Starting Soon: Remediation Management of Complex Sites

Poll Question

- Remediation Management of Complex Sites, RMCS-1 http://rmcs-1.itrcweb.org
- Download PowerPoint file
  - CLU-IN training page at http://www.clu-in.org/conf/itrc/rmcs/
- Download flowchart and checklist for reference during the training class
  - http://www.clu-in.org/conf/itrc/RMCS/Excerpts_from_ITRC_RMCS-1_2017.docx

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Welcome – Thanks for Joining this ITRC Training Class

Remediation Management of Complex Sites

Remediation Management of Complex Sites (RMCS-1)

ITRC Technical and Regulatory Guidance document

Sponsored by: Interstate Technology and Regulatory Council (www.itrcweb.org)
Hosted by: USEPA Clean Up Information Network (www.cluin.org)

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- Course time is 2¼ hours
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- Questions and feedback
  - **Throughout training:** type in the "Q & A" box
  - **At end of class:** Feedback form available from last slide
    - **Need confirmation of your participation today?** Fill out the feedback form and check box for confirmation email and certificate

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  - ITRC Industry Affiliates Program
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https://clu-in.org/conf/itrc/rmcs/

The Challenge – Meeting Site Objectives at Complex Sites

- Complete remediation (no use restrictions) is a significant challenge at complex sites

- ITRC team definition of a complex site:
  - Remediation progress is uncertain and remediation may not achieve closure or even long-term management within a reasonable time frame
  - "Reasonable time frame" for restoring resources to beneficial use is subject to interpretation and depends on site circumstances

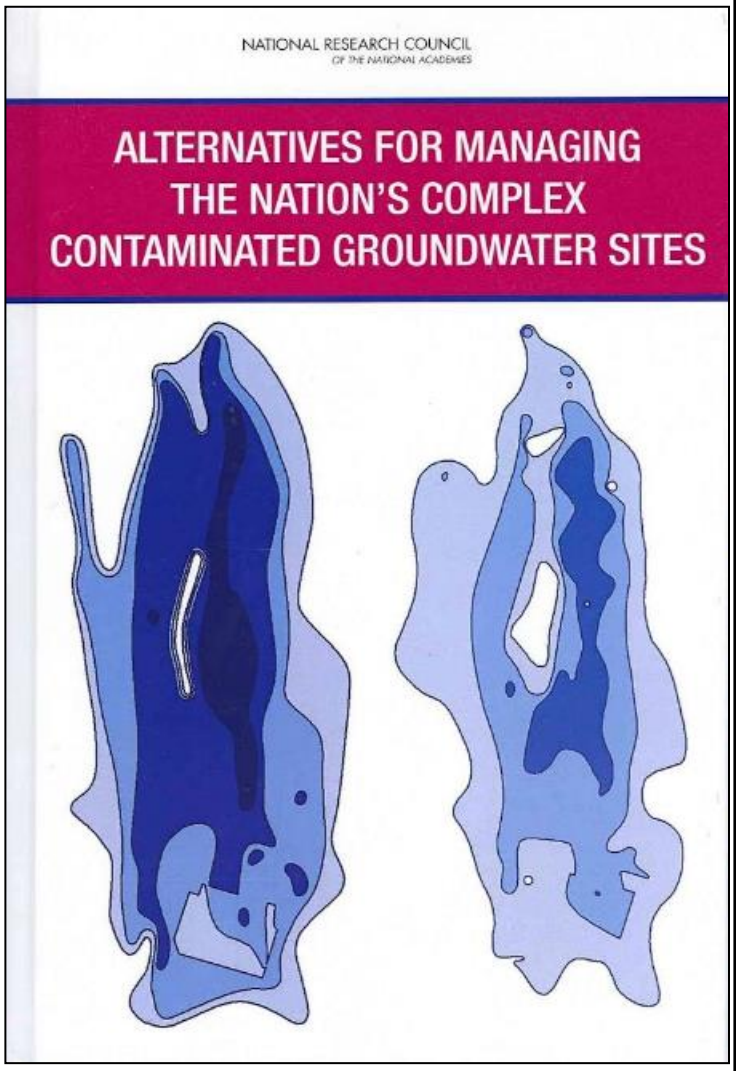
The Challenge – Meeting Site Objectives at Complex Sites

Aerial view of the Rocky Flats Site, Colorado
ITRC RMCS-1 Figure 15 (DOE 2017)

Delineating TCE plume in a residential area near Middlefield-Ellis-Whisman (MEW) Site, California
ITRC RMCS-1 Figure 12 (CPEO 2016b)

Complex Sites Nationwide

- National Research Council reported contaminant levels at 126,000 sites inhibit site closure
- Roughly 10% are “complex”
- Cost to complete = $127 billion
- Clear need for additional guidance



National Research Council, 2013

ITRC Guidance for Complex Sites

- Recommended process for complex sites
  - Adaptive site management
- Consolidates existing guidance, best practices, tools, and technologies
- 16 case studies - real-world applications

ITRC Technical and Regulatory Guidance
Remediation Management of Complex Sites
RMCS-1
http://rmcs-1.itrcweb.org

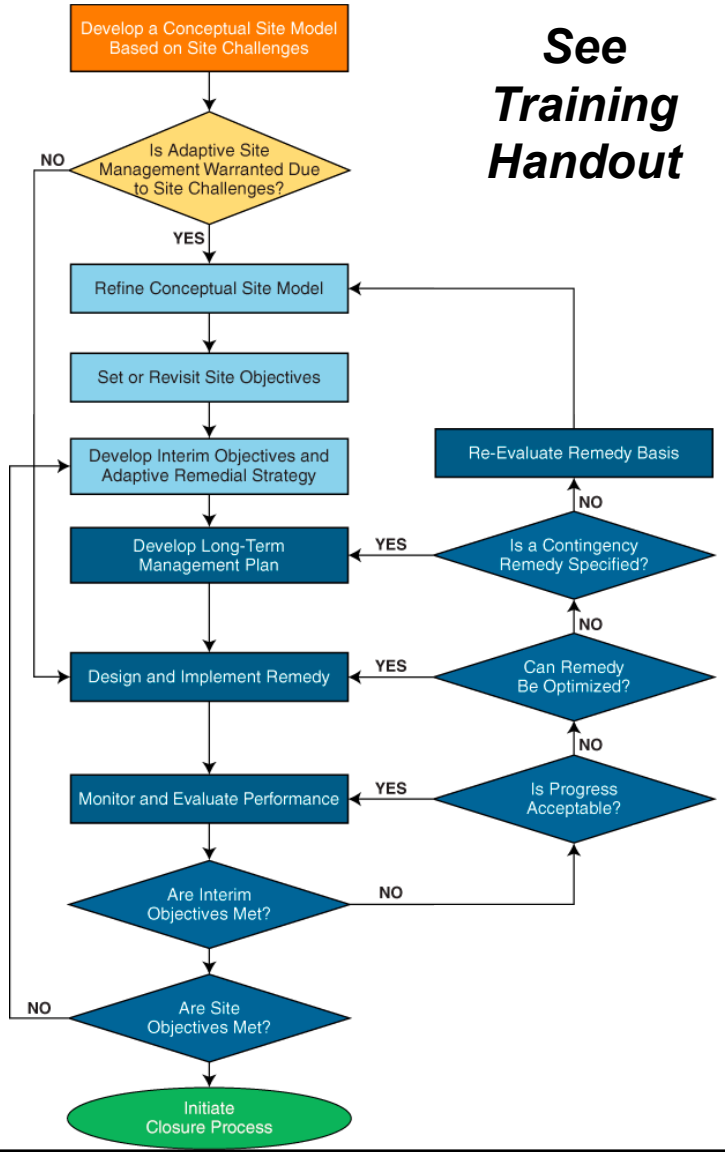
Adaptive Site Management
Comprehensive, Flexible, and Iterative

