White Paper

Examination of Risk-Based Screening Values and Approaches of Selected States

December 2005

Prepared by
The Interstate Technology & Regulatory Council
Risk Assessment Resources Team

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444 North Capitol Street, NW, Suite 445, Washington, DC 20001

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Members of the Risk Assessment Resources Team (listed in Appendix D) participated in the writing and reviewing of the document. We also wish to thank the organizations that made the expertise of these individuals available to the ITRC.

Primary authors of the document include the following:

- Stephen DiZio, California Environmental Protection Agency (CAL/EPA) Department of Toxic Substances Control, Team Leader
- Brian Espy, Alabama Department of Environmental Management
- Ligia Mora-Applegate, Florida Department of Environmental Protection
- Brad Parman, Tennessee Division of Remediation
- Jim Brown, Georgia Environmental Protection Division
- Bennett D. Kottler, Nevada Division of Environmental Protection
- Tracy Hammon, Colorado Department of Public Health and Environment
- Fran Collier, CAL/EPA, Department of Toxic Substances Control
- Smita Siddhanti, EnDyna Inc., Team Program Advisor
- Lee Poe, stakeholder representative

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EXECUTIVE SUMMARY

The Interstate Technology Regulatory Council (ITRC) Risk Assessment Resources Team, formed in 2003, aspires to provide state and federal agencies as well as the interested parties with resources that will act as an aid during the risk assessment and risk management process. The ITRC Risk Assessment Resources Team (Risk Team) prepared this document *Examination of Risk-Based Screening Values and Approaches of Selected States* (henceforth called *State Screening Values*) to provide information on the different methods used by regulatory agencies to develop and apply screening values for evaluating contaminated media. The main objective of the ITRC Risk Team study was to document and analyze the differences among selected states for the screening values used to evaluate contaminants in groundwater, surface water, and soil in residential and industrial land use scenarios. This effort was undertaken to understand the basis for the development of the various criteria and to assess how these criteria are utilized. The Risk Team focused on examining and documenting the various screening values for five specific contaminants that are often identified as drivers for management actions at contaminated sites. The approach followed was to document the differences, if any, among states for each of the selected chemicals and to explore the potential sources of variation in calculation. Additionally, the team researched how the screening values were applied in each state for various media and land-use scenarios.

Screening values, intended to be protective of human health and/or the environment, are often defined as chemical concentrations in environmental media below which no additional regulatory attention is warranted. If chemical concentrations at a site exceed the screening values, then additional investigation or evaluation of that chemical is warranted. Risk-based screening values are derived from equations combining exposure assumptions with toxicity data. The US Environmental Protection Agency's (EPA) Soil Screening Guidance (EPA 1996) provides a standard methodology to calculate risk-based soil screening levels for contaminants in soils that may be used to identify areas needing further investigation. Generic screening values are available for chemicals in various media. Screening values for a specific chemical may vary among states and even among different regions of EPA. Several explanations exist for these discrepancies among screening values, including differences regarding what constitutes a health-protective target risk level.

The ITRC Risk Team developed a questionnaire to query different states and agencies about their methodology for determining risk-based concentrations and establishing standards for chemicals in water and soil. Eleven of the thirteen states examined in this study were chosen because regulators from those states are members of the ITRC Risk Team and were able to provide information about their agency's approach to developing and/or adopting risk-based screening values. The states that participated include: Alabama, Arkansas, California, Colorado, Florida, Georgia, Kansas, Nevada, Oklahoma, South Carolina, and Tennessee. Two additional states, Kentucky and Michigan, were included in the study. Five different constituents were chosen based on the interests of the ITRC Risk Team, and the prevalence of these chemicals at hazardous waste sites. The constituents selected were arsenic, benzo(a)pyrene, lead, polychlorinated biphenyls, and trichloroethene.

State Screening Values is a summary and analysis of data collected in the ITRC Risk Team survey. It is evident that there is variability in each state's basis and intended use of the screening values. Although data has been collected regarding screening criteria from multiple media, the detailed analysis presented here focuses on soil and groundwater screening criteria. In some cases, the variability is minimal, while in others the variability may be large (e.g., greater than an order of magnitude). The minimal differences among states' published screening values may be explained by rounding of values or other small differences in the input parameters; however, published screening levels for a chemical can differ from state to state by several orders of magnitude and the reasons for these differences are not always apparent.

Throughout this study, it became clear that the developer of a particular set of screening values must publish the rationale behind each screening value and the intended uses for the screening values (along with any restrictions). A clear and well described rationale can prevent the use of screening values in situations for which they were not intended (for example, the use of a value intended to protect workers should not be used at a site being considered for a future child care center). Transparency and additional guidance also increases the confidence of the regulated community, stakeholders, and the regulators in screening values. This report highlights the need for transparency of methodologies to develop screening values and their application at contaminated sites.

ITRC DISCLAIMER

This Report is based on the ITRC Risk Team survey conducted in Spring 2004. Most of the numerical data from the States has been through Quality Assurance checks in Fall 2004 and Spring 2005, but additional information summarized from the Survey in the Appendix B of this Report that may not have been updated. The ITRC Risk Team has made every attempt to ensure accuracy of information as reported in the survey but the ITRC takes no responsibility for updating this information.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

EXAMINATION OF RISK-BASED SCREENING VALUES AND APPROACHES OF SELECTED STATES

1. INTRODUCTION

Screening values, intended to be protective of human health and/or the environment, are often defined as chemical concentrations in environmental media below which no additional regulatory attention is warranted. If chemical concentrations at a site exceed the screening values, then additional investigation or evaluation of that chemical may be warranted. Risk-based screening values are derived from equations combining exposure assumptions with toxicity data. The U.S. Environmental Protection Agency's (EPA) *Soil Screening Guidance: A User's Guide* (EPA 1996) provides a standard methodology to calculate risk-based soil screening levels for contaminants in soils that may be used to identify areas needing further investigation. Generic screening values are available for chemical concentrations in various media. For soils, the generic values are published in the *Soil Screening Guidance: Technical Background Document* (EPA 1995). Several states and EPA Regions have developed their own generic screening values. Screening values, e.g., EPA Region 3 risk-based concentrations[1] (RBCs) or EPA Region 9 preliminary remediation goals[2] (PRGs) (EPA 2004a,b), are calculated using acceptable risk levels, such as a one in one million cancer risk and default, conservative exposure values. In many instances, states have used EPA values; some states, however, have elected to modify EPA values by, for example, modifying the level of acceptable risk.[3]

1.1 The Concept of Screening

Screening values provide guidance on whether site remediation may be required. Numerical criteria for chemicals in soil, air or water are often justified on the basis of a real or perceived need for data analysis during the initial phases of an investigation. The comparison of sample results to health-based numerical criteria is often depicted as an analysis of "risk" posed by that chemical in that medium. The next step in such a process is often the decision to either determine that no further action is needed or to take some form of "action" which may range from additional sampling and analysis to contaminant removal.

Screening values are concentrations of chemicals, in various media, derived from a target excess risk level (for carcinogens) or hazard quotient (HQ, for noncarcinogens) under generic exposure assumptions. Screening values developed and used for the same chemical vary among states and among regions of EPA. Several potential explanations exist for the discrepancies among

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[1] Risk-based concentrations are values derived for over 400 chemicals by combining toxicity factors with standard exposure scenarios to calculate chemical concentrations corresponding to fixed levels of risk in water, air, fish tissue, and soil (from http://www.epa.gov/reg3hwmd/risk/human/info/cover.htm).

[2] "Chemical-specific preliminary remediation goals (PRGs) are concentration goals for individual chemicals in specific medium and land use combinations which are used by risk managers as long-term targets during the analysis and selection of remedial alternatives. They are based on readily available information and are preliminary in nature. They are revised as site-specific data become available" (From: http://risk.lsd.ornl.gov/prg/prg_document.shtml)

[3] For chemicals which cause cancer, acceptable risk levels (probability of developing cancer) set by regulatory agencies generally range from 1 in 10,000 to 1 in 1,000,000. For noncarcinogens, acceptable risk is typically defined by a hazard quotient of 1, i.e., adverse health effects are unlikely if the exposure is equal to or less than a reference dose—the dose that is assumed to be without substantial risk. Some agencies incorporate conservatism (i.e., increased protection) into their screening values by lowering the acceptable risk level.

screening values. Some screening values are health based and derived using risk-based approaches, while others are based on levels of chemicals found naturally at background levels in the environment. Screening values based on ambient (background) concentrations or analytical detection limits are not health based. Differences observed among risk-based screening values may also be due to differences in the level of protection they are designed to afford or differences in the algorithms and assumptions used to derive them. Health-based screening values are derived using risk assessment approaches, which combine toxic potency estimates, acceptable target risks and hazards, and default exposure values. Default exposure values are intended to be conservative and avoid the underestimation of the actual risks at a site.

Often hidden in the screening value comparisons are the assumptions that were made in developing and calculating those screening criteria values. For example, risk from contaminated water assumes the consumption of two liters of water per day for a significant fraction of a lifetime. In addition, the contaminant concentrations are assumed to remain unchanged during that time period. Similar assumptions are also made for exposure to contaminated soil and air. Another example is that conservative screening criteria may assume infinite sources. However, finite sources often exist for anthropogenic contaminants.

1.2 Purpose and Scope of this Document

The Risk Team prepared this document to provide insight into the different means by which regulatory agencies develop and apply screening values to evaluate contaminated media. In order to conduct an in-depth study, the Risk Team focused on examining and documenting the different screening values for five specific contaminants that have been identified as drivers for management actions at numerous contaminated sites. The approach followed was to document the differences among the states for each chemical and then explore the potential sources of variation in the calculation and use of the screening values for soil and groundwater in various land-use scenarios.

This *State Screening Values* report builds on previous information developed by the California Center for Land Recycling (CCLR), which had done some preliminary work on the potential magnitude and extent of the disparities that exist among states. The Risk Team focused this study on five selected chemicals to examine the different screening concentrations used by regulatory agencies from thirteen states and to investigate in depth the approach behind the observed differences.

Eleven of the thirteen states were chosen for this study because regulators from those states are members of the Risk Team and were able to provide information about their agencies' approach to developing risk-based screening values. These states were: Alabama, Arkansas, California, Colorado, Florida, Georgia, Kansas, Nevada, Oklahoma, South Carolina, and Tennessee. Two additional states, Kentucky and Michigan, were included in the study because a preliminary review of information from CCLR indicated that these states may have developed screening values using unique approaches. Four chemicals and one chemical group were chosen based on the interests of the Risk Team and on the prevalence of these chemicals at hazardous waste sites. The chemicals selected were arsenic, benzo(a)pyrene (B(a)P), lead, polychlorinated biphenyls

(PCBs), and trichloroethylene (TCE). This study will assist interested parties to better understand the development and application of criteria to screen contaminated sites.

1.3 Study Objectives

The main objective of this study was to document differences in screening values, methods, and rationales used to derive those values among the thirteen states. The purpose of the screening values is to evaluate whether sites require any further investigation for groundwater, surface water and soils in residential and industrial land-use scenarios. In addition, this study examined the screening values used for protecting the migration of contaminants from soil to groundwater (leachability-based values). The Risk Team sought to understand both the basis for the development of the criteria and how the screening values are utilized by the thirteen states. Although this *State Screening Values* report documents the screening values in various media, the Risk Team focused its analysis of the variability in screening values to residential soil and groundwater.

1.4 Organization of the Document

Section 2 provides an overview of policy and regulatory basis for state-level risk-based soil screening values (SSLs). It summarizes state-specific guidance for development of risk-based screening values for surveyed states. Section 3 describes other efforts related to examining state SSLs. Section 4 describes our methodology used for the ITRC Risk Team survey of risk-based screening approaches by different states. Section 5 describes the various observations made from data synthesized and analyzed from survey for risk-based screening values for As, B(a)P, Pb, PCBs and TCE for the surveyed states. Section 6 summarizes the discussion of our results and conclusion. Section 7 provides recommendations and future steps.

2. POLICY AND REGULATORY BASIS FOR STATE-LEVEL RISK-BASED SCREENING VALUES

The evaluation and management of contaminated sites relies on risk assessment approaches and criteria to determine whether contaminated media (e.g., soil, groundwater) pose unacceptable risks to human health and the environment. Risk-based approaches follow the risk assessment paradigm set forth by the National Academy of Sciences (NAS 1983). This paradigm stresses the use of a conservative bias during the screening phase. The risk assessment paradigm consists of a tiered evaluation beginning with a conservative step in which generic screening criteria (based on default assumptions as opposed to site-specific values) are used to compare and identify sites and potential contaminants of concern that merit further evaluation. During subsequent phases, however, the use of field and laboratory data is emphasized to mitigate uncertainty in the assumptions and models used to predict exposure and toxicity. The site-specific data are used to better account for the fate of contaminants in the environment and to develop more realistic exposure assumptions to support site-specific decisions. Also, more representative exposure concentrations are developed through sampling methods that rely upon actual circumstances of exposure.

Risk assessment is an interdisciplinary process that incorporates science, policy, and professional judgment. Risk-based decisions are sometimes met with intense and divisive criticism by industry and environmental stakeholders, as well as the public, in part because data gaps and uncertainty in the risk assessment process require the use of professional judgment. Thus, it is essential that the rationale for each decision in the risk assessment process be clearly stated and justified, and that the decision-making process is transparent. This will facilitate the development of supportable, reproducible risk assessments and aid regulatory agencies in addressing the challenges posed by risk-based decisions.

State regulatory agencies conduct screening evaluations utilizing approaches that are often inconsistent with one another. There are many potential factors that may contribute to the differences observed among screening criteria used by various states. First, although most of the screening values are derived using risk-based approaches, some may be based on background concentrations or on technical considerations such as detection limits and the feasibility of cleanup.[4] Second, the differences observed among risk-based screening values may be due to variations in the level of protection they are designed to afford, or differences in the algorithms and assumptions used to derive them. Third, the same values may be applied in various ways. For example, EPA Region 9 PRGs are used by some states as screening values during initial evaluation and by other states as cleanup goals during remediation or as both. Thus, it is not surprising that screening criteria used to evaluate contaminated sites vary among states.

Risk-based values incorporate policy decisions, and the science behind the development of any risk-based value has inherent uncertainty and variability that requires interpretation. To maintain consistency in development of risk-based values within a state, each state relies on either regulatory or guidance documents to assist in the selection/calculation of representative values. The following are examples of state-specific guidance for development of risk-based screening values.

2.1 Alabama

Alabama recommends that facilities use the methods/values specified in the most current version of the *Alabama Risk-Based Corrective Action (ARBCA) Guidance Manual* (ADEM 2005, henceforth called the *ARBCA Guidance Manual*) when conducting a risk assessment. Table 2-2 within the guidance manual lists the EPA Region 9 PRGs as a major reference for the list of screening levels that should be used at a site. The manual cites the Region 9 PRG values referenced for residential and commercial soils. When evaluating the soil to groundwater pathway (leachability) of a contaminant, the state has calculated values based on the model cited by ASTM E1739-95 (ASTM 2002) and the default parameters cited within the *ARBCA Guidance Manual*. When using the soil screening levels for protection of groundwater, facilities must determine if the soil source is less than or equal to 270 yds^2, otherwise, a facility must utilize the value calculated for a source size of 1 acre or derive site-specific values in accordance with the *ARBCA Guidance Manual*. For groundwater, the *ARBCA Guidance Manual* cites EPA's maximum contaminant levels (MCLs). In the absence of an MCL, EPA Region 9 tap water PRG

[4] For example, a screening level for water can be set at the MCL, which is the "highest level of a contaminant that is allowed in drinking water. MCLs are set as close to Maximum Contaminant Level Goals (MCLGs) as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards." (http://www.epa.gov/safewater/mcl.html).

values are utilized (the noncarcinogens are adjusted to reflect an HQ of 0.1 as opposed to 1) or a direct ingestion of groundwater value may be calculated in accordance with the *ARBCA Guidance Manual*. The Alabama Water Quality Criteria, located in the ADEM Administrative Code 335-6-10, is used to calculate risk-based values for surface water in addition to the USEPA R4 Ecological Screening Values for surface water. The only values for which Alabama has clear legal authority are the MCLs located in the ADEM Administrative Code 335-7-2 and the surface water values located in Division 6. Additional information regarding the *ARBCA Guidance Manual* and the Department's regulations may be located at http://www.adem.state.al.us/.

2.2 Arkansas

Arkansas enacted the Hazardous Waste Management Act in 1979. This Act provided general enabling legislation and broad authority to the Arkansas Pollution Control and Ecology Commission and to the Director of the Arkansas Department of Environmental Quality (ADEQ) to develop and implement a hazardous waste management program and a hazardous substance remediation program. Arkansas has adopted federal standards (risk-based and statutory/regulatory) for the screening and cleanup of released hazardous waste and hazardous substances. For risk-based screening values, Arkansas uses the EPA Region 6 Human Health Medium Specific Screening Levels (better known as HHMSSLs), which can be found as a link on the ADEQ website, along with specifications on the state's hazardous waste requirements, collectively grouped in Regulation 23 (updated October 24, 2003, http://www.adeq.state.ar.us/hazwaste/branch_tech_admin/default.htm#Risk).

2.3 California

An amendment to the California constitution called the Safe Drinking Water and Toxic Enforcement Act of 1986 (called "Proposition 65") mandated that the state establish a "no significant risk" level of exposure for those chemicals known to the state of California to cause cancer. This was determined in regulation to be the level at which one would predict 1 cancer case in 100,000 people exposed to a contaminant. This was the geometric mean of the "acceptable risk range" established in the Code of Federal Regulations that implemented the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). There is no documentation on the rationale used for choosing the geometric mean (as opposed to the arithmetic mean, or the upper or lower end of the range). Recently Chapter 6.10 (commencing with Section 25401) was added to Division 20 of the California Health and Safety Code, and called the California Land Environmental Restoration and Reuse Act. This chapter, among other things, mandated the CA EPA to develop separate health-based screening levels for unrestricted land uses and a restricted, nonresidential use of land. The current recommendation is to base these on the de minimis cancer risk of 1×10^{-6} or a hazard index of 1. Those values are available at: http://www.oehha.ca.gov/risk/sb32soils05.html.

2.4 Colorado

The Colorado Hazardous Waste Act (Colorado Revised Statutes 25-15, pages 301–316) and its implementing Colorado Hazardous Waste Regulations (Colorado Code of Regulations section 6-1007-3, parts 99, 100, and 260–279) cover the disposal of hazardous waste. Any facility where hazardous waste has been released into the environment after November 19, 1980 is considered to be an unpermitted disposal facility subject to the hazardous waste regulations. The hazardous waste regulations give the Colorado Department of Public Health and Environment the authority to require the cleanup of releases into the environment caused by improper disposal of hazardous waste as necessary to protect human health and the environment. Colorado does not have promulgated, state-wide, soil remediation standards. Instead, the Health Department relies on conservative human health risk-based soil remediation objectives that are based on a hazard index of 1, or an excess cancer risk not exceeding 1 x 10^{-6}. The actual concentrations detected in site soil samples are compared to the soil remediation objectives on a point-by-point basis. The soil remediation objectives are often used directly as cleanup values for smaller facilities that do not have the resources to perform site-specific risk assessments. However, every facility has the option of using the soil remediation objectives as screening values and performing a site-specific risk assessment to derive actual soil cleanup standards. The soil remediation objectives also include soil concentrations protective of groundwater for many chemicals. These values were derived using a SESOIL/AT123D fate and transport model with generic assumptions regarding soil and groundwater conditions to back-calculate chemical concentrations in soil that would not cause exceedences of state groundwater standards. The soil levels protective of groundwater concentrations are true screening values. These are primarily used to determine whether groundwater monitoring will be required to demonstrate that a release of hazardous waste has not impacted groundwater beneath the site. The derivation and use of the soil remediation objectives are described in the "Soil Remediation Objectives Policy Document" dated December 1997 and available on the state's website at www.cdphe.state.us/hm/hmhom.asp.

Colorado has developed and promulgated the Basic Standards for Groundwater under the Colorado Water Quality Control Act (Colorado Revised Statute 24-4-103) and the Colorado Water Quality Regulations (Colorado Code of Regulations section 5-1002-41). Some of the groundwater standards apply to all state groundwater, and some apply only to specific uses. In general, the state groundwater standards are human health risk-based values generated using the unit risk factors listed in EPA's Integrated Risk Information System (IRIS) database. However, the Safe Drinking Water Act MCLs are used as groundwater standards for several chemicals, which had established MCLs prior to the development of risk-based values.

2.5 Florida

Florida has established four cleanup programs that use risk-based values to evaluate contaminated sites. These are the Petroleum, Brownfields, and Dry-cleaning Programs, and the program that addresses sites not covered by the three preceding programs. These programs function under legislative mandates that define an acceptable excess cancer risk as 1 x 10^{-6} and an acceptable hazard index of 1.0 for noncarcinogens. The Petroleum Cleanup Program incorporated risk-based corrective action (RBCA) approaches in 1997 by legislative mandate. The Program rules are laid out in Chapter 62-770 and the cleanup target levels (CTLs) are referenced in Chapter 62-777 of the Florida Administrative Code (FAC). The Brownfields Redevelopment Program was created by the legislature in 1997 and included RBCA as part of the implementing legislation. The approaches used by this Program are described in Chapter 62-785 and the CTLs referenced in Chapter 62-777, FAC. The Dry-cleaning Solvent Cleanup Program (DSCP) was created by the legislature in 1994; it adopted RBCA for the Program in

1998. The approaches used by the Dry-cleaning Program are found in Chapter 62-782 and the CTLs referenced in Chapter 62-777, FAC. The first three Programs mentioned above address approximately 95% of the contaminated sites in Florida. In 2003, House Bill 1123, also known as the "Global RBCA" bill, passed. This bill mandated that RBCA principles be used on **all** contaminated sites in Florida, using the same acceptable cancer risk of 1 x 10^{-6} and a hazard index of 1.0 for noncarcinogens, the program rule for the rest of these sites is Chapters 62-780 and the CTLs are referenced in Chapter 62-777, FAC.

After numerous public workshops, attended by many interested parties (industry, academia, environmental groups, and regulators), the above mentioned rules were updated/created and adopted in February 2005. All rules became effective in April 2005; they can be found at: http://www.dep.state.fl.us/waste/quick_topics/rules/default.htm.

This same website includes, among the guidelines for the program rules, an important document entitled *Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C*. The document describes in detail the methodology used to develop the CTLs, and it contains tables with the updated CTLs used in Florida, default assumptions, toxicity information, chemical/physical properties, etc., and appendices that explain how these values should be applied (specifically appendices D and E).

2.6 Georgia

In 1996, Georgia issued a guidance document entitled, *Georgia Environmental Protection Division Guidance for Selecting Media Remediation Levels at RCRA Solid Waste Management Units* (GEPD 1996) to provide a framework for facilities wishing to achieve risk-based closure of their solid waste management units (SWMUs). If a facility prefers not to follow the Georgia SWMU guidance, it can pursue closure by remediating the releases from their SWMUs to background concentrations. The Georgia SWMU guidance is based on the proposed Subpart S rules, and is based on evaluating the risk posed by releases from SWMUs to human health and the environment by conducting a human health and ecological risk assessment. The framework is basic and relies on the specific guidance from EPA Region 4 (*Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment Bulletins, EPA Region 4, May 2000*). For the screening portion of the risk assessment, chemical concentrations in surface and subsurface soils are compared to US EPA Region 9 PRGs residential soil screening values (set at risk level of $1x10^{-6}$ or an HQ of 0.1). The only exception is for subsurface soils at industrial sites, which may be screened against the Region 9 PRG industrial soil screening values based on a risk level of $1x10^{-6}$ or a HQ of 0.1 for construction worker exposure scenarios (if additional receptors exist, residential screening levels must be used). Screening for potential leaching of chemicals into groundwater is not permitted; rather, this pathway must be addressed as part of a baseline risk assessment. Chemicals of potential concern in groundwater are compared to Region 9 PRG tap water values determined at a risk level of $1x10^{-6}$ or a HQ of 0.1. If there is the potential for ecological receptors to be impacted by a release, then contaminants are screened against EPA Region 4 ecological screening values (see *Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 2001)*.

2.7 Kansas

Kansas uses its *Risk-Based Standards for Kansas* (RSK) manual to ensure that it fairly and consistently addresses contaminated sites in the state. In this manual, the Kansas Department of Health and Environment (KDHE) describe the process for establishing chemical- and site-specific cleanup goals for soil and groundwater for sites cooperating in an appropriate state program. The manual provides an overview of the rationale and process for determining soil and groundwater cleanup levels and is not intended for use in environmental audits, assessments, or other non-KDHE managed activities. Use of Tier 2 values established in the RSK manual without KDHE oversight may constitute misapplication of the of the RSK manual, and result in risk management decisions not supported by KDHE. The manual provides detailed information on definitions, formulas, and input parameters and was developed through collaboration with a private environmental contractor that had expertise in risk assessments. Chemical-specific and media-specific risk-based cleanup goals were calculated using guidance and directives from the EPA and other technical resources referenced in Section 9 of the guidance document. The primary benefit of the manual is the predetermination of acceptable cleanup goals without requiring the performance of a baseline risk assessment and/or contaminant fate and transport models. The manual also provides the following benefits:

- streamlines the decision-making process
- promotes consistency
- ensures remedial actions are protective of human health and the environment
- promotes flexibility by providing tabulated risk-based cleanup goals and the opportunity to develop site-specific cleanup goals
- considers land use
- provides the opportunity for use of institutional controls and/or financial assurance to ensure contamination remaining on site will not pose a future threat

Since the approach is not applicable to all sites, KDHE approval must be obtained prior to its use in a risk assessment. The Kansas RSK manual may be found online at www.kdhe.state.ks.us/remedial/rsk_manual_page.htm.

