DEPARTMENT OF
ECOLOGY
State of Washington

Soil Cleanup Levels - Consideration of Concurrent Exposure Pathways

Discussion Materials

Prepared for the Science Advisory Board

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Introduction

Background

The Model Toxics Control Act (MTCA) Cleanup Regulation includes policies and procedures for establishing cleanup levels based on human health protection. Key features include:

- Cleanup levels are based on protecting sensitive population groups, including pregnant women, developing fetuses, and children.
- Cleanup levels are based on the "reasonable maximum exposure" that a person might encounter. The reasonable maximum exposure is designed to represent a high end (but not worst case) estimate of individual exposures.
- Cleanup levels are based on exposure parameters (e.g., soil ingestion rate) and toxicity factors (e.g. cancer slope factor) in EPA guidance and the scientific literature.

Ecology reviewed the available scientific literature and regulatory guidance when preparing the 2001 rule amendments. Based on that review, Ecology updated the methods used to establish soil cleanup levels. Specifically, Ecology revised the methods to require consideration of both soil ingestion and dermal contact. For most chemicals, dermal contact is evaluated only when changes to the standard equation results in site-specific cleanup levels that are "significantly higher" than values calculated using the default parameters.

Since the rule was revised in 2001, there have been several important scientific and regulatory developments relevant to establishing cleanup levels. This information raises several issues about the current MTCA procedures for establishing soil cleanup levels:

- Should Ecology revise the MTCA rule to provide clearer direction on when and how concurrent exposure pathways (e.g. soil ingestion, dermal contact and inhalation) are taken into account when establishing soil cleanup levels?
- Should Ecology revise the MTCA equations and exposure parameters based on current scientific information on age-related differences in exposure levels and susceptibility?
- Should Ecology consider other changes to the methods and policies for establishing soil cleanup levels based on current scientific information and/or regulatory guidance?
- Do the methods for establishing cleanup levels provide a reasonable level of conservatism given the uncertainty and variability in exposure and toxicity?

Purpose of the Discussion Materials

Ecology has performed several evaluations designed to support decisions on whether and how to revise the methods for establishing soil cleanup levels. This document was prepared to support the Board's review of those evaluations. When making decisions on rule revisions, Ecology will consider the results of the Board's review and the following other factors:

- Integration and consistency with other MTCA risk management choices and provisions;
- Workability of any MTCA rule revisions relative to the current regulation;
- Methods and policies used by other state and federal cleanup programs;
- Public comments on proposed revisions; and
- Incremental benefits and costs of complying with the revised cleanup level requirements.

Organization of the Discussion Materials

The rest of this document includes four main sections:

- Exposure Scenarios and Parameters. This section describes the current MTCA methods and policies used when establishing soil cleanup levels based on the direct contact pathway.
- Methods Used to Evaluate Exposure Issues: This section summarizes the methods used to evaluate the current procedures for establishing soil cleanup levels based on the direct contact pathway and options for revising those procedures
- Preliminary Observations and Comparisons: This section summarizes and compares preliminary observations based on the results of the evaluations. Appendix D and E provides results from the different simulations and exposure models.

Exposure Scenarios and Parameters

The MTCA Cleanup Regulation defines the Reasonable Maximum Exposure (RME) as: "the highest exposure that is reasonably expected to occur at a site under current and potential future site use."[1] In establishing cleanup levels and standards, as policy, the MTCA Cleanup Regulation is based on and protective of the most sensitive populations, including pregnant women, unborn children, children and most sensitive wildlife and plant species.[2] Under the MTCA Cleanup Regulation, cleanup levels are based on estimates of the "reasonable maximum exposure" (RME). [3]

- The RME is designed to represent a high end (but not worst case) estimate of individual exposures. It provides a conservative estimate that falls within a realistic range of exposures.[4]
- The RME is defined as reasonable because it is a product of several factors that are an appropriate mix of average and upper-bound estimates. RME estimates typically fall between the 90th and 99.9 percentile of the exposure distribution.[5]
- The RME takes into account both current and reasonably foreseeable future conditions.

Regardless of the site use conditions (unrestricted, residential, or restricted soils, industrial), cleanup levels and standards are based on a reasonable maximum exposure expected to occur at the site that accounts for both current and potential future uses.[6] Different sections of the MTCA Cleanup Regulation define media - specific reasonable maximum exposures:

- Ground Water Cleanup Levels and Standards, WAC 173-340-720, defines the RME for unrestricted use of ground water in terms of a child drinking 1 L/day and an adult drinking 2 L/day;
- Surface Water Cleanup Levels and Standards, WAC 173-340-730, defines the RME as the most beneficial unrestricted use of surface waters by consuming 54 g/day of fish for an adult;

[1] WAC 173-340-708 (3) (b)
[2] Washington State Department of Ecology, Concise Explanatory Statement, MTCA Cleanup Regulation, February 12, 2001, page 119.
[3] MTCA defines the RME as the "…the highest exposure that can be reasonably expected to occur for a human or other living organisms at a site under current and potential future site use." CERCLA provides a similar definition "…the highest exposure that is reasonably expected to occur at a Superfund site…"

[4] U.S. Environmental Protection Agency. An Examination of EPA Risk Assessment Principles and Practices. EPA/100/B-04/0001. March 2004.

[5] IBID.
[6] Washington State Department of Ecology, 1991 Responsiveness Summary to the MTCA Cleanup Regulation

- Unrestricted, Residential, Soil Cleanup Levels and Standards, WAC 173-340-740, defines the RME in terms of the incidental soil ingestion rate of 200 mg/day for a child;
- Restricted, Industrial, Soil Cleanup Levels and Standards, WAC 173-340-740, defines the RME in terms of the incidental soil ingestion rate of 50 mg/day for an adult;
- Air Cleanup Levels and Standards, WAC 173-340-750, defines the RME in terms of a breathing rate of $10m^3$/day for a child and $20m^3$/day for an adult.

In defining the different RME's and exposure parameters to establish cleanup levels and standards Ecology has made policy choices that provide a reasonable balance between central tendency and upper bound estimates. In combination these exposure estimates provide a reasonable maximum exposure estimate for the different media. See Appendix A for additional information on the Reasonable Maximum Exposure.

Evaluation Methods

Ecology is evaluating the influence of different exposure pathways on soil cleanup levels. The methodology employed by Ecology includes the following steps:

- Developed several exposure models to evaluate the relative importance of different soil-related exposure pathways (incidental ingestion, dermal exposure, and inhalation exposure).
- Selected exposure parameters for each exposure model and pathway.
- Selected chemicals to be evaluated and identified chemical-specific parameters for toxicity, bioavailability and other physical-chemical characteristics.
- Evaluated exposure levels and cleanup levels using the exposure models, exposure parameters and chemical-specific information (deterministic or point estimates calculations). This involved the following steps:
  - → Calculate soil cleanup levels for each chemical using the exposure models;
  - → Prepare a series of tables that illustrate the similarities and differences between cleanup levels based on different exposure models and any variations based on chemical type.
- Evaluate the variability in exposure levels and resulting cleanup levels using Monte Carlo techniques. This involved the following steps:
  - → Selected a software program to performed probabilistic evaluations;
  - → Identified which exposure parameters to consider as variables for probabilistic analysis;
  - → Selected exposure distributions to characterize those parameters;
  - → Evaluate the correlation between different exposure parameters and identify correlations coefficients for use in this evaluation.
  - → Use the Ecology's Environmental Assessment Program's simulation tool (YASAI.w.xla) to create simulated exposure distributions and evaluate where the point estimate values fall within the simulated exposure distribution (i.e. does the point estimate value fall in the 90 to 99^{th} percentile range of the simulated distribution?)

Exposure Models

Ecology developed seven exposure models that are designed to provide information relevant to the regulatory choices in the MTCA rulemaking. The seven exposure models consider different combinations of exposure pathways and age intervals:

- Child Exposure - One Exposure Pathway Model: This model is based on the standard methods for calculating soil cleanup levels in the current MTCA rule. With this model, cleanup levels based on the direct contact pathway only take into account incidental soil ingestion. No simulation modeling was performed using this one pathway exposure model.
- Child Exposure - Two Exposure Pathway Model: This model is based on the modified method for calculating soil cleanup levels in the current MTCA rule (Equation 740-5). With this model, cleanup levels based on the direct contact pathway take into account concurrent exposure via incidental soil ingestion and dermal contact.
- Child Exposure – Three Exposure Pathway Model: This model is based on the equations developed by the Oak Ridge National Laboratory that have been adopted by several EPA regions and state agencies. With this model, cleanup levels based on the direct contact pathway take into account concurrent exposure via incidental soil ingestion, dermal contact and inhalation of soil contaminants.
- Adult Exposure - Two Pathway Model: This model is similar to the modified method for calculating soil cleanup levels in the current MTCA rule except that the input parameters are based on adult exposures. With this model, cleanup levels based on the direct contact pathway take into account concurrent exposure via incidental soil ingestion and dermal contact;
- Adult Exposure – Three Exposure Pathway Model: This model is based on the equations developed by the Oak Ridge National Laboratory that have been adopted by several EPA regions and state agencies. With this model, cleanup levels based on the direct contact pathway for adult exposures taking into account concurrent exposure via incidental soil ingestion, dermal contact and inhalation of soil contaminants.
- Child and Adult Exposure - Two Exposure Pathway Model: This model is based on the equations developed by the Oak Ridge National Laboratory that have been adopted by several EPA regions and state agencies. The model is based on a 30 year exposure period (6 years for children and 24 years older children/adults). With this model, cleanup levels based on the direct contact pathway take into account concurrent exposure via incidental soil ingestion and dermal contact.
- Child and Adult Exposure – Three Exposure Pathway Model: This model is based on the equations developed by the Oak Ridge National Laboratory that have been adopted by

several EPA regions and state agencies. The model is based on a 30 year exposure period (6 years for children and 24 years older children/adults). With this model, cleanup levels based on the direct contact pathway take into account concurrent exposure via incidental soil ingestion, dermal contact and inhalation of soil contaminants.

Appendix B provides examples and descriptions of concurrent exposure pathway equations under consideration by Ecology.

Monte Carlo Analysis

Objective

As an initial, as well as an on-going evaluation, the following analysis was designed to help evaluate the importance of including different concurrent exposure pathways, and the influence exposure parameters may have on establishing risk-based cleanup levels. The analysis considers whether exposure estimates represent a reasonable maximum exposure. This analysis is an on-going effort and will evolve to include other media (groundwater in particular), age-related adjustment for early life exposures, and to account for differences in exposure patterns between adults and children.

Method

To help facilitate the risk management decision in deciding whether to establish soil cleanup levels based on direct contact via incidental ingestion only or to establish soil cleanup levels based on different routes of exposures to contaminated soils, Ecology is evaluating the influence of different exposure pathways on soil cleanup levels. The methodology employed by Ecology includes the following steps:

- Selecting of chemicals to be evaluated;
- Establishing cleanup levels using different equations that reflect different routes of exposure (incidental ingestion, dermal exposure, and inhalation exposure);
- Determining chemical-specific toxicity values, and other physical chemical-specific parameters;
- Identify which exposure parameters to consider as variables for probabilistic analysis;
- Using these exposure distributions, a sensitivity analysis was performed to determine the percent contribution each exposure variable had for variance of the soil risk-based

cleanup level. In addition, for each of the different exposure point estimate assumptions percentiles were generated based on their respective simulated exposure distributions. Also, the percentiles for risk-based cleanup levels were generated from the different exposure simulations and compared to the modified MTCA risk based cleanup level. All of the exposure distributions, point exposure estimates, and documentation are provided in Appendix C.

- For Monte Carlo simulation Ecology assumed that total body surface area was correlated with body weight, with an assumed rank correlation coefficient of 1. The fraction of the total body surface area exposed was assumed to be represented by a distribution defined by best professional judgement of minimum, maximum and most likely values (using PERT-beta).[7]

Selection of Chemicals to be Evaluated

An initial suite of five chemicals were used to evaluate soil carcinogenic cleanup levels.

- Arsenic
- Benzo[a]pyrene, [B(a)P]
- Chlordane
- Epichlorohydrin
- Trichloroethylene (TCE)

The basis for the selection of these chemicals includes:

- Availability of carcinogenic toxicity values for different routes of exposure (oral cancer potency values and inhalation unit risk values);
- Range of physical/chemical properties that may influence the dominance of one exposure pathway over another (different dermal absorption values, an inorganic non-volatile chemical and/or varying organic chemical volatility);
- Use of this evaluation for future analysis, such as, the potential that early life exposures may contribute to cancer exhibited later in life.

[7] PERT-beta refers to modeling expert opinion where the bounded estimates are minimum, most likely, and maximum values; functional YASAIw statements [=genbetapert()] are used for fraction of body surface area exposed and a child's residential exposure duration.

Defined Exposure Distributions and Correlations

Statistical descriptions of all of the exposure distributions and the YASAIw functional statements associated with the distributions are in Appendix C.[8] Exposure point estimates and statistical distributions are described for the following exposure parameters:

- Child and adult soil ingestion rates;
- Child and adult body weights;
- Child and adult exposure durations, the child exposure duration distribution is based on best professional judgment;
- Cumulative frequency distribution is described for the child's body surface area exposed and the statistical description of the distribution for the adult body surface area exposed;
- Statistical description of the distribution for the child and adult body surface areas;
- The statistical description of the distribution for the percent body surface area exposed (25%) is based on best professional judgment, professional consultation with the Science Advisory Board, and U.S. EPA exposure factor documentation;
- Soil adherence factors and volatilization factors.

- For Monte Carlo simulation Ecology assumed that total body surface area was correlated with body weight, with an assumed rank correlation coefficient of 1. The fraction of the total body surface area exposed was assumed to be represented by a distribution to represent the best professional judgment of minimum, maximum and most likely values (using PERT-beta). For deterministic analysis (not Monte Carlo simulation), the U.S. EPA recommends an assumption of 25% skin surface area exposed to soil which represents the exposed skin surface area limited to the head, hands, forearms, and lower legs. Since some studies suggest that dermal exposure may occur under clothing then the upper percentile, 25%, is recommended.[9]

Exposure Pathways Monte Carlo Analysis Tool

Three possible Monte Carlo simulation tools were considered for use in this analysis. A preliminary Monte Carlo tool was developed by Dr. Nagesha Kannadeguli. A second Monte

[8] Ecology's Environmental Assessment Programs modified/enhanced version of Yet Another Simulation Add in For Excel (YASAIw.xla). Jonathan Eckstein and Steven T. Riedmueller. YASAI: Yet Another Add-In For Teaching Elementary Monte Carlo Simulation In Ecxel. April 2001. RUTCOR (Rutgers Center for Operations Research) Research Report, Rutgers University.

[9] U.S. EPA Exposure Factors Handbook, Volume I, General Factors. August 1997. EPA/600/P-95/002Fa. Page 6-5 Depending on the clothing scenarios, roughly 10% to 25% of the skin surface area may be exposed to soil with a central tendency estimate represented by an individual wearing long sleeve shirt, pants, and shoes.

Carlo simulation tool used was Oracle's Crystal Ball. Monte Carlo simulations were conducted using mathematical models for two and three concurrent exposure pathways. After consultation with technical support from Oracle, Ecology modified and enhanced an open-source add-in to Excel (YASAIw.xla) originally developed at Rutgers University for a Monte Carlo simulation tool. A brief description of the YASAI simulation tool follows.

YASAIw.xla Monte Carlo Simulation Tool

YASAI is an free open-source add-in to Microsoft Excel developed at Rutgers University used to teach Monte Carlo simulation methods to University students. The functional design and theory of the YASAI simulation tool is published by Eckstein et al. (2000).[10] Professor Eckstein of Rutgers University developed the basic programming for the YSAI simulation tool.

Greg Pelletier, senior environmental engineer with Ecology's Environmental Assessment Program, has modified the original 2.0 version of YASAI to add new functions and features to perform Monte Carlo simulations for different exposure parameters.[11] YASAI simulation outputs, sensitivity analysis, and simulation frequency distributions were compared to Crystal Ball. All simulation outputs using YASAI were comparable to Crystal Ball using the same mathematical model. For large number of iterations (e.g. 10,000 or 100,000) the simulated percentiles of soil cleanup levels from YASAIw and Crystal Ball generally agreed within 2 to 3 significant digits (note that an exact matching of results from YASAIw and Crystal Ball are not possible because of different sequences of random number generation during the Monte Carlo simulation). Furthermore, Professor Eckstein was consulted by Greg Pelletier regarding the functional refinements and enhancements being developed using the YASAI simulation tool. The new functional features and enhancements developed by Greg Pelletier with Visual Basic programming will be incorporated into the Rutgers University YASAI simulation tool programming to be used by students. The modified version of YASAI (now called YASAIw) has been added to the suite of modeling tools used and recommended by the Environmental Assessment Program.[12] The following enhancements have been made to the YASAI simulation tool:

[10] Ecology's Environmental Assessment Programs modified/enhanced version of Rutgers University simulation tool, Yet Another Simulation Add in For Excel, YASAIw.xla. Jonathan Eckstein and Steven T. Riedmueller. YASAI: Yet Another Add-in for Teaching Elementary Monte Carlo Simulation in Excel. INFORMs Transactions on Education 2:2 (12-26)

[11] Original Rutgers University 2.0 Version of YASAI can be found at Rutgers University web site: http://www.yasai.rutugers.edu/

[12] Ecology's Environmental Assessment Program's latest version of YASAIw is located at the following link: http://www.ecy.wa.gov/programs/eap/models.html

- Additional distributions for specifying random variables;
- Functions for generating correlated random variables;
- Sensitivity analysis to estimate the correlation between forecasted variables, assumed distributions, and the contribution to variance of each forecast variable from each distribution;
- The ability to use YASAIw functions in any or all of the worksheets in the workbook for the simulation;
- Additional output worksheets with cumulative distributions, the values of each variable during each iteration, and the results of the sensitivity analysis.

Simulations, Randomized Variables and Assumptions

Ecology used YASAIw as modified and enhanced by the Environmental Assessment Program. Using YASAIw Ecology simulated different exposure distributions using 10,000 iterations producing estimates of percent contributions to the soil risk based cleanup levels and to provide percentiles where an exposure variable would lie along the simulated exposure distribution. The randomized exposure variables from the defined exposure distributions provides an estimate of the percent contribution to variance and an estimate of which of the exposure parameters contributes the most to the risk based cleanup level. For this analysis Ecology made an assumption that body weight and body surface area are directly related to one another with 100% correlation. Alternate exposure assumptions were made to develop exposure distributions based on best professional judgment for a child's residential exposure duration and the percent body surface area exposed to soils.

Preliminary Observations and Comparisons

For each of the five chemicals analyzed, exposure simulations were run as follows:

Number of Pathways	Exposure Model	Description
2 pathways		Ingestion + dermal age adjusted
	1	Child + Adult
		Ingestion + dermal not age adjusted
	2	Child only
	3	Adult only
3 pathways		Ingestion + dermal + inhalation age adjusted
	4	Child + Adult
		Ingestion + dermal + inhalation not age adjusted
	5	Child only
	6	Adult only

These simulations led to a number of preliminary observations.

Age adjustments affect how the exposure parameters contribute to variance in the calculated cleanup levels.

- For **arsenic**, the adult exposure duration and the child soil ingestion rate are the dominating exposure parameters contributing to soil cleanup levels when age adjustments are included.
- For **benzo[a]pyrene**, with age adjustments, the adult exposure duration associated with the dermal and ingestions pathway is dominant; followed by the child soil ingestion rate.
- For **chlordane**, the child soil ingestion rate and adult exposure duration associated with ingestion route of exposure are dominant. However, the order of dominance is reversed between the 2 and 3 exposure pathway models.
- For **epichlorohydrin** and **TCE**, the soil volatilization factor dominates, followed by exposure duration exposure factor for the age adjusted 3-pathway model. For the 2-pathway model (where inhalation is not included) the child soil ingestion rate and adult exposure duration are dominant exposure parameters.

Concluding observations: The soil volatilization factor is an important exposure parameter for volatile organic chemicals and dominates the percent contribution to variance in soil cleanup levels. For the other chemicals, the dominating exposure parameters include some variation in sequence between soil ingestion rates, exposure durations, or soil adherence factor. Age adjustments to the models identifies where the different exposure parameters dominate.

Some conclusions pertaining to the 2 pathway model

- For **arsenic**, **benzo[a]pyrene**, **chlordane**, **epichlorohydrin**, and **TCE,** the dominant exposure parameter is the child's soil ingestion rate for the two concurrent (ingestion + dermal), not age adjusted, exposure model. Also, for **benzo[a]pyrene** the soil adherence factor and child's exposure duration are exposure parameters that contribute to, but are not dominant exposure parameters, the soil cleanup level.
- For **arsenic**, **chlordane**, **epichlorohydrin**, and **TCE** the dominant exposure pathways are the child's soil ingestion rate and exposure duration contributing to the soil cleanup level for the two concurrent (ingestion + dermal), age adjusted, exposure model. For **benzo[a]pyrene**, the adult exposure duration for the dermal and ingestion routes of exposure are the two dominant exposure parameters followed by the child's soil ingestion rate.

Concluding Observations: Although the soil ingestion rate is the dominant exposure parameter for the two concurrent exposure pathways models, the exposure parameters are better defined for the age adjusted model exposure model with variation in sequence between soil ingestion and exposure duration.

Some conclusions pertaining to the 3 pathway model, without age adjustments but using different child and adult exposure parameters

For **arsenic**, **benzo[a]pyrene**, and **chlordane** the dominant exposure parameter is the child's soil ingestion rate for the three concurrent, not age adjusted, child's exposure model to contribute to the soil cleanup level. For **epichlorohydrin** and **TCE** the dominant exposure parameters are the soil volatilization factor, soil ingestion rate, and exposure duration that contribute to soil cleanup level for the three concurrent, not age adjusted, child's exposure model.

For **arsenic**, **benzo[a]pyrene**, **chlordane**, **epichlorohydrin** and **TCE** the exposure duration is the dominant exposure parameter for the three concurrent, not age adjusted, adult's exposure model that contributes to the soil cleanup level. For **epichlorohydrin** and **TCE** the soil volatilization factors is the second dominant exposure parameter while for arsenic and chlordane the soil ingestion rate is the second dominant exposure parameter and for benzo[a]pyrene the soil adherence factor is the second dominant exposure parameter.

Concluding Observations: Except for the two volatile chemicals epichlorohydrin and TCE, the dominant exposure parameter for the three concurrent exposure model using a child's residential exposure pattern (body weight, surface area, soil ingestion rate) remains the soil ingestion rate. For the adult residential exposure pattern, the exposure duration is the dominant exposure parameter. Comparison across the two different 3-concurrent exposure

models compared with the age adjusted models shows that age adjustment allows a better definition of the different exposure parameters that contributes to the percent variance.

Appendix D provides tabular observations for the five chemicals evaluated based on the following exposure models:

- Child-Soil Ingestion + Dermal Exposure Model, Modified Method B, Equation;
- Child-Soil 3 Concurrent Pathway (Ingestion + Dermal + Inhalation), not age adjusted;
- Child, Adult-Soil Ingestion + Dermal, Age Adjusted; and
- Child, Adult-Soil Ingestion + Dermal + Inhalation, Age Adjusted.

Also, Appendix D is divided into 3 sections:

- Section 1: Summary of Risk-based Soil Concentration for Single and Concurrent Pathway Exposure;
- Section 2: Risk – Based Soil Concentrations corresponding to Percentiles for a Simulated Exposure Distribution;
- Section 3: Summary of Contributions to Overall Variance for Simulated Distributions.

Appendix A: Reasonable Maximum Exposure

Reasonable Maximum Exposure: The federal Superfund program and the MTCA Cleanup Regulations are both designed to protect against high-end, but not worst-case, individual exposure. The reasonable maximum exposure (RME) is similarly defined for both the Superfund program and under MTCA. The RME, as defined by EPA, "is the highest exposure that is reasonably expected to occur at a Superfund site." [13] (EPA, 2004, page 102-103) Under MTCA, the RME "means the highest exposure that can be reasonably expected to occur for a human or other living organisms at a site under current and future site use." [WAC 173-340-200]

The worst-case exposure represents an extreme set of exposure conditions, usually not observed in an actual population, which is the maximum possible exposure where everything that can plausibly happen to maximize exposure, happens. (U.S. EPA Guidelines For Exposure Assessment, Federal Register Notice, Vol. 57, No. 104, May 1992, pages 22888-22938).

The preamble to the National Contingency Plan further describes the RME will:

> *…result in an overall exposure estimate that is conservative but within a realistic range of exposure. Under this policy, EPA defines "reasonable maximum" such that only potential exposure that are likely to occur will be included the in the assessment of exposures. The Superfund program has always designed its remedies to be protective of all individuals and environmental receptors that may be exposed at a site; consequently, EPA believes it is important to include all reasonably expected exposures in its risk assessments…*

[13] U.S. Environmental Protection Agency. An Examination of EPA Risk Assessment Principles and Practices. EPA/100/B-04/0001. March 2004. pages 102-103.

