

# FINAL

## Vapor Intrusion Screening Levels and Removal Action Levels 700 South 1600 East Street PCE Plume Salt Lake City, Utah

**PREPARED FOR:** D. Lynne Welsh/VA Salt Lake City Health Care System

**PREPARED BY:** Mike Bedan/CH2M HILL, Mike Novak/CH2M HILL

**COPIES:** David Waite, CH2M-Hill; Rolf Lange, Avalon; Ed Reid, First Environment, Inc.; Devin DeMarco, First Environment, Inc.

**DATE:** July 17, 2015

---

This memorandum provides the calculations and technical basis for indoor-air screening levels (SLs) and removal action levels (IRALs) to be applied during the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RI) being conducted by the U.S. Department of Veterans Affairs (VA) for the 700 South 1600 East tetrachloroethylene (PCE) plume (Plume) in Salt Lake City, Utah. These SLs and RALs will be compared to measured concentrations of specific volatile organic compounds (VOCs) measured and detected in the indoor air within structures overlying a portion of the Plume identified as Accelerated Operable Unit 1 (AOU-1). Such structures have the potential of being adversely affected by the Plume through the subsurface to indoor air vapor intrusion (VI) pathway. Additional VI SLs for exterior soil gas and groundwater are also provided.

The comparison of measured VOC concentrations to the SLs and RALs will support decisions regarding the need for additional activities under CERCLA. The VI SLs are intended for screening purposes only to identify areas that may require further data collection or completion of additional data evaluation; exceedance of an investigation SL is not an indication of unacceptable risk. In addition to other requirements of the National Contingency Plan (“NCP”), RALs will be used to assess the need for implementing interim removal actions (VI mitigation, for example) in advance of selecting and implementing the CERCLA remedial action(s). These are the sole purposes of the SLs and RALs presented in this technical memorandum. The SLs and RALs do not constitute regulatory standards or cleanup goals for AOU-1.

The SLs and RALs are provided for PCE and its biodegradation breakdown products trichloroethylene (TCE), cis-1,2-dichloroethylene, and vinyl chloride. In addition, 1,4-dioxane is included at the request of the U.S. Environmental Protection Agency (EPA) because of its use historically as a stabilizer for chlorinated solvents, notably 1,1,1-trichloroethane. However, because (1) there is no knowledge of trichloroethane use associated with historical VA operations; and (2) 1,4-dioxane was not commonly used in association with PCE, the current expectation is that 1,4-dioxane will not be found in AOU-1 groundwater as a result of known VA releases.

### Background

The Plume is located in Salt Lake City, Utah (the Site) near the Wasatch Mountains front in the northeastern corner of the Salt Lake Valley. The Site was first identified in the 1990s as a result of PCE detections in existing irrigation and municipal supply wells. EPA further delineated the Plume in 1998 through installation and sampling of seven groundwater monitoring wells. A sewer line originating from a former dry-cleaning facility in the VA Medical Center was subsequently identified as one potential PCE source (Bowen Collins, 2004). In 2010, in

## FINAL

response to an oil pipeline break near Red Butte Creek (unrelated to the VA), water samples were collected by the Salt Lake City Department of Public Utilities from Red Butte Creek and springs and seeps emanating along the Wasatch Fault scarp west of 1300 East Street. PCE was detected in several of these springs and seeps. Since 2010, additional investigations have been performed to investigate potential source areas and the nature and extent of PCE contamination (UDEQ, 2012; MWH, 2012).

In May 2013, the EPA listed the Site on the National Priorities List, making the Site eligible for comprehensive assessment and cleanup through the CERCLA, or Superfund, process (EPA, 2014a). An RI is being planned for AOU-1. A part of this investigation will consist of sampling indoor air within occupied structures overlying AOU-1 to assess if vapor has migrated from PCE-contaminated groundwater to the indoor air through VI. The SLs and RALs presented in this memorandum will support data analysis and decision making with respect to the AOU 1 indoor air data.

### **Indoor Air Screening Levels**

The indoor air SLs are risk-based concentrations of VOCs that are compared with indoor air VOC concentrations measured in samples from a receptor's (for example, resident or worker) breathing zone. As noted above, the indoor air SLs are intended only to help identify areas that may require further data collection or evaluation; exceedance of an indoor air SL is not an indication of unacceptable risk. In addition, PCE and other VOCs can be found in indoor air as a result of indoor or outdoor background sources (in other words, not related to VI from subsurface sources). Steps will be taken when comparing measured indoor air concentrations to the SLs to account for potential background sources. These steps will be described in a forthcoming Vapor Intrusion Protocol document currently being prepared.

The indoor air SLs were calculated for residential and industrial exposure scenarios following an approach consistent with the EPA's Risk Assessment Guidance for Superfund (Part F) (EPA, 2009). The SLs were calculated based on an assumption of the magnitude of exposure, the chemical toxicity, and a target risk threshold. The exposure assumptions (exposure frequency, duration, and time) are published values for a generic, reasonable maximum exposure scenario from the EPA's Regional Screening Levels (RSL) tables (EPA, 2014b), which were recently updated based on new EPA guidance (EPA, 2014c). The toxicity values used as the basis for the calculations were also from the RSL tables (EPA, 2014b). The exposure assumptions and target risk thresholds are presented in Table 1. The toxicity values are presented in Table 2.

Separate carcinogenic and non-carcinogenic risk-based SLs were calculated for each VOC when both unit risk factors (cancer inhalation toxicity values) and reference concentrations (non-cancer inhalation toxicity values) are available. The lower calculated concentration of the cancer and non-cancer values is selected as the SL.