Chapter 2. Site Challenges

Chapter 3. Remediation Potential Assessment

Chapter 4. Adaptive Remedy Selection

Chapter 5. Long-Term Management



See Training Handout

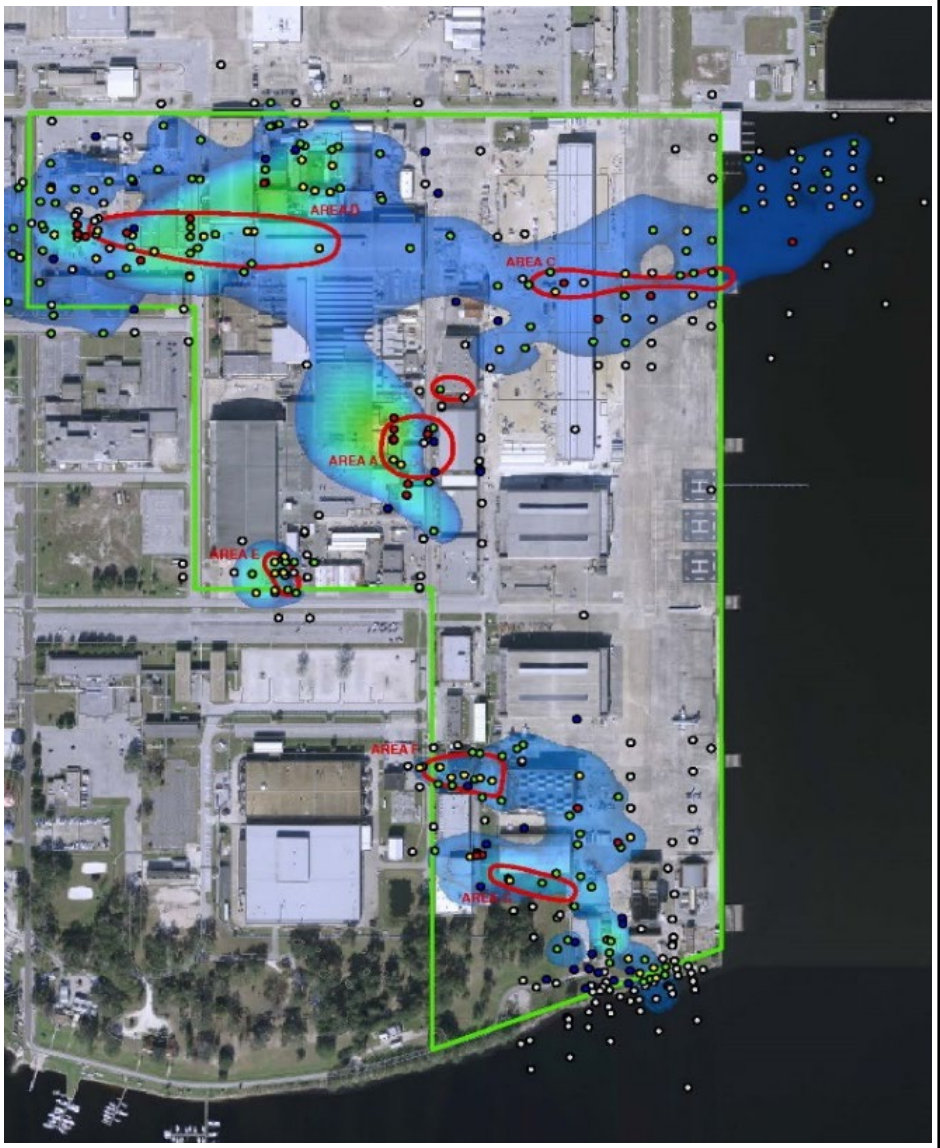
ITRC RMCS-1 Chapter 1, Figure 1

Benefits of Adaptive Site Management

- Maintain protection of human health and the environment and fulfill regulatory obligations
- Base decisions on robust conceptual site models
- Streamline decision making and save costs
- Demonstrate interim progress that leads to long-term results
- Reduce barriers to using available remedial approaches
- Return sites to beneficial reuse

Case Study: Naval Air Station Jacksonville, Florida, Operable Unit 3

- Used adaptive site management
  - Discontinued interim remedial actions
  - Refined conceptual site model
  - Determined key exposure pathways
  - Adopted a risk-based remedial approach
- Several pilot studies, innovative tools and technologies



