Generic Numerical Standards/Property-Specific Risk Assessment

OAC 3745-300-08
OAC 3745-300-09

Certified Professional
8-Hour Training

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OhioEPA
Applicable Standards

• Clean up values that are protective of human health and the environment.

• Concentrations of COCs within environmental media that are considered by the VAP to satisfy the above statement.
Environmental Media

• Soil, sediment, surface water, and ground water
• Also includes naturally occurring transitional zones such as bedrock, soil gas, and air
Generic Standards

• Standards for hazardous substances or petroleum derived for soil, indoor air, and ground water
• Generic numerical direct-contact soil standards
• Generic indoor air standards due to vapor intrusion
• Generic unrestricted potable use standards (UPUS)
Phase I and Phase II assessments

- Release history
- Selection of COCs
- Pathway analysis
- Exposure point concentration
- Demonstration of compliance with applicable standards
Guidance documents

• Risk Assessment Guidance for Superfund
• Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures
• Soil Screening Guidance, User’s Guide and Technical Background Document
• Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites
Soil direct-contact pathway

- Incidental ingestion of contaminated soil
- Inhalation of contaminated soil particulates
- Inhalation of volatile COCs from soil
- Dermal contact with non-volatile COCs in soil
Property-specific risk assessment if:

- Exposure pathways not considered in development of generic standards
- Exposure scenarios are different than those listed in the tables
- COCs are not listed in rule 08 tables
PSRA if (cont.)

- Complete exposure pathways to important ecological resources
- Standards exceeded for sediment or surface water
Petroleum Standards

GNS = BUSTR ORC 3737.882 (B)

- Pathways included in BUSTR standards do not have to be assessed separately in VAP
- If BUSTR NFA has been issued the requirement to identify as an IA has been removed
Free Product

• Definition: a separate liquid hydrocarbon phase that has a measurable thickness of greater than one one-hundredth of a foot.
Generic Standards for Soils

Table I - residential land use

- Direct contact is assumed from surface to 10 feet below surface
  - 10 foot point of compliance
- Protective for, and may be applied to, all land use categories, without restriction
Generic Standards for Soils

Table II – commercial/industrial land use

• Direct contact is assumed from surface to 2 feet below surface.
  – 2 foot point of compliance
• Requires an environmental covenant as a remedy
Generic Numerical Standards for Soils

Table III – construction/excavation activities

• Point of compliance is the anticipated depth of activity
OAC 3745-300-08
Generic Numerical Standards

• *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures*
• A transparent description of procedures used to derive generic standards
• Describes PSRA procedures
How are the standards generated?

Generic standards have historically been generated using a probabilistic method

– program runs 10,000 times, randomly selecting values from the distributions
– The 90th percentile value selected as the cleanup standard
How are the standards generated?

• Point values - deterministic method uses one value for each input

• Default US EPA assumptions already used within the RSLs, except:
  • Construction Worker standards; and
  • Ohio-specific Particulate Emission Factor and Volatilizations Factors
US EPA Regional Screening Levels Default Inputs

• Consistent with Remedial Response (RR) and RCRA
  – RSLs can be used as screening levels in RR & RCRA
  – VAP does not use RSLs as cleanup levels

• The Ohio Risk Goal and Hazard Index at 1E-05 and HI of 1 remain the same
Exposure Factors

- Exposure Duration (years)
- Exposure Frequency (days/year)
- Exposure Time (hours/day)
- Body Weight (kg)
- Soil Ingestion Rate (mg/day)
- Fraction Contaminated Soil (assume 50 percent)
- Surface Area of exposed skin (cm$^2$)
- Soil Skin Adherence Factor (mg/ cm$^2$)
Standardized modeling assumptions for soil and climatic parameters

- Fraction vegetative cover
- Soil porosity
- Soil bulk density
- Fraction organic matter
- Wind speed
- Diffusion height...etc..
COC parameters

Physical Properties
• molecular weight
• Henry’s Law constant
• organic carbon adsorption coefficient
• solubility
• air and water diffusivity
• melting point
Use of appropriate toxicity criteria

• U.S. EPA
  – IRIS
    http://www.epa.gov/iris/subst/index.html

• Ohio EPA
  – Provisional Peer-Reviewed Toxicity Values (PPRTVs)
  – ATSDR
  – California EPA and other states
Toxicity Changes in 2014

- Mutagenic mode of action in the chemical’s toxicological profile in IRIS (Methylene Chloride and TCE are examples)
- Arsenic and Vinyl chloride have new understandings adopted
Generic Numeric Direct Contact Soil Standard

