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STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Region Office
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September 30, 2024

John Fisher
Bremerton School District
200 Bruenn Ave
Bremerton, WA 98312-3108
(john.fisher@bremertonschools.org)

RE: Request for Evaluation of Trichloroethylene Risks at the following Site:

- **Site Name:** Crownhill Elementary
- **Site Address:** 1500 Rocky Point Rd NW, Bremerton, 98312
- **Facility/Site No.:** 99722456
- **CSID No:** 4487

Dear John Fisher:

During Site review and evaluation associated with the five-year periodic review, Ecology found that TCE concentrations at well MW-9 have ranged from 5 to 12 µg/l, which exceeds the Method B groundwater screening level for vapor intrusion of 1.4 µg/l (CLARC, 2024). Adjacent residences may be located within 100 feet of the TCE impacted groundwater, which could indicate a vapor intrusion risk (See Site Figure, attached). TCE concentrations during the last four monitoring events have also exceeded the short-term groundwater screening level for vapor intrusion for residential receptors of 8 µg/l (per Ecology's Publication No. 09-09-047, Guidance for Evaluating Vapor Intrusion in Washington State, Appendix A, attached).

If TCE is present in indoor air, it can result in health impacts to building occupants, the most urgent of which are to pregnant women. U.S. EPA has concluded that brief exposures to TCE in air may affect women in the first trimester of pregnancy by increasing the risk of heart malformations to a developing fetus[1].

While TCE has not been detected above screening levels in sub-slab soil gas analytical results collected at the main school building, TCE extent does not appear to have been delineated to the north and east of MW-9. Ecology understands that this is the assumed upgradient direction with respect to MW-9 and the Site, but potential impacts to indoor air in the residences are unknown.

Next Steps:

To further characterize this impact and assess off-property risk, Ecology request that the PLP install additional monitoring wells between MW-9 and the north and east fence lines.

[1] See U.S. EPA August 2014, Office of Solid Waste and Emergency Response Memorandum: Compilation of Information Relating to Early/Interim Actions at Superfund Sites and the TCE IRIS Assessment.

Please submit a sampling and analysis plan for the TCE groundwater evaluation within 60 days to Ecology for review. The goal of your evaluation is to better delineate TCE contamination at the Site and determine whether environmental contamination at the site has resulted in TCE concentrations from vapor intrusion above the short-term indoor air action levels off-Property.

Within 90 days, conduct sampling and submit the results of your evaluation to Ecology. Include recommendations on what actions, if any, are necessary to reduce TCE concentrations to below the appropriate short-term indoor air action level.

Multiple rounds of sampling may be necessary to complete the short-term TCE investigation. If that is that case, we expect that the first round of sampling will be completed within 90 days, and that a schedule for any additional sampling will be included in the sampling and analysis plan.

Ecology's Next Steps:

Depending on the site-specific circumstances, Ecology may:

1. Continue to provide technical assistance as necessary for evaluating and/or remediating short-term TCE risks.
2. Notify appropriate local, state or Federal health agencies to discuss possible health risks and any necessary public notifications.
3. Identify potentially liable parties and require additional remedial action pursuant to RCW 70.105D, such as: a) issuing an enforcement order, b) pursuing an Ecology conducted cleanup with cost recovery, or c) seeking judicial review.
4. Pursue other options necessary to adequately cleanup contamination at the site.

Contact Information:

Ecology is committed to working with you to accomplish the prompt and effective actions necessary at the Site. If you have any questions about this request, please contact me at 425-324-1438 or vatk461@ecy.wa.gov.

Sincerely,

Vance Atkins, LG, LHG
Site Manager
Toxics Cleanup Program, NWRO

Enclosure:
1. Site Figure
2. Guidance for Evaluating Vapor Intrusion in Washington State, Appendix A

cc: Kara Tebeau, Attorney General's Office, (kara.tebeau@atg.wa.gov)
Matthew M. Lewis, Aspect Consulting LLC, (mlewis@aspectconsulting.com)

1724 Dora Avenue NW (Note 2)

North Landfill Area

MW-2

Estimated Extent of TPH Cleanup Level Exceedance

MW-9

Estimated Extent of TCE Cleanup Level Exceedance

BERTHA AVE NW

MW-16 (Note 1) MW-14

EW-17 MW-13

MW-12

MW-8

MW-15 MW-5

Geotextile at 1 Foot Below Ground Surface (Summer 2013 Interim Action)

Estimated Extent of Arsenic Cleanup Level Exceedance

ROCKY POINT RD

PORTABLE CLASSROOM BUILDING

Bertha Ave NW Parking Area

MW-4

MW-6

MAIN SCHOOL BUILDING

MW-3

MW-10

South Landfill Area

MW-1

Geotextile at 1 Foot Below Ground Surface (Summer 2013 Interim Action)

MW-7

Geotextile at 1 Foot Below Ground Surface (Spring 2012 Interim Action)

MW-11

MARINE DR

DORA AVE

0 100 200 Feet

Well Locations:

- Extraction Well Included in Monitoring Program
- Monitoring Well Included in Monitoring Program
- Monitoring Well Not Included in Monitoring Program
- McKinney Domestic Well (Note 2)
- Approximate photo location & orientation for semiannual cover system inspections

Other Site Features and Interpretation:

- Interpreted Extent of Landfill Activity
- Estimated Extent of Groundwater Cleanup Level Exceedances in 2014 (Ecology, 2014)
- Bremerton School District Property Boundary
- Bremerton United Methodist Church Property Boundary
- Inferred Direction of Groundwater Flow

Note:

(1) LNAPL has been observed in Wells EW-17, MW-8, MW-13, MW-14, and MW-16.
(2) The McKinney well water sample is collected from the outdoor faucet on the north side of the residence at 1724 Dora Avenue NW.