The target cancer risk (TCR) of  $1 \times 10^{-6}$  and target non-cancer hazard quotient (THQ) of 1 used to derive the indoor air SL is based on standard EPA human health risk assessment (HHRA) methodology for SLs (EPA, 2014b; EPA, 1991). Although a  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  cancer risk range is used during the risk management decision process on CERCLA projects, investigation SLs for cancer-causing chemicals are generally set to a  $1 \times 10^{-6}$  excess lifetime cancer risk consistent with CERCLA rules and guidance (NCP Section 300.430(e)(2)(I); EPA, 2014b, EPA, 1991).

## FINAL

For carcinogens, the equation for  $SL_{\text{indoor air}}$ , the indoor air risk-based SL based on cancer toxicity, is:

$$SL_{\text{indoor air-c}} = \frac{TCR \times AT_c \times \left(\frac{365 \text{ days}}{\text{year}}\right) \times \left(\frac{24 \text{ hours}}{\text{day}}\right)}{EF \times ED \times ET \times IUR}$$

Where:

- TCR = Target cancer risk [unitless]
- $AT_c$  = Averaging time-carcinogens, residential or industrial exposure scenario [years]
- EF = Exposure frequency, residential or industrial exposure scenario [days/year]
- ED = Exposure duration, residential or industrial exposure scenario [years]
- ET = Exposure time, residential or industrial exposure scenario [hours]
- IUR = Inhalation unit risk [ $\mu\text{g}/\text{m}^3$ ]<sup>-1</sup>

For carcinogens with mutagenic mode-of-action (MMAO), which includes TCE and vinyl chloride, the SL equation for the residential receptor only is slightly modified in accordance with the RSL user's guide (EPA, 2014b).

$$SL_{\text{indoor air,mut}} = \frac{TCR \times AT_c \times \left(\frac{365 \text{ days}}{\text{year}}\right) \times \left(\frac{24 \text{ hours}}{\text{day}}\right)}{EF \times ED_{\text{MMAO}} \times ET \times IUR}$$

Where:

- TCR = Target cancer risk [unitless]
- $AT_c$  = Averaging time-carcinogens [years]
- EF = Exposure frequency, residential or industrial exposure scenario [days/year]
- $ED_{\text{MMAO}}$  = Exposure duration for MMAO, residential exposure scenario [years]
- ET = Exposure time, residential or industrial exposure scenario [hours]
- IUR = Inhalation unit risk [ $\mu\text{g}/\text{m}^3$ ]<sup>-1</sup>

$ED_{\text{MMAO}}$  is calculated with the equation:

$$ED_{\text{MMAO}} = (ED_{0-2} \times AF_{0-2}) + (ED_{2-6} \times AF_{2-6}) + (ED_{6-16} \times AF_{6-16}) + (ED_{16-26} \times AF_{16-26})$$

Where:

- $ED_{\text{MMAO}}$  = Exposure duration for MMAO, residential exposure scenario [years]
- $ED_{x-y}$  = Exposure duration for the age cohort from age x to y
- $AF_{x-y}$  = Age-dependent adjustment factor (10 for ages 0 to 2, 3 for ages 2 to 6 and 6 to 16 and 1 for ages 16 to 26)

For TCE, which has mutagenic and non-mutagenic components of the IUR, two  $SL_{\text{indoor air}}$  values are calculated using the mutagenic and non-mutagenic components of the IUR. The reciprocal of the sum of the reciprocals of those  $SL_{\text{indoor air}}$  values is used to calculate the final  $SL_{\text{indoor air}}$  value, in accordance with the EPA RSL guidance (EPA, 2014b).

For vinyl chloride, a slightly modified version of the equation for  $SL_{\text{indoor air}}$  for a residential exposure scenarios is used (EPA, 2014b):

## FINAL

$$SL_{\text{indoor air, mut, vc}} = \frac{TCR}{\left( AT_c \times \frac{EF \times ED_{MMOA} \times ET \times IUR}{AT_c \times \left( \frac{365 \text{ days}}{\text{year}} \right) \times \left( \frac{24 \text{ hours}}{\text{day}} \right)} \right)}$$

For non-carcinogens, the equation for  $SL_{\text{indoor air-nc}}$ , the indoor air risk-based SL based on non-cancer toxicity, is:

$$SL_{\text{indoor air-nc}} = \frac{THQ \times RfC \times AT_{nc} \times \left( \frac{365 \text{ days}}{\text{year}} \right) \times \left( \frac{24 \text{ hours}}{\text{day}} \right) \times \left( \frac{1000 \mu\text{g}}{\text{mg}} \right)}{EF \times ED \times ET}$$

Where,

- TCR = Target cancer risk [unitless]
- ATnc = Averaging time, non-carcinogens, residential or industrial exposure scenario [years]
- EF = Exposure frequency, residential or commercial/industrial exposure scenario [days/year]
- ED = Exposure duration, residential or commercial/industrial exposure scenario [years]
- ET = Exposure time, residential or industrial exposure scenario [hours]
- THQ = Target hazard quotient (typically 1) [unitless]
- RfC = Reference concentration, non-carcinogens [ $\text{mg}/\text{m}^3$ ]

The lower of the cancer- and non-cancer-based  $SL_{\text{indoor air}}$  values is chosen as  $SL_{\text{indoor air}}$  value that satisfies both the target cancer risk level and the THQ. Table 3 summarizes the residential and industrial SLs for indoor air. The industrial SLs are applicable to school and commercial (for example, convenience store) workers as well.

