Alternative Remediation Standards Technical Guidance Training

June 15, 2021

Christina Page, Co-Moderator
Training Committee, Chair

Lynne Mitchell, Co-Moderator
Training Committee, Manager

Continuing Education Credits (CECs)

SRP Licensing Board **has approved**

5 Technical CECs

for this Training Class

<u>Attendance Requirements</u>:

- **Webinar participants**: must be logged-in for the entire session and answer 3 out of 4 poll questions (randomly inserted in the presentation)

CECs: What's the Process?

Since the SRPL Board <u>HAS</u> approved CECs for the course:

- DEP compiles a list of "webinar" participants eligible for CECs and provides the list to the LSRPA
- LSRPA will email eligible participants a "Link" to an LSRPA webpage with certificate access instructions
- Certificates are issued by the LSRPA after paying a *$25 processing fee*

Test Your Knowledge

Why are you here today?

A. I don’t know

B. It’s too hot outside

C. Alternative Remediation Standards Technical Guidance Training

EXAMPLE WEBINAR
QUIZ SLIDE

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EXAMPLE WEBINAR QUIZ SLIDE

Question and Answer Segments

- Questions will be read aloud by the moderator as time permits
- Any questions are not addressed during the presentation, will be answered via email

Chat Function

- Please use the chat to advise the Department of technical issues with the presentation
- Please do not use the chat function to comment on presentations or to answer other attendee's questions

Remember!

Please fill out the Course Evaluation here:

https://www.surveymonkey.com/r/NG73ZTP

Stay logged in all day

Login in with only one device

Alternative Remediation Standards Technical Guidance

June 15, 2021

NJ Licensed Site Remediation Professionals Association

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Upcoming LSRPA Courses & Events

- **June 24, 2021 – LSRPA Member "Chat" Session**

  Candace Baker, LSRP and Association Treasurer
  Kathi Stetser, PG, LSRP, Vice President, GEI Consultants and Vice-Chair of the Regulatory Outreach Committee
  Bill Hose, LSRPA Assistant Executive Director

- **July 20, 2021 – Member Regulatory Roundtable** (1 Reg/.5 Tech CECs)

  Fill Material Guidance for SRP Sites

  Rodger Ferguson, LSRP, PennJersey Env. Consulting

- **August 5, 2021 – 2021 Standards Rule: Issues and Application**

  Candace Baker, LSRP, Langan Engineering and Environmental Services, Inc.,
  Michael Gonshor, LSRP, Roux Associates
  Brandi Gray, LSRP, Langan Engineering and Environmental Services, Inc.,
  Scott Drew, LSRP, Geosyntec Consultants

Visit LSRPA.org for details and registration

Upcoming LSRPA Courses & Events

UPCOMING NJDEP TRAINING

- **July 14, 2021 – NJDEP/LSRPA Soil and GW Remedial Action Protectiveness/Biennial Certification Forms Training**

Visit LSRPA.org for details and registration

Upcoming Event

Upcoming Event

Thank You!

Introduction to Alternative Remediation Standards Technical Guidance

Dr. Swati Toppin, PhD, Rule Manager
Bureau of Environmental Evaluation and Risk Assessment
swati.toppin@dep.nj.gov

Statutory Authority for ARS Guidance

- Authority Brownfield and Contaminated Site Remediation Act, N.J.S.A. 58:10B-12.f(1). Requirement for consideration of site-specific factors

- N.J.A.C.-7:26:D, Subchapter 8 sets forth the procedures for the development and approval of Alternative Remediation Standards

Exposure Pathways

- Appendix 6- ARS for Ingestion-Dermal Pathway
- Appendix 7- ARS for Inhalation Pathway
- Appendix 8- ARS for the Migration to Ground Water Pathway
- Appendix 9- ARS for the Vapor Intrusion Pathway

Alternative Remediation Standards for Soil for the Ingestion-Dermal and Inhalation Exposure Pathways

Introduction and Basis of Default Soil Remediation Standards for the Ingestion-Dermal and Inhalation Exposure Pathways

Chelsea Bray
Bureau of Environmental Evaluation and Risk Assessment
chelsea.bray@dep.nj.gov

Committee Members

NJDEP

- Allan Motter, Co-Chair
- Erica Snyder, Co-Chair
- Linda Cullen, Co-Chair (retired)
- Diane Groth (retired)
- Kathy Kunze (retired)
- Chelsea Bray

Stakeholders

- Kevin Long
- Lisa Voyce
- Mark Maddaloni
- Marian Olsen

Agenda

- Introduction – Chelsea Bray
- When to develop an ARS – Kevin Long
- Developing an ARS – Erica Snyder
- ARS requiring pre-approval – Lisa Voyce
- ARS for Lead – Mark Maddaloni
- ARS that do not require pre-approval – Allan Motter
- Submitting an ARS – Allan Motter

Intended Use of the ARS Guidance Document

- Comply with requirements set forth by N.J.A.C. 7:26D
- Who uses this?
- Developing an ARS
- Maintain human health-based goals
- Identify when and how to calculate ARS

Background for Developing Soil Remediation Standards

- Residential and nonresidential land use
- Evaluate current and potential future human exposure to contaminated soil
- Cancer risk = $1x10^{-6}$
- Hazard Quotient = 1
- Default exposure parameters

Basis for Default Ingestion-Dermal Soil Remediation Standards

- Incidental ingestion of contaminated soil or dust or contaminant absorption through skin
- Residential for carcinogenic contaminants (child; adult)
- Residential for non-carcinogenic contaminants = child inputs only
- Non-residential - outdoor worker (adult only)

Basis for Default Inhalation Soil Remediation Standards

Exposure to volatile organic compounds (VOCs) and particulates in ambient air

Parameter	Residential Land Use	Non-Residential Land Use
Exposure Time	24 hours/day	8 hours/day
Exposure Frequency	350 days/year	225 days/year
Exposure Duration	26 years	25 years

NJDEP Default Parameters vs USEPA Default Parameters

	Parameter	NJDEP Default	USEPA Default
θ_w	Water-filled soil porosity	0.23 L_{water}/L_{soil}	0.15 L_{water}/L_{soil}
n	Total soil porosity	0.41 L_{pore}/L_{soil}	0.43 L_{pore}/L_{soil}
θ_a	Air-filled soil porosity	0.18 L_{air}/L_{soil}	0.28 L_{air}/L_{soil}
f_{oc}	Organic carbon content of soil	0.002 g/g	0.006 g/g surface

Thank you!

Determining When to Develop an Alternative Remediation Standard for Soil for the Ingestion-Dermal and Inhalation Exposure Pathways

Kevin Long, Principal Consultant
Terraphase Engineering Inc.
kevin.long@terraphase.com

When to Develop an ARS for Soil

1. The **land use** results in exposure conditions that are not consistent with the assumptions used to derive the default health-based SRS

2. Site conditions indicate **physical parameters** that are not consistent with those used to derive the default health-based SRS

Accounting for Land Use

- Default health-based SRS based upon **reasonable maximum exposures (RME)** for residential and non-residential sites

- Understand RME, what it is, and how it's **definition** can be an important tool in determining whether to develop an ARS for soil

Accounting for Land Use

RME is defined as:

"*[T]he highest exposure that is* ***reasonably expected*** *to occur at a […] Site.*"

– An Examination of EPA Risk Assessment Principles and Practices (USEPA 2004)

"*result in an overall exposure estimate that is* ***conservative but*** *within a* ***realistic*** *range of exposure.*"

– Preamble to the 1994 National Oil and Hazardous Substances Pollution Contingency Plan

Accounting for Land Use

New Jersey
Department of Environmental Protection

Site Remediation and
Waste Management Program

Technical Guidance for Preparation and Submission of a Conceptual Site Model

August 2019
Version 1.1

New Jersey Department of Environmental Protection
Site Remediation and Waste Management Program

RECEPTOR EVALUATION (RE) FORM

Date Stamp
(For Department use only)

SECTION A. SITE

Site Name:

Program Interest (PI) Number(s):

Communication Center Number(s) and/or ISRA number(s) for this submission: (as *many as will fit in the space provided*)

This form must be attached to the Cover/Certification Form if not submitted through a Remedial Phase Online Service

Indicate the type of submission:

☐ Initial RE Submission

☐ Updated RE Submission

Indicate the reason for submission of an updated RE form

☐ Submission of an Immediate Environmental Concern (IEC) source control report;

☐ Submission of a Remedial Investigation Report;

☐ Submission of a Remedial Action Report;

Check if included in updated RE

☐ The known concentration or extent of contamination in any medium has increased;

☐ A new AOC has been identified;

☐ A new receptor is identified;

☐ A new exposure pathway has been identified.

SECTION B. ON SITE AND SURROUNDING PROPERTY USE

1. Identify any sensitive populations/uses that are currently on-site or surrounding property usage within 200 feet of the site property boundary (*check all that apply*):

	On-site	Off-site
None of the following	☐	☐
Residences or residential property	☐	☐
Public or Private Schools Grades K-12	☐	☐
Child care centers	☐	☐
Public parks, playgrounds or other recreation areas	☐	☐
Other sensitive population use(s) Explain	☐	☐

If any of the above applies, attach a list of addresses, facility names, type of use, and a map depicting each location relative to the site.

2. Current site uses (*check all that apply*):

☐ Industrial	☐ Residential	☐ Commercial
☐ School or child care	☐ Government	☐ Park or recreational use
☐ Vacant	☐ Agricultural	☐ Other:

3. Planned future on-site uses and off-site uses within 200 feet of the site boundary (*check all that apply*):

On-Site	Off-Site		On-Site	Off-Site		On-Site	Off-Site	
☐	☐	Industrial	☐	☐	Residential	☐	☐	Commercial
☐	☐	School or child care	☐	☐	Government	☐	☐	Park or recreational use
☐	☐	Vacant	☐	☐	Agricultural	☐	☐	Other:

Provide a map depicting the location of the proposed changes in land use.

Receptor Evaluation Form
Version 2.4 12/03/18

Page 1 of 6

Accounting for Land Use

Current and **future** land use(s) that would result in RME that are less than assumed by the default SRS

Active Recreation

Passive Recreation

Restricted Access

Infrequent Access

Accounting for Site-Specific Physical Parameters

The Rule allows for modification of certain physical parameters used to calculate the default health-based **inhalation** pathway SRS:

Depth of Volatile Contamination

% Vegetative Cover

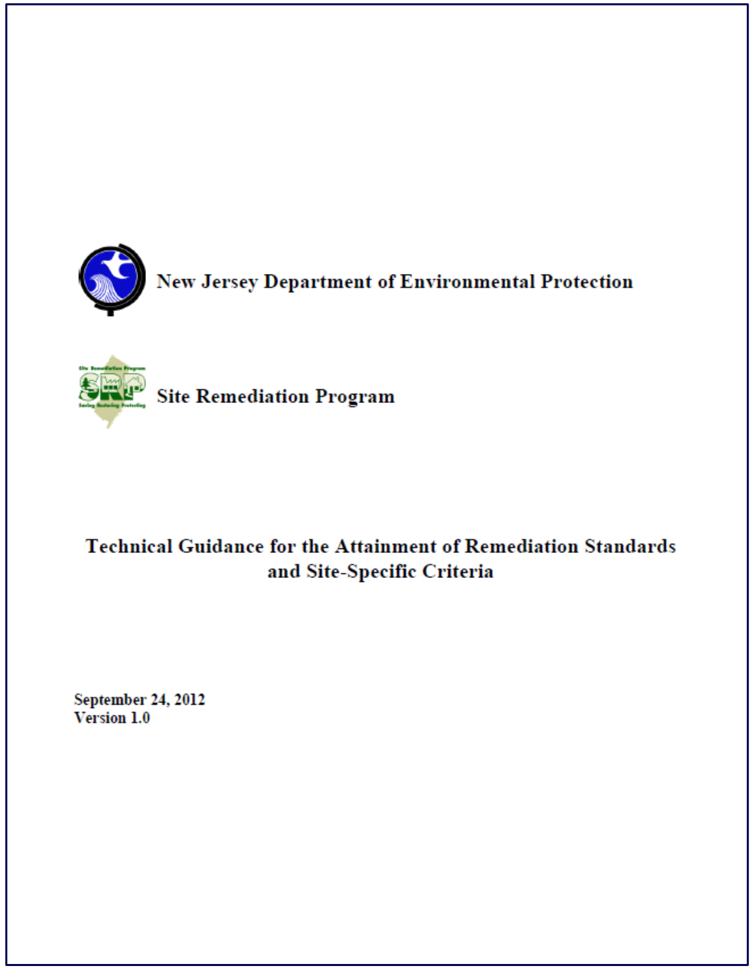
Organic Carbon Content

Additional Considerations

- May require **institutional and engineering controls**

- May require **prior approval** from the Department

- May need to account for assumptions used to derive ARS for soil when **evaluating the significance** of concentrations



New Jersey Department of Environmental Protection

Site Remediation Program

Technical Guidance for the Attainment of Remediation Standards and Site-Specific Criteria

September 24, 2012
Version 1.0

Additional Considerations

- Consider **both** the ingestion-dermal and inhalation exposure pathways
- Remember that the **lower** of the health-based calculations will drive remedial action decision-making

	Ingestion-Dermal	*Inhalation*
CANCER	$ID_c = \dfrac{TR * AT * LT * BW}{EF * ED * 10^{-6}\,kg/mg * [(CSF_O * IR) + (CSF_D * SA * AF * ABS_d)]}$	$Inh_c = \dfrac{TR * AT * LT}{IUR * 1000\,{}^{\mu g}/_{mg} * EF * \left(\frac{1}{VF} + \frac{1}{PEF}\right) * ED * ET * \frac{1day}{24hours}}$
NONCANCER	$ID_{nc} = \dfrac{THQ * AT * ED * BW}{(EF * ED * 10^{-6}\,kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$	$Inh_{nc} = \dfrac{THQ * AT * ED}{EF * ED * ET * \frac{1day}{24hours} * \frac{1}{RfC} * \left(\frac{1}{VF} + \frac{1}{PEF}\right)}$

Additional Considerations

- Consider **both** the ingestion-dermal and inhalation exposure pathways
- Remember that the **lower** of the health-based calculations will drive remedial action decision-making

	Ingestion-Dermal	*Inhalation*
Benzene	3.0 mg/kg	2.2 mg/kg

Additional Considerations

- Consider **both** the ingestion-dermal and inhalation exposure pathways
- Remember that the **lower** of the health-based calculations will drive remedial action decision-making

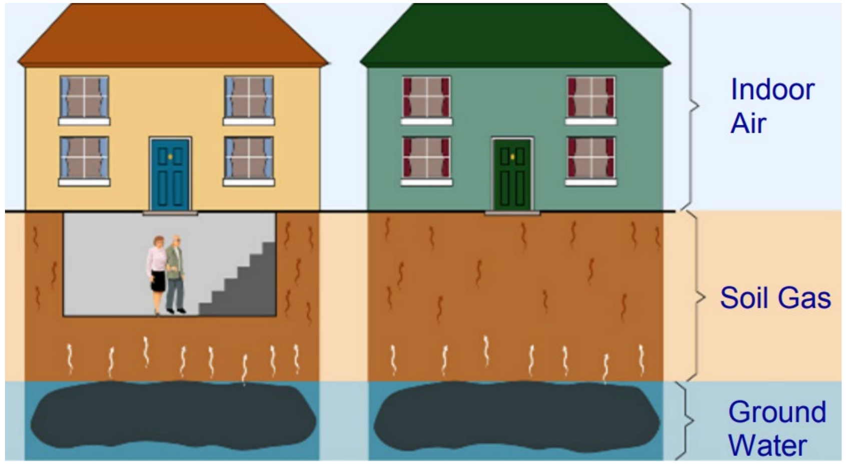
	Ingestion-Dermal	*Inhalation*
Benzene	3.0 mg/kg	2.2 mg/kg
		ARS
		8.8 mg/kg

Additional Considerations

Consider the impact of other receptor exposure scenarios

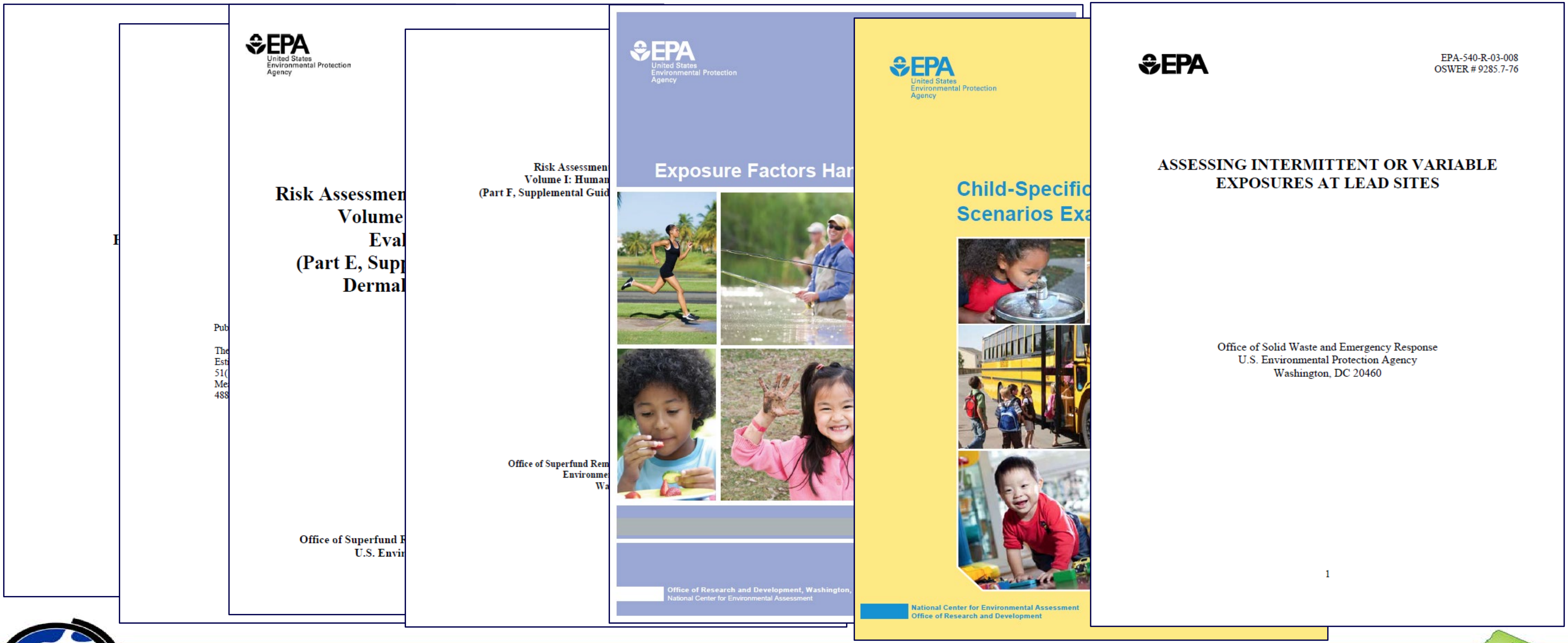
Migration to Groundwater

Ecological Exposure/Risk



Vapor Intrusion

Additional Considerations



Thank You!

Development of Alternative Remediation Standards for Soil for the Ingestion-Dermal and Inhalation Exposure Pathways

Erica Snyder, MS
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Development of Alternative Remediation Standards (ARS) for Soil

The Brownfield and Contaminated Site Remediation Act (N.J.S.A. 58:10B-12.f(1)) requires the Department to consider **site-specific** factors in determining an ARS

ARS for Soil – Options

- ARS for soil options for the ingestion-dermal and inhalation exposure pathways specified in:
  - N.J.A.C. 7:26D Appendices 6 and 7
  - *Alternative Remediation Standards Technical Guidance for Soil for the Ingestion-Dermal and Inhalation Exposure Pathways*

Ingestion-Dermal ARS for Soil – Options

- Option #1: Site-specific alternative land use exposure scenario (all contaminants)
- Option #2: Site-specific lead ARS for soil
  - Alternative land use exposure scenario
  - Bioavailability/bioaccessibility of lead in site soils
  - Use of other scientific models or methods

(More details on lead to come from Mark!)

Inhalation ARS for Soil - Options

- Option #1: Site-specific alternative land use exposure scenario (all contaminants)
- Option #2: Modification of site-specific physical parameters (all contaminants)
  - Depth range of contamination
  - Soil organic carbon content (f_{oc})
  - Fraction of vegetative cover (V)

(More to come on Option #2 from Allan!)

ARS for Soil Requests Requiring Prior Approval by the Department

- **All ingestion-dermal ARS for soil require pre-approval** from the Department prior to use (N.J.A.C. 7:26D Appendix 6, Section III)
- **Inhalation ARS for soil based on alternative land use require pre-approval** from the Department prior to use (N.J.A.C. 7:26D Appendix 7, Section III(a))
- Inhalation ARS for soil based on site-specific physical parameters do not require pre-approval (N.J.A.C. 7:26D Appendix 7, Section III(b))

Alternative Land Use – Institutional and Engineering Controls

- Institutional control and Remedial Action Permit required
- Engineering control may also be required

Test Your Knowledge

True or False:

Institutional controls and a Remedial Action Permit are required for Inhalation ARS based on alternative land use.

A. True

B. False

Test Your Knowledge

True or False:

Institutional controls and a Remedial Action Permit are required for Inhalation ARS based on alternative land use.

A. True

B. False

Development of ARS for Soil Alternative Land Use

Ingestion-Dermal Exposure Factors That Can Be Changed*

- Exposure Frequency (days/year)
- Exposure Duration (years)

*Exposure Time not applicable because exposure is evaluated as an "event" (1 event per day)

Inhalation Exposure Factors That Can Be Changed

- Exposure Time (hours/day)
- Exposure Frequency (days/year)
- Exposure Duration (years)

Development of ARS for Soil Alternative Land Use

- Ingestion-Dermal Exposure Factors That Cannot Be Changed
  - Soil Ingestion Rate (mg/day)
  - Body Weight (kg)
  - Skin Surface Area (cm^2/day)
  - Adherence Factor (mg/cm^2)
  - Dermal Absorption Fraction (unitless)

Development of ARS for Soil Alternative Land Use

- Inhalation Exposure Factors That Cannot Be Changed (Meteorological)
  - Dispersion Factor, Q/C $(g/m^2\text{-}s)/(kg/m^3)$
  - Source Area Size (m^2)
  - Mean Annual Wind Speed (m/s)
  - Anemometer Height (unitless)
  - Averaging Time

Development of ARS for Soil Alternative Land Use

- Inhalation Exposure Factors That Cannot Be Changed (Soil Parameters)
  - Air-filled Soil Porosity (L/L)
  - Water-filled Soil Porosity (L/L)
  - Total Porosity (L/L)
  - Soil Bulk Density (g/cm^3)
  - Exposure Interval (sec)

Development of ARS for Soil Alternative Land Use

- Inhalation Exposure Factors That Cannot Be Changed (Chemical Properties)
  - Soil Organic Carbon-water
  - Partition Coefficient (cm^3/g)
  - Diffusivity in Air (cm^2/sec)
  - Diffusivity in Water (cm^2/sec)
  - Henry's Law Constant (unitless)

Chemical-Specific Toxicity

- Cancer and noncancer toxicity values cannot be changed via the ARS process
  - For contaminants with no existing SRS, interim SRS may be developed in accordance with 7:26D-6
  - Toxicity values for contaminants with an existing SRS may be updated in accordance with 7:26D-7

Calculation of ARS for Soil

- Calculators accessible on the Remediation Standards website NJDEP SRP - Guidance: Remediation Standards (state.nj.us)
  - Site-specific parameters that may be adjusted are unlocked
  - Input parameters which may not be adjusted are locked
  - Calculator does not include lead

Calculators

The Soil and Soil Leachate Migration to Ground Water Exposure Pathway Calculator

- Soil and Soil Leachate Migration to Ground Water Exposure Pathway Calculator (Version 1.0 May 2021)

This includes the following calculators:

- Soil-Water Partition Equation Calculator
- Synthetic Precipitation Leaching Procedure Calculator
- Dilution-Attenuation Factor Calculator
- Fraction Organic Carbon Calculator

Soil Ingestion-Dermal Exposure Pathway Calculator

- Soil Ingestion-Dermal Exposure Pathway Calculator (Version 1.0 May 2021)

Soil Inhalation Exposure Pathway Calculator

- Soil Inhalation Exposure Pathway Calculator (Version 1.0 May 2021)

Vapor Intrusion Exposure Pathway Calculator

- Vapor Intrusion Exposure Pathway Calculator (Version 1.0 May 2021)

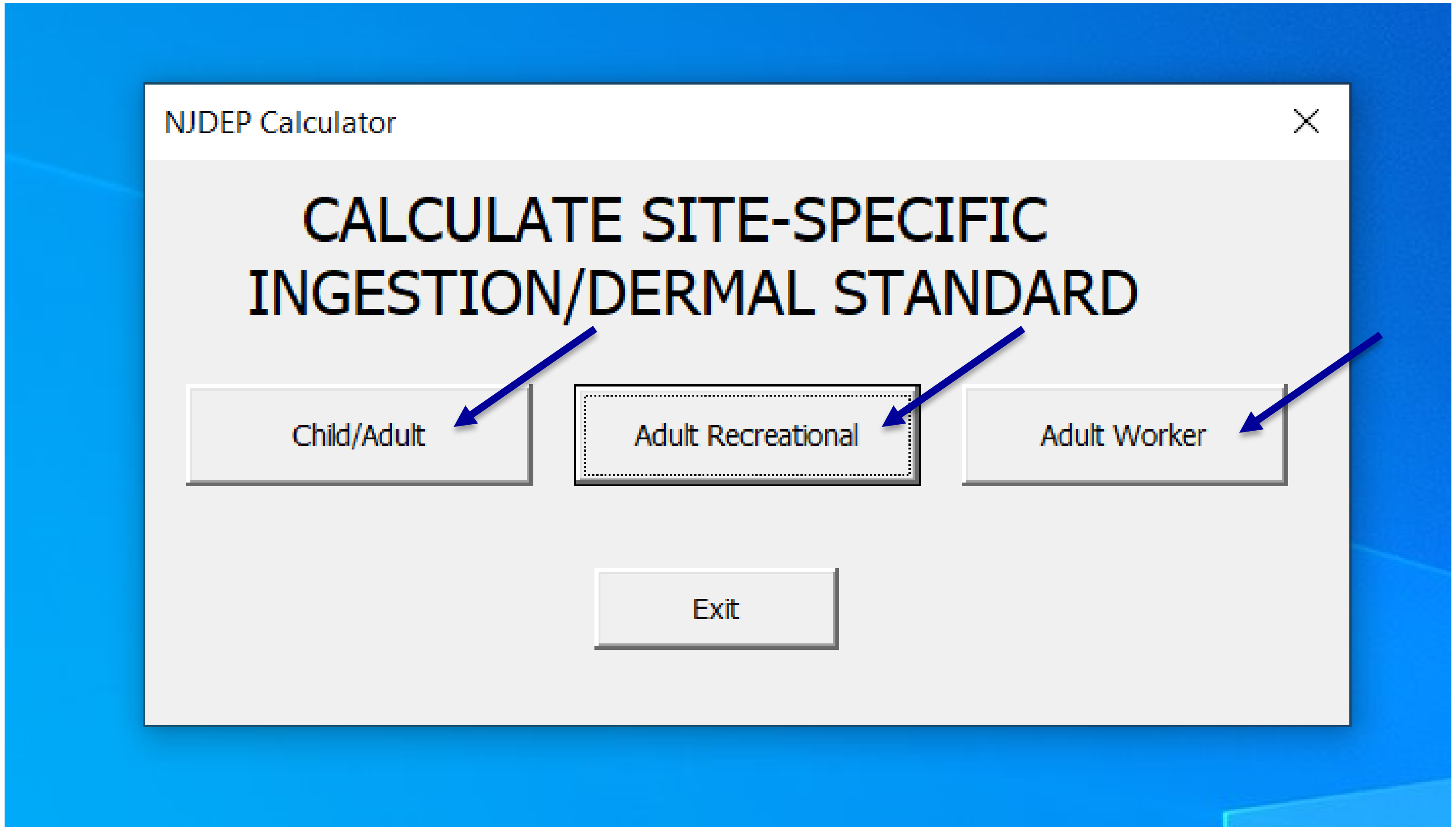
The Extractable Petroleum Hydrocarbon Ingestion-Dermal Exposure Pathway Calculator:

- Extractable Petroleum Hydrocarbon Ingestion-Dermal Exposure Pathway Calculator (Version 1.0 May 2021)

This includes the following calculators:

- Category 2 Sample-Specific Residential
- Category 2 Sample-Specific Non-Residential
- Category 1 and 2 Alternative Remediation Standards for Soil (based on Land Use Exposure Scenarios)

ARS for Soil Calculator for the Ingestion-Dermal Exposure Pathway



NJDEP 2021 Ingestion/Dermal Combined Child/Adult Calculator

Site Name:		Date:	
Contaminant:	Benzene	CAS No.:	71-43-2
		Evaluated by:	

$$ID_c = \frac{TR * AT * LT}{(10^{-6}\,kg/mg) * [(CSF_O * IFS_{adj}) + (CSF_D * DFS_{adj} * ABS_d)]}$$

$$ID_{nc} = \frac{THQ * AT * ED * BW}{(EF * ED * 10^{-6}\,kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$$

$$IFS_{adj} = \frac{EF_c * ED_c * IR_c}{BW_c} + \frac{EF_a * ED_a * IR_a}{BW_a}$$

$$DFS_{adj} = \frac{EF_c * ED_c * SA_c * AF_c}{BW_c} + \frac{EF_a * ED_a * SA_a * AF_a}{BW_a}$$

Soil Reporting Limit (mg/kg) = 0.005

Parameter	*Definition*	*Units*	*Residential Scenario*	***Alternative Scenario***	
TR	Target Cancer Risk	unitless	1.00E-06	1.00E-06	
THQ	Target Hazard Quotient	unitless	1	1	
AT	Averaging Time	days/year	365	365	
LT	Lifetime	years	70	70	
EF_c	Exposure Frequency - child	days/year	350	260	**changed**
EF_a	Exposure Frequency - adult	days/year	350	260	**changed**
ED_c	Exposure Duration - child	years	6	6	
ED_a	Exposure Duration - adult	years	20	20	
CSF_O	Oral Cancer Slope Factor	$(mg/kg\text{-}day)^{-1}$	0.23	0.23	
CSF_D	Dermal Cancer Slope Factor	$(mg/kg\text{-}day)^{-1}$	0.23	0.23	
RfD_O	Oral Reference Dose	mg/kg-day	0.004	0.004	
RfD_D	Dermal Reference Dose	mg/kg-day	0.004	0.004	
IFS_{adj}	Age-Adjusted Soil Ingestion Rate	mg/kg	36750	27300	
DFS_{adj}	Age-Adjusted Soil Dermal Contact Factor	mg/kg	103390	76804	
ABS_d	Dermal Absorption Fraction	unitless	NA	NA	
BW_c	Body Weight - child	kg	15	15	
BW_a	Body Weight - adult	kg	80	80	
IR_c	Soil Ingestion Rate - child	mg/day	200	200	
IR_a	Soil Ingestion Rate - adult	mg/day	100	100	
SA_c	Skin Surface Area - child	cm^2/day	2373	2373	
SA_a	Skin Surface Area - adult	cm^2/day	6032	6032	
AF_c	Soil Adherence Factor - child	mg/cm^2	0.2	0.2	
AF_a	Soil Adherence Factor - adult	mg/cm^2	0.07	0.07	
ID_c	**Carcinogenic Health-Based Soil Criterion (ingestion only)**	mg/kg	3	4.1	
ID_c	**Carcinogenic Health-Based Soil Criterion (ingestion/dermal)**	mg/kg	NA	NA	
ID_{nc}	**CHILD Non-carcinogenic Health-Based Soil Criterion (ingestion only)**	mg/kg	310	420	
ID_{nc}	**CHILD Non-carcinogenic Health-Based Soil Criterion (ingestion/dermal)**	mg/kg	NA	NA	
ID_{nc}	**ADULT Non-carcinogenic Health-Based Soil Criterion (ingestion only)**	mg/kg	3300	4500	
ID_{nc}	**ADULT Non-carcinogenic Health-Based Soil Criterion (ingestion/dermal)**	mg/kg	NA	NA	

Alternative Ingestion/Dermal Soil Remediation Standard:

4.1 mg/kg ***Cancer-based***

Default exposure frequency = 350 days
ARS exposure frequency = 260 days

NJDEP 2021 Ingestion/Dermal Adult Outdoor Worker Calculator

Site Name:		Date:	
Contaminant:	Benzene	CAS No.:	71-43-2
		Evaluated by:	

$$ID_c = \frac{TR * AT * LT * BW}{EF * ED * 10^{-6} kg/mg * [(CSF_O * IR) + (CSF_D * SA * AF * ABS_d)]}$$

$$ID_{nc} = \frac{THQ * AT * ED * BW}{(EF * ED * 10^{-6} kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$$