Appendix B: Equations Used For Model Development & Example of Model

Equation 1 – Not Age Adjusted, Direct Contact Single Route of Exposure

$$Ingeston\ Exposure\ Pathway[f(soil\ ingestion\ rate), f(exposure\ duration)] = \frac{Risk * ABW * AT * UCF1}{\text{CPFo} * f(\text{SIR}) * \text{AB1} * \text{EF} * f(\text{ED})}$$

Equation 2– Not Age Adjusted, Two Concurrent Routes of Exposure

$$Concurrent\ Ingestion\ and\ Dermal\ [f(soil\ ingestion\ rate), f(exposure\ duration), f(dermal\ surface\ area) f(dermal\ adherence\ factor)] =$$

$$\frac{1}{\frac{1}{\frac{Risk * ABW * AT * UCF1}{EF * f(ED) * f(SIR) * AB1 * CPFo}} + \frac{1}{\frac{Risk * ABW * AT * UCF1}{EF * ED * f(SA) * f(AF) * ABS * CPFd}}}$$

Equation 3– Not Age Adjusted, Three Concurrent Routes of Exposure

$$IngestionDermalInhalation[f(soil\ ingestion\ rate), f(exposure\ duration), f(dermal\ surface\ area) f(dermal\ adherence\ factor), f(soil\ vol.\ factor)] =$$

$$\frac{1}{\frac{1}{\frac{Risk * ABW * AT * UCF1}{EF * f(ED) * f(SIR) * AB1 * CPFo}} + \frac{1}{\frac{Risk * ABW * AT * UCF1}{EF * f(ED) * f(SA) * f(Af) * ABS * CPFd}} + \frac{1}{\frac{Risk * AT}{EF * f(ED) * UCF2 * IUR * \left[\frac{1}{f(VFS)} + \frac{1}{PEF}\right]}}}$$

Equation 4 – Age Adjusted Equation For Ingestion and Dermal Exposure Pathways

$$Age\ Adjusted\ Concurrent\ Ingestion\ and\ Dermal\ [f(soil\ ingestion\ rate), f(exposure\ duration), f(dermal\ surface\ area) f(dermal\ adherence\ factor)] =$$

$$\frac{1}{\frac{1}{\frac{Risk\ * AT}{CPFo * AB1 * EF * f(IFSadj) * UCF1}} + \frac{1}{\frac{Risk * AT}{CPFd * ABSd * EF * f(SFSadj) * UCF2}}}$$

$$\text{Where Age Adjusted Ingestion Factor for Soil (IFSadj)} = \frac{ED < 6 * SIR < 6}{\text{BWc}} + \frac{(EDresidential - EDchild\ ) * SIRadult}{\text{BWa}}$$

and

$$\text{Where Age Adjusted Dermal Exposure Factor for Soil (SFSadj)} = \frac{SA < 6 * AF < 6 * ED < 6}{\text{BWc}} + \frac{SA7 - 31 * AF7 - 31 * ED7 - 31}{\text{BWa}}$$

Equation 5 – Age Adjusted Equation For Ingestion, Dermal and Inhalation Exposure Pathways

$$Age\ Adjusted\ IngestionDermalInhalation[f(soil\ ingestion\ rate), f(exposure\ duration), f(dermal\ surface\ area) f(dermal\ adherence\ factor), f(soil\ vol.factor)] =$$

$$\frac{1}{\frac{1}{\frac{Risk * AT}{CPFo * AB1 * EF * f(IFSadj) * UCF1}} + \frac{1}{\frac{Risk * AT}{CPFd * ABSd * EF * f(SFSadj) * UCF2}} + \frac{1}{\frac{Risk * AT}{EF * f(ED) * UCF3 * InhUR * \left[\frac{1}{f(VFS)} + \frac{1}{PEF}\right]}}}$$

Concurrent Exposure Carcinogen Cleanup Level Equation-Unrestricted Soil				
Soil Ingestion Component		**Dermal Contact Component**		**Particulate Inhalation Component**
Risk * AT	+	Risk * AT	+	Risk * AT
$CPFo * AB1 * EF * IFSadj * UCF_1$		$CPFd * ABSd * EF * SFSadj * UCF_2$		$IUR * EF * \{1/VFs + 1/PEF\} * ED * UCF_3$
Final Cleanup Level	=			
1				
1	**PLUS**	**1**	**PLUS**	**1**
Soil Ingestion Component		**Soil Dermal Contact Component**		**Inhalation Component**

Age Adjustment for Exposure to Contaminated Soil

Soil Ingestion Default Exposure Parameters For Age Adjustments - Carcinogens					
Parameter	**Parameter Definition**	**Age Groups**			
		Child (< 6 years)		**Adult (<30 Years)**	
		MTCA	**EPA**	**MTCA**	**EPA**
ED	Exposure Duration, years	6	6	30	30
SIR	Soil Ingestion Rate, mg/day	200	200	50	100
BW	Body weight, kg	16	15	70	70

Age Adjustments for Soil Ingestion from exposure to carcinogen, IFS_{adj} , mg-year/kg-day			
	Child Adjustment		**Adult Adjustment**
IFSadj =	$\frac{ED_{<6} * SIR_{<6}}{BWc}$	+	$\frac{(ED_{residential} - ED_{child}) * SIR_{adult}}{BWa}$
	MTCA	**EPA**	
IFSadj =	**9.21E+01 mg-year/kg-day**	**1.14E+02 mg-year/kg-day**	

Appendix C: Statistical Descriptions For Exposure Assumptions & YASAIw Functional Statements

Child's Soil Ingestion Rate			
Child's Soil Ingestion Rate (Ages <6 Years)		Soil Ingestion Rate, Point Exposure Estimate For Children, <6 Years, mg/day	Documentation Exposure Point Concentration
Descriptive Statistic Truncated Lognormal	Soil Ingestion Rate mg/day		
Mean	44.6	200	EPA Exp. Factors Handbook, 1997
Std. Dev.	79.9		
Min	0		
Max	1000		
U.S. EPA Rocky Mountain Flats Human Health Risk Assessment. Task 3 Report and Appendices: Calculation of Surface Radionuclide Soil Action Levels for Plutonium, Americium, and Uranium. September 30, 2002. Table A-8, page 152 & Page 166.		The RME point estimate recommended for children of 200 mg/day is approximately the 96th percentile of the defined distribution.	EPA Child Specific Exp Factors Handbook, 2002 Exposure point concentration used in MTCA Eqn's 740-1 & 740-2 and 740-4

YASAI functional statement & argument for the child's soil ingestion rate: =genlimitlognormalx(reference to cell numbers statistical description of child's soil ingestion rate)

Adult Soil Ingestion Rate			
Adult's Soil Ingestion Rate (Ages 7+ Years)		Soil Ingestion Rate, Point Exposure Estimate For Children, <6 Years, mg/day	Documentation Exposure Point Concentration
Descriptive Statistic Truncated Lognormal	Soil Ingestion Rate mg/day		
Mean	63	50 Adult, Industrial	EPA Exp. Factors Handbook, 1997
Std. Dev.	42		
Min	19	100 Adult, Residential	EPA Exp. Factors Handbook, 1997
Max	133		
U.S. EPA Rocky Mountain Flats Human Health Risk Assessment. Task 3 Report and Appendices: Calculation of Surface Radionuclide Soil Action Levels for Plutonium, Americium, and Uranium. September 30, 2002. Table A-3, page 142		50 mg/day exposure point concentration used in MTCA Eqn's 745-1 & 745-2 and 745-4 & 745-5	

YASAI functional statement for the adult's soil ingestion rate: =genlimitlognormal (reference to cells numbers for descriptive statistics of adult's soil ingestion rate)

Child's Body Weight Distribution		
Male Child's Body Weight (Ages <6 Years)		Child's Body Weight, <6 Years, kg
Descriptive Statistic Truncated Lognormal	kg	
Mean	19.8	16 kg Default ABW MTCA Soil CULs Method B
Std. Dev.	3	MTCA Eqn's 740-1 & 740-2 and 740-4 and 740-5
Min	15.2	
Max	27.1	15 kg U.S. EPA
Adapted From: U.S. EPA Child-Specific Exposure Factors Handbook. EPA-600-P-00-002B. September 2002. Table 11-2, page 11-5.		15 kg Default Body Weight for child is used by U.S. EPA, Regions 3, 6 & 9

YASAI functional statement for the male child's body weight: =genlimitlognormalx(reference to cell for correlated variables & cell numbers statistical description of child's soil ingestion rate)

Adult's Body Weight Distribution		
Male Adult's Body Weight (Ages +7 Years)		Adult's Body Weight, <6 Years, kg
Descriptive Statistic Truncated Lognormal	kg	
Mean	73.23	70 kg is the standard Adult BW default used by U.S. EPA & MTCA
Std. Dev.	11.97	
Min	45.94	
Max	119.74	
Adapted From: Oregon Department of Environmental Quality. Guidance for Use of Probabilistic Analysis in Human Health Risk Assessment. January 1998 Updated November 1998. Table -44, page 3-79, using male age group 18-25 years.		70 kg Default Body Weight for child is used by U.S. EPA, Regions 3, 6 & 9; MTCA Eqns 745-1 & 2; Eqns 745-4 & 5

YASAI functional statement for the male child's body weight: genlimitlognormal (reference to cells numbers for descriptive statistics of male adults body weight)

Distributional Descriptive Statistics for Total Exposed Skin Surface Area		
Statistic Description	**Skin Surface Area For Adult Males, cm^2**	
	Total Body Surface Area (SA)	**25% of Total Body Surface Area**
Mean	18400	4600
Std. Deviation	2300	575
Minimum (Male)	15000	3750
Maximum (Matle)	23000	5750
Exposure Factors Source Book. American Industrial Health Council. May 1994. Pages 4.20 - 4.23		

YASAIw GENZ functions for generating correlated variables:

- Child Body Weight, 16 kg, during ages 1-6, =genlimitlognormalx(Reference cell to GenZ, reference to cells numbers for descriptive statistics of child's body weight)
- Adult Body Weight, 70 kg, + 7 years, =genlimitlognormalx(Reference cell to GenZ, reference to cells numbers for descriptive statistics of adult's body weight)
- YASAIw cumulative frequency distribution for total body surface area for male children correlated with body weight: =gencfdy(reference to cells defining CFD & GenZ functions)
- YASAIw cumulative frequency distribution for total body surface area for male adults correlated with body weight: =gencfdy (reference to cells defining male SA distribution & GenZ functions)

Statistical Description For Fraction (%) of Body Surface Area Exposed for Male Children and Adults	
Minimum	0.1
Most likely	0.2
Maximum	0.25
U.S. EPA Exposure Factors Handbook, Volume I, General Factors. August 1997. EPA/600/P-95/002Fa. Page 6-5	

YASAw functional statement for exposure distribution for % body surface area exposed based on professional judgment: =genbetapert (reference cells to the above min, most likely, max)

25% of Total Body Surface Area for Male Children Percentiles, cm², 3<6 years			
Construction of Non-Parametric Distribution Using Cumulative Data for CB Simulations[1]			
Percentile	YASAI Format of Body Surface Area Exposed, cm² Males, 3<6 years		
0.05	1490	1540	0.05
0.1	1540	1590	0.1
0.15	1590	1622.5	0.15
0.25	1622.5	1682.5	0.25
0.5	1682.5	1820	0.5
0.75	1820	1962.5	0.75
0.85	1962.5	2042.5	0.85
0.9	2042.5	2105	0.9
0.95	2105	2190	0.95
1	2190	2275	1

Footnote 1: Known corresponding body surface area for a given percentile but not the descriptive statistics to define the distribution.

YASAI GenCFD Format, From Above	
%ile	Value
0	1490
0.05	1540
0.1	1590
0.15	1622.5
0.25	1682.5
0.5	1820
0.75	1962.5
0.85	2042.5
0.9	2105
0.95	2190
1	2275

100% of Total Body Surface Area for Male Children Percentiles, cm², 3<6 years			
Construction of Non-Parametric Distribution Using Cumulative Data for CB Simulations[1]			
Percentile	YASAI Format of Body Surface Area Exposed, cm² Males, 3<6 years		
0.05	5960	6160	0.05
0.1	6160	6360	0.1
0.15	6360	6490	0.15
0.25	6490	6730	0.25
0.5	6730	7280	0.5
0.75	7280	7850	0.75
0.85	7850	8170	0.85
0.9	8170	8420	0.9
0.95	8420	8760	0.95
1	8760	9100	1

Footnote 1: Known corresponding body surface area for a given percentile but not the descriptive statistics to define the distribution.

YASAI GenCFD Format, From Above	
%ile	Value
0	5960
0.05	6160
0.1	6360
0.15	6490
0.25	6730
0.5	7280
0.75	7850
0.85	8170
0.9	8420
0.95	8760
1	9100

Adult Residential Exposure Duration			
Descriptive Statistics for Exposure Duration Distribution			
Distribution	Descriptive Statistics		
Truncated Lognormal for Adults	Mean	12.6	years
	Std Dev	16.2	years
	Minimum	1	years
	Maximum	87	years
U.S. EPA. Rock Mountain Flats Human Health Risk Assessment. Task 3 Report and Appendices. Sept 30, 2002. Table 4-5.			

YASAI functional statement & argument for the adult residential exposure duration: =genlimitlognormal (reference to cell numbers of descriptive statistics)

Child Residential Exposure Duration			
Descriptive Statistics for Exposure Duration Distribution			
Distribution	Descriptive Statistics		
YASAIw GENBETAPERT	Min	1	years
	Most Likely	3.5	years
Professional Judgement for Child's Resid. Expos. Duration	Max	6	years
	Opt. Wt	4	
U.S. EPA. Rock Mountain Flats Human Health Risk Assessment. Task 3 Report and Appendices. Sept 30, 2002. Appendix C, Table C-3, page 254.			

YASAI functional statement & argument for the child's residential exposure duration: = genbetapert(reference to cell numbers of descriptive statistics)

Descriptive Statistics for VFs Distribution		
Mean	6.49E+04	m^3/kg
Std Dev	2.72E+05	m^3/kg
Min	9.50E+03	m^3/kg
Max	2.90E+06	m^3/kg
Obtained From Spreadsheet VFs Factors For Soils, limited (130) chemicals that distribution drawn from		

YASAI functional statement for the soil volatilization factor: =genlimitlognormal (cell numbers for descriptive statistics

Appendix D: Preliminary Observations/Trends YASAIw.xla Results

Section 1: Summary of Risk-Based Soil Concentrations for Single and Concurrent Pathway Exposure

Arsenic
Summary of Risk-Based Soil Concentration For Single and Concurrent Pathway Exposure (mg/kg)

Expsoure Model	CUL	Ingestion Component			Dermal Component			Inhalation Component			Final Soil CUL
		Level		Rel. %	Level		Rel. %	Level		Rel. %	
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	6.67E-01			100							6.67E-01
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)		6.67E-01		9.77E+01	2.88E+01		2.26E+00	N/A		N/A	6.52E-01
Child - Soil 3 Concurrent Pathway, Not Age Adjusted		6.67E-01		9.77E+01	2.88E+01		2.26E+00	3.84E+03		1.70E-02	6.51E-01
Child, Adult-Soil Ingestion + Dermal, Age Adjusted		5.43E+01		9.63E+01	1.41E+01		3.70E+00	N/A		N/A	5.23E-01
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted		5.43E+01		9.63E+01	1.41E+01		3.70E+00	3.84E+03		1.36E-02	5.23E-01

Interpretational Note: Interpretation of percentiles relative to cleanup levels, 5 % indicates that there is a 95% probability that the cleanup level is protective of human health; a 5% probability the cleanup level will not be protective of human health.

Benzo[a]pyrene
Summary of Risk-Based Soil Concentration For Single and Concurrent Pathway Exposure (mg/kg)

Expsoure Model	CUL	Ingestion Component			Dermal Component			Inhalation Component			Final Soil CUL
		Level		Rel. %	Level		Rel. %	Level		Rel. %	
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	1.37E-01			100							1.37E-01
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)		1.37E-01		7.57E+01	4.26E-01		2.43E+01	N/A		N/A	1.04E-01
Child - Soil 3 Concurrent Pathway, Not Age Adjusted		1.37E-01		7.57E+01	4.26E-01		2.43E+01	1.50E+04		6.91E-04	1.04E-01
Child, Adult-Soil Ingestion + Dermal, Age Adjusted		1.12E-01		6.52E+01	2.09E-01		3.48E+01	N/A		N/A	7.28E-02
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted		1.12E-01		6.52E+01	2.09E-01		3.48E+01	1.50E+04		0.00E+00	7.28E-02

Chlordane
Summary of Risk-Based Soil Concentration For Single and Concurrent Pathway Exposure (mg/kg)

Expsoure Model	CUL	Ingestion Component			Dermal Component			Inhalation Component			Final Soil CUL
		Level		Rel. %	Level		Rel. %	Level		Rel. %	
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	2.86E+00			100							2.86E+00
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)		2.86E+00		9.01E+01	2.59E+01		9.92E+00	N/A		N/A	2.57E+00
Child - Soil 3 Concurrent Pathway, Not Age Adjusted		2.86E+00		9.01E+01	2.59E+01		9.92E+00	1.65E+05		1.56E-03	2.57E+00
Child, Adult-Soil Ingestion + Dermal, Age Adjusted		2.33E+00		8.45E+01	1.27E+01		1.55E+01	N/A		N/A	1.97E+00
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted		2.33E+00		8.45E+01	1.27E+01		1.55E+01	1.65E+05		1.19E-03	1.97E+00

Epichlorohydrin
Summary of Risk-Based Soil Concentration For Single and Concurrent Pathway Exposure (mg/kg)

Expsoure Model	CUL	Ingestion Component			Dermal Component			Inhalation Component			Final Soil CUL
		Level		Rel. %	Level		Rel. %	Level		Rel. %	
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	1.01E+02			100							1.01E+02
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)		1.01E+02		9.24E+01	1.22E+03		7.64E+00	N/A		N/A	9.33E+01
Child - Soil 3 Concurrent Pathway, Not Age Adjusted		1.01E+02		6.17E+01	1.22E+03		5.10E+01	1.87E+02		3.32E+01	6.23E+01
Child, Adult-Soil Ingestion + Dermal, Age Adjusted		8.23E+01		8.79E+01	6.00E+02		1.21E+01	N/A		N/A	7.24E+01
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted		8.23E+01		6.34E+01	6.00E+02		8.71E+00	1.87E+02		2.79E+01	5.22E+00

Trichloroethylene (TCE)
Summary of Risk-Based Soil Concentration For Single and Concurrent Pathway Exposure (mg/kg)

Expsoure Model	CUL	Ingestion Component			Dermal Component			Inhalation Component			Final Soil CUL
		Level		Rel. %	Level		Rel. %	Level		Rel. %	
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	1.12E+01			100							1.12E+01
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)		1.12E+01		9.24E+01	1.37E+02		7.61E+00	N/A		N/A	1.04E+01
Child - Soil 3 Concurrent Pathway, Not Age Adjusted		1.12E+01		1.21E+01	1.37E+02		9.95E-01	1.56E+00		8.69E+01	1.36+00
Child, Adult-Soil Ingestion + Dermal, Age Adjusted		9.16E+00		8.80E+01	6.70E+01		1.20E+01	N/A		N/A	8.06E+00
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted		9.16E+00		1.43E+01	6.70E+01		1.95E+00	1.56E+00		8.38E+01	1.31E+00

Section 2: Risk – Based Soil Concentrations Corresponding to Percentiles for a Simulated Exposure Distribution

Arsenic Risk-Based Soil Concentrations Corresponding to Percentiles for a Simulated Exposure Distribution (mg/kg)								
Expsoure Model	Mean	Percentiles			Risk Based CUL Point Estimate	Point Estimate Percentile	Modified Method B Soil Cleanup Level	Percentile For Method B
		1%	5%	10%				
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	o Calculation Performed				6.67E-01 Single Ing. Pathway		6.67E-01 Single Ing. Pathway	
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	2.02E+01	7.15E-01	1.67E+00	2.60E+00	6.52E-01	<1%	6.52E-01	<1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	2.05E+01	7.71E-01	1.74E+00	2.69E+00	6.51E-01	<1%	6.52E-01	<1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	7.64E+00	5.95E-01	1.05E+00	1.47E+00	5.23E-01	<1%	6.52E-01	<1%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	7.82E+00	5.70E-01	1.08E+00	1.48E+00	5.23E-01	<1%	6.52E-01	<1%

Benzo[a]pyrene Risk-Based Soil Concentrations Corresponding to Percentiles for a Simulated Exposure Distribution (mg/kg)								
Expsoure Model	Mean	Percentiles			Risk Based CUL Point Estimate	Point Estimate Percentile	Modified Method B Soil Cleanup Level	Percentile For Method B
		1%	5%	10%				
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	o Calculation Performed				1.37E-01 Single Ing. Pathway		1.37E-01 Single Ing. Pathway	
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	1.50E+00	1.37E-01	2.82E-01	3.96E-01	1.04E-01	<1%	1.04E-01	<1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	1.50E+00	1.45E-01	2.93E-01	4.00E-01	1.04E-01	<1%	1.04E-01	<1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	6.18E-01	8.30E-02	1.40E-01	1.81E-01	7.28E-02	<1%	1.04E-01	<5%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	6.21E-01	8.10E-02	1.36E-01	1.85E-01	7.28E-02	<1%	1.04E-01	<5%

Chlordane Risk-Based Soil Concentrations Corresponding to Percentiles for a Simulated Exposure Distribution (mg/kg)								
Expsoure Model	Mean	Percentiles			Risk Based CUL Point Estimate	Point Estimate Percentile	Modified Method B Soil Cleanup Level	Percentile For Method B
		1%	5%	10%				
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	No Calculation Performed				2.86E+00 Single Ing. Pathway		2.86E+00 Single Ing. Pathway	
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	5.32E+01	2.98E+00	6.81E+00	1.03E+01	2.57E+00	<1%	2.57E+00	<1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	5.35E+01	3.24E+00	7.11E+00	1.05E+01	2.57E+00	<1%	2.57E+00	<1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	2.08E+01	2.42E+00	3.96E+00	5.40E+00	1.97E+00	<1%	2.57E+00	<5%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	2.12E+01	2.30E+00	4.09E+00	5.47E+00	1.97E+00	<1%	2.57E+00	<5%

Epichlorohydrin Risk-Based Soil Concentrations Corresponding to Percentiles for a Simulated Exposure Distribution (mg/kg)								
Expsoure Model	Mean	Percentiles			Risk Based CUL Point Estimate	Point Estimate Percentile	Modified Method B Soil Cleanup Level	Percentile For Method B
		1%	5%	10%				
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	No Calculation Performed				1.01E+02 Single Ing. Pathway		1.01E+02 Single Ing. Pathway	
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	2.10E+03	1.06E+02	2.45E+02	3.73E+02	9.33E+01	<1%	9.33E+01	<1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	5.90E+02	8.72E+01	1.32E+02	1.60E+02	6.23E+01	<1%	9.33E+01	<1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	8.18E+02	8.80E+01	1.48E+02	2.01E+02	7.24E+01	<1%	9.33E+01	<5%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	2.35E+02	1.83E+01	3.45E+01	4.95E+01	5.22E+01	>10%	9.33E+01	>10%

Trichloroethylene (TCE) Risk-Based Soil Concentrations Corresponding to Percentiles for a Simulated Exposure Distribution (mg/kg)								
Expsoure Model	Mean	Percentiles			Risk Based CUL Point Estimate	Point Estimate Percentile	Modified Method B Soil Cleanup Level	Percentile For Method B
		1%	5%	10%				
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	No Calculation Performed				1.12E+01 Single Ing. Pathway		1.12E+01 Single Ing. Pathway	
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	2.34E+02	1.18E+01	2.72E+01	4.15E+01	1.04E+01	<1%	1.04E+01	<1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	4.30E+01	6.70E+00	9.00E+00	1.09E+01	1.36E+00	<1%	1.04E+01	<5%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	9.10E+01	9.79E+00	1.65E+01	2.24E+01	8.06E+00	<1%	1.04E+01	<5%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	1.87E+01	1.09E+00	2.14E+00	3.25E+00	1.31E+00	<5%	1.04E+01	<1%

Section 3: Summary of Contributions to Overall Variance for Simulated Distributions

Arsenic Summary of Contributions to Overall Variance for Simulated Distributions (%)							
Expsoure Model	Child Soil Ingestion Rate	Adult Soil Ingestion Rate	Child Exposure Duration	Adult Exposure Duration	Child Adherence Factor	Adult Adherence Factor	Body Weight
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	No Calculation Performed						
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	90%	N/A	~6%	N/A	<1%	N/A	>1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	91%		~6%		<1%		>1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	47%	5%	<1%	46%	<1%	<1%	<1%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	45%	4%	<1%	49%	<1%	<1%	<1%