2.8 Kentucky

Kentucky uses EPA Region 9 PRGs as screening values for soils, sediments, water, and air, if applicable. In other words, cleanup standards are based on a site-specific evaluation of the applicability of the PRGs. If the use of PRGs is not appropriate for a site, cleanup standards are determined with site-specific risk assessments, following EPA guidance. In addition to PRGs and risk assessment-derived cleanup values, Kentucky also permits the use of MCLs, ambient background levels, action levels, and water quality standards. Kentucky receives legal authority to use these values in Kentucky Revised Statutes (KRS) 224.01-530 and KRS 224.01-532 as part of the state's Voluntary Environmental Remediation Program. Kentucky's Risk-Based Clean-up Standards are found at its Voluntary Clean-up Program's website located at www.waste.ky.gov/programs/sf/vcpguide.htm.

2.9 Michigan

The Michigan legislature has specified statutory risk requirements for risk-based cleanup criteria as an excess cancer risk of 1 x 10^{-5} for carcinogenic hazardous substances and a hazard quotient of 1 for hazardous substances posing a risk of noncancer effects (Parts 201 and 213 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended). The Michigan Department of Environmental Quality (MDEQ) has promulgated exposure pathway-specific algorithms with corresponding chemical-specific criteria for remediation of releases of hazardous substances. These criteria apply to state-funded and state oversight cleanups including RCRA corrective action in Michigan as an authorized state and cleanups with federal oversight (e.g. CERCLA). The leaking underground storage tank program uses the same cleanup criteria, referred to as risk based screening levels (RBSLs) in Part 213. The Michigan regulations provide both certainty and flexibility by promulgated criteria for unrestricted land use, plus the option to use site specific criteria and/or land use or resource use restrictions as appropriate.

The Michigan statute also specifies additional requirements including use of state drinking water standards, aesthetic criteria, or Toxic Substances Control Act standards for cleanup of polychlorinated biphenyls, if applicable. There are frequently multiple criteria for each medium, with the lowest applicable criterion used for a specific site. As an example, surface water (called groundwater-surface water interface, or GSI, for cleanups) criteria include values to protect human health, terrestrial wildlife and aquatic life. Human health values for surface water bodies vary depending whether there is a drinking water intake that may be impacted. There are human health values for drinking water, nondrinking water, cancer risk and noncancer health effects. RBCAs are located at Part 213; the full text of this regulatory passage is located at http://www.legislature.mi.gov/mileg.asp?page=getObject&objName=mcl-451-1994-II-8-213&highlight. Additional guidance is also provided at Part 201, available at http://www.legislature.mi.gov/mileg.asp?page=getObject&objName=mcl-451-1994-II-7-201&highlight) and Part 201, Administrative Rules (http://www.michigan.gov/deq/0,1607,7-135-3311_4109_9846-58095--,00.html). Part 7 of the Cleanup Rules (Rules 701-752) contain the health based algorithms and cleanup criteria. Additionally, the Operational Memoranda for the Part 201 and Part 213 Programs can be found at http://www.michigan.gov/deq/0,1607,7-135-3311_4109_9846_30022-101581--,00.html#RRD_01. Finally, the Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria can be found at: http://www.deq.state.mi.us/documents/deq-erd-stats-s3tm.pdf.

2.10 Nevada

Nevada uses a flexible approach—each site is evaluated on a case-by-case basis. EPA Region 9 PRGs are considered for clean up of soils and sediments if the bases for the PRGs are relevant to a given site. Nevada uses MCLs as the clean-up standards for groundwater. In the absence of published values, Nevada will consider using values based on EPA's IRIS values. Nevada’s authority to develop cleanup standards derives from the Nevada Administrative Code 445A.22705, which states that if required to take corrective action, an owner may conduct a risk assessment in accordance with ASTM Method E1739-95 (ASTM 2005) or an equivalent approved method.

2.11 Oklahoma

Oklahoma does not have state regulations regarding risk evaluation of different chemicals or media. Risk evaluation is based on the most current EPA guidance on risk assessment. The specific EPA guidelines used are as follows:

- *Soil.* EPA Soil Screening Guidance (EPA 1996), EPA Region 6 Screening Levels (EPA 2005a)
- *Groundwater*. EPA MCLs (EPA 2002a), National Secondary Drinking Water Regulations (EPA 2005c); EPA Region 6 Tap Water Screening Levels (EPA 2005a)
- *Surface water.* EPA National Recommended Water Quality Criteria (EPA 2002b), Oklahoma Water Quality Standards.

The Oklahoma DEQ's policies on waste remediation, spill cleanup, and risk-based decision making are found in www.deq.state.ok.us.

2.12 South Carolina

The State of South Carolina Department of Health and Environmental Control (DHEC) Superfund program follows EPA risk assessment guidance for conducting risk assessments. South Carolina DHEC uses EPA Region 9 PRGs for screening. The South Carolina DHEC Superfund program policy is to use 1×10^{-6} excess lifetime cancer risk (ELCR) as a point of departure for all risk assessments using the residential scenario as a baseline comparison standard regardless of proposed future land use. South Carolina has Ambient Water Quality Criteria (AWQC) for surface water. Groundwater standards are achieved by enforcing federal primary and secondary MCLs. Toxic Substances Control Act (TSCA) standards for PCBs (50 mg/kg) and lead (400 mg/kg) in soil are enforced as applicable or relevant and appropriate requirements (ARARs). Other comparison levels which are addressed include: IRIS, Agency for Toxic Substances and Disease Registry (better known as ATSDR), minimum risk levels, CA EPA, health effects assessment summary table(s), and others. EPA Region IV Ecological Screening Values (ESVs) are used for ecological risk assessment screening. However, every site is evaluated on its own merits. Larger Superfund sites have developed their own site protocols that are approved for use only at those sites.

2.13 Tennessee

Tennessee does not promulgate standards for any contaminant in any medium except tap water. For screening purposes, Tennessee uses screening values from EPA. For example, for human health evaluations the Department of Environment and Conservation (TDEC) uses EPA Region 9's PRGs. For ecological screening, TDEC usually uses EPA Region 4's ecological screening values. Tennessee screens for groundwater contamination by comparing concentrations to federal or state tap water MCLs. Cleanup and risk management decisions are considered on a case-by-case basis. Where it is economically beneficial, screening values may be used as cleanup standards rather than performing an in-depth risk assessment. In aquifers used for drinking water, tap water MCLs usually are the cleanup goals.

3. OTHER RELATED EFFORTS EXAMINING ASSESSMENT OF STATE SSLs

The California Land Environmental Restoration and Reuse Act (also referred to as "SB 32", Senate Bill, Chapter 764, Statutes 2001), requires Cal/EPA to develop screening levels for common contaminants found on the state's brownfields sites. Many states and EPA have argued that in the absence of these screening levels, brownfields projects are often delayed for long periods because it is difficult to estimate the cost of cleaning up the site. The CCLR assisted Cal/EPA with developing these screening levels by compiling a comprehensive database of soil and groundwater cleanup levels for all states with promulgated levels. Data have also been collected for all relevant federal standards, including MCLs, SSLs, and EPA Regional PRGs. The resulting searchable and relational database is composed of three essential elements:

- screening level data, organized by contaminant, state and medium; included in these data are the exposure pathways considered in the development of each screening level
- a suite of statistical and graphical analysis tools
- documentation of contact information, data sources, data entry methodology, and cleanup methodologies for each state

CCLR initiated the project in the summer of 2002 in collaboration with the Environmental Careers Organization's Sustainable Communities Leadership Program (SCLP). The final product is the result of six months of dedicated work by three full-time staff, the help of a professional database design consultant, and the invaluable assistance of state regulators across the country. Since such an undertaking had never been attempted before; CCLR designed the database from the ground up. They established an extremely rigorous and disciplined approach to interpretation and analysis of source material.

In 2003, the database consisted of 65 common contaminants of concern. CCLR's objective is to expand the database to include all the contaminants of concern across all state and federal agencies and to make the database easily accessible to a wider audience, including state and federal agencies, regulators and other brownfields stakeholders. The regulatory community can use this database to build their knowledge base and learn from each other's expertise and experience. In one recent example, a California regulator noticed in the database that the screening level for a particular contaminant varied dramatically from that of most other states and used the database again to contact the appropriate regulators in these other states to discuss the variance. This discussion then led to a re-evaluation and adjustment of the state's number. This powerful analytical tool has been proven to facilitate creative and substantive debate within the regulatory community not only on the screening values for specific constituents, but also on the relative merits of the variety of risk-based approaches employed by the regulatory agencies.

4. ITRC RISK TEAM SURVEY OF RISK-BASED SCREENING APPROACHES

The Risk Team developed a questionnaire to query different states and agencies about their methodology for determining risk-based concentrations and establishing standards for chemicals in water and soil. In July 2003, a preliminary version of the questionnaire was drafted and distributed among members of the Risk Team. Members were asked to review the questionnaire, and to provide feedback on the questions.

Based on the comments received, a final version of the questionnaire was prepared. A copy of this questionnaire is provided in Appendix C of this report. The final questionnaire had five general sections: overview, contact information, chemical-specific pages, assumptions, and questions. The information requested for each section is given below.

Overview. This initial page of the spreadsheet served to provide a description of the spreadsheet as well as information on how to complete the survey and where to submit completed files.

Contact Information. Respondents to the survey was requested to fill in their respective contact information.

Chemical Specific Pages. Five chemicals, namely, arsenic (As), TCE, lead (Pb), PCBs, and benzo(a)pyrene (B(a)P), were selected for this evaluation at the Risk Team meeting held in Livermore, CA, June 23-25, 2003. The chemicals were selected in part to represent a range of various chemical types (e.g., volatiles, metals). Overall, however, the selection process was the product of a group discussion in which various members submitted specific chemicals of interest. The selection was limited to these five chemicals because they are commonly detected at hazardous waste sites (EPA 2005c) and because using a limited number of compounds reduced the time required for completing the questionnaire.

Assumptions. Responding states and/or agencies were asked to provide information detailing their respective default risk-based cleanup standards and exposure parameters used. This information is helpful in finding the source of any discrepancies when comparing state values.

Questions. A series of additional relevant questions were posed in this section of the spreadsheet. Topics included exposure scenarios, established risk levels, and application of standards. These questions were developed with input from members of the Risk Team.

The states represented in this survey are Alabama, Arkansas, California, Colorado, Florida, Georgia, Kansas, Kentucky, Michigan, Nevada, Oklahoma, South Carolina, and Tennessee. The data were analyzed using qualitative methods in which the response categories were compared across the responding states to determine if substantial differences in methodologies were present. Numeric values for calculated risk-based concentrations or state standards were compared graphically. If differences in values were observed, the questionnaires were consulted to determine the reason for the difference.

5. OBSERVATIONS AND ANALYSIS OF DATA COLLECTED FROM THE ITRC STATE SURVEY

The following subsections describe the various observations made from data synthesized and analyzed from the ITRC Risk Survey of risk-based screening values for As, B(a)P, Pb, PCBs, and TCE for the states participating in this survey (Section 5.1). Section 5.2 details the exposure parameters and values used by various states in calculating screening levels in residential soil. In Section 5.3, the states' uses for risk-based screening values are given. Detailed information from the questionnaires is provided in Appendix D.

When investigating differences in values, it is important to consider the intended use of the value. For example, risk-based values for residential exposures and those for industrial exposures would not be expected to be equivalent. Additionally, identical values would not be expected when comparing a risk-based concentration to a technologically derived standard or a performance standard applied in the field.

5.1 Comparison of State Screening Values

Screening values obtained from the ITRC Risk Survey are summarized in various tables provided in this section and the data are analyzed for chemical-specific values (Section 5.1.1), for media-specific values (Section 5.1.2), and for chemical-specific screening levels for background (Section 5.1.3).

Survey response information regarding state-specific screening levels for five chemicals of interest was compiled into five tables (Tables 5-1–5-5). Each table contains the screening levels used by the states for a given chemical and each is sorted by medium. The information in the tables is not intended to be a comprehensive list of all screening values used by the participating states, and individual states may have additional screening values not contained in the tables.

In reviewing the information in the tables, conclusions regarding interstate consistency in selection of screening values are difficult to reach. This is because only 13 states were surveyed and, of those, only a subset responded to questions regarding chemical-specific screening values. Where it was possible to draw conclusions regarding the database, the conclusions are included in the appropriate subsections below.

5.1.1 States' Chemical-Specific Screening Values

The observations from the survey are summarized for each element in Tables 5-1–5-5, and the following discussion briefly highlights the observations for each element.

5.1.1.1 Arsenic (Table 1)

All states except California, Georgia, Kentucky, and Nevada reported using solely the EPA MCL as a screening value for arsenic in groundwater. The Safe Drinking Water Act required the EPA to revise the existing 50 ppb standard for arsenic in drinking water. In response, EPA required that by January 23, 2006, all systems must comply with the new arsenic drinking water standard of 10 ppb. Thus, most of the differences seen among the MCL-based values in Table 1 are due to the use of either the "old" value of 50 ppb or the "new" value of 10 ppb. For example, the Alabama standard for arsenic is based on the "new" value of 10 ppb, even though the EPA is currently enforcing the value of 50 ppb until January 23, 2006. In Florida, the new standards for arsenic of 10 ppb became effective on January 1, 2005. Residential and industrial soil screening values reported by the states were similar in value and mostly derived with a health-based approach. Of the states that reported screening values for the leachability of arsenic from soil to groundwater, most reported values consistent with the July 1996 USEPA Soil Screening Guidance and the EPA SSL Technical Background Document (with the exception of Kansas, Kentucky, Michigan and Alabama which differed in magnitude from the others). In general, the information provided by the participating states on screening values for arsenic suggests a relatively consistent approach across the states.

5.1.1.2 Benzo(a)pyrene (Table 2)

The majority of the states surveyed used the EPA MCL as the screening value for benzo(a)pyrene in groundwater. States that do not use the MCL (Colorado, Kentucky, Georgia, and Nevada) use a value based on human health effects of benzo(a)pyrene. It should be noted that California's risk-based value (0.0029 μg/L) is two orders of magnitude lower than the MCL (0.2 μg/L). Most of the states reporting a screening value for surface water use health-based values, even though it ranges within an order of magnitude. The residential and industrial soil screening values are numerically similar and are mainly based on the health effects of the chemical on humans. The leachability from soil to groundwater pathway for benzo(a)pyrene differs by several orders of magnitude from state to state, ranging from 0.4 to 1,000 mg/kg, depending on its basis (see Table 2 for details).

5.1.1.3 Lead (Table 3)

All of the surveyed states use the EPA action level of 15 μg/L as their basis for the screening of groundwater. For surface water, screening values range from 5 to 50 μg/L (Oklahoma and Colorado, respectively). All states use the health-based screening value for residential soils value of 400 ppm, California uses 260 ppm. The results for industrial soil screening levels for lead ranged from 260 to 1460 ppm (California and Colorado, respectively). Only four of the 13 states surveyed reported a value for the leachability of lead to groundwater and these had varying basis for their values.

5.1.1.4 PCB (Table 4)

With the exception of two states (Colorado and Georgia), all of the states surveyed cited the EPA MCL as the screening value for PCBs in groundwater. Four states provided their own risk-based value, which ranged within one order of magnitude (0.18 μg/L for California to 0.034 μg/L for states using Region 9 PRGs). Six of the states surveyed did not report a screening value for surface water. Of the states that did report a value, the basis for the value was either health-based or the MCL. Florida is the only state with values derived also for protection of aquatic species for surface water. For residential soil, the states reported screening values ranging from 0.089 ppm to 0.43 ppm, varying around the Region 9 PRGs. The health-based screening values for PCBs in industrial soils ranged from 0.0028 to 2.1 mg/kg. The high industrial soil value of Florida is due to its basis in the state regulations. It is interesting to note that the screening values for leachability to protect groundwater varies three orders of magnitude between Colorado and Alabama.

5.1.1.5 TCE (Table 5)

For TCE, ten of the thirteen states surveyed use the MCL for screening groundwater. Six of the states surveyed reported a screening value for TCE in surface water usually based on MCLs or ecological concerns. All of the states use health-based screening values for residential and industrial soils. For the majority of the states, the source of these health-based values is either a default value established by EPA regional office or a state-promulgated value. The soil screening values vary considerably among states, especially for industrial soils, where the values range from 0.0038 to 66 mg/kg, the soil saturation concentration. The states also reported a wide range of values used for soil leachability.

Table 1. State Screening Values for Arsenic

Arsenic Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk =1E-06	Risk-Based Value, Human Health HQ =1.0	Other Screening Value	Basis of Value (Health-Based, MCL, etc.)	Comments
Water (µg/L)	Groundwater	AL	NA	NA	1.00E+01	MCL	In some cases still utilizing 50 ppb
		AR	NA	NA	1.00E+01	MCL	NA
		CA	2.30E-02	1.10E+01	5.00E+01	MCL	Risk based numbers are public health goals.
		CO	NA	NA	5.00E+01	MCL	Delivered at tap
		FL	NA	NA	5.00E+01	MCL	Will go to 10 ug/L in 1/05
		GA	4.50E-02	NA	NA	Health Based	Region 9 PRG
		KS	NA	NA	1.00E+01	MCL	NA
		KY	4.50E-02	NA	NA	NA	Region 9 PRG
		MI	NA	NA	1.00E+01	MCL	Criterion is state drinking water standard. Value in promulgated rules is superseded by promulgated state drinking water standard. Please see: http://www.deq.state.mi.us/documents/deq-rrd-OP-ArsenicMemo_Brochure.pdf
		NV	4.50E-02	NA	5.00E+01	MCL	Region 9 PRG
		OK	NA	NA	1.00E+01	MCL	NA
		SC	NA	NA	5.00E+01	MCL	New standard = 10 ppb
		TN	NA	NA	1.00E+01	MCL	State Tap Water MCL
	Surface Water	AL	NA	NA	1.20E-01	Health Based	ADEM Admin. Code R. 335-6-10
		AR	NA	NA	1.00+01	MCL	NA
		CA	2.30E-02	1.10E+01	5.00+01	MCL	Risk based numbers are public health goals.
		CO	NA	NA	5.00+01	MCL	For DW supply. Standard varies for other uses.
		FL	NA	NA	5.00+01	MCL	62-302 FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	1.00E+01	aquatic protect	May defer to EPA standard (0.18).
		KY	NA	NA	NA	NA	NA
		MI	NA	2.80E+02	5.00E+01	MCL	Values will be changed based on promulgated rules.
		NV	NA	NA	NA	NA	NA
		OK	1.80E-02	NA	1.90E+02	Health-based	Ambient Water Quality and OK Water Quality Criteria
		SC	NA	NA	NA	NA	NA
		TN	NA	NA	NA	NA	NA
	Residential	AL	3.90E-01	NA	NA	NA	Region 9 PRG
		AR	3.90E-01	2.20E+01	NA	NA	Region 6 Medium Specific Screening Level
		CA	4.30E-01	2.20E+01	NA	NA	SB 32 screening levels
		CO	3.90E-01	NA	NA	NA	Not promulgated
		FL[5]	8.00E-01	NA	NA	NA	62-777FAC
		GA	3.90E-01	NA	NA	NA	Region 9 PRG
		KS	1.10E+00	NA	NA	NA	NA
		KY	3.90E-01	NA	NA	NA	Region 9 PRG
		MI	7.60E+00[6]	NA	NA	Health Based	NA

Arsenic							
Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk =1E-06	Risk-Based Value, Human Health HQ =1.0	Other Screening Value	Basis of Value (Health-Based, MCL, etc.)	Comments
Soil (mg/ kg)		NV	3.90E-01	2.20E+01	NA	NA	Region 9 PRG
		OK	1.80E+00	2.20E+01	NA	NA	Region 6 Medium Specific Screening Level
		SC	3.90E-01	2.20E+01	NA	NA	Region 9 PRG
		TN	NA	NA	1.00E+01	Background	Statewide Background
	Industrial	AL	1.60E+00	NA	NA	Health Based	Region 9 PRG
		AR	1.80E+00	2.80E+02	NA	Health Based	Region 6 Medium Specific Screening Level
		CA	1.50E+00	2.60E+01	NA	Health Based	SB 32 screening levels
		CO	1.49E+00	NA	NA	Health Based	Not Promulgated
		FL[5]	3.70E+00	NA	NA	Health Based	62-777FAC
		GA	3.90E-01	NA	NA	Health Based	Region 9 residential PRG used
		KS	3.80E+00	NA	NA	Health Based	NA
		KY	1.60E+00	NA	NA	NA	Region 9 PRG
		MI	3.70E+00[6]	NA	NA	Health Based	NA
		NV	1.60E+00	2.60+E02	NA	NA	Region 9 PRG
		OK	1.80E+00	2.80E+02	NA	Health Based	Region 6 Medium Specific Screening Level
		SC	1.60E+00	2.60E+02	NA	Health Based	Region 9 PRG
		TN	NA	NA	1.00E+01	Background	Statewide background
	Leachability (Groundwater Protection)	AL	NA	NA	3.88E-01	Health Based	Alabama Risk-Based Corrective Action Document
		AR	NA	NA	2.00E+01	Health Based	Region 6 SSL using a DAF of 20
		CA	NA	NA	NA	NA	site-specific
		CO	NA	NA	2.20E+01	SWAG	Not Promulgated
		FL	NA	NA	2.90E+01	NA	SSL DAF 20, can be determined by SPLP
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	5.84E+00	MCL Based	DAF = 20
		KY	NA	NA	1	NA	Region 9 PRG using DAF = 1DAF = 1, can be modified based on site-specific conditions (see guidance)
		MI	NA	NA	4.60E+00	MCL based	This value is below default statewide soil background of 5.80E+00. Please see: http://www.deq.state.mi.us/documents/deq-rrd-OP-ArsenicMemo_Brochure.pdf
		NV	NA	NA	2.90E+01	NA	Region 9 PRG using DAF = 20
		OK	NA	NA	2.90E+01	Health Based	EPA SSL DAF = 20
		SC	NA	NA	2.90E+01	Health Based	Region 9 PRG using DAF 20
		TN	NA	NA	NA	NA	NA

5 In April 2005, Florida updated the residential SCTL to 2.1 mg/kg and the industrial SCTL to 12 mg/kg based on an in vivo bioavailability study conducted with Florida soils.
6 MI cancer based criteria multiplied by 0.1 to normalize to target excess cancer risk level of 1.00E-06 from 1.00E-05.

Table 2. State Screening Values for Benzo(a)pyrene

Benzo(a)pyrene

Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk = 1E-06	Risk-Based Value, Human Health HQ = 1.0	Other Screening Value	Basis of Value (Health Based, MCL, etc.)	Comments
Water (µg/L)	Groundwater	AL	NA	NA	2.00E-01	MCL	NA
		AR	NA	NA	2.00E-01	MCL	NA
		CA	2.90E-03	NA	2.10E-01	MCL	Risk based numbers are public health goals.
		CO	NA	NA	4.80E-03	Health Based	NA
		FL	NA	NA	2.00E-01	MCL	62-520, 62-550, and 62-777FAC
		GA	9.20E-03	NA	NA	Health Based	Region 9 PRG
		KS	NA	NA	2.00E-01	MCL	NA
		KY	9.20E-03	NA	NA	NA	Region 9 PRG
		MI	NA	NA	2.00E-01	MCL	Criterion is state drinking water standard. Value in promulgated rules is superseded by promulgated state drinking water standard.
		NV	9.20E-03	NA	2.00E-01	MCL	Region 9 PRG
		OK	NA	NA	2.00E-01	MCL	NA
		SC	NA	NA	2.00E-01	MCL	NA
		TN	NA	NA	2.00E-01	MCL	State tap water MCL
	Surface Water	AL	NA	NA	2.00E-02	Health Based	ADEM Admin. Code R. 335-6-10
		AR	NA	NA	2.00E-01	MCL	NA
		CA	2.90E-03	NA	2.10E-01	MCL	Risk based numbers are public health goals
		CO	NA	NA	4.80E-03	Health Based	For drinking supply standard, varies for other uses
		FL	NA	NA	3.10E-02	Health Based	62-302 FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	3.10E-02	Health Based	Food procurement
		KY	NA	NA	NA	NA	NA
		MI	NA	NA	NA	NA	NA
		NV	NA	NA	NA	NA	NA
		OK	3.80E-03	NA	NA	Health Based	Ambient Water Quality Criteria
		SC	NA	NA	NA	NA	NA
		TN	NA	NA	NA	NA	NA
Soil (mg/ kg)	Residential	AL	6.20E-02	NA	NA	Health Based	Region 9 PRG
		AR	6.20E-02	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		CA	3.80E-02	NA	NA	Health Based	SB 32 screening levels
		CO	6.00E-02	NA	NA	Health Based	Not promulgated
		FL	1.00E-01	NA	NA	Health Based	62-777FAC
		GA	6.20E-02	NA	NA	NA	Region 9 PRG
		KS	1.20E-01	NA	NA	Health Based	NA
		KY	6.20E-02	NA	NA	NA	Region 9 PRG
		MI	2.00E-01[7]	NA	NA	Health Based	NA
		NV	6.20E-02	NA	NA	NA	Region 9 PRG
		OK	6.20E-02	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		SC	6.20E-02	NA	NA	Health Based	Region 9 PRG
		TN	6.20E-02	NA	NA	Health Based	Region 9 PRG

Benzo(a)pyrene

Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk = 1E-06	Risk-Based Value, Human Health HQ = 1.0	Other Screening Value	Basis of Value (Health Based, MCL, etc.)	Comments
Soil (mg/ kg)	Industrial	AL	2.10E-01	NA	NA	Health Based	Region 9 PRG
		AR	2.30E-01	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		CA	1.30E-01	NA	NA	Health Based	SB 32 screening levels
		CO	1.70E-01	NA	NA	Health Based	Not Promulgated
		FL	5.00E-01	NA	NA	NA	Health-Based, 62-777FAC
		GA	6.20E-02	NA	NA	NA	Region 9 residential PRG used
		KS	2.60E-01	NA	NA	Health Based	NA
		KY	2.10E-01	NA	NA	NA	Region 9 PRG
		MI	8.00E-01[7]	NA	NA	Health Based	NA
		NV	2.10E-01	NA	NA	NA	Region 9 PRG
		OK	2.30E-01	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		SC	2.10E-01	NA	NA	Health Based	Region 9 PRG
		TN	2.10E-01	NA	NA	Health Based	Region 9 PRG
	Leachability (Groundwater Protection)	AL	NA	NA	5.34E-01	Health Based	ARBCA
		AR	NA	NA	8.00E+00	Health Based	SSL with DAF=20
		CA	NA	NA	1.30E+02	NA	NA
		CO	NA	NA	1.00E+03	NA	Arbitrary maximum set in guidance document
		FL	NA	NA	8.00E+00	Health Based	SSL DAF20 , 62-777FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	1.60E+01	soil saturation	NA
		KY	NA	NA	4.0	Health Based	Region 9 SSL DAF = 1 (see guidance)
		MI	NA	NA	NA	NA	Identified as not likely to leach.
		NV	NA	NA	See comment	Health Based	8.0 E+00 DAF 20; 4.0 E-01,DAF=1 soil screen level
		OK	NA	NA	8.00E+00	Health Based	SSL with DAF=20
		SC	NA	NA	See comment	Health Based	8.0 E+00 DAF 20; 4.0 E-01,DAF=1 soil screen level
		TN	NA	NA	NA	NA	NA

[7] MI cancer-based criteria multiplied by 0.1 to normalize to target excess cancer risk level of 1.00E-06 from 1.00E-05.

