additional ambient air sample was collected approximately 1 month later to attempt to determine the source of the initial outdoor air detection. TCE was not detected in the second ambient air sample, which suggests that the initial detection was due to an isolated incident such as a nearby business or home using a product containing TCE at the time of sampling. This home did not choose to participate in Phase II sampling. Based on the results of this study, no further action is required at this time to reduce the potential for exposure in this home.

- One home had TCE detections in two Phase I samples: the indoor air Radiello sampler and the crawlspace Radiello sampler. This home also had TCE detections in two Phase II samples: the indoor air 24-hour sample and the indoor air Radiello sampler. However, all detections were below the indoor air action levels; TCE levels below the indoor air action levels are not expected to cause harmful health effects and no action was needed to reduce exposure in this home. TCE was also not detected in sub-slab vapor samples collected below the home during either Phase I or Phase II, indicating that vapor intrusion from shallow groundwater is not likely the source of the detections. At this time, the source of the detections is unknown. Based on the results of this study, no further action is required at this time to reduce the potential for exposure in this home.

- TCE was detected below indoor air action levels in the living room of one home during Phase I sampling. TCE was not detected in the crawlspace sample collected below the home at the same time, which indicates that the indoor air detection is not likely a result of vapor intrusion from shallow groundwater. Furthermore, the resident reported conducting activities involving VOCs prior to Phase I sampling (new carpet and painting), which may have affected indoor air sampling results. There were also no detections in this home during Phase II sampling. Based on the results of this study, no further action is required at this time to reduce the potential for exposure in this home.

- TCE was detected above the long-term indoor air action level in a second-floor bedroom of one home during Phase I sampling. The detection was below the short-term indoor action level, meaning there was no immediate health risk. TCE was not detected in the other indoor air sample collected from the basement of the home at the same time, which indicates that the indoor air detection is not likely a result of vapor intrusion from shallow groundwater below the home. A sub-slab vapor sample could not be collected at the same time as the indoor air

samples because of high water table conditions; however, a sub-slab sample was collected approximately 2 weeks later during a period of dry weather and no chemicals were detected below the home at that time.

With Ecology approval, a repeated round of indoor air and sub-slab sampling was performed 1 month later to confirm these findings, including an additional sample in the basement directly below the bedroom with the initial TCE detection. There were no detections inside or below the home during this second round of sampling. This home did not choose to participate in Phase II sampling. Based on the results of this study, no further action is required at this time to reduce the potential for exposure in this home.

Summary of TCE Detections in Crawlspaces (only)

- TCE was detected below indoor air action levels in the crawlspace of one home during Phase I sampling using a 24-hour (Summa) sampling device. TCE was not detected in the crawlspace with the 21-day (Radiello) sampling device at the same location during the same event. Furthermore, TCE was not detected in any of the indoor air samples collected at the same time using both 24-hour (Summa) and 21-day (Radiello) sampling devices. A repeated round of sampling was performed to confirm these initial results and there were no detections inside or below the home during the second round of sampling. This home also participated in Phase II sampling and there were no detections of chemicals inside or below the home during that sampling event. Based on the results of this study, vapor intrusion does not appear to be the likely source of the detection and no further action is required at this time to reduce the potential for exposure in this home.

Summary of TCE Detections in Sub-Slab Vapor (only)

- TCE was detected below the sub-slab vapor screening level for TCE and the indoor air action levels in a sub-slab sample collected below one home during Phase II sampling. TCE was not detected in any of the indoor air samples collected at the same time. The home did not participate in the Phase I sampling. Based on the results of this study, vapor intrusion is not likely occurring and no further action is required at this time to reduce the potential for exposure in this home.

Based on the first and second phases of the vapor intrusion study, results from all homes indicate that no action is needed at this time to reduce the potential for exposure in any home. If action had been necessary (i.e., if short-term action levels were exceeded), Boeing was ready to take immediate action using its mitigation plan, which was approved by Ecology.