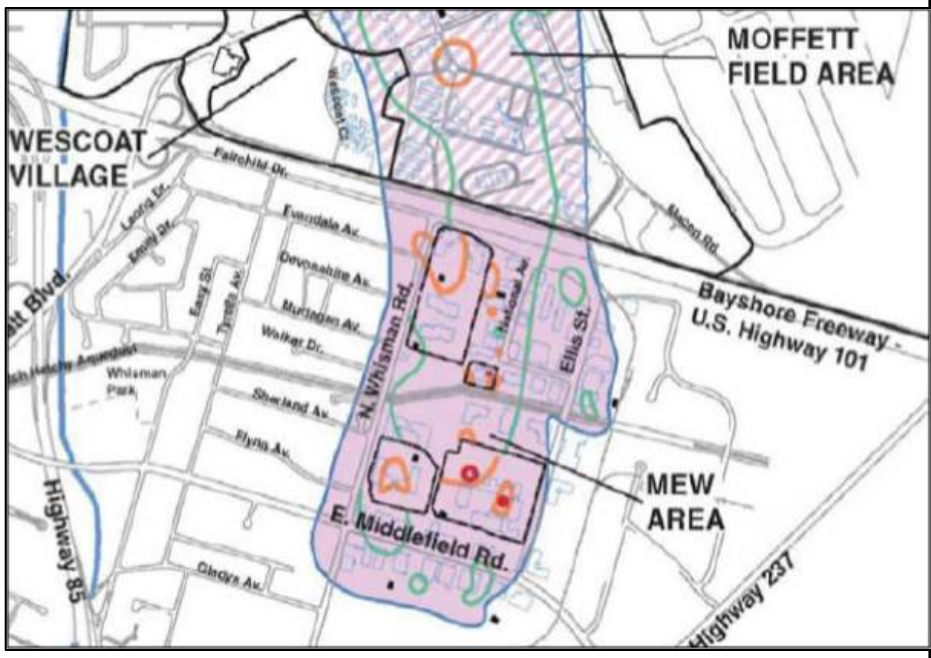
ITRC RMCS-1, Figure 28

Key to Your Success
Engage Stakeholders

- Stakeholders include citizen and Tribal communities, environmental advocacy members, and members of the affected public
- Methods for stakeholder involvement
  - Existing cleanup program processes
    - Restoration Advisory Board/stakeholder meetings
    - Public outreach and community meetings
  - Planning process
  - Adaptive site management

Case Study: Stakeholder Involvement at Middlefield-Ellis-Whisman Site

- Community members are constructive partners in decision-making
- Model permit process for cooperation between regulators and local land use planning jurisdictions



Vapor intrusion study area at Middlefield-Ellis-Whisman (MEW) site, California
ITRC RMCS-1, Figure 10, CPEO 2016a

After Today's Training We Expect You Will Be Able To:

- Identify and integrate technical and nontechnical site challenges presented by complex sites
- Use the Remediation Potential Assessment
- Apply adaptive site management principles
- Develop a long-term performance-based action plan
- Effectively engage stakeholders
- Access additional resources
- Communicate the value of this guidance

Today's Road Map

- Site challenges
- Remediation Potential Assessment
- Questions and answers
- Adaptive remedy selection
- Long-term management
- Preparing you to take action
- Questions and answers

Site Challenges
Learning Objective

Chapter 2. Site Challenges

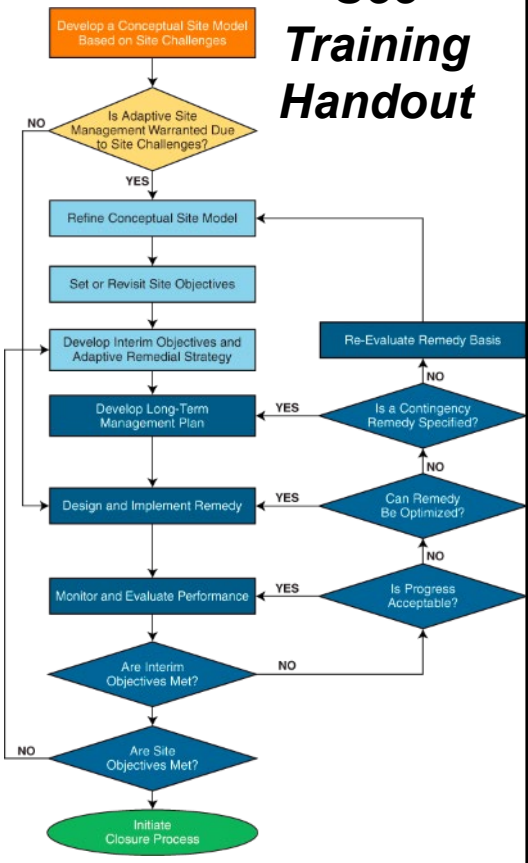
Identify and integrate technical and nontechnical site challenges into a holistic approach to remediation