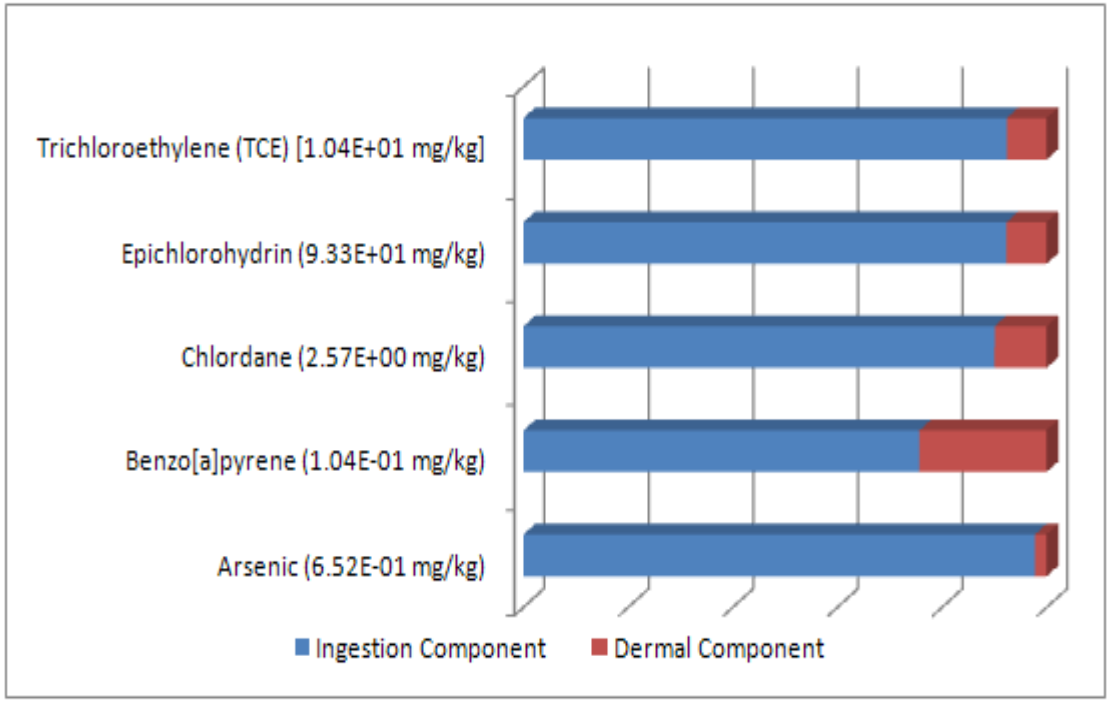
Benzo[a]pyrene Summary of Contributions to Overall Variance for Simulated Distributions (%)							
Expsoure Model	Child Soil Ingestion Rate	Adult Soil Ingestion Rate	Child Exposure Duration	Adult Exposure Duration	Child Adherence Factor	Adult Adherence Factor	Body Weight
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	No Calculation Performed						
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	61%	N/A	13%	N/A	21%	N/A	>1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	59%	N/A	14%	N/A	22%	N/A	>1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	25%	3%	1%	55%	8%	6%	<1%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	24%	2%	1%	56%	8%	8%	<1%

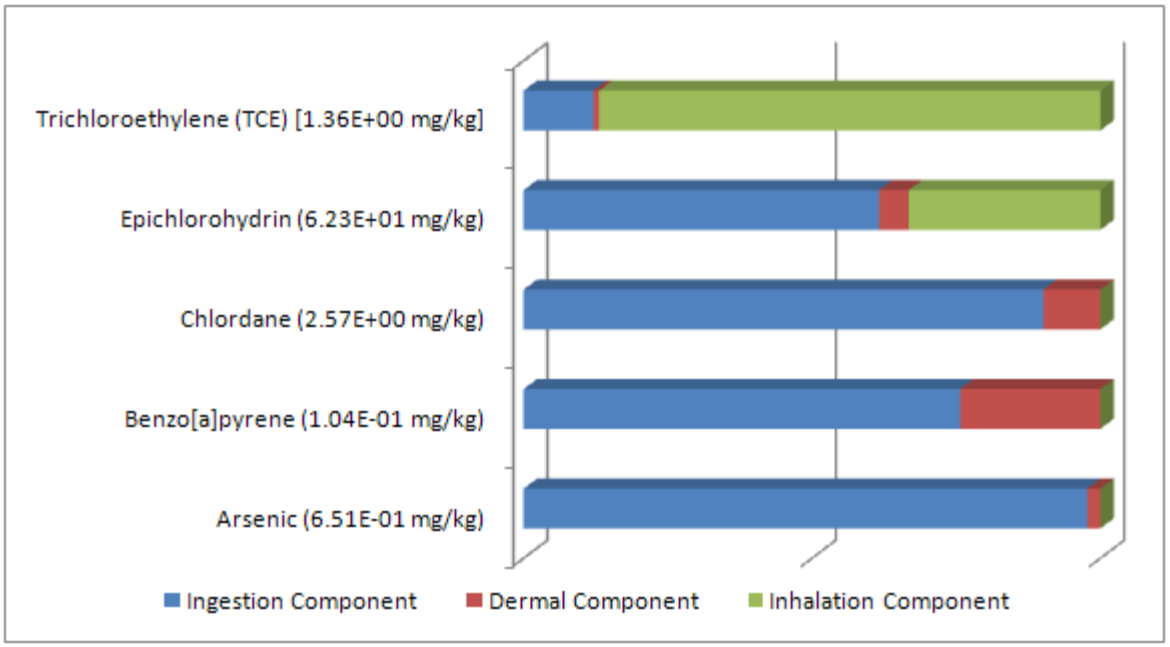
Chlordane Summary of Contributions to Overall Variance for Simulated Distributions (%)							
Expsoure Model	Child Soil Ingestion Rate	Adult Soil Ingestion Rate	Child Exposure Duration	Adult Exposure Duration	Child Adherence Factor	Adult Adherence Factor	Body Weight
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	No Calculation Performed						
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	81%	N/A	9%	N/A	6%	N/A	>1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	82%	N/A	10%	N/A	6%	N/A	>1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	40%	5%	<1%	50%	2%	2%	<1%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	38%	3%	<1%	51%	2%	3%	<1%

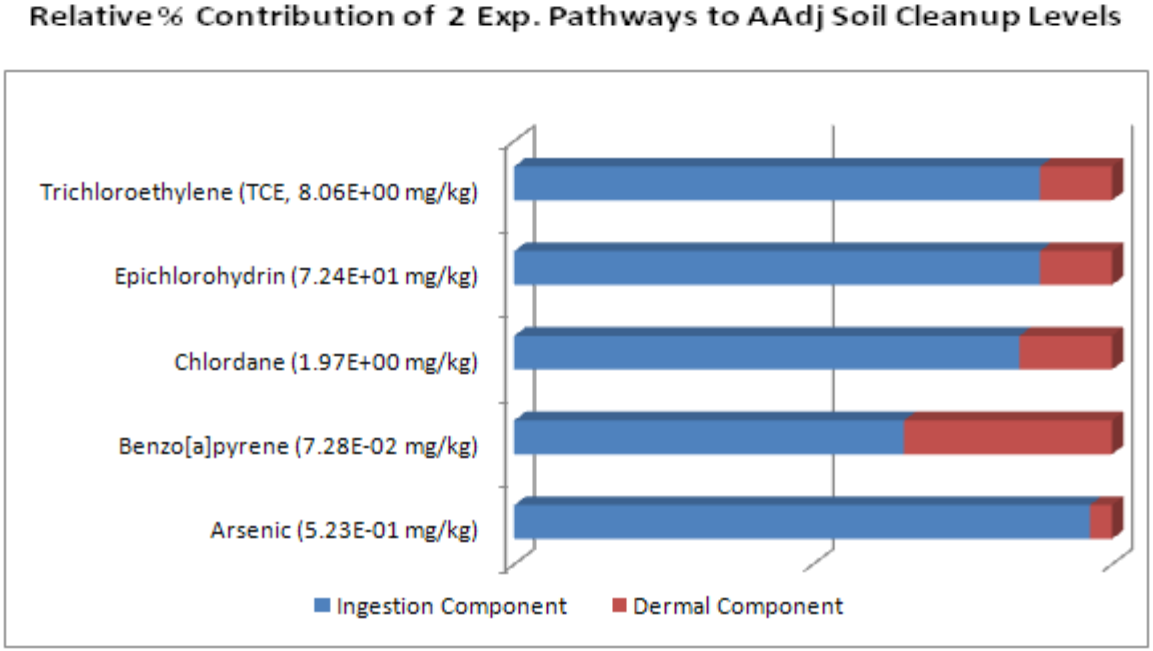
Epichlorohydrin Summary of Contributions to Overall Variance for Simulated Distributions (%)								
Expsoure Model	Child Soil Ingestion Rate	VF	Adult SIR	Child Exposure Duration	Adult Exposure Duration	Child Adherence Factor	Adult Adherence Factor	Body Weight
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	No Calculation Performed							
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	85%	N/A	N/A	8%	N/A	4%	N/A	>1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	20%	66%		14%	N/A	<1%	N/A	<1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	42%	N/A	5%	N/A	48%	2%	2%	<1%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	5%	55%	>1%	<1%	49%	<1%	<1%	<1%

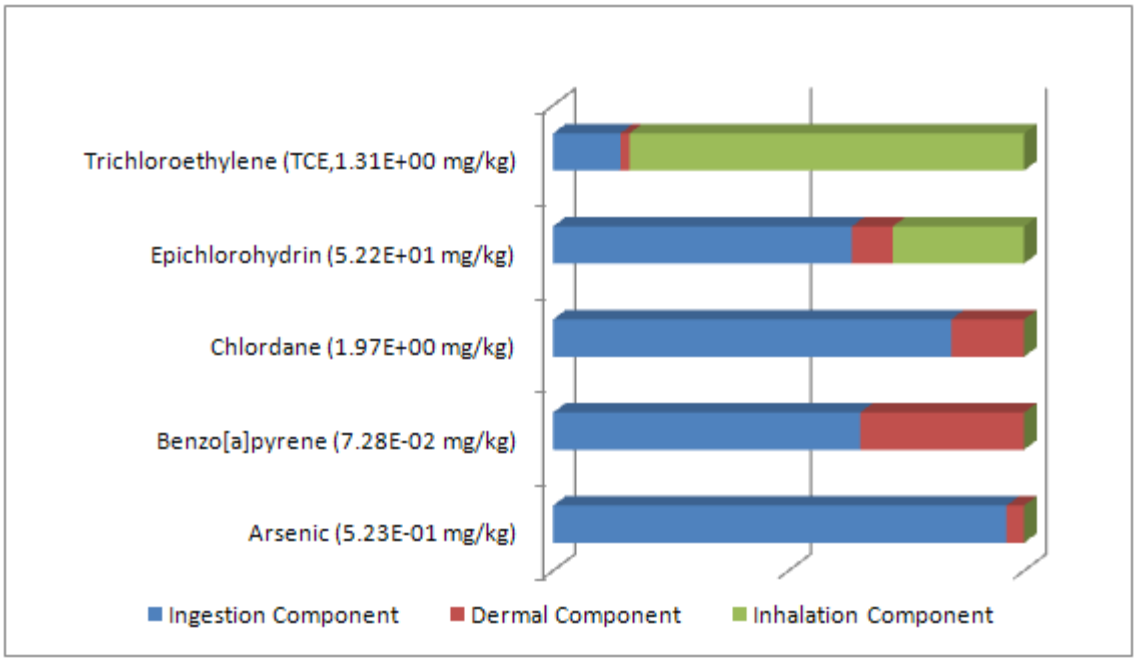
Trichloroethylene (TCE) Summary of Contributions to Overall Variance for Simulated Distributions (%)								
Expsoure Model	Child Soil Ingestion Rate	VF	Adult SIR	Child Exposure Duration	Adult Exposure Duration	Child Adherence Factor	Adult Adherence Factor	Body Weight
Child - Soil Ingestion Pathway Only (Meth. B, 740-2)	No Calculation Performed							
Child - Soil Ingestion + Dermal (Modified Meth B, 740-5)	85%	N/A	N/A	8%	N/A	4%	N/A	>1%
Child - Soil 3 Concurrent Pathway, Not Age Adjusted	9%	78%		12%		<1%		<1%
Child, Adult-Soil Ingestion + Dermal, Age Adjusted	42%	N/A	5%	<1%	50%	1%	2%	<1%
Child, Adult-Soil Ingestion + Dermal + Inhal, Age Adjusted	2%	59%	<1%	<1%	37%	<1%	<1%	<1%

Relative % Contribution of Exp. Pathways to Modified MTCA Soil CULs




Relative % Contribution of 3 Exp. Pathways to Soil CULs
Trichloroethylene (TCE) [1.36E+00 mg/kg]
Epichlorohydrin (6.23E+01 mg/kg)
Chlordane (2.57E+00 mg/kg)
Benzo[a]pyrene (1.04E-01 mg/kg)
Arsenic (6.51E-01 mg/kg)
Ingestion Component
Dermal Component
Inhalation Component


Relative % Contribution of 2 Exp. Pathways to AAdj Soil Cleanup Levels
Trichloroethylene (TCE, 8.06E+00 mg/kg)
Epichlorohydrin (7.24E+01 mg/kg)
Chlordane (1.97E+00 mg/kg)
Benzo[a]pyrene (7.28E-02 mg/kg)
Arsenic (5.23E-01 mg/kg)
Ingestion Component
Dermal Component


Relative % Contributions 3 Exp Pathways to AAdj Soil Cleanup Levels
Trichloroethylene (TCE,1.31E+00 mg/kg)
Epichlorohydrin (5.22E+01 mg/kg)
Chlordane (1.97E+00 mg/kg)
Benzo[a]pyrene (7.28E-02 mg/kg)
Arsenic (5.23E-01 mg/kg)
Ingestion Component
Dermal Component
Inhalation Component

Appendix E: % Contribution to Variance & Models Used

Age Adjusted 3-Concurrent Exposure Pathways
% Contribution to Variance for Soil Risk Based Cleanup Levels

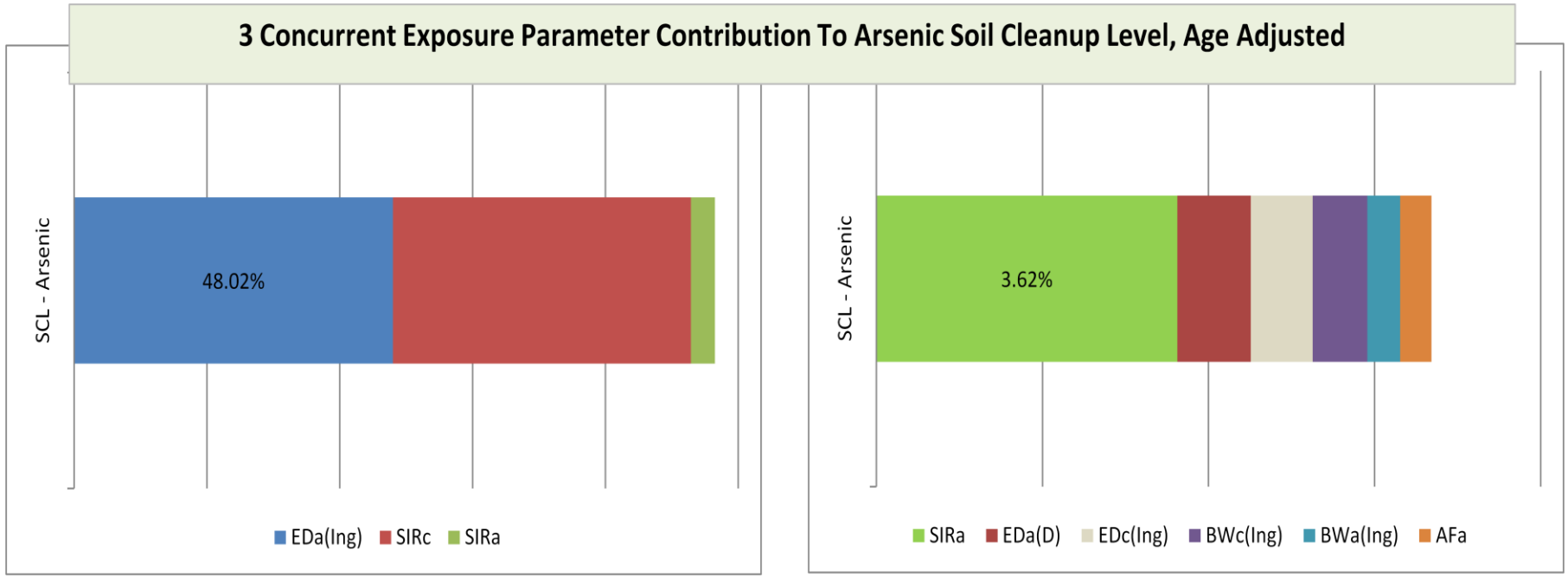
Mathematical Model

Age Adjusted Carcinogenic Cleanup Equations For Ingestion, Dermal & Inhalation Exposures - Unrestricted Land Use

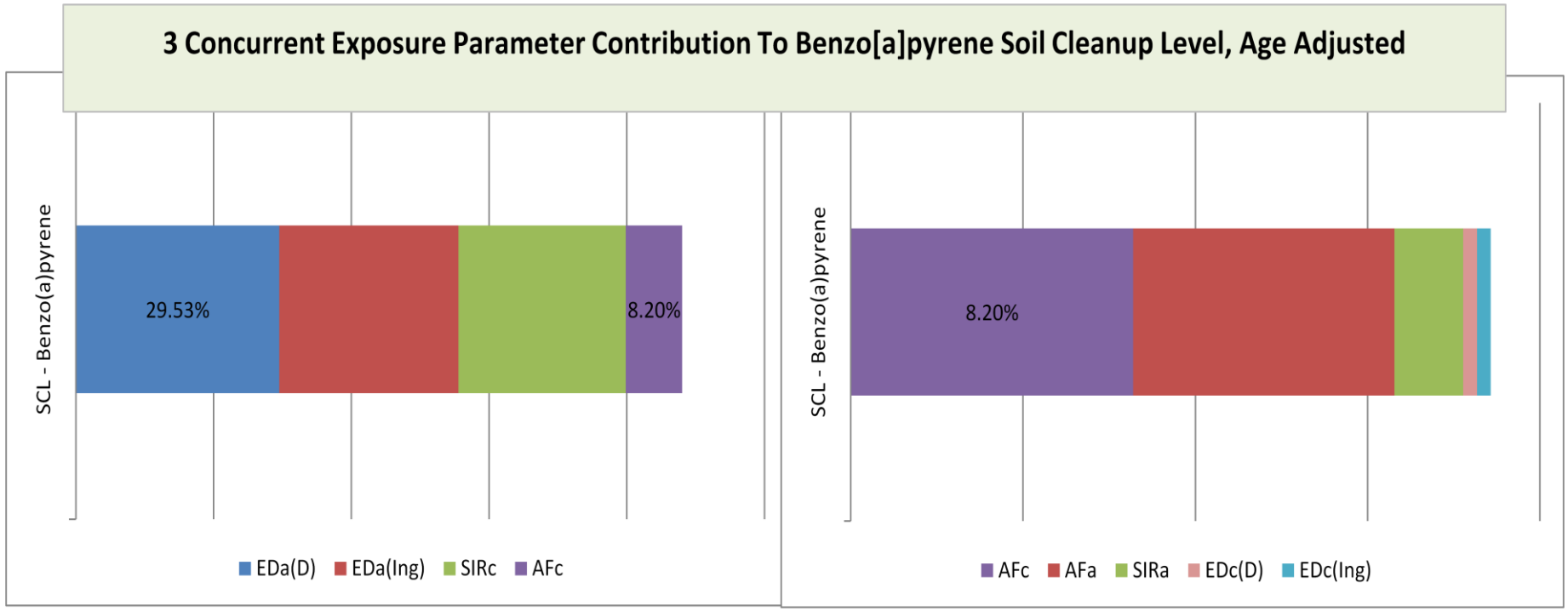
Soil Ingestion Pathway			Dermal Contact With Soil			Inhalation From Soil		
$C_{soil\text{-}o\text{-}ad}$	=	Risk * AT	$C_{soil\text{-}d\text{-}ad}$	=	Risk * AT	$C_{soil\text{-}inh\text{-}a}$	=	Risk * AT
mg/kg		$CPFo * AB1 * EF * IFSadj * UCF_1$	mg/kg		$CPFd * ABSd * EF * SFSadj * UCF_2$	mg/kg		$InhUR * EF * \{1/VFs + 1/PEF\} * ED * UCF_3$

$C_{soil\text{-}o/d/i}$	=	1
mg/kg		$1/C_{soil\text{-}o\text{-}adj} + 1/C_{soil\text{-}d\text{-}adj} + 1/C_{soil\text{-}inh\text{-}adj}$

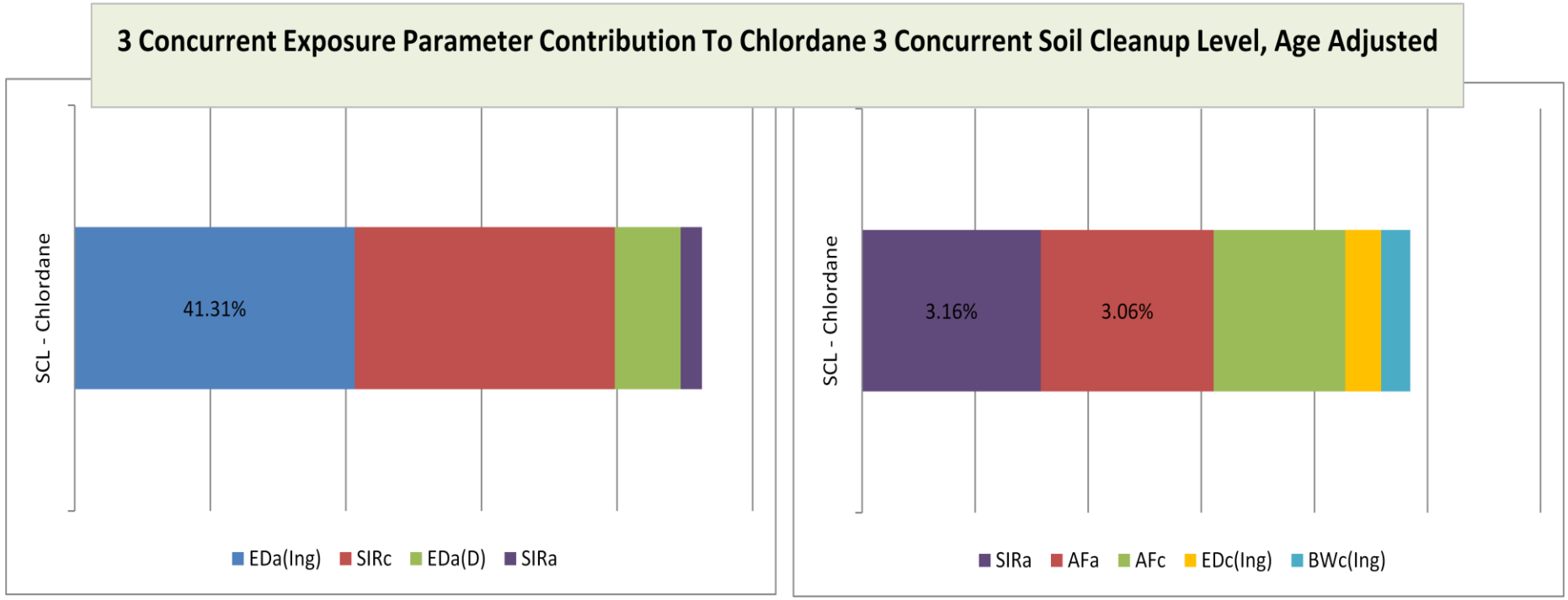
YASAI Simulation Output & % Contrib to Variance		
SCL - Arsenic	EDa(Ing)	48.02%
SCL - Arsenic	SIRc	44.87%
SCL - Arsenic	SIRa	3.62%
SCL - Arsenic	EDa(D)	0.89%
SCL - Arsenic	EDc(Ing)	0.74%
SCL - Arsenic	BWc(Ing)	0.66%
SCL - Arsenic	BWa(Ing)	0.40%
SCL - Arsenic	AFa	0.38%
SCL - Arsenic	AFc	0.23%
SCL - Arsenic	SAtot(a)	0.05%
SCL - Arsenic	BWa(D)	0.05%
SCL - Arsenic	VF-TCE	0.03%
SCL - Arsenic	VFepi	0.02%
SCL - Arsenic	SAfrac(a)	0.02%
SCL - Arsenic	EDc(Inh)	0.01%
SCL - Arsenic	SAfrac(c)	0.00%
SCL - Arsenic	EDa(Inh)	0.00%
SCL - Arsenic	EDc(D)	0.00%
SCL - Arsenic	SAtot(c)	0.00%
SCL - Arsenic	BWc(D)	0.00%