Overall, these findings indicate that vapor intrusion cannot be identified as the source of the limited detections of TCE at homes in the study area. Furthermore, when detected, concentrations were at levels below those expected to cause harmful health effects. Ecology and Boeing do not anticipate that it will be necessary to test additional homes. Boeing will continue to monitor the shallow groundwater plume for changes that suggest vapor intrusion could become an issue.

CONCLUSIONS AND NEXT STEPS

Volatile organic compounds (VOCs) related to industrial manufacturing have been found in shallow groundwater in the northeastern portion of residential Algona. It is believed that the VOCs originated from the Boeing facility. TCE and its breakdown chemicals in shallow groundwater have the potential to impact indoor air quality and human health through vapor intrusion. Boeing and Ecology designed this study to determine if vapors from groundwater were entering people's homes and could potentially be a risk to people's health. Boeing gathered data across multiple seasons (summer, fall and winter) and over varying lengths of time (24 hours to 21 days). Based on the data collected during the study, vapor intrusion cannot be identified as the source of the limited detections of TCE at homes in the study area. Furthermore, exposure to VOCs is not a health concern in residential Algona at this time.

Boeing has finalized a work plan with Ecology that includes installation of additional monitoring wells in the residential and commercial areas of Algona. These new wells will help Boeing monitor VOC concentrations in shallow groundwater on a regular basis. If shallow groundwater conditions change and VOC concentrations increase significantly, additional vapor intrusion studies may be necessary in the future.

Current information on the groundwater study and the vapor intrusion study is available on Ecology's website: https://fortress.wa.gov/ecy/gsp/Sitepage.aspx?csid=5049.