Parameter	*Definition*	*Units*	*Nonresidential Scenario*	***Alternative Scenario***
TR	Target Cancer Risk	unitless	1.00E-06	1.00E-06
THQ	Target Hazard Quotient	unitless	1	1
AT	Averaging Time	days/year	365	365
LT	Lifetime	years	70	70
EF	Exposure Frequency	days/year	225	104
ED	Exposure Duration	years	25	25
CSF_O	Oral Cancer Slope Factor	$(mg/kg\text{-}day)^{-1}$	0.23	0.23
CSF_D	Dermal Cancer Slope Factor	$(mg/kg\text{-}day)^{-1}$	0.23	0.23
RfD_O	Oral Reference Dose	mg/kg-day	0.004	0.004
RfD_D	Dermal Reference Dose	mg/kg-day	0.004	0.004
ABS_d	Dermal Absorption Fraction	unitless	NA	NA
BW	Body Weight - adult	kg	80	80
IR	Soil Ingestion Rate	mg/day	100	100
SA	Skin Surface Area - adult	cm^2/day	3527	3527
AF	Soil Adherence Factor	mg/cm^2	0.12	0.12
ID_c	**Carcinogenic Health-Based Soil Criterion (ingestion only)**	mg/kg	16	34
ID_c	**Carcinogenic Health-Based Soil Criterion (ingestion/dermal)**	mg/kg	NA	NA
ID_{nc}	**Non-carcinogenic Health-Based Soil Criterion (ingestion only)**	mg/kg	5200	11000
ID_{nc}	**Non-carcinogenic Health-Based Soil Criterion (ingestion/dermal)**	mg/kg	NA	NA

Soil Reporting Limit (mg/kg) = 0.005

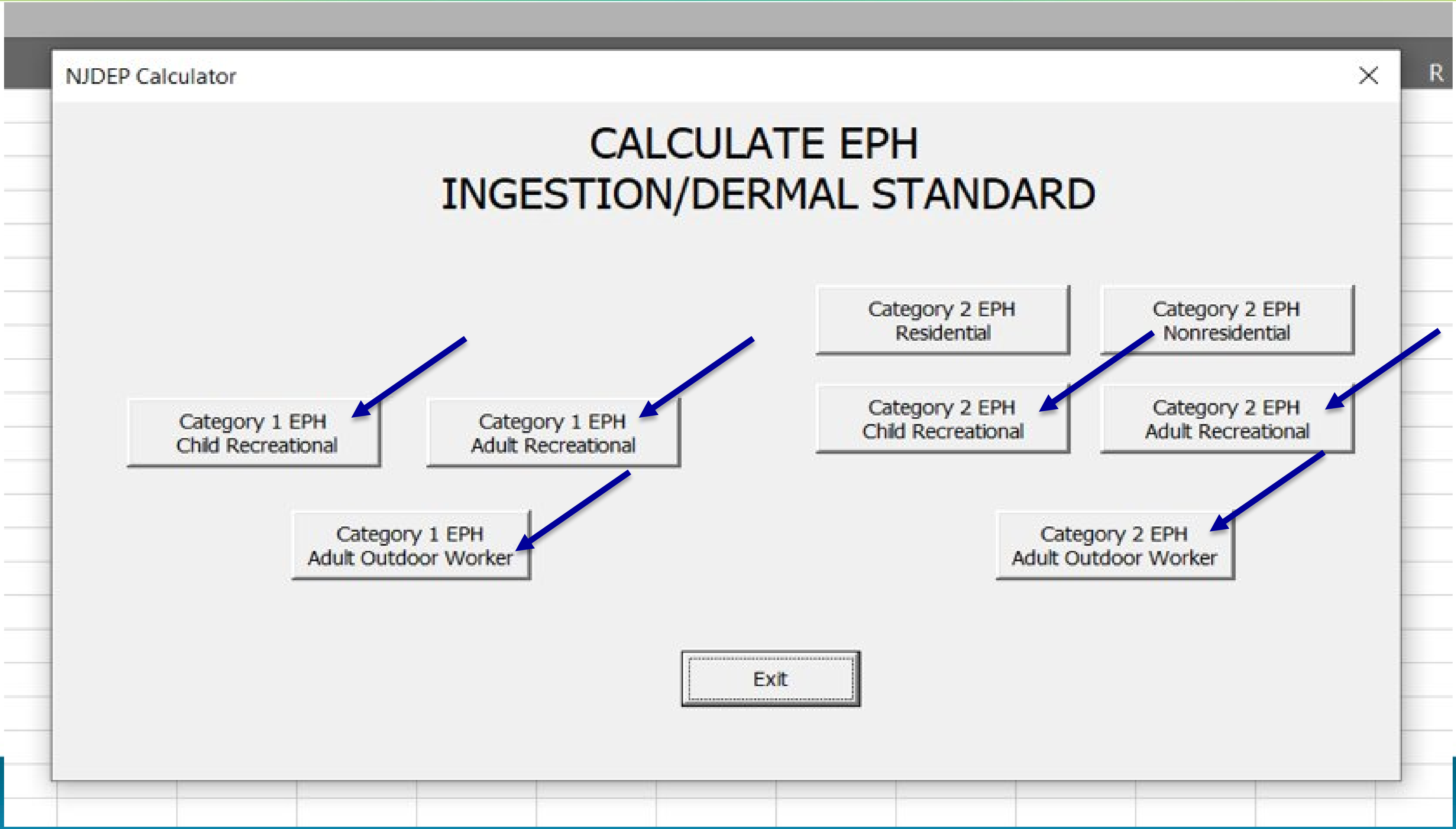
changed

Default exposure frequency = 225 days
ARS exposure frequency = 104 days

Alternative Adult Ingestion/Dermal Soil Remediation Standard:

34 mg/kg ***Cancer-based***

ARS for EPH Ingestion-Dermal Exposure Calculator



Category 1 EPH Child Recreational Exposure Scenario

NJDEP 2021 EPH Category 1 Ingestion/Dermal Child Recreational Calculator

Site Name:		Date:	
Sample ID:		Evaluated by:	

Calculated or locked cell
Required data entry
Optional data entry/modification

$$ID_{nc} = ID_{default} * \frac{EF_{default}}{EF_{site\text{-}specific}}$$

Parameter	*Definition*	*Units*	***Alternative Scenario***
$EF_{default}$	Default Exposure Frequency	days/year	350
$EF_{site\text{-}specific}$	Site-specific Exposure Frequency	days/year	350
$ID_{default}$	Default non-carcinogenic Health-Based Soil Criterion	mg/kg	5300
ID_{nc}	**Site-specific Non-carcinogenic Health-Based Soil Criterion (ingestion/dermal)**	**mg/kg**	**5300**

Reset

Back to EPH Menu

Exit

Default exposure frequency = 350 days

Cat 1 default residential scenario = 5,300mg/kg

Category 1 EPH Child Recreational Exposure Scenario

NJDEP 2021 EPH Category 1 Ingestion/Dermal Child Recreational Calculator

Site Name:		Date:	
Sample ID:		Evaluated by:	

Calculated or locked cell
Required data entry
Optional data entry/modification

$$ID_{nc} = ID_{default} * \frac{EF_{default}}{EF_{site\text{-}specific}}$$

Parameter	Definition	Units	Alternative Scenario
$EF_{default}$	Default Exposure Frequency	days/year	350
$EF_{site\text{-}specific}$	Site-specific Exposure Frequency	days/year	100
$ID_{default}$	Default non-carcinogenic Health-Based Soil Criterion	mg/kg	5300
ID_{nc}	**Site-specific Non-carcinogenic Health-Based Soil Criterion (ingestion/dermal)**	**mg/kg**	**19000**

changed

Site-specific exposure frequency = 100 days

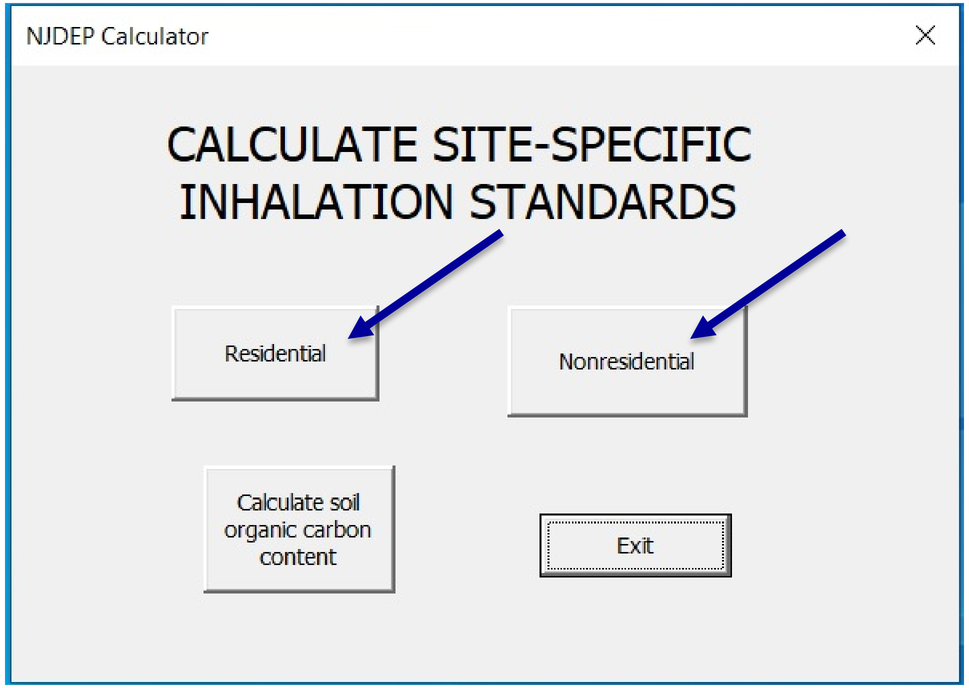
Reset

Back to EPH Menu

Exit

Site-specific Cat 1 Child Residential Scenario = 19,000 mg/kg

ARS for Soil Calculator for the Inhalation Exposure Pathway (pre-approval required)



NJDEP 2021 Inhalation Soil Remediation Standard Calculator: Residential

Site Name:	Generic Contaminated Site	Date:	6/9/2021
Contaminant:	Naphthalene	CAS No.:	91-20-3
		Evaluated by:	LSRP

Contaminant Parameters:

Parameter	Definition	Units	Value
IUR	Inhalation Unit Risk Factor	$(\mu g/m^3)^{-1}$	3.40E-05
RfC	Inhalation Reference Concentratio	mg/m^3	3.00E-03
D_i	Diffusivity in Air	cm^2/s	6.05E-02
D_w	Diffusivity in Water	cm2/s	8.38E-06
D_A	Apparent Diffusivity	cm2/s	4.46E-06
K_{oc}	Soil Organic Carbon-Water Partition Coefficient	cm^3/g	1.54E+03
K_d	Soil-Water Partition Coefficient	cm^3/g	3.09E+00
H'	Henry's Law Constant	dimensionless	1.80E-02
RL_{soil}	Soil Reporting Limit	mg/kg	0.17
S	Water Solubility	mg/L	3.10E+01
C_{sat}	Soil Saturation Limit	mg/kg	1.00E+02

Soil Parameters:

Parameter	Definition	Units	Value
θ_w	Water-filled Soil Porosity	dimensionless (v/v)	0.23
θ_a	Air-filled Soil Porosity	dimensionless (v/v)	0.18
f_{oc}	(Fraction) Organic Carbon Content of Soil	dimensionless (w/w)	0.002
ρ_b	Dry Soil Bulk Density	g/cm^3	1.5
n	Total Soil Porosity	dimensionless (v/v)	0.41

Emission/Dispersion Parameters:

Parameter	Definition	Units	Value
Q/C	Inverse Concentration at Center of Source	$(g/m^2\text{-}s)/(kg/m^3)$	86.6
VF	Soil-to-Air Volatilization Factor	m^3/kg	6.94E+04
TAVF	Time-averaged volatilization flux	$mg/cm^2/day$	Optional Calculated
PEF	Particulate Emission Factor	m^3/kg	1.67E+09

Exposure Parameters:

Parameter	Definition	Units	Value
EF	Exposure Frequency	days/year	350
ED	Exposure Duration	years	26
ET	Exposure Time	hr/day	24
LT	Lifetime	years	70
T	Exposure Interval	seconds	8.20E+08
AT	Averaging Time	days/year	365
THQ	Target Hazard Quotient	dimensionless	1
TR	Target Cancer Risk	dimensionless	1.00E-06

Scenario Paramete

Parameter	Definition	Units	Value
LL1	Depth of Top of Contamination	cm	Optional
LL	Depth of Bottom of Contamination	cm	Optional
V	Fraction Vegetative Cover	dimensionless	0.5

If values entered, click here to recalculate VF

Calculated Inhalation Soil Criteria:

Inh	Volatile, Cancer	mg/kg	5.7	
Inh	Volatile, Noncancer	mg/kg	220	above Csat
Inh	Particulate, Cancer	mg/kg	140000	
Inh	Particulate, Noncancer	mg/kg	5E+06	> 1E+06 ppm

Residential Inhalation Soil Remediation Standard:

5.7 mg/kg

CONTROLLED BY THE VOLATILE CARCINOGENIC PATHWAY

Default exposure frequency = 350 days

Default exposure duration = 26 years

Default exposure time = 24 hours

SRWMP

NJDEP 2021 Inhalation Soil Remediation Standard Calculator: Residential

Site Name:	Generic Contaminated Site	Date:	6/9/2021
Contaminant:	Naphthalene	CAS No.:	91-20-3
		Evaluated by:	1LSRP

Contaminant Parameters:

Parameter	Definition	Units	Value
IUR	Inhalation Unit Risk Factor	$(\mu g/m^3)^{-1}$	3.40E-05
RfC	Inhalation Reference Concentratio	mg/m^3	3.00E-03
D_i	Diffusivity in Air	cm^2/s	6.05E-02
D_w	Diffusivity in Water	cm2/s	8.38E-06
D_A	Apparent Diffusivity	cm2/s	4.46E-06
K_{oc}	Soil Organic Carbon-Water Partition Coefficient	cm^3/g	1.54E+03
K_d	Soil-Water Partition Coefficient	cm^3/g	3.09E+00
H'	Henry's Law Constant	dimensionless	1.80E-02
RL_{soil}	Soil Reporting Limit	mg/kg	0.17
S	Water Solubility	mg/L	3.10E+01
C_{sat}	Soil Saturation Limit	mg/kg	1.00E+02

Soil Parameters:

Parameter	Definition	Units	Value
θ_w	Water-filled Soil Porosity	dimensionless (v/v)	0.23
θ_a	Air-filled Soil Porosity	dimensionless (v/v)	0.18
f_{oc}	(Fraction) Organic Carbon Content of Soil	dimensionless (w/w)	0.002
ρ_b	Dry Soil Bulk Density	g/cm^3	1.5
n	Total Soil Porosity	dimensionless (v/v)	0.41

Emission/Dispersion Parameters:

Parameter	Definition	Units	Value
Q/C	Inverse Concentration at Center of Source	$(g/m^2\text{-}s)/(kg/m^3)$	86.6
VF	Soil-to-Air Volatilization Factor	m^3/kg	6.94E+04
TAVF	Time-averaged volatilization flux	$mg/cm^2/day$	Optional Calculated
PEF	Particulate Emission Factor	m^3/kg	1.67E+09

Exposure Parameters:

Parameter	Definition	Units	Value	
EF	Exposure Frequency	days/year	200	changed
ED	Exposure Duration	years	20	changed
ET	Exposure Time	hr/day	3	changed
LT	Lifetime	years	70	
T	Exposure Interval	seconds	8.20E+08	
AT	Averaging Time	days/year	365	
THQ	Target Hazard Quotient	dimensionless	1	
TR	Target Cancer Risk	dimensionless	1.00E-06	

Scenario Paramete

Parameter	Definition	Units	Value
LL1	Depth of Top of Contamination	cm	Optional
LL	Depth of Contamination	cm	Optional
V	Fraction Vegetative Cover	dimensionless	0.5

If values entered, click here to recalculate VF

Calculated Inhalation Soil Criteria:

$Inh_{v\text{-}c}$	Volatile, Cancer	mg/kg	100	
$Inh_{v\text{-}nc}$	Volatile, Noncancer	mg/kg	3000	*above Csat*
$Inh_{p\text{-}c}$	Particulate, Cancer	mg/kg	3E+06	*> 1E+06 ppm*
$Inh_{p\text{-}nc}$	Particulate, Noncancer	mg/kg	7E+07	*> 1E+06 ppm*

Residential Inhalation Soil Remediation Standard:

100 mg/kg

CONTROLLED BY THE VOLATILE CARCINOGENIC PATHWAY

ARS exposure frequency = 200 days

ARS exposure duration = 20 years

ARS exposure time = 3 hours

Technical Consultation

- Technical Consultation with the Department is **required** before submittal of an ARS application for lead
- Technical Consultation with the Department is available upon request for any other contaminant

Questions?

ARS for Soil Requiring Pre-approval Alternative Land Uses

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Senior Human Health and Ecological Risk Assessor
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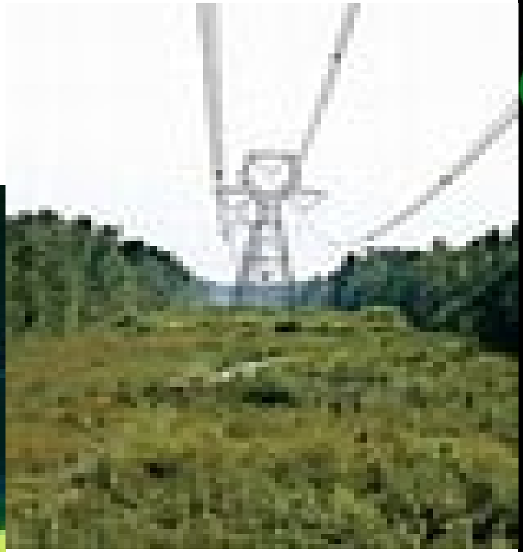


Alternative Land Uses

"ARS for soil options that require prior approval by the Department before being implemented, including guidance and examples of exposure factors for deriving an ARS for soil for exposure assumptions relevant to an ***alternative land use****…"*

Alternative Land Uses

Site-specific conditions (e.g., other than residential/non-residential land use) may result in exposures different from those assumed in the default SRS and include:

- **Active recreational use** (playing fields and playgrounds)
- **Passive recreational use** (land/trails for walking, cycling, hunting)
- **Restricted access areas** (rights-of-way to inspect/repair of utilities)
- **Infrequent access areas** (ecological preservation & conservation areas)

Alternative Land Use

Active Recreational

- This land use includes sports playing fields, playgrounds, and motorcycle and all-terrain vehicle (ATV) use areas
- Active sports or using playground, with direct contact with surface soil
- Disturbance of surface soil is expected

Alternative Land Use

Active Recreational

- Limited to certain times of the year, time of day or sports season, time spent will vary with activity
- All potential activities should be considered in developing RME/ARS
- Exposure to surface soil expected to be greater than other alternative land uses
- Motorcycle, mountain biking, ATV use have unique exposure scenarios (e.g., traffic plus inhalation)
- Evaluate on site or AOC-specific basis; technical consultation advised

Alternative Land Use

Active Recreational

When determining RME for this land use, potential exposure assumptions to consider include:

- Expected age groups engaged in recreational activities
- How much time spent
- Will other children be present (e.g., younger siblings) - how often?
- Will coaches be present - for how long?
- Are there spectators?
- Are there maintenance workers - how much time to perform maintenance? Are they subject to more exposure than others using the area?

Alternative Land Use

Passive Recreational

- Consists of land and trails for walking, cycling, hunting
- Largely undeveloped or environmentally sensitive area used for non-motorized activity
- People would be passing through the area with little time in one specific place
- Due to limited disturbance of the soil during these activities, expect minimal direct soil contact

Alternative Land Use

Passive Recreational

- Activities occur throughout the year
- All potential activities (e.g., walking, hiking, biking, jogging) should be considered to determine the RME/ARS, site or AOC-specific
- Depending on location (e.g., topography, activity) some areas may have both children and adults using area

Alternative Land Use

Passive Recreational

When determining the RME for this land use consider:

- Expected age groups using the area
- Time each age group will spend there
- Will other children (e.g., younger siblings) be present - how often?
- Are there maintenance workers? Are they subject to more exposure than others using the area – possibly making them the most sensitive receptor?

Alternative Land Use

Restricted Access

- Consists of right-of-way areas used to inspect, maintain and repair utilities
- People may clear land, install, upgrade and repair utilities
- Expected minimal direct contact with surface/subsurface soil; some activity (e.g., earthmoving) could increase contact
- Likely performed by small groups of workers throughout the year
- Site or AOC-specific; all potential activities should be considered in determining the RME

Alternative Land Use

Restricted Access

When determining RME consider:

- Time - days and hours per week - a worker spends within the restricted access area
- If area is owned by single entity (e.g., utility) limiting contact within the area to while working for utility?
- Will others be able to enter the restricted access area (e.g., is it fenced or just has no trespassing signs)?

Alternative Land Use

Infrequent Access

- Includes ecological preservation and conservation areas
- People observing nature, bird watching or hunting (if permitted)
- Assumes people walk into the area, remain in one area for a long period, relocating infrequently
- No major disturbance of soil expected; may clear a small area, exposing surface soil

Alternative Land Use

Infrequent Access

- These activities typically limited to certain times of the year or time of day (e.g., with migration of bird species)
- Length of time spent may vary greatly depending on the activity
- All activities that may happen must be considered in development of RME/ARS – site or AOC-specific

Alternative Land Use

Summary of ARS for Soil Results

- Table 2 has been provided as handout for reference
- Includes ARS for soil for six alternative land use examples, compared to default SRS
- Demonstrates how different activities and alternative land use can affect exposure and remedial standards
- Not the only possible scenarios that may be relevant for a given alternative land use
- **NOT default ARS for soil values**

Alternative Land Use

- Table 2 provides values derived using NJDEP calculators being discussed by Erica and Allan
- Includes ingestion-dermal & inhalation values – along with reporting limit and background level that may also be basis for ARS/SRS
- Health risk-based values may be derived for all contaminants
- Repeat – these are NOT default ARS for soil values - because
  - *All ARS are based on site or AOC-specific information, which may vary from examples in Table 2*

Summary of ARS Results - Table 2
See Handout

Table 2 - Summary of Example Alternative Remediation Standards Based on Site-Specific Exposure Variables

Chemical	CAS	Default Values				Active Recreation				Passive Recreation				Restricted Access Area		Infrequent Access Area	
		Residential	Footnote	Non-Residential	Footnote	Sports Playing Field	Footnote	Playground	Footnote	Jogger	Footnote	Hiker-Biker	Footnote	Utility Worker	Footnote	Birder	Footnote
Ingestion-Dermal Exposure Pathway Soil Remediation Standards (mg/kg)																	
Arsenic	7440-38-2	19	Bkg[11]	19	Bkg[11]	19	Bkg[11]	19	Bkg[11]	19	Bkg[11]	19	Bkg[11]	40	ING-C	36	ING-C
Benzene	71-43-2	3.0	ING-C	16	ING-C	16	ING-C	6.2	ING-C	17	ING-C	17	ING-C	300	ING-C	260	ING-C
Benzo(a)pyrene[12]	50-32-8	0.51	ING-C	2.3	ING-C	2.6	ING-C	1.1	ING-C	2.5	ING-C	2.8	ING-C	44	ING-C	39	ING-C
Cadmium	7440-43-9	71	ING-N	1,100	ING-N	380	ING-N	130	ING-N	1,200	ING-N	500	ING-N	8,300	ING-N	19,000	ING-N
4,4'-DDT	50-29-3	1.9	ING-C	9.5	ING-C	9.7	ING-C	3.9	ING-C	10	ING-C	11	ING-C	180	ING-C	160	ING-C
Manganese	7439-96-5	1,900	ING-N	31,000	ING-N	10,000	ING-N	3,300	ING-N	35,000	ING-N	13,000	ING-N	230,000	ING-N	540,000	ING-N
Mercury	7439-97-6	23	ING-N	390	ING-N	130	ING-N	41	ING-N	440	ING-N	160	ING-N	2,900	ING-N	6,700	ING-N
Naphthalene	91-20-3	2,500	ING-N	34,000	ING-N	13,000	ING-N	4,300	ING-N	39,000	ING-N	17,000	ING-N	260,000	ING-N	590,000	ING-N
Vinyl Chloride	75-01-4	0.97	ING-C	5.0	ING-C	5.0	ING-C	2.0	ING-C	5.5	ING-C	5.5	ING-C	95	ING-C	84	ING-C
Xylenes	1330-20-7	12,000	ING-N	190,000	ING-N	63,000	ING-N	21,000	ING-N	220,000	ING-N	82,000	ING-N	NA	a	NA	a
Inhalation Exposure Pathway Soil Remediation Standards (mg/kg)																	
Arsenic	7440-38-2	1,100	INH-C	5,200	INH-C	61,000	INH-C	45,000	INH-C	46,000	INH-C	52,000	INH-C	99,000	INH-C	88,000	INH-C
Benzene	71-43-2	2.2	INH-C	11	INH-C	120	INH-C	92	INH-C	93	INH-C	110	INH-C	200	INH-C	180	INH-C
Benzo(a)pyrene[12]	50-32-8	3,500	INH-C	16,000	INH-C	110,000	INH-C	73,000	INH-C	150,000	INH-C	150,000	INH-C	120,000	INH-C	280,000	INH-C
Cadmium	7440-43-9	2,600	INH-C	12,000	INH-C	150,000	INH-C	110,000	INH-C	110,000	INH-C	120,000	INH-C	240,000	INH-C	210,000	INH-C
4,4'-DDT	50-29-3	NA	b	NA	b	NA	b	NA	b	NA	b	NA	b	NA	b	NA	b
Manganese	7439-96-5	87,000	INH-N	400,000	INH-N	NA	a	NA	a	NA	a	NA	a	NA	a	NA	a
Mercury	7439-97-6	520,000	INH-N	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c
Naphthalene	91-20-3	5.7	INH-C	27	INH-C	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c
Vinyl Chloride	75-01-4	1.4	INH-C	6.4	INH-C	76	INH-C	56	INH-C	57	INH-C	64	INH-C	120	INH-C	110	INH-C
Xylenes	1330-20-7	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c	NA	a,c
More Restrictive of Ingestion-Dermal and Inhalation Exposure Pathways Soil Remediation Standards (mg/kg)[d]																	
Arsenic	7440-38-2	19	Bkg[11]	19	Bkg[11]	19	Bkg[11]	19	Bkg[11]	19	Bkg[11]	19	Bkg[11]	40	ING-C	36	ING-C
Benzene	71-43-2	2.2	INH-C	11	INH-C	16	ING-C	6.2	ING-C	17	ING-C	17	ING-C	200	INH-C	180	INH-C
Benzo(a)pyrene[12]	50-32-8	0.51	ING-C	2.3	ING-C	2.6	ING-C	1.1	ING-C	2.5	ING-C	2.8	ING-C	44	ING-C	39	ING-C
Cadmium	7440-43-9	71	ING-N	1,100	ING-N	380	ING-N	130	ING-N	1,200	ING-N	500	ING-N	8,300	ING-N	19,000	ING-N
4,4'-DDT	50-29-3	1.9	ING-C	9.5	ING-C	9.7	ING-C	3.9	ING-C	10	ING-C	11	ING-C	180	ING-C	160	ING-C
Manganese	7439-96-5	1,900	ING-N	31,000	ING-N	10,000	ING-N	3,300	ING-N	35,000	ING-N	13,000	ING-N	230,000	ING-N	540,000	ING-N
Mercury	7439-97-6	23	ING-N	390	ING-N	130	ING-N	41	ING-N	440	ING-N	160	ING-N	2,900	ING-N	6,700	ING-N
Naphthalene	91-20-3	5.7	INH-C	27	INH-C	13,000	ING-N	4,300	ING-N	39,000	ING-N	17,000	ING-N	260,000	ING-N	590,000	ING-N
Vinyl Chloride	75-01-4	0.97	ING-C	5.0	ING-C	5.0	ING-C	2.0	ING-C	5.5	ING-C	5.5	ING-C	95	ING-C	84	ING-C
Xylenes	1330-20-7	12,000	ING-N	190,000	ING-N	63,000	ING-N	21,000	ING-N	220,000	ING-N	82,000	ING-N	NA	a	NA	a

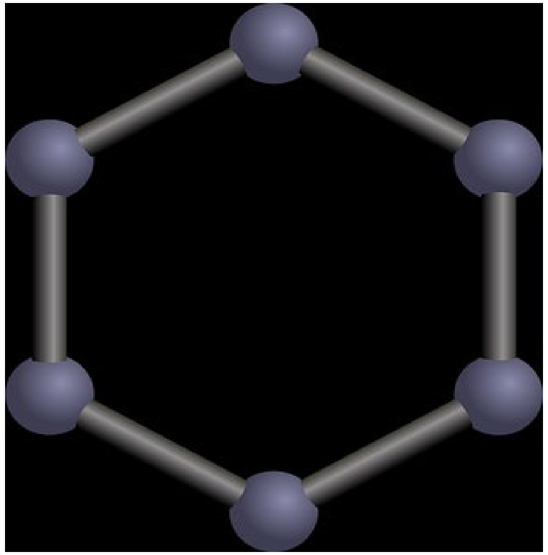
Table 2 Examples
How They Vary and What Drives Them

Arsenic

- Default based on state-wide background of 19 mg/kg
- Lower assumed exposure in restricted and infrequent access scenarios increases ARS values (e.g., utility worker - 40 mg/kg in Table 2)

Table 2 Examples How They Vary and What Drives Them

Benzene



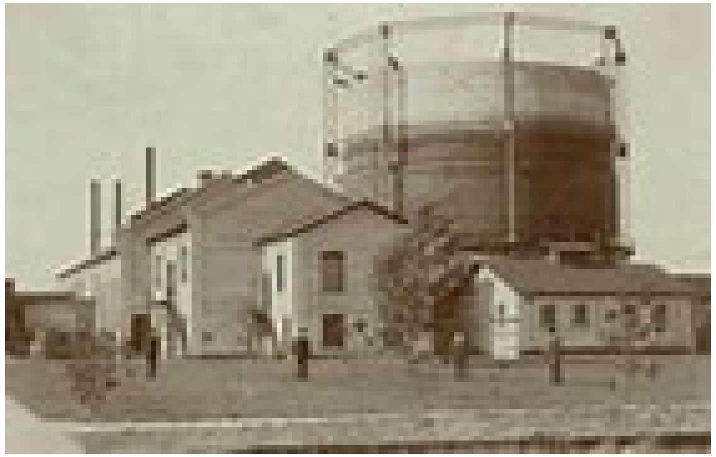
- Inhalation exposure pathway is the driver for the default SRS
- Alternative land use results in ingestion-dermal exposure pathway as the driver for 4 of 6 scenarios
- This occurs due to similar toxicity values for the two exposure pathways

  The benzene residential SRS for inhalation is 2.2 mg/kg; for ingestion-dermal 3.0 mg/kg.

- In scenarios where hours/day were adjusted (active and passive recreation) ingestion-dermal becomes the driver; however, where hours/day were not adjusted (restricted and infrequent access scenarios) inhalation remains the driver

Table 2 Examples
How They Vary and What Drives Them

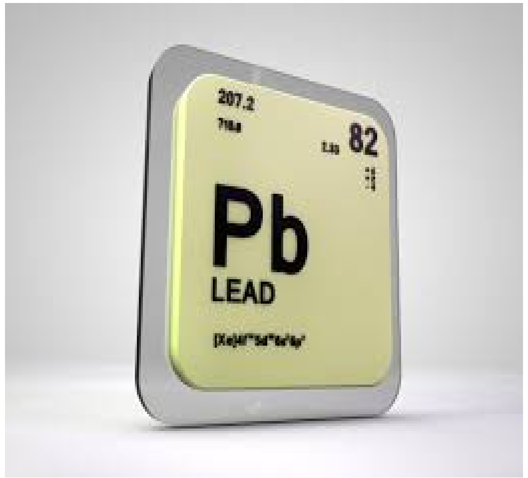
Benzo(a)pyrene



- ARS examples are slightly higher than SRS in most land use scenarios
- Both ingestion-dermal and inhalation values for restricted and infrequent use scenarios using calculator are notably higher than SRS
- The example scenarios assume less exposure, which drives higher ARS
- Like SRS, ARS examples are driven by the ingestion-dermal pathway, with values orders of magnitude lower than for inhalation

Thank You!