- Single chemical standard is lowest of cancer, non-cancer, or soil saturation value
- Must account for the presence of multiple chemicals
Soil Saturation

\[ C_{SAT} = \frac{S}{\rho_b} (K_d \rho_b + \theta_w + H' \theta_a) \]

Where:
- \( S \) = solubility in water
- \( \rho_b \) = dry soil bulk density
- \( K_d \) = soil/water partition coefficient
- \( \theta_w \) = water – filled soil porosity
- \( H' \) = Henry’s Law constant (chemical specific)
- \( \theta_a \) = air – filled soil porosity
Generic Numerical Standards for Indoor Air due to Vapor Intrusion

- Table IV – Residential Land Use
- Table V – Commercial/Industrial Land Use
- These values can be used to evaluate volatile chemicals in ground water or soil gas with use of attenuation factors
Conceptual model of the vapor intrusion exposure pathway
Unrestricted Potable Use Standards (UPUS)

- Table VI – Maximum Contaminant Levels (MCLs)
- Table VII – risk-derived
  - Ingestion
  - Inhalation
  - Dermal contact while showering
Surface Water Generic Numerical Standards

• Outside the Mixing Zone Average (OMZA) - OAC 3745-1

• Compared to 30-day average value from:
  – Adjacent ground water monitoring wells
  – Surface water on the property
  – Off-property surface water locations
Surface Water

• All regulated point source discharges must comply with all permit requirements.
• Includes general storm water permits.
• VAP relies on permit limits as meeting applicable standards for point sources.
Sediments

• Complete exposure pathways on the property
• Contaminated sediments migrating from the property
• Ohio EPA “Sediment Sampling Guide and Methodology”
Human Health Evaluation

• COCs are persistent, bioaccumulative and toxic
• Surface water produces edible-sized fish, supports wading, swimming, boating
• Property-specific risk assessment
Exposure of Important Ecological Resources to Sediments

- Sample sediments directly
- Compare to reference values in Ohio EPA “Guidance for Conducting Ecological Risk Assessment”
Exposure of Important Ecological Resources to Sediments

• If no SRVs, compare to consensus-based threshold effects concentration values in MacDonald, et al.

• Conduct PSRA if COCs are persistent, bioaccumulative, and toxic
Exposure of Important Ecological Resources to Sediments

If sediments not compared to values, or COC concentrations exceed values, then bioassay or biocriteria surveys must be conducted.
Multiple Chemical Adjustment

Technical Guidance Compendium document

- For all COCs listed in Tables I, II, III, IV, V and VII.
- MCA for soil and ground water done separately – generic standards only
- Inappropriate for Lead, Background, or MCLs (Table VI)
Adjusting for Multiple Chemicals

• Separate cancer/non cancer end points
• Divide site concentration by single chemical standard
• Add ratios
• If cumulative ratio < 1.0, the soil concentrations meet the multiple chemical standard
Adjusting for Multiple Chemicals

• Alternatively, can divide the standard for each COC by number of COCs
• Compare adjusted value to site concentration
Adjusting for Multiple Chemicals

• If ratio sum > 1.0, then one or more COCs must be remedied until the ratio equals 1.0.
• Can derive a “flexible” multiple chemical standard by utilizing the buffer of risk from all COCs
# Example of MCA

<table>
<thead>
<tr>
<th>COC</th>
<th>Concentration (mg/kg)</th>
<th>Cancer Standard</th>
<th>Non cancer standard</th>
<th>Single chemical standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td>90</td>
<td></td>
<td>3,500</td>
<td>3,500</td>
</tr>
<tr>
<td>Anthracene</td>
<td>500</td>
<td></td>
<td>18,000</td>
<td>18,000</td>
</tr>
<tr>
<td>Benzo(a)-anthracene</td>
<td>12</td>
<td>11</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Benzo (a) pyrene</td>
<td>8</td>
<td>1.1</td>
<td></td>
<td>1.1</td>
</tr>
</tbody>
</table>
Example of MCA

• Noncancer ratio < 1
  – Acenaphthene: 90/3,500 = .03
  – Anthracine: 500/18,000 = .03

• Cancer ratio > 1
  – Benzo(a)anthracene: 12/11 = 1.09
  – Benzo(a)pyrene: 8/1.1 = 7.27
MCA

• Alternatively, can calculate MCA by dividing standard by the number of COCs.

