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### ABSTRACT

The U.S. Environmental Protection Agency Office of Superfund Remediation and Technology Innovation (OSRTI), through an interagency agreement with Oak Ridge National Laboratory (ORNL), has developed an online calculator for vapor intrusion screening levels (VISL). This tool provides screening level concentrations for groundwater, soil gas (sub-slab and exterior), and indoor air for certain qualifying chemicals to assist risk assessors in determining risks due to vapor intrusion. The screening levels for groundwater and soil gas (either sub-slab gas or soil gas collected below or adjacent to buildings) are calculated from the target indoor air concentrations using empirically-based conservative "generic" attenuation factors that reflect generally reasonable worst-case conditions as described in the EPA's draft vapor intrusion guidance (EPA 2002). The default, generic VISLs are based on default exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures. In addition to calculating screening levels, this tool can estimate calculate indoor air concentrations from soil gas and groundwater concentrations entered by the user and generic, empiricallyderived attenuation factors. In addition, risk values from indoor air concentrations and user-provided exposure parameters can be calculated. This new tool will be useful for concerned citizens, risk assessors and risk managers.

## VAPOR INTRUSION BACKGROUND

Vapor intrusion is the general term given to migration of hazardous vapors from any subsurface vapor source, such as contaminated soil or groundwater, through the soil and into an overlying building or structure. These vapors can enter buildings through cracks in `basements and foundations, as well as through conduits and other openings in the building envelope. Vapors can also enter structures that are not intended for human occupancy (e.g., sewers, drain lines, access vaults, storage sheds, pump houses) through cracks and other openings. All types of buildings, regardless of foundation type (e.g., basement crawl space, slab-on-grade), have openings that render them potentially vulnerable to vapor intrusion. Buildings subject to vapor intrusion include, but are not limited to, residential buildings (e.g., detached single-family homes, trailer or 'mobile' homes, multi-unit apartments and condominiums), commercial workplaces (e.g., office buildings, retail establishments), educational and recreational buildings (e.g., schools and gyms), and industrial facilities (e.g., manufacturing plants).

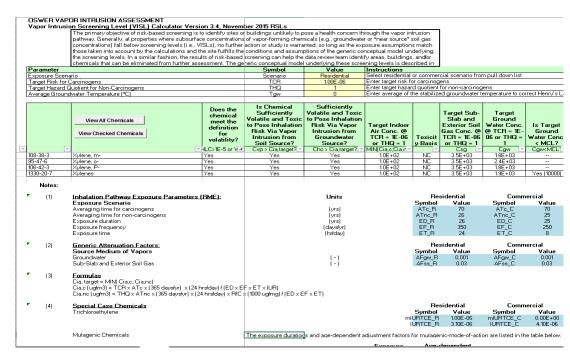
# PROJECT OBJECTIVES

- Provide an on-line version of the VISL calculator that is linked to the EPA Regional Screening Level (RSL) database <a href="https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl\_search">https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl\_search</a>
- Linkage to the RSL database will provide consistency in the air screening level equations
- Determination of volatility will be standardized between the VISL and RSL
- Chemical-specific parameters and toxicity values will be standardized and updated simultaneously
- Cumbersome spreadsheet manipulations will be replaced with the familiar GUI style of the RSL
- Output tables of all input parameters will be provided for every VISL calculator run
- Download tables will be provided in identical format to the familiar RSLs
- Output will be provided in spreadsheet and PDF format