ARS for Soil-Born Lead



Mark Maddaloni, DrPH, DABT
Cardno/ChemRisk
swati.toppin@dep.nj.gov

ARS Recommendations for Pb

- Unique Assessment
  - No recognized threshold for neurocognitive effects in kids
    - CDC (2012) No measured BLL that's not associated with IQ deficits
  - Biokinetic modeling approach based on predicted BLL
    - EPA IEUBK Model for Children
    - Policy position for establishing target BLL (moving target)

https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals

ARS Recommendations for Pb

- EPA Adult Pb Model (for non-residential adult exposures)
  - Simplified biokinetic model
  - Protects fetus of pregnant woman
- EPA All Ages Pb Model (in beta testing)
  - Models entire lifetime
  - Can model acute, intermittent and episodic exposures
  - Not quite ready for prime time

ARS Recommendations for Pb

- Requirement
  - **Consult with NJDEP**

  http://www.state.nj.us/dep/srp/srra/technical_consultation/
- Additional resources
  - EPA Region 2 TRW Member
    - McPherson.Julie@epa.gov
  - EPA Pb Model Hotline
    - 1 (800) 424-LEAD

www.shutterstock.com · 590600966

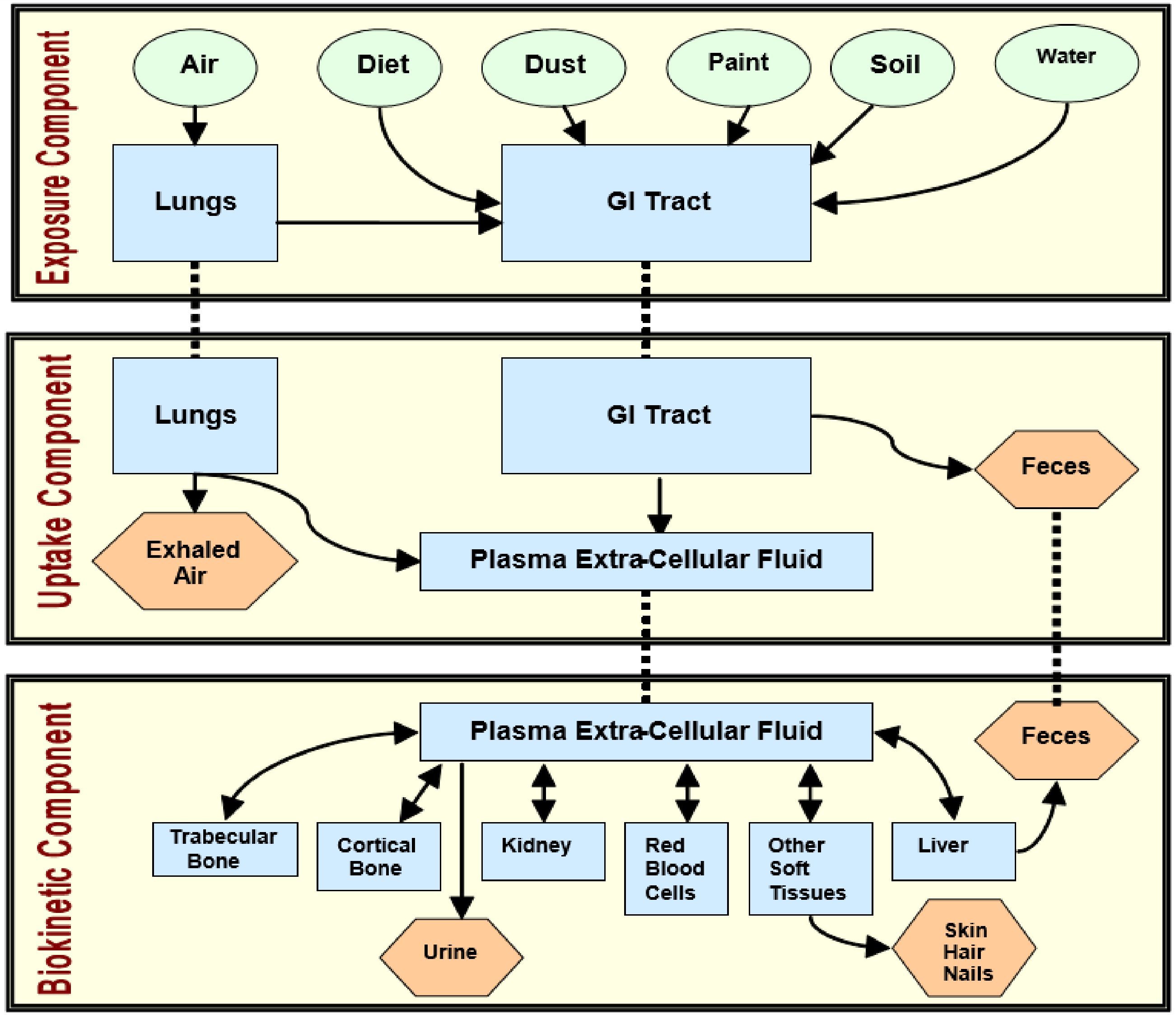
No shopping around for clean-up numbers!

Land Use

- SRS for Residential - 400 ppm
- SRS for Non-Residential - 800 ppm

(both values based on a target BLL of 10 ug/dl)

IEUBK Pb Model Input Parameters



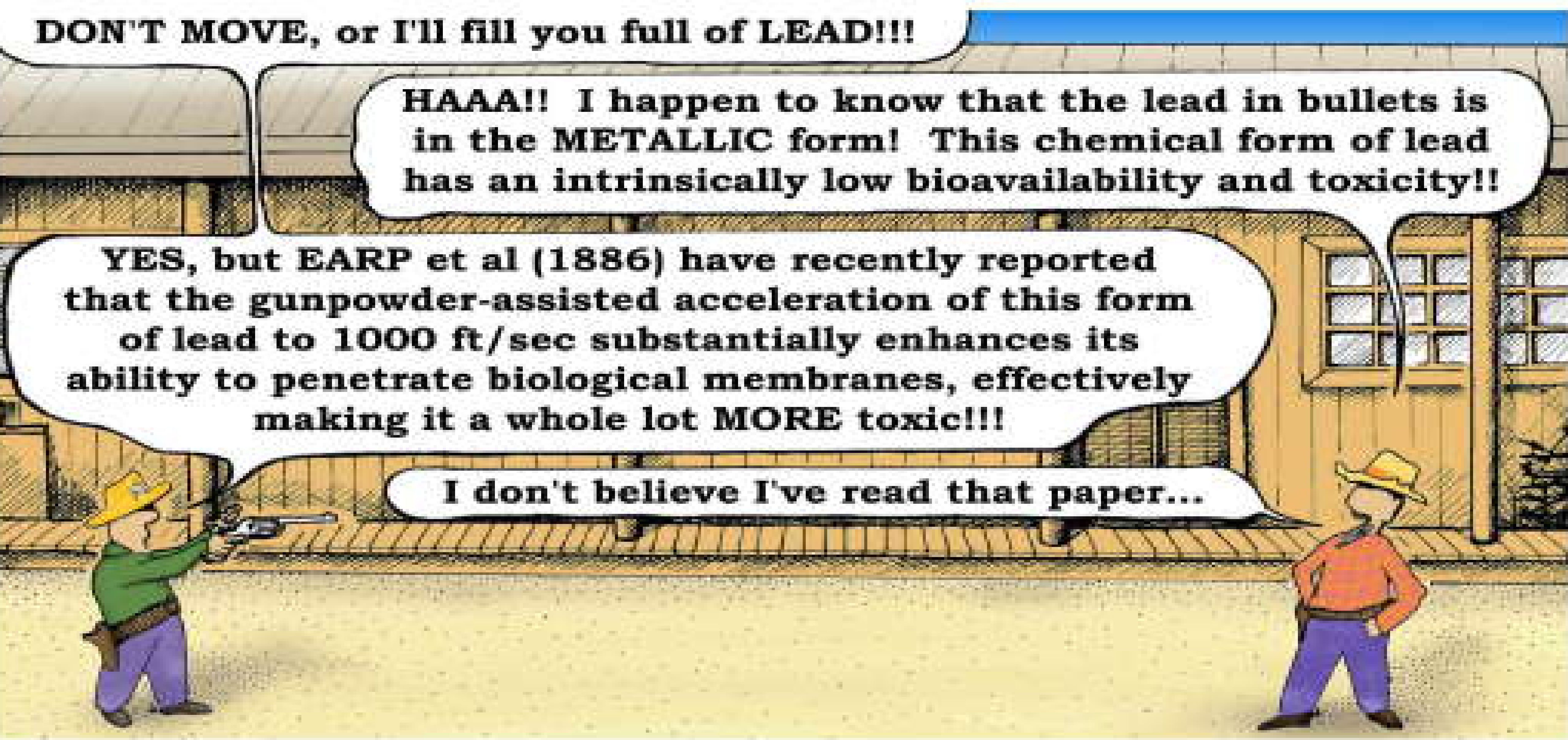
IEUBK Pb Model Input Parameters Not Adjustable

- Maternal/neonatal
- GSD - hard to support alternative value
- Same for MSD and soil/dust fractions
- Soil ingestion rate (in flux)
    - Moot for purpose of ARS development
    - NJDEP recommends using Version 1.1 of IEUBK Pb Model

ARS for lead soil contamination Adjustable Input Parameters

- Site-specific alternative land use exposure scenario
  - Exposure Frequency (days/year) can be adjusted following USEPA's *Assessing Intermittent or Variable Exposures at Lead Sites* (2003)
  - Most meet minimum pseudo steady-state exposure criteria
    - 1 day/week for a 3 month continuous exposure duration
- Bioaccessibility/Bioavailability of lead in soils
  - Use of site-specific data for residential, nonresidential, or alt land use
  - EPA validated *in vitro* extraction test
    - Can cut both ways ➡ default RBA (soil:water) is 60%

https://www.epa.gov/superfund/soil-bioavailability-superfund-sites-guidance



ENVIRONMENTAL SCIENTISTS IN THE WILD WEST

Questions?

BREAK

Inhalation Exposure Pathway Alternative Remediation Standards Which do not Require Pre-Approval

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SRWMP

Inhalation Exposure Pathway Alternative Remediation Standards

- Inhalation ARS based on physical properties does not require pre-approval from the Department prior to use (N.J.A.C. 7:26D-8.5)
- Technical Consultation with the Department is available upon request
- ARS Option details specified in N.J.A.C. 7:26D Appendix 7 and *Alternative Remediation Standards Technical Guidance for Soil for the Ingestion-Dermal and Inhalation Exposure Pathways*

Inhalation Exposure Pathway Alternative Remediation Standards

ARS options developed in accordance with N.J.A.C. 7:26D Appendix 7 III(b) (preapproval not required)

- Depth Range of Contamination
- Soil Organic Carbon Content (f_{oc})
- Fraction of Vegetative Cover (V)

Inhalation Exposure Pathway Alternative Remediation Standards

Depth Range of Contamination

- Default 0 cm to infinity
- Effects Volatiles Only
- Determine contaminant depth
  - d1 = shallowest depth at Site or AOC where contamination exceeds default standard
  - d2 = deepest depth at Site or AOC where contamination exceeds default standard

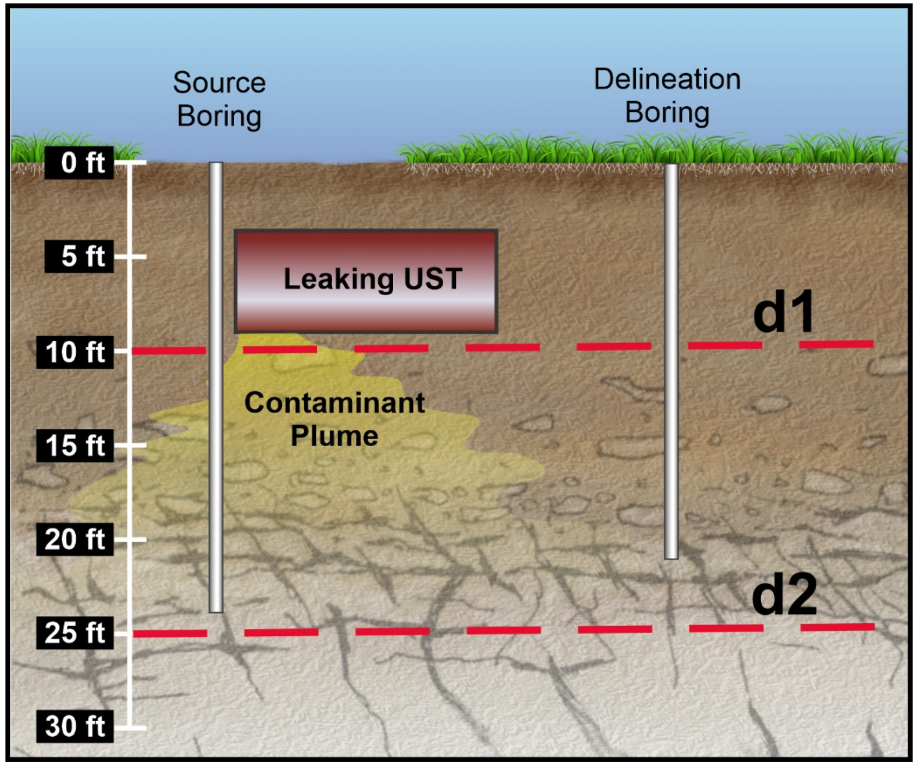
Inhalation Exposure Pathway Alternative Remediation Standards

Depth Range of Contamination

- Convert depths to cm
- Use d1 and d2 in the Department's calculator
- Provide the following information to the Department:
  - The resultant ARS
  - A description and basis of how the input parameters were selected
  - A description of any institutional and engineering controls
    - If depth starts at 0 cm, then no institutional control, otherwise need one

Inhalation Exposure Pathway Alternative Remediation Standards

Depth Range of Contamination



- d1 = 10 feet
  - 10 feet * 12 inches/foot = 120 inches
  - 120 inches * 2.54 cm/inch = 304.8 cm
- d2 = 25 feet
  - 25 feet * 12 inches/foot = 300 inches
  - 300 inches * 2.54 cm/inch = 762 cm

Inhalation Exposure Pathway Alternative Remediation Standards

Soil Organic Carbon Content (f_{oc})

- Default 0.2% (0.002) kg/kg
- Effects Volatiles Only
- Determine f_{oc} and use in the Department's calculator
- Provide the following information to the Department:
  - The resultant ARS
  - A description and basis of how the input parameters were selected
  - A description of any institutional and engineering controls

Inhalation Exposure Pathway Alternative Remediation Standards

Soil Organic Carbon Content (f_{oc})

- Collect and analyze samples for determining f_{oc} in accordance with Department guidance
  - Minimum of three samples
  - Not in areas of high organic contamination - interference
  - Representative of soil type and contaminant depth in AOC
- Analyze using Lloyd Kahn Method or equivalent

Test Your Knowledge

True or False:

When collecting samples to determine f_{oc} , the Department's guidance recommends a minimum of 3 samples.

A. True

B. False

Test Your Knowledge

True or False:

When collecting samples to determine f_{oc} , the Department's guidance recommends a minimum of 3 samples.

A. True

B. False

Inhalation Exposure Pathway Alternative Remediation Standards

Soil Organic Carbon Content (f_{oc})

- Average or lowest value (not less than 0.002):
  - Lowest if less than three samples
  - Lowest if difference is greater than an order of magnitude
  - Average if three or more samples and difference is less than an order of magnitude
- Calculator will determine appropriate f_{oc} if values are entered

Inhalation Exposure Pathway Alternative Remediation Standards

Fraction of Vegetative Cover (V)

- Default 50%
- Affects Particulates Only
- Determine V and use in the Department's calculator
- Provide the following information to the Department:
  - The resultant ARS
  - A description and basis of how the input parameters were selected
  - A description of any institutional and engineering control

Inhalation Exposure Pathway Alternative Remediation Standards

Fraction of Vegetative Cover (V)

- Impervious surfaces (concrete, asphalt, buildings) are not considered in V
- Vegetation and bare soil are considered in V
- V (versus soil) must be maintained and monitored to be an effective engineering control
- V is the amount of soil covered by vegetation using standard ecological techniques (e.g., grid or plot sampling)

Inhalation Exposure Pathway Alternative Remediation Standards

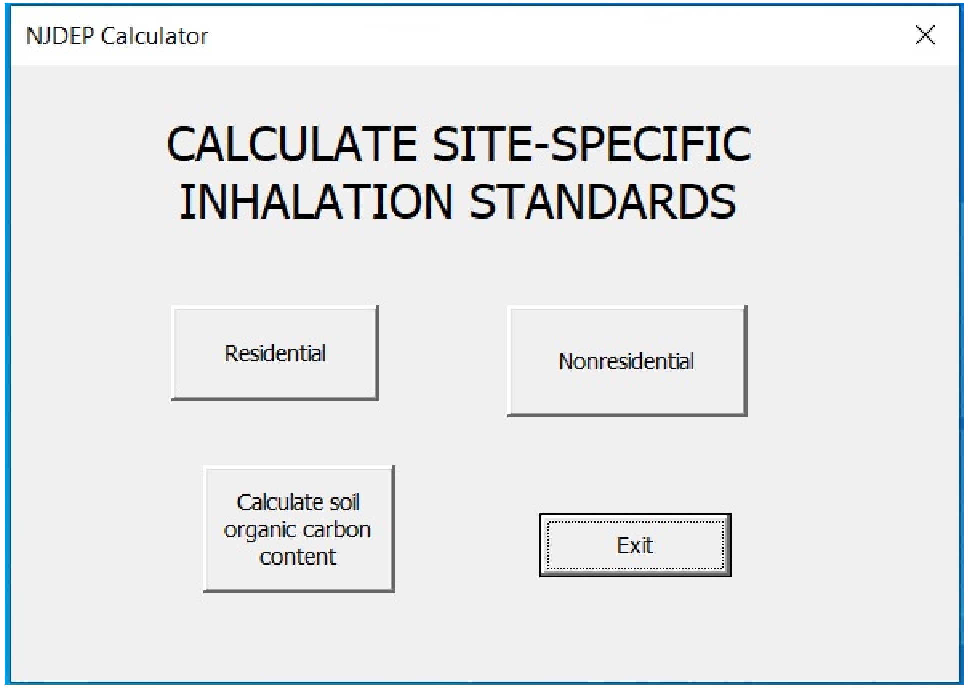
Fraction of Vegetative Cover (V)

50% Vegetation

50% Vegetation

100% Vegetation

Inhalation Exposure Pathway Alternative Remediation Standards



NJDEP 2021 Inhalation Soil Remediation Standard Calculator: Residential

Site Name:	Generic Contaminated Site	Date:	6/9/2021
Contaminant:	Naphthalene	CAS No.:	91-20-3
		Evaluated by:	LSRP

Contaminant Parameters:

Parameter	Definition	Units	Value
IUR	Inhalation Unit Risk Factor	$(\mu g/m^3)^{-1}$	3.40E-05
RfC	Inhalation Reference Concentratio	mg/m^3	3.00E-03
D_i	Diffusivity in Air	cm^2/s	6.05E-02
D_w	Diffusivity in Water	cm2/s	8.38E-06
D_A	Apparent Diffusivity	cm2/s	4.46E-06
K_{oc}	Soil Organic Carbon-Water Partition Coefficient	cm^3/g	1.54E+03
K_d	Soil-Water Partition Coefficient	cm^3/g	3.09E+00
H'	Henry's Law Constant	dimensionless	1.80E-02
RL_{soil}	Soil Reporting Limit	mg/kg	0.17
S	Water Solubility	mg/L	3.10E+01
C_{sat}	Soil Saturation Limit	mg/kg	1.00E+02

Exposure Parameters:

Parameter	Definition	Units	Value
EF	Exposure Frequency	days/year	350
ED	Exposure Duration	years	26
ET	Exposure Time	hr/day	24
LT	Lifetime	years	70
T	Exposure Interval	seconds	8.20E+08
AT	Averaging Time	days/year	365
THQ	Target Hazard Quotient	dimensionless	1
TR	Target Cancer Risk	dimensionless	1.00E-06

Soil Parameters:

Parameter	Definition	Units	Value
θ_w	Water-filled Soil Porosity	dimensionless (v/v)	0.23
θ_a	Air-filled Soil Porosity	dimensionless (v/v)	0.18
f_{oc}	(Fraction) Organic Carbon Content of Soil	dimensionless (w/w)	0.002
ρ_b	Dry Soil Bulk Density	g/cm^3	1.5
n	Total Soil Porosity	dimensionless (v/v)	0.41

Emission/Dispersion Parameters:

Parameter	Definition	Units	Value
Q/C	Inverse Concentration at Center of Source	$(g/m^2\text{-}s)/(kg/m^3)$	86.6
VF	Soil-to-Air Volatilization Factor	m^3/kg	6.94E+04
TAVF	Time-averaged volatilization flux	$mg/cm^2/day$	Optional Calculated
PEF	Particulate Emission Factor	m^3/kg	1.67E+09

Scenario Paramete

Parameter	Definition	Units	Value
LL1	Depth of Top of Contamination	cm	Optional
LL	Depth of Bottom of Contamination	cm	Optional
V	Fraction Vegetative Cover	dimensionless	0.5

If values entered, click here to recalculate VF

Calculated Inhalation Soil Criteria:

$Inh_{v,c}$	Volatile, Cancer	mg/kg	5.7	
$Inh_{v,n}$	Volatile, Noncancer	mg/kg	220	above Csat
$Inh_{p,c}$	Particulate, Cancer	mg/kg	140000	
$Inh_{p,n}$	Particulate, Noncancer	mg/kg	5E+06	>1E+06 ppm

Residential Inhalation Soil Remediation Standard:

5.7 mg/kg

CONTROLLED BY THE VOLATILE CARCINOGENIC PATHWAY

Soil Parameters:

Parameter	Definition	Units	Value
θ_w	Water-filled Soil Porosity	dimensionless (v/v)	0.23
θ_a	Air-filled Soil Porosity	dimensionless (v/v)	0.18
f_{oc}	(Fraction) Organic Carbon Content of Soil	dimensionless (w/w)	0.002
ρ_b	Dry Soil Bulk Density	g/cm^3	1.5
n	Total Soil Porosity	dimensionless (v/v)	0.41

Scenario Parameters:

Parameter	Definition	Units	Value
LL1	Depth of Top of Contamination	cm	Optional
LL	Depth of Bottom of Contamination	cm	Optional
V	Fraction Vegetative Cover	dimensionless	0.5

If values entered, click here to recalculate VF

Calculated Inhalation Soil Criteria:

$Inh_{v,c}$	Volatile, Cancer	mg/kg	5.7	
$Inh_{v,n}$	Volatile, Noncancer	mg/kg	220	above Csat
$Inh_{p,c}$	Particulate, Cancer	mg/kg	140000	
$Inh_{p,n}$	Particulate, Noncancer	mg/kg	5200000	>1E+06 ppm

Soil Parameters:

Parameter	*Definition*	*Units*	*Value*	
θ_w	Water-filled Soil Porosity	dimensionless (v/v)	0.23	
θ_a	Air-filled Soil Porosity	dimensionless (v/v)	0.18	
f_{oc}	(Fraction) Organic Carbon Content of Soil	dimensionless (w/w)	0.003	**changed**
ρ_b	Dry Soil Bulk Density	g/cm^3	1.5	
n	Total Soil Porosity	dimensionless (v/v)	0.41	

Scenario Parameters: **depth range modified**

Parameter	*Definition*	*Units*	*Value*
LL1	Depth of Top of Contamination	cm	304.8
LL	Depth of Bottom of Contaminantion	cm	7.62E+02
V	Fraction Vegetative Cover	dimensionless	0.5

If values entered, click here to recalculate VF

Calculated Inhalation Soil Criteria:

$Inh_{v,c}$	Volatile, Cancer	mg/kg	**3.9E+09**	*above Csat*
$Inh_{v,n}$	Volatile, Noncancer	mg/kg	**1.5E+11**	*above Csat*
$Inh_{p,c}$	Particulate, Cancer	mg/kg	**140000**	
$Inh_{p,n}$	Particulate, Noncancer	mg/kg	**5200000**	*>1E+06 ppm*

Residential Inhalation Soil Remediation Standard:

140000 mg/kg

CONTROLLED BY THE PARTICULATE CARCINOGENIC PATHWAY

Soil Parameters:

Parameter	Definition	Units	Value	
θ_w	Water-filled Soil Porosity	dimensionless (v/v)	0.23	
θ_a	Air-filled Soil Porosity	dimensionless (v/v)	0.18	
f_{oc}	(Fraction) Organic Carbon Content of Soil	dimensionless (w/w)	0.003	changed
ρ_b	Dry Soil Bulk Density	g/cm^3	1.5	
n	Total Soil Porosity	dimensionless (v/v)	0.41	

Scenario Parameters: depth range modified

Parameter	Definition	Units	Value	
LL1	Depth of Top of Contamination	cm	304.8	
LL	Depth of Bottom of Contaminantion	cm	7.62E+02	
V	Fraction Vegetative Cover	dimensionless	0.75	changed

If values entered, click here to recalculate VF

Calculated Inhalation Soil Criteria:

$Inh_{v,c}$	Volatile, Cancer	mg/kg	**3.9E+09**	*above Csat*
$Inh_{v,n}$	Volatile, Noncancer	mg/kg	**1.5E+11**	*above Csat*
$Inh_{p,c}$	Particulate, Cancer	mg/kg	**270000**	
$Inh_{p,n}$	Particulate, Noncancer	mg/kg	**10000000**	*>1E+06 ppm*

Residential Inhalation Soil Remediation Standard:

270000 mg/kg

CONTROLLED BY THE PARTICULATE CARCINOGENIC PATHWAY

Thank you!

Submittal of an ARS for Ingestion-Dermal and Inhalation Exposure Pathways

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Submittal of an ARS for Ingestion-Dermal and Inhalation Exposure Pathways

- LSRP must complete *Alternative or Interim Remediation Standard and/or Screening Level Application Form* and *Remediation Standard Notification Spreadsheet*
- The form, spreadsheet, and instructions for both can be found under "General Forms" in the Forms Library

[NJDEP SRP - Site Remediation Reform Act (SRRA): Forms (state.nj.us)]

Submittal of an ARS for Ingestion-Dermal and Inhalation Exposure Pathways

New Jersey Department of Environmental Protection
Site Remediation and Waste Management Program

ALTERNATIVE OR INTERIM REMEDIATION STANDARD AND/OR SCREENING LEVEL APPLICATION FORM

Date Stamp
(For Department use only)

NOTE: This form shall be completed for all contaminants for which interim or alternative remediation standards are being implemented and/or requested for a site or area of concern for the ingestion-dermal exposure pathway, inhalation exposure pathway, migration to ground water exposure pathway, or indoor air vapor intrusion exposure pathway. This form is also used for development of interim or alternative vapor intrusion screening levels (ground water, soil gas, and rapid action level for indoor air), ecological risk-based remediation goals, and/or ecological risk management decision goals. The form shall be used regardless of whether Department pre-approval is required.

SECTION A. SITE NAME AND LOCATION

Site Name:
List all AKAs:
Street Address:
Municipality: (Township, Borough, Village, or City)
County: Zip Code:
Program Interest (PI) Number(s):
Case Tracking Number(s):

SECTION B. REMEDIATION STANDARD NOTIFICATION SPREADSHEET

Complete and attach the Remediation Standard Notification Spreadsheet which can be found at: http://www.nj.gov/dep/srp/srra/forms/. This form will not be processed by the NJDEP if the spreadsheet is not attached.

SECTION C. PURPOSE FOR SUBMISSION

1. **Pre-Approval Required:**

- ☐ Ingestion-Dermal Alternative Soil Remediation Standard
- ☐ Inhalation Alternative Soil Remediation Standard (Exposure Factors)
- ☐ Migration to Ground Water Alternative Soil Remediation Standard
  - ☐ SESOIL
  - ☐ SESOIL/AT123D
  - ☐ Dilution-Attenuation Factor (DAF)
  - ☐ Ground Water Quality Standard for Class I or Class III classification
- ☐ Indoor Air Vapor Intrusion Alternative Remediation Standard
- ☐ Ecological Risk-Based Remediation Goal
- ☐ Ecological Risk Management Decision Goal
- ☐ Ecological Remediation Goal Based on Background Concentration
- ☐ Development of Interim Remediation Standard
  - ☐ Soil Ingestion-Dermal Exposure Pathway
  - ☐ Soil Inhalation Exposure Pathway
  - ☐ Migration to Ground Water Exposure Pathway
  - ☐ Indoor Air Vapor Intrusion Exposure Pathway
- ☐ Standard Developed Using Alternative Method Not in Rule

2. **No Pre-Approval Required:**

- ☐ Inhalation Alternative Soil Remediation Standard
  - ☐ Vegetative Cover
  - ☐ Organic Carbon Content of Soil
  - ☐ Depth of Contamination
- ☐ Migration to Ground Water Alternative Soil Remediation Standard
  - ☐ Soil-Water Partition Equation (SWPE) except when site-specific DAF is proposed
  - ☐ Synthetic Precipitation Leaching Procedure (SPLP) except when site-specific DAF is proposed
  - ☐ Organic Carbon Content of Soil
  - ☐ Narrative Standards
    - ☐ Immobile Chemicals
    - ☐ Site Soil and Ground Water Data Evaluation
- ☐ Vapor Intrusion Alternative Screening Level
  - ☐ Ground Water
  - ☐ Soil Gas
  - ☐ Rapid Action Level for Indoor Air
- ☐ Development of Interim Vapor Intrusion Screening Level
- ☐ Alternative Ecological Screening Criteria

SECTION D. PERSON RESPONSIBLE FOR CONDUCTING THE REMEDIATION INFORMATION AND CERTIFICATION

Full Legal Name of the Person Responsible for Conducting the Remediation:
Representative First Name: Representative Last Name:
Title:
Phone Number: Ext: Fax:
Mailing Address:
City/Town: State: Zip Code:
Email Address:

This certification shall be signed by the person responsible for conducting the remediation who is submitting this notification in accordance with Administrative Requirements for the Remediation of Contaminated Sites rule at N.J.A.C. 7:26C-1.5(a).

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, including all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, to the best of my knowledge, I believe that the submitted information is true, accurate and complete. I am aware that there are significant civil penalties for knowingly submitting false, inaccurate or incomplete information and that I am committing a crime of the fourth degree if I make a written false statement which I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

Signature: Date:
Name/Title:

Submittal of an ARS for Ingestion-Dermal and Inhalation Exposure Pathways

New Jersey Department of Environmental Protection
Site Remediation and Waste Management Program

REMEDIATION STANDARD NOTIFICATION SPREADSHEET
FOR
INTERIM OR ALTERNATIVE REMEDIATION STANDARD
INTERIM OR ALTERNATIVE SCREENING LEVEL

Instructions | Clear Form

Site Name: Generic Contaminated Site
Program Interest Number: 123456789

Chemical Name	CAS Number	Concentration Range on Site (include units)	Exposure Pathway and Option	Scenario	Type of Remediation Standard/ Screening Level/ Ecological Goal/Ecological Criterion	Default Remediation Standard/ Screening level/ Ecological Criterion (include units)	Proposed Remediation Standard/ Screening Level/Ecological Goal/Ecological Criterion (include units)
Benzene	71-43-2	ND - 28 mg/kg	Inhalation- Depth of Contamination	Other	Alternative Standard	2.2 mg/kg	14 mg/kg
Benzene	71-43-2	ND - 28 mg/kg	Ingestion-Dermal	Other	Alternative Standard	3.0 mg/kg	13 mg/kg
Benzene	71-73-2	ND - 28 mg/kg	Migration to Ground Water – Soil Water Partition Equation	Other	Alternative Standard	0.0094 mg/kg	0.094 mg/kg

Submittal of an ARS for Ingestion-Dermal and Inhalation Exposure Pathways

Exposure Pathway and Option
Ingestion-Dermal
Inhalation - Exposure Factors
Inhalation- Vegetative Cover
Inhalation- Organic Carbon Content of Soil
Inhalation- Depth of Contamination
Migration to Ground Water – Soil Water Partition Equation
Migration to Ground Water – DAF
Migration to Ground Water – SPLP
Migration to Ground Water – SESOIL model
Migration to Ground Water – SESOIL/AT123D model
Migration to Ground Water - Immobile chemical
Migration to Ground Water- Site Soil and GW Data Evaluation
Migration to Ground Water- GWQS for Class I or III Classification
Vapor Intrusion Indoor Air Remediation Standard
Vapor Intrusion Soil Gas Screening Level
Vapor Intrusion Ground Water Screening Level
Vapor Intrusion Rapid Action Level
Ecological Risk Based Remediation Goal
Ecological Risk Management Decision Goal
Ecological Screening Criterion

Scenario
Non-residential
Not Applicable
Other
Ecological

Type of Remediation Standard/ Screening Level/ Ecological Goal/Ecological Criterion
Alternative Standard
Interim Standard
Alternative Screening Level
Interim Screening Level
Ecological Risk Based Remediation Goal
Ecological Risk Management Decision Goal

Submittal of an ARS for Ingestion-Dermal and Inhalation Exposure Pathways

- Pursuant to N.J.A.C. 7:26D Appendices 6 & 7, the following is required to be submitted with the form and spreadsheet:
  - ARS calculations using Department's calculator or Pb model
  - List of modified parameters
  - Description of justification of site-specific parameters
  - Institutional and engineering controls (as needed)
  - Remedial Action Permit, pursuant to N.J.A.C. 7:26C-7 (as needed)

Submittal of an ARS for Ingestion-Dermal and Inhalation Exposure Pathways

Questions?

Vapor Intrusion Technical Guidance, Screening Levels, and Development of Alternative Values

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Committee Members

NJDEP

- Carey Compton (Chair, retired)
- Nicole Kalaigian, Chair
- John Boyer (retired)
- Diane Groth (retired)
- Andrew Sites (retired)
- Erica Snyder
- Chad VanSciver

Stakeholders

- Ken Bird, Woodard and Curran Consultants
- Brian Blum, Langan Consultants
- Scott Drew, Geosyntec Consultants
- John Engdahl, Speedway
- Peter Sorge, JM Sorge, Inc.

Additional Technical Assistance

NJDEP

- Paul Bauer
- Barry Frasco
- David Haymes
- Alex Iannone
- Steve MacGregor
- Sana Qureshi
- Paul Sanders (retired)
- Bridget Sweeney
- Renee Wright

Stakeholders

- Gunnar Barr, OBAR Systems
- Bill Morris, Vapor Mitigation Systems

What's New?

- Pursuant to N.J.A.C. 7:26D, Indoor Air Screening Levels are now Indoor Air Remediation Standards (IARS)
- Vapor Intrusion Technical (VIT) Guidance (version 5.0)
- Vapor Intrusion Screening Levels (VISL) updated to be consistent with new IARS

What's New?

- Basis and Background Documents:
  - IARS for the Vapor Intrusion Exposure Pathway
  - Vapor Intrusion Screening Levels
- Updated NJDEP Johnson and Ettinger (J&E) Spreadsheets

Where Can I Find It All?

Department's Vapor Intrusion Pathway Website Updated!!!!!!!!!!!!

