Risk Evaluation: Soil Direct Contact

8.1 Introduction

Soil direct contact is associated with a group of exposure scenarios where receptors come into contact with potentially contaminated soil. The Indiana Department of Environmental Management (IDEM) publishes screening levels for four such scenarios:

- Residential soil contact
- Commercial/industrial soil contact
- Excavation worker exposure
- Recreational user exposure (limited subset)

Soil direct contact occurs via one or more of four absorption routes:

- Absorbing chemicals through the skin when touching soil
- Inhaling vapors while in direct contact with potentially contaminated soil
- Inhaling potentially contaminated soil particles (e.g., dust)
- Ingesting potentially contaminated soil

Because these absorption routes often exist simultaneously for a given receptor, IDEM’s published screening levels combine the ingestion, inhalation, and dermal absorption routes into a single value for each exposure scenario. While screening levels are a useful benchmark during initial risk evaluations, it is also possible and often appropriate to derive and use other remediation objectives.

8.2 Applicability

Direct contact can occur at or near the existing soil surface, to subsurface soil left on the surface following excavation, or to soils exposed during trenching or excavation activities. IDEM considers both current and potential exposures when evaluating soil direct contact risk. The origin of a release, current and expected land use, and contaminant type are important considerations when evaluating soils for direct contact risk.

8.3 Evaluating Soils for Direct Contact Risk

The origin of the release is an important consideration when evaluating direct contact risk. When evaluating a surface release, it may be necessary to begin sampling soil at the ground surface, proceeding vertically and horizontally until the extent of contaminated soil is adequately understood. Conversely, an underground storage tank release may not warrant a surface investigation. The potential for soil direct exposure, rather than predetermined soil depths, drives the evaluation.
For example, the greatest risk from recreational exposure at a city park (e.g., baseball field or playground) may be from routine exposure to the top few inches of soil. Gardening or landscaping activities may result in soil direct contact risk to a depth of two feet or more. Deeper soils, once excavated and left on the surface, may pose a future direct contact risk. Where excavation or utility work is reasonably likely to expose workers to soils at depth, evaluate those soils for direct contact risk.

Current and expected future land use are also important when assessing soil direct contact risk. Evaluations of potential exposure scenarios require judgment regarding the reasonable likelihood of unacceptable risk based on current and future land use(s). Important factors in this evaluation include:

- Chemical type (volatile organic compounds, metals, etc.)
- Chemical distribution
- Chemical concentration and mass

Some chemicals are more likely than others to pose long-term soil direct contact risk. For example, IDEM’s residential soil direct contact screening levels assume exposures over a 30-year period. However, volatile chemicals are unlikely to persist at the soil surface because they tend to dissipate into the air. Conversely, semivolatile compounds and metals are likely to persist in surface soil and may pose a greater long-term direct contact risk.

Chemical distribution is important when evaluating the potential of subsurface soil to contribute to future direct contact risk. For example an isolated “hot spot” of contaminated subsurface soil is less likely to be excavated and become surface soil than is a larger area of contaminated subsurface soil. Vertical distribution is also important. Shallower soils are more likely to be excavated than deeper soils. IDEM considers it generally unlikely that soils deeper than 15 feet below ground surface will be brought to the surface in the future, and in most cases it is not necessary to evaluate soils deeper than 15 feet for soil direct contact risk.

Contaminant concentration and mass are other factors to consider when evaluating direct contact risk for subsurface soil. Highly concentrated contamination (e.g., 100 times the screening level) may result in an overall higher average concentration if the soil is mixed and brought to the surface. This is also a function of depth and distribution: highly contaminated soil at a relatively shallow depth (e.g., four to ten feet) that is uniformly distributed across a relatively large area is more likely to result in excessive direct contact risk if the soil is brought to the surface.

Excavation worker exposure can occur below the ground surface during trenching or excavation activities. Excavation worker remediation objectives apply in subsurface soils to an appropriate site-specific depth wherever excavation is reasonably likely. Other site-specific considerations may also be relevant; IDEM will evaluate other site-specific considerations on their merits.
8.4 Soil Direct Contact: Exposure Point Concentrations (EPCs)

Methods for deriving EPCs vary according to sampling approach. For judgmentally collected samples, the individual sample results for each potential contaminant are generally the EPCs. Where judgmentally collected samples are of sufficient density and spacing, it may be appropriate to estimate the upper confidence limit of the mean (UCL)\textsuperscript{49} to represent the EPC. If the sampling locations are judgmentally guided using field instruments (e.g., photoionization detector), the resulting UCL is likely to be biased high. Nevertheless, some investigators may wish to use this approach to derive a conservative EPC, particularly where a few individual sample results exceed remediation objectives. For systematically collected samples, the EPC is an appropriate UCL calculated for each potential contaminant using results from a sample array that corresponds to the area under evaluation. The resulting UCL is the EPC.