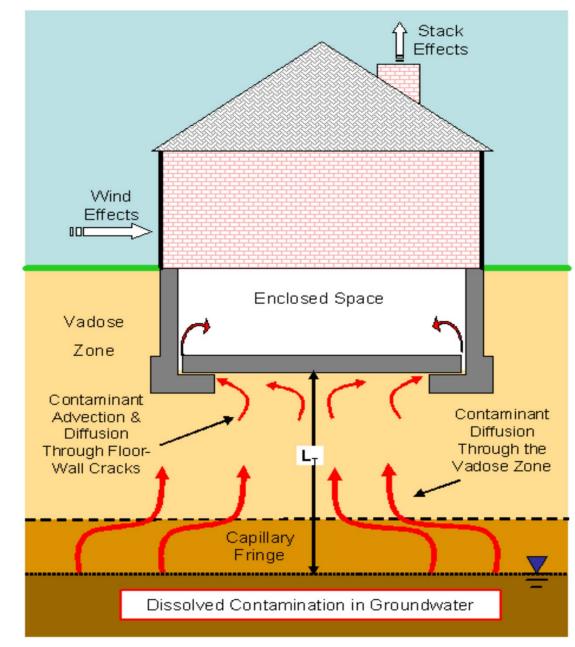
# Web-Based Calculator for Vapor Intrusion Screening Levels (VISL) https://epa-visl.ornl.gov/index.html

# METHODS

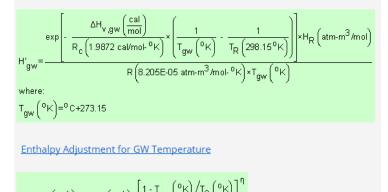
- Convert spreadsheet to web-interface tool
- Chemical parameters stored in Oracle®
- Calculations executed in SAS<sup>®</sup>
- Web services utilize Apache and Perl