3 Concurrent Exposure Parameter Contribution To Arsenic Soil Cleanup Level, Age Adjusted
SCL - Arsenic
48.02%
EDa(Ing)
SIRc
SIRa
SCL - Arsenic
3.62%
SIRa
EDa(D)
EDc(Ing)
BWc(Ing)
BWa(Ing)
AFa

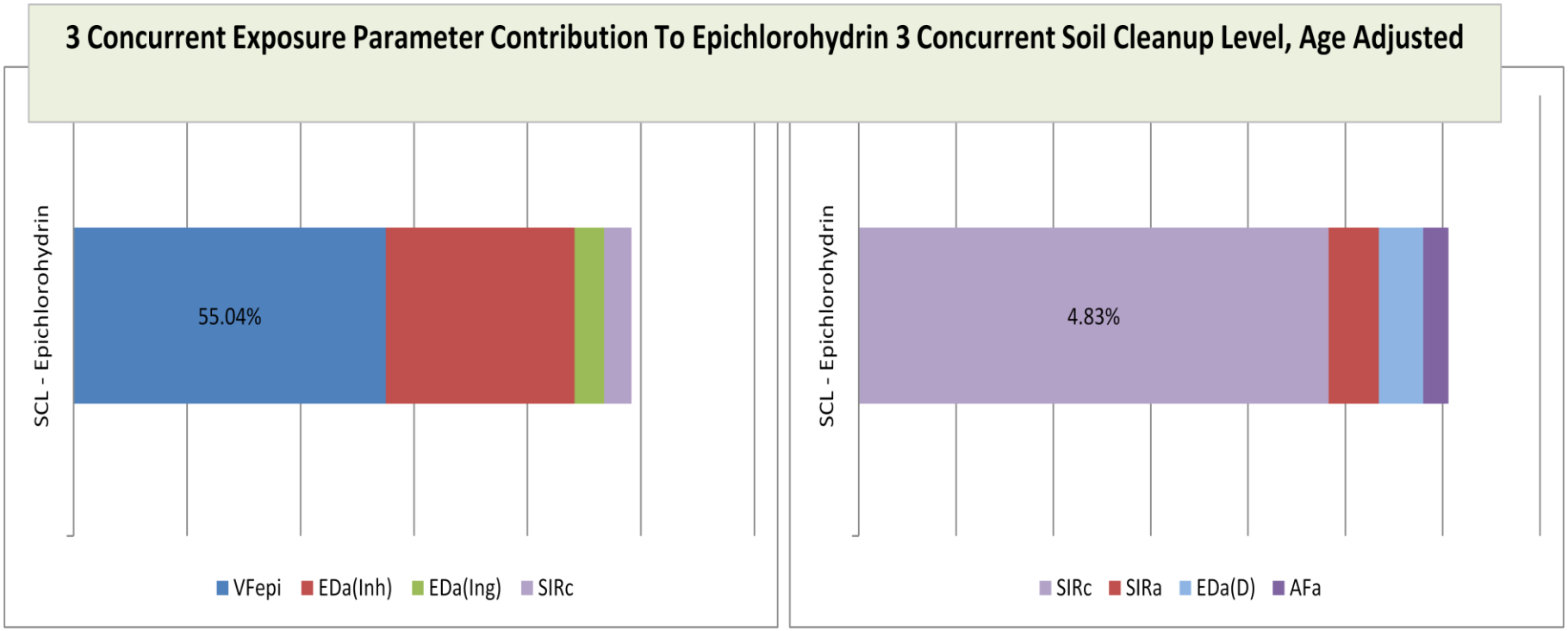
YASAI Simulation Output & % Contrib to Variance		
SCL - Benzo(a)pyrene	EDa(D)	29.53%
SCL - Benzo(a)pyrene	EDa(Ing)	26.03%
SCL - Benzo(a)pyrene	SIRc	24.28%
SCL - Benzo(a)pyrene	AFc	8.20%
SCL - Benzo(a)pyrene	AFa	7.58%
SCL - Benzo(a)pyrene	SIRa	1.99%
SCL - Benzo(a)pyrene	EDc(D)	0.41%
SCL - Benzo(a)pyrene	EDc(Ing)	0.39%
SCL - Benzo(a)pyrene	SAfrac(c)	0.36%
SCL - Benzo(a)pyrene	SAfrac(a)	0.30%
SCL - Benzo(a)pyrene	BWc(Ing)	0.25%
SCL - Benzo(a)pyrene	BWa(Ing)	0.25%
SCL - Benzo(a)pyrene	BWa(D)	0.13%
SCL - Benzo(a)pyrene	SAtot(a)	0.13%
SCL - Benzo(a)pyrene	VF-TCE	0.05%
SCL - Benzo(a)pyrene	VFepi	0.04%
SCL - Benzo(a)pyrene	SAtot(c)	0.02%
SCL - Benzo(a)pyrene	BWc(D)	0.02%
SCL - Benzo(a)pyrene	EDa(Inh)	0.01%
SCL - Benzo(a)pyrene	EDc(Inh)	0.00%


3 Concurrent Exposure Parameter Contribution To Benzo[a]pyrene Soil Cleanup Level, Age Adjusted
SCL - Benzo(a)pyrene
29.53%
8.20%
EDa(D)
EDa(Ing)
SIRc
AFc
SCL - Benzo(a)pyrene
8.20%
AFc
AFa
SIRa
EDc(D)
EDc(Ing)

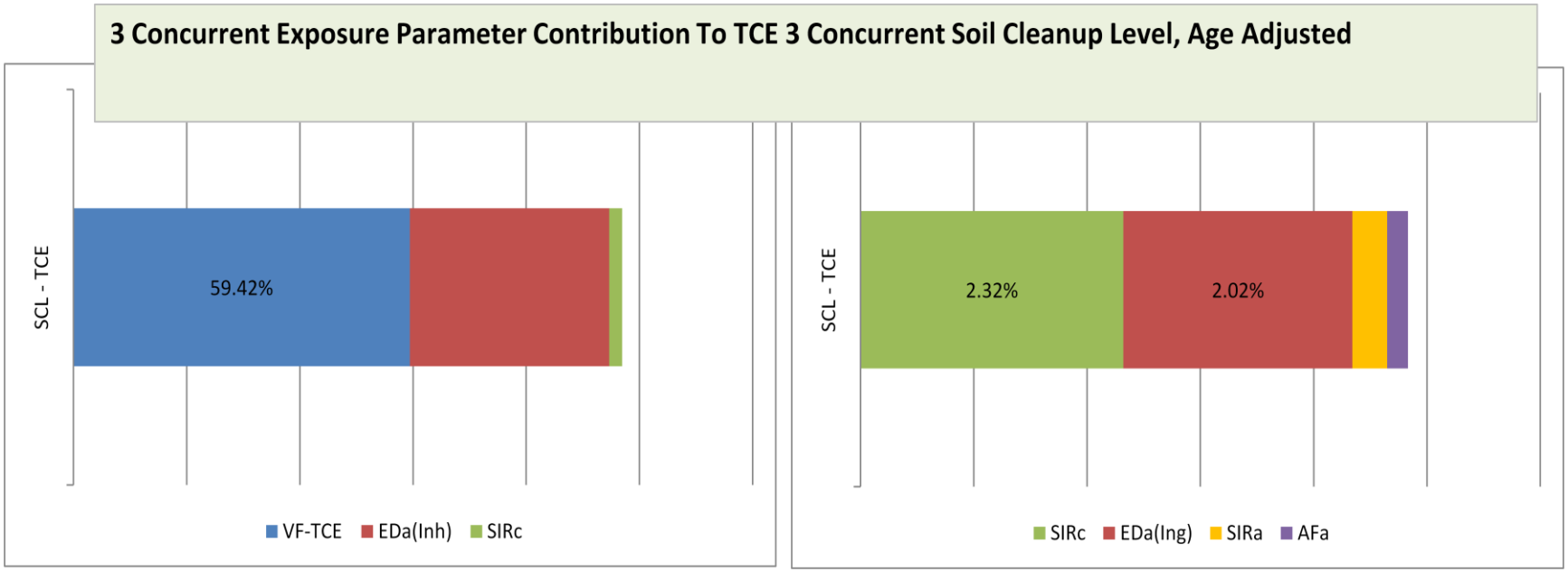
YASAI Simulation Output & % Contrib to Variance		
SCL - Chlordane	EDa(Ing)	41.31%
SCL - Chlordane	SIRc	38.35%
SCL - Chlordane	EDa(D)	9.72%
SCL - Chlordane	SIRa	3.16%
SCL - Chlordane	AFa	3.06%
SCL - Chlordane	AFc	2.33%
SCL - Chlordane	EDc(Ing)	0.64%
SCL - Chlordane	BWc(Ing)	0.52%
SCL - Chlordane	BWa(Ing)	0.37%
SCL - Chlordane	SAfrac(a)	0.13%
SCL - Chlordane	SAtot(a)	0.09%
SCL - Chlordane	BWa(D)	0.09%
SCL - Chlordane	EDc(D)	0.09%
SCL - Chlordane	SAfrac(c)	0.05%
SCL - Chlordane	VF-TCE	0.04%
SCL - Chlordane	VFepi	0.04%
SCL - Chlordane	SAtot(c)	0.01%
SCL - Chlordane	BWc(D)	0.01%
SCL - Chlordane	EDa(Inh)	0.01%
SCL - Chlordane	EDc(Inh)	0.01%


3 Concurrent Exposure Parameter Contribution To Chlordane 3 Concurrent Soil Cleanup Level, Age Adjusted
SCL - Chlordane
41.31%
EDa(Ing)
SIRc
EDa(D)
SIRa
SCL - Chlordane
3.16%
3.06%
SIRa
AFa
AFc
EDc(Ing)
BWc(Ing)

YASAI Simulation Output & % Contrib to Variance		
SCL - Epichlorohydrin	VFepi	55.04%
SCL - Epichlorohydrin	EDa(Inh)	33.27%
SCL - Epichlorohydrin	EDa(Ing)	5.19%
SCL - Epichlorohydrin	SIRc	4.83%
SCL - Epichlorohydrin	SIRa	0.52%
SCL - Epichlorohydrin	EDa(D)	0.45%
SCL - Epichlorohydrin	AFa	0.26%
SCL - Epichlorohydrin	EDc(Inh)	0.14%
SCL - Epichlorohydrin	AFc	0.09%
SCL - Epichlorohydrin	EDc(Ing)	0.07%
SCL - Epichlorohydrin	VF-TCE	0.04%
SCL - Epichlorohydrin	SAfrac(a)	0.03%
SCL - Epichlorohydrin	SAtot(c)	0.02%
SCL - Epichlorohydrin	BWc(D)	0.02%
SCL - Epichlorohydrin	BWa(Ing)	0.01%
SCL - Epichlorohydrin	BWc(Ing)	0.01%
SCL - Epichlorohydrin	SAtot(a)	0.01%
SCL - Epichlorohydrin	BWa(D)	0.00%
SCL - Epichlorohydrin	SAfrac(c)	0.00%
SCL - Epichlorohydrin	EDc(D)	0.00%


3 Concurrent Exposure Parameter Contribution To Epichlorohydrin 3 Concurrent Soil Cleanup Level, Age Adjusted
SCL - Epichlorohydrin
55.04%
VFepi
EDa(Inh)
EDa(Ing)
SIRc
SCL - Epichlorohydrin
4.83%
SIRc
SIRa
EDa(D)
AFa

YASAI Simulation Output & % Contrib to Variance		
SCL - TCE	VF-TCE	59.42%
SCL - TCE	EDa(Inh)	35.22%
SCL - TCE	SIRc	2.32%
SCL - TCE	EDa(Ing)	2.02%
SCL - TCE	SIRa	0.31%
SCL - TCE	AFa	0.18%
SCL - TCE	EDc(Inh)	0.18%
SCL - TCE	EDa(D)	0.15%
SCL - TCE	EDc(Ing)	0.08%
SCL - TCE	AFc	0.03%
SCL - TCE	SAtot(c)	0.03%
SCL - TCE	BWc(D)	0.02%
SCL - TCE	VFepi	0.01%
SCL - TCE	BWa(Ing)	0.01%
SCL - TCE	BWc(Ing)	0.01%
SCL - TCE	SAfrac(a)	0.00%
SCL - TCE	EDc(D)	0.00%
SCL - TCE	SAfrac(c)	0.00%
SCL - TCE	SAtot(a)	0.00%
SCL - TCE	BWa(D)	0.00%


3 Concurrent Exposure Parameter Contribution To TCE 3 Concurrent Soil Cleanup Level, Age Adjusted
SCL - TCE
59.42%
VF-TCE
EDa(Inh)
SIRc
SCL - TCE
2.32%
2.02%
SIRc
EDa(Ing)
SIRa
AFa

Age Adjusted 2-Concurrent Exposure Pathways
% Contribution to Variance for Soil Risk Based Cleanup Levels

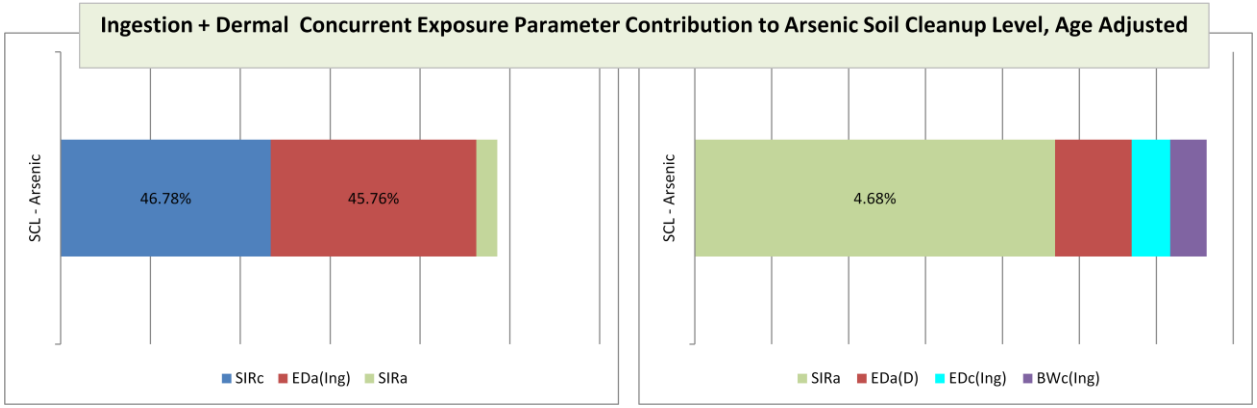
Mathematical Model

Carcinogenic Cleanup Formula Modifed for Age Adjusted Dermal and Ingestion Pathways(WAC 173-340-740, Equation 740-5)

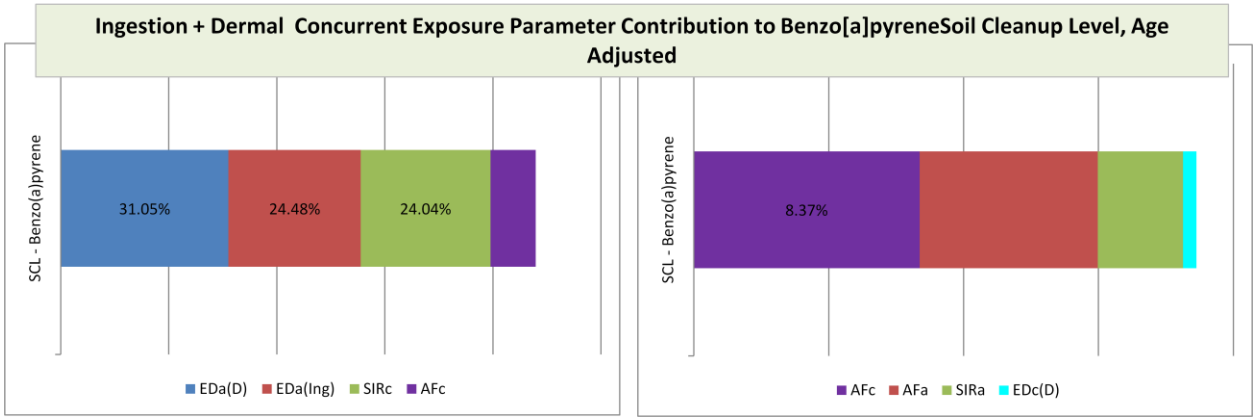
$$\text{MTCA Modified Soil Cleanup Level (mg/kg)} = \underbrace{\frac{\text{Risk} * \text{AT}}{\text{CPFo} * \text{AB1} * \text{EF} * \text{IFSadj} * \text{UCF}_1}}_{\text{A Ingestion Component}} \text{ plus } \underbrace{\frac{\text{Risk} * \text{AT}}{\text{CPFd} * \text{ABSd} * \text{EF} * \text{SFSadj} * \text{UCF2}}}_{\text{B Dermal Component}}$$

$$= \frac{1}{\frac{1}{\text{Ingestion Component}} \text{ plus } \frac{1}{\text{Dermal Component}}}$$

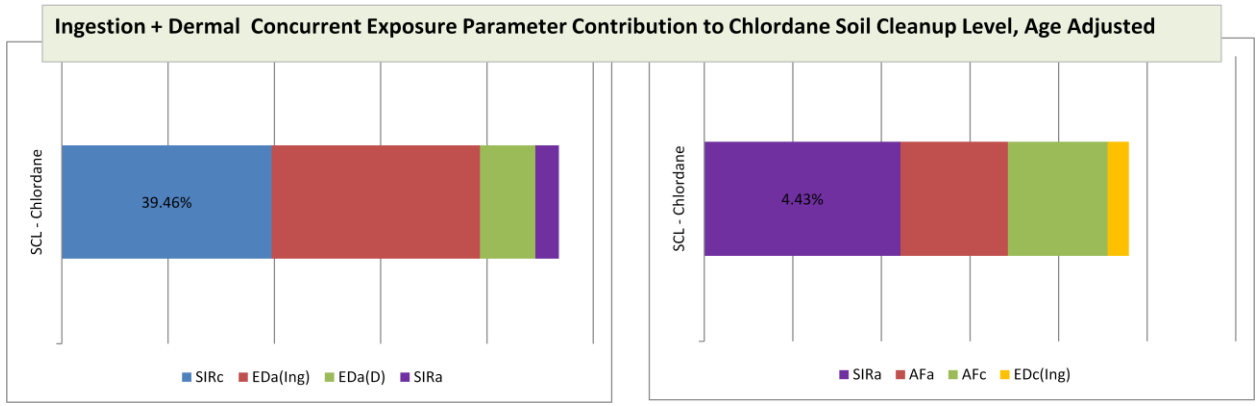
YASAI Simulation Output & % Contrib to Variance			
	SCL - Arsenic	SIRc	46.78%
	SCL - Arsenic	EDa(Ing)	45.76%
	SCL - Arsenic	SIRa	4.68%
	SCL - Arsenic	EDa(D)	1.00%
	SCL - Arsenic	EDc(Ing)	0.50%
	SCL - Arsenic	BWc(Ing)	0.47%
	SCL - Arsenic	BWa(Ing)	0.31%
	SCL - Arsenic	AFc	0.18%
	SCL - Arsenic	AFa	0.18%
	SCL - Arsenic	SAtot(c)	0.03%
	SCL - Arsenic	BWc(D)	0.03%
	SCL - Arsenic	SAfrac(a)	0.02%
	SCL - Arsenic	EDc(D)	0.02%
	SCL - Arsenic	BWa(D)	0.01%
	SCL - Arsenic	SAtot(a)	0.01%
	SCL - Arsenic	SAfrac(c)	0.01%



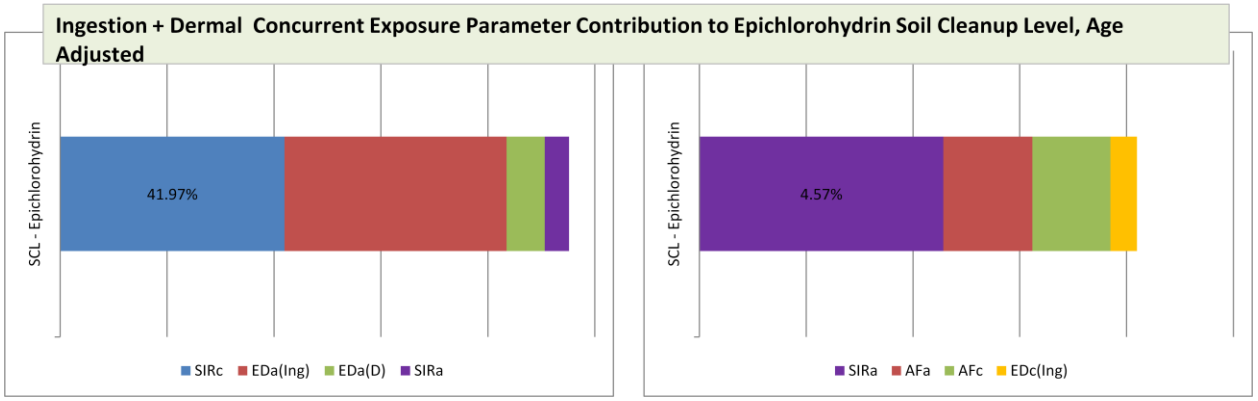
YASAI Simulation Output & % Contrib to Variance			
	SCL - Benzo(a)pyrene	EDa(D)	31.05%
	SCL - Benzo(a)pyrene	EDa(Ing)	24.48%
	SCL - Benzo(a)pyrene	SIRc	24.04%
	SCL - Benzo(a)pyrene	AFc	8.37%
	SCL - Benzo(a)pyrene	AFa	6.60%
	SCL - Benzo(a)pyrene	SIRa	3.16%
	SCL - Benzo(a)pyrene	EDc(D)	0.50%
	SCL - Benzo(a)pyrene	BWc(Ing)	0.36%
	SCL - Benzo(a)pyrene	EDc(Ing)	0.36%
	SCL - Benzo(a)pyrene	SAfrac(a)	0.33%
	SCL - Benzo(a)pyrene	BWa(Ing)	0.15%
	SCL - Benzo(a)pyrene	BWa(D)	0.14%
	SCL - Benzo(a)pyrene	SAtot(a)	0.14%
	SCL - Benzo(a)pyrene	BWc(D)	0.12%
	SCL - Benzo(a)pyrene	SAtot(c)	0.12%
	SCL - Benzo(a)pyrene	SAfrac(c)	0.09%



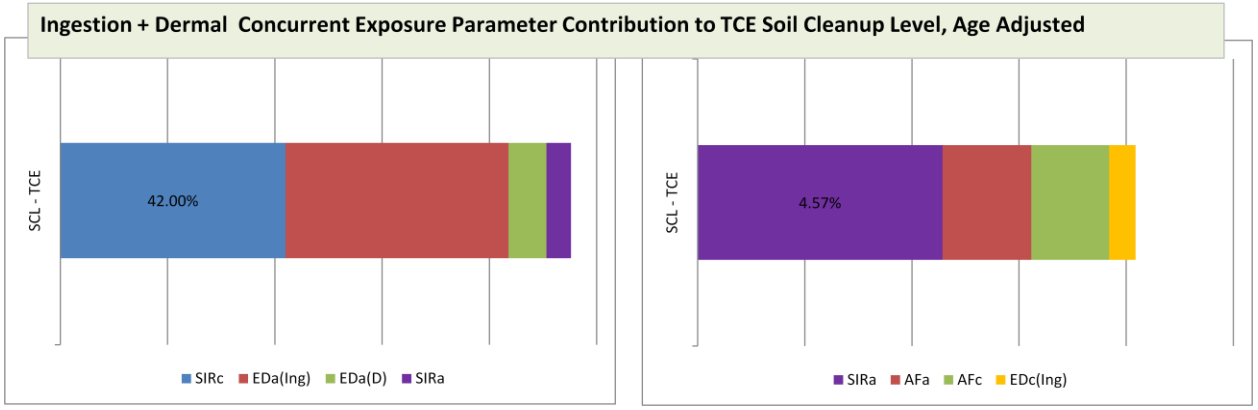
YASAI Simulation Output & % Contrib to Variance			
	SCL - Chlordane	SIRc	39.46%
	SCL - Chlordane	EDa(Ing)	39.22%
	SCL - Chlordane	EDa(D)	10.43%
	SCL - Chlordane	SIRa	4.43%
	SCL - Chlordane	AFa	2.42%
	SCL - Chlordane	AFc	2.25%
	SCL - Chlordane	EDc(Ing)	0.48%
	SCL - Chlordane	BWc(Ing)	0.45%
	SCL - Chlordane	BWa(Ing)	0.26%
	SCL - Chlordane	EDc(D)	0.16%
	SCL - Chlordane	SAfrac(a)	0.15%
	SCL - Chlordane	SAtot(c)	0.07%
	SCL - Chlordane	BWc(D)	0.07%
	SCL - Chlordane	BWa(D)	0.07%
	SCL - Chlordane	SAtot(a)	0.07%
	SCL - Chlordane	SAfrac(c)	0.00%