Site Plan

2023 Annual Report
Crownhill Elementary
Bremerton, Washington

Aspect Consulting	JAN-2020	BY: DLH / PPW	FIGURE NO. 1
	PROJECT NO. 100094	REVISED BY: EAC	

Appendix A: Vapor Intrusion (VI) Investigations and Short-term Trichloroethene (TCE) Toxicity

A-1 Introduction

Appendix A provides recommendations for addressing the VI pathway at sites contaminated with TCE and discusses:

- Indoor air action levels that are protective of short-term exposures to TCE.
- Default (non-site-specific) subsurface VI screening levels that are protective of the short-term indoor air TCE action levels.
- Options for effectively and rapidly responding to those situations where TCE concentrations in indoor air from VI are above action levels.
- A goal to keep indoor air TCE concentrations from VI below short-term action levels.
- Public notification and other outreach-related tasks that responsible parties should perform when VI may be resulting in indoor air concentrations that exceed action levels.

Information in this Appendix assumes that Ecology is directly involved at the site. Section A-5.2 provides recommended steps that should be followed by the parties performing independent site investigation and cleanup.[108]

A-2 Background

In 2014, EPA concluded that short-term inhalation exposures to TCE in indoor air have the potential to cause serious heart defects in a developing fetus.[109] The damage can occur early in a pregnancy, possibly before the pregnancy is recognized. This Appendix focuses on issues that are specific to situations where short-term TCE exposures are occurring or likely to be occurring. These issues are:

[108] In later portions of Appendix A, we use the term "responsible party" to refer to the party who is conducting remedial actions at the site. In many cases, the responsible party will be a person meeting the statutory definition of a "potentially liable person" (see RCW 70A.305.040).

[109] (USEPA 2014) *Memorandum: Compilation of Information Relating to Early/Interim Actions at Superfund Sites and the TCE IRIS Assessment*.

1. **Response speed.** Actions to protect a fetus from unacceptable TCE exposures should occur as rapidly as possible after discovering the contamination, usually within days or weeks, depending on the likelihood and degree of potential exposure.

2. **Focus on women of childbearing age (which includes pregnant women).** The developing fetus is sensitive to the effects of short-term TCE exposure, and preventing harm to the fetus relies on reducing the mother's exposure.

3. **Public outreach.** Promptly contacting people who live and work near TCE contamination is crucial for three reasons: 1) to identify women of childbearing age; 2) to explain the potential health hazards to building occupants and, 3) if warranted by site-specific conditions, to obtain permission to access buildings for property-specific investigation and exposure-reduction activities. Whenever possible, outreach activities should be conducted in collaboration with public health departments.

This degree of urgency, and the need for more intensive outreach to specific individuals, is not typical at most MTCA sites. These three issues are further discussed in Sections A-4 through A-6.

A-3 VI screening and action levels for TCE

A-3.1 Indoor air action levels for TCE

A **screening level** is the concentration of a hazardous substance derived from standardized equations that if exceeded may result in indoor air concentrations above the applicable cleanup level. A **cleanup level is** the concentration of a hazardous substance in soil, water, air, or sediment that is determined to be protective of human health and the environment under specified exposure conditions (WAC 173-340-200).[110] An **action level** is the concentration of a hazardous substance in indoor air that may pose short-term risks to potential receptors. Action levels are not MTCA Method B or C air cleanup levels.

Indoor air cleanup levels for TCE are provided in the CLARC Air data tables.[111] Cleanup levels are used during Tier 1 and Tier 2 evaluations to determine whether further sampling, interim actions, or cleanup actions are indicated. The concentrations for indoor air cleanup levels are the same as for standard cancer and non-cancer Method B and C air cleanup levels in CLARC's Air data tables.

Air cleanup levels for TCE are lower than indoor air action levels. Cleanup levels apply to long-term average air concentrations (over at least one year) for the entire population, all genders and ages. Short-term indoor air action levels, on the other hand, only apply to three-week average concentrations for women of childbearing age.

[110] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-200 (Definitions.)
[111] Cleanup Levels and Risk Calculation (CLARC). https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contamination-clean-up-tools/CLARC/Data-tables

The average indoor air TCE concentration due to vapor intrusion over **any** three-week interval should not exceed the applicable action level.

VI indoor air cleanup levels for long-term TCE exposures, and action levels for short-term exposures to women of childbearing age, are provided in Tables A-1 and A-2 below. The table's indoor air cleanup and action levels are compared to average indoor air TCE concentrations that result solely from VI. In some cases, this means that contributions to indoor air measurements from non-VI sources, such as outdoor or indoor sources, will need to be distinguished from contributions due solely to subsurface sources.

The short-term action levels for TCE in Table A-2 are based on values recommended by EPA Region 10 (memorandum dated December 13, 2012) and EPA Region 9 (memorandum dated July 9, 2014).[112] The Region 10 memorandum from 2012 states that, pursuant to an IRIS toxicological review, exposure to TCE can cause fetal cardiac malformations during a 21-day gestation window. To protect against the possibility of this occurring, the average concentration of TCE in residential indoor air should not exceed 2.0 µg/m^3 during any consecutive 21-day period in a given year. For commercial / industrial settings, where receptors of concern are workers, indoor air TCE should not exceed 8 µg/m^3. The Region 9 memorandum identifies "accelerated" and "urgent response action levels" for residents and workers. The "accelerated" levels range from 2 to 8 µg/m^3; the "urgent" levels vary from 6 to 24 µg/m^3. The range of levels for both categories accounts for the varied lengths of time that receptors are expected to be exposed.