Chapter 3. Remediation Potential Assessment

Chapter 4. Adaptive Remedy Selection

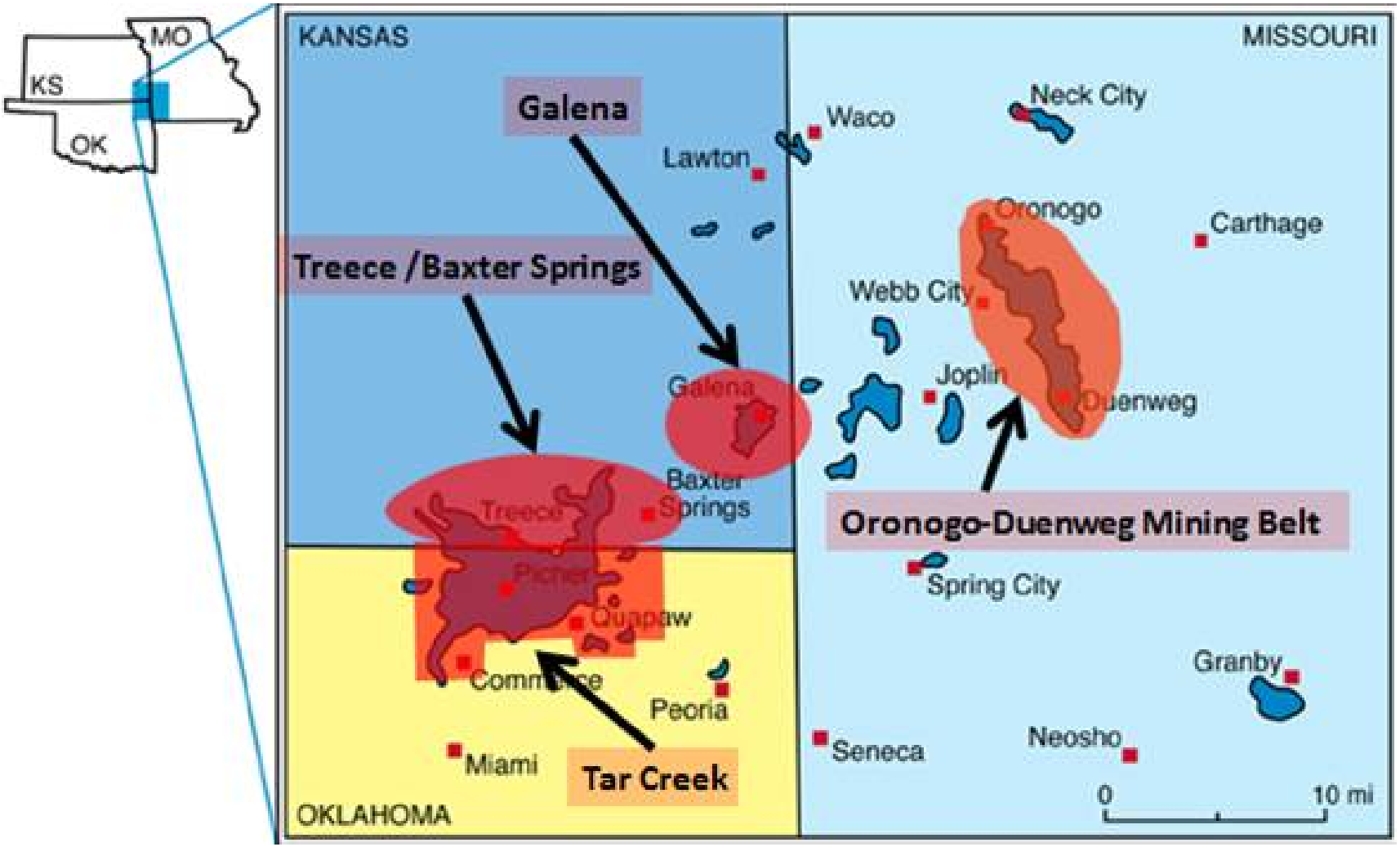
Chapter 5. Long-Term Management

See Training Handout



ITRC RMCS-1, Figure 1

Complex Site?



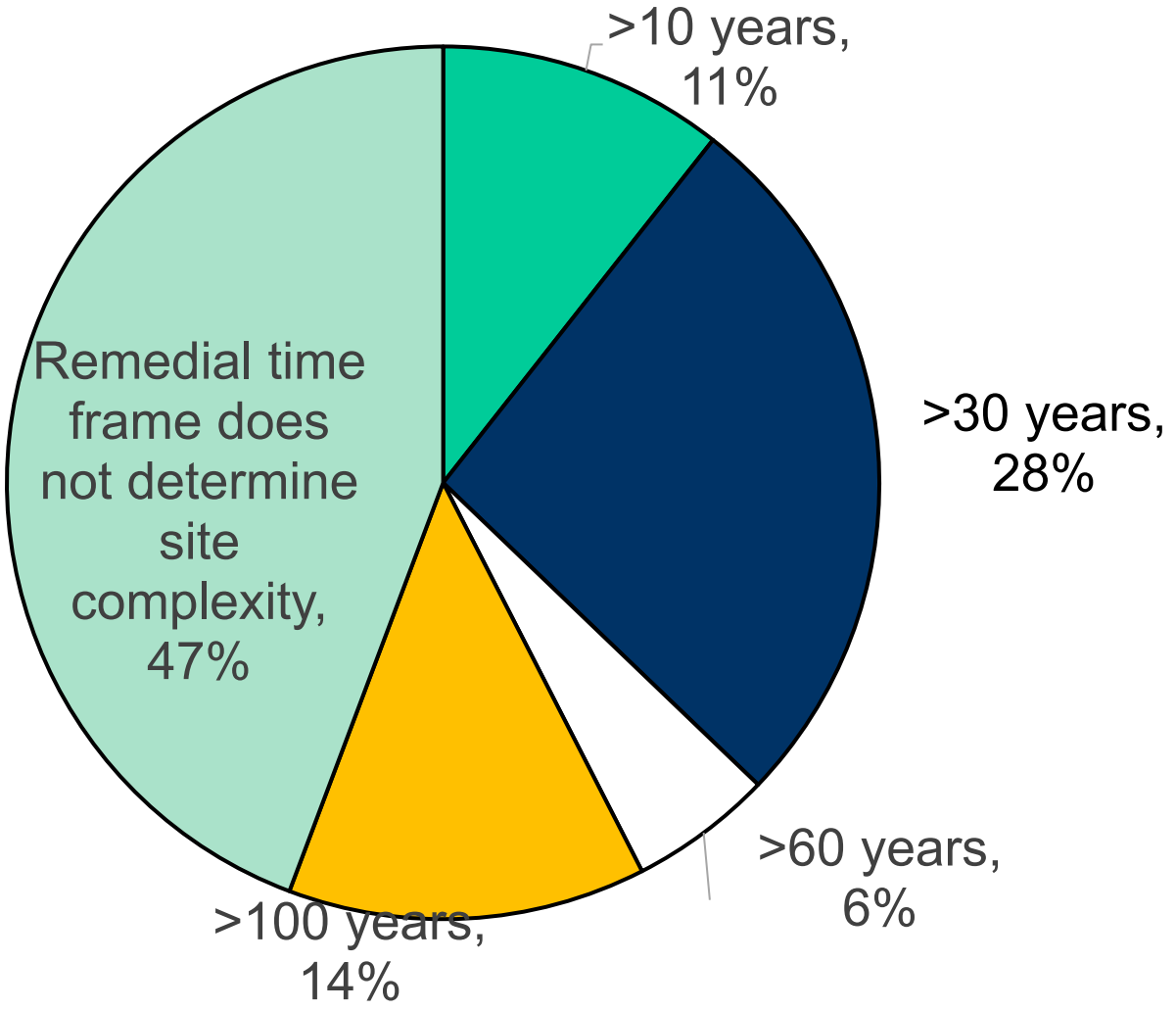
ITRC RMCS-1, Figure 37, modified from Kansas Geological Survey, 2001

Description of a Complex Site

- At “complex sites”, remediation progress is uncertain and remediation is not anticipated to achieve closure or even long-term management within a reasonable time frame
- Both technical and non-technical challenges can impede remediation
- Identifying challenges can improve the conceptual site model (CSM) and maximize remedial effectiveness