Table 3. State Screening Values for Lead

Lead Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk = 1E-06	Risk-Based Value, Human Health HQ = 1.0	Other Screening Value = 1.90E+02	Basis of Value (Health Based, MCL, etc.)	Comments
Water (µg/L)	Groundwater	AL	NA	NA	1.50E+01	MCL	NA
		AR	NA	NA	1.50E+01	MCL	NA
		CA	NA	NA	1.50E+01	MCL	Human health standards based on drinking water.
		CO	NA	NA	1.50E+01	Action Level	Considered exceeded if 90 percentile lead level is greater than 15 ug/l
		FL	NA	NA	1.50E+01	Health Based	62-520, 62-550, 62-777 FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	1.50E+01	State Standard	Based on EPA action level
		KY	NA	NA	1.50E+01	Action Level	Drinking water action level
		MI	1.40E+01	NA	1.50E+01	MCL	Lead criteria based on IEUBK model with sliding scale between soils and groundwater; groundwater not to exceed MCL.
		NV	NA	NA	1.50E+01	MCL	NA
		OK	NA	NA	1.50E+01	MCL	NA
		SC	NA	NA	1.50E+01	MCL	Level for tap water
		TN	NA	NA	1.50E+01	MCL	Federal drinking water action level
	Surface Water	AL	NA	NA	8.50E+00	Health Based	ADEM Admin. Code R. 335-6-10
		AR	NA	NA	1.50E+01	MCL	NA
		CA	NA	NA	1.50E+01	MCL	Human health standards based on drinking water.
		CO	NA	NA	5.00E+01	NA	Drinking water supply standard, varies for other uses.
		FL	NA	NA	5.60E+00	Protection of aquatic species	62-302, 62-777 FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	1.50E+01	Domestic Water	
		KY	NA	NA	NA	NA	NA
		MI	1.40E+01	NA	1.90E+02	NA	Other screening value is for non-cancer, non-drinking water
		NV	NA	NA	NA	NA	NA
		OK	NA	NA	5.00E+00	Health Based	Oklahoma Water Quality Criteria
		SC	NA	NA	NA	NA	NA
		TN	NA	NA	NA	NA	NA
Soil (mg/kg)	Residential	AL	NA	4.00E+02	NA	EPA IEU/BK	Region 9 PRG
		AR	NA	4.00E+02	NA	EPA IEU/BK	Region 6 Medium Specific Screening Level
		CA	2.60E+02	NA	NA	CA Lead Model	SB 32 Screening Levels
		CO	NA	4.00E+02	NA		Not Promulgated
		FL	NA	4.00E+02	NA	Health Based	62-777FAC
		GA	NA	4.00E+02	NA	Health Based	Region 9 PRG
		KS	NA	4.00E+02	NA	Health Based	NA
		KY	NA	4.00E+02	NA	NA	Region 9 PRG
		MI	NA	4.00E+02	NA	Health Based	NA
		NV	NA	4.00E+02	NA	NA	Region 9 PRG
		OK	NA	4.00E+02	NA	Health Based	Region 6 Medium Specific Screening Level
		SC	NA	4.00E+02	NA	Health Based	Modified Region 9 PRG

Lead

Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk = 1E-06	Risk-Based Value, Human Health HQ = 1.0	Other Screening Value = 1.90E+02	Basis of Value (Health Based, MCL, etc.)	Comments
Soil (mg/kg)		TN	NA	4.00E+02	NA	Health Based	Region 9 PRG
	Industrial	AL	NA	8.00E+02	NA	Health Based	Region 9 PRG
		AR	NA	8.00E+02	NA	Health Based	Region 6 Medium Specific Screening Level
		CA	2.60E+02	NA	NA	Health Based	SB 32 Screening Levels
		CO	NA	1.46E+03	NA	EPA guidelines	Not Promulgated
		FL	NA	NA	9.20E+02	NA	62-777FAC
		GA	NA	4.00E+02	NA	Health Based	Region 9 residential PRG used
		KS	NA	NA	1.00E+03	NA	NA
		KY	NA	8.00E+02	NA	NA	Region 9 PRG
		MI	NA	9.00E+02	NA	Health Based	NA
		NV	NA	8.00E+02	NA	NA	Region 9 PRG
		OK	NA	8.00E+02	NA	Health Based	Region 6 Medium Specific Screening Level
		SC	NA	8.00E+02	NA	Health Based	Modified Region 9 PRG
		TN	NA	8.00E+02	NA	Health Based	Region 9 PRG
	Leachability (Groundwater) Protection)	AL	NA	NA	4.00E+02	SSL	ARBCA
		AR	NA	NA	NA	NA	site specific
		CA	NA	NA	NA	NA	site specific
		CO	NA	NA	2.20E+01	SWAG	Not cleanup value
		FL	NA	NA	NA	NA	Compare SPLP leachate to groundwater standard
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	NA	NA	NA
		KY	NA	NA	NA	NA	NA
		MI	NA	NA	7.00E+02	NA	NA
		NV	NA	NA	NA	NA	NA
		OK	NA	NA	4.00E+02	NA	EPA SSL DAF=20
		SC	NA	NA	NA	NA	No soil to groundwater protection pathway
		TN	NA	NA	NA	NA	NA

Table 4. State Screening Values for PCBs

PCBs Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk = 1E-06	Risk-Based Value, Human Health HQ = 1.0	Other Screening Value	Basis of Value (Health Based, MCL, etc.)	Comments
Water (µg/L)	Groundwater	AL	NA	NA	5.00E-01	MCL	NA
		AR	NA	NA	5.00E-01	MCL	NA
		CA	1.80E-01	7.30E-01	5.00E-01	MCL	Risk based numbers are public health goals.
		CO	NA	NA	1.75E-02	MCL	NA
		FL	NA	NA	5.00E-01	Health Based	62-520, 62-550-, 62-777 FAC
		GA	3.40E-02	NA	NA	Health Based	Region 9 PRG
		KS	NA	NA	5.00E-01	MCL	NA
		KY	3.40E-02	NA	5.00E-01	MCL	Region 9 PRG
		MI	NA	NA	5.00E-01	MCL	Criterion is state drinking water standard.
		NV	3.40E-02	NA	5.00E-01	MCL	NA
		OK	NA	NA	5.00E-01	MCL	Region 6 Medium Specific Screening Level
		SC	NA	NA	5.00E-01	MCL	NA
		TN	NA	NA	5.00E-01	MCL	State Tap Water MCL
	Surface Water	AL	NA	NA	1.40E-02	Health Based	ADEM Admin. Code R. 335-6-10
		AR	NA	NA	5.00E-01	MCL	NA
		CA	1.80E-01	7.30E-01	5.00E-01	MCL	Risk based numbers are public health goals
		CO	NA	NA	1.75E-02	Health Based	Drinking water supply standard varies for other uses.
		FL	NA	NA	4.50E-05	protection of aquatic species	62-302FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	7.90E-06	Health Based	Food procurement
		KY	NA	NA	NA	NA	NA
		MI	2.60E-04	NA	NA	Health Based	Value for drinking and non-drinking water
		NV	NA	NA	NA	NA	NA
		OK	NA	NA	NA	Health Based	Values are congener specific.
		SC	NA	NA	NA	NA	NA
		TN	NA	NA	NA	NA	NA
Soil (mg/kg)	Residential	AL	2.20E-01	NA	NA	Health Based	Region 9 PRG
		AR	2.20E-01	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		CA	8.90E-02	1.10E+00	NA	Health Based	SB 32 Screening Levels
		CO	2.20E-01	NA	NA	Health Based	Not promulgated
		FL	5.00E-01	NA	NA	Health Based	62-777FAC
		GA	2.20E-01	NA	NA	NA	Region 9 PRG
		KS	4.30E-01	NA	NA	Health Based	NA
		KY	2.20E-01	NA	NA	NA	Region 9 PRG
		MI	4.00E-01[8]	NA	NA	Health Based	TSCA supersedes if regulated by TSCA.
		NV	2.20E-01	NA	NA	NA	Region 9 PRG
		OK	NA	NA	NA	Health Based	Values are congener specific.

PCBs

Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk = 1E-06	Risk-Based Value, Human Health HQ = 1.0	Other Screening Value	Basis of Value (Health Based, MCL, etc.)	Comments
Soil (mg/kg)		SC	2.20E-01	NA	NA	Health Based	Region 9 PRG
		TN	2.20E-01	NA	NA	Health Based	Region 9 PRG
	Industrial	AL	7.40E-01	NA	NA	Health Based	Region 9 PRG
		AR	8.30E-01	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		CA	3.00E-01	1.10E+01	NA	Health Based	SB 32 Screening Levels
		CO	6.20E-01	NA	NA	Health Based	Not promulgated
		FL	2.10E+00	NA	NA	NA	health-based, 62-777FAC
		GA	2.20E-01	NA	NA	NA	Region 9 residential PRG used
		KS	9.50E-01	NA	NA	Health Based	NA
		KY	2.80E-02	NA	NA	NA	1/10 of KY's PRG
		MI	1.60E-00[8]	NA	NA	Health Based	TSCA supersedes if regulated by TSCA
		NV	7.40E-01	NA	NA	NA	Region 9 PRG
		OK	NA	NA	NA	Health Based	values are congener specific
		SC	7.40E-01	NA	NA	Health Based	Region 9 PRG
		TN	7.40E-01	NA	NA	Health Based	Region 9 PRG
	Leachability (Groundwater Protection)	AL	NA	NA	1.13E-00	NA	ARBCA
		AR	NA	NA	NA	NA	NA
		CA	NA	NA	6.30E+00	NA	NA
		CO	NA	NA	1.00E+03	NA	Not promulgated
		FL	NA	NA	1.70E+01	NA	DAF 20, 62-777FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	5.30E+01	MCL Based	DAF = 20
		KY	NA	NA	NA	NA	NA
		MI	NA	NA	NA	NA	NA
		NV	NA	NA	NA	NA	NA
		OK	NA	NA	NA	Health Based	Values are congener specific.
		SC	NA	NA	NA	NA	NA
		TN	NA	NA	NA	NA	NA

[8] MI cancer-based criteria multiplied by 0.1 to normalize to target excess cancer risk level of 1.00E-06 from 1.00E-05.

Table 5. State Screening Values for TCE

TCE Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk =1E-06	Risk-Based Value, Human Health HQ = 1.0	Other Screening Value	Basis of Value (Health Based, MCL, etc.)	Comments
Water (µg/L)	Groundwater	AL	NA	NA	5.00E+00	MCL	NA
		AR	NA	NA	5.00E+00	MCL	NA
		CA	8.00E-01	2.10E+00	5.00E+00	MCL	Risk based numbers are public health goals.
		CO	NA	NA	5.00E+00	MCL	NA
		FL	NA	NA	3.00E+00	Health Based	62-520, 62-550, 62-777FAC
		GA	2.80E-02	NA	NA	Health Based	Region 9 PRG
		KS	NA	NA	5.00E+00	MCL	NA
		KY	2.80E-02	NA	NA	NA	Region 9 PRG
		MI	NA	NA	5.00E+00	MCL	Criterion is state drinking water standard.
		NV	2.80E-02	NA	5.00E+00	MCL	Region 9 PRG
		OK	NA	NA	5.00E+00	MCL	NA
		SC	NA	NA	5.00E+00	MCL	NA
		TN	NA	NA	5.00E+00	MCL	EPA MCL
	Surface Water	AL	NA	NA	2.40E+01	Health Based	ADEM Admin. Code R. 335-6-10
		AR	NA	NA	5.00E+00	MCL	NA
		CA	8.00E-01	2.10E+00	5.00E+00	Primary MCL	Risk based numbers are public health goals.
		CO	NA	NA	5.00E+00	MCL	For drinking water supply. Standard varies for other uses.
		FL	NA	NA	8.07E+01	Health-Based	62-302 FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	NA	NA	NA
		KY	NA	NA	NA	NA	NA
		MI	2.90E+00[9]	NA	2.00E+02	Health Based	Other value is for chronic protection of aquatic life.
		NV	NA	NA	NA	NA	NA
		OK	2.70E+00	NA	2.70E+00	Health Based	Ambient Water Quality Criteria
		SC	NA	NA	NA	NA	NA
		TN	NA	NA	NA	NA	NA
Soil (mg/kg)	Residential	AL	5.30E-02	NA	NA	Health Based	Region 9 PRG
		AR	4.30E-02	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		CA	2.30E-03	1.60E+01	NA	Health Based	SB32 Screening levels/ Soil Gas: 1,500 ug/m^3
		CO	4.54E+00	NA	NA	Health Based	Uses old slope factor. Not Promulgated
		FL	6.00E+00	NA	NA	Health Based	62-777FAC
		GA	5.30E-02	NA	NA	NA	Region 9 PRG
		KS	6.20E+00	NA	NA	Health Based	NA
		KY	5.30E-02	NA	NA	NA	Region 9 PRG
		MI	5.30E+01[9]	NA	5.00E+02	Health Based	Other value is soil saturation concentration (Csat)
		NV	5.30E-02	NA	NA	NA	Region 9 PRG
		OK	4.30E-02	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		SC	5.30E-02	NA	NA	Health Based	Region 9 PRG

[9] MI cancer based criteria multiplied by 0.1 to normalize to target excess cancer risk level of 1E-06 from 1E-05.

TCE Media	Submedia/ Land Use	State	Risk-Based Value, Human Health Risk =1E-06	Risk-Based Value, Human Health HQ = 1.0	Other Screening Value	Basis of Value (Health Based, MCL, etc.)	Comments
Soil (mg/kg)		TN	5.30E-02	NA	NA	Health Based	Region 9 PRG
	Industrial	AL	1.10E-01	NA	NA	Health Based	Region 9 PRG
		AR	1.00E-01	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		CA	3.80E-03	1.10E+02	NA	Health Based	SB 32 Screening levels/ Soil Gas: 2,500 ug/m3
		CO	2.14E+01	NA	NA	Health Based	Value of 1000 is an arbitrary cap. Uses old slope factor.
		FL	8.50E+00	NA	NA	NA	Health-Based, 62-777FAC
		GA	5.3E-02	NA	NA	Health Based	Region 9 residential PRG used
		KS	9.80E+00	NA	NA	Health Based	NA
		KY	1.10E-01	NA	NA	NA	Region 9 PRG
		MI	6.60E+01[10]	NA	5.00E+02	Health Based	Other value is soil saturation concentration (Csat)
		NV	1.10E-01	NA	NA	NA	Region 9 PRG
		OK	1.00E-01	NA	NA	Health Based	Region 6 Medium Specific Screening Level
		SC	1.10E-01	NA	NA	Health Based	Region 9 PRG
		TN	1.10E-01	NA	NA	Health Based	Region 9 PRG
	Leachability (Groundwater Protection)	AL	NA	NA	2.95E-03	Health Based	ARBCA
		AR	NA	NA	6.00E-02	Health Based	SSL with DAF=20
		CA	NA	NA	4.60E-01	NA	GW is DW : 0.46 GW is not DW:33
		CO	NA	NA	6.80E-01	Leach Modeling	Not cleanup value
		FL	NA	NA	3.00E-02	NA	DAF of 20, 62-777FAC
		GA	NA	NA	NA	NA	NA
		KS	NA	NA	2.00E-01	MCL Based	DAF = 20
		KY	NA	NA	3.00E-03	NA	Region 9 PRG with DAF=1
		MI	NA	NA	1.00E-01	MCL	NA
		NV	NA	NA	6.00E-02	NA	Region 9 PRG with DAF=20
		OK	NA	NA	6.00E-02	Health Based	EPA SSL DAF=20
		SC	NA	NA	comments	Health Based	6.0E-02, DAF 20, 3.0E-03 DAF1 Soil screening
		TN	NA	NA	NA	NA	NA

[10] MI cancer based criteria multiplied by 0.1 to normalize to target excess cancer risk level of 1E-06 from 1E-05.

5.1.2 State's Medium-Specific Screening Values

In addition to attempting to discern similarities and differences in states' screening levels for the chemicals of concern, similar information was sought related to specific media. ITRC queried the thirteen participating states on the bases for their soil (residential, industrial, and leachability from soil to groundwater) and water (surface and groundwater) screening level values. The states' responses are summarized in the following subsections.

5.1.2.1 Residential Soil

Most of the states reported using health-based screening levels for chemicals in residential soils. Even though some are based on Region 6 or Region 9 PRGs, they still differ in their reported screening values. Six of the states (Alabama, Georgia, Kentucky, Nevada, Tennessee and South Carolina) used the Region 9 PRGs as the basis for their residential soil screening values. South Carolina noted that it modified the Region 9 PRG. Tennessee is the only state that used a different basis for its level for arsenic, using statewide background levels instead. Oklahoma (1.8 mg/kg) and Arkansas (0.39 mg/kg) reported using Region 6 medium specific screening levels, but they differ in order of magnitude for residential soils.

The other states followed their own state statutes and regulations that differed from EPA. California appeared to use health-based levels that had been codified or associated with specific state statutes and regulations. Kentucky allows inorganic background to eliminate chemicals from further evaluation. These values can be modified upward if site-specific natural background is higher for the inorganics or if the practical quantitation limit (PQL) is higher. The reported screening values can also be used as CTLs.

5.1.2.2 Industrial Soil

As with residential soils, most of the states reported using health-based screening levels for industrial soils. Those states (Alabama, Georgia, Kentucky, Nevada, South Carolina and Tennessee) that use Region 9 PRGs for residential soil screening values also use Region 9 PRGs for industrial soil screening values. As with residential soil, Tennessee used the statewide background level for its arsenic industrial soil screening level. Georgia used residential PRGs for its screening values for industrial soil, and South Carolina used a modified PRG for its industrial soil screening value for lead. California used health based levels that had been codified or associated with specific state guidance. In most instances, the residential and industrial soil screening levels are different from each other for each chemical (see the explanation for this in Section 5.2).

5.1.2.3 Leachability (Groundwater Protection)

There was a great deal of difference among states and among chemicals regarding the basis for deriving soil screening values for the protection of groundwater. Some states used Region 9 PRGs (Nevada, South Carolina, Kentucky) while others relied on EPA SSLs (Oklahoma), or based on site-specific data (California), or state-based guidance (Alabama). The two most significant contributing factors for variation in the leachability-based values are the state groundwater protection standards (MCLs, etc.), and the dilution-attenuation factor (DAF) of either 20 or 1 (both of which are provided by EPA Region 9 in its PRG table, www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf).

5.1.2.4 Groundwater

The survey responses for groundwater screening values indicate that many states use the federal MCL. Other states use health-based, site-specific, or background screening values for groundwater. Alabama uses MCLs as the basis for screening values for groundwater. For those chemicals without MCLs many states, including Alabama, Georgia and Tennessee, use Region 9 PRGs for tap water (the tap water value is divided by a factor of 10 for noncarcinogens). Colorado's screening values for groundwater are based, in part, on MCLs. For some chemicals, Colorado uses "action levels" or other health-based values. Screening values for groundwater in California and Kansas are based on MCLs. Georgia relies on Region 9 health-based PRGs for four of the five chemicals in the survey (no value was given for lead in groundwater). California is the only state that has derived its own MCLs.

5.1.2.5 Surface Water

Five of the 13 states did not report surface water screening values for any of the five chemicals (Georgia, Kentucky, Nevada, South Carolina, and Tennessee). The states that did report surface water screening values based them on one of several different criteria including health, aquatic protection, ambient water quality, or MCLs.

5.2 Comparison of Generic Residential Soil Levels and Exposure Assumptions

The development of risk-based screening values requires selection of several parameter values which, when combined mathematically, yield a value protective of human health. The parameters fall into two groups: toxicity parameters and exposure parameters. The toxicity values are usually established by EPA (for example, IRIS). The exposure values may be found in EPA exposure guidance documents (for example, EPA July 1996). However, states may still utilize different assumptions regarding exposure, depending on such factors as site-specific information (such as weather) and variations in receptor behavior. For example, a screening value will likely be different for a child than for an industrial site worker due to differing physiological parameters and exposure variables.

To evaluate different uses of exposure parameters among the states, survey responses were examined and parameter inputs used to derive residential soil screening levels were compared. For the purposes of this evaluation, survey questions regarding exposure parameters on residential exposure to soil were evaluated. To facilitate comparison of exposure assumptions, the following analysis used the average daily dose (ADD) for carcinogens and noncarcinogens as the basis for comparing the variation in values of oral, dermal, and inhalation exposure parameters from various states. Contaminant soil concentrations were assumed to be the same (1 mg/kg) for ease of analysis. In addition to ADD, relative residential soil screening levels (SSL_{RR}) were used to compare target risk levels used by each state.

Tables 5-6 and 5-7 summarize the exposure parameters provided in the following section 5.2.1, which are used in to calculate the ADD by various pathways of exposure. ADD for oral intake is described in Section 5.2.2, dermal in Section 5.2.3, and inhalation in Section 5.2.4. The influence of target risk used by selected states is shown in the calculations of SSL_{RR} described in Section 5.2.5.

5.2.1 Exposure Parameters Used

The values for exposure parameters used by states to calculate soil screening levels for carcinogens and noncarcinogens are presented in Table 6 and Table 7, respectively. Of the 13 states participating in the survey, five (California, Colorado, Florida, Kansas, and Michigan) develop their own residential soil screening levels. Two states (Arkansas and Oklahoma) use levels developed by EPA Region 6. Two other states (Nevada and South Carolina) use EPA Region 9 PRGs without modification. Kentucky uses most Region 9 PRGs values except for soil adherence, soil absorption, and values for ages 7 to 18 for site-specific evaluations. The remaining three states (Alabama, Georgia and Tennessee) modified the EPA Region 9 PRGs by dividing the PRGs for noncarcinogens by a factor of ten. This is functionally equivalent to setting the acceptable HQ to 0.1 instead of 1.0.

Only California has conducted the research for developing chemical-specific screening level dermal absorption fractions, which range from 0.001 for cadmium to 0.25 for organophosphates and pentachlorophenol, based upon research sponsored by the state using living primates in vivo and human skin in vitro. For the purposes of the comparisons presented in this section, the dermal absorption fraction of 0.1 was utilized for California, because California assigns most organic chemicals an absorption fraction of 0.1.