[NJDEP SRP - Guidance: Vapor Intrusion Pathway - Indoor Air]

Site Remediation Program

Vapor Intrusion Pathway

The presence of volatile chemicals in contaminated soil or ground water offers the potential for chemical vapors to migrate through subsurface soils and/or preferential pathways (such as underground utilities) thereby impacting the indoor air quality of area buildings. Vapor intrusion refers to this migration of volatile chemicals from the subsurface into overlying buildings. The vapor intrusion information linked from this page represent specific guidance developed by the Department to assist in the investigation of the vapor intrusion pathway at contaminated sites.

The Vapor Intrusion Technical Guidance Version 5.0, Posted May 2021

It is recommended that the user periodically refer to the NJDEP Vapor Intrusion web site for the latest information on the vapor intrusion pathway.

Vapor Intrusion Technical Information and Updates:

- Background Levels of Volatile Organic Chemicals in Homes: A Review of Recent Literature Posted August 2016
- Installation Procedures for Permanent Sub-slab Probes Posted August 2016
- Vapor Intrusion Template Letters & Results Tables Posted May 2017
- Vapor Intrusion Screening Levels and Indoor Air Remediation Standards Tables Posted May 2021
- Comparison of 2013 and 2021 Vapor Intrusion Screening Levels and Indoor Air Remediation Standards
  - Comparison of 2013 and 2021 Ground Water Screening Levels Posted May 2021
  - Comparison of 2013 and 2021 Soil Gas Screening Levels Posted May 2021
  - Comparison of 2013 Indoor Air Screening Levels and 2021 Indoor Air Remediation Standards Posted May 2021
  - Comparison of 2013 and 2021 Rapid Action Levels Posted May 2021
- Vapor Intrusion Screening Levels Basis and Background Posted May 2021
- Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway Basis and Background Posted May 2021
- Revised Instructions for the Johnson & Ettinger Spreadsheets - NJDEP Version Posted May 2021
- Important Information about Vapor Mitigation Systems and Power Outages Posted 5 November 2012, Updated 5 March 2018
- List of Certified Labs

Analysis of naphthalene and 2-methylnaphthalene for vapor intrusion samples

The Department completed its evaluation of the provisions of N.J.A.C. 7:26E-2.1(c)3 and the Vapor Intrusion Technical Guidance (Version 3.1) as it relates to the analysis of naphthalene and 2-methylnaphthalene for vapor intrusion (VI) samples. Based on a continuing review of scientific information, effective July 16, 2013, the Department is requiring the following:

The analysis for 2-methylnaphthalene will not be required for VI samples collected during the investigation of kerosene, jet fuel, diesel fuel, fuel oil No. 2, and heavier petroleum products. The Department intends to update the Technical Requirements for Site Remediation to remove the requirement to analyze VI samples for 2-methylnaphthalene. Until the rule is updated, persons responsible can apply a variance pursuant to N.J.A.C. 7:26E-1.7 to not perform this analysis. The Department has already updated other posted web documents to reflect this change.

Naphthalene analysis will be required for VI samples collected during the investigation of kerosene, jet fuel, diesel fuel, fuel oil No. 2, and heavier petroleum products. In addition to USEPA Method TO-17, the Department will also allow the use of USEPA Method TO-15, NJDEP Method Low Level TO-15 and USEPA Method TO-13 A. Any laboratory performing the methods must have the applicable laboratory certifications and must have a demonstrated reporting limit of less than or equal to 3 ug/m3 consistent with N.J.A.C. 7:26E-2.1(a)3.

Vapor Intrusion Pathway Archive documents

Additional Vapor Intrusion Information

- DEP Contacts for Vapor Intrusion
- Community Outreach Guidance
- Fact Sheet: Evaluating Indoor Air Near VOC Contaminated Sites
- Fact Sheet: Subsurface Depressurization Systems
- Common Household Sources of Background Indoor Air Contamination
- NJDOH's Fact Sheet: Potential Health Risks Associated with Exposures to Trichloroethylene (TCE) in the Indoor Air [pdf] Posted 1 June 2016

Help for the file formats

Related Links

- NJDEP Office of Quality Assurance
- New Analytical Method for Volatile Organics in Air NJDEP-LLTO-15- 3/2007

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

SITE REMEDIATION AND WASTE MANAGEMENT PROGRAM

VAPOR INTRUSION TECHNICAL GUIDANCE

May 2021
Version 5.0

Vapor Intrusion Technical Guidance Version 5.0

- Appendix G updated to provide guidance on the derivation and application of the new IARS, VISL, and alternative values
- Global change of "Indoor Air Screening Level" to "IARS" for the vapor intrusion exposure pathway"

Vapor Intrusion Technical Guidance Version 5.0

- Section 6.1.1.6 of VIT updated
  - Mitigation based on preliminary data without a confirmed completed VI pathway
  - Applies to new construction/retrofitting existing building with VI mitigation system (vapor barrier, SSDS)
  - Sampling requirements – follow N.J.A.C. 7:26E-1.15
  - No longer automatic IEC designation

Vapor Intrusion Technical Guidance Version 5.0

- Other minor revisions identified in the “Vapor Intrusion Technical Guidance Change Log”

Site Remediation Guidance Library

https://www.nj.gov/dep/srp/guidance/index.html#vi

33.

Vapor Intrusion

Brief Description of Document

Document:	Vapor Intrusion Technical Guidance Page Version 5.0, Issued 5/2021, Posted 5/17/2021 https://www.nj.gov/dep/srp/guidance/vaporintrusion/
Change Log:	Vapor Intrusion Technical Guidance Change Log [pdf 84 Kb] Posted 5/17/2021
Response to Comments:	Updates to the Vapor Intrusion Technical Guidance Response to Comments [pdf 425 Kb] Version 5.0 May 2021, Posted 5/17/2021
Training Links on this topic:	SRWMP Training - Vapor Intrusion - Webinar

Vapor Intrusion Screening Levels (VISL) Updates

- Ground water (GWSL), soil gas (SGSL), and indoor air rapid action levels (RAL) for vapor intrusion updated to be consistent with IARS
- List of 35 chemicals is based on those constituents included in the USEPA Volatile Organic Compounds (VOC) Target Compound List (TCL) and the NJDEP-SRP Low Level USEPA TO-15 Air Analytical Method. Elemental mercury is also included.

Vapor Intrusion Screening Levels (VISL) Updates

- 14 chemicals dropped from previous list
  - 3 chemicals not on TCL List (bromoethene, 1,3-butadiene, 3-chloropropene)
  - 11 chemicals without appropriate toxicological information
- 2 contaminants added
  - 1,4-dioxane and 1,2,4-trimethylbenzene

VISL and IARS Tables on Vapor Intrusion Pathway Website

- New Vapor Intrusion Screening Levels and Indoor Air Remediation Standards Tables
  - Table 1: Default GWSL, SGSL, and IARS
  - Table 2: RAL for Indoor Air
  - Table 3: GWSL for Alternate Soil Textures
- Comparison Tables of the former 2013 values and new 2021 values

TABLE 1
NJDEP MASTER TABLE
VAPOR INTRUSION SCREENING LEVELS AND INDOOR AIR REMEDIATION STANDARDS

Chemical	CAS No.	Ground Water Screening Levels	Soil Gas Screening Levels		Indoor Air Remediation Standards	
			Residential	*Nonresidential*	*Residential*	*Nonresidential*
		µg/L	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*
Acetone (2-propanone)	67-64-1	-	-	-	-	-
Benzene	71-43-2	23[a]	18	79	0.64[b]	1.6
Bromodichloromethane	75-27-4	-	-	-	-	-
Bromoform	75-25-2	-	-	-	-	-
Bromomethane (methyl bromide)	74-83-9	20	260	1,100	5.2	22
2-Butanone (methyl ethyl ketone)	78-93-3	2,500,000	260,000	1,100,000	5,200	22,000
Carbon disulfide	75-15-0	1,500	36,000	150,000	730	3,100
Carbon tetrachloride	56-23-5	1.0[c]	23	100	1.3[b]	2.0
Chlorobenzene	108-90-7	770	2,600	11,000	52	220
Chloroethane (ethyl chloride)	75-00-3	26,000	520,000	2,200,000	10,000	44,000
Chloroform	67-66-3	1,000	5,100	21,000	100	430
Chloromethane (methyl chloride)	74-87-3	240	4,700	20,000	94	390
Cyclohexane	110-82-7	16,000[a]	310,000	1,300,000	6,300	26,000
Dibromochloromethane	124-48-1	-	-	-	-	-
1,2-Dibromoethane (ethylene dibromide)	106-93-4	0.45	15[b]	15[b]	1.5[b]	1.5[b]
1,2-Dichlorobenzene (o)	95-50-1	6,800	10,000	44,000	210	880
1,4-Dichlorobenzene (p)	106-46-7	21,000	42,000	180,000	830	3,500
Dichlorodifluoromethane (Freon 12)	75-71-8	-	-	-	-	-
1,1-Dichloroethane	75-34-3	-	-	-	-	-
1,2-Dichloroethane	107-06-2	230	360	1500	7.3	31
1,1-Dichloroethene	75-35-4	26	1,000	4,400	21	88
1,2-Dichloroethene (cis)	156-59-2	-	-	-	-	-
1,2-Dichloroethene (trans)	156-60-5	-	-	-	-	-
1,2-Dichloropropane	78-87-5	11	38	170	0.92[b]	3.3
1,3-Dichloropropene (total)[d]	542-75-6	8.4	35	150	0.91[b]	3.1
1,4-Dioxane	123-91-1	2,500	28	120	0.72[b]	2.5
Ethylbenzene	100-41-4	700[a,c]	56	250	1.1	4.9
Hexachlorobutadiene	87-68-3	-	-	-	-	-
n-Hexane	110-54-3	160[a]	36,000	150,000	730	3,100
Mercury, elemental	7439-97-6	-[e]	-[e]	-[e]	1[b]	1.3
Methylene chloride (dichloromethane)	75-09-2	2,600	14,000	61,000	280	1,200

Comparison of 2013 and 2021 Rapid Action Levels

Chemical	CAS No.	Residential Rapid Action Levels		Nonresidential Rapid Action Levels	
		2013	2021	2013	2021
		$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
Acetone (2-propanone)	67-64-1	64,000	-	280,000	-
Benzene	71-43-2	30	36	200	160
Bromodichloromethane	75-27-4	7	-	30	-
Bromoethene (vinyl bromide)	593-60-2	6	-	26	-
Bromoform	75-25-2	200	-	1,100	-
Bromomethane (methyl bromide)	74-83-9	10	10	44	44
1,3-Butadiene	106-99-0	4	-	18	-
2-Butanone (methyl ethyl ketone)	78-93-3	10,000	10,000	44,000	44,000
Carbon disulfide	75-15-0	1,500	1,500	6,200	6,200
Carbon tetrachloride	56-23-5	40	47	200	200
Chlorobenzene	108-90-7	100	100	440	440
Chloroethane (ethyl chloride)	75-00-3	20,000	20,000	88,000	88,000
Chloroform	67-66-3	10	200	50	860
Chloromethane (methyl chloride)	74-87-3	190	190	780	780
3-Chloropropene (allyl chloride)	107-05-1	2	-	8	-
Cyclohexane	110-82-7	13,000	13,000	52,000	52,000
Dibromochloromethane	124-48-1	9	-	50	-
1,2-Dibromoethane (ethylene dibromide)	106-93-4	4	1.5	4	2.0
1,2-Dichlorobenzene (o)	95-50-1	420	420	1,800	1,800
1,4-Dichlorobenzene (p)	106-46-7	20	1,700	100	7,000
Dichlorodifluoromethane (Freon 12)	75-71-8	200	-	880	-
1,1-Dichloroethane	75-34-3	200	-	800	-
1,2-Dichloroethane	107-06-2	9	15	50	62
1,1-Dichloroethene	75-35-4	420	42	1,800	180
1,2-Dichloroethene (trans)	156-60-5	130	-	520	-
1,2-Dichloropropane	78-87-5	8	8.4	36	36

Residential RAL	
RAL Increasing	12
RAL Decreasing	3
RAL the Same	18
RAL Added	2
RAL Removed	14

Nonresidential RAL	
RAL Increasing	4
RAL Decreasing	6
RAL the Same	23
RAL Added	2
RAL Removed	14

Ground Water Screening Levels (GWSL) Updates

- Revised NJDEP J&E Spreadsheets
  - Updated toxicity information
  - Updated chemical properties information
  - Updated exposure duration for residential land use (30 to 26 yrs)
  - Ground water temperature of 13^{o}C and default sandy soil texture unchanged

Ground Water Screening Levels (GWSL) Updates

- Adjustments for hydrocarbon degradation:
  - Benzene, cyclohexane, ethylbenzene, n-hexane, naphthalene, styrene, toluene, 1,2,4-trimethylbenzene, and xylene
- GWSL is the higher of the calculated health-based value and Ground Water Remediation Standard

Ground Water Screening Levels (GWSL) Updates

GWSL Increasing	12
GWSL Decreasing	2
GWSL the Same	18
GWSL Added	2
GWSL Deleted	14

- GWSL for 1,1-Dichloroethene (order of magnitude (OOM)) and xylenes are decreasing

Soil Gas Screening Levels (SGSL) Updates

- The equation used to derive SGSLs has not changed

$$Health-based\ Screening\ Value\left(\frac{\mu g}{m^3}\right) = Health-based\ Indoor\ Air\ Value\left(\frac{\mu g}{m^3}\right)\Big/\alpha$$

- Attenuation factor (α) = 0.02
- Resultant SGSL is the higher of the health-based screening value or the analytical RL

Soil Gas Screening Levels (SGSL) Updates

Residential SGSL	
SGSL Increasing	12
SGSL Decreasing	4
SGSL the Same	16
SGSL Added	2
SGSL Deleted	14

Nonresidential SGSL	
SGSL Increasing	4
SGSL Decreasing	3
SGSL the Same	25
SGSL Added	2
SGSL Deleted	14

- SGSL for 1,1-Dichloroethene are decreasing by an OOM
- 1,2-dibromoethane, 1,1,2-trichloro-1,2,2-trifluoroethane, and carbon tetrachloride (residential only) also decreasing

Indoor Air Rapid Action Levels (RAL) Updates

- The calculations used to derive RAL have not changed
  - A factor of 100 applied to the carcinogenic indoor air human health-based criteria
  - A factor of 2 applied to the non-carcinogenic indoor air human health-based criteria
- Resultant RALs are the lesser of the carcinogenic and non-carcinogenic values, or the higher analytical RL

Rapid Action Levels (RAL) for Indoor Air Updates

Residential RAL	
RAL Increasing	12
RAL Decreasing	3
RAL the Same	18
RAL Added	2
RAL Deleted	14

Nonresidential RAL	
RAL Increasing	4
RAL Decreasing	6
RAL the Same	23
RAL Added	2
RAL Deleted	14

Rapid Action Levels (RAL) for Indoor Air Updates

- RAL for 1,1-Dichloroethene is decreasing by an OOM
- RAL for 1,2-dibromoethane and 1,1,2-trichloro-1,2,2-trifluoroethane are decreasing for both land use types
- Nonresidential RALs for benzene, ethylbenzene, and vinyl chloride are decreasing due to significant figures

Phase-In of New VISL

- Phase in for VISL will be consistent with that for the IARS
- All new cases shall use the new VISL and IARS
- Sites/AOCs with NJDEP approved or LSRP certified RAWP/RAR by May 17th may be remediated using prior VISL, **except** for 1,1-dichloroethene

Phase-In of New VISL

- Sites/AOCs with NJDEP approved or LSRP certified RAWP/RAR within 6 months of effective date of the new IARS/VISL (November 17th) can be remediated using prior VISL, **except** for 1,1-dichloroethene
  - Report should state which version of VISL and IARS are being used
- Sites/AOCs with final remediation document, no additional action required, **except** for 1,1-dichloroethene

Additional Information on Vapor Intrusion Screening Levels

- Vapor Intrusion Screening Levels, Basis and Background
  https://www.nj.gov/dep/srp/guidance/vaporintrusion/

- Vapor Intrusion Exposure Pathway Calculator
  https://www.nj.gov/dep/srp/guidance/rs/index.html

Derivation of Alternative Remediation Standards (ARS) for Indoor Air for the Vapor Intrusion Exposure Pathway

Development of Alternative Remediation Standards (ARS) for Indoor Air

- The Brownfield and Contaminated Site Remediation Act (N.J.S.A. 58:10B-12.f(1)) requires the Department to consider **site-specific** factors in determining an ARS
- Site-specific factors may vary from those used by the Department in the development of the default IARS pursuant to N.J.A.C. 7:26D Appendix 9

Development of Alternative Remediation Standards (ARS) for Indoor Air

- All ARS for indoor air require pre-approval from the Department prior to use
- Institutional control and Remedial Action Permit required
- Engineering control may be required

Development of Alternative Remediation Standards (ARS) for Indoor Air

- Not an option for residential buildings, schools, or child care facilities
- Option for nonresidential buildings where exposures are not consistent with exposure assumptions used to develop the default health-based IARS

Development of Alternative Remediation Standards (ARS) for Indoor Air

- Examples where site-specific modification of exposure parameters may be acceptable:
  - A small generating station
  - An isolated storage facility
  - A restricted access area of nonresidential building
  - An adjustment of workday hours (differ from 8 hrs/day)

Exposure Factors That Can be Changed when Developing an ARS for Indoor Air

- Exposure Frequency (days/year)
- Exposure Time (hours/day)

Exposure Factors That Cannot be Changed when Developing an ARS for Indoor Air

- Exposure Duration (years)

Chemical-Specific Toxicity

- Inhalation Unit Risk (IUR) factors and noncancer reference concentrations (RfC) cannot be changed via the ARS process
  - For chemicals with no existing IARS, interim IARS may be developed in accordance with 7:26D-6
  - Toxicity values for contaminants with an existing IARS may be updated in accordance with 7:26D-7

SRWMP

Site-Specific Exposure Factor Adjustments

- Modification of the exposure factors (ET and/or EF) must reflect the Reasonable Maximum Exposure (RME) associated with site-specific use of the nonresidential building
- RME is defined as "the highest exposure that is reasonably expected to occur at a site"

Site-Specific Exposure Factor Adjustments

- When determining the RME, potential exposure assumptions to consider include:
  - Current and future use of the building
  - Time spent in building by all receptors (e.g., office workers, maintenance workers, etc.)
  - Engineering controls to restrict access

Calculation of ARS for Indoor Air

- Vapor Intrusion Exposure Pathway Calculator accessible on the Remediation Standards website [NJDEP SRP - Guidance: Remediation Standards (state.nj.us)]
  - Site-specific parameters that may be adjusted are unlocked
  - Input parameters which may not be adjusted are locked
  - Calculator also calculates SGSL and RAL consistent with ARS for indoor air exposure assumptions

Calculation of ARS for Indoor Air

- Both carcinogenic and non-carcinogenic health endpoints are applicable
- ARS for indoor air based on the lower of the carcinogenic and non-carcinogenic indoor air human health-based criteria, or analytical RL if higher

Calculators

The Soil and Soil Leachate Migration to Ground Water Exposure Pathway Calculator

- Soil and Soil Leachate Migration to Ground Water Exposure Pathway Calculator (Version 1.0 May 2021)

This includes the following calculators:

- Soil-Water Partition Equation Calculator
- Synthetic Precipitation Leaching Procedure Calculator
- Dilution-Attenuation Factor Calculator
- Fraction Organic Carbon Calculator

Soil Ingestion-Dermal Exposure Pathway Calculator

- Soil Ingestion-Dermal Exposure Pathway Calculator (Version 1.0 May 2021)

Soil Inhalation Exposure Pathway Calculator

- Soil Inhalation Exposure Pathway Calculator (Version 1.0 May 2021)

Vapor Intrusion Exposure Pathway Calculator

- Vapor Intrusion Exposure Pathway Calculator (Version 1.0 May 2021)

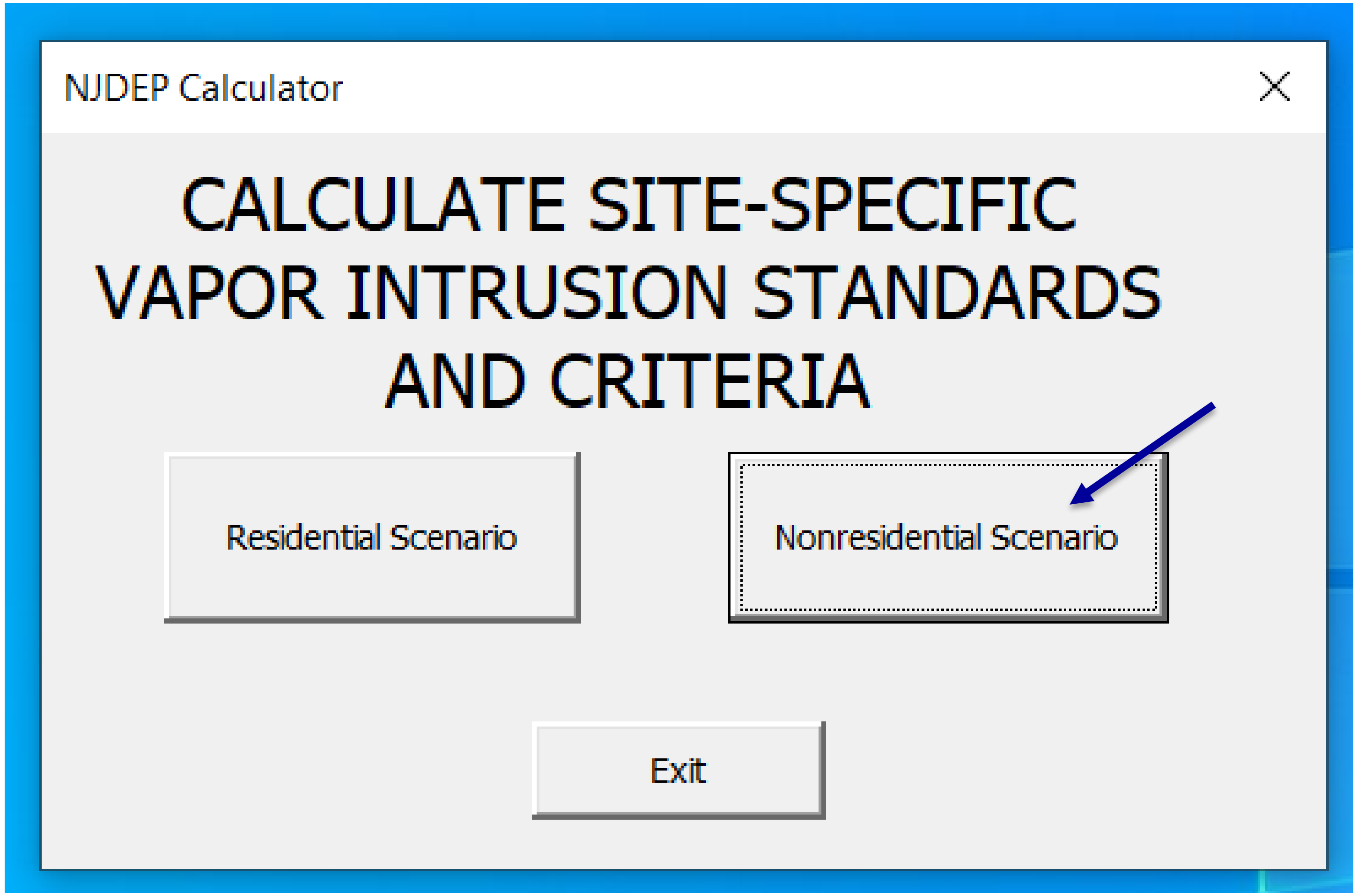
The Extractable Petroleum Hydrocarbon Ingestion-Dermal Exposure Pathway Calculator:

- Extractable Petroleum Hydrocarbon Ingestion-Dermal Exposure Pathway Calculator (Version 1.0 May 2021)

This includes the following calculators:

- Category 2 Sample-Specific Residential
- Category 2 Sample-Specific Non-Residential
- Category 1 and 2 Alternative Remediation Standards for Soil (based on Land Use Exposure Scenarios)

Vapor Intrusion Exposure Pathway Calculator



Vapor Intrusion Exposure Pathway Calculator

NJDEP 2021 Vapor Intrusion Nonresidential Air, Soil Gas and Rapid Action Level Calculator

Site Name:		Date:	
Contaminant:	Benzene	CAS No.:	71-43-2
		Evaluated by:	

$$IA_c = \frac{TR * AT * LT}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * IUR}$$

$$IA_{nc} = \frac{THQ * AT * ED * \frac{1000}{}\frac{\mu g}{mg}}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * \frac{1}{RfC}}$$

SL_{nr} = Lower of cancer and noncancer SL

$$SGSL = \frac{IA}{0.02}$$

$$RAL = Lower\ of\ 100 * IA_c\ or\ 2 * IA_{nc}$$

Air Reporting Limit ($\mu g/m^3$) =	0.64
Soil Gas Reporting Limit =	6.4

Parameter	Definition	Units	Default Scenario	Alternative Scenario
TR	Target Cancer Risk	unitless	1.00E-06	1.00E-06
THQ	Target Hazard Quotient	unitless	1	1
AT	Averaging Time	days/year	365	365
LT	Lifetime	years	70	70
EF	Nonresidential Exposure Frequency	days/year	250	250
ED	Nonresidential Exposure Duration	years	25	25
ET	Nonresidential Exposure Time	hours/day	8	8
IUR	Inhalation Unit Risk	$(\mu g/m^3)^{-1}$	7.80E-06	7.80E-06
RfC	Inhalation Reference Concentration	mg/m^3	0.03	0.03
IA_c	Carcinogenic Indoor Air Human Health-Based Criterion	$\mu g/m^3$	1.6	1.6
IA_{nc}	Non-carcinogenic Indoor Air Human Health-Based Criterion	$\mu g/m^3$	130	130
IA	Indoor Air Human Health-Based Criterion	$\mu g/m^3$	1.6	1.6
SGSL	Human Health-Based Soil Gas Screening Criterion	$\mu g/m^3$	79	79
RAL	Human Health-Based Rapid Action Criterion	$\mu g/m^3$	160	160

Alternative Nonresidential Indoor Air Standard:	**1.6**	**$\mu g/m^3$**	**Cancer-based**
Alternative Nonresidential Soil Gas Screening Level:	**79**	**$\mu g/m^3$**	
Alternative Nonresidential Rapid Action Level:	**160**	**$\mu g/m^3$**	**Cancer-based**

Default exposure frequency = 250 days

Default exposure time = 8 hours

Vapor Intrusion Exposure Pathway Calculator

NJDEP 2021 Vapor Intrusion Nonresidential Air, Soil Gas and Rapid Action Level Calculator

Site Name:		Date:	
Contaminant:	Benzene	CAS No.:	71-43-2
		Evaluated by:	

$$IA_c = \frac{TR * AT * LT}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * IUR}$$

$$IA_{nc} = \frac{THQ * AT * ED * \frac{1000}{} \frac{\mu g}{mg}}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * \frac{1}{RfC}}$$

SL_{nr} = Lower of cancer and noncancer SL

$$SGSL = \frac{IA}{0.02}$$

$$RAL = Lower\ of\ 100 * IA_c\ or\ 2 * IA_{nc}$$

Air Reporting Limit (µg/m³) =	0.64
Soil Gas Reporting Limit =	6.4

Parameter	Definition	Units	Default Scenario	Alternative Scenario	
TR	Target Cancer Risk	unitless	1.00E-06	1.00E-06	
THQ	Target Hazard Quotient	unitless	1	1	
AT	Averaging Time	days/year	365	365	
LT	Lifetime	years	70	70	
EF	Nonresidential Exposure Frequency	days/year	250	250	
ED	Nonresidential Exposure Duration	years	25	25	
ET	Nonresidential Exposure Time	hours/day	8	4	changed
IUR	Inhalation Unit Risk	$(\mu g/m^3)^{-1}$	7.80E-06	7.80E-06	
RfC	Inhalation Reference Concentration	mg/m^3	0.03	0.03	
IA_c	Carcinogenic Indoor Air Human Health-Based Criterion	$\mu g/m^3$	1.6	3.1	
IA_{nc}	Non-carcinogenic Indoor Air Human Health-Based Criterion	$\mu g/m^3$	130	260	
IA	Indoor Air Human Health-Based Criterion	$\mu g/m^3$	1.6	3.1	
SGSL	Human Health-Based Soil Gas Screening Criterion	$\mu g/m^3$	79	160	
RAL	Human Health-Based Rapid Action Criterion	$\mu g/m^3$	160	310	

Alternative Nonresidential Indoor Air Standard:	**3.1**	**$\mu g/m^3$**	**Cancer-based**
Alternative Nonresidential Soil Gas Screening Level:	**160**	**$\mu g/m^3$**	
Alternative Nonresidential Rapid Action Level:	**310**	**$\mu g/m^3$**	**Cancer-based**

ARS for indoor air exposure time = 4 hours

Submittal of an ARS for Indoor Air Application

- LSRP must complete *Alternative or Interim Remediation Standard and/or Screening Level Application Form* and *Remediation Standard Notification Spreadsheet*
- The form, spreadsheet, and instructions for both can be found under "General Forms" in the Forms Library

NJDEP SRP - Site Remediation Reform Act (SRRA): Forms (state.nj.us)

Submittal of an ARS for Indoor Air Application

- Pursuant to 7:26D Appendix 9, the following is required to be submitted with the form and spreadsheet:
  - ARS calculations using the Department's calculator
  - Description of justification of site-specific exposure factors
  - Institutional controls, engineering controls (as needed), and proposed monitoring

Submittal of an ARS for Indoor Air Application

- Overview of the history and contamination at site or AOC
  - Description of VI investigations related to ARS for indoor air
  - Extent of VI related soil and ground water contamination
  - Summary table of analytical results
  - Description of subject building with scaled map of site and surrounding area
  - Uses in the subject building and locations where receptors are present

Derivation of Alternative Vapor Intrusion Screening Levels

Alternative Ground Water Screening Levels (GWSL)

- **Alternative GWSL Options have not changed**
- Applicable to residential and nonresidential buildings
  - Exposure factors for residential scenario **required**
- May be developed based on site-specific soil texture and depth to ground water

Alternative Ground Water Screening Levels (GWSL) Options

- **Option 1: Alternate Soil Textures**
  - Table 3 of the *Vapor Intrusion Screening Levels and Indoor Air Remediation Standards Tables* list GWSL for alternate soil texture types
    - Available for loamy sand, sandy loam, and loam soil
  - Use of the Table 3 alternative GWSL requires the determination of site-specific soil texture as described in Appendix G of the VIT Guidance.

TABLE 3

NJDEP GROUND WATER SCREENING LEVELS FOR ALTERNATE SOIL TEXTURES

Chemical	CAS No.	LOAMY SAND: Ground Water Screening Levels (µg/L)	SANDY LOAM: Ground Water Screening Levels (µg/L)	LOAM: Ground Water Screening Levels (µg/L)
Acetone (2-Propanone)	67-64-1	-	-	-
Benzene	71-43-2	51[a]	120[a]	190[a]
Bromodichloromethane (Dichlorobromomethane)	75-27-4	-	-	-
Bromoform	75-25-2	-	-	-
Bromomethane (Methyl bromide)	74-83-9	43	110	160
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	2,700,000	3,100,000	3,900,000
Carbon disulfide	75-15-0	3,200	8,100	12,000
Carbon tetrachloride	56-23-5	2.0	5.3	8.3
Chlorobenzene	108-90-7	1,700	3,800	5,800
Chloroethane (Ethyl chloride)	75-00-3	57,000	140,000	220,000
Chloroform	67-66-3	2,300	5,400	8,100
Chloromethane (Methyl chloride)	74-87-3	510	1,300	1,900
Cyclohexane	110-82-7	37,000[a]	-[a,b]	-[a,b]
Dibromochloromethane (Chlorodibromomethane)	124-48-1	-	-	-
1,2-Dibromoethane (Ethylene dibromide)	106-93-4	0.73	1.1	1.5
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	14,000	28,000	41,000
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	47,000	-[b]	-[b]
Dichlorodifluoromethane (Freon 12)	75-71-8	-	-	-
1,1-Dichloroethane	75-34-3	-	-	-
1,2-Dichloroethane	107-06-2	440	850	1,200
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	59	160	240
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2	-	-	-
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5	-	-	-
1,2-Dichloropropane	78-87-5	25	55	83

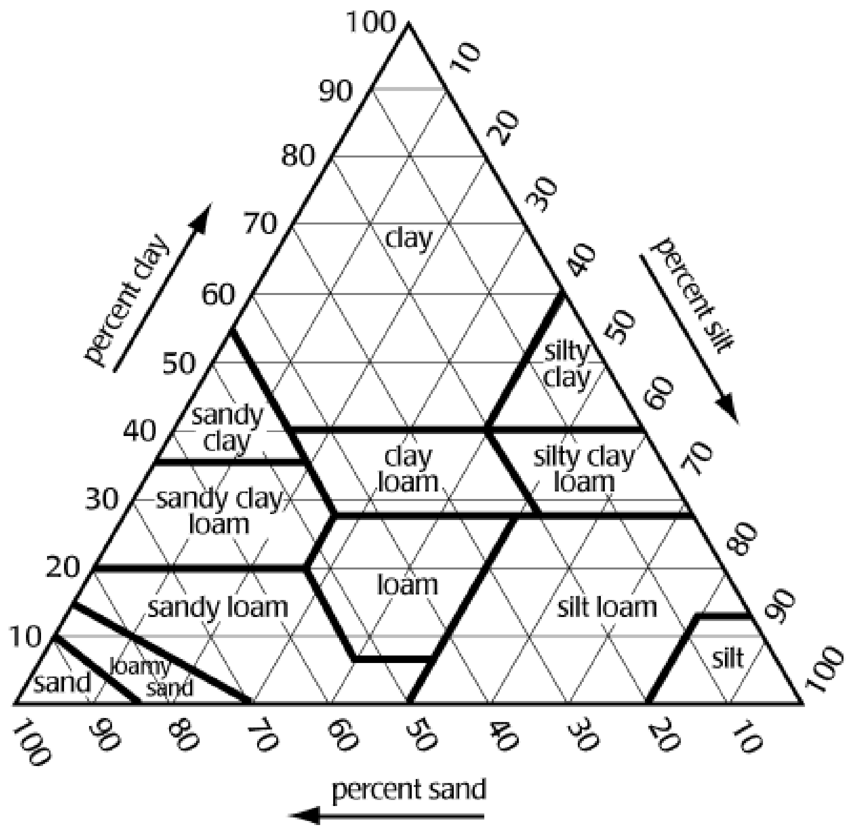
Alternative Ground Water Screening Levels (GWSL) Options

- NJDEP J&E Spreadsheets may be used to develop alternative GWSL using soil textures other than those used in Tables 1 and 3 of *VISL and IARS Tables*
  - Alternative GWSL requires determination of site-specific soil texture
- Updated NJDEP J&E Spreadsheets and instructions can be found at:

https://www.nj.gov/dep/srp/guidance/vaporintrusion/njje.htm

Determining Soil Texture

- Collect soil core(s)
- Soil samples submitted to laboratory for texture analysis
- Textures assigned using USDA soil triangle



Alternative Ground Water Screening Levels (GWSL) Options

- **Option 2: Modifying the Depth to Ground Water**
  - Enter the depth of the water table (soil surface to water table) on either the screening or advanced New Jersey J&E Spreadsheets, which can be found at: https://www.nj.gov/dep/srp/guidance/vaporintrusion/njje.htm

eset to
efaults

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71432		Benzene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
200	352.5	S	13	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm²)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)
S			S	1.66	0.375	0.054

Lookup Soil Parameters

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	26	26	350

Used to calculate risk-based groundwater concentration.