TABLE 1
SUMMARY OF RESULTS BY RESIDENCE AND FOUNDATION TYPE
ALGONA RESIDENTIAL VAPOR INTRUSION ASSESMENT
BOEING AUBURN

Phase of the Study (a)	Sample Type	Location Description	Sample Location	Sample Date (b)	Trichloroethene ($\mu g/m^3$)	cis-1,2-Dichloroethene ($\mu g/m^3$)	trans-1,2-Dichloroethene ($\mu g/m^3$)	Vinyl Chloride ($\mu g/m^3$)	Radiello Trichloroethene ($\mu g/m^3$)
		Concentration Long-term Indoor Air Action Levels (c)			*0.91*	--	*27*	*2.8*	*0.91*
		Concentration Short-term Indoor Air Action Levels (c)			*2.0*	--	--	--	--
Foundation: Slab-on-Grade									
1	Sub-Slab Vapor	1st Floor TV Room	SSV050	8/13/2013	<0.16	<0.12	<0.60	<0.039	--
1	Sub-Slab Vapor	1st Floor Master Bedroom	SSV051	8/13/2013	<0.16	<0.12	<0.61	<0.039	--
1	Indoor Air	1st Floor TV Room	IA026	8/14/2013	<0.18	<0.13	<0.65	<0.042	<0.048
1	Indoor Air	1st Floor Master Bedroom	IA027	8/14/2013	<0.17	<0.13	<0.64	<0.041	<0.048
1	Indoor Air	1st Floor Office	IA028	8/14/2013	<0.15	<0.11	<0.57	<0.036	<0.048
1	Ambient Air	Outside	AA012	8/14/2013	<0.17	<0.12	<0.61	<0.040	--
1	Sub-Slab Vapor	1st Floor Hallway	SSV057	9/15/2013	<0.42	<0.31	<1.5	<0.099	--
1	Indoor Air	1st Floor TV Room	IA043	9/14/2013	<0.27	<0.20	<1.0	<0.064	--
1	Indoor Air	1st Floor Master Bedroom	IA044	9/14/2013	<0.19	<0.14	<0.69	<0.045	--
1	Ambient Air	Outside	AA018	9/14/2013	<0.20	<0.14	<0.72	<0.047	--
2	Sub-Slab Vapor	Garage	SSV063	1/29/2014	<0.16	<0.12	<0.59	<0.038	--
2	Sub-Slab Vapor	1st Floor Closet	SSV064	1/29/2014	**0.43**	<0.12	<0.59	<0.038	--
2	Indoor Air	1st Floor Room	IA062	1/27/2014	<0.15	<0.11	<0.56	<0.036	--
2	Ambient Air	Outside	AA026	1/27/2014	<0.20	<0.15	<0.74	<0.048	--
1	Sub-Slab Vapor	Garage	SSV054	8/27/2013	<0.16	<0.12	<0.61	<0.039	--
1	Sub-Slab Vapor	Garage	SSV055	8/27/2013	<0.82	<0.61	<3.0	<0.20	--
2	Sub-Slab Vapor	Garage	SSV066	3/7/2014	<0.16	<0.12	<0.59	<0.038	--
2	Sub-Slab Vapor	Garage	SSV067	3/7/2014	<0.16	<0.12	<0.61	<0.039	--
1	Sub-Slab Vapor	1st Floor Closet	SSV053	8/21/2013	<0.17	<0.12	<0.62	<0.040	--
1	Indoor Air	1st Floor Bedroom	IA032	8/19/2013	**0.54**	<0.32	<1.6	<0.10	--
1	Indoor Air	1st Floor Office/Storage Room	IA033	8/19/2013	**0.81**	<0.14	<0.70	<0.045	--
1	Ambient Air	Outside	AA014	8/19/2013	**1.1**	<0.13	<0.66	<0.042	--
1	Ambient Air	Outside	AA022	9/25/2013	<0.16	<0.12	<0.59	<0.038	--
Foundation: Slab-on-Grade & Crawlspace									
1	Sub-Slab Vapor	1st Floor Bedroom/TV Room	SSV052	8/13/2013	<0.17	<0.12	<0.63	<0.040	--
1	Crawlspace	Crawlspace	CSA003	8/15/2013	**0.19**	<0.13	<0.66	<0.042	<0.050
1	Indoor Air	1st Floor Bedroom/TV Room	IA029	8/15/2013	<0.18	<0.14	<0.68	<0.044	<0.050
1	Indoor Air	2nd Floor TV Room	IA030	8/15/2013	<0.19	<0.14	<0.72	<0.046	<0.050
1	Indoor Air	3rd Floor Bedroom	IA031	8/15/2013	<0.19	<0.14	<0.69	<0.044	<0.050
1	Ambient Air	Outside	AA013	8/15/2013	<0.18	<0.13	<0.65	<0.042	--
1	Sub-Slab Vapor	Garage	SSV059	10/16/2013	<0.15	<0.11	<0.57	<0.036	--
1	Crawlspace	Crawlspace	CSA009	10/15/2013	<0.17	<0.12	<0.61	<0.040	--
1	Indoor Air	1st Floor Bedroom/TV Room	IA047	10/15/2013	<0.18	<0.13	<0.65	<0.042	--
1	Indoor Air	2nd Floor TV Room	IA048	10/15/2013	<0.15	<0.11	<0.54	<0.035	--
1	Indoor Air	3rd Floor Bedroom	IA055	10/15/2013	<0.17	<0.12	<0.62	<0.040	--