YASAI Simulation Output & % Contrib to Variance			
	SCL - Epichlorohydrin	SIRc	41.97%
	SCL - Epichlorohydrin	EDa(Ing)	41.53%
	SCL - Epichlorohydrin	EDa(D)	7.14%
	SCL - Epichlorohydrin	SIRa	4.57%
	SCL - Epichlorohydrin	AFa	1.67%
	SCL - Epichlorohydrin	AFc	1.46%
	SCL - Epichlorohydrin	EDc(Ing)	0.49%
	SCL - Epichlorohydrin	BWc(Ing)	0.46%
	SCL - Epichlorohydrin	BWa(Ing)	0.28%
	SCL - Epichlorohydrin	SAfrac(a)	0.11%
	SCL - Epichlorohydrin	EDc(D)	0.11%
	SCL - Epichlorohydrin	SAtot(c)	0.06%
	SCL - Epichlorohydrin	BWc(D)	0.06%
	SCL - Epichlorohydrin	BWa(D)	0.05%
	SCL - Epichlorohydrin	SAtot(a)	0.05%
	SCL - Epichlorohydrin	SAfrac(c)	0.00%



YASAI Simulation Output & % Contrib to Variance			
	SCL - TCE	SIRc	42.00%
	SCL - TCE	EDa(Ing)	41.56%
	SCL - TCE	EDa(D)	7.09%
	SCL - TCE	SIRa	4.57%
	SCL - TCE	AFa	1.66%
	SCL - TCE	AFc	1.45%
	SCL - TCE	EDc(Ing)	0.49%
	SCL - TCE	BWc(Ing)	0.46%
	SCL - TCE	BWa(Ing)	0.28%
	SCL - TCE	SAfrac(a)	0.11%
	SCL - TCE	EDc(D)	0.11%
	SCL - TCE	SAtot(c)	0.06%
	SCL - TCE	BWc(D)	0.06%
	SCL - TCE	BWa(D)	0.05%
	SCL - TCE	SAtot(a)	0.05%
	SCL - TCE	SAfrac(c)	0.00%



2-Concurrent Exposure Pathways - Not Age Adjusted - Child Exposure
% Contribution to Variance for Soil Risk Based Cleanup Levels

Mathematical Model

Carcinogenic Cleanup Formula Modifed for Dermal and Ingestion Pathways(WAC 173-340-740, Equation 740-5)

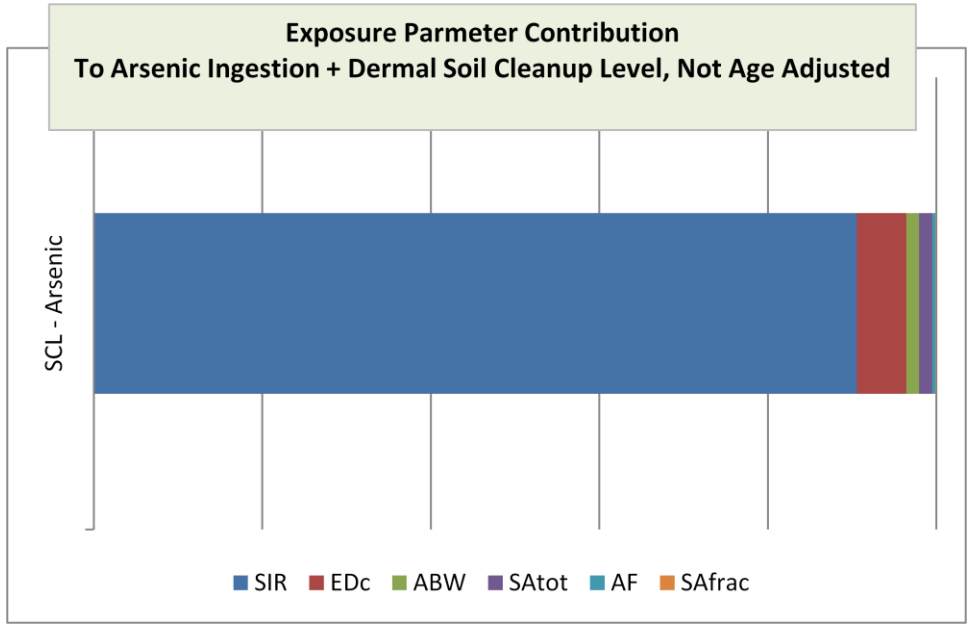
$$\text{MTCA Modified Soil Cleanup Level (mg/kg)} = \frac{A}{\text{Ingestion Component}} + \frac{B}{\text{Dermal Component}}$$

$$\text{Ingestion Component} = \frac{\text{Risk} \cdot \text{ABW} \cdot \text{AT} \cdot \text{UCF1}}{\text{EF} \cdot \text{ED} \cdot \text{SIR} \cdot \text{AB1} \cdot \text{CPFo}}$$

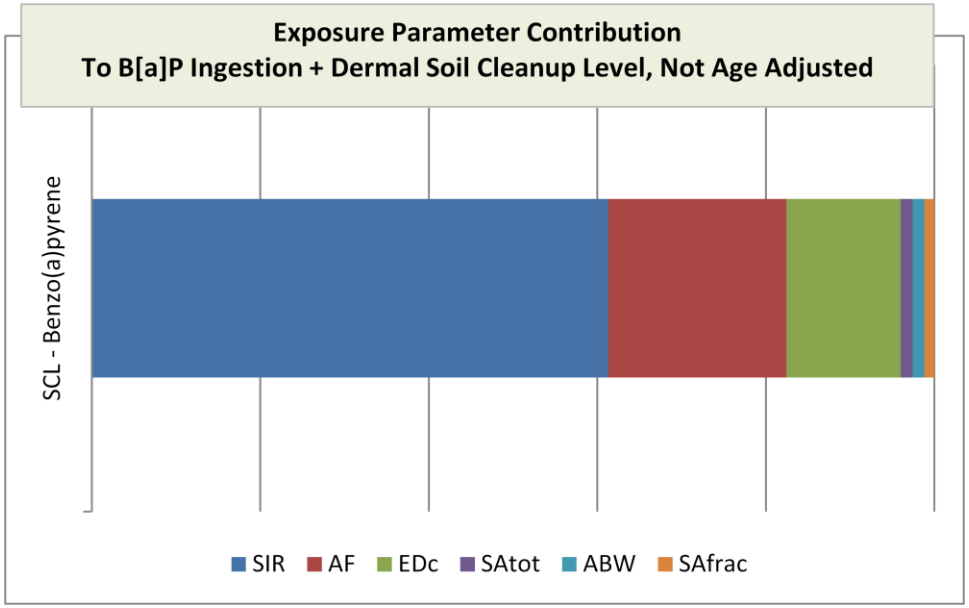
$$\text{Dermal Component} = \frac{\text{Risk} \cdot \text{ABW} \cdot \text{AT} \cdot \text{UCF1}}{\text{EF} \cdot \text{ED} \cdot \text{SA} \cdot \text{AF} \cdot \text{ABS} \cdot \text{CPFd}}$$

$$= \frac{1}{\frac{1}{\text{Ingestion Component}} + \frac{1}{\text{Dermal Component}}}$$

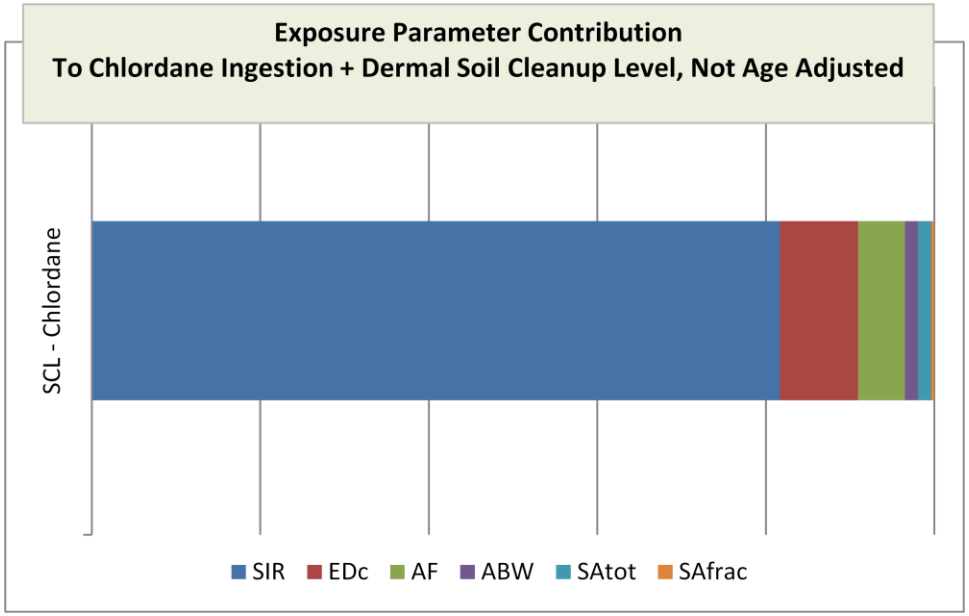
YASAI Simulation Output & % Contrib to Variance			
	SCL - Arsenic	SIR	90.56%
	SCL - Arsenic	EDc	5.87%
	SCL - Arsenic	ABW	1.53%
	SCL - Arsenic	SAtot	1.53%
	SCL - Arsenic	AF	0.43%
	SCL - Arsenic	SAfrac	0.07%



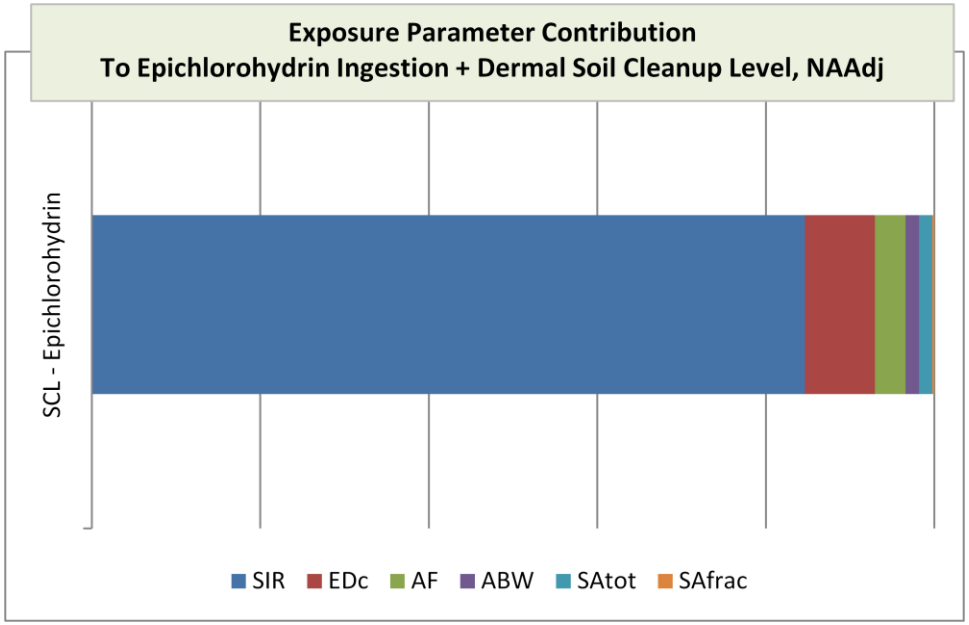
YASAI Simulation Output & % Contrib to Variance				
		SCL - Benzo(a)pyrene	SIR	61.27%
		SCL - Benzo(a)pyrene	AF	21.17%
		SCL - Benzo(a)pyrene	EDc	13.57%
		SCL - Benzo(a)pyrene	SAtot	1.41%
		SCL - Benzo(a)pyrene	ABW	1.41%
		SCL - Benzo(a)pyrene	SAfrac	1.17%



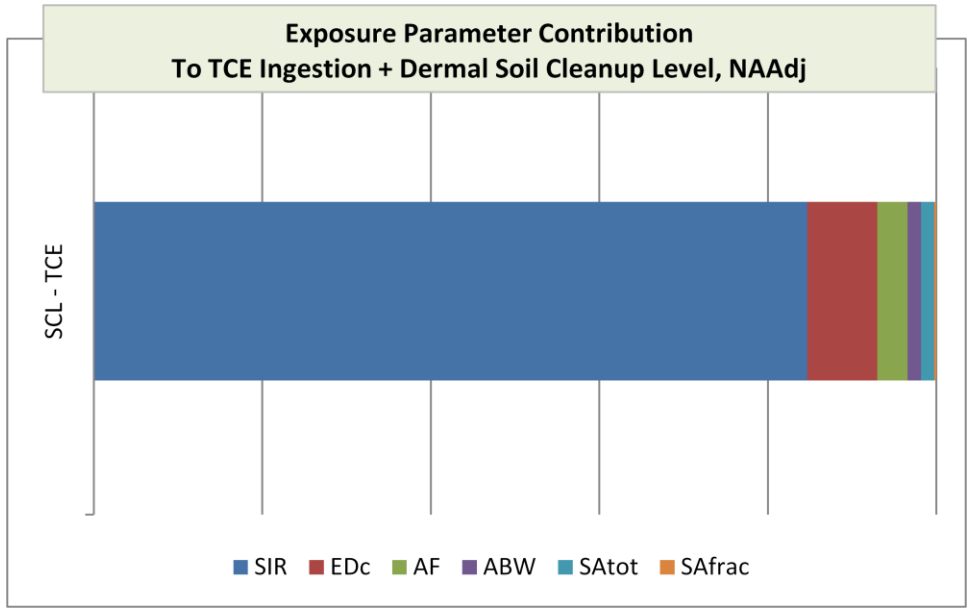
YASAI Simulation Output & % Contrib to Variance				
		SCL - Chlordane	SIR	81.69%
		SCL - Chlordane	EDc	9.23%
		SCL - Chlordane	AF	5.58%
		SCL - Chlordane	ABW	1.55%
		SCL - Chlordane	SAtot	1.55%
		SCL - Chlordane	SAfrac	0.39%



YASAI Simulation Output & % Contrib to Variance				
		SCL - Epichlorohydrin	SIR	84.64%
		SCL - Epichlorohydrin	EDc	8.32%
		SCL - Epichlorohydrin	AF	3.64%
		SCL - Epichlorohydrin	ABW	1.56%
		SCL - Epichlorohydrin	SAtot	1.56%
		SCL - Epichlorohydrin	SAfrac	0.28%



YASAI Simulation Output & % Contrib to Variance				
		SCL - TCE	SIR	84.68%
		SCL - TCE	EDc	8.31%
		SCL - TCE	AF	3.62%
		SCL - TCE	ABW	1.56%
		SCL - TCE	SAtot	1.56%
		SCL - TCE	SAfrac	0.28%


Exposure Parameter Contribution
To TCE Ingestion + Dermal Soil Cleanup Level, NAAdj
SCL - TCE
SIR
EDc
AF
ABW
SAtot
SAfrac

2-Concurrent Exposure Pathways - Not Age Adjusted - Adult Exposure
% Contribution to Variance for Soil Risk Based Cleanup Levels

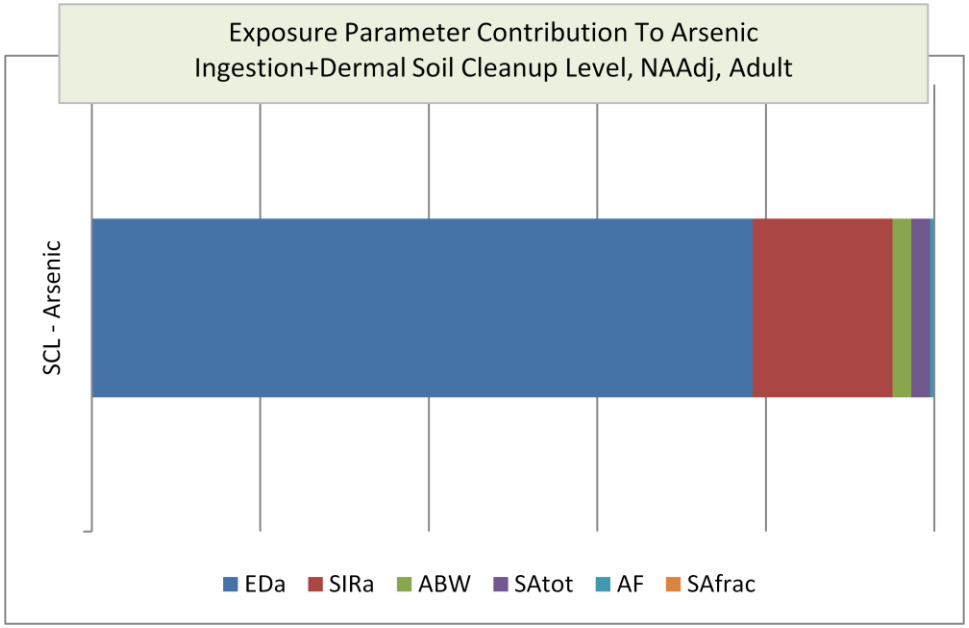
Mathematical Model

Carcinogenic Cleanup Formula Modifed for Dermal and Ingestion Pathways(WAC 173-340-740, Equation 740-5)

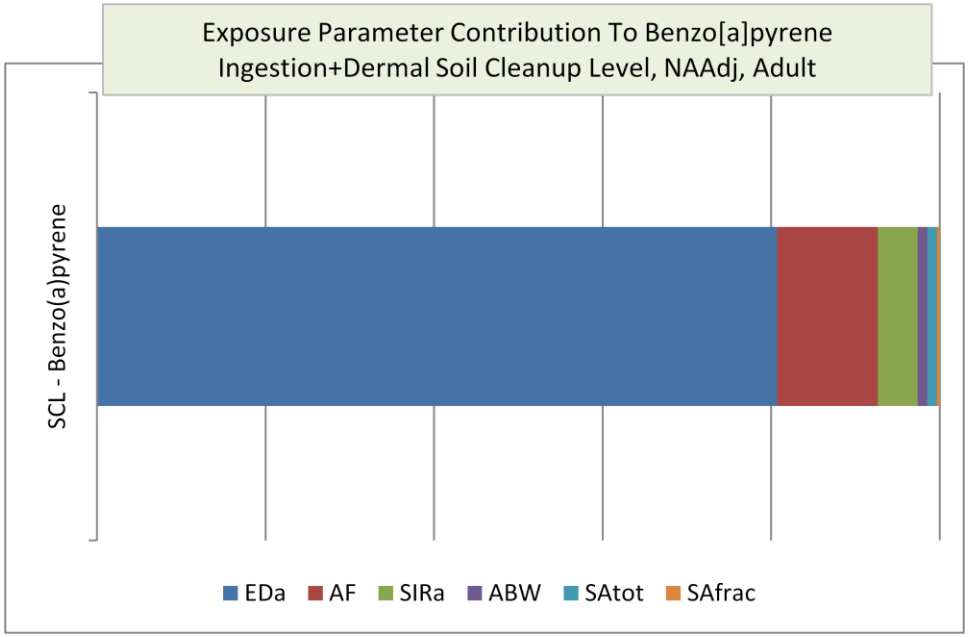
$$\text{MTCA Modified Soil Cleanup Level (mg/kg)} = A_{\text{Ingestion Component}} \frac{\text{Risk} \cdot \text{ABW} \cdot \text{AT} \cdot \text{UCF1}}{\text{EF} \cdot \text{ED} \cdot \text{SIR} \cdot \text{AB1} \cdot \text{CPFo}} \text{ plus } B_{\text{Dermal Component}} \frac{\text{Risk} \cdot \text{ABW} \cdot \text{AT} \cdot \text{UCF1}}{\text{EF} \cdot \text{ED} \cdot \text{SA} \cdot \text{AF} \cdot \text{ABS} \cdot \text{CPFd}}$$

$$= \frac{1}{\frac{1}{\text{Ingestion Component}} \text{ plus } \frac{1}{\text{Dermal Component}}}$$

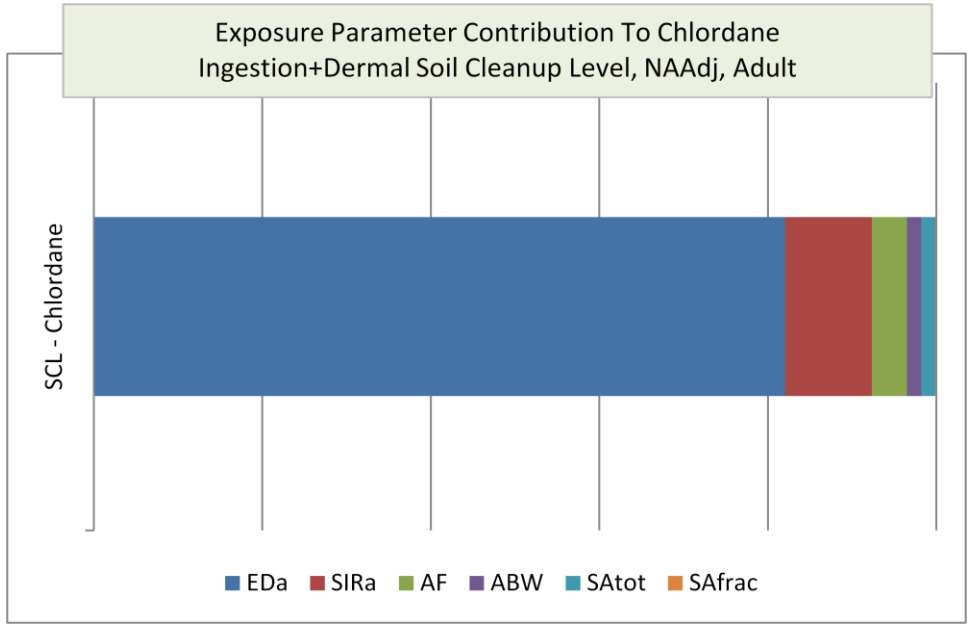
YASAI Simulation Output & % Contrib to Variance				
		SCL - Arsenic	EDa	78.41%
		SCL - Arsenic	SIRa	16.62%
		SCL - Arsenic	ABW	2.25%
		SCL - Arsenic	SAtot	2.24%
		SCL - Arsenic	AF	0.49%
		SCL - Arsenic	SAfrac	0.00%



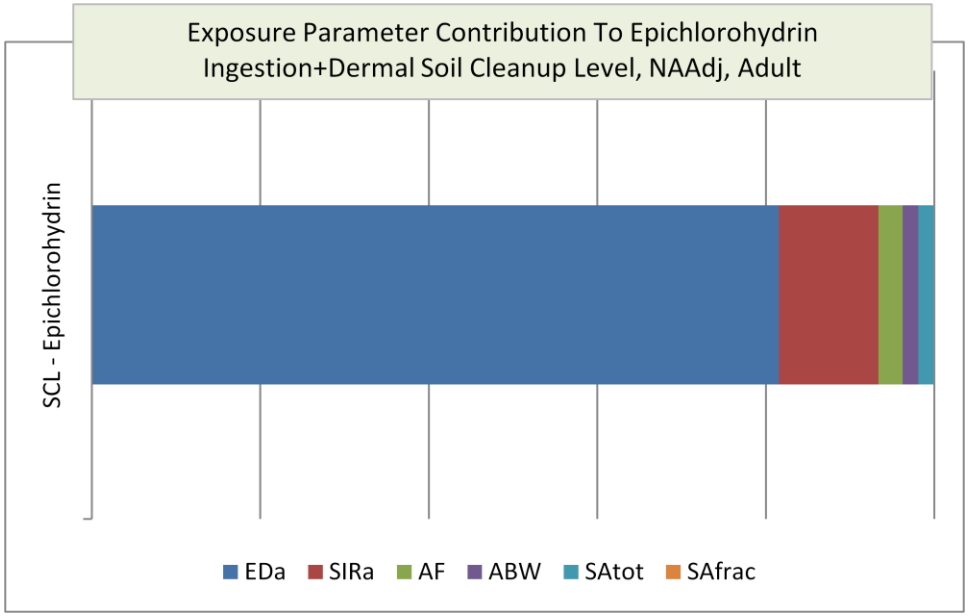
YASAI Simulation Output & % Contrib to Variance				
		SCL - Benzo(a)pyrene	EDa	80.71%
		SCL - Benzo(a)pyrene	AF	11.93%
		SCL - Benzo(a)pyrene	SIRa	4.74%
		SCL - Benzo(a)pyrene	ABW	1.14%
		SCL - Benzo(a)pyrene	SAtot	1.13%
		SCL - Benzo(a)pyrene	SAfrac	0.35%