END

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
200	352.5	S	13

SRWMP

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
2.30E+00	2.00E+02	2.30E+00	1.79E+06	2.30E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

- Apply a factor of 10 for chemicals with known hydrocarbon degradation
- Final GWSL based on the higher of the health-based groundwater criterion and GWRS

Alternative Ground Water Screening Levels (GWSL) Options

- **Option 3: Soil Texture Layers**
  - Requires the use of the New Jersey advanced J&E Spreadsheet, which can be found at: https://www.nj.gov/dep/srp/guidance/vaporintrusion/njje.htm
  - Layers must be continuous across the site and may not be fractured, as demonstrated by soil borings
  - Enter the thickness of each soil layer (max. 3) in the advanced J&E and select built-in soil properties for each layer

ENTER Average soil/ groundwater temperature, T_S (^{o}C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Totals must add up to value of L_{WT} (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
13	200	352.5	252.5	50	50	C	S	S		

ENTER Stratum A SCS soil type Lookup Soil Parameters	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type Lookup Soil Parameters	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type Lookup Soil Parameters	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)
	1.66	0.375	0.054		1.66	0.375	0.054		1.66	0.375

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
2.30E+00	2.00E+02	2.30E+00	1.79E+06	2.30E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

- Apply a factor of 10 for chemicals with known hydrocarbon degradation
- Final GWSL based on the higher of the health-based groundwater criterion and GWRS

Alternative Soil Gas Screening Levels (SGSL)

- **Applicable to nonresidential buildings only**
- Alternative SGSL may be developed using an ARS for indoor air that has been approved by the Department
- Department's Vapor Intrusion Exposure Pathway calculator will calculate alternative SGSL

Alternative SGSL = ARS for indoor air health-based value/0.02

Alternative Rapid Action Levels (RAL) for Indoor Air

- **Applicable to nonresidential buildings only**
- Alternative RAL may be developed using an ARS for indoor air that has been approved by the Department

Alternative Rapid Action Levels (RAL) for Indoor Air

- Department's Vapor Intrusion Exposure Pathway calculator will calculate alternative RAL
  - 100X the carcinogenic ARS for indoor air health-based criterion
  - 2X the non-carcinogenic ARS for indoor air health-based criterion
  - Alternative RAL lesser of carcinogenic and non-carcinogenic health-based values or analytical RL

NJDEP 2021 Vapor Intrusion Nonresidential Air, Soil Gas and Rapid Action Level Calculator

Site Name:		Date:	
Contaminant:	Benzene	CAS No.:	71-43-2
		Evaluated by:	

$$IA_c = \frac{TR * AT * LT}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * IUR}$$

$$IA_{nc} = \frac{THQ * AT * ED * \frac{1000}{}\frac{\mu g}{mg}}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * \frac{1}{RfC}}$$

SL_{nr} = Lower of cancer and noncancer SL

$$SGSL = \frac{IA}{0.02}$$

$$RAL = Lower\ of\ 100 * IA_c\ or\ 2 * IA_{nc}$$

Air Reporting Limit ($\mu g/m^3$) =	0.64
Soil Gas Reporting Limit =	6.4

Parameter	Definition	Units	Default Scenario	Alternative Scenario
TR	Target Cancer Risk	unitless	1.00E-06	1.00E-06
THQ	Target Hazard Quotient	unitless	1	1
AT	Averaging Time	days/year	365	365
LT	Lifetime	years	70	70
EF	Nonresidential Exposure Frequency	days/year	250	250
ED	Nonresidential Exposure Duration	years	25	25
ET	Nonresidential Exposure Time	hours/day	8	4
IUR	Inhalation Unit Risk	$(\mu g/m^3)^{-1}$	7.80E-06	7.80E-06
RfC	Inhalation Reference Concentration	mg/m^3	0.03	0.03
IA_c	Carcinogenic Indoor Air Human Health-Based Criterion	$\mu g/m^3$	1.6	3.1
IA_{nc}	Non-carcinogenic Indoor Air Human Health-Based Criterion	$\mu g/m^3$	130	260
IA	Indoor Air Human Health-Based Criterion	$\mu g/m^3$	1.6	3.1
SGSL	Human Health-Based Soil Gas Screening Criterion	$\mu g/m^3$	79	160
RAL	Human Health-Based Rapid Action Criterion	$\mu g/m^3$	160	310

changed

Alternative Nonresidential Indoor Air Standard: 3.1 $\mu g/m^3$ Cancer-based

Alternative Nonresidential Soil Gas Screening Level: 160 $\mu g/m^3$

Alternative Nonresidential Rapid Action Level: 310 $\mu g/m^3$ Cancer-based

SRWMP

Submittal and Approval Process for Alternative Vapor Intrusion Screening Levels

- Pre-approval is not required for alternative VISL but recommended prior to use
- SGSL and RAL derived directly from an ARS for indoor air, which must be approved prior to use
  - Option to submit application for ARS for indoor air, SGSL, and/or RAL simultaneously but cannot use until ARS for indoor air approved

Submittal and Approval Process for Alternative Vapor Intrusion Screening Levels

Documentation Requirements:

- *Alternative or Interim Remediation Standard and/or Screening Level Application Form* and *Remediation Standard Notification Spreadsheet*
- Basis for the site-specific parameters used in the development of the alternative VISL
- Application of the alternative VISL at the site or AOC

Submittal and Approval Process for Alternative Vapor Intrusion Screening Levels

Documentation Requirements (continued):

- Printout of the applicable calculations showing the modified input parameters and resulting alternative VISL using:
  - Department's Vapor Intrusion Exposure Pathway Calculator at https://nj.gov/dep/srp/guidance/rs/ (SGSL and RAL)
  - NJDEP J&E Spreadsheet (GWSL)
- Approved ARS for indoor air for alternative SGSL/RAL if applying separately

Additional Information on Vapor Intrusion Website

- Vapor Intrusion Technical Guidance, Appendix G
- VISL Basis and Background
- IARS for the Vapor Intrusion Exposure Pathway Basis and Background

https://www.nj.gov/dep/srp/guidance/vaporintrusion/

NJDEP Vapor Intrusion Contacts

- Erica Snyder – IARS and VISL
  - Erica.Snyder@dep.nj.gov

- Nicole Kalaigian – VI Investigation and Mitigation
  - Nicole.Kalaigian@dep.nj.gov

Technical Consultations Available Upon Request

Questions?

LUNCH

DO NOT LOG OUT OF THE WEBINAR

Alternative Remediation Standards for the Migration to Ground Water Pathway

Introduction and Overview of the Migration to Ground Water Exposure Pathway

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Bureau of Environmental Evaluation and Risk Assessment
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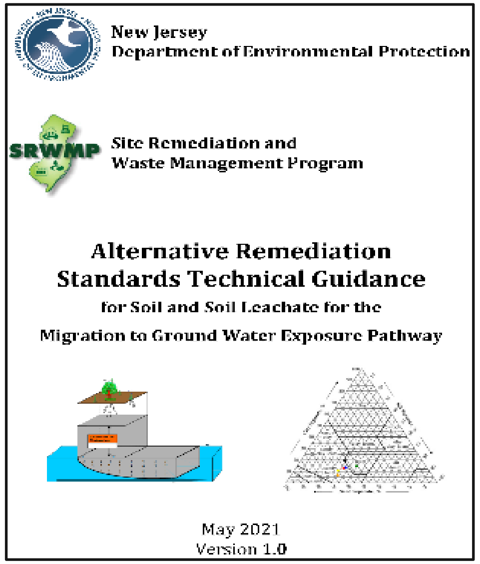

New Jersey
Department of Environmental Protection

SRWMP Site Remediation and Waste Management Program

Alternative Remediation Standards Technical Guidance
for Soil and Soil Leachate for the
Migration to Ground Water Exposure Pathway

May 2021
Version 1.0

Sections 1.0-3.0

Committee Members

NJDEP

Dr. Swati Toppin, Chair

George Blyskun (retired)

William Carp

Ann Charles

Dr. Barry Frasco

MaryAnne Kuserk

Dr. Paul Sanders (retired)

Matthew Turner

Stakeholders

Stephen Posten, LSRP

Michael Gonshor, LSRP

* Robert Schneiker, SEAVIEW Model, Environmental Software Consultants

SRWMP

Presentation Objectives

- Pertinent website details
- Ins and outs of the ARS as it pertains to MGW pathway and the various options
- Will not address remediation options, compliance and attainment options (such as capping) or permits
- Regulatory authority - See N.J.A.C.-7:26D. This is Appendix 8 in the rule

Introduction to the ARS Process

The Guidance is on the SRWMP webpage at:

https://www.nj.gov/dep/srp/guidance

or

Access through the Remediation Standards Website at:

https://www.nj.gov/dep/srp/guidance/rs/

Remediation Standards

Introduction to Remediation Standards

May 2021

These rules implement the provisions of the Brownfield and Contaminated Site Remediation Act, N.J.S.A. 58:10B-12, and other statutes, by establishing standards for the remediation of contaminated ground water, surface water, soil, soil leachate and indoor air. These rules supplement the requirements of the Technical Requirements for Site Remediation rules, N.J.A.C. 7:26E.

On June 2, 2008, the Department adopted new Remediation Standards rules at N.J.A.C. 7:26D. These rules were readopted without change on April 27, 2015. The soil remediation standards contained in those rules were effective on June 2, 2008. The ground water and surface water remediation standards were previously effective at N.J.A.C. 7:26E-1.13.

On September 18, 2017, the Department updated the soil remediation standards for 19 contaminants, as listed in N.J.A.C. 7:26D, Appendix 1, Tables 1A and 1B. The updated soil remediation standards reflect revisions to the toxicity information for these contaminants, as contained in the United States Environmental Protection Agency (USEPA) Integrated Risk Information System (IRIS) database (see www.epa.gov/iris), on which the soil remediation standards are based.

On May 17, 2021, the Department adopted amended rules at N.J.A.C. 7:26D. Included in the amended rules are soil and soil leachate remediation standards for the migration to ground water exposure pathway and indoor air remediation standards for the vapor intrusion exposure pathway. Also included is the replacement of direct contact soil remediation standards with separate soil remediation standards for the inhalation exposure pathway and the ingestion-dermal exposure pathway. In addition, the rule amendments Expands the existing interim remediation standard process to include soil and soil leachate for the migration to ground water exposure pathway, indoor air for the vapor intrusion exposure pathway, and ground water. Also, the existing process for updating remediation standards has been expanded to include soil and soil leachate for the migration to ground water exposure pathway, indoor air for the vapor intrusion exposure pathway, and ground water. The existing alternative remediation standards process has been expanded to include soil and soil leachate for the migration to ground water exposure pathway and indoor air for the vapor intrusion exposure pathway.

Remediation Standards

- Remediation Standards, N.J.A.C. 7:26D (May 17, 2021)
- Remediation Standards Proposal (April 6, 2020)
- Remediation Standards Adoption Package (May 17, 2021)

Phase In/Order of Magnitude Guidance

The Department has revised the following guidance documents that will help remediating parties comply with the new remediation standards:

- Phase-In Period Guidance for the Use of Remediation Standards, N.J.A.C. 7:26D (Updated May 2021)
- Order of Magnitude Evaluation Guidance (Updated May 2021)

Basis and Background Documents

- Soil and Soil Leachate Remediation Standards for the Migration to Ground Water Exposure Pathway, Basis and Background (May 2021)
- Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway, Basis and Background (May 2021)
- Soil Remediation Standards for the Inhalation Exposure Pathway, Basis and Background (May 2021)
- Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway, Basis and Background (May 2021)

Guidance Documents

- Alternative Remediation Standards Technical Guidance for Soil and Soil Leachate for the Migration to Ground Water Exposure Pathway (Version 1.0 May 2021)
- Alternative Remediation Standards Technical Guidance for Soil for the Ingestion-Dermal and Inhalation Exposure Pathways (Version 1.0 May 2021)
- Vapor Intrusion Technical Guidance (Version 5.0 May 2021) - Appendix G provides guidance for the derivation and application of Alternative Remediation Standards for indoor air

Calculators

The Soil and Soil Leachate Migration to Ground Water Exposure Pathway Calculator

- Soil and Soil Leachate Migration to Ground Water Exposure Pathway Calculator (Version 1.0 May 2021)

This includes the following calculators:

Site Remediation Guidance Library

Alternative Remediation Standards Technical Guidance for Soil and Soil Leachate for the Migration to Ground Water Exposure Pathway

Brief Description of Document

Document:	Alternative Remediation Standards Technical Guidance for Soil and Soil Leachate for the Migration to Ground Water Exposure Pathway [pdf 1.9 Mb] Version 1.0 May 2021 USEPA Lloyd Kahn method for determination of soil organic carbon
Response to Comments:	Comments and Responses to Comments on release of Draft Alternative Remediation Standards Technical Guidance for the Migration to Ground Water Exposure Pathway [pdf 309 Kb] Version 1.0 May 2021
Training Links on this topic:	

Has Anything Changed?

The new rule does <u>not</u> fundamentally change the way this pathway now needs to be addressed from how it was or should have been addressed prior to this rule adoption

Before rule adoption, site specific IGWSRS still had to be developed from IGWSSLs. The pathway was then addressed using these either these site specific IGWSRS or IGWARS

Now, there is one step less. We have SRS-MGW. The pathway is now addressed using these either these SRS-MGW or ARS-MGW

ARS-MGW Process

- ARS potentially comes into play when total contaminant concentrations in soil exceed SRS-MGW
- There can be several ARS on a site
- How to determine when an ARS really needed

ARS-MGW Process

ARS potentially comes into play when total contaminant concentrations in soil exceed SRS-MGW

Reasons for ARS-MGW

There can be several different ARS on a site, which may be based on:

- Different contaminants
- Different locations- AOC or site-wide
- Different depths
- Different soil types
- ARSs for other exposure pathways

The Importance of an ARS

- ARS is an alternative remediation standard, and for the MGW exposure pathway it means no institutional or engineering controls are required on the AOC or site (the exception is SESOIL/AT123D, which involves a CEA)
- This obviously pertains only to the contaminant and AOC or site that the ARS is approved for, and for the MGW pathway
- There may be deed restrictions for other contaminants, other AOCs and other pathways

ARS Required?

ARS may not be Necessarily be Needed

Some reasons why an ARS may not be necessary:

- Will contamination be automatically addressed via remediation of other contaminants?
- Will contamination be automatically addressed when other pathways are addressed?
- Can some of the worst areas be removed, and then compliance/attainment done?
- Careful with volatile organic contaminants!!

Types of ARS-MGW

1. Numerical, associated with standards or numbers: Options involving SWPE, SPLP, SESOIL and SESOIL/AT123D

2. Narrative Standards: no concentration is listed for ARS-MGW, but certain conditions are satisfied, leading to the conclusion that the MGW exposure pathway is not of concern

Preapproval or Final NJDEP Approval

Preapproval from DEP may or may not be required depending on the ARS-MGW option (see subchapter 8)

Nevertheless:

- All applications go through the normal inspection & review process, and may be audited by the DEP
- All ARS-MGW options still need final DEP approval, as per the Brownfield Act

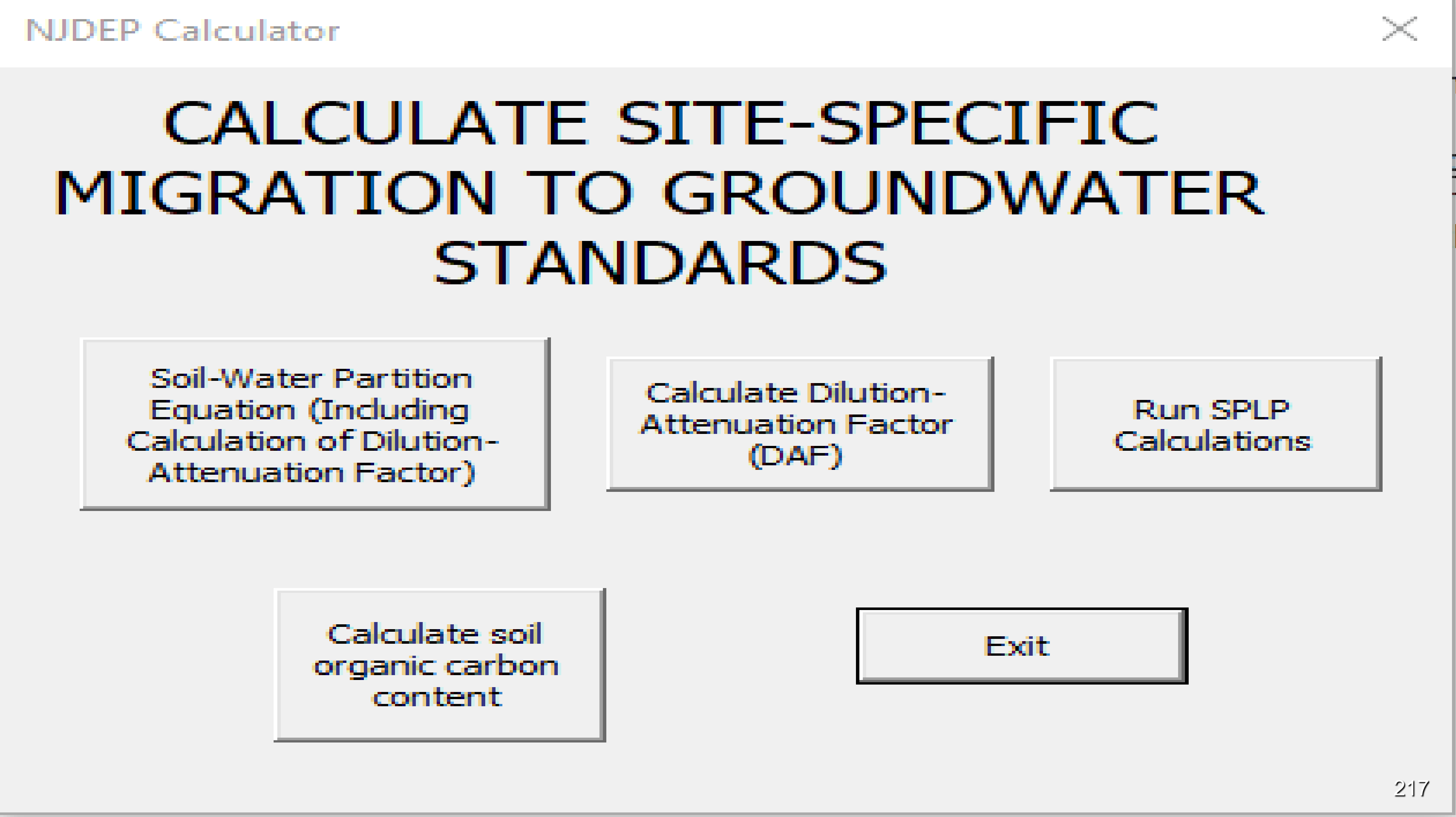
Soil and Soil Leachate Migration to Ground Water Exposure Pathway Calculator

Calculators must be used where applicable:

Soil and Soil Leachate Migration to Ground Water Exposure Pathway Calculator (Version 1.0 May 2021)

This includes the following calculators:

- Soil-Water Partition Equation Calculator
- Synthetic Precipitation Leaching Procedure Calculator
- Dilution-Attenuation Factor Calculator
- Fraction Organic Carbon Calculator


NJDEP Calculator
CALCULATE SITE-SPECIFIC MIGRATION TO GROUNDWATER STANDARDS
Soil-Water Partition Equation (Including Calculation of Dilution-Attenuation Factor)
Calculate Dilution-Attenuation Factor (DAF)
Run SPLP Calculations
Calculate soil organic carbon content
Exit

Interactions between Options

- A site/AOC specific value derived using an option, may be used in other options
- There are certain caveats (check guidance for these)
- For example, site specific adsorption coefficient, Kd, derived using SPLP may be used in SWPE

Important Note

- Need good documentation
- Check ARS guidance document
- Make it easy for reviewer – separate ARS-MGW section(s)

Forms

- ARS Form
- Remediation Standards Notification Spreadsheet

https://www.nj.gov/dep/srp/srra/forms/

under "General Forms"

General Forms	Download		Version & Date	Changes Since Last Version	Rule
7.5 Percent Cost of Remediation Form	Form pdf 190 Kb	Instructions pdf 162 Kb	1.1 - 9/17/2018	See Update Log	7:26C-4.10
Alternative or New Remediation Standard and/or Screening Level Application form (Name change. Was "Alternative Soil Remediation Standard and/or Screening Level Application form")	Form pdf 195 Kb	Instructions pdf 212 Kb	2.4 - 5/3/2021	See Update Log	7:26D-7.4

Thank You!

Soil-Water Partition Equation

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Licensed Site Remediation Professional Association (LSRPA)
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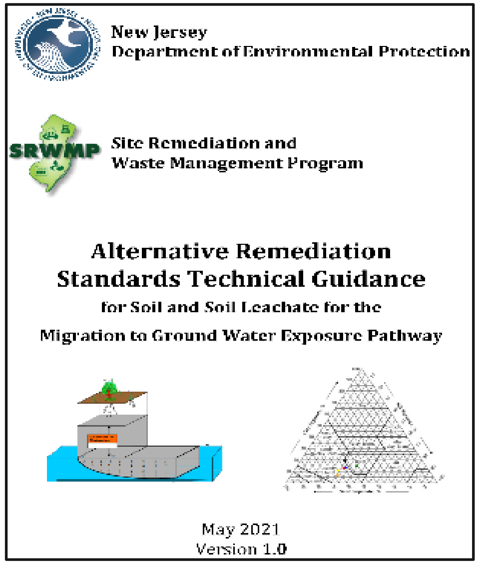

New Jersey
Department of Environmental Protection

Site Remediation and
Waste Management Program

Alternative Remediation
Standards Technical Guidance
for Soil and Soil Leachate for the
Migration to Ground Water Exposure Pathway

May 2021
Version 1.0

Section 4.0

Soil-Water Partition Equation (SWPE)

- Equation used to calculate default SRS-MGW
- Incorporated directly from EPA Soil Screening Guidance (1996)
  - Does not require knowledge of specific depths of contamination (although necessary for delineation)
  - Very conservative: assumes entire soil column is contaminated
- Generally expected that Investigator will calculate site-specific SRS-MGW in lieu of default value
- Limited ability to modify inputs to SWPE equation
  - Typically, modified inputs result in limited impact on default MGW values

Soil-Water Partition Equation

Generic IGW (Soil-Water Partition Equation):

$$MGW_c = GWRS * \frac{mg}{1000\mu g} * \left\{ (K_{oc} * f_{oc}) + \frac{\theta_w + (\theta_a * H')}{\rho_b} \right\} * DAF$$

$K_{oc} * f_{oc} = K_d$ (SPLP)

Soil-Water Partition Equation

$$MGW_c = GWRS * \frac{mg}{1000\,\mu g} * \left\{ (K_{oc} * f_{oc}) + \frac{\theta_w + (\theta_a * H')}{\rho_b} \right\} * DAF$$

Parameter	Definition	Units	Default
MGW_c	Migration to ground water soil criterion	mg/kg	Contaminant-specific
$GWRS$	Ground water remediation standard	µg/L	Contaminant-specific
K_d	Soil-water partition coefficient	L/kg	Contaminant-specific or site-specific*
K_{oc}	Soil organic carbon-water partition coefficient	L/kg	Contaminant-specific
f_{oc}	Organic carbon content of soil	kg/kg	0.002 or site-specific
θ_w	Water-filled soil porosity	L_{water}/L_{soil}	0.23
θ_a	Air-filled soil porosity	L_{air}/L_{soil}	0.18
H'	Henry's law constant	unitless	Contaminant-specific
ρ_b	Dry soil bulk density	kg/L	1.5
DAF	Dilution-attenuation factor	unitless	20 or site-specific

*ARS-MGW determined using a SPLP-derived K_d may not exceed the highest concentration tested

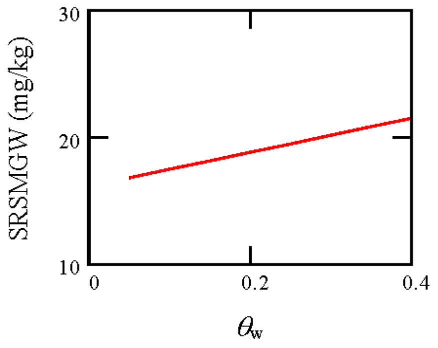
Soil-Water Partition Equation

Sensitivity Analysis of Fixed Parameters

5. Sensitivity of remediation standard (SRS-MGW) to soil moisture (θ_w)
   Results shown for xylene.

θ_w	SRSMGW (mg/kg)
0.05	16.7
0.1	17.4
0.15	18.1
0.2	18.8
0.25	19.4
0.3	20.1
0.35	20.8
0.4	21.4

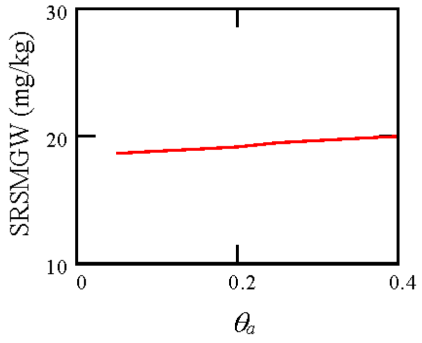
Sensitivity to θ_w is small.



6. Sensitivity of remediation standard (SRS-MGW) to soil air content (θ_a).
Results shown for xylene.

θ_a	SRSMGW (mg/kg)
0.05	18.7
0.1	18.9
0.15	19
0.2	19.2
0.25	19.4
0.3	19.6
0.35	19.8
0.4	20

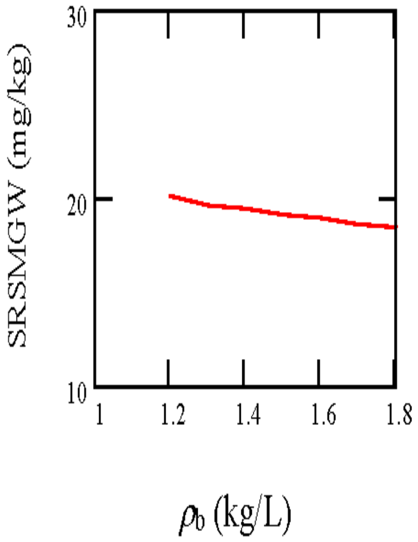
Sensitivity to θ_a is small



7. Sensitivity of remediation standard (SRS-MGW) to soil bulk density (ρ_b)
   Results shown for xylene.

ρ_b (kg/L)	SRSMGW (mg/kg)
1.2	20.1
1.3	19.7
1.4	19.4
1.5	19.2
1.6	18.9
1.7	18.7
1.8	18.5

Sensitivity to ρ_b is small.



NJDEP SWPE Calculator: Updated 2021

NJDEP 2021 Soil-Water Partition Equation Calculator

Site Name:		Date:	
Contaminant:	Acenaphthene	CAS No.:	83-32-9
		Evaluated by:	

	Calculated or locked cell
	Required data entry
	Optional data entry/modification

Instructions

CLICK HERE if Chemical is not on drop-down list, or to enter alternate GWRS

$$MGW_c = GWRS * \frac{mg}{1000\mu g} * \left\{ K_d + \frac{\theta_w + \theta_a * H'}{\rho_b} \right\} * DAF$$

$$K_d = K_{oc} * f_{oc}$$

$$DAF = 1 + \frac{K * i * d}{I * L}$$

$$d = (0.0112 * L^2)^{0.5} + d_a * \{1 - \exp[(-L * I) / (K * i * d_a)]\}$$

$$C_{sat} = \frac{S}{\rho_b} * [(K_{oc} * f_{oc} * \rho_b) + \theta_w + (H' * \theta_a)]$$

Contaminant Parameters:

Parameter	Definition	Units	Value
GWRS	Ground Water Remediation Standard	µg/L	400
K_{oc}	Soil Organic Carbon-Water Partition Coefficient	L/kg	5.03E+03
K_d	Soil-Water Partition Coefficient	L/kg	1.01E+01
H'	Henry's Law Constant	dimensionless	7.52E-03
S	Water Solubility	mg/L	3.90E+00
RL_{soil}	Soil Reporting Limit	mg/kg	0.17
C_{sat}	Soil Saturation Limit	mg/kg	40
C_{bck}	Ambient Background Concentration	mg/kg	NA

Soil Parameters:

Parameter	Definition	Units	Value
θ_w	Water-filled soil porosity	dimensionless (v/v)	0.23
θ_a	Air-filled Soil Porosity	dimensionless (v/v)	0.18
f_{oc}	(Fraction) Organic Carbon Content of Soil	dimensionless (w/w)	0.002
ρ_b	Dry Soil Bulk Density	kg/L	1.5

NOTES: (click outside box when finished)

Reset

Back to MGW Site-Specific Menu

Exit

DAF Parameters:

Parameter	Definition	Value	units	Converted to metric: Value	units
L	Length of Area of Concern Parallel to Ground Water Flow	100	ft	30.5	m
d_a	Aquifer Thickness	11.5	ft	3.5	m
I	Infiltration Rate	11	in/yr	0.28	m/yr
K	Aquifer Hydraulic Conductivity	51865	ft/yr	15808	m/yr
i	Gradient	0.003	dimensionless	0.003	dimensionless
d	Mixing Zone Depth			3.4	m
DAF	Dilution-Attenuation Factor			20	dimensionless

Site-specific Migration to Groundwater Soil Criterion: 8.20E+01 mg/kg

Site-specific Migration to Ground Water Soil Remediation Standard (MGWSRS): NA mg/kg

ABOVE SOIL SATURATION LIMIT

SRWMP

Soil-Water Partition Equation

- Calculated SRS-MGW cannot exceed C_{sat}
- For determination of the fraction of soil organic carbon (f_{oc}), DEP recommends use of the Lloyd Kahn laboratory analytical method (other comparable methods acceptable)
  - Minimum 3 samples
  - Specific data handling procedures depending on magnitude of test result variability
  - Site specific f_{oc} also requires recalculation of C_{sat} (as necessary)

NEW: NJDEP f_{oc} Calculator

NJDEP 2021 Organic Carbon Calculator

Site Name:		Date:	
Additional Description:		Evaluated by:	

Calculated or locked cell
Required data entry
Optional data entry

Total organic carbon (mg/kg)

Enter up to 20 total organic carbon content values in the outlined cells. Use units of mg/kg. Leave unused cells blank. Reset button will clear entries.

Maximum organic carbon =	0	mg/kg
Minimum organic carbon =	0	mg/kg
Maxium/Minimum =	#DIV/0!	
Average organic carbon =	#DIV/0!	mg/kg

#DIV/0!

(Fraction) organic carbon content for MGW soil-water partition	#DIV/0!	#DIV/0!
Percent organic carbon for SESOIL model:	#DIV/0!	#DIV/0!
Percent organic carbon for SESOIL/AT123D model:	#DIV/0!	
(Fraction) organic carbon for inhalation pathway:	#DIV/0!	#DIV/0!

#DIV/0!

Reset

Back to MGW Site-Specific Menu

Exit

NOTES: (click outside box when finished)

Soil-Water Partition Equation

- The K_{oc} of phenolic compounds is dependent on soil pH
  - Site-specific K_{oc} and resultant SRS-MGW can be developed:
    - Minimum 3 soil samples for pH analysis
    - Consult guidance document table: "K_{oc} Values (L/kg) for Ionizing Organics as a Function of pH"
- Consultation with DEP required for use of SWPE:
  - Determination of GWRS in Class I and III aquifers
  - Determination of GWRS for unlisted contaminants

Thank You!