### Indoor Air Removal Action Levels

The indoor air RALs are risk-based concentrations used to support decisions regarding the need for implementing Removal Actions after the data from the indoor air sampling has been generated, validated and evaluated, prior to the implementation of remedial actions. Such actions may include source treatment, institutional controls, short-term mitigation measures, long-term mitigation, or a combination of these actions. The presence of indoor air concentrations above an RAL, measure with the portable field GC/MS, will not automatically result in such actions. Additional verification activities will precede a decision to implement interim actions in order to confirm that the measured indoor air concentration is valid and not an isolated occurrence, an erroneous reading, or a source unrelated to VI. Verification activities could include:

- confirmation indoor-air sampling;
- collection and evaluation of additional data and information to help ascertain whether the indoor VOC concentrations are related to VI; or
- confirmation that the indoor air samples are representative of regularly occupied spaces.

Only indoor air results from time-weighted TO-15 indoor-air samples, and not field analytical data or data collected under non-ambient conditions (that is, building depressurization), will be used in making final decisions regarding the need for a Removal Action.

# FINAL

The same equations, methods, and assumptions used to derive the indoor air SLs were used for the RALs with the exception of the target risk levels. Exhibit 1 summarizes the rationale for the target risk levels used to derive two tiers of RALs. Consistent with EPA guidance (EPA, 2014d, e), the two tiers of RALs were calculated to address different risk management situations:

- Tier 1 RALs were calculated using TCR level of  $1 \times 10^{-5}$  and a noncancer hazard quotient of 1. After confirmation that VI resulted in indoor air concentrations above the Tier 1 RALs, planning and implementation of interim action, such as a long-term mitigation, would be completed within six months.
- Tier 2 RALs were calculated using TCR level of  $1 \times 10^{-4}$  and a noncancer hazard quotient of 3. After confirmation that VI was resulting in indoor air concentrations above the Tier 2 RALs, implementation of a short-term mitigation action, such as installation of portable air purifiers, would be completed as soon as arrangements can be made with occupants, generally within a week. A confirmation sample will generally be collected soon after receipt of the original result and before starting the air purifier. Planning and implementation of interim action such as long-term mitigation would be completed within six months.

When indoor air concentrations fall between the indoor air screening levels and the Tier 2 RALs, additional data evaluation and/or ongoing monitoring is generally recommended.

<b>EXHIBIT 1</b> <b>Rationale for Removal Action Level (RAL) Target Risk Levels</b>				
<b>RAL Tier</b>	<b>Target Cancer Risk (TCR)</b>	<b>TCR Rationale</b>	<b>Target Noncancer Hazard Quotient (THQ)</b>	<b>THQ Rationale</b>
Tier 1	$1 \times 10^{-5}$	Taking interim action to control risks to below $1 \times 10^{-5}$ will result in risks at the lower end (bottom 10%) of the target range ( $1 \times 10^{-6}$ to $1 \times 10^{-4}$ ). Cumulative risks from multiple analytes, if applicable, will not exceed $1 \times 10^{-4}$ . Lifetime exposures will equate to much lower risks because the removal action timeframe (a few years) is much shorter than the assumed 26-year exposure duration used to derive the RALs.	1	Taking interim action to control risks to below a THQ of 1 will result in noncancer risks below the target value.
Tier 2	$1 \times 10^{-4}$	Taking action within two weeks to control risks to below $1 \times 10^{-4}$ will lower calculated risks to within the target range.	3	Taking action within two weeks to control risks to below a THQ of 3 will result in noncancer risks that fall within the range of order-of-magnitude uncertainty factored into the underlying inhalation reference concentration (EPA, 2014e).

Recent guidance has also been released by several EPA regions (for example, EPA Region 9 [EPA, 2014d]) regarding the risks associated with short-term exposure to TCE in indoor air. These regulators have released interim action levels for TCE (not applicable to other Site VOCs

# FINAL

of concern) and recommend response action intended to be protective of sensitive populations., specifically women in the first trimester of pregnancy because of the potential for cardiac malformations to the developing fetus. TCE is detected infrequently and only at low levels in AOU-1 groundwater and surface water. TCE is not known to be associated directly with VA-related releases. Its presence at AOU 1 could be attributed to upgradient localized anaerobic biodegradation of PCE. TCE could also be related to a non-VA source.

Based on existing AOU-1 groundwater analytical data, the likelihood of site-related TCE impacts to indoor air that exceed the EPA regions' and other states' interim action levels is low. Selection of the THQ of 1 for the RAL calculation addresses this issue because the potential for fetal heart malformations was one of the endpoints considered in EPA's development of the TCE noncancer reference concentration. Based on the EPA's risk assessment and risk management framework, adverse health effects are not expected for exposure point concentrations less than or equal to an HQ of 1.

Tables 4 and 5 summarize the Tiers 1 and 2 residential and industrial indoor air RALs.

## Exterior Soil Gas Investigation Screening Levels

The exterior soil gas SLs are risk-based SLs used to assess soil gas concentrations collected away from the footprint of a building that may migrate into a building to a receptor breathing zone. The soil gas SLs are intended for screening purposes only—to identify areas that may require further data collection or evaluation—an exceedance of a soil gas SL is not an indication of unacceptable risk.

The SLs for soil gas are based on the exposure equations and assumptions used to derive the indoor air SLs (described above) and the soil-gas-to-indoor-air attenuation factors for existing residential buildings. The soil-gas-to-indoor air attenuation factor (AF) is 0.03 (EPA, 2014f). AFs are conservative and generic; the AF and other assumptions used in the derivation of the gas SLs will be reassessed as site-specific empirical data become available.