Table 6. Exposure assumptions used to calculate residential soil screening levels for carcinogenic contaminants*

State:	Alabama	Arkansas	California	Colorado	Florida	Georgia	Kansas	Kentucky	Michigan	Nevada	Oklahoma	South Carolina	Tennessee
Basis	R9 [a]	R6 [b]	Cal EPA	State [c]	State	R9	State	R9[e]	State	R9	R6 [b]	R9	R9
Target Excess Lifetime Cancer Risk	1.0E-6	1.0E-06	1.0E-06	1.0E-06	1.0E-06	1.0E-06	1.0E-05	1.0E-06	1.0E-05	1.0E-06	1.0E-06	1.0E-06	1.0E-06
Averaging Time, d	25550	25550	25550	25550	25550	25550	25550	25550	25550	25550	25550	25550	25550
Exposure Duration, yr	30/6 [j]	30/6	24/6	30	30	30/6	30	30/6	30/6	30/6	30/6	30/6	30/6
Oral and Inhalation Exposure Frequency, d/yr	350	350	350	350	350	350	350	350	350	350	350	350	350
Dermal Exposure Frequency, event/yr	350	350	350	350	350	350	350	350	245	350	350	350	350
Body Weight, kg	70/15	70/16	70/15	70/15	59[f]	70/15	70/15	70/15	70/15	70/15	70/15	70/15	70/15
Soil Ingestion Rate, mg/d	100/200	100/200	100/200	100/200	120[g]	100/200	100/200	100/200	100/200	100/200	100/200	100/200	100/200
Soil Oral Absorption Efficiency, fraction	1	1	1	1	1	1	1	1	0.5-1.0[k]	1	1	1	1
Skin Surface Area Exposed, cm^2/event	5700/ 2800	5700/ 2800	5700/ 2900	7100/ 4600	4810[h]	5700/ 2800	5000/ 1750	5700/ 2800	5800/ 2670	5700/ 2800	5700/ 2800	5700/ 2800	5700/ 2800
Skin Soil Adherence Factor, mg/cm^2	0.07/0.2	0.07/0.2	0.7/0.2	0.2	0.2/0.6	0.07/0.2	0.2	0.07/0.2	0.07/0.2	0.07/0.2	0.07/0.2	0.07/0.2	0.07/0.2
Dermal Absorption fraction[d]	0.1	0.1	0.1	0.1	0.01	0.1	0.1	0.1	0.01-0.1[k]	0.1	0.1	0.1	0.1
Inhalation Rate, m^3/d	20/10	20/10	20	20/10	12.2[i]	20/10	20/10	20/10	20	20/10	20/10	20/10	20/10
Particulate Emission Factor, m^3/kg	1.3E+09	1.3E+09	1.3E+09	1.1E+09	1.24E+09	1.3E+09	1.18E+09	1.3E+09	1.28E+08	1.3E+09	1.3E+09	1.3E+09	1.3E+09
Inputs and Equations References	1	6	1	2	3	1	4	1	5	1	6	1	1

[a] R9: Values are equivalent to EPA's Region 9 Preliminary Remediation Goals (PRGs).
[b] R6: Values are equivalent to EPA's Region 6 Screening Levels.
[c] State: Values developed by the state.
[d] Value assumed for semi-volatile contaminants.
[e] Used for site-specific risk assessment, Region 9 exposure factors used for screening level PRG development, also includes adolescent values
[f] Value based on 6 yrs. at 15 kgs. And 24 yrs. at 70 kgs.
[g] Value based on 6 yrs. at 200 mg/day and 24 yrs. at 100 mg/day
[h] Value based on age-specific exposed surface areas for ages 1-31 years that were averaged to derive the exposed surface area for the aggregate resident
[i] Value based on age-specific inhalation rates for ages 1-31 years that were averaged to derive the exposed surface area for the aggregate resident
[j] Where 2 values are shown within a cell, it should be read as: adult value/child value
[k] The first value is for inorganic hazardous substances and the second value is for organic hazardous substances

References:

1. http://www.epa.gov/region09/waste/sfund/prg/files/02userguide.pdf; pages 21-24.
2. http://www.cdphe.state.co.us/hm/soilplcydraft.pdf; pages 55-56.
3. http://www.dep.state.fl.us/waste/quick_topics/rules/pages/777_tabfig.htm; Figures 5-6 and 5- 6.
4. http://www.kdhe.state.ks.us/remedial/download/RSK303.pdf; Pages 26-27.
5. http://www.deq.state.mi.us/documents/deq-rrd-OpMemo_1-Attachment6.pdf
6. http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/03screenvalues.pdf

Table 7. Exposure assumptions used to calculate residential soil screening levels for non-carcinogenic contaminants

State:	Alabama	Arkansas	California	Colorado	Florida	Georgia	Kansas	Kentucky	Michigan	Nevada	Oklahoma	South Carolina	Tennessee
Basis	R9 [a]	R6 [b]	Cal EPA	State [c]	State	R9	State	R9[f]	State	R9	R6 [b]	R9	R9
Target Hazard Quotient	0.1	1	0.2	1	1	0.1	1	1	1	1	1	1	0.1
Averaging Time, d	2190	2190	10950	2190	2190	2190	8750	2190	10950	2190	2190	2190	2190
Exposure Duration, yr	6	6	6	6	6	6	6	6	30/6[g]	6	6	6	6
Oral and Inhalation Exposure Frequency, d/yr	350	350	350	350	350	350	350	350	350	350	350	350	350
Dermal Exposure Frequency, event/yr	350	350	350	350	350	350	350	350	245	350	350	350	350
Body Weight, kg	15	16	15	15	15	15	15	15	70/15	15	15	15	15
Soil Ingestion Rate, mg/d	200	200	200	200	200	200	200	200	100/200	200	200	200	200
Soil Oral Absorption Efficiency, fraction	1	1	1	1	1	1	1	1	0.5[h]	1	1	1	1
Skin Surface Area Exposed, cm^2/event	2800	2800	2900	4600	2960	2800	1750	2800	5800/2670	2800	2800	2800	2800
Skin Soil Adherence Factor, mg/cm^2	0.2	0.2	0.2	0.2	0.6	0.2	0.2	0.07	0.07/0.2	0.2	0.2	0.2	0.2
Dermal Absorption fraction[e]	0.1	0.1	0.1	0.1	0.01[d]	0.1	0.1	0.1	0.1[i]	0.1	0.1	0.1	0.1
Inhalation Rate, m^3/d	10	8	20	20	8.1	10	10	10	20	10	8	10	20
Particulate Emission Factor, m^3/kg	1.3E+09	1.3E+09	1.3E+09	1.1E+09	1.24E+09	1.3E+09	1.18E+09	1.3E+09	1.28E+08	1.3E+09	1.3E+09	1.3E+09	1.3E+09
Inputs and Equations References	1	6	1	2	3	1	4	1	5	1	6	1	1

[a] R9: Values are equivalent to EPA's Region 9 Preliminary Remediation Goals (PRGs).
[b] R6: Values are equivalent to EPA's Region 6 Screening Levels.
[c] State: Values developed by the state.
[d] For inorganics Florida uses 0.001
[e] Value assumed for semi-volatile contaminants.
[f] Used for site-specific risk assessment, Region 9 exposure factors used for screening level PRG development, also includes adolescent values
[g] 30/6, 30 years total: 6 as child, 24 as adult
[h] 0.5 is for inorganic hazardous substances and 1.0 is for organic hazardous substances
[i] 0.01 is for inorganic hazardous substances and 0.1 is for organic hazardous substances

References:

1. http://www.epa.gov/region09/waste/sfund/prg/files/02userguide.pdf; pages 21-24.
2. http://www.cdphe.state.co.us/hm/soilplcydraft.pdf;pages 55-56.
3. http://www.dep.state.fl.us/waste/quick_topics/rules/pages/777_tabfig.htm; Figures 5-6 and Table 6.
4. http://www.kdhe.state.ks.us/remedial/download/RSK303.pdf; pages 26-27.
5. http://www.deq.state.mi.us/documents/deq-rrd-opmemo_1-Attachmentb.pdf
6. http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/03screenvalues.pdf

5.2.2 ADDs by Oral Intake (ADD_O)

A comparison of ADD by oral intake (ADD_O in mg/kg-day) during a lifetime for contaminants is provided in Figures 1A and 1B. ADD_O values developed by states that do not use age-adjusted values are determined with Formula 1 for both carcinogens and noncarcinogens.

Formula 1

$$\mathrm{ADD_O} = \frac{(\text{Ingestion Rate})(\text{Soil Absorption Efficiency})(\text{Exposure Duration})(\text{Exposure Frequency})}{(\text{Body Weight})(\text{Averaging Time})}$$

For example, the state of Florida derives an ADD_O for carcinogens of 0.836 mg/kg-d as follows:

$$ADD_O = 0.836\ {}^{mg}\!/_{kg-d} \quad = \frac{\left(120\ {}^{mg}\!/_{d}\right)(1)(30\ y)\left(350\ {}^{d}\!/_{y}\right)}{(59\ kg)(25550\ d)}$$

For carcinogens and noncarcinogens, ADD_O values based on EPA Region 6 Screening Values or U.S. EPA Region 9 PRGs are derived using an age-adjusted soil ingestion factor (IFS_{adj}) and are determined with Formula 2.

Formula 2

$$\mathrm{ADD_O} = \frac{(\mathrm{IFS_{adj}})(\text{Soil Absorption Efficiency})(\text{Exposure Frequency})}{(\text{Averaging Time})}$$

where

$$\mathrm{IFS_{adj}} = \left[\frac{\begin{pmatrix}\text{Exposure}\\ \text{Duration}\end{pmatrix}\begin{pmatrix}\text{Ingestion}\\ \text{Rate}\end{pmatrix}}{(\text{Body Weight})}\right]_c + \left[\frac{\left(\begin{pmatrix}\text{Exposure}\\ \text{Duration}\end{pmatrix}_a - \begin{pmatrix}\text{Exposure}\\ \text{Duration}\end{pmatrix}_c\right)\begin{pmatrix}\text{Ingestion}\\ \text{Rate}\end{pmatrix}_a}{(\text{Body Weight})_a}\right]$$

and ‘a’ is adult and ‘c’ is child

For example, all states using EPA Region 6 and Region 9 assumptions derive an ADD_O for carcinogens of 1.56 mg/kg-d as follows:

$$ADD_O = 1.56\ \mathrm{mg}/\mathrm{kg-d} = \frac{\left(114\ \mathrm{mg}/\mathrm{d}\right)(1)\left(350\ \mathrm{d}/\mathrm{y}\right)}{(25{,}550\ \mathrm{d})}$$

where

$$IFS_{adj} = 114\ \mathrm{mg}/\mathrm{d} = \left[\frac{(6\ \mathrm{y})\left(200\ \mathrm{mg}/\mathrm{d}\right)}{(15\ \mathrm{kg})}\right] + \left[\frac{(30\ \mathrm{y} - 6\ \mathrm{y})\left(100\ \mathrm{mg}/\mathrm{d}\right)}{(70\ \mathrm{kg})}\right]$$

Figure 1A shows that ADD_O for carcinogens are the same for Alabama, Georgia, Kentucky, Nevada, Oklahoma, South Carolina and Tennessee. Arkansas has a slightly lower concentration due to the state's use of 16 kg for the body weight of a child as opposed to the 15 kg recommended by EPA Region 6. The value of 16 kg originates from a memo from Mr. David Riley of EPA to Mr. Donald Williams entitled *Central Tendency and RME Exposure Parameters* (Riley 2002). California and Colorado reported ADD_O values that were approximately 7.5% lower than the states that used either R9 or R6 values. This was primarily due to the absence of an exposure duration value for the child receptor being used for the calculation of screening values. Nearly half of the ADDs used by the states using R9 or R6 values were reported by the states of Florida, Kansas, and Michigan. Florida and Kansas have lower ADD_O values due to a number of variations in comparison to many of the other states. Michigan has the lowest ADD_O among the states due to the state's utilization of a soil absorption efficiency that is half of the value reported by all of the other states.

Figure 1B shows that ADD_O values for noncarcinogens are the same for Alabama, Colorado, Florida, Georgia, Kentucky, Nevada, Oklahoma, South Carolina and Tennessee. Arkansas has a slightly lower concentration due to the state's use of 16 kg for the body weight of a child. Note in Figure 1B that Colorado and Florida fell into a group that is parallel with the states that typically use either Region 9 or Region 6 values. California went from being a state with one of the highest ADDs (Figure 1A) to a state with one of the lowest ADDs (Figure 2B). This is mainly due to California using a larger averaging time (10,950 days/30 years) than all of the states except for Michigan (10,950 days). Kansas and Michigan also have values lower than the states that defer to the Region 6 or Region 9 values due to differing assumptions.

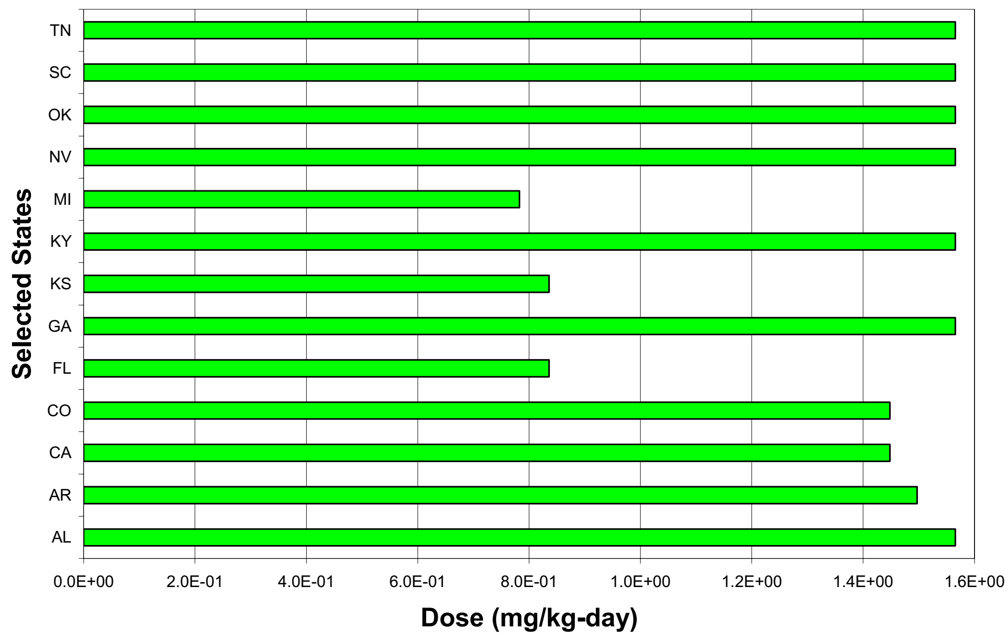

Figure 1A. Carcinogen Oral Average Daily Dose (ADD_O)

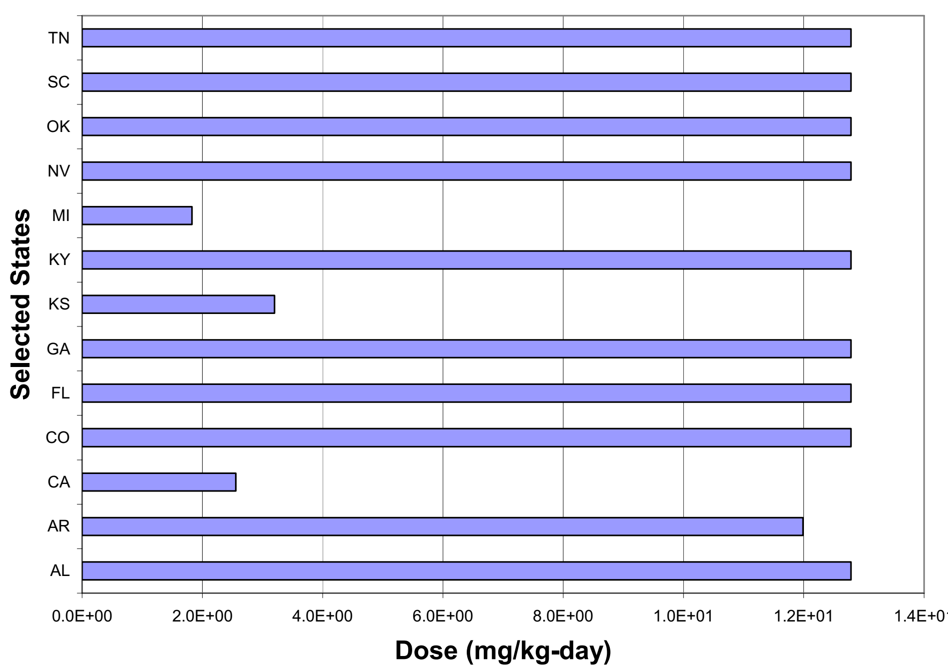

Figure 1B. Noncarcinogen Oral Average Daily Dose (ADD_O)

5.2.3 Average Daily Dermal Dose (ADD_D)

A comparison of average daily dermal dose (ADD_D in mg/kg-day) during a lifetime for semivolatile contaminants is provided in Figures 2A and 2B. With the exception of Michigan, Formula 3 is used by all of the states to calculate an ADD_D value for noncarcinogens. Michigan uses age-adjusted values for both carcinogens and noncarcinogens. For carcinogens, all of the states surveyed use age-adjusted ADD_D values. These values are determined using Formula 4.

Formula 3

$$\mathrm{ADD_D} = \frac{\begin{pmatrix}\text{Skin Surface Area}\\ \text{Exposure}\end{pmatrix}\begin{pmatrix}\text{Skin Soil Adherence}\\ \text{Factor}\end{pmatrix}\begin{pmatrix}\text{Dermal Absorption}\\ \text{Factor}\end{pmatrix}\begin{pmatrix}\text{Exposure}\\ \text{Frequency}\end{pmatrix}\begin{pmatrix}\text{Exposure}\\ \text{Duration}\end{pmatrix}}{\begin{pmatrix}\text{Body}\\ \text{Weight}\end{pmatrix}\begin{pmatrix}\text{Averaging}\\ \text{Time}\end{pmatrix}}$$

For example, the state of Alabama derives an ADD_D for noncarcinogens of 3.58 mg/kg-d as follows:

$$ADD_D = 3.58\ {}^{mg}\!/_{kg-d} = \frac{\left(2{,}800\ {}^{cm^2}\!/_{event}\right)(0.2)(0.1)\left(350\ {}^{event}\!/_{y}\right)(6\ y)}{(15\ kg)(2{,}190\ d)}$$

For carcinogens, all of the states surveyed use ADD_D values that are derived using an age-adjusted soil dermal factor (SFS_{adj}) and are determined with Formula 4.

Formula 4

$$\mathrm{ADD_D} = \frac{(\mathrm{SFS_{adj}})(\text{Dermal Absorption Factor})(\text{Exposure Frequency})}{(\text{Averaging Time})}$$

where

$$\mathrm{SFS_{adj}} = \left[\frac{\begin{pmatrix}\text{Exposure}\\ \text{Duration}\end{pmatrix}\begin{pmatrix}\text{Skin Soil}\\ \text{Adherence Factor}\end{pmatrix}\begin{pmatrix}\text{Skin Surface}\\ \text{Area Exposed}\end{pmatrix}}{(\text{Body Weight})}\right]_c + \left[\frac{\left(\begin{pmatrix}\text{Exposure}\\ \text{Duration}\end{pmatrix}_a - \begin{pmatrix}\text{Exposure}\\ \text{Duration}\end{pmatrix}_c\right)\begin{pmatrix}\text{Skin Soil}\\ \text{AdherenceFactor}\end{pmatrix}\begin{pmatrix}\text{Skin Surface}\\ \text{Area Exposed}\end{pmatrix}_a}{(\text{Body Weight})_a}\right]$$

and "a" stands for adult and "c" stands for child

For example all states using EPA Region 6 and Region 9 assumptions derive an ADD_D for carcinogens of 0.494 mg/kg-d as follows:

$$ADD_D = 0.494\ \mathrm{mg/kg-d} = \frac{\left(360.8\ \mathrm{kg/cm^2}\right)(0.1)\left(350\ \mathrm{event/y}\right)}{(25{,}550\ \mathrm{d})}$$

where

$$SFS_{adj} = 360.8\ \mathrm{kg/cm^2} = \left[\frac{(6\ \mathrm{y})(0.2)\left(2{,}800\ \mathrm{cm^2/event}\right)}{(15\ \mathrm{kg})}\right] + \left[\frac{(30\ \mathrm{y} - 6\ \mathrm{y})(0.07)\left(5{,}700\ \mathrm{cm^2/event}\right)}{(70\ \mathrm{kg})}\right]$$

Figure 2A shows that ADD_D for carcinogens are the same for Alabama, Georgia, Kentucky, Nevada, Oklahoma, South Carolina, and Tennessee. Arkansas has a dose slightly lower than the aforementioned states due to the difference in the body weight of a child. California is slightly lower due to using a higher skin surface area than that used by EPA Region 6 and 9. Florida has the lowest ADD_D value due to the use of a dermal absorption factor one tenth that of the other states. Different assumptions regarding soil adherence factors result in the remaining disparities observed among the states. The highest ADD_D result (Colorado) among all of the selected states is due to the greater child and adult values that Colorado uses for the *skin surface area exposed* parameter.

Figure 2B shows that Alabama, Georgia, Kentucky, Nevada, Oklahoma, South Carolina, and Tennessee all have the same ADD_D value. The state of Arkansas has a similar ADD_D value, but differs slightly due to the body weight parameter. The states of California, Florida, Kansas, and Michigan have ADD_D values that range from 68% - 84% less than the states that use either R9 or R6 screening parameters. The reason for such a large decrease in the ADD_D value is not consistent from state to state and is best explained through a state to state examination of the parameters shown on Table 7. Colorado has the highest ADD_D value out of the group of states. Colorado's ADD_D value is 64% greater than the states that use either R9 or R6 screening parameters. This difference is due to the higher *skin surface area exposed* parameter, which is also 64% greater than the states that use either R9 or R6 screening parameters.

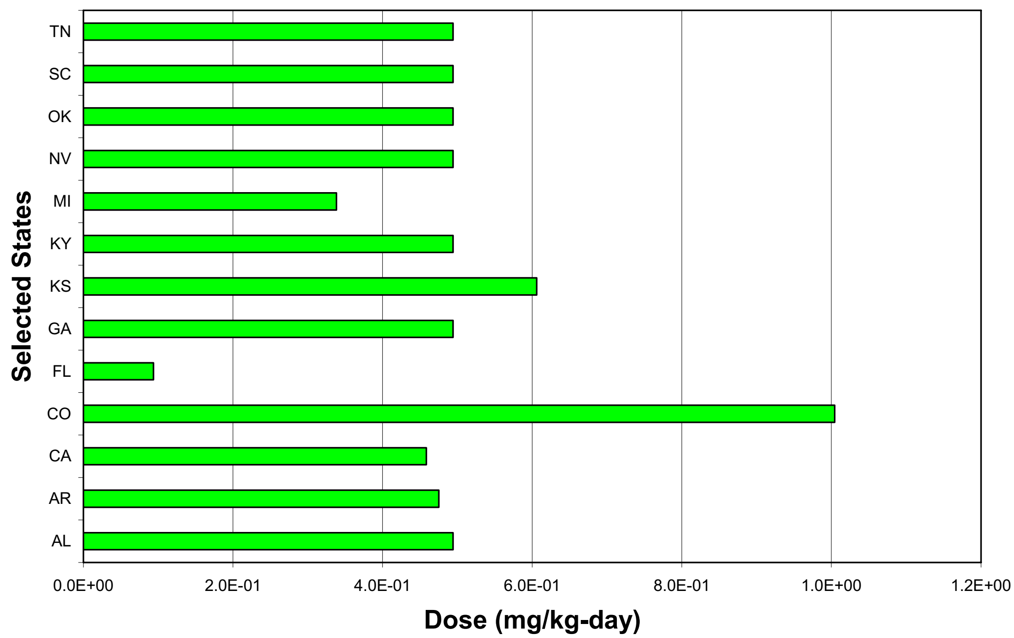

Figure 2A. Carcinogen Dermal Average Daily Dose (ADD_D)

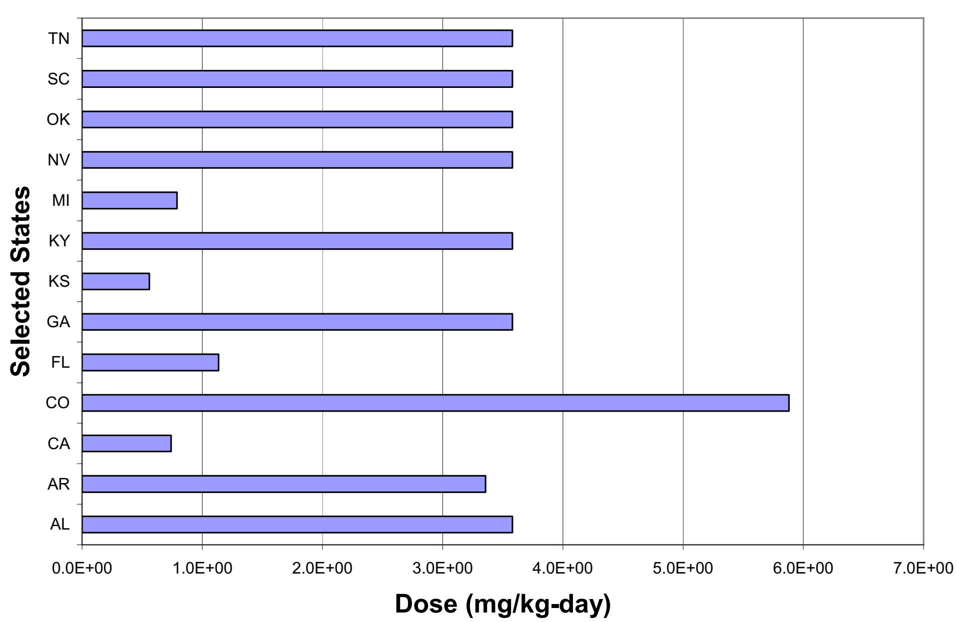

Figure 2B. Noncarcinogen Dermal Average Daily Dose (ADD_D)

5.2.4 Average Daily Inhalation dose (ADD_I)

A comparison of the thirteen states' average daily inhalation dose (ADD_I in mg/kg-day) is provided in Figures 3A and 3B. For carcinogens, ADD_I values developed by states that do not use age-adjusted values are determined by using Formula 5. It should be noted that unlike the ADD_O and the ADD_D, the Michigan ADD_I was not calculated based on age-adjusted values. The reason for this difference is due to Michigan's cleanup program using a value equivalent to a Reference Concentration (RfC) or Inhalation Unit Risk Factor (IURF) in the equations for cleanup criteria to protect for indoor and ambient air concentrations associated with soil and/or groundwater contamination. The RfC and the IURF differ from oral toxicity values in that they represent a concentration in the media of concern (i.e., air) rather than a dose to the receptor in units of mg/kg-day. These values are presumed to be protective of most human receptors. The Air Toxics rules used to generate the acceptable air concentrations specify the inhalation rate of 20 m^3/day for a 70 kg adult. Formula 5 is used by all of the states when calculating an ADD_I value for noncarcinogens.