Poll Question

ITRC Survey Results: Diversity of Responses – Remedial Time Frame



ITRC RMCS-1, Table 1

Identify Site Challenges

Technical Examples

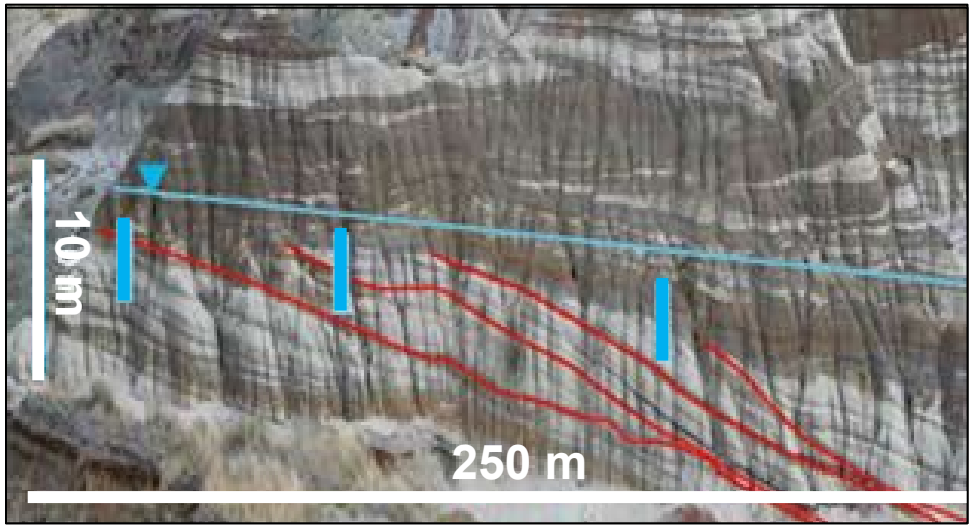
- Geologic
- Hydrogeologic
- Geochemical
- Contaminant-related
- Large-scale

Non-Technical Examples

- Site objectives
- Changes over long time frames
- Regulatory
- Institutional controls
- Land use
- Funding

Identify Technical Challenges
Geologic Conditions

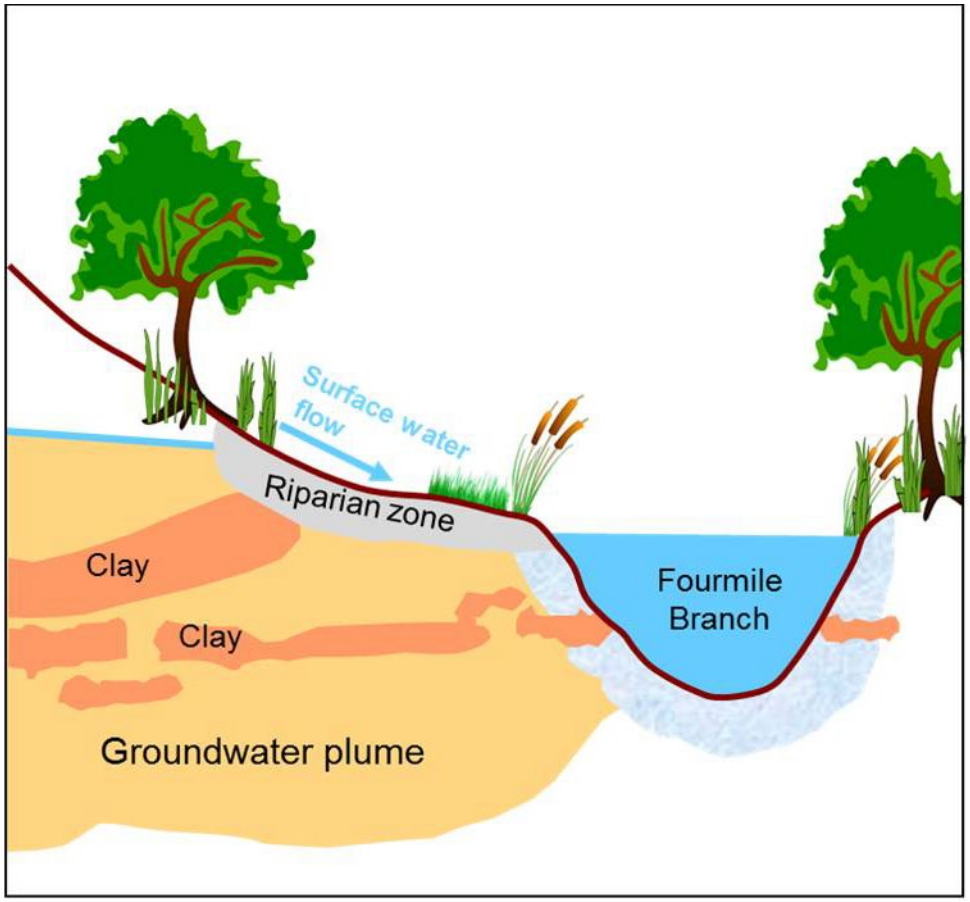
- Geologic heterogeneity/ preferential flow paths
- Fractured bedrock
- Karst bedrock
- Low-permeability media



Clay units (dark colored) dip from upper left to lower right, an example of stratigraphic heterogeneity Photo courtesy of Hubbard 2015

Identify Technical Challenges
Hydrogeologic Conditions

- Extreme or variable groundwater velocities
- Fluctuating water table
- Deep contamination
- Surface water and groundwater interactions and impacted sediment



Surface water/groundwater interactions downgradient of F-Area, Savannah River Site, South Carolina

Identify Technical Challenges
Geochemical Conditions

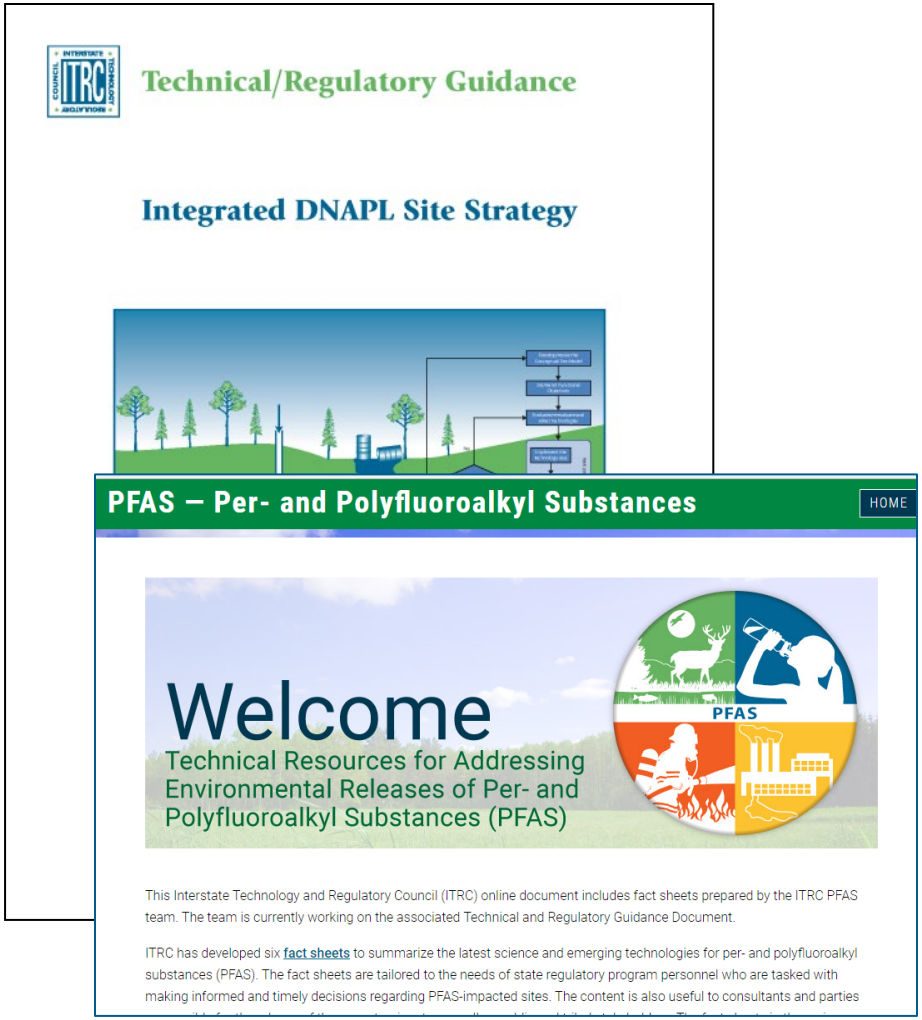
- Extreme geochemistry
  - Alkalinity, pH, redox conditions, salinity, ionic strength, hardness
- Extreme groundwater temperatures
  - Geothermal sources
  - Low temperatures, permafrost