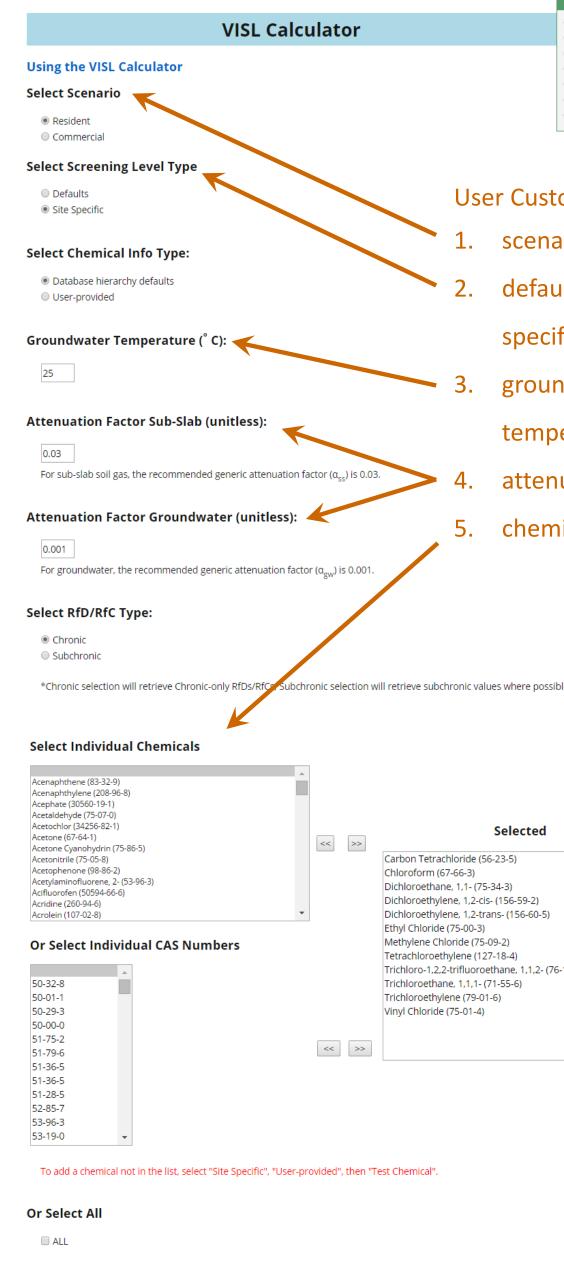


Current Spreadsheet input process









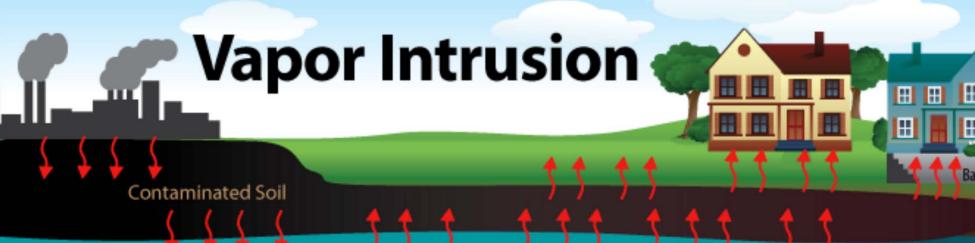
Include Metadata

Yes

### Retrieve

Website input process





Contaminated Groundwater

Generic Table

# RESULTS

Contents							
VISL Home     User's Guide	VISL Calculator Using the VISL Calculator	VISL Home     User's Guide     What's New     FAQ					
What's New     FAQ     Equations		<ul><li>Equations</li><li>Generic Table</li><li>Calculator</li></ul>					
Generic Tables     Calculator	Resident Exposure to Vapor						
	Indoor Air Screening Level Equations and Para	meters					
	Air Carcinogenic Inhalation						
tomization:	Air Carinogenic-(Trichloroethylene) Inhalation						
	Air Carinogenic-(Vinyl Chloride) Inhalation						
ario	Air Non-Carcinogenic Inhalation						
ults or site-	$C_{\text{res-ia,nc}}\left(\mu g/m^{3}\right) = \frac{\text{THQ} \times \text{AT}_{r}\left(\frac{365 \text{ days}}{\text{year}} \times \text{ED}_{r}\left(26 \text{ years}\right)\right) \times \left(\frac{1000 \ \mu g}{\text{mg}}\right)}{\text{EF}_{r}\left(\frac{350 \ \text{days}}{\text{year}}\right) \times \text{ED}_{r}\left(26 \text{ years}\right) \times \text{ET}_{r}\left(\frac{24 \ \text{hours}}{\text{day}}\right) \times \left(\frac{1 \ \text{day}}{24 \ \text{hours}}\right) \times \frac{1}{\text{RfC}\left(\frac{\text{mg}}{\text{mg}}\right)}$						
ific method							
ine method		et hazard quotient) unitless					
nd water	350     EF <sub>res</sub> (exposure frequency) day/year     70     LT (lifetime	-					
	24     ET <sub>res</sub> (exposure time) hour/day     1.0E-6     TR (target	risk) unitless					
oerature	<ol> <li>Input fields with a "pink" background are a required entry.</li> <li>Input fields with a "blue" background are calculated dynamically.</li> </ol>						
	3. IUR=inhalation unit risk (µg/m <sup>3</sup> ) <sup>-1</sup> . chemical-specific						
nuation factors	<ol> <li>RfC=inhalation reference concentration (mg/m<sup>3</sup>). chemical-specific</li> </ol>						
	Mutagenic Equation and Parameters						
nicals	Air Carinogenic-Mutagen Inhalation						
	2 ED <sub>0-2</sub> (exposure duration first phase) year 350 EF <sub>6-16</sub> (exp	oosure frequency third phase) da					
	4 ED <sub>2-6</sub> (exposure duration second phase) year 350 EF <sub>16-26</sub> (ex	posure frequency fourth phase)					
	10 ED <sub>6-16</sub> (exposure duration third phase) year 24 ET <sub>0-2</sub> (expo	osure time first phase) year					
	10     ED <sub>16-26</sub> (exposure duration fourth phase) year     24     ET <sub>2-6</sub> (exposure duration fourth phase) year	osure time second phase) year					
	350 EF <sub>0-2</sub> (exposure frequency first phase) day/year	oosure time third phase) year					
	350 EF <sub>2-6</sub> (exposure frequency second phase) day/year 24 ET <sub>16-26</sub> (ex	posure time fourth phase) year					
sible.	Groundwater and Soil Gas						
	Correcting the Henry's Law Constant for GW Temperature						
	Enthalpy Adjustment for GW Temperature						
	Groundwater Screening Level Equation						
	Soil Gas Screening Level Equation						
	$C_{sg}(\mu g/m^3) = \frac{C_{ia}, target}{AF_{ss}}$						
	Vapor Concentration at the Source						
	$C_{sv}(g/cm^3-v)=H'_{TS}\times C_w(g/cm^3-w)$						
		ndwater Temperature) <sup>°</sup> C					
	0.03 AF <sub>ss</sub> (Attenuation Factor Sub-Slab) unitless						
76-13-1)	<b>NOTES:</b> 1. Input fields with a "blue" background were selected on the intro page.						
	Retrieve Clear						