Formula 5

$$\mathrm{ADD_I} = \frac{\left(\mathrm{Inhalation\ Rate} \big/ \mathrm{Particle\ Emission\ Factor}\right)\left(\mathrm{Exposure\ Frequency}\right)\left(\mathrm{Exposure Duration}\right)\left(1\mathrm{E}+03\right)}{\left(\mathrm{Body\ Weight}\right)\left(\mathrm{Averaging\ Time}\right)}$$

For example the state of Michigan derives an ADD_I for noncarcinogens of 2.14E-06 mg/kg-d as follows:

$$ADD_I = 2.14E-06\ {}^{mg}\!\big/_{kg-d} = \frac{\left(20\ {}^{m^3}\!\big/_{d} \Big/ 1.28E+08\ {}^{m^3}\!\big/_{kg}\right)\left(350\ {}^{event}\!\big/_{y}\right)\left(30\ y\right)\left(1E+03\right)}{\left(70\ kg\right)\left(10{,}950\ d\right)}$$

For carcinogens, ADD_I values based on U.S. EPA Region 6 Screening Values or U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) are derived using an age-adjusted soil inhalation factor (SFS_{adj}) and are determined with Formula 6.

Formula 6

$$ADD_I = \frac{\left(InhF_{adj}\right)\left(\text{Exposure Frequency}\right)\left(1E+03\right)}{\left(\text{Averaging Time}\right)\left(\text{Particle Emission Factor}\right)}$$

where

$$InhF_{adj} = \left[\frac{\left(\begin{matrix}\text{Exposure}\\\text{Duration}\end{matrix}\right)\left(\begin{matrix}\text{Inhalation}\\\text{Rate}\end{matrix}\right)}{\left(\text{Body Weight}\right)}\right]_c + \left[\frac{\left(\left(\begin{matrix}\text{Exposure}\\\text{Duration}\end{matrix}\right)_a - \left(\begin{matrix}\text{Exposure}\\\text{Duration}\end{matrix}\right)_c\right)\left(\begin{matrix}\text{Inhalation}\\\text{Rate}\end{matrix}\right)_a}{\left(\text{Body Weight}\right)_a}\right]$$

and "a" stands for adult and "c" stands for child

For example, all states using EPA Region 6 and Region 9 assumptions derive an ADD_I for carcinogens of 1.14E-07 mg/kg-d as follows:

$$ADD_I = 1.14E-07\ \mathrm{mg/kg-d} = \frac{\left(10.86\ \mathrm{kg/m^3}\right)\left(350\ \mathrm{event/y}\right)\left(1E+03\right)}{\left(25{,}550\ \mathrm{d}\right)\left(1.3E+09\ \mathrm{m^3/kg}\right)}$$

where

$$InhF_{adj} = 10.86\ \mathrm{kg/m^3} = \left[\frac{\left(6\ \mathrm{y}\right)\left(10\ \mathrm{m^3/d}\right)}{\left(15\ \mathrm{kg}\right)}\right] + \left[\frac{\left(30\ \mathrm{y} - 6\ \mathrm{y}\right)\left(20\ \mathrm{m^3/d}\right)}{\left(70\ \mathrm{kg}\right)}\right]$$

For simplicity, inhalation of contaminants volatilizing from soil is not included in this analysis. Therefore, the plots reflect only differences in inhalation rates and the amount of soil dust suspended into air.

For carcinogens, many of the states use the same default exposure values for determining the ADD_I (Figure 3A). The only significant exception is Michigan. The approximate 8-fold difference between Michigan and the other states is due to Michigan's assumption of a particle emission factor that is approximately an order of magnitude lower than the rest of the states. The minor disparities that exist among the remaining states are due to slight differences in the parameters used to calculate ADD_I. Greater variation occurs in the ADD_I for noncarcinogens due to a larger variation among the states regarding the following assumptions: averaging time, inhalation rate, and particle emission factor (Figure 3B). Colorado and Michigan are the only outliers in the group of states. Colorado is approximately 136% higher than the majority of the states surveyed. This difference is not due to one variation in a parameter, but rather slight variations in multiple parameters. Michigan is approximately 335% higher than the majority of the states surveyed. This difference is primarily due to the value used for the particulate emission factor being an order of magnitude lower than the other surveyed states.

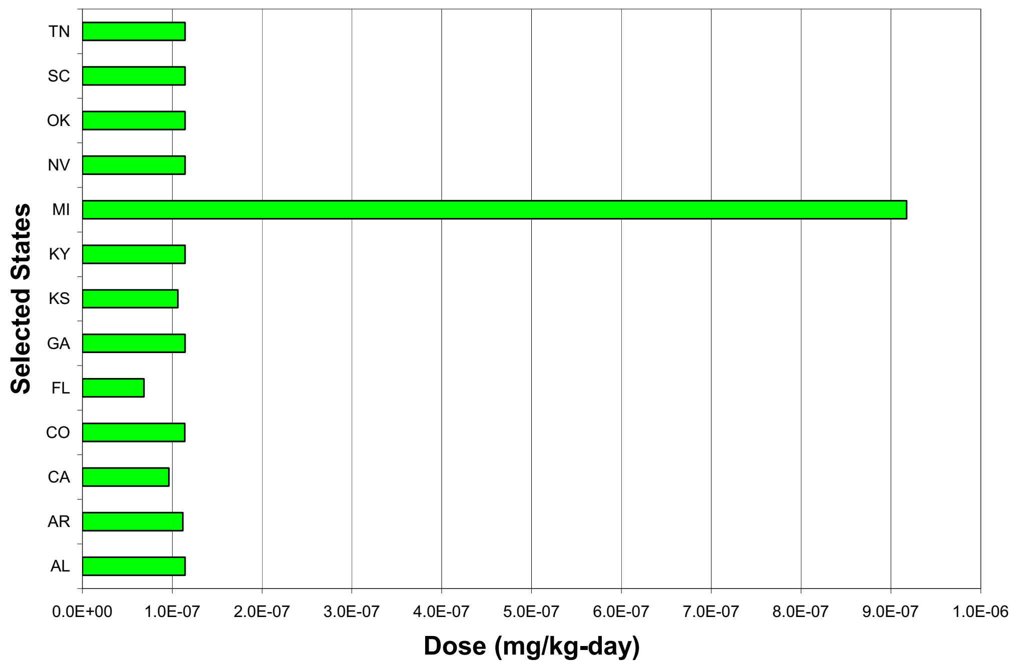

Figure 3A. Carcinogen Inhalation Average Daily Dose (ADD_I)

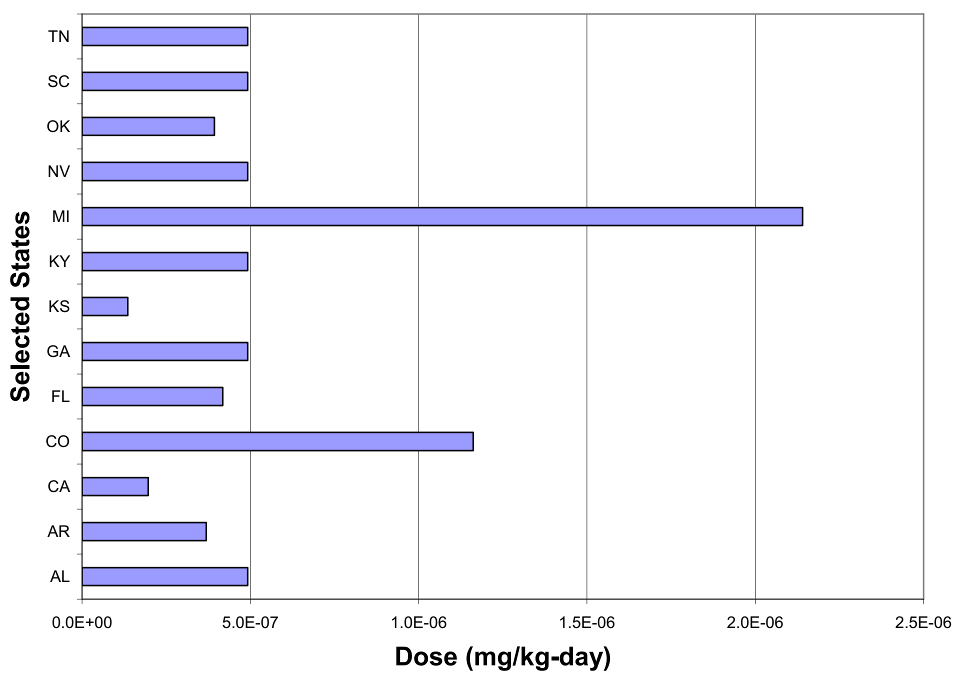

Figure 3A. Carcinogen Inhalation Average Daily Dose (ADD_I)

5.2.5 Relative Residential Soil Screening Levels (SSL_{RR})

To facilitate comparison of the exposure assumptions among the states, SSL_{RR} were determined for each state. SSL_{RR} are determined for carcinogens using Formula 7. Note that "Target Risk" refers to the target cancer risk. Also, the rationale for dividing by a factor of 3 in the equation is to maintain the assumption of a contaminant concentration of 1 mg/kg for ease of analysis.

Formula 7

$$SSL_{RR\ State} = \left(\frac{\text{Target Risk}_{State}}{\text{Target Risk}_{USEPA\ Region9}}\right)\left(\frac{\left(\frac{ADD_{O\ State}}{ADD_{O\ USEPA\ Region9}}\right)+\left(\frac{ADD_{D\ State}}{ADD_{D\ USEPA\ Region9}}\right)+\left(\frac{ADD_{I\ State}}{ADD_{I\ USEPA\ Region9}}\right)}{3}\right)$$

For example, Kansas derives 8.96 as an SSL_{RR} for carcinogens as follows:

$$SSL_{RR\ State} = 8.96 = \left(\frac{1.0E-05}{1.0E-06}\right)\left(\frac{\left(\frac{0.84}{1.57}\right)+\left(\frac{0.61}{0.49}\right)+\left(\frac{1.06E-07}{1.14E-07}\right)}{3}\right)$$

SSL_{RR} are determined for noncarcinogens using Formula 8.

Formula 8

$$SSL_{RR\ State} = \left(\frac{HQ_{State}}{HQ_{USEPA\ Region9}}\right)\left(\frac{\left(\frac{ADD_{O\ State}}{ADD_{O\ USEPA\ Region9}}\right)+\left(\frac{ADD_{D\ State}}{ADD_{D\ USEPA\ Region9}}\right)+\left(\frac{ADD_{I\ State}}{ADD_{I\ USEPA\ Region9}}\right)}{3}\right)$$

For example Kansas derives 0.23 as an SSL_{RR} for noncarcinogens as follows:

$$SSL_{RR\ State} = 0.23 = \left(\frac{1.0}{1.0}\right)\left(\frac{\left(\frac{3.20}{12.79}\right)+\left(\frac{0.56}{3.58}\right)+\left(\frac{1.36E-07}{4.92E-07}\right)}{3}\right)$$

The Region 9 PRG exposure assumptions were used as the standard of comparison for the results shown in Figures 4A and 4B. If a state uses the same relative soil screening level as determined with the default values in the Region 9 PRGs, the state will be represented as having a value of 1. Similarly, if a state assumes a soil screening level, target cancer risk or HQ an order of magnitude higher than determined by the Region 9 PRGs, it will have a value of 10 in Figures 4A and 4B. The ITRC Risk Team does not endorse or rebut the use of the Region 9 values by using the values as a mode of comparison.

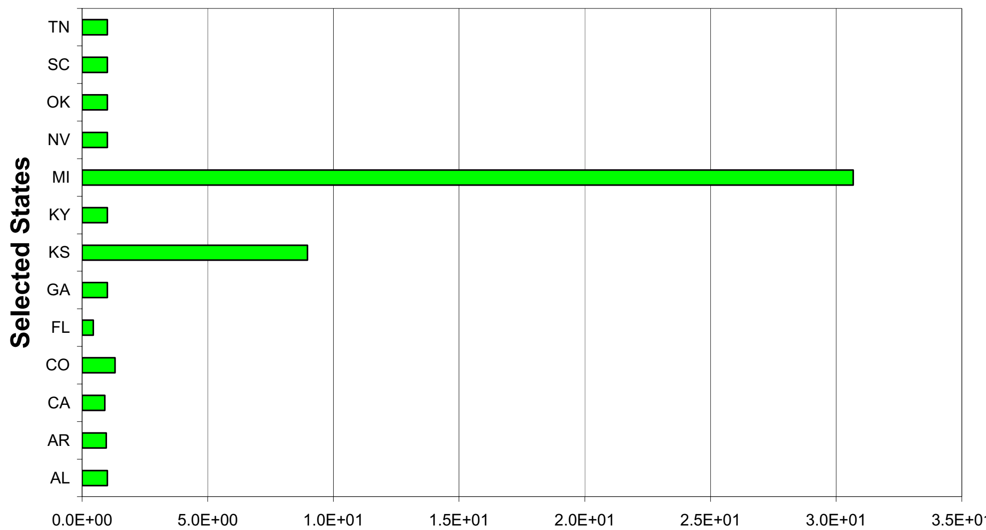

Figure 4A. Carcinogen Relative Residential Soil Screening Levels (SSL_{RR})

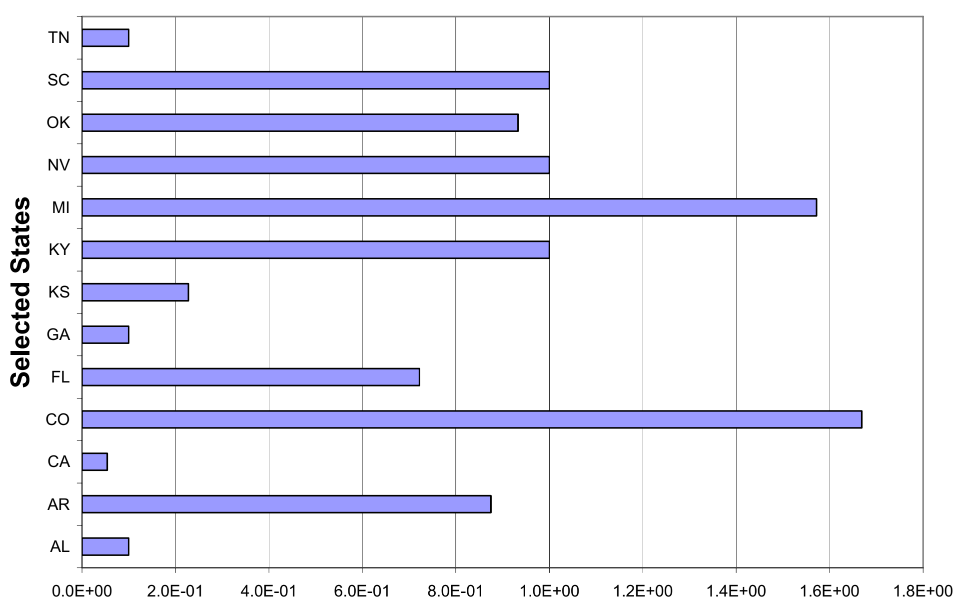

Figure 4B. Noncarcinogen Relative Residential Soil Screening Levels (SSL_{RR})

The trends observed for the individual exposure routes (ADD_O, ADD_D, and ADD_I) are also evident in the composite SSL_{RR}. Neither the target cancer risk nor the HQ were integrated into the equations used to determine ADD_O, ADD_D, or ADD_I. However, the target cancer risk and the HQ were integrated into Formulas 7 and 8, respectively, in order to better determine what factors were the main driving force for the differences that exist among the selected state's screening values.

For carcinogenic compounds, the data shown in Figure 4A suggests the conclusion that the states with substantially different SSL_{RR} are Kansas (difference is approximately 8 times greater than the majority of the states) and Michigan (difference is approximately 31 times greater than the majority of the states). A careful examination of the exposure factors that comprise Formula 7 reveals that in comparison to the other selected states, the less conservative target cancer risk of 1×10^{-5} used by both Kansas and Michigan is the driving factor in the difference. Of the remaining states that do not utilize the Region 9 PRGs (Arkansas, California, Colorado, Florida, Kentucky, and Oklahoma), the values for the exposure parameters that they use are not significantly different than the R9 PRG exposure assumptions.

For non-carcinogenic compounds, the inclusion of the target HQ to Formula 8 has also had a large effect on the results of the SSL_{RR} (Figure 4B). Through an inspection of the states that utilize Region 9 PRGs as their basis in Figure 4B (Alabama, Georgia, Kentucky, Nevada, South Carolina, and Tennessee), it is clear which states modify the Region 9 values and which states do not. The states that modify the values have a value of 0.1 shown in Figure 4B to reflect the use of a HQ of 0.1 as opposed to a value of 1 as utilized by Region 9. Of the remaining states that do not use Region 9 values as their basis, Arkansas, Florida, and Oklahoma are all similar in value and have values that range from 7 - 28% less than those states that use unmodified Region 9 PRGs. The state of Colorado has the highest value shown in Figure 4B. The value is 67% higher than those states that use unmodified R9 PRGs. This increase in SSL_{RR} for noncarcinogens is primarily due to the skin surface area exposed term (4,600 cm^2 /event). Michigan also has a high value as shown in Figure 4B. The value shown is only 6% lower than Colorado's value. The primary reason for the difference in comparison with the unmodified Region 9 values is due to the particulate emission factor in addition to slight variations among a number of the other exposure assumptions used to calculate screening values in the state of Michigan.

These results indicate that a greater variation exists among the surveyed state's exposure parameters for non-carcinogen screening values than among the exposure parameters used to calculate screening values for carcinogens

5.3 Comparison of States' Applications of Screening Values

Once a state has developed risk-based screening values, the next critical step is to clearly define how those values are to be used, i.e. what are the intended uses of the values and how, specifically, should a risk assessor evaluate site data in order to compare site-specific information to the state's risk-based values. The 13 states participating in this effort were asked to provide information related to these two questions. States' responses are summarized and reviewed here (complete response data are included in Appendix C). Specific and detailed information on the use of screening values can be found at many of the 13 states' websites, some of which are provided in section 2 and as a response to the survey in Appendix D.

5.3.1 Definition of Screening Level

When asked for their definition of "screening level", the states' responses were fairly uniform: a level that provides information on whether additional evaluation of a specific chemical in a medium is required. For the definition of "cleanup goal", most states indicated that this related to the level at which no further remediation would be required; Oklahoma noted that its cleanup goals must comply with ARARs, which could require additional effort. The definitions and interpretation of "target level" varied; states that responded to this question interpreted "target level" to mean either a chemical level in a given medium that is protective of human health, or an acceptable risk level (e.g., a specific cancer risk and/or HQ).

5.3.2 Intended Application of Screening Values

Risk-based values provide an opportunity for simplification of a complex process (i.e., a site evaluation with a full human health risk assessment), but at the same time can create confusion if their intended uses are not clearly delineated. Thus, states were asked to give information on intended uses of risk-based screening values.

Of the 13 states queried, all indicated that their risk-based values should be used for screening and/or cleanup guidance. Some states (South Carolina, Florida, Alabama, and Oklahoma) permit the use of these values as actual cleanup levels. Only Florida listed screening, cleanup goal, cleanup guidance, and cleanup levels as intended uses of risk-based values; however, if used as cleanup levels, they can be modified based on site-specific considerations. It appears that Tennessee limits the use of screening values as cleanup goals to sites that are too small for a risk assessment to be economically feasible.

5.3.3 Methods Used to Determine Site Soil Concentrations Used for Comparison with SSL

When conducting risk assessments, risk assessors have relied on EPA guidance for estimating soil concentrations at a site, for example EPA's *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA 1992). In this guidance, EPA calls for the estimation of a 95% upper confidence limit (UCL) on the arithmetic mean.[11] Many risk assessors use this method for determining a site soil value for comparison with risk-based screening values. In response to questions regarding choice of methodology for determining which estimate of site soil concentration should be used, most states indicated that estimation of the 95% UCL is their default method. However, some interesting exceptions are noted below:

- Tennessee permits any statistically defensible method for calculating the UCL.
- Michigan requires that data from hot spots not be used in the estimation of the 95% UCL.
- Michigan allows the use of 95% UCL if appropriate for the exposure pathway, if there is sufficient representative data (random), and if the data set meets the assumptions of the statistical method. Michigan's guidance does recommend exclusion of hot spots for

[11] Information from EPA on calculating the UCL is available at www.epa.gov/nerlesd1/tsc/software.htm.

estimation of a 95% UCL. Individual samples may be compared to cleanup criteria. See pages 1.1 to 1.3 of ST3M found at: http://www.deq.state.mi.us/documents/deq-erd-stats-s3tm.pdf.

- With the exception of Colorado, Kansas, Alabama and Georgia, states require a comparison of the 95% UCL for the site with the risk-based screening value. Alabama does not permit exceedances of the risk-based values and requires the use of the 95% UCL or the maximum detected value. Colorado compares individual soil sample results with risk-based values. California accepts either a comparison to 95% UCLs or exceedances based on individual samples. In Florida, if 95% UCL is used, at least ten samples are needed, apportionment must be accomplished, and hot spots can not be above 3 times the SCTL.

Most of the states do not approve of compositing of soil samples prior to analysis. As noted by Florida, compositing may mask hot spots at a site. The number of samples taken and the variability in soil concentrations will have a substantial influence on the value of the 95% UCL. For sites where few soil samples were collected and/or where large variability in concentrations is found among the samples, the 95% UCL is likely to be greater than the maximum value at the site. Other than the state of Alabama, states did not comment on whether, for sites where the 95% UCL exceeds the site maximum, the site maximum is a suitable value to be used for screening (see, for example, EPA's *Supplemental Guidance to RAGS: Calculating the Concentration Term*). Alabama does allow the aforementioned procedure. In addition, states did not specify the method for estimating the 95% UCL. EPA has described two methods, depending on whether the data are normally or lognormally distributed, and these methods can provide very different results for the 95% UCL. Florida has adopted specific guidance for this issue (please see www.dep.state.fl/waste/quick/topics/rules/default.htm) as has Alabama. Alabama's guidance is located in the most current version of the Alabama Risk-Based Corrective Action Guidance Manual.

5.3.4 Site Area Permitted for Estimation of Exposure Point Concentration

Some large or complex sites are divided into units for purposes of determining exposure point concentrations for site risk-based screening and/or risk assessment. These units are often based on use (as in the case of Florida, where an exposure "unit" in a residential scenario is 0.25 acres, or a section of an industrial site where workers perform their daily activities). Some states permit averaging of soil concentrations over a unit area to estimate exposure point concentrations. Several states have determined a default area for residential properties of 0.5 acres (Colorado, Kentucky, and Oklahoma). California's default acreage for a residential property is 0.02 acre.

5.3.5 Soil Sampling Depth

According to the EPA (EPA 1989), "assessment of surface exposures will be more certain if samples are collected from the shallowest depth that can be practically obtained, rather than, for example, zero to two feet." The participating states were asked to provide information on their recommendations regarding the depth interval for surface soil collection to evaluate direct exposure to surface soil. States that responded to this query were consistent: surface soil is considered to range from 0 to 12 inches or less. The exception is California, which permits surface soil samples to be collected to a depth of 120 inches.

A question about soil sampling related to the recommended sampling depth when considering exposure to volatiles emanating from the subsurface. Only a few states responded to this question, with recommended depths ranging from 3 to 60 inches (Oklahoma) to 0 to 144 inches (Colorado). California recommended a depth of greater than 120 inches. Tennessee, Georgia, Florida and Alabama do not permit mixing of soil samples when evaluating for volatile compounds.

5.3.6 Additional Information on Soils and Volatiles

The information collected from various states regarding their treatment of volatiles in soil for risk assessment and during remediation that influences derivation and application of screening levels can be described in the following categories.

5.3.6.1 Depth of Soil Samples

Risk assessors must take into account exposures to chemicals in subsurface soils that may occur from such activities as excavation. Frequently, the depth of the soil sample that the risk assessor includes in the exposure estimates is based on best professional judgment. States were asked to provide their recommendations on excavation depth for use in exposure assessment. Of the states that responded, the depths ranged from 24 to 144 inches (1 to 12 feet). Georgia and Alabama indicated that the excavation depth is determined on a site-specific basis. In Florida, excavation depth is decided on a site-specific basis but could be to the water table.