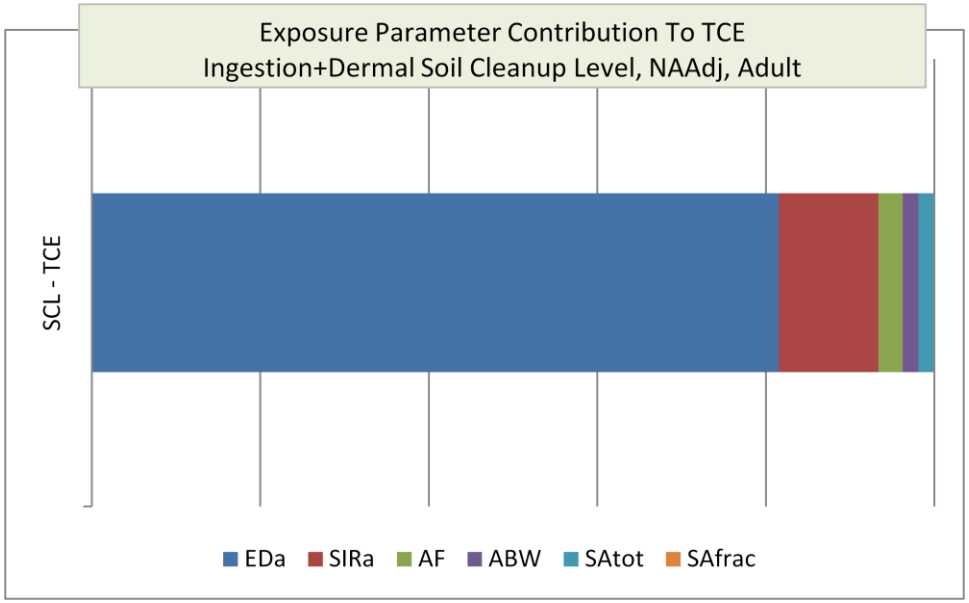
YASAI Simulation Output & % Contrib to Variance				
		SCL - Chlordane	EDa	82.06%
		SCL - Chlordane	SIRa	10.29%
		SCL - Chlordane	AF	4.15%
		SCL - Chlordane	ABW	1.72%
		SCL - Chlordane	SAtot	1.71%
		SCL - Chlordane	SAfrac	0.08%



YASAI Simulation Output & % Contrib to Variance				
		SCL - Epichlorohydrin	EDa	81.57%
		SCL - Epichlorohydrin	SIRa	11.77%
		SCL - Epichlorohydrin	AF	2.91%
		SCL - Epichlorohydrin	ABW	1.85%
		SCL - Epichlorohydrin	SAtot	1.84%
		SCL - Epichlorohydrin	SAfrac	0.05%



YASAI Simulation Output & % Contrib to Variance				
		SCL - TCE	EDa	81.56%
		SCL - TCE	SIRa	11.80%
		SCL - TCE	AF	2.90%
		SCL - TCE	ABW	1.85%
		SCL - TCE	SAtot	1.85%
		SCL - TCE	SAfrac	0.05%


Exposure Parameter Contribution To TCE
Ingestion+Dermal Soil Cleanup Level, NAAdj, Adult
SCL - TCE
EDa
SIRa
AF
ABW
SAtot
SAfrac

3-Concurrent Exposure Pathways - Not Age Adjusted - Child Exposure
% Contribution to Variance for Soil Risk Based Cleanup Levels

Mathematical Model

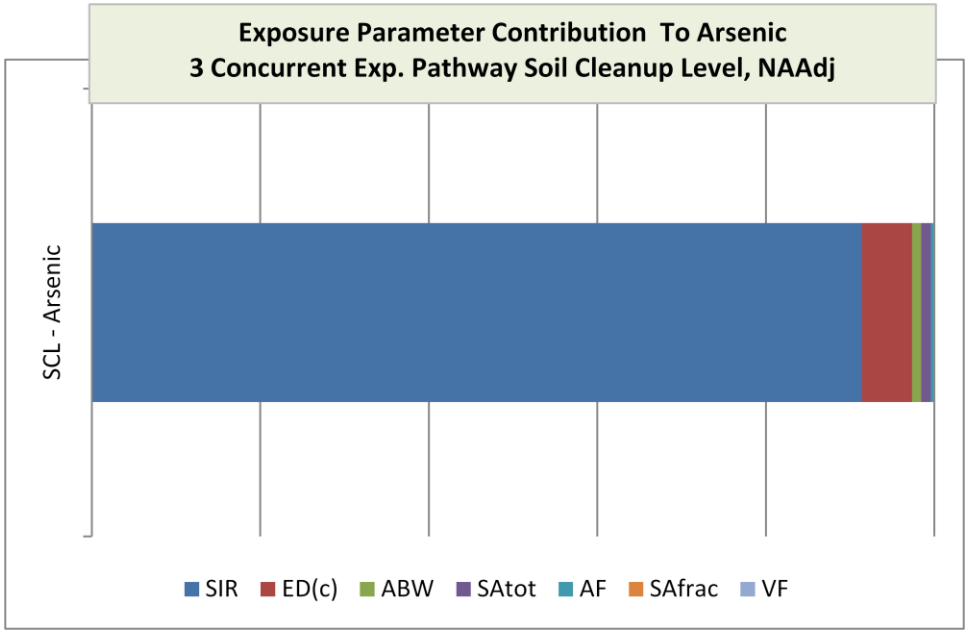
Soil Cleanup Level Equations For Ingestion, Dermal & Inhalation Exposure Pathways & Exposure Parameters, Carcinogen, NOT Age Adjusted

Ingestion Component | Dermal Component | Inhalation Component

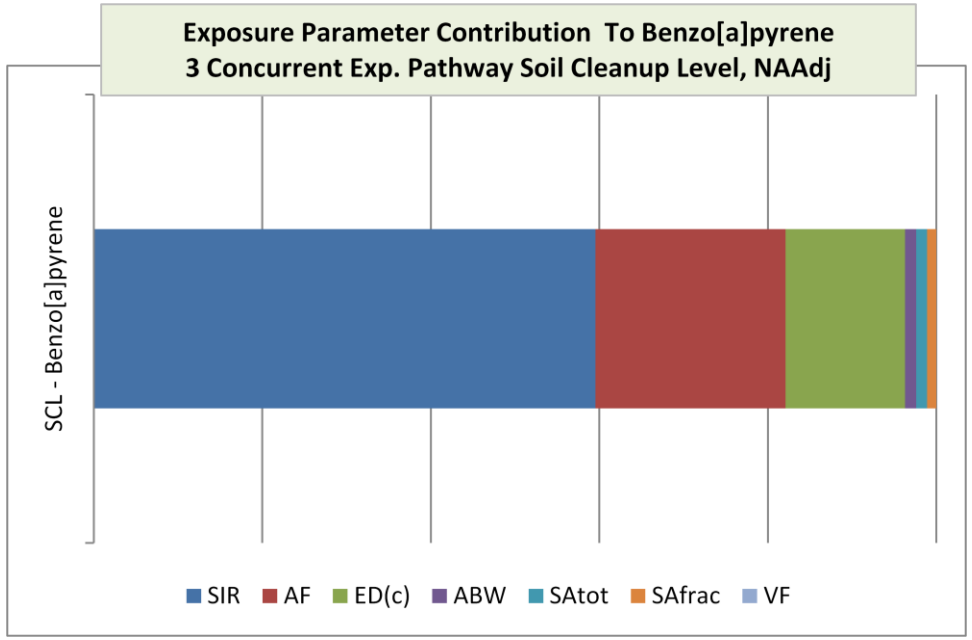
$$\text{Concurrent Soil Cleanup Level, Not Age Adjusted (mg/kg)} = \frac{\text{Risk} * \text{ABW} * \text{AT} * \text{UCF1}}{\text{EF} * \text{ED} * \text{SIR} * \text{AB1} * \text{CPFo}} \text{ plus } \frac{\text{Risk} * \text{ABW} * \text{AT} * \text{UCF1}}{\text{EF} * \text{ED} * \text{SA} * \text{AF} * \text{ABS} * \text{CPFd}} \text{ plus } \frac{\text{Risk} * \text{AT}}{\text{EF} * \text{ED} * \text{UCF2} * \text{InhUR} * [1/\text{VFs} + 1/\text{PEF}]}$$

$$\text{Concurrent Soil Cleanup Level, Not Age Adjusted (mg/kg)} = \frac{1}{\frac{1}{\text{Ingestion Component}} \text{ plus } \frac{1}{\text{Dermal Component}} \text{ plus } \frac{1}{\text{Inhalation Component}}}$$

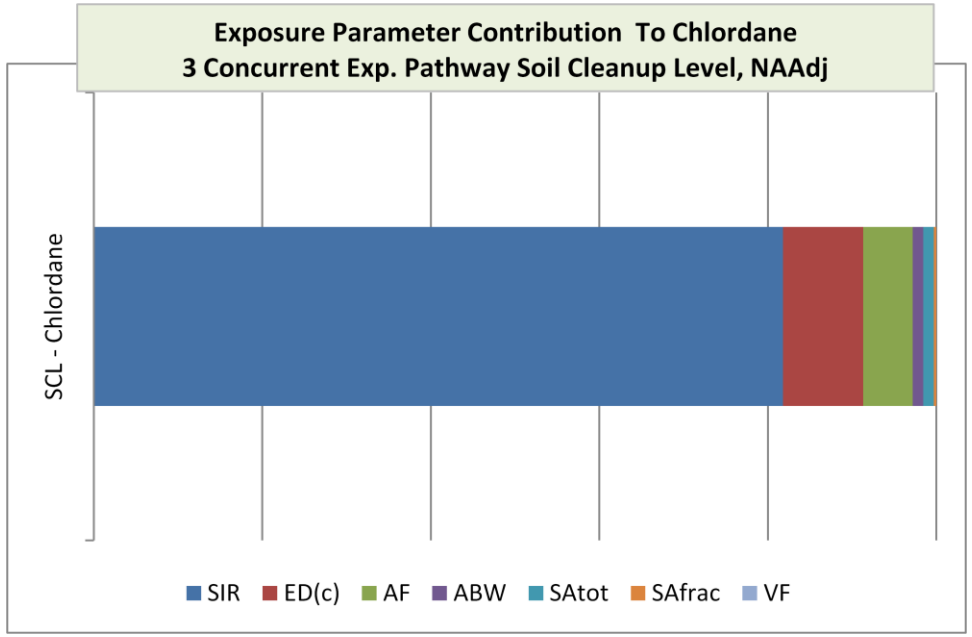
YASAI Simulation Output & % Contrib to Variance				
		SCL - Arsenic	SIR	91.39%
		SCL - Arsenic	ED(c)	5.95%
		SCL - Arsenic	ABW	1.12%
		SCL - Arsenic	SAtot	1.11%
		SCL - Arsenic	AF	0.38%
		SCL - Arsenic	SAfrac	0.03%
		SCL - Arsenic	VF	0.00%



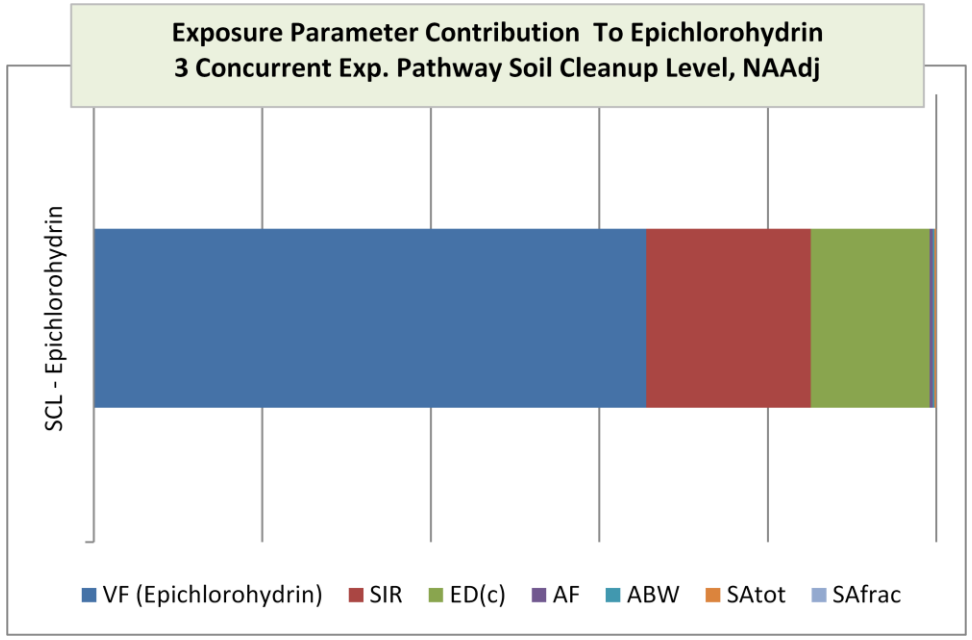
YASAI Simulation Output & % Contrib to Variance				
		SCL - Benzo[a]pyrene	SIR	59.53%
		SCL - Benzo[a]pyrene	AF	22.56%
		SCL - Benzo[a]pyrene	ED(c)	14.20%
		SCL - Benzo[a]pyrene	ABW	1.31%
		SCL - Benzo[a]pyrene	SAtot	1.30%
		SCL - Benzo[a]pyrene	SAfrac	1.10%
		SCL - Benzo[a]pyrene	VF	0.00%



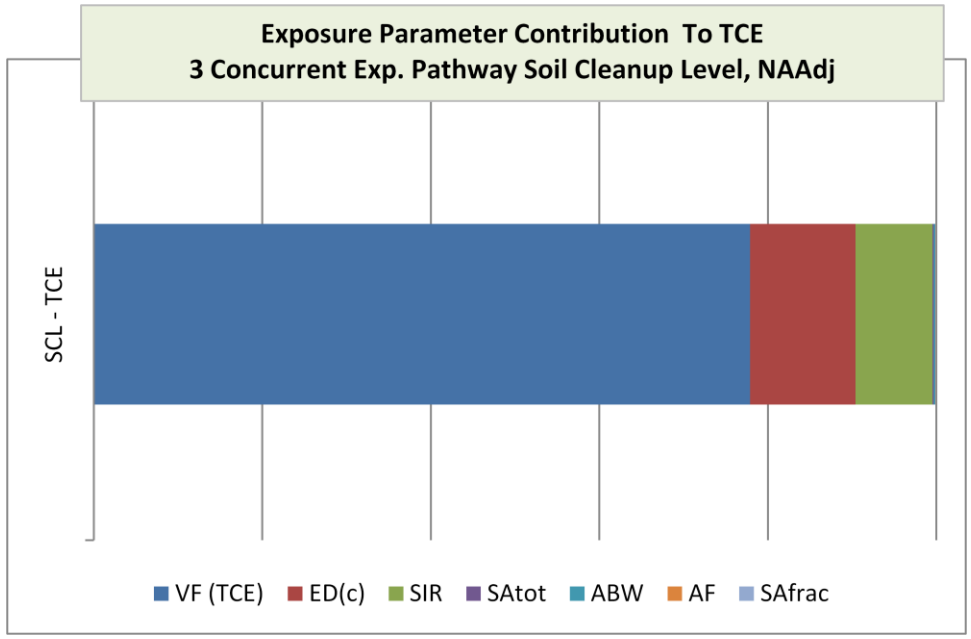
YASAI Simulation Output & % Contrib to Variance				
		SCL - Chlordane	SIR	81.80%
		SCL - Chlordane	ED(c)	9.52%
		SCL - Chlordane	AF	5.86%
		SCL - Chlordane	ABW	1.25%
		SCL - Chlordane	SAtot	1.25%
		SCL - Chlordane	SAfrac	0.31%
		SCL - Chlordane	VF	0.00%



YASAI Simulation Output & % Contrib to Variance				
		SCL - Epichlorohydrin	VF (Epichl	65.56%
		SCL - Epichlorohydrin	SIR	19.52%
		SCL - Epichlorohydrin	ED(c)	14.12%
		SCL - Epichlorohydrin	AF	0.37%
		SCL - Epichlorohydrin	ABW	0.21%
		SCL - Epichlorohydrin	SAtot	0.20%
		SCL - Epichlorohydrin	SAfrac	0.02%

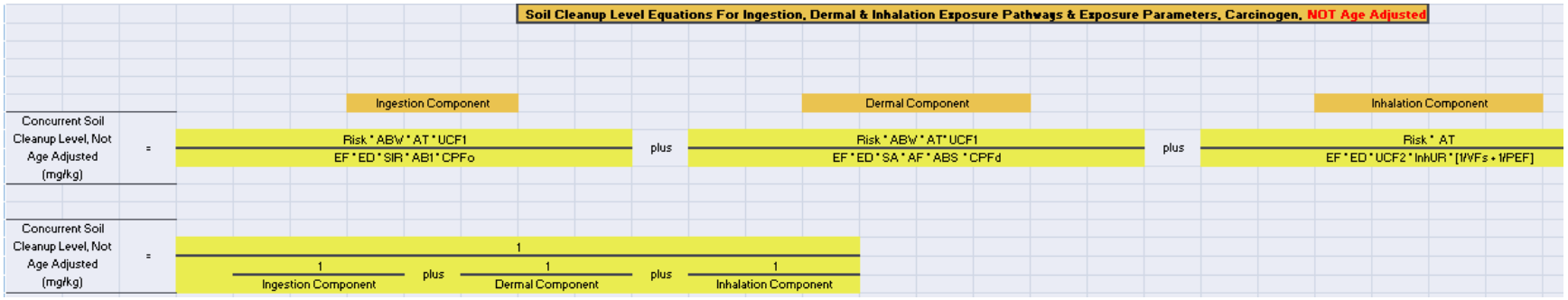


YASAI Simulation Output & % Contrib to Variance				
		SCL - TCE	VF (TCE)	77.90%
		SCL - TCE	ED(c)	12.52%
		SCL - TCE	SIR	9.13%
		SCL - TCE	SAtot	0.17%
		SCL - TCE	ABW	0.17%
		SCL - TCE	AF	0.05%
		SCL - TCE	SAfrac	0.05%

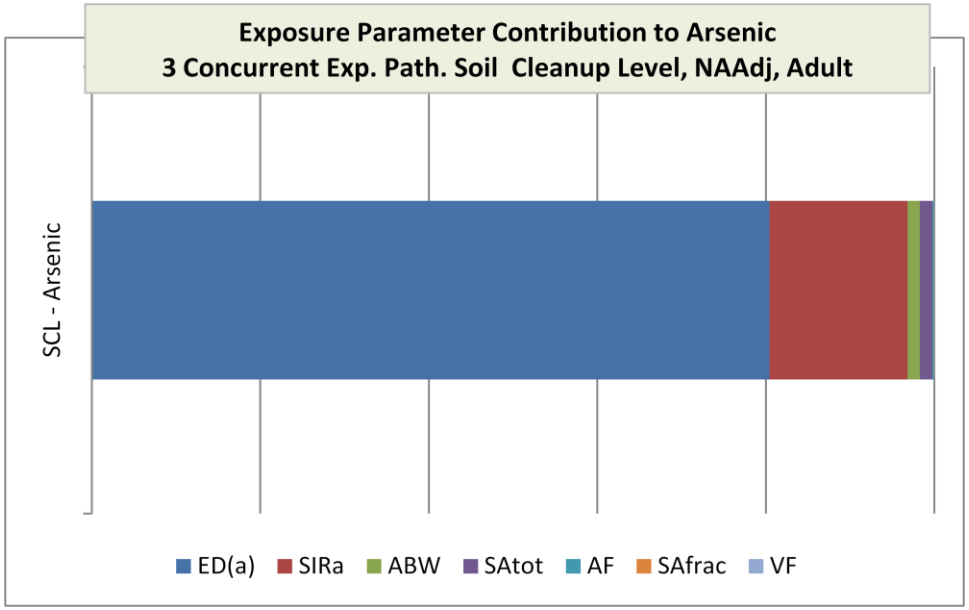


3-Concurrent Exposure Pathways - Not Age Adjusted - Adult Exposure
% Contribution to Variance for Soil Risk Based Cleanup Levels

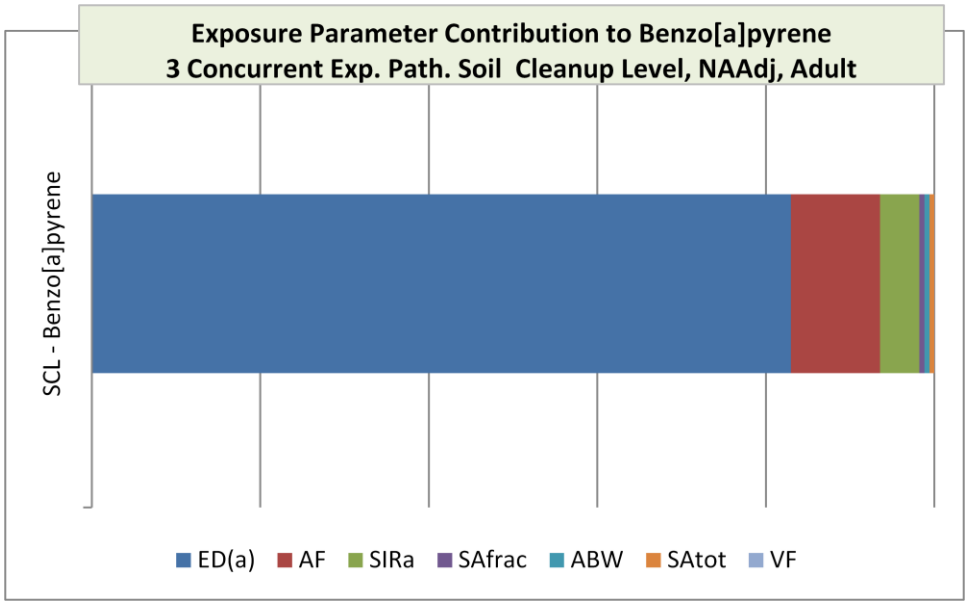
Mathematical Model



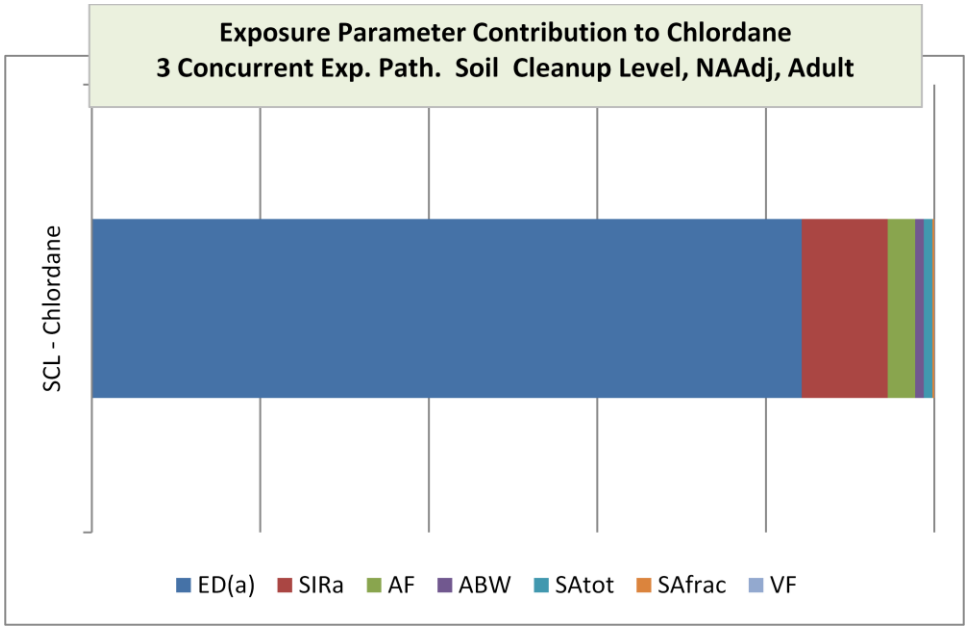
YASAI Simulation Output & % Contrib to Variance			
	SCL - Arsenic	ED(a)	80.42%
	SCL - Arsenic	SIRa	16.39%
	SCL - Arsenic	ABW	1.49%
	SCL - Arsenic	SAtot	1.48%
	SCL - Arsenic	AF	0.20%
	SCL - Arsenic	SAfrac	0.03%
	SCL - Arsenic	VF	0.00%



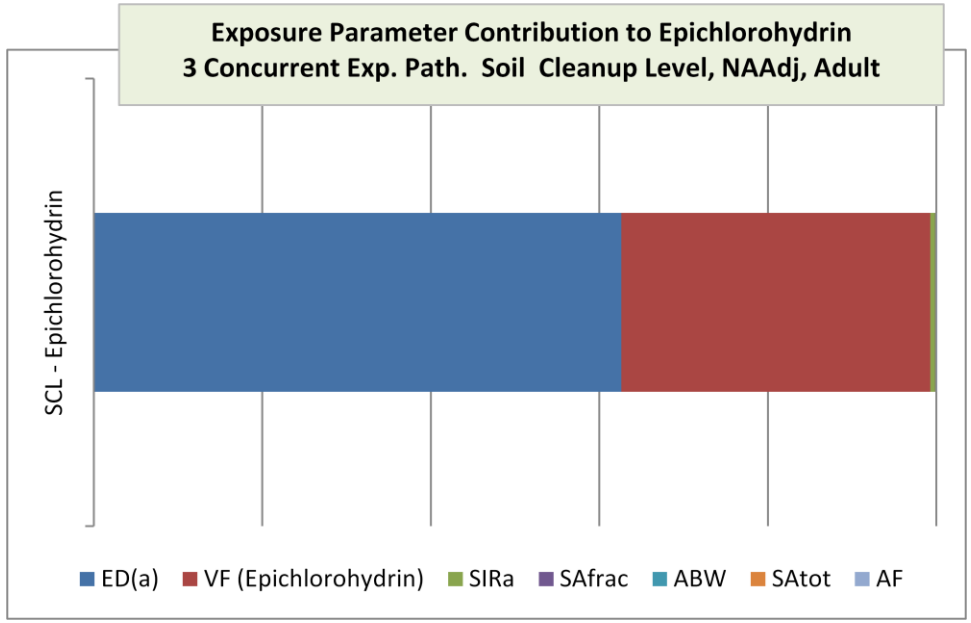
YASAI Simulation Output & % Contrib to Variance				
		SCL - Benzo[a]pyrene	ED(a)	82.97%
		SCL - Benzo[a]pyrene	AF	10.58%
		SCL - Benzo[a]pyrene	SIRa	4.65%
		SCL - Benzo[a]pyrene	SAfrac	0.63%
		SCL - Benzo[a]pyrene	ABW	0.59%
		SCL - Benzo[a]pyrene	SAtot	0.58%
		SCL - Benzo[a]pyrene	VF	0.00%