Low temperatures decrease biological activity at North Slope Refinery, Alaska, Redbullet16 / Wikimedia Commons

ITRC RMCS-1, Table 2

Identify Technical Challenges
Contaminant-Related Conditions

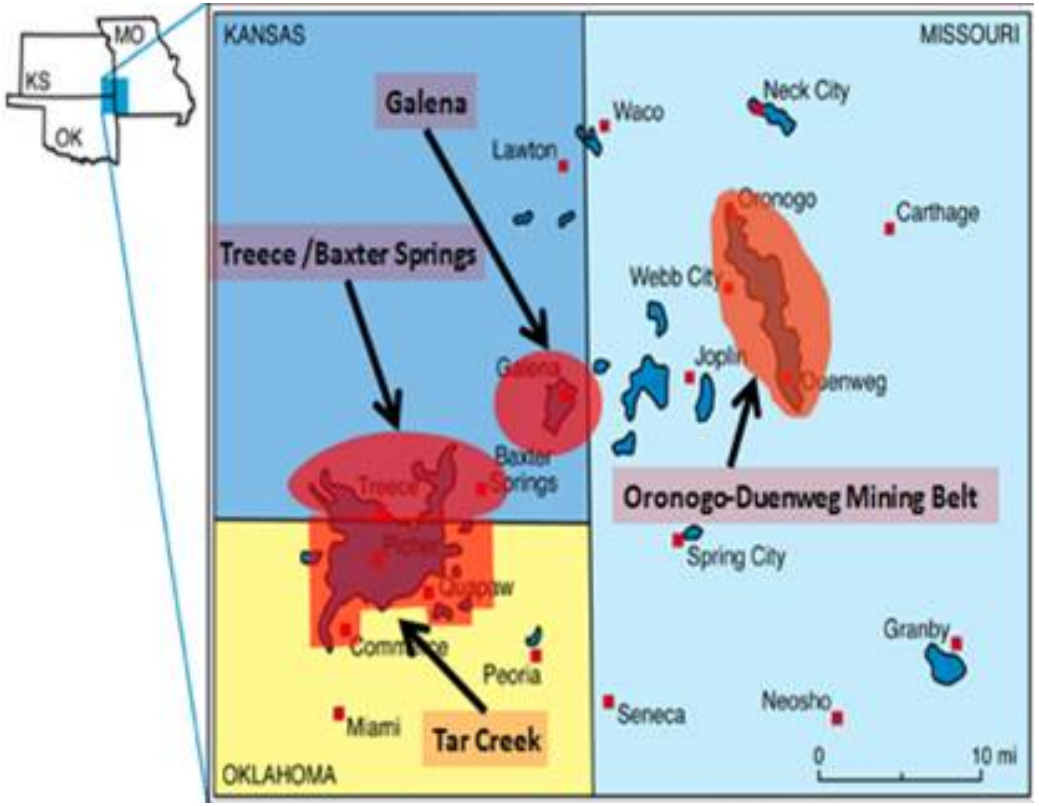
- Light or dense nonaqueous phase liquids (LNAPL or DNAPL)
- Recalcitrant contaminants
- High concentrations or multiple contaminants
- Emerging contaminants



ITRC RMCS-1, Table 2; ITRC ISC-1 2015;
ITRC IDSS-1 2015; ITRC Fractured Rock and PFAS Team Fact Sheets, 2017

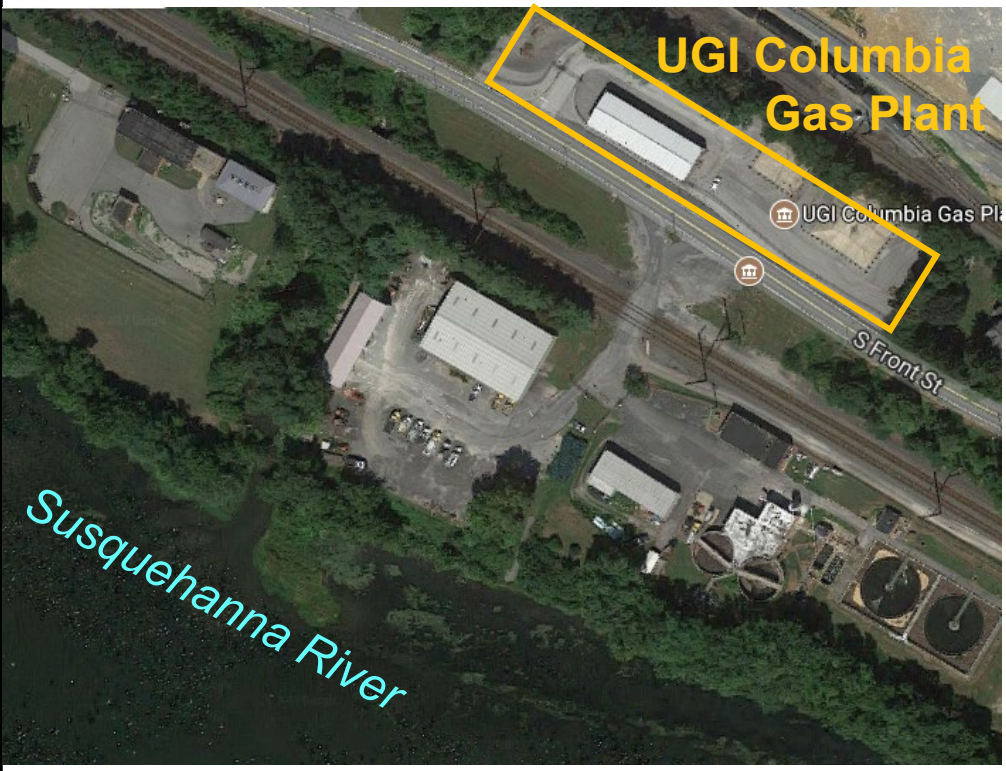
Identify Technical Challenges
Large-Scale Sites