• Determine if site concentration exceeds standard

• Can adjust the standard to make up for “extra risk” in other COCs
Soil Standards - COC
Concentrations From Soil to Ground Water

• Concentrations that meet UPUS for GW when GW meets UPUS

• Any other pathway requirements that must be met when GW exceeds UPUS
Property-Specific Risk Assessment

• Based on same principles as generic numeric standards
• Elective or mandatory application
  – Use of property-specific information as algorithm inputs
PSRA – Mandatory Applications

- Exposure pathways not included in generic standards
- COC does not have a generic standard
- Concentrations of COCs exceed standards in surface water or sediment
PSRA – Mandatory Applications

- Complete exposure pathway to important ecological resource
- COCs are persistent, bioaccumulative and toxic
PSRA – Risk Goals

• Same as for generic numerical standards

• Industrial risk goal of $1E^{-04}$ for carcinogenic COCs

• Petroleum release assessment dependent on petroleum fraction of product
Human Health Risk Assessment

- Selection of COCs
- Exposure assessment
- Toxicity assessment
- Risk and Hazard Characterization
  - Incremental and cumulative risk from multiple pathways
  - Uncertainty analysis (optional)
Human Health Risk Assessment

• Exposure Assessment
  – Identify receptors
  – Evaluation of exposure pathways
  – Quantification of intake
Human Health Risk Assessment

- Toxicity Assessment
  - IRIS updates
- Risk Characterization
  - Calculation of incremental risk
    - For each cancer and non cancer COC and for each exposure pathway
  - Calculate cumulative risk across complete pathways for each receptor
Calculation of Site-Wide Risk (cancer)

<table>
<thead>
<tr>
<th></th>
<th>Soil Direct Contact (from all COCs)</th>
<th>Indoor Air (from all COCs)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>0.8</td>
<td>0.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Incremental Risk</td>
<td>8E-06</td>
<td>9E-06</td>
<td>1.7E-05</td>
</tr>
</tbody>
</table>
Important Ecological Resources

- Excluding sediment and surface water
- Rare, endangered or threatened species
- Wildlife populations and their important nesting areas and food resources
Aquatic Life Use Designation

- Assessment of physical habitat
- Knowledge of what the habitat will support
- Ohio EPA sampled reference sites
Aquatic Life Use Designations

Biological assessment of fish and macroinvertebrates

- Exceptional warm water habitat (EWH)
- Warm water habitat (WWH)
- Modified warm water habitat (MWH)
- Coldwater habitat (CWH)
- Seasonal salminid habitat (SSH)
Biocriteria

- Measure of attainment of designated use
- Habitat plays an important role
- Metrics provide an analysis of possible effects from site impacts
Biological Surveys

• Ohio biocriteria certification training
• Bioassessment under paid technical assistance
Sediments - Ecological Risk Assessment

- Demonstrate that COCs on the property are not contributing to the failure to meet, or
- Remedy source and/or sediment
Applicable Standards From a PSRA

- Concentration of COCs meeting human health risk goals;
- Concentration of COCs meeting ecological risk goals
- Sediment standards
- Surface water
- Soil saturation
Risk Assessment Report

- Reason for PSRA
- List of institutional and/or engineering controls
- List of COCs not considered
Risk Assessment Report (cont.)

• List of receptor populations and exposure pathways
• Derivation and application of exposure factors used to quantify intake
• Toxicity values
• Risk characterization
Risk Assessment Report (cont.)

- Uncertainty analysis (if conducted)
- Ecological, sediment, surface water assessment
- Summary of compliance with applicable standards
COMMERCIAL/INDUSTRIAL LAND USE

IA-1: FORMER MANUFACTURING FACILITY

IA-2: FORMER PAINT BOOTH

IA-3: TCE SPILL

IA-4: FORMER UST

WAREHOUSE

PROPERTY BOUNDARY

CREEK

RESIDENTIAL LAND USE
## Site Conceptual Model

### Identified Areas
- **Surface Soils**
  - Volatilization
  - Wind erosion
- **Sub-Surface Soils**
  - Leaching
- **Shallow Ground Water**
  - Leaching
- **Bedrock Ground Water**

### Exposure Medium
- **Particulate Emissions**
  - Soil gas
- **Soil Gas**
  - Volatilization
  - Diffusive or convective transport

### Reception
- **Indoor air**
  - Oral
  - Dermal
  - Inhalation

### Exposure Mechanisms
- **Primary Source**
- **Secondary Source**

### Table

<table>
<thead>
<tr>
<th></th>
<th>On-Property</th>
<th>Off-Property</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C/I</td>
<td>C/E</td>
</tr>
<tr>
<td>Oral</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Dermal</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Inhalation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Dermal</td>
<td>X</td>
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<td></td>
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</tr>
<tr>
<td>Dermal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhalation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Site Conceptual Model

Identified Areas

Primary Source → Secondary Source → Exposure Medium → Receptor

- Surface Soils
- Sub-Surface Soils
- Shallow Ground Water
- Bedrock Ground Water
- Surface Water & Sediment

Release Mechanism:
- Volatilization
- Diffusive or Convective Transport
- Wind Erosion
- Leaching

Particulate Emissions

Soil Gas

Indoor Air

On-Property

- Oral
- Dermal
- Inhal.