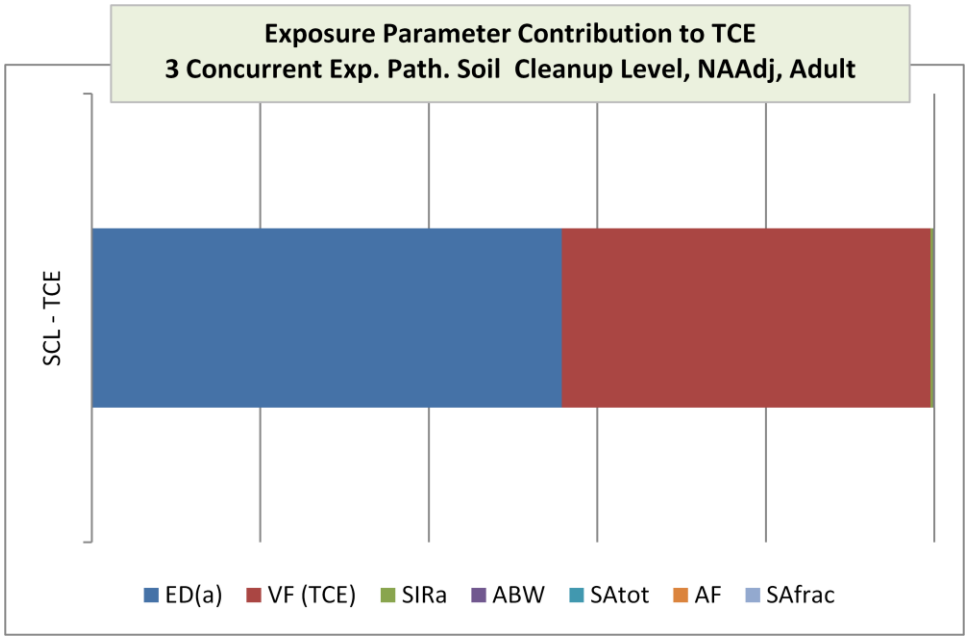
YASAI Simulation Output & % Contrib to Variance				
		SCL - Chlordane	ED(a)	84.25%
		SCL - Chlordane	SIRa	10.21%
		SCL - Chlordane	AF	3.24%
		SCL - Chlordane	ABW	1.03%
		SCL - Chlordane	SAtot	1.02%
		SCL - Chlordane	SAfrac	0.23%
		SCL - Chlordane	VF	0.00%



YASAI Simulation Output & % Contrib to Variance				
		SCL - Epichlorohydrin	ED(a)	62.61%
		SCL - Epichlorohydrin	VF (Epichl	36.66%
		SCL - Epichlorohydrin	SIRa	0.58%
		SCL - Epichlorohydrin	SAfrac	0.05%
		SCL - Epichlorohydrin	ABW	0.04%
		SCL - Epichlorohydrin	SAtot	0.04%
		SCL - Epichlorohydrin	AF	0.03%



YASAI Simulation Output & % Contrib to Variance			
	SCL - TCE	ED(a)	55.80%
	SCL - TCE	VF (TCE)	43.74%
	SCL - TCE	SIRa	0.33%
	SCL - TCE	ABW	0.05%
	SCL - TCE	SAtot	0.05%
	SCL - TCE	AF	0.04%
	SCL - TCE	SAfrac	0.00%

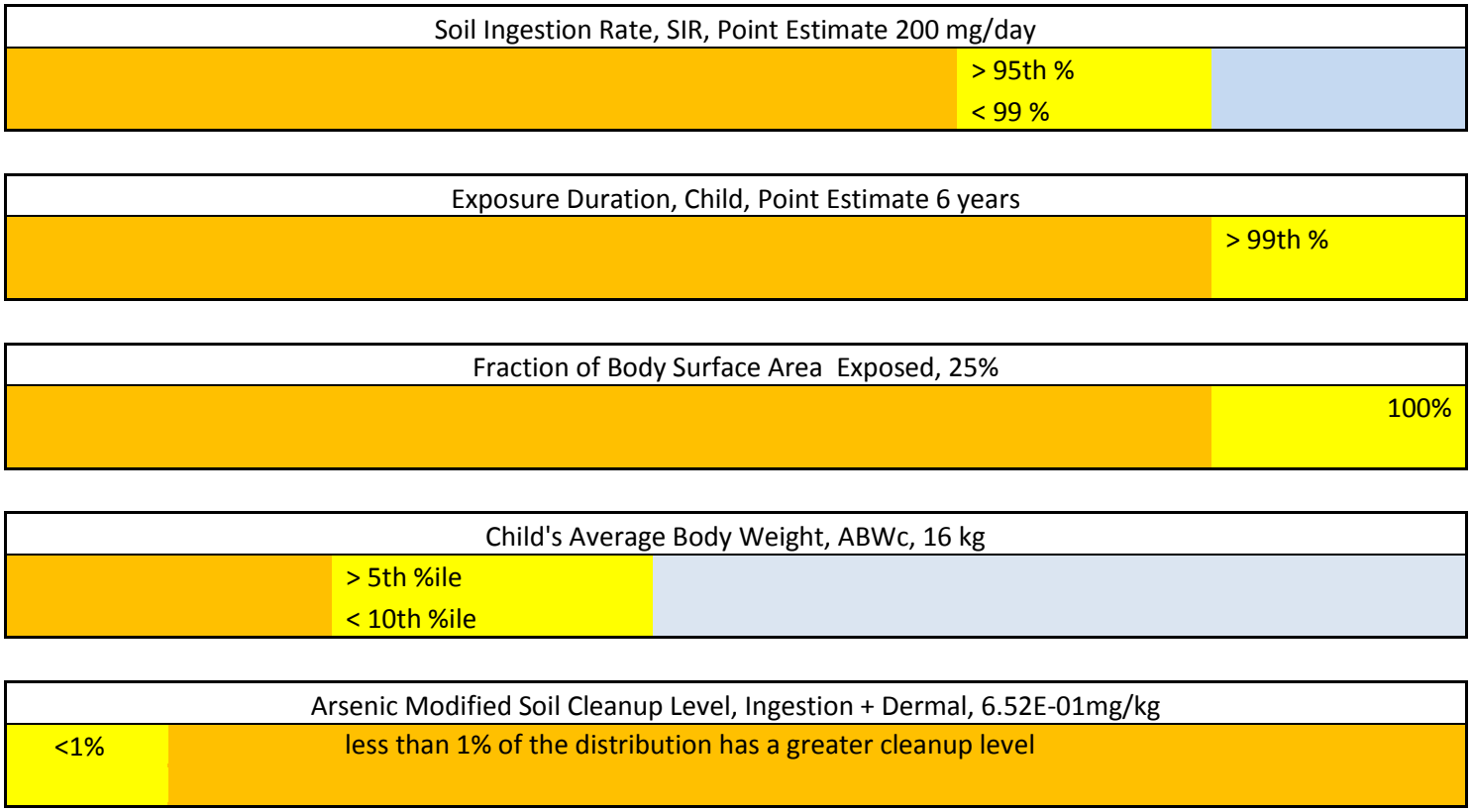


Appendix F: Percentiles for Exposure Assumptions

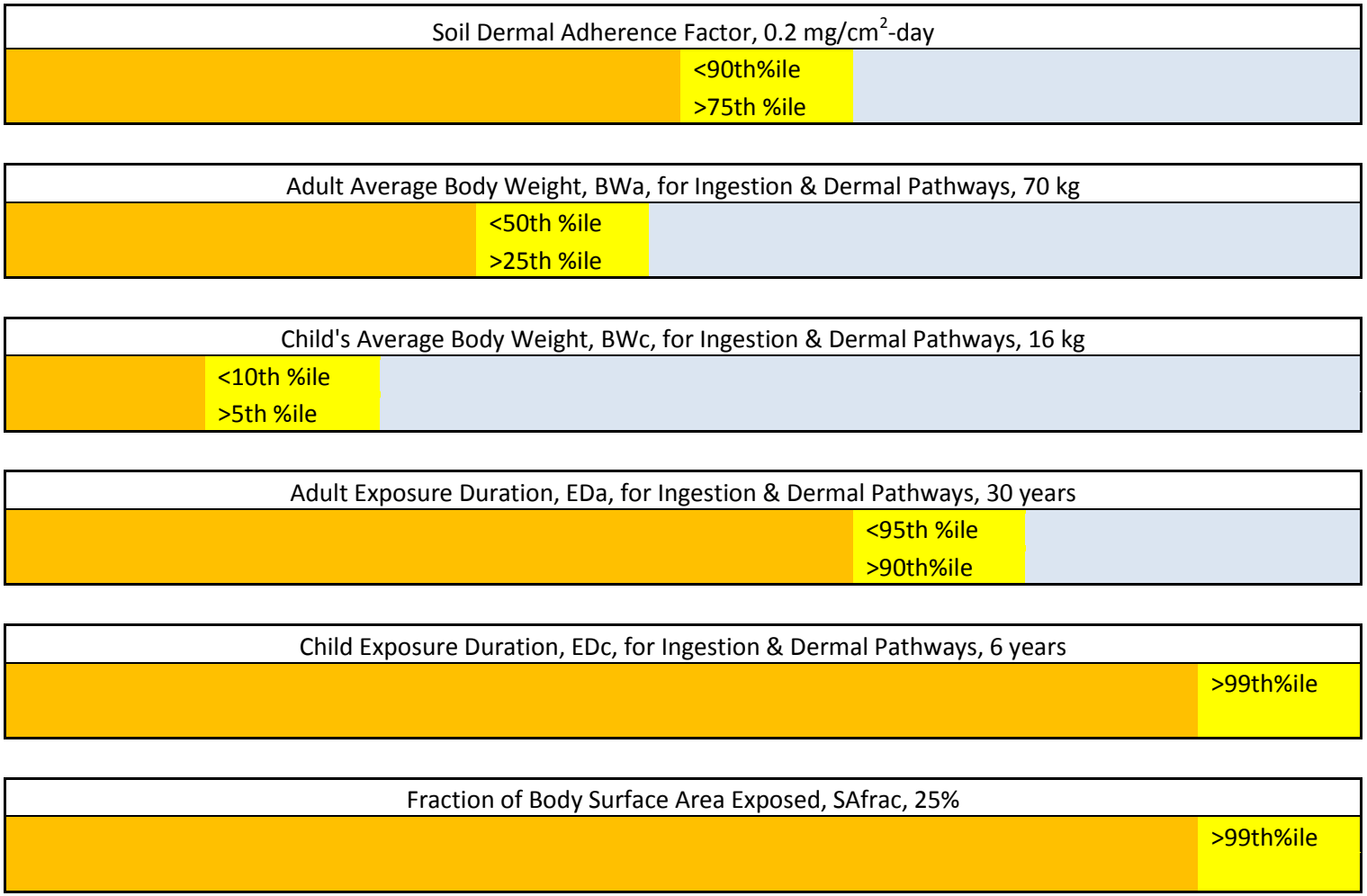
2-Concurrent Exposure Pathways - Not Age Adjusted - Child Exposure
Percentiles for Exposure Assumptions

YASAIw Simulation Output	
Workbool	Soil Concurrent Ing+D NAAdj YASAI (10K Simulations)Correlated BW-SA (PERT-beta)20090520 (gp).xlsx
Start Date	5/26/2009
Somulatic	10000

Output Name		Mean	Standard Deviation	Percentiles 0%	1%	5%	10%	25%	50%	75%	90%	95%	99%	100%
ABW		19.824	2.865	15.200	15.200	15.228	16.147	17.673	19.577	21.672	23.695	25.143	27.100	27.100
AF		0.137	0.103	0.009	0.021	0.035	0.044	0.068	0.110	0.174	0.263	0.337	0.521	1.123
EDc		3.488	0.949	1.065	1.535	1.934	2.210	2.783	3.485	4.201	4.755	5.046	5.481	5.905
SAfrac		0.192	0.027	0.106	0.128	0.143	0.153	0.172	0.193	0.213	0.227	0.234	0.242	0.250
SAtot		7332.987	768.354	5960.565	6000.408	6150.914	6361.469	6726.685	7280.114	7850.442	8407.498	8771.179	9050.571	9099.826
SCL - Arse	6.52E-01 mg/kg	20.243	25.480	0.227	0.715	1.674	2.598	5.391	12.296	24.899	46.319	66.458	121.706	439.400
SCL - Benz	1.04E-01 mg/kg	1.507	1.321	0.045	0.137	0.282	0.396	0.666	1.153	1.920	2.975	3.945	6.279	25.543
SCL - Chlo	2.75E+00 mg/kg	53.247	53.069	0.962	2.979	6.808	10.283	19.836	38.262	68.722	111.689	152.056	250.385	989.429
SCL - Epich	9.33E+01 mg/kg	2108.967	2189.300	34.136	105.735	244.499	373.035	734.185	1479.167	2696.261	4518.510	6179.429	10336.269	39366.712
SCL - TCE	1.04E+01 mg/kg	234.970	244.071	3.797	11.763	27.198	41.503	81.737	164.740	300.327	503.496	688.119	1150.203	4386.046
SIR		45.391	72.899	0.225	1.359	3.124	4.859	9.918	22.118	49.871	105.334	161.788	364.175	955.385


Soil Ingestion Rate, SIR, Point Estimate 200 mg/day
> 95th %
< 99 %
Exposure Duration, Child, Point Estimate 6 years
> 99th %
Fraction of Body Surface Area Exposed, 25%
100%
Child's Average Body Weight, ABWc, 16 kg
> 5th %ile
< 10th %ile
Arsenic Modified Soil Cleanup Level, Ingestion + Dermal, 6.52E-01mg/kg
<1%
less than 1% of the distribution has a greater cleanup level

Age Adjusted 2-Concurrent Exposure Pathways Percentiles for Exposure Assumptions														
YASAIw Simulation Output														
Workbook	Soil Concurrent Ing + D Age Adjusted YASAI (10K Simulations) Correlated BW-SA (PERT-beta)20090521.xlsx													
Start Date	5/26/2009													
Assimilations	10000													
				Percentiles										
Output Name		**Mean**	**Standard Deviation**	**0%**	**1%**	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**	**100%**
AFa		0.140	0.112	0.009	0.023	0.035	0.045	0.068	0.110	0.177	0.264	0.345	0.565	1.787
AFc		0.141	0.112	0.007	0.021	0.034	0.044	0.068	0.109	0.178	0.270	0.349	0.582	1.602
BWa(D)		73.195	12.031	45.940	49.509	55.026	58.413	64.559	72.335	80.653	89.094	94.661	105.916	119.740
BWa(Ing)		73.336	11.804	46.226	50.682	55.395	58.832	64.945	72.277	80.776	88.963	94.320	104.845	119.544
BWc(D)		19.827	2.834	15.200	15.200	15.240	16.175	17.767	19.565	21.664	23.740	25.020	27.100	27.100
BWc(Ing)		19.916	2.620	15.205	15.356	15.978	16.585	17.910	19.716	21.692	23.547	24.764	26.320	27.079
EDa(D)		12.168	12.469	1.002	1.191	1.790	2.395	4.149	7.979	15.353	27.027	37.427	63.454	86.971
EDa(Ing)		11.850	12.213	1.010	1.169	1.733	2.373	4.180	7.744	14.703	26.198	36.893	63.420	86.926
EDc(D)		3.505	0.959	1.117	1.509	1.923	2.204	2.785	3.512	4.240	4.786	5.062	5.490	5.869
EDc(Ing)		3.497	0.938	1.152	1.530	1.966	2.254	2.801	3.487	4.201	4.767	5.024	5.464	5.796
SAfrac(a)		0.192	0.028	0.110	0.127	0.144	0.154	0.172	0.193	0.213	0.227	0.234	0.243	0.250
SAfrac(c)		0.192	0.028	0.106	0.127	0.144	0.154	0.172	0.194	0.213	0.227	0.234	0.242	0.250
SAtot(a)		18400.367	2139.260	15000.000	15000.000	15000.000	15508.086	16744.453	18270.386	19860.774	21435.888	22455.666	23000.000	23000.000
SAtot(c)		7334.503	761.247	5960.583	5998.709	6152.951	6366.790	6751.644	7276.563	7848.492	8418.534	8748.346	9027.372	9099.774
SCL - Arsenic		7.636	9.271	0.221	0.595	1.054	1.471	2.582	4.774	9.125	16.369	23.152	44.306	177.200
SCL - Benzo(a)pyrene		0.618	0.525	0.026	0.083	0.140	0.181	0.289	0.474	0.772	1.224	1.590	2.584	7.548
SCL - Chlordane		20.847	19.754	0.933	2.427	3.963	5.407	8.835	15.123	25.871	42.400	56.464	94.034	308.373
SCL - Epichlorohydrin		817.521	806.820	33.142	88.045	148.255	201.211	333.548	584.950	1008.605	1679.486	2262.071	3867.766	13418.964
SCL - TCE		91.071	89.936	3.687	9.795	16.492	22.400	37.143	65.119	112.396	186.995	251.883	431.691	1497.103
SIRa		57.952	26.917	19.003	19.999	23.641	27.145	36.471	52.472	74.218	99.261	112.528	126.747	132.951
SIRc		43.124	67.811	0.364	1.379	3.123	4.752	9.846	21.523	48.559	96.639	154.661	346.362	986.698

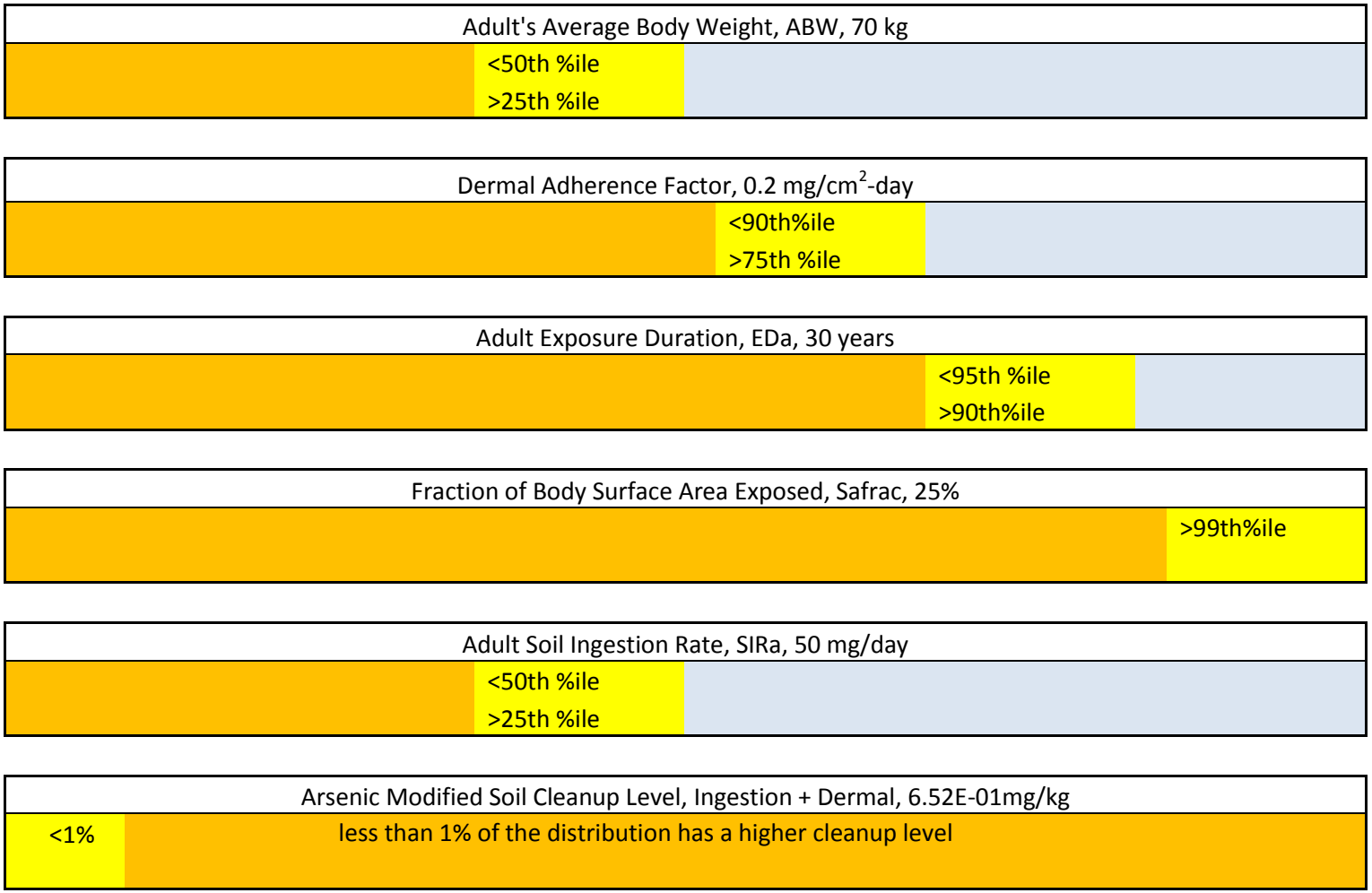

Soil Dermal Adherence Factor, 0.2 mg/cm2-day
<90th%ile
>75th %ile
Adult Average Body Weight, BWa, for Ingestion & Dermal Pathways, 70 kg
<50th %ile
>25th %ile
Child's Average Body Weight, BWc, for Ingestion & Dermal Pathways, 16 kg
<10th %ile
>5th %ile
Adult Exposure Duration, EDa, for Ingestion & Dermal Pathways, 30 years
<95th %ile
>90th%ile
Child Exposure Duration, EDc, for Ingestion & Dermal Pathways, 6 years
>99th%ile
Fraction of Body Surface Area Exposed, SAfrac, 25%
>99th%ile

Adult Soil Ingestion Rate, SIRa, 50 mg/day		
	<50th %ile >25th %ile	

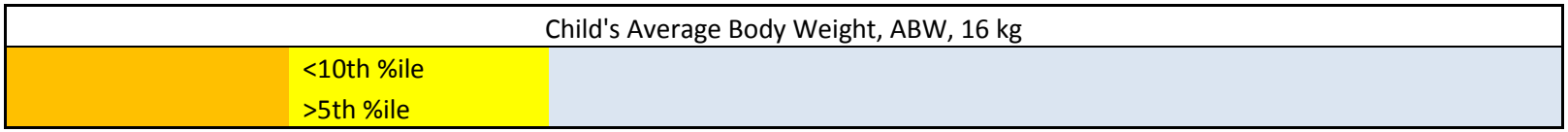
Child's Soil Ingestion Rate, SIRa,200 mg/day		
	< 99th%ile >95th%ile	

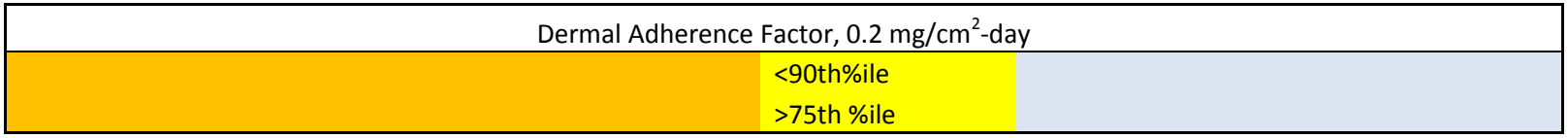
Arsenic Modified Soil Cleanup Level, Ingestion + Dermal, 6.52E-01mg/kg	
<5%	less than 5% of the distribution has a higher cleanup level