The survey also requested information on the greatest depth that states consider when evaluating inhalation exposure to volatiles migrating from soil. Only one state provided a specific value (Oklahoma, 96 inches), suggesting that most consider influences on the migration of volatiles to be site-specific. Additional state-specific support documents are cited in Appendix D, Section 5.

5.3.6.2 Soil Removal for Protection of Human Health

During site cleanup, soil removal may be required in order to reduce exposure and risks to human health. Requirements for soil removal vary from state to state. States that provided information on soil removal (5 states) gave depths for surface soil removal from 0.5 foot of soil removed (Arkansas) to 0 to 12 inches (South Carolina).

States were also asked to provide information on soil removal depths where the goal is to reduce exposure and risk associated with volatiles in subsurface soils. Only one state (Oklahoma) provided a numerical value (5–15 feet). South Carolina, Florida, Arkansas, and Alabama indicated that the decision on depth of soil removal is site-specific.

5.3.6.3 Residence Time for Volatiles in Soil

States were asked for their input on estimations of residence time for volatiles in surface soil. For the states that responded, their answers were consistent. It appears that the interpretation of this question was: should risk estimates include assumptions about loss of volatiles over time? The answer was no. Florida noted that there does not appear to be any guidance suggesting that biodegradation or volatilization should be taken into account per se when assessing risk and elaborated that the volatilization model used to derive the risk-based screening values discussed in this report (while assuming an infinite source) accounts for volatilization of contaminants over time, decreasing volatilization rates. Florida also acknowledged that biodegradation may be a factor influencing decrease in risk over long term exposures. For site-specific evaluations, Florida allows the use of the EMSOFT (Exposure Model for Soil-Organic Fate and Transport) model to determine volatilization factors for exposures starting at some time in the future. Florida also requires that current site concentrations (that probably have decreased over time due to volatilization) be used to compare to the screening values or SCTLs. Colorado has data that demonstrate that volatile compounds are detected for indefinite periods of time, even in hot, semi-arid environments.

5.3.6.4 Vapor Intrusion Evaluation

For the states that responded to questions regarding vapor intrusion, with the exception of Florida and Kentucky, the states all evaluate vapor intrusion (South Carolina noted that its program is not “well-defined”). Most rely on a version of the Johnson and Ettinger model (Johnson and Ettinger 1991) for assessing vapor intrusion. However, Kansas does not use models; rather, they rely on field testing.

6. DISCUSSION AND CONCLUSIONS

Screening values provide guidance on whether further site investigation is required. Numerical screening criteria for chemicals in soil, air or water are often justified on the basis of a real or perceived need for data analysis during the initial phases of an investigation. The next step in such a process is often the decision to either determine that no further action is needed or to take some form of action that can range from further sampling and analysis to contaminant removal.

Screening values vary among EPA regions and also vary among states. The goal of this report was to gain an understanding of these differences by surveying 13 states. The survey contained questions on the derivation and use of screening numbers for soils in residential and commercial land uses, as well as for groundwater. The survey used five chemicals as a basis for this comparison: arsenic, lead, benzo-a-pyrene, TCE, and PCBs. Because of the extensive information provided in the completed surveys, the focus of this report was narrowed to address how the screening numbers were derived and applied for soils in residential land use. The survey confirmed that states have different screening numbers because they vary in how the numbers were derived and how they are applied. The previous sections of this report compare the responses from the state surveys and discuss the details of the underlying differences.

6.1 General Differences Among States

This survey of the selected states and federal numerical criteria for soils highlights two general causes of variability among state risk screening values. First, each state refines the various default assumptions used in defining exposure and risk to individuals exposed to soils. Second, consensus is lacking among the states as to how screening criteria are to be applied. Underlying differences in how the screening numbers are developed include statutory or policy requirements for target risk and hazard levels to protect human health and the environment. For example, some states use 10^{-6} as a target risk level, while others use 10^{-5}. In addition, some states also base soil screening levels on resource protection, such as groundwater quality. Background concentrations for inorganic substances and detection limits are also used.

Other differences include the slight variations in the values or exposure factors used in standard equations to calculate risk and hazard. These exposure factors include the following:

- exposure duration
- exposure frequency
- body weight
- soil ingestion rate
- soil adsorption efficiency
- exposed skin surface area
- dermal adsorption fraction
- inhalation rate
- particulate emission factor
- averaging time
- child exposure parameters or adult exposure parameters or both

States also differ in the way screening numbers are applied. The following differences were found:

- the depth and lateral extent of soil over which the are applied
- determination of action or further assessment needed
- use of screening values as cleanup levels
- eligibility of the size or type of sites to use the screening numbers
- incorporating the screening numbers into the state's overall regulatory structure of site assessment and remediation

The following analysis details these findings.

6.2 Specific Differences Among State Screening Levels

As discussed in the preceding sections of this report, there is variability in the screening values, as well as their bases and intended uses, from state to state. In some cases, the variability may be minimal, while in others it may be substantial. The minimal differences among states' published screening values are easily explained by rounding values or other small differences in input values. However, published screening levels for a chemical can differ from state to state by several orders of magnitude and the reason for these differences is not always apparent.

Most states cite screening values published by EPA Headquarters, or those published by regional EPA offices. However, values published by the different regional offices may differ. For example, the Region 9 PRG (same as SSLs), based on groundwater protection of TCE (with a DAF of 1) is 2.4×10^{-3} mg/kg, while the Region 3 Risk Based Concentration (RBC) is 1×10^{-5} mg/kg. Both cite the same reference (EPA 1996) for the source of the values, making it difficult to comprehend why the values would differ by over two orders of magnitude.

Based on the results of ITRC's survey, screening values for contaminants leaching to groundwater tend to have the largest variability. For example, the screening value for leaching of TCE to groundwater in Michigan is 0.1 mg/kg while in Kentucky it is 0.003 mg/kg. The remedial goal for leaching of benzo(a)pyrene to groundwater in South Carolina is 8 mg/kg while the Colorado standard is 1000 mg/kg. Regional geologic and geographic differences, that include soil organic content, soil type, temperature or average depth to groundwater, account for some of the spread in these screening values. However, different approaches in the use of default assumptions for the sites may have a greater influence on the screening values.

An assessment of the survey responses revealed certain striking differences among the states, including the following examples:

- The states' screening levels for benzo(a)pyrene in residential soil range from 0.038 ppm (CA) to 0.12 ppm (KS)—an approximately 30-fold difference.
- Arkansas utilizes a screening value for TCE of 0.1 ppm for industrial soil, as compared to 21.4 ppm in Colorado.
- States varied in the assumptions that were used to develop screening values, including acceptable excess cancer risk (the majority of the states used a 10^{-6} risk level, while Kansas and Michigan used a risk level of 10^{-5}), surface area of exposed skin (Kansas assumes 1,750 cm^2 of a child receives dermal contact, whereas states quoting Region 9 PRGs assume 2,800 cm^2, and Kentucky has used 7,500 cm^2 for adolescents in site-specific risk assessment). In addition different exposure routes may be assumed.
- Even though most states in this sample were consistent in their groundwater screening level based on drinking water MCLs, a few had their own health-based levels based either on Regional PRGs or their own.

6.2.1 Variation in Underlying Assumptions

The published documents that give the generic screening values (PRGs and RBCs) have provided the underlying assumptions for their calculations and can be used as the baseline for comparison (EPA, 1996; EPA, 2004a, b). EPA Regions 3 and 9 screening values are based on a standard set of established exposure criteria and toxicological data used to determine the concentration of chemical corresponding to an HQ of 1 or an elevated cancer risk of 1×10^{-6}. These are some of the underlying assumptions:

- Soil contact is calculated as surface soil contact; however, surface soil may be defined differently by different states.
- The residential scenario includes children while the industrial scenario does not (although some industrial sites may have day-care centers on-site).
- Limited consideration is given to decreases in contaminant concentration due to chemical breakdown.
- Calculations assume a steady state exposure to surface soil or drinking water.
- No estimate is taken of the mass of the source, only concentration and sometime size are considered.

6.2.2 Variation in Application of Screening Values Among States

As noted in Section 5 of this report, even if assumptions underlying the screening values are the same and result in equivalent values among states, there may still be a variation in the application of these values from state to state. For example, states may differ in their (i) sampling criteria; (ii) statistical methods for calculating exposure point concentrations (e.g., 95% UCL); (iii) use of background concentrations; and (iv) the consideration of ecological scenarios. Some of these variations are described in Section 6.3 and others are described below.

In reviewing federal guidance on using SSLs (EPA 1996), it is apparent that there are several well-developed concepts that link the rationale for the screening criteria with sampling strategies (objectives) for using those criteria. Surface soils to which humans may be exposed are distinguished from deeper soils, which would have to be disturbed and distributed to the surface before being available for ingestion and inhalation as dust. However, states define surface soil at various depths from surface, to as deep as 120 inches. Varying assumptions pertaining to exposure scenarios may explain these differences, for instance, under most residential scenarios it is assumed that residents will routinely come into contact with the shallow subsurface during routine activities such as gardening. Therefore, different assumptions will impact site sampling strategies as well as interpretation of site data. In the ITRC Risk Team survey, the justification for the variability in states' definition of surface soil was not apparent.

Understanding the rationale behind screening values enables those who use them to properly apply their site-specific data to the screening values. For instance, many states reduced by half their industrial soil PRGs between the years 2002 and 2003 due to an EPA Region 9 change in the default soil ingestion rate for industrial workers. The previous industrial worker soil ingestion rate of 50 mg/day now corresponds to office worker exposure. The new industrial worker soil ingestion rate of 100 mg/day is an outdoor default. Depending on the situation at a site, either rate could be appropriate. Providing the user the underlying rationale for the determination of a screening value allows the user to critically evaluate the screening value and to modify the value, if necessary and permitted, to best suit the application.

Because the Region 9 PRGs have no ecological component, some states and/or EPA regions may have separate criteria for use at sites where ecological risk is a potential problem. For example, Region 9 gives concentrations of 23,000 ppm for both iron and zinc in residential soils. If significant amounts of soil with 23,000 ppm iron or zinc were to wash into a stream, the metals could have a negative impact on the ecosystem. Thus, some EPA Regions (4 and 9) have also attempted to develop ecological screening levels (for example, ecological screening values for iron and zinc in soils are 200 mg/kg and 50 mg/kg respectively).

6.2.3 Variation in State Requirements

In addition to differences between states' and EPA's screening values, there are also differences in requirements for calculating the site soil concentration to compare with the screening values. In general, for soil concentrations, most states accept a calculated 95% UCL. This UCL may be calculated based upon a normal or lognormal distribution or upon nonparametric statistical techniques. In some states, a single "high concentration" sample may be all that is necessary to trigger remediation or an extensive follow-up investigation. Other states prefer area-weighted concentrations.

6.2.4 Variation Within State Policy

Besides differences in screening levels and PRGs among states, there may also be differences within each state. Many states have departments of environment or health that are divided by media (e.g., air, surface water, or groundwater) or by legislative authority (e.g., CERCLA or RCRA). A potentially responsible party or regulator may have to negotiate with several departments, divisions, or bureaus with overlapping authorities and concerns. In some cases, the various entities may use conflicting screening criteria based on the entity's particular area of concern. Identifying the issues of concern and rationale behind any screening values would be helpful information that would aid in clarifying the rationale behind the calculation of a screening value.

6.2.5 Lack of Transparency

The absence of a common basis for the development of state screening levels points to the need for publishing the rationale used to calculate each screening value and its intended uses, along with any restrictions. A transparent rationale would assist in preventing the misuse of screening values in situations for which they were not intended (for example, the use of a value intended to protect workers should not be used at a site being considered for a future child care center). Transparency and additional guidance would also increase the confidence of the regulated community, stakeholders, and the regulators in those screening values.

The assumptions and rationale presented in federal soil screening guidance (EPA 1996) provides an example of how to create transparency in a risk-based analysis. While much of the actual analysis presented is based upon default values, the reader has the opportunity to see the range of values that are appropriate for various scenarios, and a sampling approach tied directly to the collection of data for which a clear use is presented. Because published screening values and PRGs are invaluable tools, a thorough understanding of the assumptions used to arrive at screening values or PRGs is necessary.

One potential solution would be to supplement the presentation of PRGs or other numerical criteria with information that makes clear and certain the intended use of the criteria and the assumptions incorporated in the development of those criteria. This should be presented in a way that makes the process transparent to any reader.

7. RECOMMENDATIONS AND FUTURE STEPS

Screening values are invaluable tools that may be applied and utilized in a variety of situations, including as guidelines during site remediation activities and in prioritizing an expensive remediation project in order to properly direct limited funds.

It is apparent from this survey of the selected state and federal numerical criteria for soils that variability in these criteria at the regional and state level has two primary causes. The first is frequent state-specific refinement of the various default assumptions used in defining exposure and risk to individuals exposed to soils. The second is a lack of consensus as to how screening criteria are to be applied and what the criteria signify. Nonetheless, the majority of states surveyed use the same soil screening and exposure assumption values.

This document does not recommend any one approach for developing screening criteria over another. States have developed their specific approaches not only due to statutory or policy differences but also due to differences in environmental conditions. For example, soil screening numbers developed for use in an arid warm weather state with deep aquifers may not be appropriate to use in a cold and wet state with shallow ground water.

7.1 Recommendations

From the examination in this report, the Risk Team has developed the following recommendations:

- *Publish the basis of the development of each criterion*. With the many valid but varying assumptions and guidelines that are possible, a thorough understanding of the assumptions used to arrive at the screening values is necessary. For example, it could be costly and unnecessary to clean deep subsurface soil to a level based on surface exposure. The analysis from the survey validated that it is important to ask the question, "what is the basis for the development of this criterion, and how is the criterion to be used in a manner consistent with that basis?″

- *Make the underlying assumptions and values transparent*. Transparency of assumptions used will enable stakeholders to evaluate when it is appropriate to use a screening assessment versus conducting a full risk assessment for a specific site. ITRC recommends that states and EPA regional offices supplement the presentation of numerical criteria with information that makes it clear and certain the intended use of the criteria and the assumptions incorporated into the development of those criteria.

- *Publish the intended use and application along with screening values*. This report recommends that each state publish a document describing the underlying principles and factors used in developing screening numbers as well as how the numbers are used within the overall state program of assessing and remediating sites. This transparency aids the public and professionals in the field to better understand the use of screening levels to achieve effective site cleanups that protect public health and the environment.

- *Provide training and communication tools*. No orderly, consistent practice of the use of screening criteria exists throughout the country today. As has been noted, even within a single state there are many programs that address chemical contamination in the environment, ranging from city services, county services, state agencies, and federal programs, all with different practices and regulatory mandates. Organizations such as the ITRC should take an active role in both the description and proper use of numerical criteria. This begins with the present document and should continue with other forms of communication, training, and forums in which the needs of the states are openly discussed. At a minimum, those entities that develop the technologies for site cleanup must be brought into a consensus. There should be a clear understanding of the expectations of all when numerical criteria are used in the development of performance standards for cleanup technologies.

7.2 Future Steps

This document is intended to be the first in a series that investigates how various U.S. states vary in their practice of risk assessment. The focus of this effort was to document the various means by which regulatory agencies develop and apply screening values to evaluate contaminated media. The data collected and analysis for this effort should create a platform for others to initiate examination of related aspects of the use of risk assessment in decision making for remediation. A number of questions remain to be studied further:

- This paper focused primarily on the screening criteria for residential soil, surface water and groundwater and peripherally explored existence of screening values based on ecological risk. An additional area to examine would be the application of risk-based criteria to other media or pathways.

- In the current study, thirteen states provided information with regards to five chemicals. To more accurately reflect the range of approaches used among states, subsequent efforts may attempt to increase both the number of states as well as chemicals examined. This study was limited only to screening values and exposure assumptions used as part of the process to determine if further investigation or corrective action is warranted. Although we did touch upon the application of these screening values, this is an area for additional study that should not only address the variation in application, but also whether these criteria are being used for their intended purpose.

- Although differences in screening criteria were documented in this report, the explanation for the source of these differences was not fully investigated. Screening values may vary because they are based on different background concentrations, technical considerations, protection levels, exposure assumptions, or algorithm calculation. Examining the influence of these sources of variation used in the derivation of screening criteria may provide useful insight into risk assessment practices.

- A limited number of exposure scenarios were included in this report. Because residential exposure is typically assumed as part of the screening process, industrial exposure scenarios were not analyzed. Future efforts may highlight the exposure assumptions used by the states and federal agencies regarding workers and children and examine additional exposure scenarios.

- Another area to be investigated is the collection and integration of site-specific data into risk assessment by various states. This information would include a review of guidance on sampling and the fate of contaminants.

- An area that requires examination is the use of risk assessment resulting in the development of cleanup goals at sites and in turn their influence on remedy selection.

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APPENDIX A

Acronyms

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ACRONYMS

ADD	average daily dose
ADD_O	oral average daily dose
ADD_D	dermal average daily dose
ADD_I	inhalation average daily dose
ADEQ	Arkansas Department of Environmental Quality
ARBCA	Alabama Risk-Based Corrective Action
ARAR	applicable or relevant and appropriate requirement
As	arsenic
AWQC	ambient water quality control
B(a)P	benzo(a)pyrene
CAL/EPA	California Environmental Protection Agency
CCLR	California Center for Land Recycling
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CTL	cleanup target levels
DAF	dilution attenuation factor
DHES	Department of Health and Environmental Control
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHEC	Department of Health and Environmental Control
DSCP	dry-cleaning solvent cleanup program
DWC	drinking water criteria
DWSL	drinking water screening level
ELCR	excess lifetime cancer risk
EMSOFT	exposure model for soil-organic fate and transport
ECOS	Environmental Council of the States
EPA	U. S. Environmental Protection Agency
ERIS	Environmental Research Institute of the States
ESV	ecological screening levels
FAC	Florida Administrative Code
GEPD	Georgia Environmental Protection Division
HHMSSL	human health medium specific screening level
HQ	hazard quotient
IFS_{adj}	age-adjusted soil ingestion factor
IRIS	Integrated Risk Information System
ITRC	Interstate Technology and Regulatory Council
KDHE	Kansas Department of Health and Environment
KRS	Kentucky Revised Statutes
MCL	maximum contaminant level
MCLG	maximum contaminant level goals
Pb	lead
PCB	polychlorinated biphenyl
PQL	practical quantitation limit
PRG	preliminary remediation goals

RBC	risk-based concentration
RBCA	risk-based corrective action
RSK	Risk-Based Standards for Kansas
SCLP	Sustainable Communities Leadership Programs
SCTL	soil cleanup target level
SFS_{adj}	age-adjusted soil inhalation factor
SSL	soil screening levels
SSL_{RR}	relative residential soil screening levels
SWMU	solid waste management units
TCE	trichloroethene
TSCA	Toxic Substances Control Act
UCL	upper confidence level

APPENDIX B

Glossary

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GLOSSARY

absorbed dose. The amount of a substance absorbed into the body, usually per unit of time. The most common unit of dose is mg per kg body weight per day (mg/kg-day).

absorption. Specifically, the penetration of a substance into the body from the skin, lungs, or digestive tract.

acute toxicity. Any poisonous effect produced within a short period of time following exposure, usually up to 24–96 hours, resulting in biological harm and often death.

attributable risk. The rate of a disease in exposed individuals that can be attributed to the exposure. This measure is derived by subtracting the rate (usually incidence or mortality) of the disease among nonexposed persons from the corresponding rate among exposed individuals.

background level. The level of pollution present in any environmental medium attributable to natural or ubiquitous sources.

benzo(a)pyrene (BaP). A carcinogenic polycyclic aromatic hydrocarbon.

bioaccumulation. The process whereby certain toxic substances collect in living tissues, thus posing a substantial hazard to human health or the environment.

biota. The sum total of the living organisms of any designated area

body burden. The total amount of a specific substance (for example, lead) in an organism including the amount stored, the amount that is mobile, and the amount absorbed.

carcinogen. A substance or agent that produces or incites cancerous growth.

carcinogenesis. Development of carcinoma or, in more recent usage, producing any kind of malignancy.

carcinogen potency. The gradient of the dose-response curve for a carcinogen.

confidence interval. A range of values ($a_1 < a < a_2$) in which a fixed proportion (commonly 0.95 or 0.99) includes the true value, x, of an estimated parameter.

contamination. Contact with an admixture of an unnatural agent, with the implication that the amount is measurable.

degradation. Physical, metabolic, or chemical change to a less complex form.

dilution attenuation factor. A factor used when establishing a soil concentration that is protective of groundwater to account for soil leachate mixing with a clean aquifer.

dose. The amount or concentration of undesired matter or energy deposited at the site of effect.

dose effect. The relationship between dose (usually an estimate of dose) and the gradation of the effect in a population, that is a biological change measured on a graded scale of severity, although at other times one may only be able to describe a qualitative effect that occurs within some range of exposure levels.

dose-response. A correlation between a quantified exposure (dose) and the proportion of a population that demonstrates a specific effect (response).

D-R assessment. The process of characterizing the relation between the dose of an agent administered or received and the incidence of an adverse health effect in exposed populations and estimating the incidence of the effect as a function of human exposure to the agent.

effect. A biological change caused by an exposure.

exposure. Contact between a potentially harmful agent and a receptor (e.g., a human or other organism) that could be affected.

exposure assessment. The process of measuring or estimating the intensity, frequency, and duration of human exposures to an agent currently present in the environment or of estimating hypothetical exposures that might arise from the release of new chemicals into the environment.

hazard. A condition or physical situation with a potential for an undesirable consequence, such as harm to life or limb.

hazard assessment. An analysis and evaluation of the physical, chemical and biological properties of the hazard.

hazard identification. The process of determining whether exposure to an agent can cause an increase in the incidence of a health condition.

hazardous waste. Any waste or combination of wastes which pose a substantial present or potential hazard to human health or living organisms because such wastes are nondegradable or persistent in nature or because they can be biologically magnified, or because they can be lethal, or because they may otherwise cause or tend to cause detrimental cumulative effects.

health effect. A deviation in the normal function of the human body.

H-E assessment. The component of risk assessment which determines the probability of a health effect given a particular level or range of exposure to a hazard.

health risk. Risk in which an adverse event affects human health.

leachate. Liquid that has percolated through soil or solid waste and has extracted dissolved or suspended materials from it.

leaching. The process by which nutrient chemicals or contaminants are dissolved and carried away by water, or are moved into a lower layer of soil or groundwater.

mobility. The ability of a chemical element or a pollutant to move into and through the environment (e.g., the mobilization of an element from a water column to sediment).

multi-stage model. A carcinogenesis dose-response model where it is assumed that cancer originates as a "malignant" cell, which is initiated by a series of somatic-like mutations occurring in finite steps. It is also assumed that each mutational stage can be depicted as a Poisson process in which the transition rate is approximately linear in dose rate.

pollutant. Any material entering the environment that has undesired effects.

population at risk. A limited population that may be unique for a specific dose-effect relationship; the uniqueness may be with respect to susceptibility to the effect or with respect to the dose or exposure itself.

ppm. Parts per million. A measurement of concentration such as 1 µg per gram.

probability. A probability assignment is a numerical encoding of the relative state of knowledge.

risk. The potential for realization of unwanted, adverse consequences to human life, health, property, or the environment; estimation of risk is usually based on the expected value of the conditional probability of the event occurring times the consequence of the event given that it has occurred.

risk assessment. The process of establishing information regarding acceptable levels of a risk and/or levels of risk for an individual, group, society, or the environment.

risk estimation. The scientific determination of the characteristics of risks, usually in as quantitative a way as possible. These include the magnitude, spatial scale, duration and intensity of adverse consequences, and their associated probabilities as well as a description of the cause and effect links.

risk identification. Recognizing that a hazard exists and trying to define its characteristics. Often risks exist and are even measured for some time before their adverse consequences are recognized. In other cases, risk identification is a deliberate procedure to review, and it is hoped, anticipate possible hazards.

soil screening. The process of identifying and defining areas, contaminants, and conditions at a site that do not require further federal attention under CERCLA or from a state agency

source. A place where pollutants are emitted into the environment, i.e. an illegal discharge.

threshold dose. The minimum application of a given substance required to produce an observable effect.

threshold limit value. Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers are protected while repeatedly exposed for an 8-hr day, 5 days a week (expressed as ppm for gases and vapors and as milligrams per cubic meter (mg/m^3) for fumes, mists, and dusts).

toxic substance. A chemical or mixture that may present an unreasonable risk of injury to health or the environment.

uncertainty analysis. A detailed examination of the systematic and random errors of a measurement or estimate; an analytical process to provide information regarding the uncertainty.

water pollution. The addition of sewage, industrial wastes, contaminants or other harmful or objectionable material to water in concentrations or in sufficient quantities to result in measurable degradation of water quality.

water quality criteria. Levels of pollutants in bodies of water that are consistent with various uses of water, i.e. drinking water, sport fishing, industrial use.

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APPENDIX C

The ITRC Risk Survey
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THE ITRC RISK SURVEY

The ITRC Risk Team developed a questionnaire to query different states and agencies about their methodology for determining risk based concentrations and establishing standards for chemicals in water and soil. In July 2003, a preliminary version of the questionnaire was drafted and distributed among members of the ITRC Risk Assessment Resources team. Members were asked to review the questionnaire, and to provide feedback on the questions.