TABLE 1
SUMMARY OF RESULTS BY RESIDENCE AND FOUNDATION TYPE
ALGONA RESIDENTIAL VAPOR INTRUSION ASSESMENT
BOEING AUBURN

Phase of the Study (a)	Sample Type	Location Description	Sample Location	Sample Date (b)	Trichloroethene ($\mu g/m^3$)	cis-1,2-Dichloroethene ($\mu g/m^3$)	trans-1,2-Dichloroethene ($\mu g/m^3$)	Vinyl Chloride ($\mu g/m^3$)	Radiello Trichloroethene ($\mu g/m^3$)
		Concentration Long-term Indoor Air Action Levels (c)			*0.91*	--	*27*	*2.8*	*0.91*
		Concentration Short-term Indoor Air Action Levels (c)			*2.0*	--	--	--	--
1	Ambient Air	Outside	AA020	10/15/2013	<0.17	<0.12	<0.61	<0.040	--
2	Sub-Slab Vapor	Garage	SSV068	4/1/2014	<0.17	<0.12	<0.61	<0.040	--
2	Crawlspace	Crawlspace	CSA013	4/2/2014	NR (d)	NR (d)	NR (d)	NR (d)	<0.052
2	Crawlspace	Crawlspace	CSA014	4/10/2014	<0.17	<0.12	<0.62	<0.040	--
2	Indoor Air	1st Floor Bedroom/TV Room	IA072	4/2/2014	<0.17	<0.12	<0.63	<0.040	<0.052
2	Indoor Air	2nd Floor TV Room	IA073	4/2/2014	<0.18	<0.13	<0.65	<0.042	<0.052
2	Indoor Air	3rd Floor Bedroom	IA074	4/2/2014	<0.18	<0.14	<0.68	<0.044	<0.052
2	Ambient Air	Outside	AA031	4/2/2014	<0.17	<0.13	<0.64	<0.041	--
2	Ambient Air	Outside	AA032	4/10/2014	<0.16	<0.12	<0.60	<0.039	--
1	Sub-Slab Vapor	Garage	SSV058	9/24/2013	<0.34	<0.25	<1.2	<0.081	--
1	Crawlspace	Crawlspace	CSA007	9/25/2013	<0.16	<0.12	<0.59	<0.038	**0.055**
1	Indoor Air	1st Floor TV Room	IA046	9/25/2013	<0.16	<0.12	<0.58	<0.038	**0.18**
1	Ambient Air	Outside	AA019	9/25/2013	<0.16	<0.12	<0.59	<0.038	--
2	Sub-Slab Vapor	Garage	SSV065	2/25/2014	<0.17	<0.13	<0.63	<0.041	--
2	Crawlspace	Crawlspace	CSA011	2/26/2014	<0.16	<0.12	<0.58	<0.038	<0.052
2	Indoor Air	1st Floor TV Room	IA069	2/26/2014	**0.32**	<0.14	<0.69	<0.044	**0.17**
2	Ambient Air	Outside	AA029	2/26/2014	<0.17	<0.13	<0.63	<0.041	--
1	Sub-Slab Vapor	Garage	SSV056	8/30/2013	<1.6	<1.2	<5.9	<0.38	--
1	Crawlspace	Crawlspace	CSA005	8/28/2013	<0.16	<0.12	<0.61	<0.039	--
1	Indoor Air	1st Floor Master Bedroom	IA036	8/28/2013	<0.19	<0.14	<0.70	<0.045	--
1	Indoor Air	1st Floor Bedroom	IA037	8/28/2013	<0.18	<0.13	<0.66	<0.043	--
1	Indoor Air	1st Floor TV Room/Dining Room	IA038	8/28/2013	<0.19	<0.14	<0.71	<0.046	--
1	Ambient Air	Outside	AA016	8/28/2013	<0.17	<0.12	<0.61	<0.040	--
Foundation: Crawlspace									
1	Crawlspace	Crawlspace	CSA002	8/5/2013	<0.20	<0.14	<0.72	<0.047	<0.048
1	Indoor Air	1st Floor TV Room	IA023	8/5/2013	<0.18	<0.13	<0.67	<0.043	<0.048
1	Indoor Air	1st Floor Bedroom	IA024	8/5/2013	<0.20	<0.14	<0.72	<0.043	<0.048
1	Indoor Air	2nd Floor Master Bedroom	IA025	8/5/2013	<0.19	<0.14	<0.69	<0.045	<0.048
1	Ambient Air	Outside	AA011	8/5/2013	<0.19	<0.14	<0.71	<0.046	--
1	Crawlspace	Crawlspace	CSA008	9/25/2013	<0.17	<0.13	<0.63	<0.041	<0.052
1	Indoor Air	1st Floor TV Room	IA049	9/25/2013	<0.17	<0.12	<0.62	<0.040	<0.052
1	Indoor Air	1st Floor Bedroom	IA050	9/25/2013	<0.19	<0.14	<0.70	<0.045	<0.052
1	Indoor Air	1st Floor Bedroom	IA051	9/25/2013	<0.17	<0.13	<0.64	<0.041	<0.052
1	Ambient Air	Outside	AA021	9/25/2013	<0.17	<0.12	<0.62	<0.040	--
1	Crawlspace	Crawlspace	CSA001	7/29/2013	<0.18	<0.13	<0.67	<0.043	--
1	Indoor Air	Garage Sump	IA017	7/29/2013	<0.18	<0.13	<0.67	<0.043	--
1	Indoor Air	1st Floor Master Bedroom	IA018	7/31/2013	<0.16	<0.12	<0.59	<0.038	--