Table A-1: Vapor intrusion TCE Indoor Air **Cleanup Levels,** chronic (mean long-term air concentration for RME receptor)*

Level of Concern	Concentration (µg/m^3)	Risk Basis
Method B (unrestricted land use)	**0.37**	Cancer risk 1E-6
Method B (unrestricted land use)	**0.91**	Hazard quotient 1
Method C (industrial land use)	**6.3**	Cancer risk 1E-5
Method C (industrial land use)	**2.0**	Hazard quotient 1

* These values are available in CLARC (Ecology 2018a).

Table A-2: Vapor intrusion TCE Indoor Air **Action Levels**, short-term (maximum 3-week mean concentration for women of childbearing age)

Level of Concern	Concentration (µg/m^3)	Risk Basis
Unrestricted (residential) land use	**2.0**	Noncarcinogenic effect based on 24 hours/day, 7 days/week
Workplace scenario (commercial or industrial)	**7.5**	Noncarcinogenic effect based on 45-hour work week

[112] For the Region 9 and 10 memoranda, see Ecology's Vapor Intrusion webpage at https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Vapor-intrusion-overview

A number of other EPA Regions and states, including Massachusetts, New Jersey, New Hampshire, Minnesota, Ohio, Alaska, and Connecticut, have also adopted short-term TCE levels and recommended responses. The levels and response timeframes vary.

Consistent with guidance from EPA Region 10, TCE action levels in Table A-2 are intended to be compared to the highest measured (or estimated) VI-caused indoor air levels averaged over any 21-day period. It is unknown whether potential fetal health effects from an exposure to action level concentrations could occur over a period less than three weeks, or whether shorter periods would only be harmful if TCE concentrations were significantly higher than action levels.

Given this uncertainty, Ecology recommends that, if any 24-hour or 8-hour measurements of average indoor air TCE concentrations exceed Table A-2's action levels (for residents or workers, respectively), **take prompt action**. This could include either reducing those concentrations or reducing the degree to which women of childbearing age are exposed. Ecology will revisit this recommendation as more information becomes available about the health effects attributable to short-term TCE exposures.

Table A-2 provides short-term TCE indoor air action levels for residential land use and commercial/industrial workers.

- The residential concentration is intended to protect women of childbearing age who reside in the building and are continuously exposed to indoor air contaminated by VI.
- The commercial/industrial concentration is protective of women of childbearing age who work full-time shifts up to 45 hours per week.[113]
- However, other women of childbearing age who occupy a building where VI is occurring may also be receptors of concern. For example, building visitors, part-time workers, and students could also be potentially be exposed to contaminated indoor air over extended periods of time.

Use the short-term action levels in Table A-2 to determine whether prompt and protective measures like interim actions should be implemented (see WAC 173-340-430).[114] Remember that **action levels are not MTCA Method B or C air cleanup levels** and that the MTCA cleanup regulations require that cleanup levels be established for one of two specific land uses: *unrestricted* or *industrial* site use.

[113] This paragraph refers to the protection of the developing fetus. Exposures to TCE can also potentially affect the health of women themselves and this should be assessed using the indoor air cleanup levels in the CLARC data tables, not the short-term action levels.

[114] https://app.leg.wa.gov/wac/default.aspx?cite=173-340-430

A-3.2 VI short-term screening levels for TCE in groundwater and soil gas

CLARC's data tables also provide groundwater and soil gas screening levels that can be used to assess the potential for chronic exposure threats posed by a subsurface source.

CLARC's groundwater screening levels are intended to be protective of corresponding indoor air cleanup levels, and assume there will be 1,000-times attenuation between groundwater VOC concentrations (in equilibrium with vapor concentrations) and indoor air levels.

CLARC's sub-slab soil gas screening levels are also expected to be protective of indoor air cleanup levels. They assume there will be 33-times attenuation between soil gas VOC concentrations just below a building's slab and indoor air levels. (For further discussion on attenuation factors, see the note box following Table A-4.)

VI groundwater and sub-slab soil gas screening levels protective of short-term TCE indoor air action levels are presented in Tables A-3 and A-4 below. These screening levels embody the same attenuation assumptions used to calculate the chronic subsurface screening levels provided in CLARC (as discussed above). In summary:

- The short-term VI screening levels for groundwater and soil gas are higher than CLARC's VI TCE cleanup levels, which are calculated for chronic indoor exposures.
- For residential buildings, the short-term screening level for groundwater is about twice as high as CLARC's chronic-based non-carcinogenic screening level (8 µg/L versus 3.8 µg/L, respectively), and approximately five times higher than CLARC's carcinogenic screening level (8 µg/L versus 1.6 µg/L).
- Similarly, the short-term screening level for TCE in soil gas is about twice as high as CLARC's chronic-based non-carcinogenic sub-slab screening level (67 µg/m³ versus 31 µg/m³), and a little more than five times higher than CLARC's carcinogenic sub-slab screening level (67 µg/m³ versus 12 µg/m³).