The soil gas investigation screening level that corresponds to a chemical's indoor air investigation screening level is calculated by dividing the indoor air SLs by the generic soil-gas-to-indoor-air attenuation factor:

$$SL_{soil\ gas} = \frac{SL_{indoor\ air}}{AF_{ss}}$$

Where:

- $SL_{soil\ gas}$  = Soil gas screening level [ $\mu\text{g}/\text{m}^3$ ]
- $SL_{indoor\ air}$  = Indoor air screening level [ $\mu\text{g}/\text{m}^3$ ]
- $AF_{soil\ gas}$  = Soil-gas-to-indoor-air attenuation factor (i.e., the ratio of indoor air concentration to soil gas concentration) [unitless]

Tables 6 and 7 summarize the residential and commercial/industrial soil gas SLs, respectively.

## Groundwater Investigation Screening Levels

The groundwater SLs are risk-based SLs used to assess groundwater concentrations in proximity of a building that may volatilize and migrate through the building foundation into the receptor breathing zone. Groundwater SLs are intended for screening purposes only—to identify

# FINAL

areas that may require further data collection or evaluation—and exceedance of a groundwater SL is not an indication of unacceptable risk.

The groundwater SL corresponding to a chemical's target indoor air concentration is calculated by dividing the indoor air SL by an AF of 0.001 (EPA, 2014f, g) and then converting the vapor concentration to an equivalent groundwater concentration, assuming equilibrium between the aqueous and vapor phases at the water table. The equilibrium partitioning is assumed to obey Henry's Law so that:

$$SL_{\text{groundwater}} = \frac{SL_{\text{indoor air}}}{HLC \times AF_{\text{gw}} \times \left(\frac{1000 \text{ L}}{\text{m}^3}\right)}$$

Where:

$SL_{\text{groundwater}}$	= Groundwater screening level [ $\mu\text{g/L}$ ]
$SL_{\text{indoor air}}$	= Indoor air screening level [ $\mu\text{g/m}^3$ ]
HLC	= Henry's Law Constant, at 25 degrees Celsius [unitless] (EPA, 2014g)
$AF_{\text{gw}}$	= Soil-gas-to-indoor-air attenuation factor for an existing residential exposure scenario (i.e., the ratio of indoor air concentration to groundwater concentration) [unitless]

AFs are conservative and generic; the AF and other assumptions used in the derivation of the groundwater SLs will be reassessed as site-specific empirical data become available.

Tables 8 and 9 summarize the residential and commercial/industrial groundwater SLs, respectively.

## Summary

The technical basis and rationale for calculating and employing site-specific SLs and indoor air RALs for the proposed VI investigation are presented in this technical memorandum. The risk-based SLs and RALs were calculated for residential and industrial exposure scenarios following an approach consistent with the EPA Guidance. The SLs will be used to identify areas, including homes and other structures, that may require further data collection or evaluation. Decisions to implement Removal Actions will be based on RAL exceedances, but only following further verification, validation, and decision making.

Exterior soil gas and groundwater SLs for a current residential exposure scenario are summarized in Table 10. A summary of the proposed indoor air RALs for existing residential land use are also provided in Table 10. The decision matrix for comparing measured concentrations against the SL and RALs is provided in Table 11.

# FINAL

## References

- Bowen Collins. 2004. *PCE Well Contamination Evaluation*. Technical Memorandum prepared for Salt Lake City Department of Public Utilities. June.
- Department of Toxic Substances Control (DTSC). 2014. *HUMAN HEALTH RISK ASSESSMENT (HHRA) NOTE. HERO HHRA NOTE NUMBER 5: Health-based Indoor Air Screening Criteria for Trichloroethylene (TCE)*. August 21.
- DTSC. 2011b. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)*. October.
- U.S. Environmental Protection Agency (EPA). 2014a. [EPA Home; Region 8](http://www2.epa.gov/region8/700-south-1600-east-pce-plume); 700 South 1600 East PCE Plume. Accessed 18 March 2014. Available at: <http://www2.epa.gov/region8/700-south-1600-east-pce-plume>
- EPA. 2014b. *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. May. [www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm)
- EPA. 2014c. *Memorandum: Human Health Evaluation Manual, Supplemental Guidance: Updated o Standard Default Exposure Factors*. Office of Solid Waste and Emergency Response, February.
- EPA. 2014d. *EPA Region 9 Response Action Levels and Recommendations to Address Near-Term Inhalation Exposures to TCE in Air from Subsurface Vapor Intrusion*. July 9.
- EPA. 2014e. *Revised Superfund Removal Actions Levels*. Office of Solid Waste and Emergency Response. Washington, DC. September 17.
- EPA. 2014f. *DRAFT OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air*. September 4.
- EPA. 2014g. *Vapor Intrusion Screening Level (VISL) Calculator and User's Guide*. Office of Solid Waste and Emergency Response, Office of Superfund Remediation and Technology Innovation. May. <http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6>
- EPA, 2009. *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*. EPA-540-R-070-002 OSWER 9285.7-82. January. <http://www.epa.gov/oswer/riskassessment/ragsf/index.htm>
- EPA. 2002. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*. Office of Solid Waste and Emergency Response. Washington, DC. EPA 530-D-02-004. November. [www.epa.gov/osw/hazard/correctiveaction/eis/vapor/complete.pdf](http://www.epa.gov/osw/hazard/correctiveaction/eis/vapor/complete.pdf)
- EPA, 1991. *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)*. OSWER Directive 9285.7-01B. Office of Emergency and Remedial Response. [www.rais.ornl.gov/documents/HHEMB.pdf](http://www.rais.ornl.gov/documents/HHEMB.pdf)
- MWH. 2012. Final Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection at Salt Lake City's Drinking Water Well #18 (also referred to as the 500 South Well). Prepared for Salt Lake City Department of Public Utilities. July.
- Utah Department of Environmental Quality (UDEQ). 2012. East Side Springs, Salt Lake County, Utah Site Investigation Analytical Results Report, UTN000802825. Division of Environmental Response and Remediation (DERR). Prepared by Craig Barnitz.