- Location and extent of contamination
- Depth of contamination
- Number, type and proximity of receptors
- Extensive or comingled plumes



ITRC RMCS-1, Table 2 and Figure 37, modified from Kansas Geological Survey, 2001

Technical Challenges Case Study: UGI Columbia Gas Site, Pennsylvania



Google Maps 2017

- Residual tar in river sediments, groundwater and deep in fractured bedrock
- Tar will slowly dissolve over centuries

Identify Non-Technical Challenges

- Site objectives
  - Changing site objectives
  - Societal expectations
  - Green and sustainable remediation
- Managing changes over long time frames
  - Phased remediation
  - Future use
  - Site management
- Regulatory
  - Federal and state cooperation
  - Changing laws and regulation
  - Orphan sites
  - Contaminants without regulatory guidance/criteria

ITRC RMCS-1, Table 3; ITRC GSR-2

Identify Non-Technical Challenges

- Institutional controls
  - Tracking and managing
  - Enforcing
  - Long-term management
- Land use
  - Changing land, water use
  - Multiple owners
  - Site access
- Funding
  - Lack of funds, political influence on program funding

Deer graze on Rocky Flats National Wildlife Refuge in Colorado Footwarrior, Wikimedia Commons

ITRC RMCS-1, Table 3; ITRC IC-1, 2016

Non-Technical Challenges Case Study: Velsicol Site, Michigan

ITRC RMCS-1 Figure 46, Heidlauf 2017

- Contaminated city wells and Pine River
  - DNAPL pools 100 feet deep
- Livestock impacts and community economic hardship
- Limited funding prompted stakeholder involvement

Conceptual Site Model Maturity

General Environmental Cleanup Steps	CSM Life Cycle
Site Assessment	Preliminary CSM → Baseline CSM
Site Investigation and Alternatives Evaluation	Characterization CSM Stage
Remedy Selection	Design CSM Stage
Remedy Implementation	Remediation / Mitigation CSM Stage
Post-Construction Activities	Post-Remedy CSM Stage
Site Completion	

Conceptual

Quantitative

USEPA, 2011a. Environmental cleanup best practices: Effective use of the project life cycle conceptual site model. EPA 542-F-11-011.

Site Challenges Summary

- Complex sites typically have multiple challenges
- Both technical and non-technical challenges can impede remediation
- Identifying them can improve the conceptual site model and maximize remedial effectiveness

Today's Road Map

- Introduction
- Site challenges
- Remediation Potential Assessment
- Questions and answers
- Adaptive remedy selection
- Long-term management
- Preparing you to take action
- Questions and answers

Remediation Potential Assessment Learning Objective

Chapter 2. Site Challenges

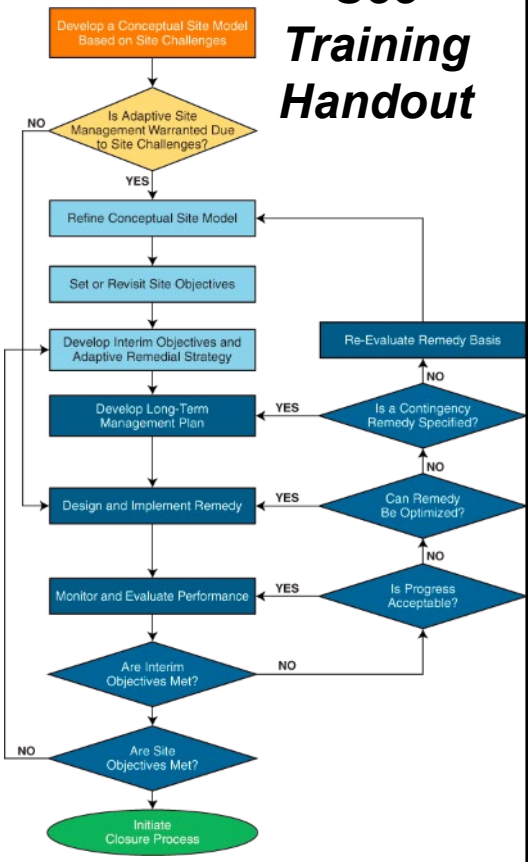
Chapter 3. Remediation Potential Assessment

Use the Remediation Potential Assessment to identify whether Adaptive Site Management is warranted due to site challenges

Chapter 4. Adaptive Remedy Selection

Chapter 5. Long-Term Management

See Training Handout



ITRC RMCS-1, Figure 1

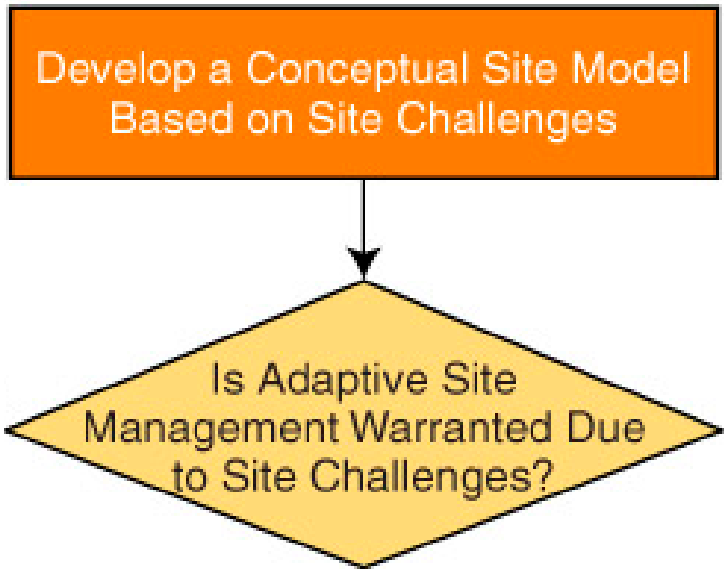
Remediation Potential Assessment Process and Outcome

Process

- Screening tool uses weight-of-evidence approach to assess if site is likely to achieve remedial objectives in a reasonable time frame
- Basis for aligning expectations with actual remediation potential
- Promotes effective and transparent interaction

Outcome

- Site objectives are attainable OR
- Remediation potential is low – consider adaptive site management



ITRC RMCS-1, Figure 1

"Can You Get There?"