Table A-3: Vapor intrusion subsurface screening levels for **groundwater** for short-term exposures to TCE

Short-term TCE Subsurface Screening Levels	Concentration	Basis
residential short-term VI screening level for groundwater	**8 µg/L**	• TCE as a non-carcinogen • receptor of concern: women of childbearing age • residential indoor scenarios
non-residential short-term VI screening level for groundwater	**31 µg/L**	• TCE as a non-carcinogen • receptor of concern: women of childbearing age • commercial/industrial workplace scenarios

Table A-4: Vapor intrusion subsurface screening levels for **soil gas** for short-term exposures to TCE

Short-term TCE Subsurface Screening Levels	Concentration	Basis
residential short-term VI screening level for sub-slab soil gas	**67 µg/m³**	• TCE as a non-carcinogen • receptor of concern: women of childbearing age • residential indoor scenarios
non-residential short-term VI screening level for sub-slab soil gas	**250 µg/m³**	• TCE as a non-carcinogen • receptor of concern: women of childbearing age • commercial/industrial workplace scenarios

Note: The 2009 Draft VI Guidance had differentiated between the amount of attenuation that should be assumed for soil gas VOC concentrations that are located immediately below the building (like sub-slab), versus those concentrations that are at significantly greater distances below ground surface (called "deep"). CLARC's VI data tables also make this distinction. "Deep" soil gas screening levels in CLARC assume 100-times attenuation between soil gas VOC concentrations and indoor air levels. This distinction was based on the approach set out in EPA's 2002 Vapor Intrusion guidance.

However, EPA's Technical guide for assessing and mitigating the vapor intrusion pathway from subsurface vapor sources to indoor air [115] (USEPA June 2015) does not recommend that soil gas levels be assumed to attenuate more than 33 times, regardless of depth. As a result, Ecology has now eliminated the use of deep soil gas VI screening levels.

A-4 VI Investigation

This section provides site investigation recommendations when short-term inhalation exposures to TCE from VI are a potential concern.

A-4.1 Identify any buildings where VI may result in indoor TCE concentrations above the short-term action level.

Note:

- **Section A-4.1's** discussion assumes that indoor air sampling for TCE has not been conducted.
- If indoor air has already been sampled, and indoor TCE concentrations due to VI exceed the applicable short-term action level, see the appropriate responses described in **Section A-5**.
- If indoor air was sampled and TCE concentration measurements were below the short-term action level, the VI assessment team should determine whether those measurements represent the highest 3-week average indoor TCE concentration. See **Section A-4.4** for additional discussion.

Determining which buildings are a potential concern is commonly accomplished by mapping site areas where TCE is, or may be, present in soils or shallow groundwater. Buildings above or close to these areas can then be identified. In parts of the site where soils are contaminated

[115] https://www.epa.gov/vaporintrusion/technical-guide-assessing-and-mitigating-vapor-intrusion-pathway-subsurface-vapor

with TCE, soil gas samples are typically collected and analyzed.[116] CLARC's VI soil gas screening levels the short-term soil gas screening levels in Tables A-2 and A3 can then be used to determine if VI could potentially result in indoor air cleanup level or action level exceedances (respectively) at nearby buildings.

Regardless of whether the potential subsurface VI source is contaminated soil or shallow groundwater, investigators can collect soil gas samples below or near a building and use the measured TCE levels to determine the potential for an indoor exceedance of indoor air cleanup levels and/or action levels. However, if TCE concentrations in shallow groundwater are above CLARC's VI screening levels, or if significant soil contamination or residual non-aqueous phase liquid (NAPL) is close to a building and likely to contain elevated TCE concentrations, investigators should not delay indoor air sampling (see Section A-4.3). When these conditions are present, the first indoor sampling event(s) should be a priority and performed immediately, without waiting for a preliminary soil gas investigation.[117]

In areas where soils are not contaminated and shallow groundwater is the only potential VI source, investigators can use groundwater VI screening levels in CLARC and short-term groundwater screening levels in Tables A-2 and A-3 to distinguish between buildings where VI could potentially result in exceedances of indoor air cleanup (chronic) or action (short-term) levels, and those where exceedances are highly unlikely.

In addition to the exceedance of subsurface VI screening levels, there may be other building- or site-specific reasons for suspecting that indoor air TCE concentrations could exceed the short-term action level. For instance, at some building locations, contaminated shallow groundwater may be the only potential VI source and TCE concentrations in this groundwater may be below the short-term screening level. However, the short-term groundwater screening levels assume a certain amount of attenuation and dilution of vapor-phase TCE between the groundwater surface and the indoor environment. While these are conservative assumptions for most buildings, they may not be if:

- There are preferential subsurface pathways that may result in higher soil gas VOC levels below the building than the short-term groundwater screening levels assume, or if

[116] *De minimis* levels of TCE in vadose zone soils (i.e., above the seasonal low water table) are unlikely to pose a VI threat. WAC 173-340-740(3)(b)(iii)(C)(III) defines such levels as concentrations no higher than concentrations "derived for protection of groundwater for drinking water beneficial use under WAC 173-340-747(4)." Concluding that TCE levels in soils are this low requires adequate characterization of vadose zone contamination.

[117] Ecology does not recommend that soil gas sampling be *initiated* at this point to determine if TCE concentrations exceed short-term soil gas screening levels. This is because it takes time to prepare (and approve) soil gas Sampling and Analysis Plans (SAPs); obtain access; schedule and mobilize the related work; and review the sampling results. Indoor air sampling should not be delayed while these activities are being performed. It is prudent to obtain soil gas data during or immediately following the first indoor air sampling event.