## TABLES

**TABLE 1**  
**Vapor Intrusion Investigation Screening Levels and Action Levels Exposure Assumptions**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

Scenario	Parameter	Symbol	Value	Units	Source
General parameters	Target cancer risk - Investigaiton Screening Level	TR	1E-06	unitless	EPA, 2014a
	Target Hazard Quotient - Investigation Screening Level	THQ	1	unitless	EPA, 2014a
	Target cancer risk - Removal Action Level - Tier 1	TR_removal	1E-05	unitless	Site-specific
	Target Hazard Quotient - Removal Action Level -Tier 1	THQ_removal	1	unitless	EPA, 2014b; DTSC, 2014
	Target cancer risk - Removal Action Level - Tier 2	TR_removal	1E-04	unitless	Site-specific
	Target Hazard Quotient - Removal Action Level -Tier 2	THQ_removal	3	unitless	EPA, 2014b; DTSC, 2014
	Averaging time, carcinogenic	AT_C	70	years	EPA, 2014a
Residential	Averaging time, non-carcinogenic	AT_Nr	26	years	EPA, 2014a
	Exposure duration	ED_res	26	year	EPA, 2014a
	Exposure frequency	EF_res	350	day/year	EPA, 2014a
	Exposure Time (per day)	ET_res	24	hours	EPA, 2014a
Existing Residential Building	Near-Source Exterior Soil Gas-to-Indoor Air Attenuation Factor	AF_res_ex_source	0.03	unitless	EPA, 2014d
	Groundwater-to-Indoor Air Attenuation Factor	AF_res_gw	0.001	unitless	EPA, 2014c; EPA, 2014d
Industrial/Commercial	Averaging time, non-carcinogenic	AT_Nic	25	years	EPA, 2014a
	Exposure duration	ED_ic	25	year	EPA, 2014a
	Exposure frequency	EF_ic	250	day/year	EPA, 2014a
	Exposure Time (per day)	ET_ic	8	hours	EPA, 2014a
Existing Commercial Building	Near-Source Exterior Soil Gas-to-Indoor Air Attenuation Factor	AF_ic_ex_source	0.03	unitless	EPA, 2014d
	Groundwater-to-Indoor Air Attenuation Factor	AF_ic_gw	0.001	unitless	EPA, 2014c; EPA, 2014d

Notes:

DTSC, 2014. Department of Toxic Substances Control (DTSC) UMAN HEALTH RISK ASSESSMENT (HHRA) NOTE. HERO HHRA NOTE NUMBER 5: Health-based Indoor Air Screening Criteria for Trichloroethylene (TCE). August 21.

EPA, 2014a. United States Environment Protection Agency (EPA). Regional Screening Levels. November. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)

EPA, 2014b. EPA Region 9 Response Action Levels and Recommendations to Address Near- Term Inhalation Exposures to TCE in Air from Subsurface Vapor Intrusion. July 9.

EPA, 2014c. Vapor Intrusion Screening Level (VISL) Calculator and User's Guide. Office of Solid Waste and Emergency Response, Office of Superfund Remediation and Technology Innovation. May

EPA, 2014d. DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. Office of Solid Waste and Emergency Response. September 4.

**TABLE 2**  
**Toxicity Factors used in the Calculation of the California Human Health Screening Levels - Vapor Intrusion Pathways**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	USEPA Inhalation Unit Risk Factor (IUR) (ug/m <sup>3</sup> ) <sup>-1</sup>	IUR Source	USEPA Non-Cancer Reference Concentration (RfC) (ug/m <sup>3</sup> )	RfC Source
75354	1,1-Dichloroethylene			200	IRIS <sup>a</sup>
123911	1,4-Dioxane	5.0E-06	IRIS <sup>a</sup>	30	IRIS <sup>a</sup>
156592	cis-1,2-Dichloroethylene				
127184	Tetrachloroethylene	2.6E-07	IRIS <sup>a</sup>	40	IRIS <sup>a</sup>
79016	Trichloroethylene	4.1E-06	IRIS <sup>a</sup>	2	IRIS <sup>a</sup>
75014	Vinyl chloride (chloroethene)	4.4E-06	IRIS <sup>a</sup>	100	IRIS <sup>a</sup>

Notes:

USEPA: United States Environmental Protection Agency

References:

a: USEPA, 2014. Regional Screening Level - Toxicity Information. URL: <http://www.epa.gov/region9/superfund/prg/index.html>. May.