ARS-MGW Development using the Synthetic Precipitation Leachate Procedure (SPLP)

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Principal Hydrogeologist - Roux Associates, Inc.
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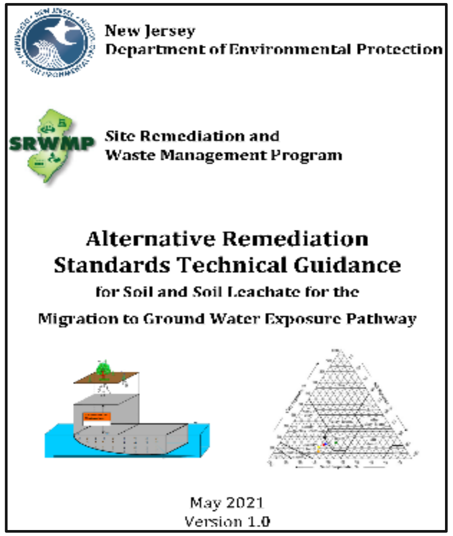

New Jersey
Department of Environmental Protection

SRWMP Site Remediation and
Waste Management Program

Alternative Remediation
Standards Technical Guidance
for Soil and Soil Leachate for the
Migration to Ground Water Exposure Pathway

May 2021
Version 1.0

Section 6.0

Proposed SRS Modifications Related to SPLP

- Leachate Standards (LS) (formerly Leachate Criteria): Some LS changed with new SRS-MGW
- Be sure to evaluate SPLP results vs. new LS
- SPLP calculator spreadsheet was updated by NJDEP to reflect new LS under the new SRS-MGW

Sampling Considerations

- Separate samples for each soil type
- Separate samples for each AOC
- Lithology
  - Highly variable lithology (e.g., silt-sand-clay stringers)
- Field Screening Readings and Observations
  - Varying field screening readings over short intervals
  - Variability in staining
  - Free or residual product visible or suspected

Each of the above can complicate obtaining samples with consistent concentrations, especially for samples for VOC analyses

Sampling Considerations (cont.)

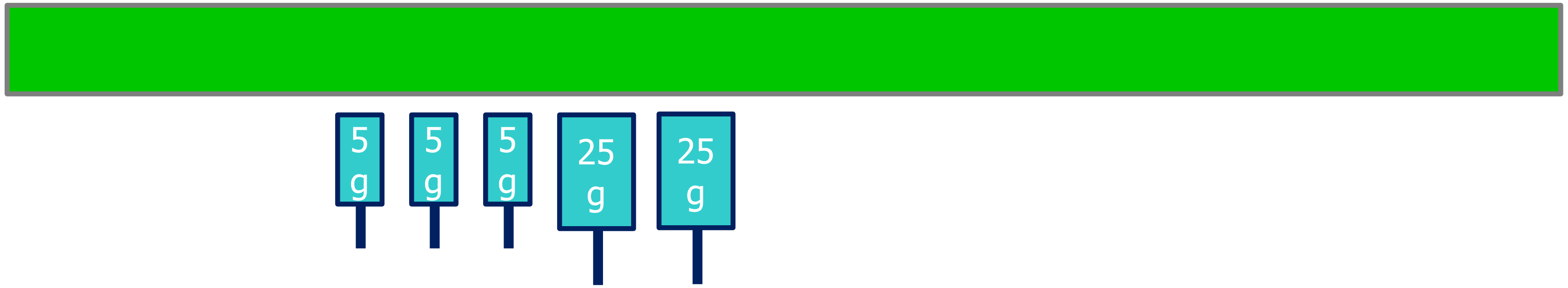
- Collect a sufficient number of samples for potential SPLP analyses
- Be mindful of holding times for SPLP extractions and analyses
  - Consider extract and hold for SPLP analyses
- Costs for collection of additional sample volume and SPLP extractions is minimal relative to re-sampling
- Don't forget the dry weight sample when collecting samples for VOC analyses

Homogenization - FSPM Section 6.2.8

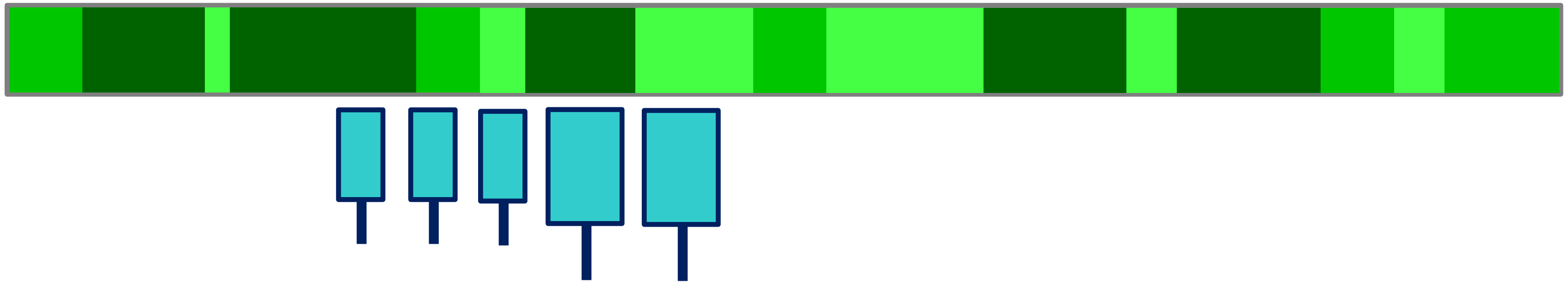
- Collect soil samples for VOC analysis first – Do <u>not</u> homogenize samples for VOC analyses
- Soil to be analyzed for <u>non</u>-VOC parameters must be homogenized to create a representative sample
  - It is important that mixing of soil be as thorough as possible - the goal is to achieve a consistent physical appearance

Sampling Procedures –Volatiles

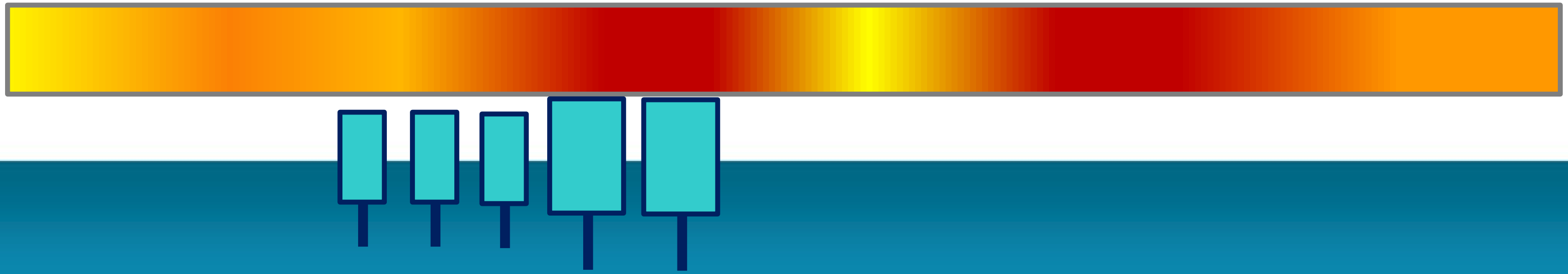
Homogeneous Lithology. Consistent PID Readings



Silt, Sand and Clay Stringers

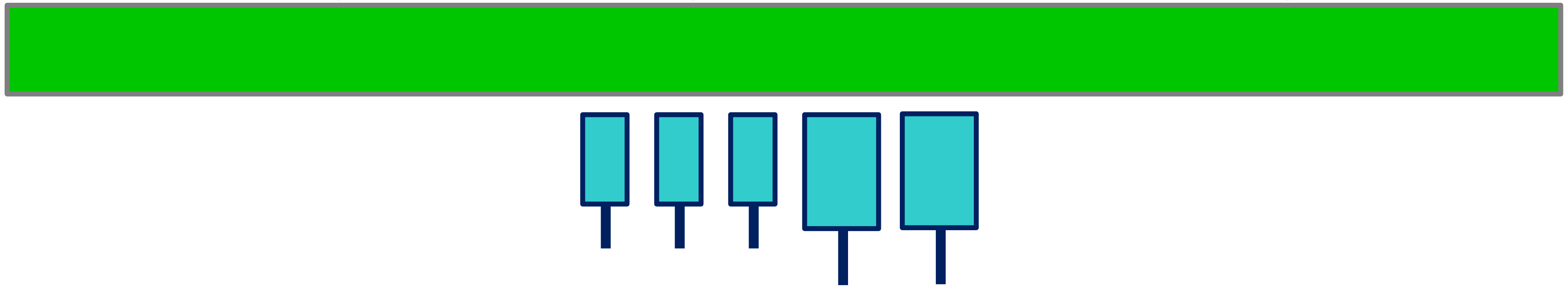


Varying PID Readings

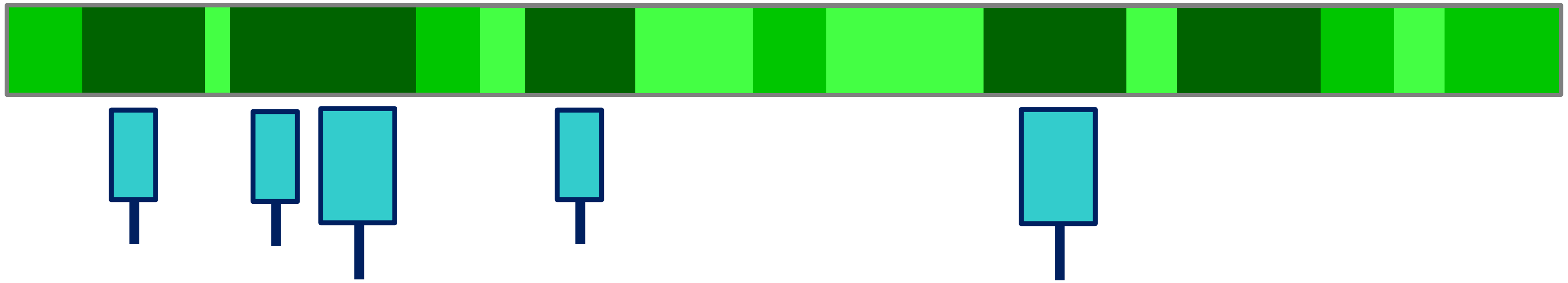


Sampling Procedures –Volatiles

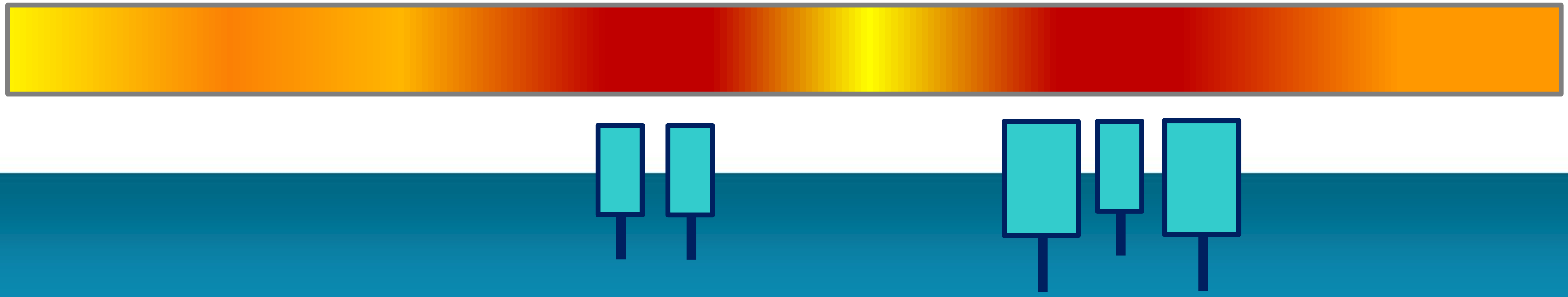
Homogeneous Lithology. Consistent PID Readings



Silt Sand and Clay Stringers



Varying PID Readings

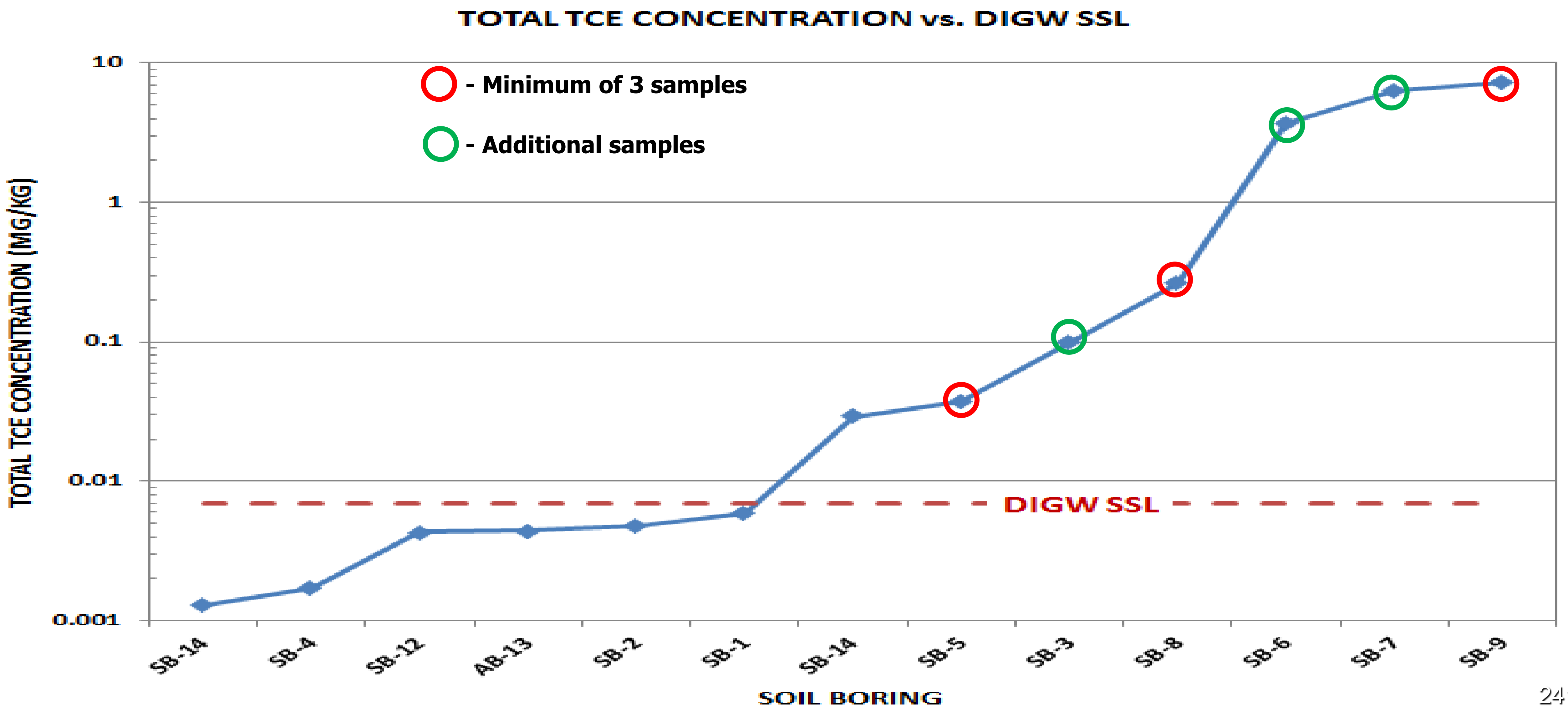


Sample Selection for SPLP Analyses

- **Minimum Number of Samples vs. A Good Idea**
  - Minimum - 3 samples per SPLP Guidance (per AOC and Soil Type)
    - UHOT Exception – 1 sample
  - A Good Idea – More than 3
- **Samples to Release for SPLP Analyses**
  - Guidance suggests range of concentrations including maximum detected total concentration
  - May not be a good idea for VOCs
  - Will be dependent of soil type, total organic carbon, individual VOC of concern, and total concentrations

Use your Professional Judgment and Experience

Sample Selection for SPLP Analyses



Data Evaluation

- Leachate from soil is diluted when it mixes with the groundwater
- The amount of dilution is the DAF (default of 20 for NJ)
- Therefore: LS is 20 times the GWRS

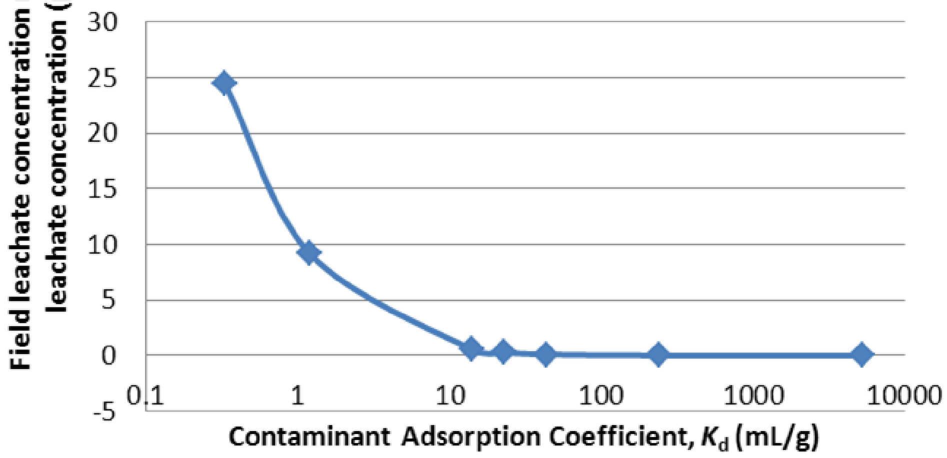
Data Evaluation

- Must use SPLP calculator spreadsheet
  - Do not directly compare SPLP aqueous leachate concentrations to NJDEP Leachate Standards

<u>TCE</u>

Sample ID	Soil sample weight (kg)	Leachate Volume (L)	Total Soil Concentration (mg/kg)	SPLP Leachate Concentration (µg/L)	Final pH of Leachate	Kd (L/kg)	% Contaminant in Leachate	Field leachate concentration (µg/L)
SB-5	0.025	0.5	0.0376	0.72	[illegible]	[illegible]	[illegible]	1.2
SB-3	0.025	0.5	0.0989	3.5	[illegible]	[illegible]	[illegible]	11.7
SB-6	0.025	0.5	3.7	103	[illegible]	[illegible]	[illegible]	229.4
SB-9	0.025	0.5	7.27	144	[illegible]	[illegible]	[illegible]	236.9

Figure 1
Difference between SPLP leachate concentration and field leachate concentration as a function of contaminant K_d



Data Evaluation (cont') d

- Are Data Valid - Do Results Make Sense
- High Kd Outlier Example
- Negative Kd Outlier Example
- RLs vs. MDLs

Suspect Result

Case name/area of concern:	Lead Test 1
Case number:	1
Sampling date:	3/26/2013
Contaminant:	Lead (total)
CAS No:	7439-92-1
Water solubility (mg/L)	NA
Aqueous reporting limit (µg/L):	5.00E+00
Soil reporting limit (mg/kg):	1.00E+00
Health-based GWQC (µg/L)	5.00E+00
DAF (13, or site-specific if approved	13
Leachate Criterion (µg/L):	6.50E+01
Henry's law constant (dimensionles	0.00E+00

CALCULATE SITE SPECIFIC IGW STANDARD

Reset Spreadsheet

Print Res

Print to

CLICK HERE if chemical is not on drop-down list, or to enter alternate GWQC

NOTE:

USE ONE PAGE PER CONTAMINANT, do not leave empty rows between samples

Do not enter samples with soil concentrations at or below the reporting limit

When leachate concentration is non-detect, enter the aqueous reporting limit

Enter site-specific dilution-attenuation factor (DAF) if desired

Data entry cells (do not skip rows)

Optional data entry

Calculated or locked cells

Indicates that Alternative Remediation Standard needs to be recalculated

Sample ID	Soil sample weight (kg)	Leachate Volume (L)	Total Soil Concentration (mg/kg)	SPLP Leachate Concentration (µg/L)	Final pH of Leachate	Optional data				Kd (L/kg)	% Contaminant in Leachate	Field leachate concentration (µg/L)	Pass or fail?
						Sampling Depth (ft)	Soil Type	Organic Carbon (mg/kg)	Organic Carbon (%)				
SB-12	0.1001	2.002	92	50	9.3	0.5-1.0	Sandy Loar	NA	NA	1820.0	1.09	50.5	PASS
SB-3	0.1005	2.01	75	50	4.68	1.5-2.0	Sandy Loar	NA	NA	1480.0	1.33	50.7	PASS
SB-14	0.05	1	120	65	8.85	0-0.5	Sandy Loar	NA	NA	1826.2	1.08	65.7	FAIL
SB-1RA	0.05	1	300	110	8.65	0-0.5	Sandy Loar	NA	NA	2707.3	0.73	110.8	FAIL
SB2RB	0.0569	1.138	870	177	5.86	0-0.5	Sandy Loar	NA	NA	4895.3	0.41	177.7	FAIL
SB1-RD	0.05	1	1600	220	8.83	0-0.5	Sandy Loar	NA	NA	7252.7	0.28	220.6	FAIL
SB-10	0.1	2	2000	370	9.43	0-0.5	Sandy Loar	NA	NA	5385.4	0.37	371.4	FAIL
BT-SB-10/0-2 Control	0.1004	2.008	5000	386	6.33	0-2	Sandy Loar	NA	NA	12933.4	0.15	386.6	FAIL
SB-10	0.1	2	2900	7200	4.82	1.5-2	Sandy Loar	NA	NA	382.8	4.97	7573.2	FAIL

SPLP RESULTS for

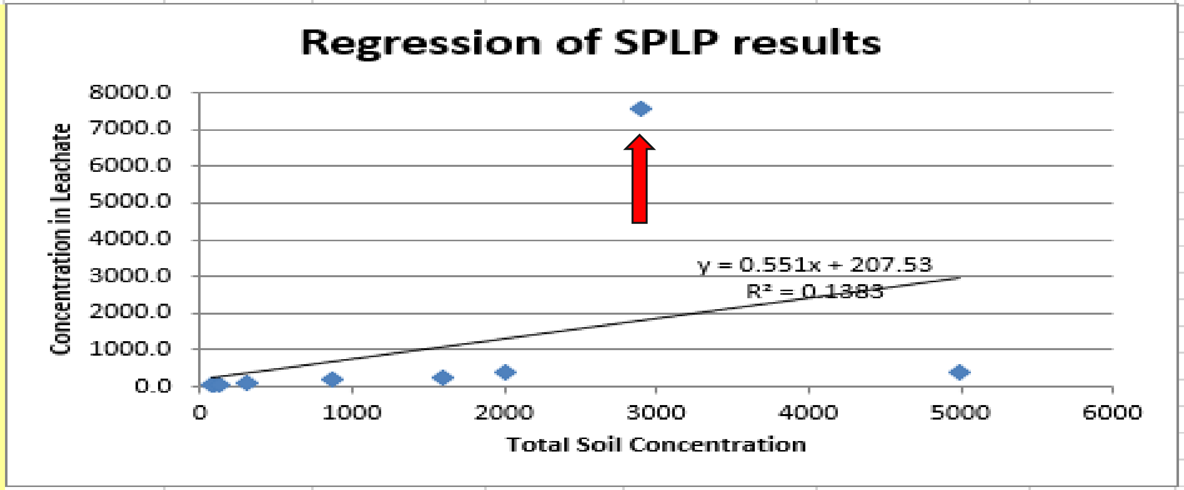
OPTION 1a: All adjusted leachate concentrations are below the leachate criterion
OPTION 1a NOT VALID

OPTION 1b: Simple inspection of tabulated results to find highest acceptable standard

REMEDIATION STANDARD = 92 mg/kg

OPTION 2: Remediation standard using site-specific Kd value
Kd ratio = 33.79, USE MINIMUM Kd
Kd USED FOR CALCULATING STANDARD = 382.78 L/kg
result before adjustment = 24.8905 mg/kg
REMEDIATION STANDARD = 25 mg/kg

OPTION 3: Remediation standard using linear regression
Number of points = 9
Soil concentration midrange = 2537.5
Number of points above midrange = 2
Enough points above midrange? NO
R-Square high enough? NO
Leachate criterion within range of leachate concentrations? YES
OPTION 3 NOT VALID



Case name/area of concern:	Lead Test 2		
Case number:	1		
Sampling date:	3/26/2013		
Contaminant:	Lead (total)		

CALCULATE SITE SPECIFIC IGW STANDARD

Reset Spreadsheet

Print Res

CLICK HERE if chemical is not on drop-down list, or to enter alternate GWQC

Print to

Suspect Result Removed / Sample Re-Analyzed

CAS No:	7439-92-1
Water solubility (mg/L)	NA
Aqueous reporting limit (µg/L):	5.00E+00
Soil reporting limit (mg/kg):	1.00E+00
Health-based GWQC (µg/L)	5.00E+00
DAF (13, or site-specific if approved	13
Leachate Criterion (µg/L):	6.50E+01
Henry's law constant (dimensionles	0.00E+00

NOTE:
USE ONE PAGE PER CONTAMINANT, do not leave empty rows betw
Do not enter samples with soil concentrations at or below the repo
When leachate concentration is non-detect, enter the aqueous rep
Enter site-specific dilution-attenuation factor (DAF) if desired

Data entry cells (do not skip rows)
Optional data entry
Calculated or locked cells
Indicates that Alternative Remediation Standard needs to be recalculated

Sample ID	Soil sample weight (kg)	Leachate Volume (L)	Total Soil Concentration (mg/kg)	SPLP Leachate Concentration (µg/L)	Final pH of Leachate	Optional data: Sampling Depth (ft)	Optional data: Soil Type	Optional data: Organic Carbon (mg/kg)	Optional data: Organic Carbon (%)	Kd (L/kg)	% Contaminant in Leachate	Field leachate concentration (µg/L)	Pass or fail?
SB-12	0.1001	2.002	92	10	9.3	0.5-1.0	Sandy Loar	NA	NA	9180.0	0.22	10.0	PASS
SB-3	0.1005	2.01	75	10	4.68	1.5-2.0	Sandy Loar	NA	NA	7480.0	0.27	10.0	PASS
SB-14	0.05	1	120	65	8.85	0-0.5	Sandy Loar	NA	NA	1826.2	1.08	65.7	FAIL
SB-1RA	0.05	1	300	110	8.65	0-0.5	Sandy Loar	NA	NA	2707.3	0.73	110.8	FAIL
SB2RB	0.0569	1.138	870	177	5.86	0-0.5	Sandy Loar	NA	NA	4895.3	0.41	177.7	FAIL
SB1-RD	0.05	1	1600	220	8.83	0-0.5	Sandy Loar	NA	NA	7252.7	0.28	220.6	FAIL
SB-10	0.1	2	2000	370	9.43	0-0.5	Sandy Loar	NA	NA	5385.4	0.37	371.4	FAIL
BT-SB-10/0-2 Control	0.1004	2.008	5000	386	6.33	0-2	Sandy Loar	NA	NA	12933.4	0.15	386.6	FAIL

SPLP RESULTS for

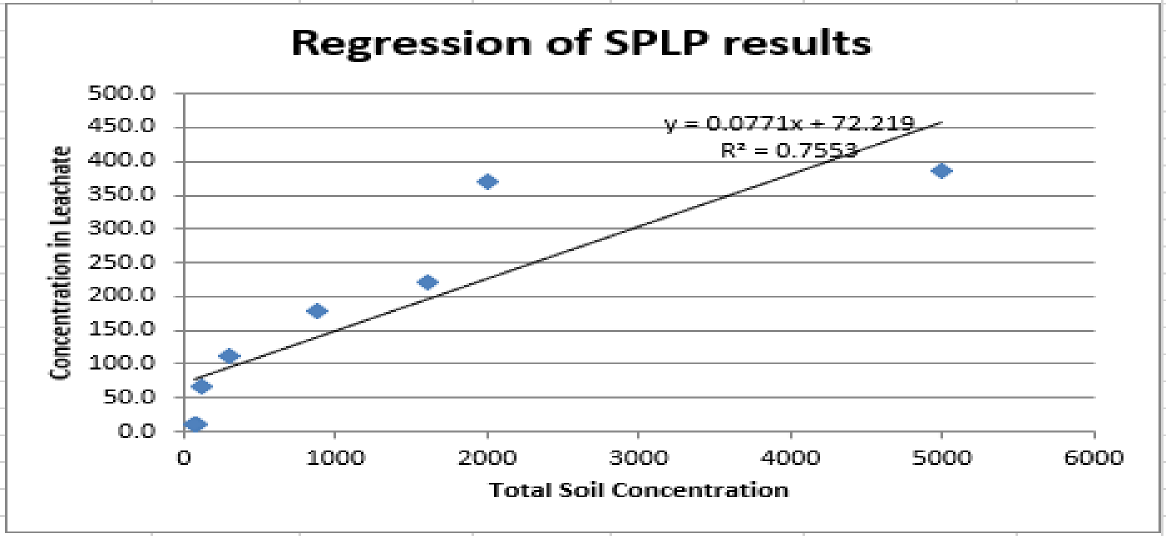
OPTION 1a: All adjusted leachate concentrations are below the leachate criterion
OPTION 1a NOT VALID

OPTION 1b: Simple inspection of tabulated results to find highest acceptable standard

REMEDIATION STANDARD = 92 mg/kg

OPTION 2: Remediation standard using site-specific Kd value
Kd ratio = 7.08, AVERAGING Kds OK
Kd USED FOR CALCULATING STANDARD = 6457.52 L/kg
result before adjustment = 419.7489 mg/kg
REMEDIATION STANDARD = 420 mg/kg

OPTION 3: Remediation standard using linear regression
Number of points = 8
Soil concentration midrange = 2537.5
Number of points above midrange = 1
Enough points above midrange? NO
R-Square high enough? YES
Leachate criterion within range of leachate concentrations? YES
OPTION 3 NOT VALID



High Kd Outlier

Case name/area of concern:	TCE Test 1
Case number:	1
Sampling date:	3/15/2013
Contaminant:	Trichloroethene (TCE) (Trichloroeth
CAS No:	79-01-6
Water solubility (mg/L)	1.10E+03
Aqueous reporting limit (µg/L):	1.00E+00
Soil reporting limit (mg/kg):	5.00E-03
Health-based GWQC (µg/L)	1.00E+00
DAF (13, or site-specific if approved	13
Leachate Criterion (µg/L):	1.30E+01
Henry's law constant (dimensionles	4.22E-01

CALCULATE SITE SPECIFIC IGW STANDARD

Reset Spreadsheet

Print Results

Print to file

CLICK HERE if chemical is not on drop-down list, or to enter alternate GWQC

NOTE:

USE ONE PAGE PER CONTAMINANT, do not leave empty rows between samples

Do not enter samples with soil concentrations at or below the reporting limit

When leachate concentration is non-detect, enter the aqueous reporting limit

Enter site-specific dilution-attenuation factor (DAF) if desired

Data entry cells (do not skip rows)

Optional data entry

Calculated or locked cells

Indicates that Alternative Remediation Standard needs to be recalculated

Sample ID	Soil sample weight (kg)	Leachate Volume (L)	Total Soil Concentration (mg/kg)	SPLP Leachate Concentration (µg/L)	Final pH of Leachate	Optional data				Kd (L/kg)	% Contaminant in Leachate	Field leachate concentration (µg/L)	Pass or fail?
						Sampling Depth (ft)	Soil Type	Organic Carbon (mg/kg)	Organic Carbon (%)				
SB-7	0.025	0.5	6.28	0.22	6.12	17-17.5	Clay	NA	NA	28525.5	0.07	0.2	PASS
SB-5	0.025	0.5	0.0376	0.72	7.1	25.5-26	Clay	NA	NA	32.2	38.30	1.2	PASS
SB-3	0.025	0.5	0.0989	3.5	7.42	18-18.5	Clay	NA	NA	8.3	70.78	11.7	PASS
SB-6	0.025	0.5	3.7	103	6.7	16-16.5	Clay	NA	NA	15.9	55.68	229.4	FAIL
SB-9	0.025	0.5	7.27	144	7.22	22+22.5	Clay	NA	NA	30.5	39.61	236.9	FAIL

SPLP RESULTS for

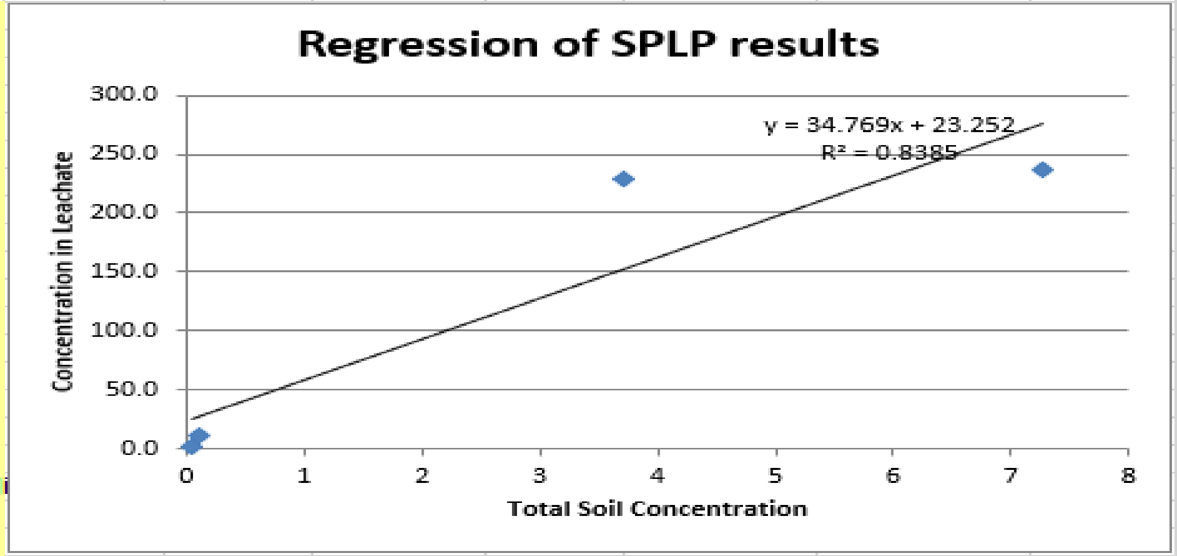
OPTION 1a: All adjusted leachate concentrations are below the leachate criterion
OPTION 1a NOT VALID