- There may be a higher soil gas flowrate into the building than the short-term groundwater and soil gas screening levels assume.[118]

A-4.2 Notify and involve Ecology

This Appendix presumes that Ecology will be involved throughout the VI evaluation process, including owner/tenant notifications, the initial building visit, indoor air sampling, data analysis, and post-sampling decision making described in the rest of this section and Sections A-5 and A-6. The recommended actions and decisions identified below are therefore intended for both the party conducting the remedial actions (the responsible party) and Ecology.[119] However, when responsible parties are acting independently and choose not to involve Ecology during some or all of these actions and decisions, they should complete the applicable and recommended steps themselves.

Regardless of whether Ecology oversees the site throughout the cleanup process, or whether another party independently conducts the remedial actions, the following should occur:

1. Ecology should be contacted as soon as the responsible party determines that women of childbearing age are current building occupants and indoor air sampling is needed to assess the potential for a short-term TCE action level exceedance (see Section A-4.3 below).

2. If an Ecology staff person has already been assigned to the site, this individual should be notified. Otherwise, the responsible party should contact their local Ecology regional office. They should not wait for Ecology's response before moving to the next steps of the investigation / response process. Find Ecology's contact information at https://ecology.wa.gov/About-us/Get-involved/Report-an-environmental-issue

[118] The short-term groundwater screening levels assume that vapor-phase TCE concentrations will attenuate by a factor of 1000 between soil gas levels immediately above and in equilibrium with contaminated groundwater and indoor air. This is generally a conservative assumption, but may over-predict the degree of subsurface attenuation in certain cases, such as sites with a shallow water table, or sites with subsurface conduits capable of transporting elevated soil gas levels to areas directly below the building with minimal attenuation.

The short-term soil gas screening levels assume that vapor-phase TCE concentrations will attenuate by a factor of at least 33 times between soil gas levels immediately below the building and indoor air. This is usually a conservative assumption, but less attenuation is possible if the building or its foundation allows soil gas to enter interior spaces relatively unimpeded. This can occur when slab or basement wall penetrations or large cracks provide preferential conduits for entry.

[119] As noted in Section 1.1, "PLP" in this Guidance broadly refers to the individual or party responsible for cleaning up the site. It is not intended to limit responsibility to only those who are designated as PLPs per RCW 70A.305.040. Instead, it is a general reference to the *responsible party.*

A-4.3 Prepare for indoor air sampling

As soon as one or more site buildings have been identified as a location where VI may potentially result in indoor air TCE concentrations above the short-term action level, investigators should quickly plan for the next steps of the evaluation, unless they confirm that women of childbearing age do not regularly occupy the buildings. At this point in the investigation, it is only *potentially possible* that indoor TCE concentrations actually exceed the action level, but several actions should occur without delay including:

1. **Contact building owner and/or tenant.** The owner/tenant of the building should be contacted to determine if women of childbearing age are current occupants, and to schedule a building and property visit. This initial contact should occur soon after the building has been identified as potentially at risk. The owner and tenant(s) of these buildings should be notified that there is the *possibility* that VI-caused indoor air TCE concentrations exceed the acceptable chronic and/or short-term screening/action levels.

2. **Schedule a building visit.** If women of childbearing age are current building occupants, a building visit should be scheduled as soon as possible. During this visit Ecology and the responsible party need to be prepared to discuss the potential TCE risk, explain next steps, and answer exposure-related and other questions.[120] If the responsible party does not own the building, they should also be prepared at this time to request building access for the purpose of collecting indoor air samples. Interactions with building owners and tenants preceding indoor air sampling are further discussed in Section A-6.0.

3. **Prepare and finalize a SAP.** Following the visit to the building and property, an indoor air Sampling and Analysis Plan (SAP) should be expeditiously prepared, reviewed, and finalized.[121] The SAP should identify the timeframes for gathering and reviewing the data. The SAP should also include a site/building-specific VI conceptual site model (CSM) that serves as the basis for selecting data quality objectives and sampling design. The VI CSM is a combination of information, assumptions, and hypotheses that investigators use to help evaluate the adequacy of available site-specific information, and guide the identification of critical data gaps. The VI CSM is discussed in Section 2.4 of this guidance and Section 5.4 of EPA's 2015 *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA June 2015).

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[120] Please see VI-related risk communications in Section A-6.1.

[121] This assumes that: a) an exceedance of the short-term TCE indoor air action level has not yet been measured, and b) the responsible party has decided not to pursue a "preemptive" response action. If an exceedance of the action level has already been measured, no additional pre-mitigation sampling may be needed. See Section A-5.0 for a description of appropriate response actions.

Preemptive mitigation is a term often used to describe VI mitigation efforts implemented without (or prior to) confirmation that VI-caused indoor air contamination exceeds acceptable levels. When preemptive mitigation has been chosen as the next step in Section A-4.3, indoor air sampling is not typically conducted until after mitigation has been implemented. Section 7.8 of EPA's OSWER VI guidance document (USEPA June 2015) provides additional information about preemptive mitigation.

- **Schedule indoor air sampling.** Immediately schedule the first indoor air sampling event as soon as the SAP is final. . It should not be delayed to coincide with more desirable seasonal or meteorological conditions.[122]

A-4.4 Determine if 3-week average indoor air TCE concentrations exceed the short-term action level.

For those buildings occupied by women of childbearing age, the VI investigation should provide sufficient information to determine whether 3-week average indoor air TCE concentrations ever exceed the short-term action level. A single indoor air sampling event may not provide sufficient evidence unless it coincides with a period when maximum VI impacts are occurring. This is because VI impacts can vary significantly over time, and because this variability cannot be easily predicted. As a result, it can be difficult to schedule an indoor sampling event that represents the highest 3-week average unless the sampling program is designed to intentionally create near-maximum VI conditions.[123] Unless the first sampling event finds TCE concentrations exceeding the short-term indoor air action level, the investigation will need multiple sampling events.