**TABLE 3**  
**Summary Table of Indoor Air Screening Levels**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	Residential Indoor Air - C RBSL <sup>a</sup>	Residential Indoor Air - NC RBSL <sup>a</sup>	Residential Indoor Air - Investigation SL <sup>b</sup>	Commercial/Industrial Indoor Air - C RBSL <sup>a</sup>	Commercial/Industrial Indoor Air - NC RBSL <sup>a</sup>	Commercial/Industrial Indoor Air - SL <sup>b</sup>
75354	1,1-Dichloroethylene		210	210		880	880
123911	1,4-Dioxane	0.56	31	0.56	2.5	130	2.5
156592	cis-1,2-Dichloroethylene						
127184	Tetrachloroethylene	11	41	11	47	180	47
79016	Trichloroethylene	0.48	2.1	0.48	3	8.8	3
75014	Vinyl chloride (chloroethene)	0.17	100	0.17	2.8	440	2.8

a: The indoor air Regional Screening Levels (EPA, 2014a) are used as the indoor air risk-based screening level (RBSL) based on the exposure assumptions and equations in Table 1 using toxicity values in Table 2.

The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.

The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.

b : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.

Final investigation screening levels are rounded to nearest 2 significant figures.

Notes:

C : carcinogenic (cancer-causing)

NC : non-carcinogenic (non-cancer-causing)

CASRN : chemical abstract service registry number

µg/m<sup>3</sup> : micrograms per cubic meter

EPA : United States Environment Protection Agency.

EPA, 2014a. Regional Screening Levels for Residential Soil. November. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)

EPA, 2014b. Vapor Intrusion Screening Levels. <http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6>

**TABLE 4**  
**Summary Table of Tier 1 Indoor Air Removal Action Levels**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	Residential Indoor Air - C RAL <sup>b</sup>	Residential Indoor Air - NC RAL <sup>b</sup>	Residential Indoor Air RAL <sup>c</sup>	Commercial/ Industrial Indoor Air - C RAL <sup>b</sup>	Commercial/ Industrial Indoor Air - NC RAL <sup>b</sup>	Commercial/ Industrial Indoor Air RAL <sup>c</sup>
		(ug/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )
75354	1,1-Dichloroethylene		210	210		880	880
123911	1,4-Dioxane	5.6	31	5.6	25	130	25
156592	cis-1,2-Dichloroethylene						
127184	Tetrachloroethylene	110	41	41	470	180	180
79016	Trichloroethylene	4.8	2.1	2.1	30	9	8.8
75014	Vinyl chloride (chloroethene)	1.7	100	1.7	28	440	28

a: The indoor air Regional Screening Levels (EPA, 2014a) are used as the indoor air risk-based screening level (RBSL) based on the exposure assumptions and equations in Table 1 using toxicity values in Table 2.

The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.

The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.

b: The C RAL values were derived using a target cancer risk level (TRL) of 1E-05.

The NC RAL values were derived using a target noncancer hazard quotient (THQ) of 1.

c: The vapor intrusion removal action level (RAL) is the lowest value between carcinogenic and non-carcinogenic RALs.

The RALs are rounded to nearest 2 significant figures.

Notes:

RAL : removal action level

C : carcinogenic (cancer-causing)

NC : non-carcinogenic (non-cancer-causing)

CASRN : chemical abstract service registry number

µg/m<sup>3</sup> : micrograms per cubic meter

EPA : United States Environment Protection Agency.

EPA, 2014a Regional Screening Levels for Residential Soil. November. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)

EPA, 2014b Vapor Intrusion Screening Levels. <http://www.epa.gov/oswer/vaporintrusion/guidance.html#item6>

**TABLE 5**  
**Summary Table of Tier 2 Indoor Air Removal Action Levels**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	Residential Indoor Air - C RAL <sup>b</sup>	Residential Indoor Air - NC RAL <sup>b</sup>	Residential Indoor Air RAL <sup>c</sup>	Commercial/ Industrial Indoor Air - C RAL <sup>b</sup>	Commercial/ Industrial Indoor Air - NC RAL <sup>b</sup>	Commercial/ Industrial Indoor Air RAL <sup>c</sup>
		(ug/m <sup>3</sup> )	(ug/m <sup>3</sup> )	(ug/m <sup>3</sup> )	(ug/m <sup>3</sup> )	(ug/m <sup>3</sup> )	(ug/m <sup>3</sup> )
75354	1,1-Dichloroethylene		630	630			2,640
123911	1,4-Dioxane	56	93	56	250	390	250
156592	cis-1,2-Dichloroethylene						
127184	Tetrachloroethylene	1,100	123	120	4,700	540	540
79016	Trichloroethylene	48	6.3	6.3	300	26.4	26
75014	Vinyl chloride (chloroethene)	17	300	17	280	1,320	280

a: The indoor air Regional Screening Levels (EPA, 2014a) are used as the indoor air risk-based screening level (RBSL) based on the exposure assumptions and equations in Table 1 using toxicity values in Table 2.

The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.

The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.

b: The C RAL values were derived using a target cancer risk level (TRL) of 1E-04.

The NC RAL values were derived using a target noncancer hazard quotient (THQ) of 3.

c : The vapor intrusion removal action level (RAL) is the lowest value between carcinogenic and non-carcinogenic RALs.

The RALs are rounded to nearest 2 significant figures.

Notes:

RAL : removal action level

C : carcinogenic (cancer-causing)

NC : non-carcinogenic (non-cancer-causing)

CASRN : chemical abstract service registry number

ug/m<sup>3</sup> : micrograms per cubic meter

EPA : United States Environment Protection Agency.