OPTION 1b: Simple inspection of tabulated results to find highest acceptable standard

REMEDIATION STANDARD = 0.0989 mg/kg

OPTION 2: Remediation standard using site-specific Kd value
Kd ratio = 3454.64, USE MINIMUM Kd
Kd USED FOR CALCULATING STANDARD = 8.26 L/kg
result before adjustment = 0.11 mg/kg
REMEDIATION STANDARD = 0.1 mg/kg

OPTION 3: Remediation standard using linear regression
Number of points = 4
(points were eliminated because leachate concentrations were not above the aqueous reporting li
Soil concentration midrange = 3.65
Number of points above midrange = 2
Enough points above midrange? YES
R-Square high enough? YES
Leachate criterion within range of leachate concentrations? YES
result before adjustment = -0.2949 mg/kg
REMEDIATION STANDARD = 0.005 mg/kg (controlled by soil PQL)



High Kd Value Removed

Case name/area of concern:	TCE Test 1
Case number:	1
Sampling date:	3/15/2013

CALCULATE SITE SPECIFIC IGW STANDARD

Reset Spreadsheet

CLICK HERE if chemical is not on drop-down list, or to enter alternate GWQC

Contaminant:	Trichloroethene (TCE) (Trichloroeth
CAS No:	79-01-6
Water solubility (mg/L)	1.10E+03
Aqueous reporting limit (µg/L):	1.00E+00
Soil reporting limit (mg/kg):	5.00E-03
Health-based GWQC (µg/L)	1.00E+00
DAF (13, or site-specific if approved	13
Leachate Criterion (µg/L):	1.30E+01
Henry's law constant (dimensionles	4.22E-01

NOTE:
USE ONE PAGE PER CONTAMINANT, do not leave empty rows between samples
Do not enter samples with soil concentrations at or below the reporting limit
When leachate concentration is non-detect, enter the aqueous reporting limit
Enter site-specific dilution-attenuation factor (DAF) if desired

Data entry cells (do not skip rows)
Optional data entry
Calculated or locked cells
Indicates that Alternative Remediation Standard needs to be recalculated

Sample ID	Soil sample weight (kg)	Leachate Volume (L)	Total Soil Concentration (mg/kg)	SPLP Leachate Concentration (µg/L)	Final pH of Leachate	Optional data				Kd (L/kg)	% Contaminant in Leachate	Field leachate concentration (µg/L)	Pass or fail?
						Sampling Depth (ft)	Soil Type	Organic Carbon (mg/kg)	Organic Carbon (%)				
SB-5	0.025	0.5	0.0376	0.72	7.1	25.5-26	Clay	NA	NA	32.2	38.30	1.2	PASS
SB-3	0.025	0.5	0.0989	3.5	7.42	18-18.5	Clay	NA	NA	8.3	70.78	11.7	PASS
SB-6	0.025	0.5	3.7	103	6.7	16-16.5	Clay	NA	NA	15.9	55.68	229.4	FAIL
SB-9	0.025	0.5	7.27	144	7.22	22-22.5	Clay	NA	NA	30.5	39.61	236.9	FAIL

SPLP RESULTS for

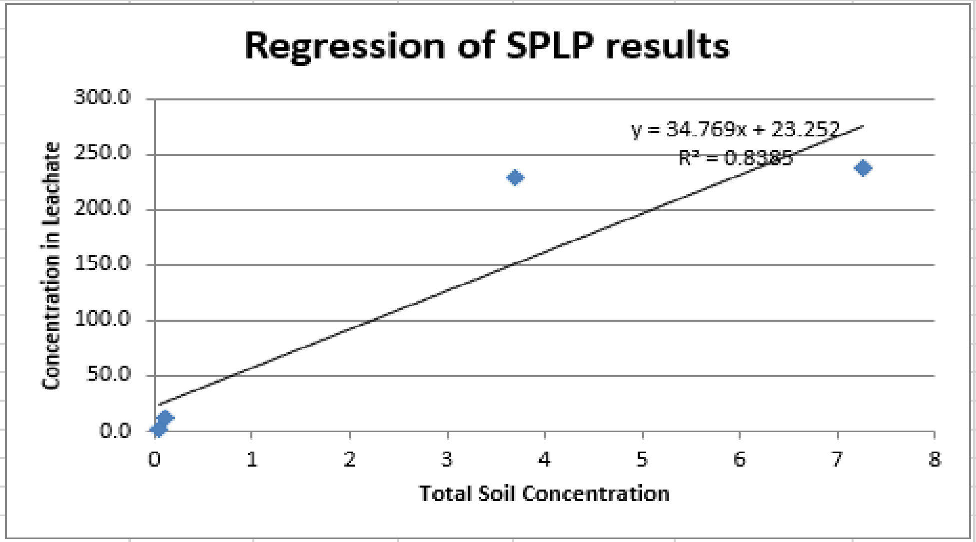
OPTION 1a: All adjusted leachate concentrations are below the leachate criterion
OPTION 1a NOT VALID

OPTION 1b: Simple inspection of tabulated results to find highest acceptable standard

REMEDIATION STANDARD = 0.0989 mg/kg

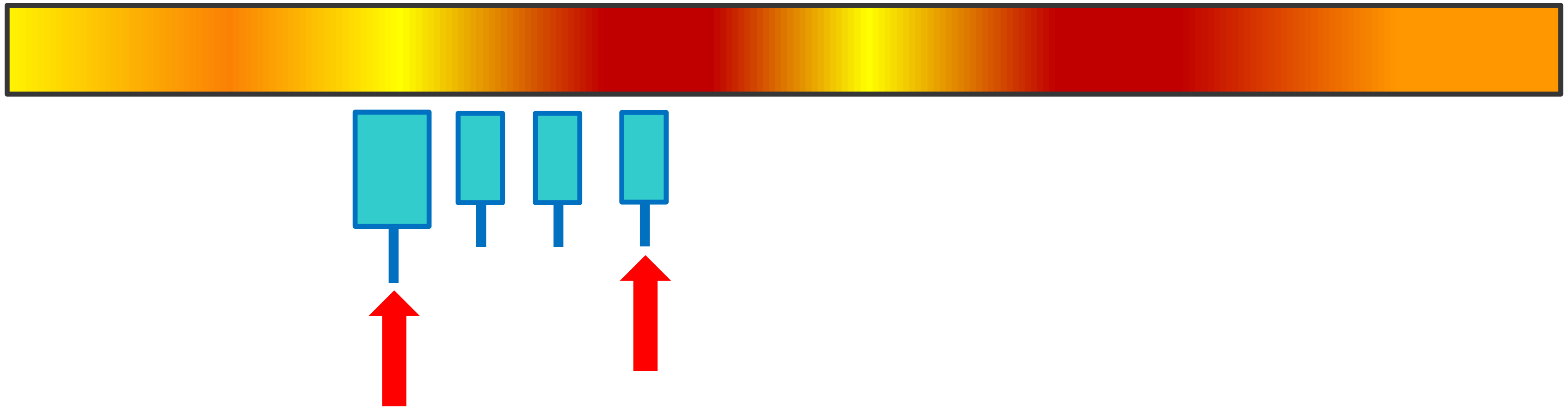
OPTION 2: Remediation standard using site-specific Kd value
Kd ratio = 3.90, AVERAGING Kds OK
Kd USED FOR CALCULATING STANDARD = 21.72 L/kg
result before adjustment = 0.285 mg/kg
REMEDIATION STANDARD = 0.3 mg/kg

OPTION 3: Remediation standard using linear regression
Number of points = 4
Soil concentration midrange = 3.65
Number of points above midrange = 2
Enough points above midrange? YES
R-Square high enough? YES
Leachate criterion within range of leachate concentrations? YES
result before adjustment = -0.2949 mg/kg
REMEDIATION STANDARD = 0.005 mg/kg (controlled by soil PQL)

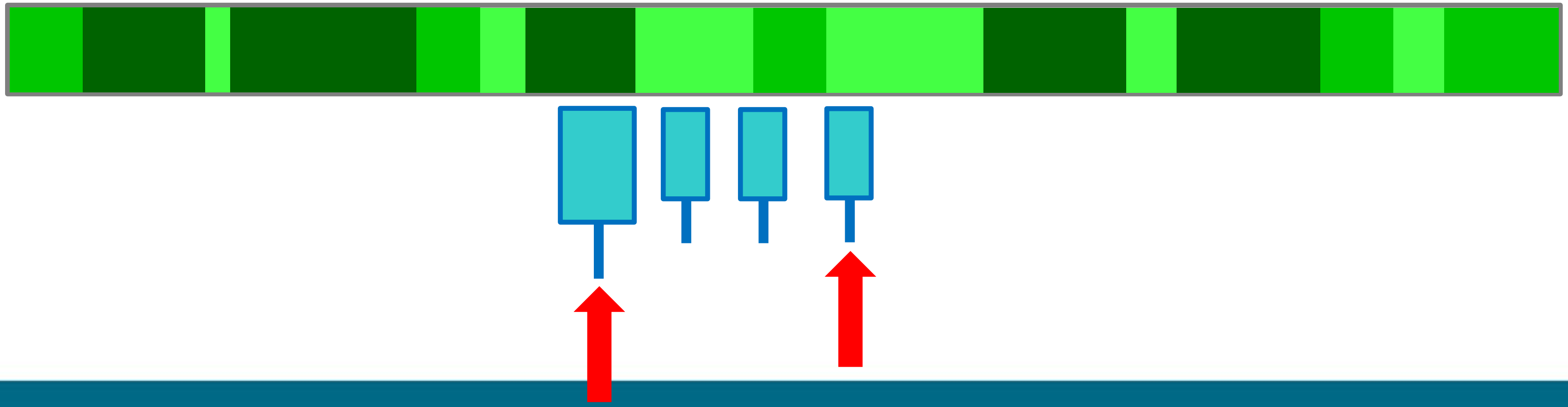


High Kd Values
Possible Cause – Mismatched Samples

Varying PID Readings



Silt Sand and Clay Stringers



Negative Kd Value Example

NJDEP SPLP Spreadsheet, V3.1, November 2013

Case name/area of concern: Ajax
Case number: 11111
Sampling date: 4/4/2014

Contaminant: Trichloroethene (TCE) (Trichloroeth
CAS No: 79-01-6
Water solubility (mg/L): 1.10E+03
Aqueous reporting limit (µg/L): 1.00E+00
Soil reporting limit (mg/kg): 5.00E-03
Health-based GWQC (µg/L): 1.00E+00
DAF (20, or site-specific if approved): 20
Leachate Criterion (µg/L): 2.00E+01
Henry's law constant (dimensionless): 4.22E-01

NOTE:
USE ONE PAGE PER CONTAMINANT, do not leave empty rows between samples
Do not enter samples with soil concentrations at or below the reporting limit
When leachate concentration is non-detect, enter the aqueous reporting limit
Enter site-specific dilution-attenuation factor (DAF) if desired

Data entry cells (do not skip rows)
Optional data entry
Calculated or locked cells
Indicates that Alternative Remediation Standard needs to be recalculated

Sample ID	Soil sample weight (kg)	Leachate Volume (L)	Total Soil Concentration (mg/kg)	SPLP Leachate Concentration (µg/L)	Final pH of Leachate (except VOCs)	Optional data: Sampling Depth (ft)	Optional data: Soil Type	Optional data: Organic Carbon (mg/kg)	Optional data: Organic Carbon (%)	Kd (L/kg)	% Contaminant in Leachate	Field leachate concentration (µg/L)	Pass or fail?
SB-Ust-1	0.02	0.4	0.0079	0.28	9.08					8.2	70.89	0.28	PASS
SB-UST-2	0.02	0.4	0.058	0.63	9					72.1	21.72	0.63	PASS
SB-UST-3	0.02	0.4	0.0047	1.3	9.07					0.0	553.19	23.03	FAIL
SB-UST-4	0.02	0.4	2.4	40	7.13					40.0	33.33	59.70	FAIL
SB-UST-5	0.02	0.4	3.2	56	5.84					37.1	35.00	85.68	FAIL
SB-UST-6	0.02	0.4	3	87	8.68					14.5	58.00	204.27	FAIL
SB-IND-7	0.02	0.4	250	8600	8.2					9.1	68.80	26957.84	FAIL

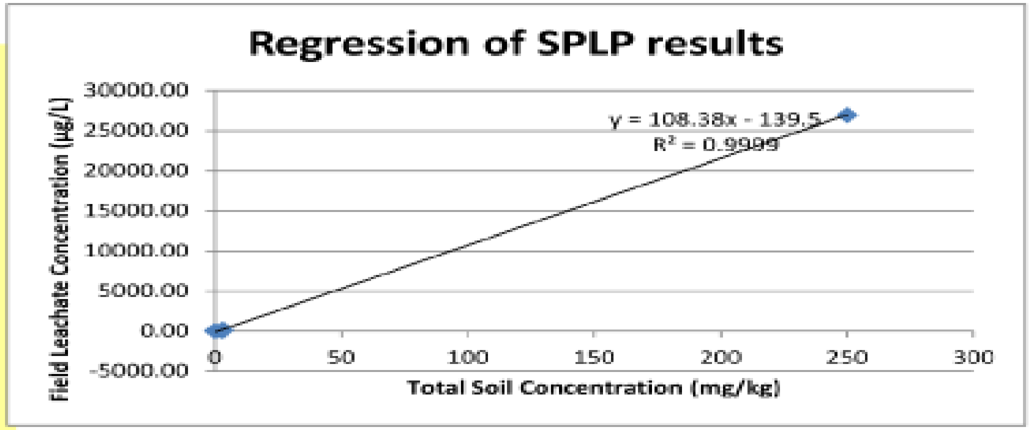
SPLP RESULTS for

OPTION 1a: All adjusted leachate concentrations are below the leachate criterion
OPTION 1a NOT VALID

OPTION 1b: Simple inspection of tabulated results to find highest acceptable standard
THE LOWEST SOIL CONCENTRATION FAILED, USE OPTIONS 2 OR 3

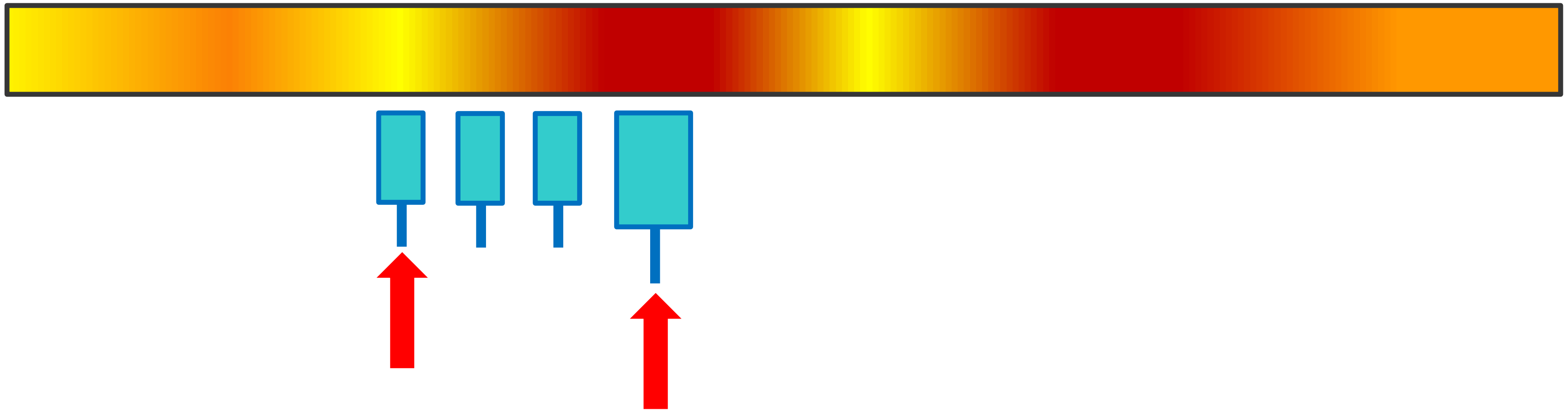
OPTION 2: Remediation standard using site-specific Kd value
Kd ratio = 720634.92, USE MINIMUM Kd
Kd USED FOR CALCULATING STANDARD = . L/kg
result before rounding = 0.0041 mg/kg
REMEDIATION STANDARD = 0.005 mg/kg (controlled by soil PQL)

OPTION 3: Remediation standard using linear regression
Number of points = 5
(points were eliminated because leachate concentrations were not above the aqueous reporting limit)
Soil concentration midrange = 125
Number of points above midrange = 1
Enough points above midrange? NO
R-Square high enough? YES
Leachate criterion within range of leachate concentrations? NO
OPTION 3 NOT VALID

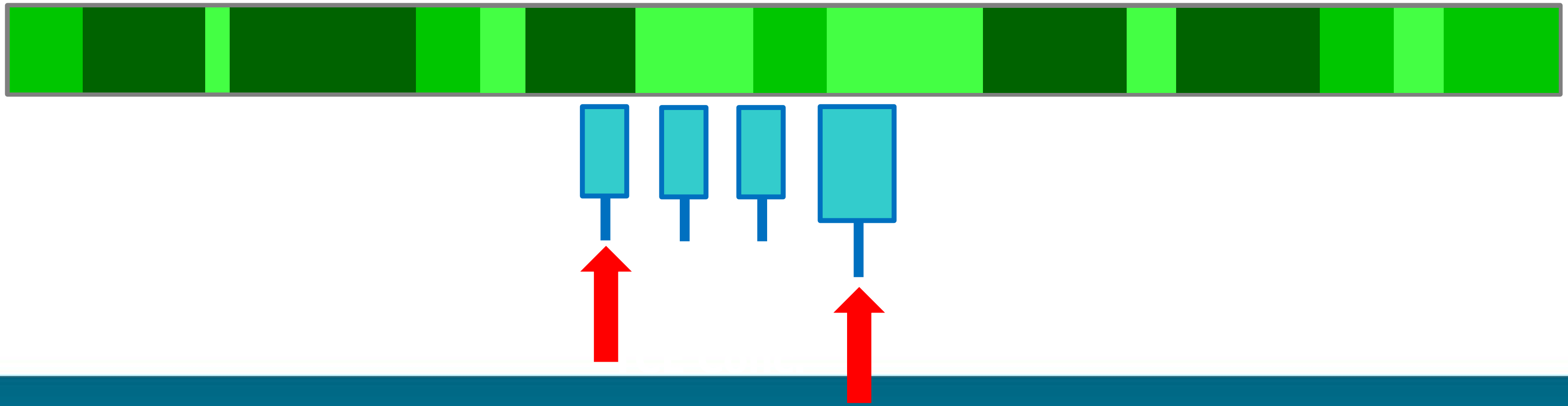


Negative Kd Value
Possible Cause - Mismatched Samples

Varying PID Readings



Silt Sand and Clay Stringers



Use of RL vs. MDL

CALCULATE SITE SPECIFIC IGW STANDARD

Reset Spreadsheet

Print Results

Print to file

CLICK HERE if chemical is not on drop-down list, or to enter alternate GWQC

Case name/area of concern:	BaA Test
Case number:	
Sampling date:	8/3/2015 - 8/7/2015
Contaminant:	Benzo(a)anthracene (1,2-Benzanth
CAS No:	56-55-3
Water solubility (mg/L)	9.40E-03
Aqueous reporting limit (µg/L):	1.00E-01
Soil reporting limit (mg/kg):	2.00E-01
Health-based GWQC (µg/L)	5.00E-02
DAF (20, or site-specific if approved):	20
Leachate Criterion (µg/L):	1.00E+00
Henry's law constant (dimensionless)	1.37E-04

NOTE:

USE ONE PAGE PER CONTAMINANT, do not leave empty rows between samples

Do not enter samples with soil concentrations at or below the reporting limit

When leachate concentration is non-detect, enter the aqueous reporting limit

Enter site-specific dilution-attenuation factor (DAF) if desired

Data entry cells (do not skip rows)

Optional data entry

Calculated or locked cells

Indicates that Alternative Remediation Standard needs to be recalculated

Sample ID	Soil sample weight (kg)	Leachate Volume (L)	Total Soil Concentration (mg/kg)	SPLP Leachate Concentration (µg/L)	Final pH of Leachate (except VOCs)	Optional data: Sampling Depth (ft)	Optional data: Soil Type	Optional data: Organic Carbon (mg/kg)	Optional data: Organic Carbon (%)	Kd (L/kg)	% Contaminant in Leachate	Field leachate concentration (µg/L)	Pass or fail?
RISB-8 (1.5-2)	0.1	2	0.95	0.1						9480.0	0.21	0.10	PASS
RISB-13 (1.5-2)	0.1	2	22	0.23	9.4					95632.2	0.02	0.23	PASS
RISB-19 (0.5-1)	0.1	2	92	1.3	10.6					70749.2	0.03	1.30	FAIL
RISB-1 (1-1.5)	0.1	2	171	1.8	9.67					94980.0	0.02	1.80	FAIL

RL Used = Low Kd

SPLP RESULTS for

OPTION 1a: All adjusted leachate concentrations are below the leachate criterion

OPTION 1a NOT VALID

OPTION 1b: Simple inspection of tabulated results to find highest acceptable standard

REMEDIATION STANDARD = 22 mg/kg

OPTION 2: Remediation standard using site-specific Kd value

Kd ratio = 10.09, USE MINIMUM Kd

Kd USED FOR CALCULATING STANDARD = 9480. L/kg

result before rounding = 9.4802 mg/kg

REMEDIATION STANDARD = 9 mg/kg

OPTION 3: Remediation standard using linear regression

Number of points = 3

(points were eliminated because leachate concentrations were not above the aqueous reporting limit)

Soil concentration midrange = 96.5

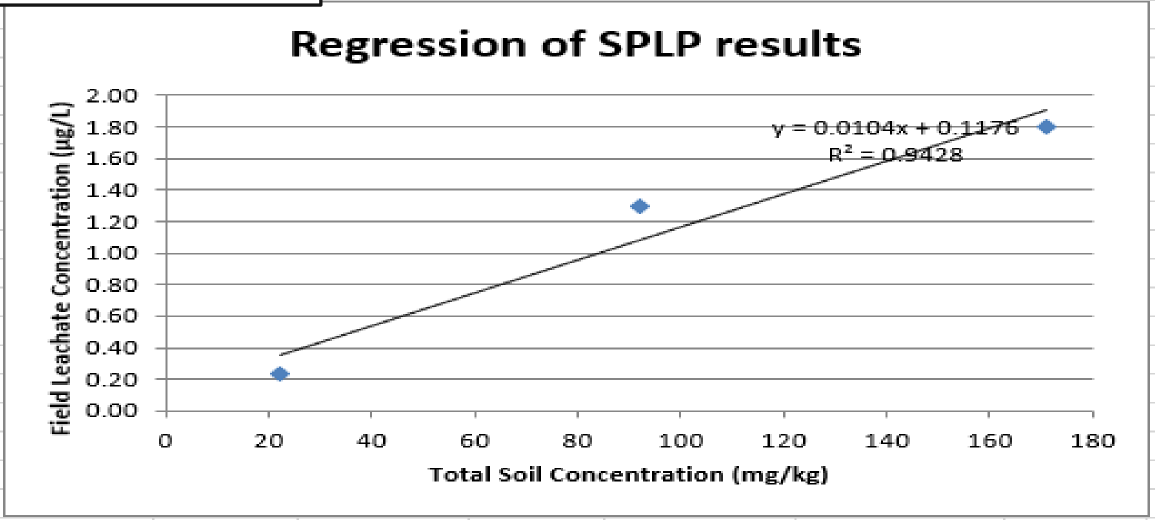
Number of points above midrange = 1

Enough points above midrange? NO

R-Square high enough? YES

Leachate criterion within range of leachate concentrations? YES

OPTION 3 NOT VALID



Use of RL vs. MDL

CALCULATE SITE SPECIFIC IGW STANDARD

Reset Spreadsheet

Print Results

Print to file

CLICK HERE if chemical is not on drop-down list, or to enter alternate GWQC

Case name/area of concern:	BaA Test
Case number:	
Sampling date:	8/3/2015 - 8/7/2015
Contaminant:	Benzo(a)anthracene (1,2-Benzanth
CAS No:	56-55-3
Water solubility (mg/L)	9.40E-03
Aqueous reporting limit (µg/L):	1.00E-01
Soil reporting limit (mg/kg):	2.00E-01
Health-based GWQC (µg/L)	5.00E-02
DAF (20, or site-specific if approved):	20
Leachate Criterion (µg/L):	1.00E+00
Henry's law constant (dimensionless)	1.37E-04

NOTE:

USE ONE PAGE PER CONTAMINANT, do not leave empty rows between samples

Do not enter samples with soil concentrations at or below the reporting limit

When leachate concentration is non-detect, enter the aqueous reporting limit

Enter site-specific dilution-attenuation factor (DAF) if desired

Data entry cells (do not skip rows)

Optional data entry

Calculated or locked cells

Indicates that Alternative Remediation Standard needs to be recalculated

Sample ID	Soil sample weight (kg)	Leachate Volume (L)	Total Soil Concentration (mg/kg)	SPLP Leachate Concentration (µg/L)	Final pH of Leachate (except VOCs)	Optional data: Sampling Depth (ft)	Soil Type	Organic Carbon (mg/kg)	Organic Carbon (%)	Kd (L/kg)	% Contaminant in Leachate	Field leachate concentration (µg/L)	Pass or fail?
RISB-8 (1.5-2)	0.1	2	0.95	0.02	[illegible]					47480.0	0.04	0.02	PASS
RISB-13 (1.5-2)	0.1	2	22	0.23	9.4					95632.2	0.02	0.23	PASS
RISB-19 (0.5-1)	0.1	2	92	1.3	10.6					70749.2	0.03	1.30	FAIL
RISB-1 (1-1.5)	0.1	2	171	1.8	9.67					94980.0	0.02	1.80	FAIL

MDL Used = Consistent Kd

SPLP RESULTS for

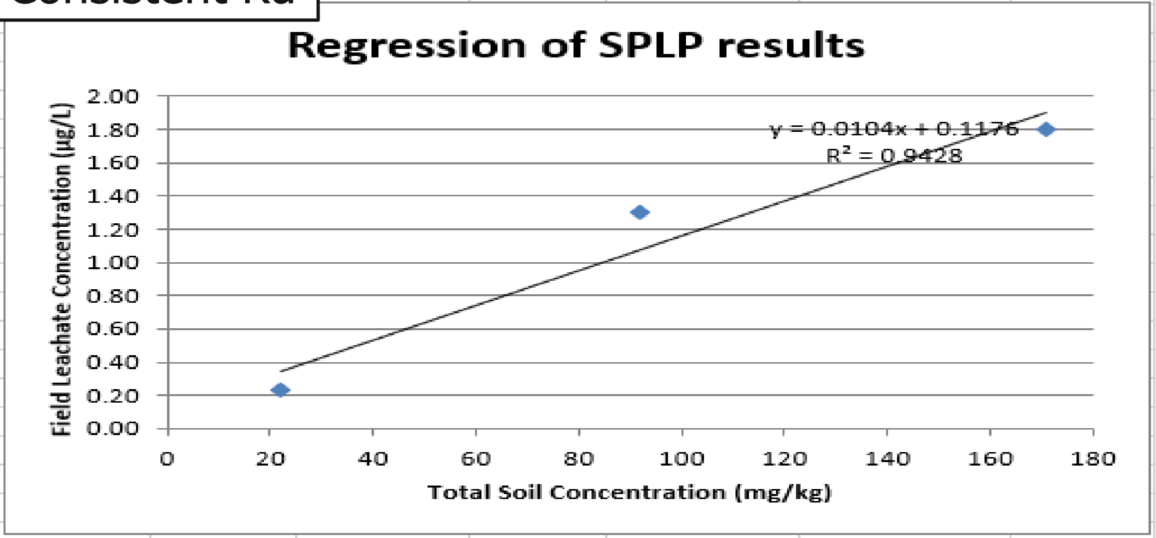
OPTION 1a: All adjusted leachate concentrations are below the leachate criterion
OPTION 1a NOT VALID

OPTION 1b: Simple inspection of tabulated results to find highest acceptable standard

REMEDIATION STANDARD = 22 mg/kg

OPTION 2: Remediation standard using site-specific Kd value
Kd ratio = 2.01, AVERAGING Kds OK
Kd USED FOR CALCULATING STANDARD = 77210.35 L/kg
result before rounding = 77.2105 mg/kg
REMEDIATION STANDARD = 77 mg/kg

OPTION 3: Remediation standard using linear regression
Number of points = 3
(points were eliminated because leachate concentrations were not above the aqueous reporting limit)
Soil concentration midrange = 96.5
Number of points above midrange = 1
Enough points above midrange? NO
R-Square high enough? YES
Leachate criterion within range of leachate concentrations? YES
OPTION 3 NOT VALID



Report

- Need ARS Form and applicable calculator spreadsheets
- Thorough support documentation – Important for all ARS-MGW evaluation methods
- Good chance NJDEP will review, regardless if "pre-approval" is required

Questions

- What if you don't have 3 or more samples with exceedances of Default SRS-MGW?
- Applicability of SRS-MGW – Unsaturated zone vs. saturated zone

Questions?

BREAK

ARS-MGW Development Using a Site-Specific Dilution Attenuation Factor

Mary Anne Kuserk, Chief
Bureau of Ground Water Pollution Abatement
maryanne.kuserk@dep.nj.gov

Dilution Attenuation Factor (DAF)

The discussion of the DAF is outlined Section 5 in the *Alternative Remediation Standards Technical Guidance for Soil and Soil Leachate for the Migration to Ground Water Exposure Pathway*

www.nj.gov/dep/srp/guidance/srra/ars_migration_to_gw_guidance.pdf

Dilution Attenuation Factor (DAF)

- What is the DAF?
  - As infiltrating precipitation containing leached contaminant recharges an aquifer at the water table, it mixes with ground water, reducing the leachate contaminant concentration

  - The amount of dilution and the resulting ground water contaminant concentration can be calculated with a *DAF*

Dilution Attenuation Factor (DAF)

- The default DAF the Department calculated is 20
  - This assumes an aquifer hydraulic gradient of 0.003 and an aquifer hydraulic conductivity of 142 ft/day (51865 ft/yr)
  - See Migration to Ground Water Basis and Background Document https://www.nj.gov/dep/srp/guidance/rs/
- If site-specific values for either of these parameters are higher than these default values, a *DAF* higher than the default value of 20 may be calculated

Dilution Attenuation Factor (DAF)

- The DAF is used in various ARS- MGW calculations including:
  - MGW Soil Leachate Remediation Standards
  - Soil-Water Partitioning Equation
  - SPLP
  - SESOIL

ARS-MGW developed site-specific DAF require **pre-approval** from the Department prior to use

DAF Equation

$$DAF = 1 + \frac{K * i * d}{I * L}$$

DAF = dilution-attenuation factor (unitless)
K = aquifer hydraulic conductivity (m/yr)
i = aquifer hydraulic gradient (unitless)

d = mixing zone depth (m)
I = infiltration rate (m/yr)
L = length of area of concern parallel to ground water flow (m)

Calculating Site-Specific DAF

- Site-Specific Parameters
  - L = Length of the Plume
  - I = Infiltration Rate
  - GW Parameters: K = Hydraulic Conductivity
    i = Gradient

Calculating Site-Specific DAF

- Length of Plume must be adjusted for actual site conditions

- Infiltration Rate will not consider low or impermeable covers

Calculating Site-Specific DAF

- Hydraulic Conductivity and Gradient must be determined from field measurements pursuant to the Department's Ground Water Technical Guidance

- Because *K* and *i* are closely linked parameters affecting ground water velocity, they <u>must be adjusted together</u>

DAF Spreadsheet

NJDEP 2021 Migration to Ground Water Dilution-Attenuation Factor Calculator

Site Name:		Date:	
Additional Description:		Evaluated by:	

	Calculated or locked cell
	Required data entry
	Optional data entry/modifica

$$DAF = 1 + \frac{K * i * d}{I * L}$$

$$d = (0.0112 * L^2)^{0.5} + d_a * \{1 - \exp[(-L * I)/(K * i * d_a)]\}, d \le d_a$$

Instructions

Reset

Back to MGW Site-Specific Menu

Exit

Parameter	*Definition*	*Value*	*units*	Converted to metric: *Value*	*units*
L	Length of Area of Concern Parallel to Ground Water Flow	100	ft	30.5	m
d_a	Aquifer Thickness	11.5	ft	3.5	m
I	Infiltration Rate	11	in/yr	0.28	m/yr
K	Aquifer Hydraulic Conductivity	51865	ft/yr	15808	m/yr
i	Gradient	0.003	dimensionless	0.003	dimensionless
d	Mixing Zone Depth			3.4	m
DAF	Dilution-Attenuation Factor			20	dimensionless

NOTES: (click outside box when finished)

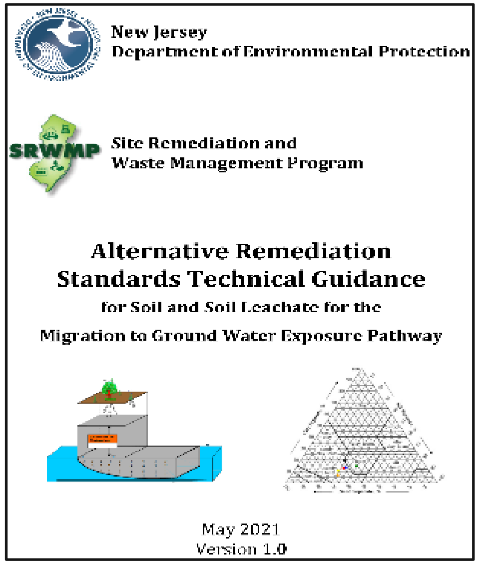
Submittals

- Copy of the Spreadsheet
- Technical justification and data used to determine input parameters

Thank You!