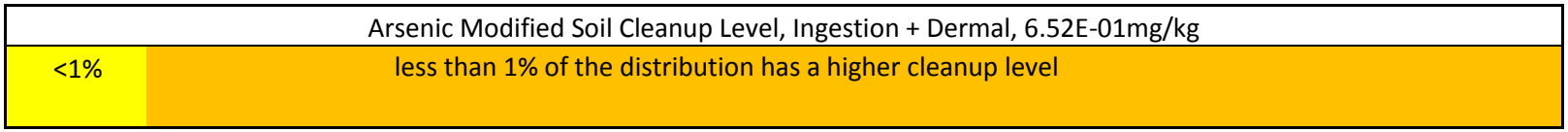
2-Concurrent Exposure Pathways - Not Age Adjusted - Adult Exposure Percentiles for Exposure Assumptions													
YASAIw Simulation Output													
Workbook	Soil Concurrent Ing+D NAAdj YASAI (10K Simulations)Correlated BW-SA (PERT-beta) ADULT 20090525 (gp).xlsx												
Start Date	5/27/2009												
Simulations:	10000												
				Percentiles									
Output Name		**Mean**	**Standard Deviation**	**0%**	**1%**	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**	**100%**
ABW		73.026	11.989	45.940	49.293	54.888	58.479	64.392	72.081	80.439	88.787	94.507	105.675	119.740
AF		0.139	0.109	0.010	0.021	0.035	0.045	0.069	0.110	0.175	0.264	0.337	0.548	1.507
EDa		11.849	11.950	1.000	1.181	1.744	2.362	4.170	7.865	14.901	26.590	36.398	60.322	86.458
SAfrac		0.192	0.027	0.108	0.127	0.143	0.154	0.173	0.194	0.213	0.227	0.234	0.242	0.249
SAtot		18370.310	2132.333	15000.000	15000.000	15000.000	15521.426	16711.202	18221.089	19820.215	21379.356	22427.635	23000.000	23000.000
SCL - Arsenic		13.309	15.408	0.334	0.793	1.446	2.061	3.958	8.083	16.400	31.070	43.427	78.114	157.604
SCL - Benzo(a)pyrene		1.335	1.557	0.027	0.080	0.145	0.209	0.400	0.811	1.664	3.047	4.279	7.819	18.398
SCL - Chlordane		42.351	48.260	1.105	2.663	4.781	6.837	12.993	25.918	52.753	96.875	134.576	247.131	494.493
SCL - Epichlorohydrin		1620.340	1846.299	44.684	102.396	181.049	260.088	495.642	994.559	2013.986	3724.699	5181.092	9402.019	18163.677
SCL - TCE		180.435	205.600	4.974	11.397	20.158	28.968	55.205	110.733	224.236	414.669	577.514	1046.948	2021.464
SIRa		57.159	26.817	19.003	20.008	23.512	26.918	35.726	51.365	73.529	97.817	110.799	127.731	132.995

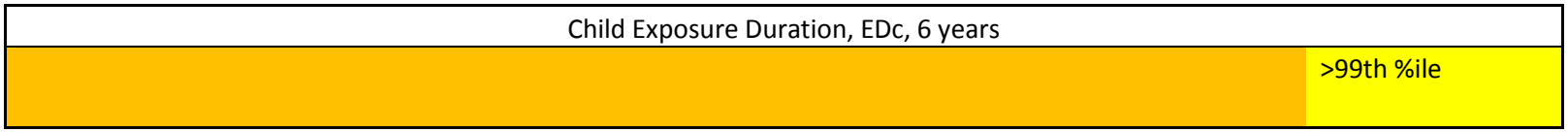

Adult's Average Body Weight, ABW, 70 kg
<50th %ile
>25th %ile
Dermal Adherence Factor, 0.2 mg/cm2-day
<90th%ile
>75th %ile
Adult Exposure Duration, EDa, 30 years
<95th %ile
>90th%ile
Fraction of Body Surface Area Exposed, Safrac, 25%
>99th%ile
Adult Soil Ingestion Rate, SIRa, 50 mg/day
<50th %ile
>25th %ile
Arsenic Modified Soil Cleanup Level, Ingestion + Dermal, 6.52E-01mg/kg
<1%
less than 1% of the distribution has a higher cleanup level

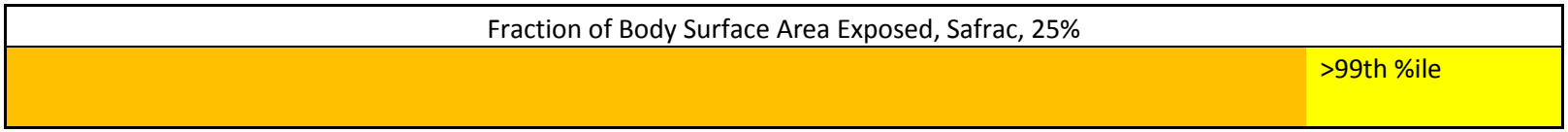
3-Concurrent Exposure Pathways - Not Age Adjusted - Child Exposure Percentiles for Exposure Assumptions														
YASAIw Simulation Outp														
Workbook	Soil Concurrent Ing+D+Inh NAAdj YASAI (10K sim) correlated BW-SA-GP_ (PERT-beta)20090520.xlsx													
Start Date	May 26,'09													
Simulations:	10000													
				Percentiles										
Output Name		**Mean**	**Standard Deviation**	**0%**	**1%**	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**	**100%**
ABW		19.831	2.840	15.200	15.200	15.292	16.147	17.720	19.589	21.678	23.703	25.010	27.100	27.100
AF		0.141	0.110	0.009	0.023	0.036	0.046	0.069	0.110	0.177	0.270	0.348	0.551	1.807
ED(c)		3.499	0.953	1.129	1.536	1.954	2.212	2.782	3.506	4.205	4.781	5.056	5.489	5.952
SAfrac		0.192	0.028	0.106	0.127	0.144	0.154	0.173	0.194	0.213	0.227	0.233	0.242	0.249
SAtot		7336.850	763.717	5960.049	6004.313	6162.294	6361.439	6739.205	7283.962	7852.404	8409.445	8746.370	9030.030	9098.880
SCL - Arsenic		20.583	25.621	0.241	0.771	1.744	2.697	5.680	12.255	25.357	47.779	68.257	123.086	379.343
SCL - Benzo[a]pyrene		1.501	1.284	0.049	0.145	0.293	0.400	0.669	1.157	1.915	2.955	3.916	6.258	25.318
SCL - Chlordane		53.505	52.434	1.028	3.242	7.117	10.551	20.221	38.191	68.448	113.046	151.399	248.211	1020.033
SCL - Epichlorohydrin		589.492	616.613	27.792	87.211	131.495	160.000	232.287	388.835	710.019	1231.418	1693.747	3135.917	7452.879
SCL - TCE		46.040	53.942	3.201	6.716	9.009	10.923	16.152	28.237	54.536	98.087	139.763	272.277	809.450
SIR		43.179	67.132	0.285	1.292	2.947	4.582	9.594	21.510	47.955	100.962	155.777	344.439	827.911
VF (Epichlorohydrin)		94569.370	195842.814	9501.304	9829.653	10850.655	12296.103	18300.398	35803.618	87774.569	208662.932	365923.629	930543.206	2882326.358
VF (TCE)		96675.188	210309.445	9503.358	9763.065	10800.084	12167.619	18152.208	35884.794	85490.632	203987.713	357593.506	1144981.542	2837241.233

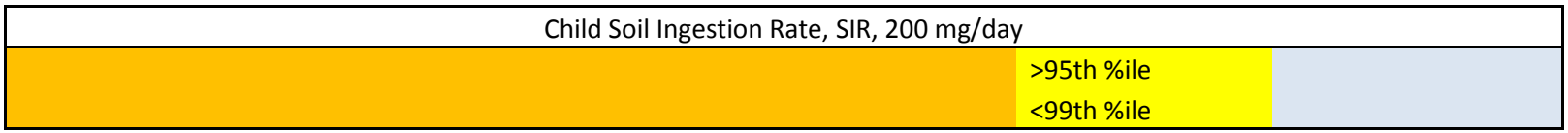

Child's Average Body Weight, ABW, 16 kg
<10th %ile
>5th %ile


Dermal Adherence Factor, 0.2 mg/cm2-day
<90th%ile
>75th %ile

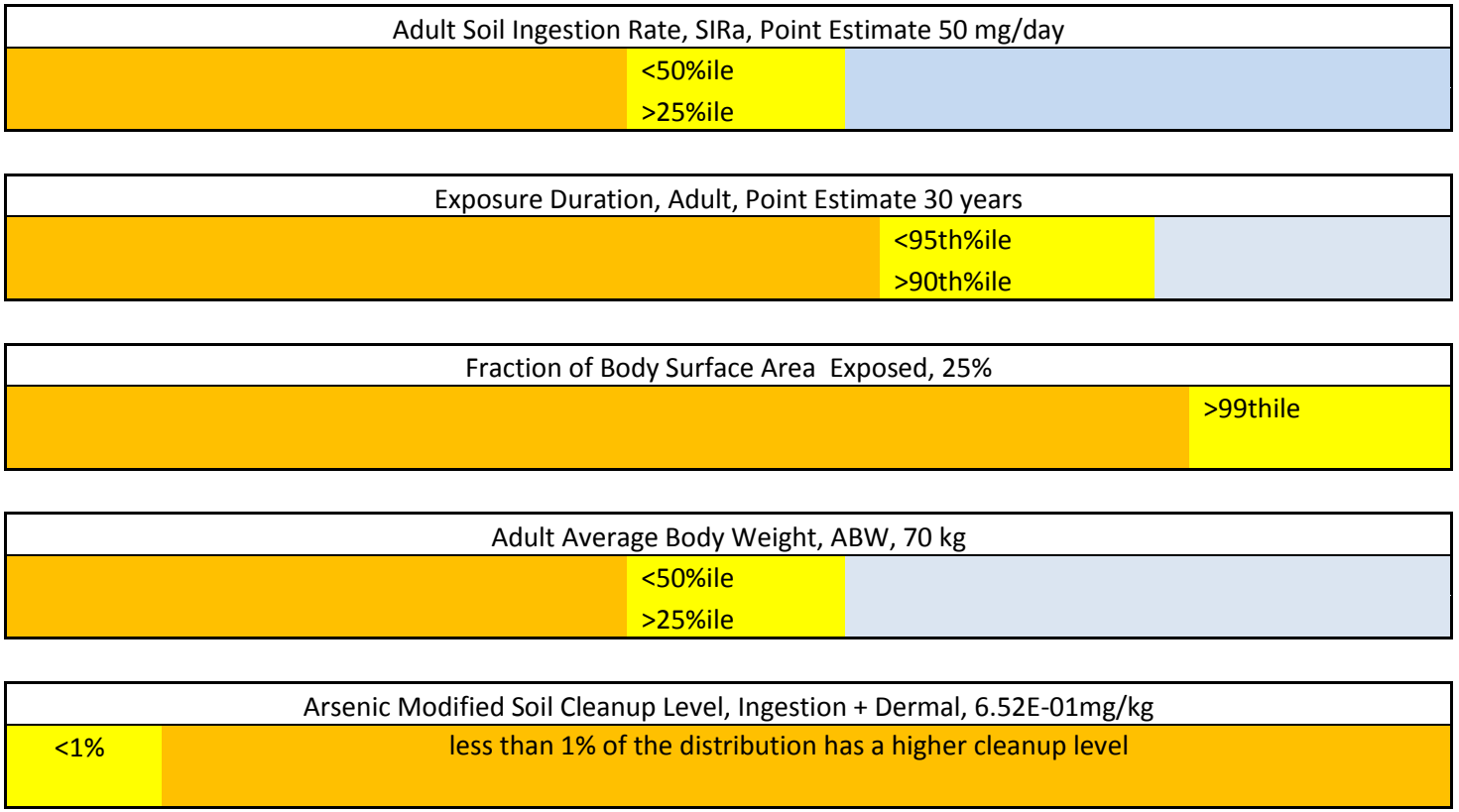

Arsenic Modified Soil Cleanup Level, Ingestion + Dermal, 6.52E-01mg/kg
<1%
less than 1% of the distribution has a higher cleanup level


Child Exposure Duration, EDc, 6 years
>99th %ile


Fraction of Body Surface Area Exposed, Safrac, 25%
>99th %ile


Child Soil Ingestion Rate, SIR, 200 mg/day
>95th %ile
<99th %ile

3-Concurrent Exposure Pathways - Not Age Adjusted - Adult Exposure Percentiles for Exposure Assumptions														
YASAIw Simulation Output														
Workbook	Soil Concurrent Ing+D+Inh NAAdj YASAI (10K sim) correlated BW-SA-GP_ (PERT-beta) ADULT 20090525 (gp).xlsx													
Date: May 25, 2009														
Simulations:	10000													
				Percentiles										
Output Name		Mean	StandardDeviation	0	0.01	0.05	0.1	0.25	0.5	0.75	0.9	0.95	0.99	1
ABW		73.07138	11.82111854	45.94	49.4895	55.47215	58.77955	64.78604	72.12964	80.17116	88.61122	94.2455	105.4788	119.74
AF		0.138886	0.108259196	0.008943	0.022227	0.03441	0.044783	0.067903	0.108793	0.175269	0.266734	0.344395	0.550745	1.216031
ED(a)		12.0464	12.27499925	1.006233	1.202731	1.814678	2.379476	4.121001	7.877572	15.23088	27.26543	37.29015	62.25514	86.68046
SAfrac		0.191762	0.027500251	0.107462	0.12844	0.143865	0.153826	0.171941	0.193392	0.21299	0.227218	0.233627	0.242124	0.249327
SAtot		18374.42	2101.918726	15000	15000	15000	15582.59	16789.64	18230.55	19769.68	21346.83	22380.12	23000	23000
SCL - Arsenic		12.94508	14.44020436	0.29135	0.764805	1.438515	2.093957	3.941437	8.006827	16.19011	29.87246	41.45729	72.29093	132.9973
SCL - Benzo[a]pyrene		1.307842	1.482922479	0.023912	0.079537	0.146138	0.211857	0.398826	0.81245	1.633997	2.985081	4.17902	7.348775	18.28043
SCL - Chlordane		41.40589	45.65311946	1.079726	2.578557	4.721587	6.831478	12.79992	25.96503	51.97905	95.15916	131.4703	230.1259	481.4748
SCL - Epichlorohydrin		422.2543	600.2918742	7.620011	16.30397	31.90339	48.22889	97.9704	224.4293	493.0718	1006.747	1454.322	2982.911	9219.563
SCL - TCE		32.40627	50.65397616	0.468082	1.064715	2.131078	3.263804	6.624107	15.48088	36.02824	78.45346	119.2844	253.2372	1014.406
SIRa		57.38812	27.05729483	19.00187	19.99815	23.40577	27.04841	35.74549	51.57861	73.54511	98.63112	112.505	127.8225	132.9865
VF (Epichlorohydrin)		93598.27	195872.0323	9500.674	9758.414	10679.76	12242.12	18155.03	35195.13	87640.56	201807.7	348997.9	960304	2885352
VF (TCE)		92372.26	185899.1156	9500.213	9794.057	10884.74	12374.96	18264.47	36463.87	86460.6	202629.3	347927.8	939641.8	2757798


Adult Soil Ingestion Rate, SIRa, Point Estimate 50 mg/day
<50%ile
>25%ile
Exposure Duration, Adult, Point Estimate 30 years
<95th%ile
>90th%ile
Fraction of Body Surface Area Exposed, 25%
>99thile
Adult Average Body Weight, ABW, 70 kg
<50%ile
>25%ile
Arsenic Modified Soil Cleanup Level, Ingestion + Dermal, 6.52E-01mg/kg
<1%
less than 1% of the distribution has a higher cleanup level

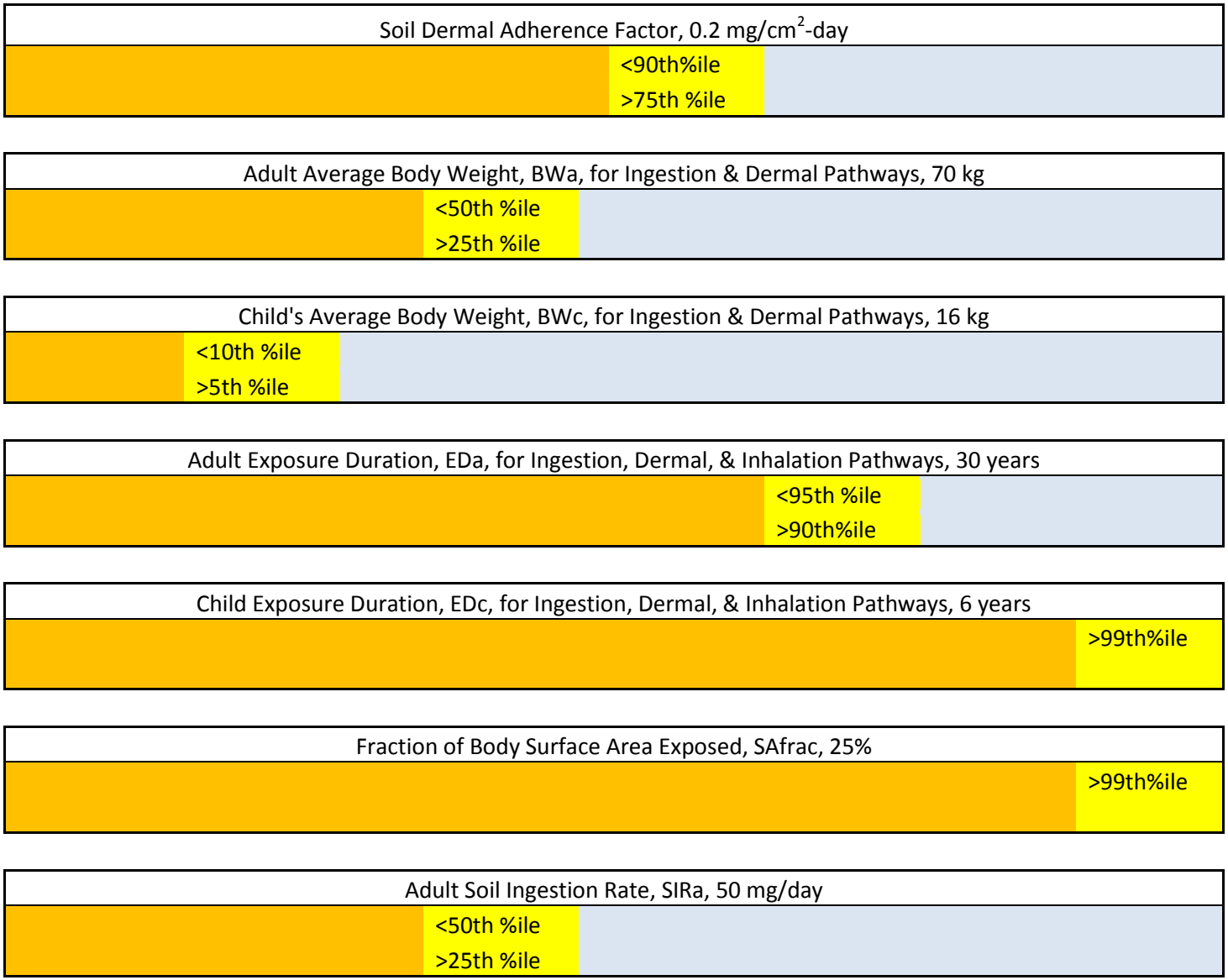
Age Adjusted 3-Concurrent Exposure Pathways
Percentiles for Exposure Assumptions

YASAIw Simulation Output

Workbook AAdj 3 Concur Exp Correlations-(Pert-beta) BW-SA, Exp Dur, Inha 20090521.xls
Start Date 5/21/2009

Simulatio 10000

		Standard	Percentiles										
Output Name	Mean	Deviation	0	0.01	0.05	0.1	0.25	0.5	0.75	0.9	0.95	0.99	1
AFa	0.14181	0.11107	0.00945	0.02216	0.03567	0.04575	0.06968	0.11099	0.17787	0.27265	0.35135	0.55939	1.33586
AFc	0.14197	0.11458	0.00949	0.02168	0.03489	0.0449	0.06959	0.11163	0.17617	0.27205	0.3602	0.55311	2.13187
BWa(D)	73.328	11.9914	45.94	49.0954	55.1614	58.7443	64.991	72.4101	80.6046	88.9646	94.5555	106.372	119.74
BWa(Ing)	73.5468	11.8992	46.0684	50.4109	55.7129	58.9964	64.9677	72.527	81.1233	89.1904	94.8422	105.719	119.533
BWc(D)	19.8089	2.83115	15.2	15.2	15.3097	16.1994	17.6942	19.5693	21.6387	23.6893	25.1154	27.1	27.1
BWc(Ing)	19.9493	2.61193	15.2005	15.4596	16.0513	16.6496	17.9367	19.7082	21.7128	23.6201	24.7871	26.3636	27.098
EDa(D)	11.9853	12.0892	1.00089	1.1773	1.74137	2.39728	4.16084	7.9622	15.1045	26.8836	36.2022	60.4273	86.8676
EDa(Ing)	11.804	12.0623	1.00632	1.16422	1.73075	2.31215	4.02809	7.75795	14.8548	26.2342	36.7257	60.949	86.4823
EDa(Inh)	11.9997	12.436	1.00054	1.19357	1.74519	2.30172	4.07048	7.77969	15.1005	26.246	37.3838	63.8468	86.643
EDc(D)	3.51246	0.93164	1.1178	1.55349	1.99279	2.27044	2.81069	3.51054	4.19055	4.75946	5.0599	5.47729	5.82689
EDc(Ing)	3.49439	0.95086	1.11353	1.47272	1.9391	2.22376	2.79723	3.48666	4.21197	4.77517	5.06276	5.43992	5.93652
EDc(Inh)	3.49989	0.94598	1.13199	1.57231	1.94511	2.23187	2.78853	3.50218	4.20167	4.77612	5.03774	5.47076	5.93408
SAfrac(a)	0.19208	0.02743	0.1054	0.12828	0.14363	0.15402	0.17256	0.19392	0.21347	0.22701	0.23342	0.24227	0.24909
SAfrac(c)	0.1913	0.02757	0.10907	0.12705	0.14247	0.15311	0.17196	0.19314	0.21276	0.22679	0.23307	0.24181	0.24957
SAtot(a)	18424.4	2119.92	15000	15000	15000	15575.4	16830.4	18284.9	19851.6	21412.1	22436.5	23000	23000
SAtot(c)	7330.02	761.18	5960.77	5998.65	6165.42	6371.44	6732.4	7277.85	7842.94	8405.97	8766.2	9023.57	9099.09
SCL - Arsenic	7.82388	9.47581	0.19605	0.57646	1.08858	1.48479	2.55074	4.83818	9.24552	17.1777	24.5725	46.9526	142.661
SCL - Benzo(a)pyrene	0.62135	0.52721	0.02998	0.08131	0.13686	0.18545	0.28804	0.47085	0.77173	1.23765	1.60483	2.73778	6.49396
SCL - Chlordane	21.191	20.2375	0.82917	2.30841	4.09605	5.47133	8.75762	15.2072	26.0142	43.7893	59.1317	104.996	279.183
SCL - Epichlorohydrin	234.536	245.228	8.21502	18.336	34.491	49.5927	91.9436	163.596	288.713	488.962	668.035	1206.49	4258.12
SCL - TCE	18.7707	21.1107	0.44628	1.0892	2.13906	3.25922	6.27172	12.1902	23.3653	41.6476	56.742	103.822	373.019
SIRa	57.2066	26.5389	19.0085	19.9334	23.5145	27.0465	35.9737	51.6728	73.6935	96.8069	111.545	126.678	132.937
SIRc	43.7798	70.3351	0.19734	1.3447	2.98081	4.65745	9.42548	21.5455	48.9641	101.152	152.507	342.248	961.377
VF-TCE	91205.3	182220	9501.25	9771.7	10911.9	12438.6	18258.4	36066.7	86680.3	201887	336706	898514	2753370
VFepi	95599	199433	9503.4	9781.42	10849.1	12361.7	18046.9	35290.1	86302.2	212773	360779	1025796	2828889


Soil Dermal Adherence Factor, 0.2 mg/cm2-day
<90th%ile
>75th %ile
Adult Average Body Weight, BWa, for Ingestion & Dermal Pathways, 70 kg
<50th %ile
>25th %ile
Child's Average Body Weight, BWc, for Ingestion & Dermal Pathways, 16 kg
<10th %ile
>5th %ile
Adult Exposure Duration, EDa, for Ingestion, Dermal, & Inhalation Pathways, 30 years
<95th %ile
>90th%ile
Child Exposure Duration, EDc, for Ingestion, Dermal, & Inhalation Pathways, 6 years
>99th%ile
Fraction of Body Surface Area Exposed, SAfrac, 25%
>99th%ile
Adult Soil Ingestion Rate, SIRa, 50 mg/day
<50th %ile
>25th %ile

Child's Soil Ingestion Rate, SIRa,200 mg/day		
	< 99th%ile	
	>95th%ile	

Arsenic Modified Soil Cleanup Level, Ingestion + Dermal, 6.52E-01mg/kg	
<5%	less than 5% of the distribution has a higher cleanup level