Off-Property

- C/I
- C/E
- Res

Exposure Medium

- Oral
- Dermal
- Inhal.

Receptor

- X
- F
- X
- X
- X
- X
- X
- X
- X
- X
- X
- X
- X
### SOIL DIRECT-CONTACT PATHWAY
for commercial/industrial land use

<table>
<thead>
<tr>
<th>COC</th>
<th>EPC (mg/kg)</th>
<th>STANDARD FOR A SINGLE CHEMICAL NON-CARCINOGEN (mg/kg)</th>
<th>HAZARD QUOTIENT</th>
<th>STANDARD FOR A SINGLE CHEMICAL CARCINOGEN (mg/kg)</th>
<th>RISK RATIO</th>
<th>SOIL SATURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>B(a)P</td>
<td>4.1</td>
<td>NA</td>
<td>NA</td>
<td>5.8</td>
<td>0.707</td>
<td>NA</td>
</tr>
<tr>
<td>LEAD*</td>
<td>120</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>TCE</td>
<td>50</td>
<td>170</td>
<td>0.294</td>
<td>690</td>
<td>0.072</td>
<td>51</td>
</tr>
<tr>
<td>VINYL CHLORIDE</td>
<td>ND</td>
<td>1,000</td>
<td>NA</td>
<td>50</td>
<td>NA</td>
<td>3,900</td>
</tr>
</tbody>
</table>

**TOTAL**

- **0.3**
- **0.8 (8E-06)**

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Table II of OAC 3745-300-08 Appendix A

![Ohio EPA Logo](Ohio EPA Logo)
GROUNDWATER TO INDOOR AIR PATHWAY
for commercial/industrial land use

<table>
<thead>
<tr>
<th>COC</th>
<th>EPC (µg/L)</th>
<th>CALCULATED INDOOR AIR CONCENTRATION (µg/m³)</th>
<th>HAZARD QUOTIENT</th>
<th>RISK RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCE</td>
<td>42</td>
<td>8.3</td>
<td>0.95</td>
<td>0.28</td>
</tr>
<tr>
<td>VINYL CHLORIDE</td>
<td>110</td>
<td>82.5</td>
<td>0.19</td>
<td>3.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>1</td>
<td>3 (3E-05)</td>
<td></td>
</tr>
</tbody>
</table>

U.S. EPA’S VISL Calculator
COMMERCIAL/INDUSTRIAL LAND USE

IA-1: FORMER MANUFACTURING FACILITY

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RESIDENTIAL LAND USE

100 ft. PROPERTY BOUNDARY

soil boring
monitoring well
sediment/surface water sample
soil gas sample

CREEK

Ohio EPA

100 ft.
# Groundwater to Indoor Air Pathway

## For Commercial/Industrial Land Use

<table>
<thead>
<tr>
<th>COC</th>
<th>EPC (µg/m³)</th>
<th>Calculated Indoor Air Concentration (µg/m³)</th>
<th>Hazard Quotient</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCE</td>
<td>42</td>
<td>10.2</td>
<td>1.4</td>
<td>0.42</td>
</tr>
<tr>
<td>VINYL CHLORIDE</td>
<td>192</td>
<td>57.6</td>
<td>0.13</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2</strong></td>
<td><strong>3 (3E-05)</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**U.S. EPA’s VISL Calculator**

[Image of the U.S. EPA’s VISL Calculator]
COMMERCIAL/INDUSTRIAL LAND USE

IA-1: FORMER MANUFACTURING FACILITY

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PROPERTY BOUNDARY

RESIDENTIAL LAND USE

CREEK

soil boring
monitoring well
sediment/surface water sample
soil gas sample

100 ft.
CUMULATIVE RISK
for commercial/industrial land use

<table>
<thead>
<tr>
<th>PATHWAY</th>
<th>HAZARD QUOTIENT</th>
<th>RISK RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOIL DIRECT-CONTACT</td>
<td>0.3</td>
<td>0.8</td>
</tr>
<tr>
<td>SOIL AND GROUNDWATER TO INDOOR AIR</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.5</td>
<td>0.9</td>
</tr>
</tbody>
</table>