SESOIL
Seasonal Soil Compartment Model

William Carp
Bureau of Environmental Evaluation and Risk Assessment
william.carp@dep.nj.gov



New Jersey
Department of Environmental Protection

Site Remediation and
Waste Management Program

Alternative Remediation
Standards Technical Guidance
for Soil and Soil Leachate for the
Migration to Ground Water Exposure Pathway

May 2021
Version 1.0

Section 7.0

Seasonal Soil Compartment Model (SESOIL)

- May be used to demonstrate that a specified existing or proposed concentration distribution of contaminant in soil **will not result in future contamination of ground water above the GWRS.**
  - Contaminant concentration distribution may then be used to define an ARS, for the ARS-MGW.
- ARS-MGW developed under this option will typically be a depth-dependent vertical concentration distribution, rather than a single number.
- Appropriately delineated unsaturated soil contamination must also be demonstrated.

SESOIL Implementation

- Use of SEVIEW software package (ESCI, 2017) for modeling
  - incorporates a convenient user interface for preparing and processing SESOIL model input and output

Prior approval from Department required before applying the ARS-MGW that are developed using SESOIL

SESOIL

SESOIL can be used for three scenarios:

- Can model existing concentrations
- Can model concentrations that will remain behind after remediation
- Can model theoretical maximum concentrations

SESOIL

SESOIL is most useful when:

- there are contaminants with lower mobility that are located a significant distance above the water table and will not reach the water table in 100 years
- there are degradable volatile hydrocarbons at concentrations that do not greatly exceed the ARS-MGW
- there are volatile contaminants that do not greatly exceed the SRS-MGW and the soil texture at the site has been characterized

SESOIL Model Notations

- SESOIL model may be used whether the ground water is currently contaminated or not. However, **<u>no additional</u> ground water contamination from contaminants located in the unsaturated zone is permitted**.
- Sites with impermeable caps must be modeled as if no cap is present
  - Because of this requirement, the ARS-MGW determined using the SESOIL model allows for unrestricted land use (capped or uncapped)

Test Your Knowledge

True or False:

SESOIL model may be used whether the ground water is currently contaminated or not.

A. True

B. False

Test Your Knowledge

True or False:

SESOIL model may be used whether the ground water is currently contaminated or not.

A. True

B. False

SESOIL Model Notations (cont'd)

- The Department has assigned default input values for most of the parameters used in the SESOIL model. Several of these may be adjusted on an AOC- or site-specific basis. The two parameters below, must be determined using AOC or site-specific information:
  - the contaminant concentration distribution in the unsaturated zone
  - the depth to ground water

SESOIL Model Notations (cont'd)

Allowed site-specific parameters

- Soil texture (default is sand) – If actual texture measured, allows turning on volatilization (important for VOCs). The leaching rate may also be reduced for soil textures other than sand.
- Percent soil organic carbon (default is 0.2%). May be layer specific. Higher soil organic carbon will slow leaching rate and reduce SESOIL leachate concentrations for organics.
- 1 month degradation half-life for BTEX and other non-PAH hydrocarbons – greatly reduces BTEX leachate concentrations

Site-specific depth to ground water must be used

SESOIL Model Notations (cont'd)

Allowed site-specific parameters

Site-specific parameters not discussed in this SESOIL presentation

- Site-specific leachate criterion (from site-specific DAF). See SPLP and DAF sections of guidance
- Site-specific Kd from SPLP test – reduces leaching rate and leachate concentrations. **See SPLP guidance**

SESOIL and Ground Water Impact

SESOIL is used in two ways to show that GW will not be impacted:

1. To see if maximum predicted leachate concentration from SESOIL does not exceed Soil Leachate Remediation Standard

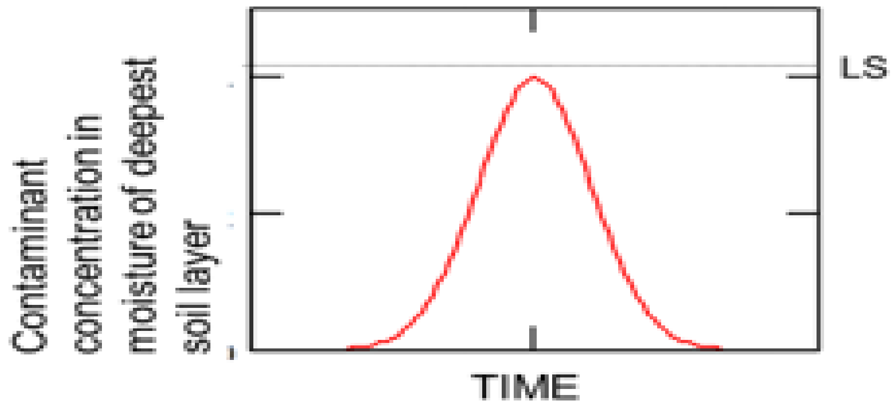


Figure 1

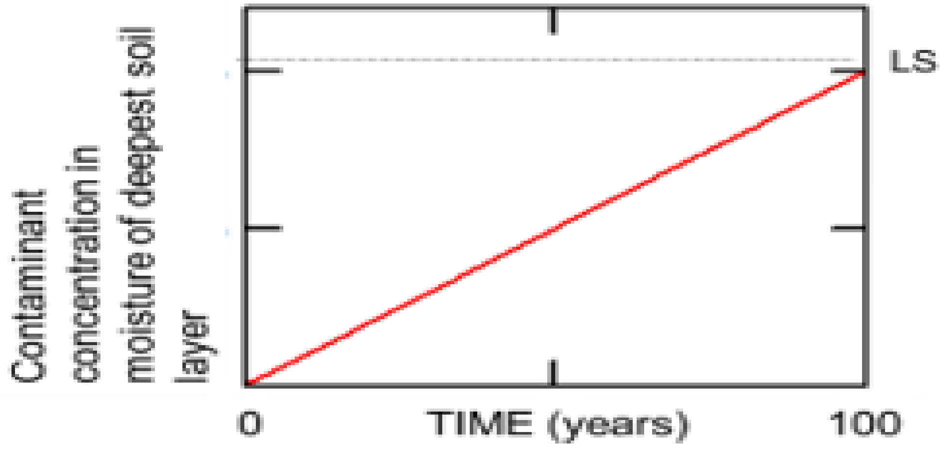


Figure 2

SESOIL and Ground Water Impact (cont'd)

2. To demonstrate that the contaminant will not reach ground water over a 100-year time period

Contaminant does not quite reach the water table, therefore OK

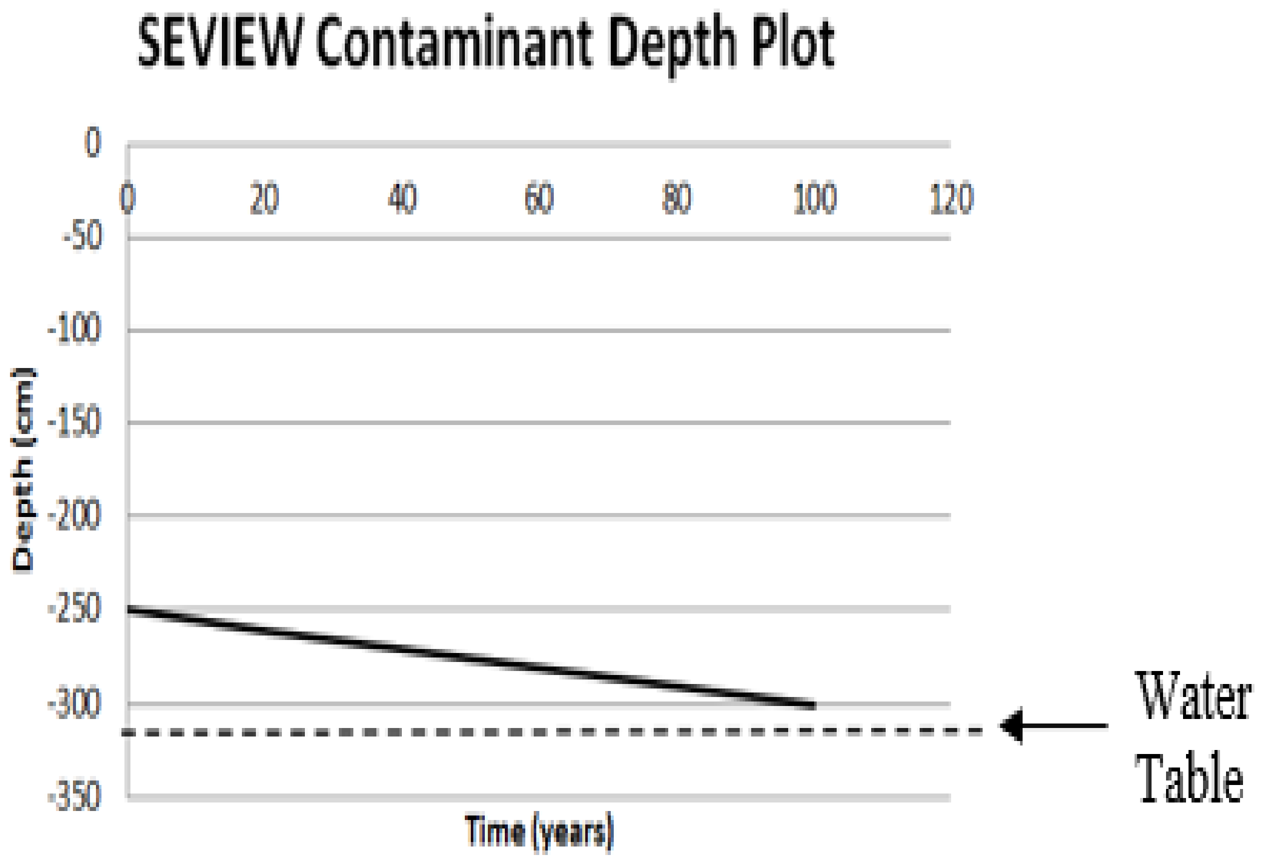


Figure 3

SESOIL versus combined SESOIL/AT123D

	SESOIL	SESOIL/AT123D
Media	Unsaturated soil	Unsaturated soil and ground water
Objective	Calculated leachate < $MGW_{LEACHATE}$	GWRS achieved within CEA timeframe
CEA Required?	No	Yes
Impermeable Cap?	May be present (but modeled as if not present)	Cannot be present (for duration of CEA)
Contaminants	All	All, but typically used only for mobile contaminants (VOCs)
Site-specific testing of soil/aquifer parameters	Not required	Some required

SESOIL versus combined SESOIL/AT123D

SESOIL

- Models maximum leachate at bottom of vadose zone
- Concentration-based endpoint

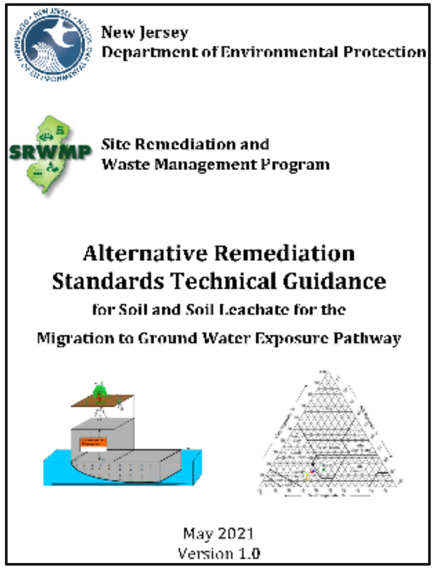
SESOIL/AT123D

- Models how quickly predicted ground water concentrations decrease with time
- Time-based endpoint

Thank You!

SESOIL/AT123D Models

Steve Posten, LSRP, Vice President
Wood Environment & Infrastructure Solutions, Inc.
Licensed Site Remediation Professional Association (LSRPA)
stephen.posten@amecfw.com


New Jersey
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May 2021
Version 1.0

Section 8.0

SESOIL/AT123D

- SESOIL = 1D (vertical) vadose zone transport model
- AT123D = 2/3D (horizontal) saturated zone transport model
  - Key aspect: separate contaminant load can be entered at each time step, allowing for linkage with SESOIL
- AT123D is an acronym for the "Analytical Transient 1-, 2- and 3-Dimesional Simulation of Waste Transport in the Aquifer System"
- Originally developed in 1981 at the Oak Ridge National Laboratory (ORNL) for evaluation of RCRA/CERCLA sites
- Model results have been shown to be comparable to more sophisticated simulations using the numerical MODFLOW (flow) and MT3D (transport) models

SESOIL

- **SESOIL**
  - One dimensional vertical infiltration model
  - Applied alone (without AT123D) **generally when ground water is not impacted,** and a “clean” zone exists between contaminated soil water table
  - Calculates concentration at bottom of soil column based on vertically distributed contaminant concentrations
  - Determines whether existing contamination will impact ground water, or can allow for back-calculation of acceptable soil contaminant distribution

SESOIL/AT123D

- **SESOIL/AT123D**
  - Combines one-dimensional vertical infiltration model (SESOIL) with two-dimensional ground water transport model (AT123D)
  - **Used when ground water is already impacted**
  - AT123D incorporates leachate concentration from SESOIL to define ground water source mass, and then applies advection, dispersion, aquifer matrix sorption and biodegradation to the transport of dissolved contaminants

SESOIL/AT123D

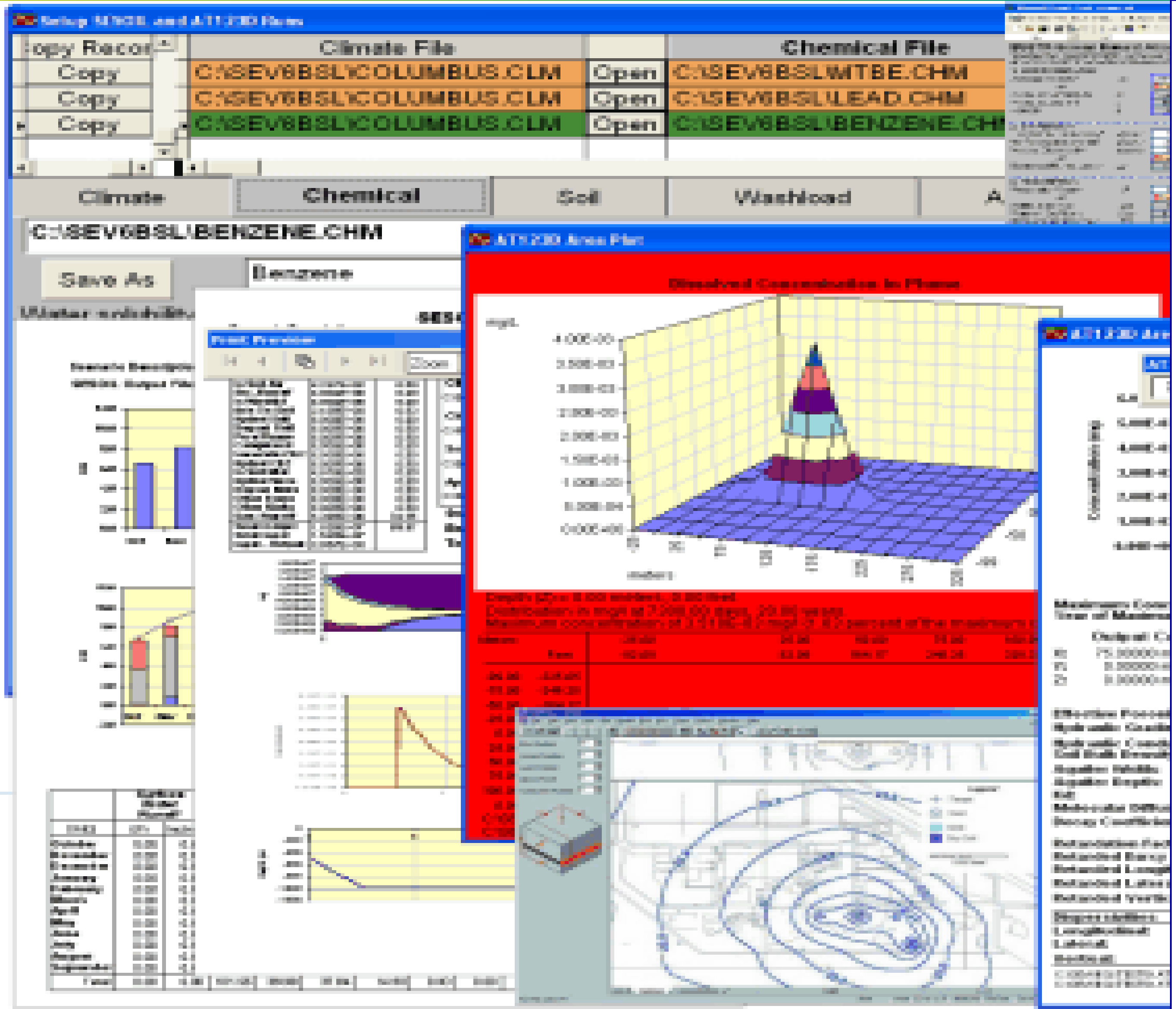
SESOIL/AT123D can be used in two ways:

- Determine whether existing contamination in the vadose zone will impact GW; or
- Model proposed contaminant concentrations that will be left behind after proposed remediation, to determine if the proposed remediation plan is acceptable.

In both cases:

- Ground water quality is compared to GWQS within specific timeframes at specific compliance points, and
- Vadose zone contamination represents a depth discrete distribution, not a specific value

SESOIL/AT123D



SEVIEW

Groundwater and Vadose Transport With AT123D and SESOIL

Version 7.1
November 2014

User's Guide
for
Microsoft® Windows

SEVIEW, Ver. 7.1
ESCI, LLC

Environmental Software Consultants Inc, LLC
P.O. Box 2622
Madison, Wisconsin 53701-2622
Phone: 608 240-9878
Fax: 608 285-5131
www.seview.com

SESOIL/AT123D

- Requirements for Application of AT123D:
  - Groundwater quality is currently degraded by contamination migrating from soil at the area of concern (AOC)
  - AOC may not be capped with low permeability cap
    - SESOIL/AT123D model relies on infiltration, ground water recharge and volatilization to attenuate chemicals; these processes are inhibited when a site is capped.
  - Receptor Evaluation completed and impacts addressed

SESOIL/AT123D

- Requirements for Application of AT123D:
  - Free and residual product must be treated or removed to the extent practicable or contained when treatment or removal is not practicable
  - Soil and ground water contamination has been appropriately delineated, an adequate ground water monitoring network is installed, and long-term monitoring is performed in accordance with the requirements of the site-specific remedial action permit for ground water
  - In accordance with N.J.A.C. 7:26C-7.9(f), ground water monitoring must demonstrate that contaminant concentrations are below the applicable standards in order to achieve site closure

SESOIL/AT123D

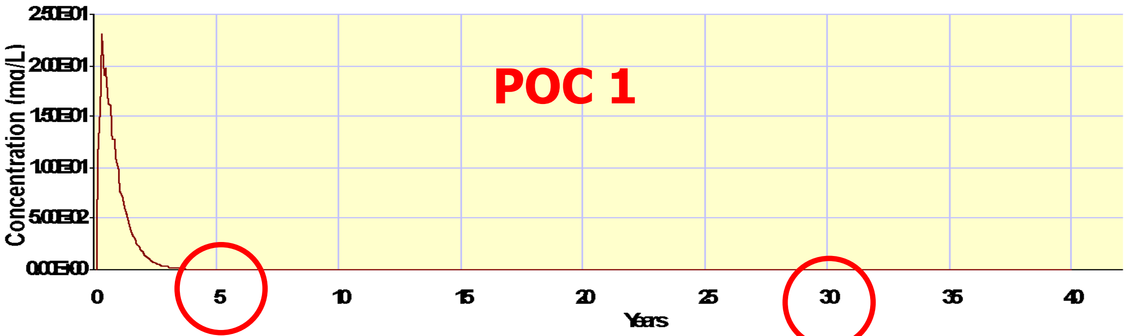
- Model Inputs
  - Size and location of source
  - Climate data from weather station located proximal to site
  - Chemical-specific parameters from DEP database
  - Distribution coefficient (K_d); default or site-specific (e.g., SPLP)
  - Soil texture (grain size analysis)
  - SESOIL-specific soil parameters (based on soil texture analysis)
  - SESOIL-specific vertical contaminant distribution
  - Soil organic carbon (F_{oc})
  - Depth to water table
  - Hydraulic conductivity
  - Hydraulic gradient
  - Effective porosity (default or site-specific)
  - Bulk density (default or site-specific)
  - Dispersion (longitudinal, transverse, vertical)

SESOIL/AT123D

- Model Outputs
  - Contaminant concentrations in groundwater over time at specified points of compliance (POC):
    - POC 1: A location at the centerline of the plume at surface of the water table at the downgradient edge of the AOC.
    - POC 2: A location at the centerline of the plume at the maximum extent of the plume at the surface of the water table.
  - Acceptance Criteria:
    - Contaminant concentrations are below the GWQS at all POCs at the end of the model simulation period (= CEA duration).

SESOIL/AT123D

AT123D Point of Compliance Report



Maximum Concentration: 2.300E-01 mg/L
Year of Maximum Concentration: 0.33

Output Coordinates

X:	8.60000 m	28.2149 ft	Output Time Step:	0.0833 years	1.0005 months
Y:	0.00000 m	0.0000 ft	Initial Load (mg/L):	0.0000E+00	
Z:	0.00000 m	0.0000 ft	Initial Load (kg):	0.7300E+03	

Input Parameters

Porosity: 0.30000 Soil Organic Carbon Content (percent): 0.20000
Hydraulic Gradient: 0.00530 Carbon Adsorption Coeff. (ug/g)/(ug/ml): 0.1550E+03

Hydraulic Conductivity:	8.890E-01	m/hr	2.469E-02	cm/sec
Soil Bulk Density:	1.580E+03	kg/m3	1.580E+00	g/cm3
Aquifer Width:	Infinite	m	Infinite	ft
Aquifer Depth:	8.700E+00	m	2.854E+01	ft
Kd:	3.100E-04	m3/kg	3.100E-01	(ug/g)(ug/ml)
Molecular Diffusion:	2.952E-06	m2/hr	8.200E-06	cm2/sec
Decay Coefficient:	0.000E+00	1/hr	0.000E+00	1/day

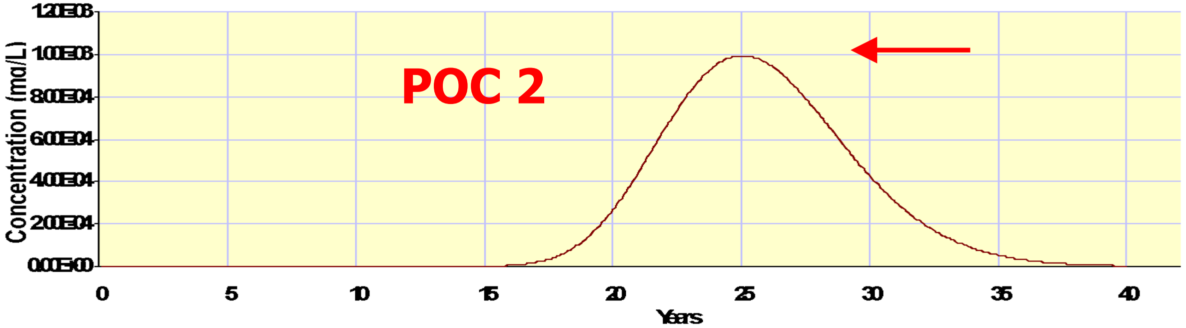
Retardation Factor:	2.633E+00			
Retarded Darcy Velocity:	5.966E-03	m2/hr	1.657E-02	cm2/sec
Retarded Longitudinal Disp. Coefficient:	7.696E-02	m2/hr	2.137E-01	cm2/sec
Retarded Lateral Dispersion Coefficient:	7.699E-03	m2/hr	2.138E-02	cm2/sec
Retarded Vertical Dispersion Coefficient:	7.733E-04	m2/hr	2.148E-03	cm2/sec

Dispersivities	Meters	Feet
Longitudinal:	1.290E+01	4.232E+01
Lateral:	1.290E+00	4.232E+00
Vertical:	1.290E-01	4.232E-01

Load	Begin (m)	End (m)	Begin (ft)	End (ft)
X:	-8.600E+00	8.600E+00	-2.821E+01	2.821E+01
Y:	-8.600E+00	8.600E+00	-2.821E+01	2.821E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

C:\SEVIEW63\WSFINAL_.ATI
C:\SEVIEW63\WSFINAL_.ATO

AT123D Point of Compliance Report



Maximum Concentration: 9.940E-04 mg/L
Year of Maximum Concentration: 24.92

Output Coordinates

X:	1307.00000 m	4288.0056 ft	Output Time Step:	0.0833 years	1.0005 months
Y:	0.00000 m	0.0000 ft	Initial Load (mg/L):	0.0000E+00	
Z:	0.00000 m	0.0000 ft	Initial Load (kg):	0.7300E+03	

Input Parameters

Porosity: 0.30000 Soil Organic Carbon Content (percent): 0.20000
Hydraulic Gradient: 0.00530 Carbon Adsorption Coeff. (ug/g)/(ug/ml): 0.1550E+03

Hydraulic Conductivity:	8.890E-01	m/hr	2.469E-02	cm/sec
Soil Bulk Density:	1.580E+03	kg/m3	1.580E+00	g/cm3
Aquifer Width:	Infinite	m	Infinite	ft
Aquifer Depth:	8.700E+00	m	2.854E+01	ft
Kd:	3.100E-04	m3/kg	3.100E-01	(ug/g)(ug/ml)
Molecular Diffusion:	2.952E-06	m2/hr	8.200E-06	cm2/sec
Decay Coefficient:	0.000E+00	1/hr	0.000E+00	1/day

Retardation Factor:	2.633E+00			
Retarded Darcy Velocity:	5.966E-03	m2/hr	1.657E-02	cm2/sec
Retarded Longitudinal Disp. Coefficient:	7.696E-02	m2/hr	2.137E-01	cm2/sec
Retarded Lateral Dispersion Coefficient:	7.699E-03	m2/hr	2.138E-02	cm2/sec
Retarded Vertical Dispersion Coefficient:	7.733E-04	m2/hr	2.148E-03	cm2/sec

Dispersivities	Meters	Feet
Longitudinal:	1.290E+01	4.232E+01
Lateral:	1.290E+00	4.232E+00
Vertical:	1.290E-01	4.232E-01

Load	Begin (m)	End (m)	Begin (ft)	End (ft)
X:	-8.600E+00	8.600E+00	-2.821E+01	2.821E+01
Y:	-8.600E+00	8.600E+00	-2.821E+01	2.821E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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SESOIL/AT123D

- Reporting requirements
  - SESOIL related:
    - Table of contaminant distribution with depth
    - 4 model output pages documenting inputs and outputs
  - AT123D related:
    - Delineated groundwater plume indicating source locations
    - Table of source concentration data
    - Model generated point of compliance report for each POC
    - Electronic submission: Model output (“project”) file in *.prj format

SESOIL/AT123D

- Closure requirements:
  - A Department approved ground water monitoring program designed to monitor the predictions of the AT123D model must be implemented.
  - If observed ground water concentrations have not decreased at the end of the CEA, soil sampling may be required. Consult the Monitored Natural Attenuation Technical Guidance Document for further details.

Note: Compliance averaging of soil concentrations is not applicable to SESOIL or AT123D modeling at this time

Thank You!

Questions?

Alternative Remediation Standards Immobile Chemicals Option for the Migration to Ground Water Exposure Pathway

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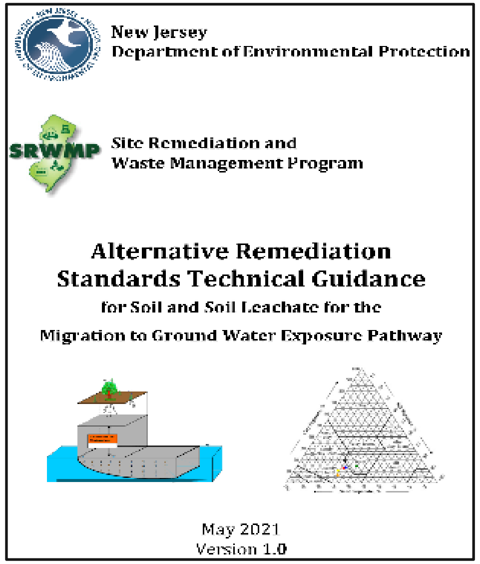

New Jersey
Department of Environmental Protection

SRWMP Site Remediation and
Waste Management Program

Alternative Remediation
Standards Technical Guidance
for Soil and Soil Leachate for the
Migration to Ground Water Exposure Pathway

May 2021
Version 1.0

Section 9.0

Immobile Chemicals: Option Overview

- Section 9: ARS-MGW Guidance document
- Immobile chemicals option a narrative standard, not a numerical standard
- Specific list of eligible chemicals
- Evaluate after RI completed, delineation completed
- Requires 2-foot clean zone between contamination and seasonally high water table
- There are site conditions where Immobile Chemicals Option cannot be used

How the Immobile Chemicals were Determined

- NJDEP performed contaminant transport model
- Model run using default properties for calculating the SRS-MGW
- Sandy loam soil
- Chemical needed to be transported less than two feet over 100 years
- Immobile chemicals list has been updated from prior guidance

List of Immobile Chemicals

- Lead
- Aldrin
- Benzo(a)anthracene
- Bis(2-ethylhexyl phthalate)
- Chlordane
- Dichlorodiphenyldichloroethane (DDD)
- Dichlorodiphenyldichloroethylene (DDE)
- Dichlorodiphenyltrichloroethane (DDT)
- PCBs
- 2,3,7,8-tetrachlorodibenzo-p-dioxin
- Toxaphene

SRWMP

Immobile Chemicals

Site Conditions where option CANNOT be used:

- When site conditions are present that might increase the normal mobility of the contaminant
  - Examples:
    - Contaminant part of mixture
    - Co-solvent present
    - Soil pH altered from acids or bases

Reminder: Soil texture cannot be coarser than sandy loam

Immobile Chemicals: Submittal Requirements

- Sampling results:
  - including samples from 2-foot zone between contamination and seasonally high water table
- Analytical results tables
- Soil boring logs
- Evaluation of all conditions identified in the guidance

Thank You!

Soil and Ground Water Data Evaluation

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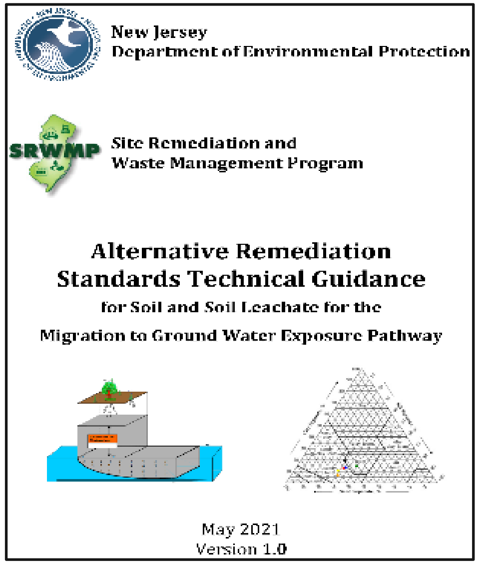
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Section 10.0

Site Soil and Ground Water Data Option

- **Narrative Standard**: found in Section 10.0 of the "Alternative Remediation Standards Technical Guidance for Soil and Soil Leachate for the Migration to Ground Water Exposure Pathway."

This means no numerical standard: – just that the pathway has been satisfactorily evaluated and needs no further action

Site Soil and Ground Water Data Option

This option uses current ground water data to arrive at a conclusion about soil contamination acceptability for the MGW exposure pathway

Site Soil and Ground Water Data Option

Conditions:

- Contamination is not due to recent discharge
- Highest contaminant levels are at the water table
- Ground water concentrations are below GWRS

All must apply!

Site Soil and Ground Water Data Option

To implement this option:

- Soil sampling with appropriate delineation to the applicable SRS-MGW or ARS-MGW
- Two rounds of groundwater sampling, 30 days apart

Site Soil and Ground Water Data Option Reporting Requirements

Supporting data should include:

- Table with soil and ground water data
- Methodology used to derive this
- History of site, especially with reference to the discharge

See guidance for further details

Test Your Knowledge

Supporting data for the soil and ground water data option should include:

A. Table with soil and ground water data

B. Methodology used to derive this

C. History of site, especially with reference to the discharge

D. All of the above

Test Your Knowledge

Supporting data for the soil and ground water data option should include:

A. Table with soil and ground water data

B. Methodology used to derive this

C. History of site, especially with reference to the discharge

D. All of the above

Important Note

Methodologies and models other than those in this guidance document may be submitted for the MGW exposure pathway

- all such will require DEP preapproval prior to use, and
- a detailed review may be necessary

Submission of a new model or methodology does not guarantee its approval for use

Questions?

Thank You for Attending!

Please complete the Course Evaluation at:

https://www.surveymonkey.com/r/NG73ZTP