When the receptor of concern is a current occupant of the building, and air samples are being analyzed at an off-site laboratory, request expedited turnaround times. For at least the first sampling event, the goal should be to receive the laboratory's sampling data within three business days.

Immediately after the data have been received, share with members of the decision-making team including the Ecology site manager.[124] For at least the first indoor air sampling event, the goal should be to distribute the results to the decision-making team within seven days of sample collection. The objective of the decision-making team's review is to quickly determine if: 1) the relevant TCE short-term indoor air action levels listed in Table A-1 are being exceeded, and 2) VI is the likely cause.

The immediate review, and the decisions arising from that review, will not have the benefit of a sampling-data quality assessment or validation. These activities will typically occur later, when the results of the sampling event are being integrated into a VI evaluation report. It is possible that a later assessment of data quality will lead to a conclusion that VI is *not* causing short-term indoor air action level exceedances, and that the earlier determination was incorrect. However, if the receptors of concern are current occupants of the building, the importance of providing

[122] Additional sampling events may be necessary even if the measured indoor air concentrations were less than cleanup levels.

[123] Sections 4.5.1 and 4.10 of this Guidance provide additional direction for mechanically creating negative pressures within a building.

[124] If an Ecology site manager has not been assigned to the project, send the results to the designated Regional contact.

timely information to those receptors should outweigh the potential that the information provided might later need to be revised.

This section (A-4) is specifically devoted to recommendations related to the potential for *short-term* inhalation exposures to TCE. As discussed in Section A-3, CLARC's VI indoor air cleanup levels for TCE are lower concentrations than action levels established to be protective of short-term indoor exposures. This is because the indoor air cleanup levels in CLARC are based on chronic VI-caused exposures. Therefore, remedial actions such as VI mitigation may be needed to protect long-term indoor exposures, regardless of whether the short-term indoor air TCE action level is exceeded.

A-5 Responding to exceedances of the short-term TCE indoor air action level

If VI is causing an exceedance of the TCE short-term indoor air action level, *prompt* **action is needed.** Such actions should be taken in consultation with the building's owner (and tenant, if applicable). Protecting people inside affected buildings is a high priority and action should not be delayed. If follow-up indoor air or other sampling is scheduled before the selected action is fully implemented, this sampling needs to be conducted in a manner that does not interfere with efforts to quickly and effectively reduce indoor exposures to TCE.

A-5.1 Systems for mitigating vapor intrusion

VI *mitigation* generally refers to actions that reduce VI-caused indoor air contamination, and the focus is often on reducing the amount of contaminated soil gas entering the building.[125] Mitigation systems creating **depressurization** of the sub-slab zone or crawl space will often be the most effective approach for reducing VI impacts (until subsurface cleanup permanently remediates the source of elevated soil gas concentrations). However, these types of systems can take weeks to design, construct, and fully implement. Additional time is then needed to demonstrate that target VOC concentrations in indoor air have actually been achieved.

Active VI mitigation systems such as sub-slab and sub-membrane depressurization are often able to reduce VI-caused TCE indoor air contamination to concentrations below the short-term action levels. But before the mitigation system has been successfully implemented, TCE action levels can be exceeded. If a woman of childbearing age lives or works in an area of the building where elevated TCE concentrations are present and does not relocate, she will continue to be exposed. Mitigation should therefore be designed, constructed, and implemented as quickly as

[125] Subsurface *remediation*, on the other hand, includes cleanup actions designed to reduce soil gas VOC levels. Although these actions will also reduce VI-caused indoor air contamination, they are not typically referred to as VI "mitigation" unless they can be successfully implemented within a relatively short timeframe.

possible,[126] and other actions considered that would effectively reduce exposures during the interim.

A-5.2 EPA-recommended actions and MTCA cleanups

Prompt actions to reduce TCE exposures include the recommended responses described in EPA Region 9's 2014 TCE Memorandum[127] under two headings: "Implementation of early or interim measures to mitigate TCE inhalation exposure," and "Tiered response actions" (USEPA 2014a). Many of EPA's recommendations in these sections are appropriate guides for selecting proper response actions in Washington state. However, Ecology has clarified three of the Region 9 recommendations in terms of their applicability at MTCA cleanup sites:

1. EPA's recommendation to increase building pressurization/ventilation.

> **Ecology**: Positively pressurizing the building (with respect to the subsurface) can create a pressure barrier to advective flow of soil gas into the structure and mitigate VI impacts. However, it will not always be possible or sufficiently effective. Likewise, increasing ventilation can dilute VI impacts if the outdoor-to-indoor air exchange rate is increased. But it may not be practicable to increase the ventilation rate enough to reduce indoor air TCE below cleanup/action levels. Moreover, if the methods to increase the outdoor-to-indoor air exchange rate result in greater building depressurization, VI impacts may actually be exacerbated. Regardless, follow-up monitoring of indoor air quality should be performed to ensure TCE concentrations have been reduced to an acceptable level.