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BOEING AUBURN

Phase of the Study (a)	Sample Type	Location Description	Sample Location	Sample Date (b)	Trichloroethene ($\mu g/m^3$)	cis-1,2-Dichloroethene ($\mu g/m^3$)	trans-1,2-Dichloroethene ($\mu g/m^3$)	Vinyl Chloride ($\mu g/m^3$)	Radiello Trichloroethene ($\mu g/m^3$)
		Concentration Long-term Indoor Air Action Levels (c)			*0.91*	--	*27*	*2.8*	*0.91*
		Concentration Short-term Indoor Air Action Levels (c)			*2.0*	--	--	--	--
1	Indoor Air	1st Floor TV Room	IA019	7/31/2013	**0.30**	<0.15	<0.77	<0.050	--
1	Ambient Air	Outside	AA008	7/29/2013	<0.16	<0.12	<0.61	<0.039	--
1	Ambient Air	Outside	AA010	7/31/2013	<0.17	<0.13	<0.63	<0.041	--
2	Crawlspace	Crawlspace	CSA010	2/3/2014	<0.14	<0.10	<0.53	<0.034	--
2	Indoor Air	Garage Sump	IA063	2/3/2014	<0.15	<0.11	<0.57	<0.036	--
2	Indoor Air	1st Floor Master Bedroom	IA064	2/3/2014	<0.17	<0.13	<0.63	<0.041	--
2	Indoor Air	1st Floor TV Room	IA065	2/3/2014	<0.18	<0.13	<0.66	<0.042	--
2	Ambient Air	Outside	AA027	2/3/2014	<0.15	<0.11	<0.55	<0.036	--
1	Crawlspace	Crawlspace	CSA006	9/11/2013	<0.17	<0.12	<0.63	<0.040	--
1	Indoor Air	1st Floor TV Room	IA039	9/11/2013	<0.19	<0.14	<0.70	<0.045	--
1	Indoor Air	1st Floor Bedroom	IA040	9/11/2013	<0.18	<0.14	<0.68	<0.044	--
1	Indoor Air	1st Floor Bedroom	IA041	9/11/2013	<0.17	<0.12	<0.63	<0.040	--
1	Indoor Air	1st Floor Bedroom	IA042	9/11/2013	<0.18	<0.13	<0.65	<0.042	--
1	Ambient Air	Outside	AA017	9/11/2013	<0.14	<0.11	<0.54	<0.034	--
1	Crawlspace	Crawlspace	CSA004	8/22/2013	<0.18	<0.13	<0.66	<0.042	--
1	Indoor Air	1st Floor TV Room	IA034	8/22/2013	<0.18	<0.13	<0.67	<0.043	--
1	Indoor Air	1st Floor Bedroom	IA035	8/22/2013	<0.18	<0.14	<0.68	<0.044	--
1	Ambient Air	Outside	AA015	8/22/2013	<0.21	<0.16	<0.78	<0.050	--
2	Crawlspace	Crawlspace	CSA012	3/25/2014	<0.16	<0.12	<0.59	<0.038	--
2	Indoor Air	1st Floor TV Room	IA070	3/25/2014	<0.17	<0.12	<0.63	<0.040	--
2	Indoor Air	1st Floor Bedroom	IA071	3/25/2014	<0.18	<0.14	<0.68	<0.044	--
2	Ambient Air	Outside	AA030	3/25/2014	<0.19	<0.14	<0.69	<0.045	--
Foundation: Slab-On-Grade & Basement									
1	Sub-Slab Vapor	Basement Storage Room	SSV060	10/17/2013	<0.33	<0.24	<1.2	<0.078	--
1	Basement	Basement	IA052	9/30/2013	<0.17	<0.13	<0.63	<0.041	--
1	Indoor Air	2nd Floor Master Bedroom	IA053	9/30/2013	**1.20**	<0.12	<0.60	<0.039	--
1	Indoor Air	2nd Floor Bedroom	IA054	9/30/2013	<0.17	<0.13	<0.63	<0.041	--
1	Ambient Air	Outside	AA023	9/30/2013	<0.18	<0.13	<0.65	<0.042	--
1	Sub-Slab Vapor	Basement Storage Room	SSV061	10/30/2013	<0.16	<0.12	<0.59	<0.038	--
1	Basement	Basement	IA056	10/29/2013	<0.17	<0.13	<0.63	<0.041	--
1	Basement	Basement	IA057	10/29/2013	<0.16	<0.12	<0.6	<0.039	--
1	Indoor Air	2nd Floor Master Bedroom	IA058	10/29/2013	<0.18	<0.13	<0.65	<0.042	--
1	Indoor Air	2nd Floor Bedroom	IA059	10/29/2013	<0.19	<0.14	<0.71	<0.046	--
1	Ambient Air	Outside	AA024	10/29/2013	<0.15	<0.11	<0.56	<0.036	--
1	Indoor Air	Basement Bedroom	IA020	7/31/2013	<0.18	<0.13	<0.67	<0.043	--
1	Indoor Air	Basement Computer Room	IA021	7/31/2013	<0.18	<0.13	<0.65	<0.042	--
1	Indoor Air	Basement Sewer Pipe Access	IA022	7/31/2013	<0.18	<0.13	<0.66	<0.042	--