EPA, 2014a Regional Screening Levels for Residential Soil. November. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)

**TABLE 6**  
**Exterior Soil Gas Vapor Intrusion Investigation Screening Levels - Existing and Future Residential**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	Residential Indoor Air - C RBSL <sup>a</sup>	Residential Indoor Air - NC RBSL <sup>a</sup>	Existing Residential Near-Source-Exterior-Soil-Gas-to-Indoor-Air Attenuation Factor <sup>b</sup>	Existing Residential Soil Gas - C RBSL <sup>c</sup>	Existing Residential Soil Gas - NC RBSL <sup>c</sup>	Existing Residential Soil Gas SL <sup>d</sup>
		(ug/m <sup>3</sup> )	(ug/m <sup>3</sup> )	(--)	(ug/m <sup>3</sup> )	(ug/m <sup>3</sup> )	(ug/m <sup>3</sup> )
75354	1,1-Dichloroethylene		210	0.03		7,000	7,000
123911	1,4-Dioxane	0.56	31	0.03	18.7	1,030	19
156592	cis-1,2-Dichloroethylene			0.03			
127184	Tetrachloroethylene	11	41	0.03	367	1,370	370
79016	Trichloroethylene	0.48	2.1	0.03	16	70	16
75014	Vinyl chloride (chloroethene)	0.17	100	0.03	5.67	3,330	5.7

a: Indoor air risk-based screening level (RBSL) based on USEPA (2014a) exposure assumptions and equations (Table 1) using toxicity values in Table 2.

The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.

The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.

b : Residential "near source" exterior-soil-gas-to-indoor-air RBSLs are based on the EPA (2014b) soil gas-to-indoor air attenuation factor of 0.03.

c : The RBSLs is calculated dividing the associated indoor air RBSL by the soil gas-to-indoor air attenuation factor.

d : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.

Final investigation screening levels are rounded to nearest 2 significant figures.

Notes:

C : carcinogenic (cancer-causing)

NC : non-carcinogenic (non-cancer-causing)

CASRN : chemical abstract service registry number

ug/m<sup>3</sup> : micrograms per cubic meter

EPA : United States Environment Protection Agency.

EPA, 2014a Regional Screening Levels for Residential Soil. November. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)

EPA, 2014<sup>b</sup> DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. September 4.

**TABLE 7**  
**Exterior Soil Gas Vapor Intrusion Screening Levels - Commercial/Industrial**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	Commercial/ Industrial Indoor Air - C RBSL <sup>a</sup>	Commercial/ Industrial Indoor Air - NC RBSL <sup>a</sup>	Existing Commercial /Industrial Near-Source- Exterior-Soil-Gas-to- Indoor-Air Attenuation Factor <sup>b</sup>	Existing Commercial/ Industrial Soil Gas - C RBSL <sup>c</sup>	Existing Commercial/ Industrial Soil Gas - NC RBSL <sup>c</sup>	Existing Commercial/ Industrial Soil Gas SL <sup>d</sup>
		(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(--)	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )
75354	1,1-Dichloroethylene		880	0.03		29,300	29,000
123911	1,4-Dioxane	2.5	130	0.03	83.3	4,330	83
156592	cis-1,2-Dichloroethylene			0.03			
127184	Tetrachloroethylene	47	180	0.03	1,570	6,000	1,600
79016	Trichloroethylene	3	8.8	0.03	100	293	100
75014	Vinyl chloride (chloroethene)	2.8	440	0.03	93.3	14,700	93

a: Indoor air risk-based screening level (RBSL) based on USEPA (2014a) exposure assumptions and equations (Table 1) using toxicity values in Table 2.

The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.

The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.

b : Commercial/Industrial "near source" exterior soil gas-to-indoor-air RBSLs are based on the EPA (2014b) soil-gas-to-indoor attenuation factor of 0.03.

c : The RBSLs is calculated dividing the associated indoor air RBSL by the subslab-to-indoor-air attenuation factor.

d : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.

Final investigation screening levels are rounded to nearest 2 significant figures.

Notes:

C : carcinogenic (cancer-causing)

NC : non-carcinogenic (non-cancer-causing)

CASRN : chemical abstract service registry number

µg/m<sup>3</sup> : micrograms per cubic meter

EPA : United States Environment Protection Agency.

EPA, 2014a. Regional Screening Levels for Residential Soil. November. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)

EPA, 2014b. DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. September 4.



**TABLE 8**  
**Groundwater Vapor Intrusion Screening Levels - Existing and Future Residential**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	Residential Indoor Air - C RBSL <sup>a</sup>	Residential Indoor Air - NC RBSL <sup>a</sup>	Henry's Law Constant <sup>b</sup>	Residential Groundwater-to-Indoor-Air Attenuation Factor <sup>c</sup>	Residential Groundwater - C RBSL <sup>d</sup>	Residential Groundwater - NC RBSL <sup>d</sup>	Residential Groundwater Investigation SL <sup>e</sup>
		(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(--)	(--)	(µg/L)	(µg/L)	(µg/L)
75354	1,1-Dichloroethylene		210	1.07E+00	0.001		197	200
123911	1,4-Dioxane	0.56	31	1.96E-04	0.001	2,850	158,000	2,900
156592	cis-1,2-Dichloroethylene			1.67E-01	0.001			
127184	Tetrachloroethylene	11	41	7.24E-01	0.001	15.2	56.7	15
79016	Trichloroethylene	0.48	2.1	4.03E-01	0.001	1.19	5.21	1.2
75014	Vinyl chloride (chloroethen	0.17	100	1.14E+00	0.001	0.15	88	0.15

a : Indoor air risk-based screening level (RBSL) based on USEPA (2014a) exposure assumptions and equations (Table 1) using toxicity values in Table 2.

The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.

The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.

b : Henry's Law Constant (HLC) values are taken from USEPA (2014a). HLCs are assumed at 25 degree Celsius.

c : Residential groundwater-to-indoor-air RBSLs are based on the EPA (2014b, c) groundwater-to-indoor attenuation factor of 0.001.

d : The RBSLs are calculated dividing the associated indoor air RBSL by the Henry's Law Constant, the groundwater-to-indoor-air attenuation factor, and a conversion factor of 1000 liters per cubic meter.

e : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.