2. EPA's recommendation to seal potential conduits.

> **Ecology**: It is possible that a single foundation or building feature is primarily responsible for the degree of vapor intrusion, leading to short-term indoor air TCE action level exceedances. For instance, there could be an uncovered earthen floor in part of the building, an unsealed basement sump, a disconnected floor drain, or an unsealed utility line penetration at ground level or sub-grade. If the building has a crawl space, there could be unsealed first floor openings around pipes or wiring that run between the two levels. The crawl space could also be walled-in, preventing any significant sub-floor ventilation and dilution of soil gas emissions.
>
> Often, however, it won't be obvious where the most significant soil gas entry points are located. For this reason, consider using a portable field sampling device to identify these locations, and then subsequently implementing conduit-sealing measures to limit this influence.

[126] A qualified individual or firm should be identified early, which is often during the planning phase of the investigation.

[127] Available on Ecology's website at https://ecology.wa.gov/DOE/files/4f/4fb8c34a-f785-41f7-8dea-e2ee341a31a2.pdf

If a portable device isn't used, Ecology recommends promptly initiating sealing efforts that are:

a. Focused on any easily observable and obvious major routes by which soil gas is likely entering the building;
b. Only undertaken as the initial response if the sealing activity can be completed quickly; and
c. Promptly followed up with indoor air sampling to verify the sealing's effectiveness.

3. EPA's recommendation to respond differently, based on whether the "urgent" response action level has been exceeded.

Ecology: The EPA Region 9 Memorandum states that the response to exceeding an "accelerated" action level should be "completed and confirmed within a few weeks." If the higher "urgent" action level is also exceeded, the response time should be reduced to "a few days."

Ecology agrees that, all else being equal, there should be a greater sense of urgency when TCE concentrations are much higher than the short-term action level established for the site and building. It is also true that the types of responses likely to be effective will often partly depend on how high the indoor air TCE concentrations are. **But Ecology believes any exceedance of the short-term action level merits prompt action.**

This means that if VI is causing an exceedance of the TCE short-term indoor air action level, quickly consult with the building's owner (and if applicable, the tenant) and determine which action will be taken. The goal should be to reduce TCE exposures for women of childbearing age as soon as possible. This may require that a "stopgap" response be taken right away, while plans for long-term mitigation proceed on a parallel track. Stopgap responses include temporarily relocating the receptor, and/or installing effective indoor air treatment.

Carbon-based indoor air VOC treatment devices, sometimes referred to as air purification units (APUs) or "air cleaners," can be installed relatively quickly. These devices can be used for extended periods, but their typical VI application is temporary use. They are often operated only while a more permanent form of mitigation is being designed/constructed. As discussed in EPA's 2017 *Engineering Issue*[128] that describes these devices, indoor air treatment can be accomplished with portable air cleaning units or HVAC in-duct systems (USEPA 2017). The former usually employs a built-in air circulation fan and carbon sorbent bed.

[128] Engineering Issue (USEPA 2017) at https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NERL&dirEntryId=337835

Indoor air treatment devices may not always be able to quickly reduce TCE concentrations to acceptable levels. Regardless of which treatment device is selected, investigators cannot assume that the installed unit will *sustainably* reduce indoor air TCE to concentrations below the short-term action level. As noted in the 2017 *Engineering Issue*, this needs to be confirmed with air sampling.[129]

A-6 Working with people who are affected by vapor intrusion

This section discusses interactions with the owners and occupants of buildings where vapor intrusion is, or may be, contaminating indoor air with TCE.

In the simplest case, the building is a single-family residence owned by the occupants. The responsible party and Ecology are then interacting primarily with a head of household.

But the property where the building is located will not always be owned by the responsible party, and other scenarios will also be common, such as:

a. The building is a single-family residence where the owner resides elsewhere.
b. The building is occupied by a single business, which also owns the property.
c. The building is occupied by a single business, which does not own the property or building.
d. The building is occupied by multiple businesses, none or only one of which owns the property or building.

Throughout this Appendix, we've used the term "building owners/tenants" when referring to notifications, access requests, information sharing, and other interactions with the affected public. We use this term for simplicity, but recognize that owners are not always building occupants and receptors, and building occupants are not always owners or tenants. Women of childbearing age who occupy a building could be owners, tenants, employees or other workers, students, or visitors.

For communication purposes, it is helpful for the responsible party and Ecology to have no more than two designated "building contacts." Communications about scheduling building visits,

[129] In the EPA 2017 *Engineering Issue* discussion of treatment systems, Attachment A lists a large number of VOC air cleaners by brand name. In 2014, the California DTSC reported the use of Air Rhino and AirMedic Vocarb stand-alone air purifiers. The New Hampshire Department of Environmental Services and Massachusetts Department of Environmental Protection reported the use of portable Austin HealthMate units in 2015 and 2016, respectively. (See "TCE Vapor Intrusion Case Study" presented at the 2015 NEWMOA conference, http://www.newmoa.org/events/event.cfm?m=157 and the October 2016 Field Assessment and Support Team (FAST): "An Expedited Approach to the Investigation and Mitigation of the Vapor Intrusion Pathway").

Ecology does not endorse these particular products. We include these references here only to indicate that the products have been used in at least three states to reduce VI-caused indoor air contamination.

obtaining access, sharing sampling data and data evaluations, and consultations concerning any response actions, can then be limited to a small number of individuals (who may or may not be potential "receptors"). It will be incumbent upon these building contacts to not only disseminate the information they receive from the responsible party and Ecology to (other) building occupants who are potentially being exposed, but to relay those occupants' concerns and questions back to the decision makers.

A-6.1 Outreach before indoor air sampling

As discussed in Section A-4.1, any site building where VI may potentially result in indoor TCE concentrations above the short-term action level should be identified based on subsurface sampling and other site data. When women of childbearing age are occupants in these buildings, perform the planning, notification, and pre-sampling activities described in Section A-4.3. This includes visiting the building itself.