Based on comments received, a final version of the questionnaire was prepared. A copy of this questionnaire is provided in Appendix 1of this Report. The final questionnaire had five general sections: overview, contact information, chemical-specific pages, assumptions, and questions. The states represented in this survey are Alabama, Arkansas, California, Colorado, Florida, Georgia, Kansas, Kentucky, Michigan, Nevada, Oklahoma, South Carolina, and Tennessee. The information requested for each section is given below.

Overview: This initial page of the spreadsheet served to provide a description of the spreadsheet as well as information on how to complete the survey and where to submit completed files.

Contact Information: Each respondent to the survey was requested to fill in his/her respective contact information.

Chemical Specific Pages: Five chemicals, arsenic, TCE, lead, PCBs, and benzo(a)pyrene (B(a)P) were selected for this evaluation at the ITRC Risk Resources team meeting held in Livermore, CA, June 23–25, 2003. The chemicals were selected in part to represent a range of various chemical types (e.g., volatiles, metals). However, overall the selection process was the product of a group discussion in which various members submitted specific chemicals of interest. The selection was limited to five chemicals to limit the time required to complete the questionnaire. The five chemicals chosen were considered to be the most prevalent at hazardous waste sites by the team.

Assumptions: Responding states and/or agencies were asked to provide information detailing their respective default risk-based clean-up standards and exposure parameters used. This information is helpful in distinguishing the source of any discrepancies when comparing of state values.

Questions: A series of additional questions were posed in this section of the spreadsheet. Topics included exposure scenarios, established risk levels, and application of standards. The questions were developed with input from members of the ITRC Risk Resources Team.

Please fill in the following information:

State or Agency: ______________________________

Name: ______________________________

Address:
____
____
____

Phone: ______________________________

Email: ______________________________

State:				

Additional Questions

A) Available Criteria

1)	Does your State/Agency use risk-based values for evaluation of contaminants in environmental media?			
		Yes	No	
	Has your State/Agency develop risk-based values or instead uses values developed by others?			
		Yes	No	
	Developed by the State/Agency itself			
		Yes	No	Name of source of numbers
	Developed by others			
2)	For any of the chemicals evaluated, does your State/Agency use background concentrations or reference values in addition to risk-based values? If so, please list the concentrations used and type of value (reference or background, etc.) for each chemical.			
		Soil, ppm	GW, ppb	type of value
	Arsenic			
	Trichloroethylene			
	Lead			
	PCBs			
	Benzo(a)pyrene			
3)	Has your State/Agency developed a set of ecological soil values for these or any other chemicals? If yes, please provide additional detail, including documented references for their technical basis.			

4)	Is any groundwater value used by your State/Agency based on organoleptic or nuisance considerations, or equal to a reporting, quantitation, or detection limit?					
			(Yes, No)		Examples	
	Based on organolpetic/nuisance considerations?					
	Equal to some reporting/quantitation/detection limit?					
5)	For the chemicals evaluated or any other, does your State/Agency also have acute toxicity soil values?					
		Yes	No	Example		
B) Approaches and Assumptions used for Development of Chronic Risk-Based Criteria						
1)	What is the acceptable cancer risk and hazard index used by your State/Agency to calculate risk-based soil values?					
	Acceptable cancer risk:					
	Acceptable non-cancer hazard quotient:					
2)	What are the exposure scenarios for which your State/Agency has developed soil values, and what are the routes considered?					
	Exposure scenarios:					
	Exposure routes:					
3)	Please enter the values used as input for the exposure assumptions used to calculate soil values for each scenario. Note: If your State has a spreadsheet of values already developed, you can insert this page into this spreadsheet under "assumptions", rather than filling in the fields provided below					
	Residential Scenario				Industrial/commercial	
		Cancer	NC		Cancer	NC
	Body weight (kg)					

	Soil ingestion rate (mg/d):										
	Exposure frequency (d/yr):										
	Exposure duration (yr)										
	Skin surface area (cm2):										
	Skin adherence factor (mg/cm2):										
	Dermal absorption:										
	Inhalation rate (m3/d)										
	Averaging time carcinogens (d):										
	Averaging time non-carcinogens (d):										
	Particulate emission factor (m3/kg):										
C) Use of Risk-Based Criteria											
1)	What is the intended application of the risk-based values used by your State/Agency?										
	Used for screening purposes only										
	Used as cleanup goals										
	Used for screening and to guide cleanup										
	Used as cleanup levels										
	Any Other? Please specify										
A	Please provide the working definitions used by your State/Agency for the following terms:										
	Screening:										
	Cleanup Goals:										
	Target Level:										
B	Please provide any other additional comments.										

2)	Please describe how the soil values are typically applied within your State/Agency: For example; not to exceed, comparison to 95%UCL, 3x risk-based value evaluation					
	Screening				Risk management based on Project Manager decision	
		Yes	No		Yes	No
	Not to exceed					
	Comparison with 95%UCL					
	3X the risk-based value evaluation					
	Simple Average					
	average determined by composite sample					
	Other					
	Please provide additional comments (e.g. no compositing, why not?). Also, provide the definition and evaluation of a 'hot spot' if their identification is one of the uses of your soil criteria. Provide documented references and technical justification as available:					
3)	In the event you allow averaging of soil concentrations to derive an exposure point concentration, what is the area over which your State/Agency allows this averaging to be calculated? In addition, does your State/Agency use default size areas for evaluating future residential scenarios on undeveloped sites?					
A	Definition of area over which averaging is allowed:					
B	Default size of area for residential evaluations (Acres):					

4)	Please specify what is the depth interval over which your State/Agency recommends mixing of the soil sample to evaluate direct exposure to surface soil and inhalation exposure to volatiles emanating from the subsurface.					
		From (in)	to (in)			
	Surface					
	Subsurface					
5)	**a.** To what depth does your State/Agency assume soil can be disturbed or excavated and redistributed to the surface and then be available for direct exposure?					
		depth (in)				
	b. From what depth does your State/Agency assume volatiles can migrate up to and through the soil surface and provide an inhalation exposure?					
		depth (in)				
	c. Please provide the technical basis for these assumptions, including written documentation as available.					
6)	What is the depth in feet to which your State/Agency requires removal to eliminate risks from direct exposure to surface soil and exposure to volatiles from subsurface?					
		Surface	Subsurface			
	Arsenic					Please provide the technical basis for these assumptions, including written documentation as available.
	Trichloroethylene					N/A
	Lead					
	PCBs					
	Benzo(a)pyrene					
7)	How long does your State/Agency assume a volatile chemical (ie., Trichloroethylene) will reside in “surface soil” as defined in Question #4					

	Minutes
	Hours
	Days
	Years
	Same as exposure duration used for deriving criterion
	Please provide the technical basis for these assumptions, including written documentation as available.
	N/A
8)	Is vapor intrusion evaluated by your State/Agency, and if so how are air concentrations modeled? (infinite source or finite source)
9)	Is there a website(s) that contains more details on the calculation of risk based concentrations or other soil values? If yes, please list below.
a	
b	
c	
d	

APPENDIX D

Information Collected from Survey of 13 States

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INFORMATION COLLECTED FROM SURVEY OF 13 STATES

The data collected in this appendix is accurate for the time when the survey was conducted in the fall of 2003 and spring of 2004. Some of the information may have changed since then and the ITRC Risk Team is not updating it to its current status. There are also additional data collected and summarized in this appendix which have not been used in this paper. The ITRC Risk Team plans to use this additional data in future products.

LB*Left Blank
NA Not Applicable
ND Not Defined

TN Tennessee Division of Superfund
MI Michigan Dept. of Environmental Quality
NV Nevada Division of Environmental Protection
CO Colorado Dept of Public Health and Environment
AR Arkansas Department of Environmental Quality
CA California EPA, SF Bay Regional Board
FL Florida Department of Environmental Protection
SC South Carolina Department of Health and Environmental Control
KS Kansas Department of Health and Environment
KY Kentucky Division of Waste Management
GA Georgia Environmental Protection Division
AL Alabama Department of Environmental Management
OK Oklahoma Department of Environmental Quality

A) AVAILABLE CRITERIA

1) Has your State/Agency developed risk-based values for evaluation of contaminants and/or values developed by others?

a) Developed by the State/Agency itself:

State	Yes	No
TN		X
MI	X	
NV		X
CO	X	
AR		
CA	X	
FL	X	
SC		X
KS	X	
KY	X	

State	Yes	No
GA		X
AL	X	
OK	X	

b) Developed by others:

State	Yes	No	Name Of Source Of Numbers
TN	X		EPA R4 and R9
MI	NA		
NV	X		EPA reg. 9
CO	X		EPA Reg. 9 PRGs
AR			
CA	X		Various
FL	NA		For water Fl uses some of the MCLs
SC	X		Default assumptions for residential and industrial land uses based on the Risk Assessment Guidance for Superfund (RAGS)
KS	X		Reg. 9
KY	NA		
GA	X		Reg. 9 PRGs are used for screening
AL	X		EPA Reg. 9 & EPA MCLs
OK	X		EPA Reg. 6

2) For any of the chemicals evaluated, does your State/Agency use background concentrations or reference values in addition to risk-based values? If so, please list the concentrations used and type of value (reference or background, etc.) for each chemical.

State	Chemical	Soil ppm	Ground water ppb	Type of Value	Comment
CO	Arsenic	4	4	Site Specific Bkg can be used	
	TCE	4	4		
	Lead			Site Specific Bkg can be used	
	Benzo(a)pyrene	Maybe		Requires extensive Bkg data	
CA	Arsenic	5.5	mg/kg	Soil ave.	
FL	Arsenic	Yes	No value given	Site-specific natural Background	Or the risk-based value, whichever is higher
	Lead		No value given	Inorganics can be compared to Bkg on a site specific basis	

State	Chemical	Soil ppm	Ground water ppb	Type of Value	Comment
MI	Arsenic	5.8			No, not unless RBSL is less than background levels.
	Lead	21			
SC	Arsenic		50	Groundwater MCL	
	TCE		5		
	Lead		15	Groundwater MCL	
	PCB’s		0.5	Groundwater MCL	
	Benzo(a)pyrene		0.2	Groundwater MCL	
KY	Arsenic	8.9		Mean	Generic Bkg Concentrations for KY Soils have been developed for inorganic substances including Arsenic
	Lead	30		Mean	
TN	Arsenic	10		Calculated background for state	Arsenic and other metals typically found in soil are based upon the third quartile of data from a statewide survey by UT Knoxville and USGS.
AL	Arsenic	4	4	Site specific	For soils: Two times the arithmetic mean of the background sample’s concentrations should be screened against the on-site maximum detected concentration. If the contaminant of potential concern is less than 2 times the background level, then the contaminant should be eliminated as a concern.
	Trichloroethylene	NA	4	Site specific	
	Lead	4	4	Site specific	
	PCB’s	NA	4	Site specific	
	Benzo(a)pyrene	NA	4	Site specific	
KS	Arsenic			Site specific	
	Trichloroethylene			Site specific	
	Lead			Site specific	
	PCB’s			Site specific – Requires extensive background data	
	Benzo(a)pyrene			Site specific	
AR	Arsenic	NA	10	MCL	
	Trichloroethylene	NA	5	MCL	
	Lead	NA	15	MCL	
	PCB’s	NA	0.5	MCL	
	Benzo(a)pyrene	NA	0.2	MCL	
GA	All	Site specific background for all			
NV					No, they are based on site specific background values collected.
OK	LB*				

Special notes on Question A.2 from MI

Background concentrations may be calculated for either (a) Site-specific background, using methods in Memorandum #15, the Verification of Soil Remediation Guidance Document. Acceptable default values are listed below or (b) Regional background values, using data from Waste Management Division's Soil Survey Document. Data from a similar soil type and the appropriate geological lobe must be used. Background concentration is calculated as the mean plus three (3) times the standard deviation. Contact supervisor to determine how this approach should be used in your district.

Special notes on Question A.2 from MI

No, they are based on site-specific background values collected.

Special notes on Question A.2 from KY

Yes. Generic Background Concentrations for Kentucky Soils have been developed for inorganic substances.

3) Has your State/Agency developed a set of ecological soil values for these or any other chemicals? If yes, please provide additional detail, including documented references for their technical basis.

State	Additional Details
CO	Not for Generic Use. However, several large Federal Facilities have developed site specific ecological soil concentration screening values.
CA	Reference compilation put together by Ontario Ministry of Environment (1996). MOEE, 1996, Rational for the Development and Application of Generic Soil, Groundwater and Sediment Criteria for Use at Contaminated Sites in Ontario: Ontario Ministry of Environment and Energy, Standards Development Branch, December, 1996, www.ene.gov.on.ca/.
SC	They are not State developed numbers. We use the Region IV Ecological Screening Values (ESV) for all media.
FL	No
MI	No, sites that are remediated to protect drinking water or surface water are assumed to be protective of ecological hazards. However, the need for an ecological risk assessment must be considered based on the presence of contaminants that bioaccumulate, nonhuman species which are at the top of the food chain, endangered species (plants or animals), or critical habitat. The five chemicals in questions do not fall into this category.
NV	Yes by means of using EPA materials found at the website: http://www.epa.gov/superfund/programs/risk/tooleco.htm
KY	Yes. Documents listed below were used to develop Kentucky's risk-based clean-up standards and the procedures used in calculating risk-based concentrations. A checklist is used to determine if an ecological risk assessment needs to be conducted. 1) Simini, M., Checkai, R.T., and Maly, M.E. 2000. Tri-Service Remedial Project Manager's Handbook for Ecological Risk Assessment. Air Force Center for Environmental Excellence, Army Environmental Center, and Navy Facilities Service Center. SFIM-AEC-ER-CR-200015. 2) United States Environmental Protection Agency (EPA). 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, DC. EPA/600/R-93/187a 3) EPA. 1997a. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final. EPA Environmental Response Team, Edison, NJ.

State	Additional Details
	4) EPA. 1998. Guidelines for Ecological Risk Assessment. Risk Assessment Forum, Washington, DC. EPA/630/R-95/002F.
KS	No, Any values used are for human health.
TN	No, we use EPA.
AR	Arkansas primarily uses EPA Region 4's eco screening levels derived in large part from the G.P. Friday Report (November 1998) As-1.1-16.7; TCE-NA; Lead - 10-18; BAP - NA; PCBs - NA
OK	No, DEQ uses the values published by EPA.
GA	No
AL	No

4) Is any groundwater value used by your State/Agency based on organoleptic or nuisance considerations, or equal to a reporting, quantitation, or detection limit?

a) Based on organolpetic/nuisance considerations?

State	Yes	No	Examples
KS	X		Zn,Ag
CA	X		Listed
SC	X		All cleanup levels are quantifiable
NV		X	
AR		X	
MI		X	
GA		X	
TN		X	
CO	X		Copper, iron, manganese, chloride based on odor color etc.
FL	X		X, T, EB, Fe, Mn etc.
KY		X	
AL		X	
OK	X		TPH

b) Equal to some reporting/quantitation/detection limit?

State	Yes	No	Examples
FL	X		Aldrin, and many others , we use the PQL
KY		X	
KS		X	
TN		X	
GA		X	
NV		X	
MI		X	
CO	NA		
AR			
SC		X	All cleanup levels are quantifiable.

State	Yes	No	Examples
CA		X	
AL		X	
OK		X	

c) Does your State/Agency use a Federal Maximum Contaminant Level for drinking water for evaluating groundwater for any of the chemicals under evaluation? If so, please list which.

State	Federal MCL Used?
TN	Yes, all of them in a potable and likely used aquifer
MI	Yes for all five chemicals [As, TCE, Pb, PCB, B(a)P]
NV	Yes for all five chemicals [As, TCE, Pb, PCB, B(a)P]
AR	All of them
KS	Yes. The state promulgates federal MCLs, in absence of more restrictive state standards. Drinking water standard used when MCL absent (e.g. nitrate).
KY	
OK	Yes, all the listed chemicals in the National Primary Drinking Water Regulations
FL	Yes, except for TCE
AL	Yes, for all 5 chemicals.

5) For the chemicals evaluated or any other, does your state/agency also have acute toxicity soil values?

State	Yes	No	Examples
FL	X		Vanadium, Cd, Ba, Cyanide, Copper, Phenol,Ni and Fluoride
KY		X	Although parameters available to calculate vapor exposure from soil.
KS		X	
TN		X	Refer to NIOSH
GA		X	
NV	X		There are residential and industrial values for inhalation from soil
MI		X	Sites that comply with drinking water or GSI criteria are assumed to be protective of physical hazards and acute vapor toxicity. Although parameters available.
CO		X	
AR		X	
SC		X	
CA		X	
AL		X	
OK		X	

B) APPROACHES AND ASSUMPTIONS USED FOR DEVELOPMENT OF CHRONIC RISK-BASED CRITERIA

1) What is the acceptable cancer risk and hazard index used by your State/Agency to calculate risk-based soil values?

State	Acceptable Cancer Risk	Acceptable Non-Cancer Hazard Quotient
CO	1E-06	1
CA	1.00E-06	0.2
SC	10-6 either residential or industrial	1 either residential or industrial
FL	1E-06	1
MI	1E-05	1
NV	1E-06	1
KY	1E-06	1
TN	10-6 for screening 10-5 final cleanup	1
AR	10E-6 screen	1
KS	10E-6	See RSK Manual
OK	10E-5	1
GA	1E-04 to 1E-06 based on site specific determination	1-3 based on site specific determination
AL	1E-05	0.1

2) What are the exposure scenarios for which your State/Agency has developed soil values, and what are the routes considered?

State	Exposure Scenarios	Exposure Routes
CO	Residential, industrial and some commercial.	LB*
CA	Residential, commercial/industrial, construction worker.	Inhalation, dermal absorption, ingestion
SC	We do not have State numbers. But we commonly use residential and industrial scenarios for cleanup decisions.	Inhalation, Dermal, Ingestion
FL	Residential, industrial.	Oral, inhalation, dermal
MI	Residential (7-31)/Residential (1-6) /Industrial/Commercial/Utility Worker (Max GW Exposure)	Oral, dermal, and respiratory
NV	Adult Resident /Adult Worker / Child	Air/Soil-Inhale/Soil-Dermal /Soil-Ingest /Soil-Combined/Water-Inhale Water-Ingest/Water-Combined
KY	Child (<7 y); Adult (including Children 7-18)); Adult Worker; Outdoor adult (landscaping, construction, rural outdoor activities, & tilling & gardening)	Ingestion (soil, water, water during swimming), Dermal (soil; water during swimming or wading; water during bathing or showering), Inhalation (soil particulates and vapor), during bathing or showering), Inhalation (soil particulates; vapor from soil; vapor in residential water and water during showering).
GA	N/A	N/A
KS	Residential and Nonresidential	Ingestion, inhalation (particulate, volatile), dermal, soil to GW

State	Exposure Scenarios	Exposure Routes
TN	No state-authored screening values other than tap water MCLs.	Ingestion for tap water MCLs
AR	Residential, Industrial Indoor Worker, Industrial Outdoor Worker.	Ingestion, Dermal, Inhalation
OK	See EPA reg. 6 MSSL	See EPA reg. 6 MSSL
AL	Residential, commercial/industrial, construction worker.	Ingestion, dermal, inhalation

a) Please enter the values used as input for the exposure assumptions used to calculate soil values for each scenario. Note: If your State has a spreadsheet of values already developed, you can insert this page into this spreadsheet under "assumptions", rather than filling in the fields provided below

State	Scenario	Body Wt. (kg)	Soil Ingest Rate (mg/d)	Expos Freq. (d/yr)	Expos Dur. (yr)	Skin Surf. Area (cm2)	Skin Adhere Factor (mg/c2)	Dermal Absor.	Inhale. Rate (m3/d)	Avg. Time Carcin (d)	Avg. Time Non-Carcin (d)	Particulate Emission Factor (m3/kg)
CA	Residential (Child)	15	200	350	30	2800	0.2	Varies	10	70	30	1.32E+09
	Residential (Adult)	70	100	350	30	5700	0.7	Varies	20	70	30	1.32E+09
	Indust./Comm. (Cancer)	70	100	250	25	3300	0.2	Varies	20	70	25	1.32E+09
	Indust./Comm. (NC)	70	100	250	25	3300	0.2	Varies	20	70	25	1.32E+09
SC	Residential (Cancer)	70/15	100/200	350	24/6	5000/ 1800	1.0/1.0	1% Org/ 0.1% Inorg	20/15	25550	8760	1.32×10^9
	Residential (NC)	70/15	100/200	350	24/6	5000/ 1800	1.0/1.0	1% Org / 0.1% Inorg	20/15	25550	2190	1.32×10^9
	Indust./Comm. (Cancer)	70	100	250	25	3200	1	1% Org/ 0.1% Inorg	20	25550	9125	1.32×10^9
	Indust./Comm. (NC)	70	100	250	25	3200	1	1% Org/ 0.1% Inorg	20	25550	9125	1.32×10^9
TN	Resident Child	15	200	350	6	2800	0.2	0.1	10	25550	2190	1.30E+09
	Resident Adult	70	100	350	30	5700	0.07	0.1	20	25550	10950	1.30E+09
	Industrial	70	100	250	25	3300	0.2	0.1	20	25550	9125	1.30E+09
GA	LB											
CO	LB											
AL	Residential (Child)	15	200	350	6	2500	0.5	0.01 Org / 0.001 Inorg	10.008*	25550	2190	**
	Residential (Adult)	70	100	350	30	5000	0.5	0.01 Org / 0.001 Inorg	15.192*	25550	10950	**
	Commercial Worker	70	50	250	25	5000	0.5	0.01 Org / 0.001 Inorg	36*	25550	9125	**
	Construction Worker	70	100	250	1	5000	0.5	0.01 Org /	36*	25550	365	**

State	Scenario	Body Wt. (kg)	Soil Ingest Rate (mg/d)	Expos Freq. (d/yr)	Expos Dur. (yr)	Skin Surf. Area (cm2)	Skin Adhere Factor (mg/c2)	Dermal Absor.	Inhale. Rate (m3/d)	Avg. Time Carcin (d)	Avg. Time Non-Carcin (d)	Particulate Emission Factor (m3/kg)
								0.001 Inorg				
	Trespasser	45	200	350	10	5000	0.5	0.01 Org / 0.001 Inorg	36*	25550	3650	**
FL	Res(cancer);non cancer child	59;15	120 ;200	350	30;6	3674; 1800	0.2;0.6	0.01(org);.001 (inorg)	15;10	25550	2190	1.24E09
	Indust adult	70	50	350	25	2000	.6	.01 org;.001 inorg	20	25550	9125	1.24E+09
MI	Residential (Age 7-31)	70	100	350	24/30*	5000	1	0.1/0.01**	ND	25550	10950	ND
	Residential (Age 1-6)	15	200	245	24	1820	1	0.1/0.01**	ND	25550	7665	ND
	Industrial	70	50	112	21	2570	1	0.1/0.01**	ND	25550	7665	ND
	Commercial	70		160 or 128***	21	2570 or 4575**	1	0.1/0.01**	ND	25550	7665	ND
	Utility Worker (Max GW Exposure)	70	ND	20	21	3000	1	0.1/0.01**	ND	25550	7665	ND
NV	Adult Resident	70	100	350	30	5700	0.07	0.1	20	25550	25550	1.3 + 09
	Adult Worker	70	100	250	25	3300	0.2	0.1	20	25550	25550	1.3 + 09
	Child (1-6)	15	200	350	6	2800	0.2	0.1	10	25550	25550	1.3 + 09
AR	Residential	15	200	350	6	2800	0.2	Chem	8	70	6	1.32 E+09
	Industrial	70	100	225	25	3300	0.2	Chem	20	70	25	1.32 E+09
KS	Residential	70	100	350	30	5000	0.2	0.1 org	20	25550	8760	1.18×10^9
	Non-Residential	15	200	350	6	1750	0.2	in org	10	25550	2190	
KY	Child (<7 years)	15	200	140	6	2800	1	0.25/0.1/ 0.05*	20	25550	2190	9.30E+08
	Child 7-18 years/Adult	43/70	100	350	12	7500/ 5700	1	0.25/0.1/ 0.05*	20	25550	4380	9.30E+08
	Adult Worker	70	50	250	25	3300	1	0.25/0.1/ 0.05*	12.5	25550	9125	6.20E+08
	Outdoor Adult:Worker/Urban Res./Rural	70	480	185/52/ 104	25/12/22	4700	1	0.25/0.1/ 0.05*	12.5/20 /20	25550	9125/4380 /8030	6.2E+08/9.3 E+08

State	Scenario	Body Wt. (kg)	Soil Ingest Rate (mg/d)	Expos Freq. (d/yr)	Expos Dur. (yr)	Skin Surf. Area (cm2)	Skin Adhere Factor (mg/c2)	Dermal Absor.	Inhale. Rate (m3/d)	Avg. Time Carcin (d)	Avg. Time Non-Carcin (d)	Particulate Emission Factor (m3/kg)
OK	Residential (cancer)	70	50	350	Adjusted or 6	2800 or adjusted	0.2		20 or adjust.	25550	2190	1.32x10+9
	Res. Non cancer	70	50	350	Adjusted or 6	2800 or adjusted	0.2		10 for child		2190	1.32x10+9

Notes on state responses:

MI
* Soil or water respectively
** Volatiles or Semi-Volatiles respectively
*** Commercial Subcategory III (Gas Station Attendant With Indoor & Outdoor Activities or Commercial Subcategory IV) (Office Worker With Indoor Activities & Outdoor Breaks/Lunch) Respectively

GA
* LB

AL
* Currently, for AL the inhalation rate is under discussion and may be changing shortly to 20 m^3/day for an adult and 12 m^3/day for a child.
**The state of AL uses a particulate emission rate (g/cm^2sec): Residential & Commercial = 6.90E-14; Trespasser & Construction Worker = 6.90E-09

KY
* Notes: VOCs/Semivolatiles/Inorganics
** Additional item to KY questionnaire: Skin contact per time (fraction per day):

- Child <7 years = 0.3
- Child 7-18 years/Adult = 0.3/0.5/0.5
- Adult Worker = 0.3
- Outdoor Adult: Worker/Urban Res./Rural = 0.3/0.5/0.5

C) USE OF RISK-BASED CRITERIA

1) What is the intended application of the risk-based values used by your State/Agency?