Different procedures are appropriate when deriving soil direct contact EPCs for lead. When deriving screening levels for lead, IDEM uses the Integrated Exposure Uptake Biokinetic (IEUBK) Model for residential child exposure and the Adult Lead Methodology (ALM) for commercial and industrial exposures. Because those models utilize central tendency parameters, U.S. EPA (2003, 2007) suggests basing EPCs for evaluation of soil direct contact with lead on the arithmetic mean (unweighted average) of lead samples from soil particles less than 250 μm in diameter.\textsuperscript{50} While U.S. EPA guidance focuses on residential yards, the arithmetic mean is also appropriate for larger areas, provided the sample design reasonably represents exposure across those areas. Stratified grid sampling\textsuperscript{51} is one means of accomplishing this, as it limits the size of each exposure area under evaluation.

Sometimes it is necessary to resample an area and derive new EPCs. For example, resampling is appropriate following removal or treatment of contamination.

\textsuperscript{49} Software applications exist that can perform the necessary calculations and recommend an appropriate UCL. For example, \textit{ProUCL} is available for free download at the U.S. EPA website. Whatever the approach, IDEM review of UCL calculations will require submission of algorithm inputs and outputs.

\textsuperscript{50} This typically requires sieving soil during the sample collection process.

\textsuperscript{51} See U.S. EPA (1996a, especially Chapter 4) for additional guidance.
8.5 Soil Direct Contact: Screening Levels

As noted earlier, IDEM publishes soil direct contact screening levels for several exposure scenarios. A comparison (Section 8.7) of EPCs derived from site analytical data against appropriate screening levels is usually the first step when evaluating potential exposure risk. *Appropriate screening levels depend on the likely exposure scenario.*

Figure 8-A highlights the location of soil direct contact screening levels in the screening levels table. In this example, Chemical G has the following soil direct contact screening levels:

- Residential soil direct contact (Column A) 1200 mg/kg
- Commercial/industrial soil direct contact (Column B) 3700 mg/kg
- Excavation worker soil direct contact (Column C) 6200 mg/kg

**Figure 8-A: Soil Direct Contact Screening Levels**

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CASRN</th>
<th>Soil Exposure Direct Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Res (mg/kg)</td>
</tr>
<tr>
<td>Chemical A</td>
<td>1-1</td>
<td>380</td>
</tr>
<tr>
<td>Chemical B</td>
<td>1-2</td>
<td>340</td>
</tr>
<tr>
<td>Chemical C</td>
<td>1-3</td>
<td>120</td>
</tr>
<tr>
<td>Chemical D</td>
<td>2-1</td>
<td>1700</td>
</tr>
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<td>Chemical E</td>
<td>2-2</td>
<td>85000</td>
</tr>
<tr>
<td>Chemical F</td>
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<td>Chemical G</td>
<td>3-1</td>
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</tr>
<tr>
<td>Chemical J</td>
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</tr>
<tr>
<td>Chemical K</td>
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</tr>
<tr>
<td>Chemical L</td>
<td>4-3</td>
<td>42000</td>
</tr>
</tbody>
</table>

*Note: For ease of presentation, this sample of the screening levels table does not include columns related to ground water or vapor exposure.*

Most of IDEM’s screening levels appear in Table A-6 of Appendix A. Recreational soil direct contact screening levels for a smaller subset of chemicals appear in Table A-7.
8.6 Soil Direct Contact: Site-specific Levels

Appendix A describes the procedures that IDEM uses to derive screening levels from U.S. EPA’s Regional Screening Level (RSL) tables.

U.S. EPA (2011) describes procedures for deriving screening levels. Those procedures use equations that incorporate many different parameters, some of which exhibit a considerable range of values. U.S. EPA typically employs parameter values at the protective end of their ranges when deriving screening levels. However, those parameter values may not accurately reflect conditions at a particular site. Where that is the case, it may be worthwhile to collect site-specific data for one or more parameters and use those data in conjunction with the relevant equations to derive site-specific levels. When properly derived, site-specific levels are entirely appropriate for use in evaluating potential exposure risks.

Sometimes, even large changes in particular parameter values have little or no effect on the site-specific levels of a chemical. In other cases, effects may be substantial in some chemicals and negligible in others. IDEM suggests careful consideration of the potential benefits and expense of performing site-specific evaluations before undertaking them. A sensitivity analysis using an iterative evaluation of the reasonable range of potential values for each parameter may prove useful.

8.7 Soil Direct Contact: Closure

In general, areas where soil direct contact EPCs are less than residential remediation objectives are typically eligible for unconditional closure of the soil direct contact exposure pathway.

Options for sites where EPCs exceed residential remediation objectives include:

- Removal or treatment of contamination until EPCs are below residential remediation objectives.
- Implementation of institutional controls and, if necessary, engineering controls, that reduce exposures to acceptable levels.
- A demonstration, using risk characterization or appropriate lines of evidence, that a remedy is not necessary.

Figure 7-A (Section 7.7) presents a generalized decision tree for comparing EPCs and remediation objectives.