Notes:

C : carcinogenic (cancer-causing)

NC : non-carcinogenic (non-cancer-causing)

CASRN : chemical abstract service registry number

µg/m<sup>3</sup> : micrograms per cubic meter

EPA : United States Environment Protection Agency.

EPA, 2014a. Regional Screening Levels for Residential Soil. November. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)

EPA, 2014b. Vapor Intrusion Screening Levels. <http://www.epa.gov/oswer/vaporintrusion/guidance.html#item6>

EPA, 2014c. DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. September 4.

**TABLE 9**  
**Groundwater Vapor Intrusion Screening Levels - Existing and Future Commercial/Industrial Buildings**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	Commercial/ Industrial Indoor Air RBSL <sup>a</sup> - C	Commercial/ Industrial Indoor Air RBSL <sup>a</sup> - NC	Henry's Law Constant <sup>b</sup>	Commercial/ Industrial Groundwater- to-Indoor-Air Attenuation Factor <sup>c</sup>	Commercial/ Industrial Groundwater - C RBSL <sup>d</sup>	Commercial/ Industrial Groundwater - NC RBSL <sup>d</sup>	Commercial/ Industrial Groundwater Investigation SL <sup>e</sup>
		(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(--)	(--)	(µg/L)	(µg/L)	(µg/L)
75354	1,1-Dichloroethylene		880	1.07E+00	0.001		825	830
123911	1,4-Dioxane	2.5	130	1.96E-04	0.001	12,700	663,000	13,000
156592	cis-1,2-Dichloroethylene			1.67E-01	0.001			
127184	Tetrachloroethylene	47	180	7.24E-01	0.001	65	249	65
79016	Trichloroethylene	3	8.8	4.03E-01	0.001	7.45	21.9	7.5
75014	Vinyl chloride (chloroethene)	2.8	440	1.14E+00	0.001	2.46	387	2.5

a: Indoor air risk-based screening level (RBSL) based on USEPA (2014a) exposure assumptions and equations (Table 1) using toxicity values in Table 2.

The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.

The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.

b : Henry's Law Constant (HLC) values are taken from USEPA (2014a). HLCs are assumes at 25 degree Celsius.

c : Commercial/industrial groundwater-to-indoor-air RBSLs are based on the EPA (2014b, c) groundwater-to-indoor attenuation factor of 0.001.

d : The RBSLs is calculated dividing the associated indoor air RBSL by the Henry's Law Constant, the groundwater-to-indoor-air attenuation factor, and a conversion factor of 1,000 liters per cubic meter.

e : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.

Notes:

C : carcinogenic (cancer-causing)

NC : non-carcinogenic (non-cancer-causing)

CASRN : chemical abstract service registry number

µg/m<sup>3</sup> : micrograms per cubic meter

EPA : United States Environment Protection Agency.

EPA, 2014a. Regional Screening Levels for Residential Soil. November. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)

EPA, 2014b. Vapor Intrusion Screening Levels. <http://www.epa.gov/oswer/vaporintrusion/guidance.html#item6>

EPA, 2014c. DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. September 4.

**TABLE 10**  
**Summary of Screening Levels and Removal Action Levels**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

CASRN	Chemical	Residential Indoor Air SL	Residential Indoor Air Tier 1 RAL	Residential Indoor Air Tier 2 RAL	Residential Soil Gas SL	Residential Groundwater SL	Commercial/ Industrial Indoor Air SL	Commercial/ Industrial Indoor Air Tier 1 RAL	Commercial/ Industrial Indoor Air Tier 2 RAL	Commercial/ Industrial Soil Gas SL	Commercial/ Industrial Groundwater SL
		(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/L)	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/m <sup>3</sup> )	(µg/L)
75354	1,1-Dichloroethylene	210	210	630	7,000	200	880	880	2,640	29,000	830
123911	1,4-Dioxane	0.56	5.6	56	19	2,900	2.5	130	390	83	13,000
156592	cis-1,2-Dichloroethylene										
127184	Tetrachloroethylene	11	41	120	370	15	47	180	540	1,600	65
79016	Trichloroethylene	0.48	2.1	6.3	16	1.2	3	8.8	26	100	7.5
75014	Vinyl chloride (chloroethene)	0.17	1.7	17	5.7	0.15	2.8	440	1,320	93	2.5

Notes:

SL : screening level

RAL : removal action level

**TABLE 11**  
**Site Management Decision Matrix**  
**700 South 1600 East PCE Plume**  
**Salt Lake City, Utah**

<b>Indoor Air SL/RAL Comparison Result</b>	<b>Site Management Decision</b>	<b>Possible Actions</b>
Indoor Air <= SL	No further evaluation or actions	None
SL < Indoor air <= Tier 1 RAL	Monitoring and Further Evaluation	Additional Data Collection Periodic Monitoring Additional Data Evaluation
Tier 1 RAL < Indoor Air <= Tier 2 RAL	Further Evaluation, Mitigation, Monitoring	Additional Data Collection Long-term Mitigation Periodic Monitoring Additional Data Evaluation
Indoor Air >= Tier 2 RAL	Response Action Needed	Additional Data Collection Short-term Mitigation (e.g., portable filtration) Long-term Mitigation Periodic Monitoring Additional Data Evaluation

Notes:  
SL : investigation screening level  
RAL : removal action level