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Phase of the Study (a)	Sample Type	Location Description	Sample Location	Sample Date (b)	Trichloroethene ($\mu g/m^3$)	cis-1,2-Dichloroethene ($\mu g/m^3$)	trans-1,2-Dichloroethene ($\mu g/m^3$)	Vinyl Chloride ($\mu g/m^3$)	Radiello Trichloroethene ($\mu g/m^3$)
		Concentration Long-term Indoor Air Action Levels (c)			*0.91*	--	*27*	*2.8*	*0.91*
		Concentration Short-term Indoor Air Action Levels (c)			*2.0*	--	--	--	--
1	Ambient Air	Outside	AA009	7/31/2013	<0.18	<0.13	<0.65	<0.042	--
2	Indoor Air	Basement Bedroom	IA068	2/20/2014	**0.17** (e)	<0.13	<0.64	<0.041	--
2	Indoor Air	Basement Computer Room	IA066	2/20/2014	<0.18	<0.14	<0.68	<0.044	--
2	Indoor Air	Basement Sewer Pipe Access	IA067	2/20/2014	<0.17	<0.13	<0.63	<0.041	--
2	Ambient Air	Outside	AA028	2/20/2014	<0.15	<0.11	<0.57	<0.036	--

Note: Each group of data represents one residence.

-- = Not applicable

< = Indicates the compound was not detected at the reported concentration.

Bold = Detected compound.

$\mu g/m^3$ = Micrograms per cubic meter

NR = Not Reported

(a) The first phase (summer sampling) of the residential vapor intrusion assessment began in summer 2013 and concluded in early fall 2013. The second phase (winter sampling) of the residential vapor intrusion assessment began in the first quarter of 2014 and concluded in early spring of 2014.

(b) Sample Date is the date samples were set up. The Summa canister sample period is 24 hours long, the Radiello® sample period is 21 days long, and the sub-slab vapor sample period is approximately 30 minutes long.

(c) Action levels are protective, health-based concentrations. The actions levels included in this table assume only one chemical was detected. Currently, there is no health-based concentration for cis-1,2-DCE in air. The short-term action level applies only to TCE.

(d) The Summa canister that collected this sample malfunctioned. With approval from Ecology, the sample was re-collected.

(e) This concentration was marked as an estimate by the laboratory.