In addition to obtaining the building and receptor-behavior information usually needed to prepare a VI indoor air SAP, during building visits Ecology and the responsible party should:[130]

1. Verify whether women of childbearing age regularly occupy the building. If they do (especially for non-residential buildings), ascertain which areas these women spend most of their time, and the hours they are typically present in the building.

2. Determine if women of childbearing age may be occupants in the foreseeable future, even if they aren't currently present.

3. Discuss site contamination and how vapor intrusion can potentially contaminate indoor air; discuss next steps and the need for sampling access; and answer their questions.

During the building visit, Ecology and the responsible party will need to be prepared for questions the occupants may have regarding potential short- and long-term TCE health effects and how to reduce their exposures. Decisions should be made during the planning period (described in Section A-4.3) about how and when this information should be provided, and who should communicate it.

Pursuant to health-related VI questions, Ecology staff are expected to answer only the most basic health-related VI questions. Routinely refer the public to local health departments or their family physicians for answers to questions that require toxicological or medical expertise.

Washington's state and local health departments are generally more familiar with local communities and their concerns than Ecology site management staff. Health departments also have more expertise at conveying health-related information. If women of childbearing age are

[130] As noted in Section A-4.2, Appendix A assumes that Ecology will be involved throughout the VI evaluation process. When this is not the case, parties performing the site investigation and cleanup should independently complete the recommended steps outlined in this Appendix.

potentially exposed to site-related TCE contamination, it is recommended that site managers and the responsible party rapidly coordinate with state/local health departments. These agencies can better explain the potential health hazards to building occupants and/or help gain access to buildings for investigation and remediation if needed. If Ecology has assigned a Community Outreach and Environmental Education Specialist (COEES) to the site, the site manager should also confer with this individual during the pre-sampling period.[131]

Before any indoor air sampling can occur, the party performing that sampling need to obtain owner/tenant consent.[132] Typically during VI investigations, this consent is documented in an "access agreement," which usually specifies the conditions under which access is granted. Finalizing an access agreement can be a lengthy process. Sometimes it is difficult to make timely contact with the building owner or tenant. Sometimes the owner will elect to get the advice of legal counsel before entering into an agreement. There can be protracted negotiations regarding considerations such as access-related payment, or other site-specific issues. While securing access is normally the duty of the responsible party, Ecology may become involved with disputes or delays when the health threat relates to a short-term exposure to site contamination. The parties need to realize that Ecology will make best efforts, including – if needed – exercising its legal authorities, to ensure access agreements are finalized as soon as possible.

A-6.2 Outreach after indoor air sampling

Indoor air sampling results, together with other lines of evidence, should indicate whether VI is causing an exceedance of the TCE short-term indoor air action level. Once the indoor air sampling data have been received from the laboratory (assuming no "real time" sampling was performed), the responsible party and Ecology should: 1) discuss the results, 2) make a preliminary decision as to whether VI is likely to be resulting in a TCE short-term action level exceedance, 3) agree on next steps, then 4) contact the building owner/tenant.

As discussed in Section A-4.4, when women of childbearing age are current occupants of the building, this decision-making and outreach process should begin as soon as the data are initially received, without waiting for data quality assessment. In these cases, the goal should be to quickly determine the likelihood of a TCE short-term indoor air action level exceedance and then inform building owners/tenants of the sampling results. Unless owners, tenants, and other concerned building occupants would prefer to wait until the quality of sampling data has

[131] Ecology's COEESs are typically not assigned to independent cleanup sites or those in the Voluntary Cleanup Program (VCP). However, if a COEES has been assigned to a site where VI is causing or may potentially result in indoor TCE concentrations above the short-term action level, their assistance can improve communications with the owners, tenants, and occupants of the affected buildings, as well as other members of the concerned public.

[132] With limited exceptions, such as emergency situations.

been rigorously assessed and validated, they should be notified of sampling results soon after results arrive from the laboratory.[133]

The responsible party and/or Ecology should tell the building owner/tenant what the sampling results indicate and what the next steps should be. During this discussion, it is important to:

1. Explain how the conclusions were reached.
2. Differentiate between what is known (e.g., the results from this single sampling event), what was inferred from the information collected, and what is not known.
3. Urge the owner/tenant to share and explain these results – as well as plans for follow-up actions – with concerned building occupants. This includes all women of childbearing age who live or work in affected portions of the building.

Coordinating with the site's assigned COEES and state/local health departments is critical at this stage and can improve the effectiveness of these communications.

If sampling data indicate that VI is likely to be causing an exceedance of the TCE short-term indoor air action level, and if a woman of childbearing age is a building occupant, quickly determine the proper response in consultation with the building's owner (and tenant, if applicable). Section A-5.0 lists various response actions that may apply. The selected action will depend on a number of building-specific factors, such as how high the indoor air TCE concentrations appear to be, and the preferences of the building's owner/tenant and receptors of concern. Promptly reaching and carrying out a mutually acceptable decision may require the involvement of state/local health departments.

If measured levels of indoor air TCE are below the action level, however, the next step may simply be to schedule a re-sampling event for the future.[134]

[133] When the data are shared this quickly, the building occupants should be informed that implications of the sampling results could change after the data quality is evaluated. Also inform them that if the implications did change, the responsible party and/or Ecology would immediately notify the owner/tenant.

[134] Typically, a sampling report is prepared after the data have been quality assured and validated. A copy of the report, and a copy of any Ecology response letter(s), should be provided to the building owner/tenant.