State	Used For Screening Purposes Only	Used As Cleanup Goal	Used For Screening And To Guide Cleanup	Used As Cleanup Levels	Any Other (Please Specify)
CA	X		X		
FL	X	X	X	X	Mgmt
SC		X	X	X	
MI			X		
NV			X		
KY			X		Evaluate when ecorisk assessment needed
KS			X		
TN			X		
AR			X		
GA	4 Reg. 9 PRGs	Site spec.		Site spec.	
CO	See note				
AL			X	X	
OK		X	X	X	

a) Please provide the working definitions used by your State/Agency for the following terms:

State	Term	Working Definition
CA	Screening	Initial evaluation of potential environmental concerns based on comparison of site data and characteristics to our environmental screening levels.
	Cleanup Goals	Final cleanup goals based on consideration of site-specific environmental concerns and feasibility factors.
	Target Level	None
SC	Screening	Values calculated for each chemical based on default residential or industrial scenarios from the Risk Assessment Guidance for Superfund.
	Cleanup Goals	Modification of screening value based on the nine criteria of CERCLA, and adjustments for those chemicals that target specific organs. Move up as appropriate within the risk range, not to exceed 10-4.
	Target Level	
FL	Screening	Initial comparison of maximum site concentration to Soil Cleanup Target Level (SCTL) (Petroleum program); other programs may compare the 95%UCL within their exposure unit to the SCTL with apportionment as applicable.
	Cleanup Goals	Concentrations that are used to guide remedial actions; could be the SCTLs
	Target Level	Concentrations that should be attained to guarantee protection of human health and the environment. It can be done trough cleanup, engineering and institutional controls. Target levels can be modified based on site-specific conditions
MI	Screening	Values below which no further risk-based evaluation is necessary
	Cleanup Goals	Term not clearly defined and the term "cleanup target" is used in some documents

State	Term	Working Definition
	Target Level	Not clearly defined but refers to site specific levels.
NV	Screening	To help identify areas, contaminants, and conditions that do not require further federal attention at a particular site
	Cleanup Goals	Site specific, long-term final level of contamination remaining after a particular remedy has been completed
	Target Level	Initial cleanup goals
KY	Screening	A concentration of a hazardous substance or petroleum in the soil, an exceedance of which could result in potential adverse effects to human health or the environment. These values are default, non-site specific values, below which no further risk-based evaluation is necessary.
	Cleanup Goals	Site specific clean-up concentrations for restoration to residential or industrial/commercial use
	Target Level	Unclear/Term not used
KS	Screening	See RSK Manual
	Cleanup Goals	See RSK Manual
	Target Level	See RSK Manual
TN	Screening	The elimination of COPCs with insignificant risk from risk assessment to focus on most important constituents.
	Cleanup Goals	Soil concentrations back calculated from risk estimates and other considerations (contaminant migration etc) to be the point at which you can stop digging or declare other remediations complete.
	Target Level	Amount of risk or hazard quotient deemed acceptable to leave in place.
AR	Screening	Elimination of COPCs posing minimal/insignificant risk and identifying those requiring further investigation
	Cleanup Goals	Clean-up levels in each media necessary to be protective of all applicable receptors
	Target Level	The risk levels deemed adequate to be protective of any given site.
GA	LB	
CO	See note	
AL	Screening	Evaluation of collected data to determine source areas and areas of interest that may need further evaluation
	Cleanup Goals	Generic or site-specific levels that are determined to be protective of human health and the environment
	Target Level	Acceptable risk level for both carcinogenic and non-carcinogenic health effects.
OK	Screening	Process of identifying and defining areas, contaminants, and conditions at a particular site that does not require further attention.
	Cleanup Goals	Concentrations of contaminants that are protective of human health and the environment and that comply with the ARARs
	Target Level	A value that is combined with exposure and toxicity information to calculate a risk-based concentration.

b) Please provide any other additional comments.

State	Comments
CO	Note: The human health risk based soil remediation objectives are a goal for all cleanups. However, there primary use is as conservative screening values so that NFA determinations can be easily provided if site concentrations are below residential SROs. Facilities are allowed to develop site specific soil remediation objectives with Health Department Guidance and Approval. Cleanup to scenarios other than residential requires enforceable environmental covenant as allowed under State Law.
CA	For details refer to our Environmental Screening Levels document at: http://www.swrcb.ca.gov/rwqcb2/esl.htm
KS	Questions 2-5 based on land use restrictions.
TN	Screening values are used for cleanup only at sites that are too small for a risk assessment to be feasible (typical small area sniff-dig-haul). Even then, other considerations are made such as possibility of runoff to streams or migration to groundwater. Cleanups of this type are usually considered interim cleanups and if further investigation shows nothing of concern, a "no further action" order is filed.
FL	Details and updates can be found at: http://fdep.ifas.ufl.edu/

2) Please describe how the soil values are typically applied within your State/Agency: For example; not to exceed, comparison to 95%UCL, 3x risk-based value evaluation

State	Not To Exceed	Comparison With 95% UCL	3X The Risk-Based Value Evaluation	Simple Average	Average Determined By Composite Example	Comments
CO See Note						
CA	X	X				
SC	LB*					
MI		X				Sample results from hot spots are addressed separately and not included in calculation of the 95% UCL.
NV		X				
KY		X				
TN		X				UCL may be calculated by any standard and statistically defensible method.
AR		X				They are used as screening values and then if necessary a site specific RA is done and we use the 95%UCL of Arithmetic mean for exposure point concentration

State	Not To Exceed	Comparison With 95% UCL	3X The Risk-Based Value Evaluation	Simple Average	Average Determined By Composite Example	Comments
FL (Baseline Evalua-tion)	X	X	X		X	If the 95%UCL is used to calculate SCTls, the maximum concentration cannot exceed 3X of the SCTL: apportionment should be considered
KS						Default values; however site-specific may lend to modification.
OK		X				
GA	LB	LB	LB	LB	LB	95 % UCL or max value based on # of measurements and confidence in UCL
AL	X					Generally, the max value is used; however, 95% UCL, arithmetic avg., volumetric avg., or an area-weighted avg. is sometimes used.

Please provide additional comments (e.g. no compositing, why not?). Also, provide the definition and evaluation of a 'hot spot' if their identification is one of the uses of your soil criteria. Provide documented references and technical justification as available:

State	Comments
CO	Health Department preference is to compare each individual soil sample result to the SRO and cleanup anything above SRO. However, with Agency guidance and approval, SRO values can be used for comparison to exposure point concentrations derived from soil sample results from a specific area.
CA	No compositing for final verification samples if VOCs. Potential compositing for non VOCs.
SC	This question is not clear. Risk screening and cleanup values are calculated independent of how the source term is evaluated. We do utilize many of the tools for characterizing a source term listed above. Depending on the conceptual site model, compositing may be used to characterize a source, if appropriate. A 95% UCL is used to derive the risk based concentration of the source to be compared to the screening or cleanup level. Once the risk based concentration is derived to represent the source for comparison to the cleanup level, if it exceeds the cleanup level, it will trigger remediation.

State	Comments
FL	Compositing is allowed only on very few occasions to avoid masking of hot spots. In the few instances it has been used has been mainly to avoid excessive expenditure on costly analyses. For example, this approach was used to evaluate dioxin contamination in residential lots of a neighborhood where the transport mechanism was thought not to be conducive of generating hot spots. In this situation, a composite sample from five individual grabs (four near each corner and one in the center) was obtained from each lot. Hot spots are those areas where contamination is significantly higher than in other areas of the site. They are usually identified as those areas where the corresponding criterion is exceeded by a factor of 3.
MI	A 'Hot Spot' is two or more adjacent sample locations in reasonably close proximity at which concentrations are sufficiently above criteria and surrounding location (i.e. spatially correlated concentrations sufficiently above criteria) to indicate that they: - Represent a different statistical population and - Pose a potential risk that should not be masked by a statistical analysis. See: MDEQ's Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria
KY	No definition found for 'Hot Spot'
TN	If possible, sites are divided into probable exposure areas (Where future targets may live or work). Remediation goals are usually calculated to be less than 95% UCL for each exposure area (area based). "Hot Spots" (small areas with higher contaminant concentration than the overall remediation goal) may be left in place or removed depending on likelihood that the "hot spot" represents a significant proportion of an exposure area.
AR	Composting is not preferred since it could allow discreet areas of elevated concentrations to go unnoticed.
AL	Compositing is allowed for constituents other than VOCs or Semi-VOCs. Certain Departmental approved guidelines regarding the compositing of samples must be followed.

3) **In the event you allow averaging of soil concentrations to derive an exposure point concentration, what is the area over which your State/Agency allows this averaging to be calculated? In addition, does your State/Agency use default size areas for evaluating future residential scenarios on undeveloped sites?**

a) Definition of area over which averaging is allowed:

State	Comments
CO	Residential = 0.5 acre is the default. Industrial, recreational and alternate residential areas allowed with Agency approval
CA	Averaging in area no larger than 1000 ft2 for residential sites. For details refer to our Environmental Screening Levels document at: http://www.swrcb.ca.gov/rwqcb2/esl.htm
SC	The area is only evaluated over the extent of the source term.
FL	The area is the exposure unit relevant for each scenario. For residential evaluations, the unit is the residential lot (0.25 acre). For industrial scenarios the unit is the facility or the area where workers usually perform their daily activities "area over which the receptor will have equal and random contact".
MI	Averaging in groundwater is allowed/defined as the cross sectional area of the contaminated plume used to estimate the discharge rate of venting groundwater in the request for a mixing zone determination. In soils, averaging is allowed across an unstated area in soil as long as specified. Areas other than 0.5 acres use a modifying factor in calculations. Averaging is allowed under limited conditions i.e. Hot Spots & upgradient wells. Averaging must included a sufficient number of samples to allow statistical analysis and produce representative concentrations for the area in question.
NV	No known guidelines
TN	Case by case
AR	This has not been determined. Functional area on industrial site have been allowed

State	Comments
AL	There is not an area size min or max defined. It is all site-specific. Many times the area-weighted average is used and the site is divided into different sections ranging in size. The answer to the second part is no.
OK	More than an acre.

b) Default size of area for residential evaluations (Acres):

State	Default Size (Acres)
CO	0.5
CA	0.02
FL	0.25
MI	0.5
KY	0.5
AR	NA
GA	LB
TN	LB
NV	NA
SC	NA
KS	NA
AL	NA
OK	0.5

4) Please specify what is the depth interval over which your State/Agency recommends mixing of the soil sample to evaluate direct exposure to surface soil and inhalation exposure to volatiles emanating from the subsurface.

State		From (in)	To (in)	Notes/Other
CO	Surface	0	6	
	Subsurface	0	144	
SC	Surface	0	12	
	Subsurface			
TN	Surface	<12”		We don't allow mixing soil samples for volatiles
	Subsurface			
FL	Surface	0	6	12

	Subsurface	24 and beyond	Water tb etc.	
CA	Surface	0	120	0-3m
	Subsurface	>120		>3m
AR	Surface	0	6	
	Subsurface	No finite depth	depth	
GA				We don't recommend mixing soil samples when evaluating for volatiles and we define surface and subsurface soils on a site specific basis, but default depths are 0-1 ' for surface and 1'-Groundwater tables for subsurface.
MI	ND	ND	ND	ND
NV	ND	ND	ND	ND
KY	ND	ND	ND	ND
KS	ND	ND	ND	ND
AL	Surface	0	12	
	Subsurface	12	Water Table	We don't recommend mixing soil samples when evaluating for volatiles
OK	Surface	0	3	
	Subsurface	3	60	

5)

a. To what depth does your State/Agency assume soil can be disturbed or excavated and redistributed to the surface and then be available for direct exposure?

State	Depth (in)
CO	144
CA	120+
SC	n/a
FL	To water tablet
TN	24
AR	120
GA	Site specific
MI	ND
NV	ND
KY	ND
KS	ND
AL	Site specific
OK	LB

b. From what depth does your State/Agency assume volatiles can migrate up to and through the soil surface and provide an inhalation exposure?

State	Depth (in)
CO	Any depth
CA	Any depth
SC	n/a
FL	From under the water table/site-specific
MI	ND
AR	Varies

State	Depth (in)
GA	Site specific
TN	N/A
NV	ND
KY	LB
KS	LB
AL	Site specific
OK	96 in

c. Please provide the technical basis for these assumptions, including written documentation as available

State	Comments
CO	We have no specific reference for the 144 inch (12 foot) depth assumed as the maximum depth for a residential basement excavation. Depth to groundwater is not a variable that is considered when deciding whether indoor air samples are required to evaluate potential indoor air impacts.
CA	For details refer to our Environmental Screening Levels document (Appendix 1)at: http://www.swrcb.ca.gov/rwqcb2/esl.htm
SC	Below 12 inches, leachability to groundwater and whether the material is a principle threat source material will drive remediation at these depths.
FL	US EPA Region 4 defines surface soil as the top 12 inches, but states sampling should occur from the most contaminated portion of surface soil. (Region 4 Human Health Risk Assessment Bulletins - Supplement to RAGS; also Appendix D from Development of Cleanup Target Levels for Chapter 62-777FAC found at http://fdep.ifas.ufl.edu/.
TN	We assume anyone can dig 2' with a shovel and usually require at least 4' of clean cover over a hazard left in place.
AR	No technical documentation; these assumptions have been adopted as long standing practices of the risk assessment program
GA	LB*
NV	ND
MI	ND
KS	LB*
KY	ND
AL	EPA Region 4 defines surface soil as the top 12 inches, but states sampling should occur from the most contaminated portion of surface soil. (Region 4 Human Health Risk Assessment Bulletins - Supplement to RAGS. Additional background information may be located in the Alabama Risk-Based Corrective Action (ARBCA) document and the Alabama Environmental Investigation and Remediation Guidance (AEIRG).
OK	RAGS, 1986; Data Usability in Risk Assessment, 1992, EPA Draft Vapor Intrusion Guidance, 2002

6) What is the depth in feet to which your State/Agency requires removal to eliminate risks from direct exposure to surface soil and exposure to volatiles from subsurface?

Chemical	State	Surface (ft)	Subsurface (ft)	Comment
Arsenic	SC	0-12	Site specific	
	FL	2		Contamination below 2 ft can be managed with ICs
	TN	N/A	N/A	
	MI	ND	ND	
	NV	ND	ND	
	CO			
	CA			
	KS			
	KY	ND	ND	
	GA *	LB*	LB*	
	OK	0-5	5-15	
	AL	0-1	Site specific	
	AR	0.5	varies	
Trichloroethylene	SC	0-12	Site specific	0-12 inches is the zone of soil that represents an exposure potential for a given land use. Below this level, cleanup is driven by groundwater protection and whether the material is a principle threat source material, based on EPA guidance
	NV	ND	ND	
	CO			
	CA			
	OK	0-5	5-15	
	KS			
	KY	ND	ND	
	GA	LB*	LB*	
	AL	0-1	Site specific	
	FL	2		kids can dig; if contamination below 2ft, it can be managed with IC
	MI	ND	ND	
	AR	0.5	varies	
	TN	N/A	N/A	Case by case
Lead	SC	0-12	Site specific	
	NV	ND	ND	
	MI	ND	ND	
	CO			
	OK			
	CA			
	KS			
	KY	ND	ND	
	GA		LLBB	
	AL	0-1	Site specific	
	FL	2		Same as responses above
	TN	N/A	N/A	
	AR	0.5	varies	
PCBs	SC	0-12	Site specific	
	NV	ND	ND	
	MI	ND	ND	
	CO			
	CA			
	OK			
	KS			

Chemical	State	Surface (ft)	Subsurface (ft)	Comment
	KY	ND	ND	
	GA		LLBB	
	AL	0-1	Site specific	
	Fl	2		Same as responses above
	TN	N/A	N/A	
	AR	0.5	Varies	
Benzo(a)pyrene	SC	0-12	Site specific	
	FL	2		Same as responses above
	CO			
	CA			
	KS			
	KY	ND	ND	
	GA	LB*	LB*	
	AL	0-1	Site specific	
	OK			
	NV	ND	ND	
	MI	ND	ND	
	TN	N/A	N/A	
	AR	0.5	Varies	

* GA Removal is not required but is always considered a remedial option.

7) How long does your State/Agency assume a volatile chemical (ie., Trichloroethylene) will reside in "surface soil" as defined in Question #4?

State	Notes/Other
AR	Varies
FL	We acknowledge biodegradation may be a factor ameliorating cancer risks/health effects that require protracted exposures. We are not aware of any guidance that suggests biodegradation or volatilization should be taken into account when evaluating risks. On the other hand, the most recent data are always preferred to evaluate risks. With contamination assessments lasting several years and often starting well after releases had taken place, it seems there is little justification for assuming risks will substantially decrease in the future. In any event, for site-specific evaluations, FDEP allows the use of the EMSOFT model to determine volatilization factors for exposures starting at some time in the future.
CO	We have specific surface soil results that show that volatile organics can be detected in surface soil indefinitely even in a hot, semi-arid to arid environment like Colorado.
SC	These contaminants are evaluated as a snapshot in time during sampling. Whatever level they are during sampling will be the concentration used to derive an exposure unit concentration.
GA	No assumption is made
MI	ND
NV	ND
TN	NA
AL	No assumption made

State	Notes/Other
CA	
KS	
KY	ND
OK	

8) Is vapor intrusion evaluated by your State/Agency, and if so how are air concentrations modeled? (Infinite source or finite source)

State	Note/Other
TN	We usually have to use the infinite source.
MI	With the Johnson and Ettinger model.
NV	Johnson Ettinger Model is used on a case by case basis.
AR	The modified Johnson Ettinger Model is used in accordance with EPA Guidance.
KS	Field testing. KS does not use models.
KY	Uncertain.
OK	By using the J & E model.
CA	EPA Johnson & Ettinger model spreadsheets. Both infinite source and finite source models used.
SC	This program is not well defined.
FL	Not currently.
GA	Vapor intrusion is handled on a site specific basis.
CO	
AL	Vapor intrusion is handled on a site-specific basis and the EPA Johnson and Ettinger model is typically used.

9) Is there a website(s) that contains more details on the calculation of risk based concentrations or other soil values? If yes, please list below.

State	Website
TN	No state website
MI	Yes. Tier 1 Lookup Tables for Risk-Based Corrective Action are located at: http://www.michigan.gov/deq/0,1607,7-135-3311_4109_4215-17551--,00.html. Data concerning water standards were obtained from the EPA at: http://www.epa.gov/safewater/mcl.html. See Clean-up Criteria and Statistics section of the website: http://www.michigan.gov/deq/0,1607,7-135-3311_4109_9846---,00.html. Verification of Soil Remediation Guidance: http://www.deq.state.mi.us/documents/deq-erd-vsr.pdf
NV	Yes. Nevada defers to federal standards noted in Preliminary Remediation Goals at EPA Region 9's website: http://www.epa.gov/region09/waste/sfund/prg/index.htm Water standards were obtained from the U.S. EPA's drinking water standards at: http://www.epa.gov/safewater/mcl.html#mcls http://www.epa.gov/iris/index.html
AR	Too numerous to mention. ADEQ does not have any sites of it's own in this regard.
KS	Yes, but currently under development. Updated version available soon. www.kdhe.state.ks.us/remedial/rsk_manual_page.htm
KY	Yes, Kentucky's Risk-Based Clean-up Standards are found at it Voluntary Clean-up Program's website located at: http://www.waste.ky.gov/programs/sf/vcpguide.htm
OK	No website for the state
CO	www.cdphe.state.co.us/hm/hmpubs.asp (Corrective Action Guidance Document, Guidance for Analysis of

	Indoor Air Samples, Interim Final Policy and Guidance on Risk Assessments for Corrective Action at RCRA Sites, Proposed Soil Remediation Objectives Policy Document, Environmental Covenants Senate Bill 01-145.
CA	http://www.swrcb.ca.gov/rwqcb2/esl.htm
SC	No
FL	www.fdep.ifas.ufl.edu
GA	Environmental Protection Division Guidance for Selecting Media Remediation Levels at RCRA Solid Waste Units. November 1996 http://www.dnr.state.ga.us/dnr/environ/techguide_files/hwb/swmurisk.pdf and EPA 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment http://www.epa.gov/region4/waste/ots/otsguid.htm
AL	The ARBCA and the AEIRG will be placed on the following website shortly. Both versions are currently in draft form. http://www.adem.state.al.us/

APPENDIX E

Risk Assessment Resources Team Contacts, ITRC Fact Sheet and Product List

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RISK ASSESSMENT RESOURCES TEAM CONTACTS

Stephen DiZio, Team Leader
CA-EPA, Department of Toxic Substances Control
P: 916-255-6634
F: 916-255-6695
sdizio@dtsc.ca.gov

Smita Siddhanti, PhD, Program Advisor
EnDyna, Inc.
2230 Gallows Road, Suite 380
Vienna, VA 22027
P: 703-289-0000 x201
F: 703-289-9950
Siddhanti@endyna.com

Justine Alchowiak
Office of Basic and Applied Research
Office of Environmental Management
P: 202-586-4629
F: 202-586-1492
justine.alchowiak@em.doe.gov

Alan Anthony
VA Department of Environmental Quality
P: 804-698-4114
F: 804-698-4264
ajanthony@deq.virginia.gov

Caroline (Cal) Baier-Anderson
University of Maryland
Program in Toxicology
P: 410-706-1767
F: 410-706-6203
Cbaie001@umaryland.edu

Michael Barainca
US DOE, Office of Legacy Management (LM-40)
P: 301-903-7259
F: 301-903-0174
michael.barainca@em.doe.gov

Dennis L. Brandon
US Army Engineer Research and Development Center
P: 601-634-2807
F: 601-634-3120
brandod@wes.army.mil

Jim Brown
Georgia Environmental Protection Division
P: 404-656-7802
F: 404-651-9425
jim_brown@dnr.state.ga.us

Anna H. Butler
USACE, Savannah District
P: 912-652-5515
F: 912-652-5311
a.h.butler@sas02.usace.army.mil

Frank Camera
NJ Department of Environmental Protection
P: 609-633-7840
F: 609-292-0848
Frank.camera@dep.state.nj.us

Daniel Clanton
Arkansas Department of Environmental Quality, Hazardous Waste Division, Active Sites Branch
P: 501-682-0834
F: 501-682-0565
clanton@adeq.state.ar.us

Fran Collier
CAL/EPA Dept. of Toxic Substances Control
P: 916-255-6431
F: 916-255-6657
fcollier@dtsc.ca.gov

Brian C. Espy
Industrial Hazardous Waste Branch
AL Dept. Environmental Mgmt.
P: 334-271-7749
F: 334-279-3050
bespy@adem.state.al.us

Dibakar (Dib) Goswami
WA State Department of Ecology
P: 509-372-7902
F: 509-372-7971
Dgos461@ecy.wa.gov

Scott Hill
US Army Environmental Center
Aberdeen Proving Ground, MD 21010
P: 410-436-6868
F: 410-436-6836
scott.hill@aec.apgea.army.mil

Keith Hoddinott
USACHPPM
P: 410-436-5209
F: 410-436-8170
keith.hoddinott@amedd.army.mil

Bennett D. Kottler
Nevada Division of Environmental Protection
P: 775-687-9378
F: 775-687-6396
bkottler@ndep.nv.gov

Katharine Kurtz
Navy Environmental Health Center
P: 757-953-0944
F: 757-953-0675
kurtzk@nehc.med.navy.mil

Mark Mercer
US EPA Hazardous Waste Remedial Program
P: 703-308-8652
F: 703-308-8635
mercer.mark@epa.gov

Anita Meyer
US Army Corps of Engineers
HTRW Center of Expertise
12565 W. Center Rd.
Omaha, NE 68144-3869
P: 402-697-2585
F: 402-697-2595
anita.k.meyer@usace.army.mil

Stephen D. Mueller
Wisconsin Department of Commerce
P: 414-220-5402
F: 414-220-5374
smueller@commerce.state.wi.us

Katherine Owens
Paragon Professional Associates
P: 208-522-0513
C: 208-521-3696
F: 208-522-0513
paragon@ida.net

Ruth Owens
NFESC
P: 805-982-4798
F: 805-982-4304
Ruth.owens@navy.mil

W. Lee Poe
ITRC Stakeholder
803-642-7297
leepoe@mindspring.com

Vera Wang
Environmental Engineer
Navy Environmental Health Center
620 John Paul Jones Blvd, Suite 1100
Portsmouth, VA 23708
P: 757-953-0940
F: 757-953-0675
wangv@nehc.med.navy.mil

Ashley Whitlow
Arkansas DEQ
P: 501-682-0869
F: 201-682-0565
whitlow@adeq.state.ar.us