VISL			
Site-specific			
Resident Equation Inputs			
Output to Spreadsheet			
Output to PDF			
Variable	Value		
ED <sub>res</sub> (exposure duration) year	26		
TR (target risk) unitless	1.0E-6		
THQ (target hazard quotient) unitless	1		
LT (lifetime) year	70		
EF <sub>res</sub> (exposure frequency) day/year	350		
ED <sub>0-2</sub> (exposure duration first phase) year	2		
ED <sub>2-6</sub> (exposure duration second phase) year	4		
ED <sub>6-16</sub> (exposure duration third phase) year	10		
ED <sub>16-26</sub> (exposure duration fourth phase) year	10		
EF <sub>0-2</sub> (exposure frequency first phase) day/year	350		
EF <sub>2-6</sub> (exposure frequency second phase) day/year	350		
EF <sub>6-16</sub> (exposure frequency third phase) day/year	350		
EF <sub>16-26</sub> (exposure frequency fourth phase) day/year	350		
ET <sub>res</sub> (exposure time) hour/day	24		
ET <sub>0-2</sub> (exposure time first phase) year	24		
ET <sub>2-6</sub> (exposure time second phase) year	24		
ET <sub>6-16</sub> (exposure time third phase) year	24		

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16-26 (exposure time fourth phase) year

### Resident Risk-Based Vapor Intrusion Screening Levels (VISL)

Chemical	,	Target Indoor Air Concentration C <sub>i,a</sub> (µg/m <sup>3</sup> )	Toxicity Basis	Target Sub-Slab and Exterior Soil Gas Concentration (µg/m <sup>3</sup> )	MCL (ug/L)	Target Groundwater Concentration (µg/m <sup>3</sup> )	ls Target Groundwater Conc. < MCL?	Pure Vapo @
Carbon Tetrachloride		4.68E-01	CA	1.56E+01	5	4.15E-01	Yes	9.: ^
Chloroform		1.22E-01	CA	4.07E+00	80	8.14E-01	Yes	1.2
Dichloroethane, 1,1-		1.75E+00	CA	5.85E+01	-	7.64E+00	No	1.2
Dichloroethylene, 1,2-cis-		-		-	70	-	NA	1.(
Dichloroethylene, 1,2-trans-		-		-	100	-	NA	1.
Ethyl Chloride		1.04E+04	NC	3.48E+05	-	2.30E+04	No	3.5
Methylene Chloride		1.01E+02	CA	3.38E+03	5	7.63E+02	No	1.9
Tetrachloroethylene		1.08E+01	CA	3.60E+02	5	1.49E+01	No	1.6
Trichloro-1,2,2-trifluoroethane, 1,1,2-		3.13E+04	NC	1.04E+06	-	1.46E+03	No	3.(
Trichloroethane, 1,1,1-		5.21E+03	NC	1.74E+05	200	7.42E+03	No	8.9
Trichloroethylene		4.78E-01	CA	1.59E+01	5	1.19E+00	Yes	4.₹ ▼

## **CONCLUSIONS AND FUTURE DEVELOPMENTS**

fourth phase) day/ye

- Unification with the RSL database and screening levels is achieved
- Calculation flow is much better understood
- Changing parameters is associated with more descriptive text
- Output is preserved in one place or file
- Calculation is associated with descriptive text and equations
- Application of J&E Model features are planned for the future







- VISL Home
- User's Guide What's New
- FAQ
- Equations
- Generic Tables Calculator