- Small, shallow site
- Sandy water bearing unit
- Low concentrations
- Benzene (attenuates fast)
- Very little non-aqueous phase liquid

Source: DanTD / Wikimedia Commons

"Can You Get There?"

- Small, shallow site
- Sandy water bearing unit
- Low concentrations
- BTEX (attenuates fast)
- Very little NAPL

- Large site, deep contamination
- Much of source under buildings
- Sand, silt, fractured clays
- Not much biodegradation
- Need > 99.9% reduction

Sources: DanTD / Wikimedia Commons, GSI Environmental

Remediation Potential Assessment Purpose

- Intended to inform the remedial decision process and determine if adaptive management process is beneficial
- Can allow for greater transparency and facilitate future reviews of the process
- Flexible process that can be modified as appropriate for the site

Remediation Potential Assessment (RPA)

DOES:

- Allow flexibility and site-specific input in an iterative process
- Require detailed supporting data on the nature and extent of contamination
- Consider remediation potential of individual factors in context of other pertinent factors

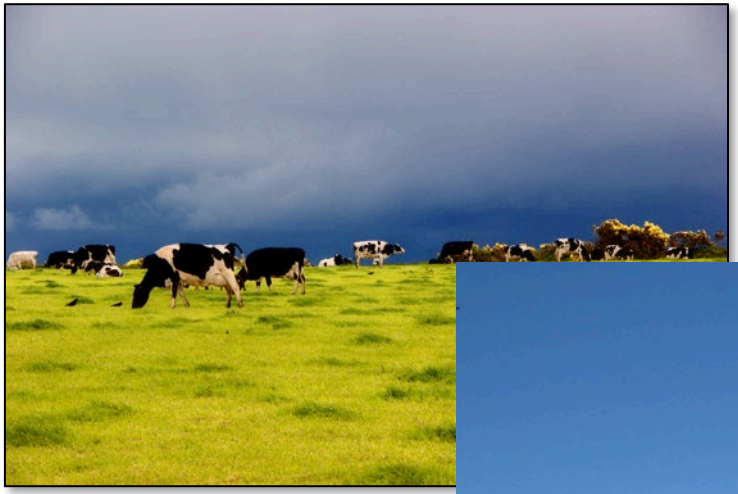
DOES NOT:

- Provide a means to avoid requirements
- Evaluate whether a site is complex
- Directly consider cost
- Produce a default decision

Remediation Potential Assessment
Key Criteria (Pre-Remedy)

8 Questions…

1. How difficult is it to work at the surface of the site?



Martin Abegglen / Wikimedia Commons

ITRC RMCS-1 Figure 12, CPEO, 2016b

Remediation Potential Assessment
Key Criteria (Pre-Remedy)

8 Questions…

1. How difficult is it to work at the surface of the site?

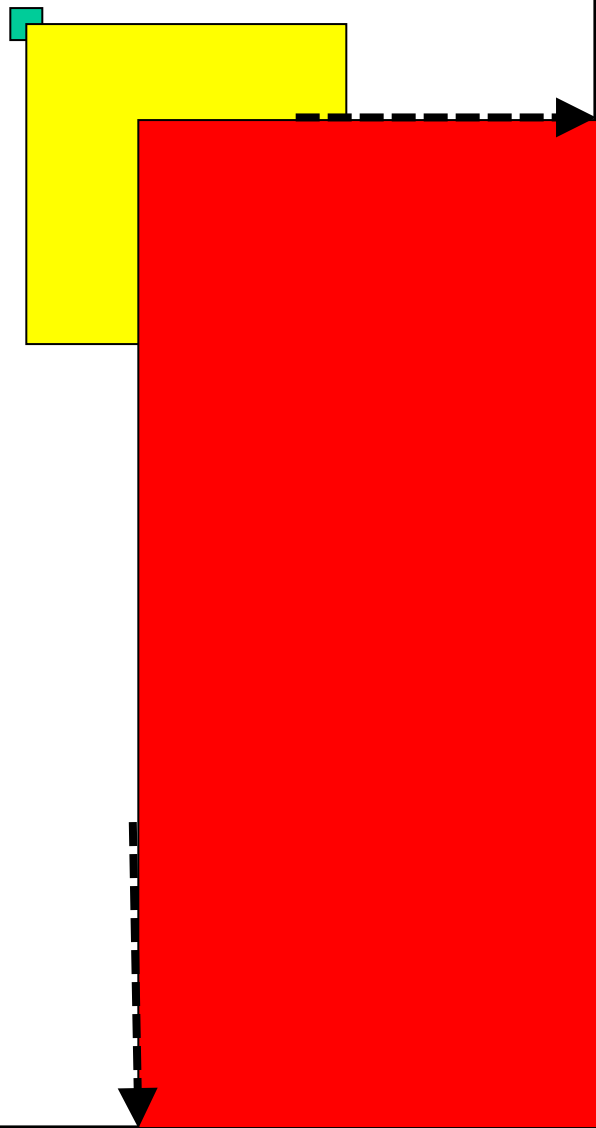
Laurent Deschodt / Wikimedia Commons

2. How difficult is it to drill at the site?

Wilson44691 / Wikimedia Commons

Remediation Potential Assessment
Key Criteria (Pre-Remedy)

3. What is the scale of the source zone or plume?



Remediation Potential Assessment
Key Criteria (Pre-Remedy)

3. What is the scale of the source zone or plume?

4. What contaminant concentration reduction is needed?

90% ?

99% ?

99.9% ?

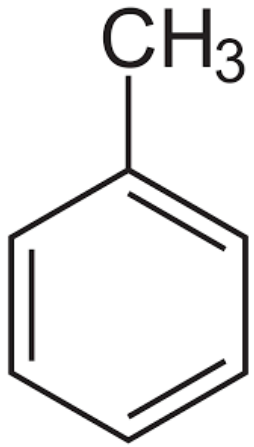
99.99% ?

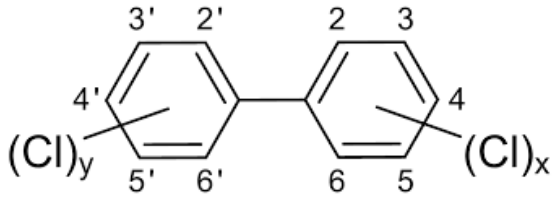
Remediation Potential Assessment
Key Criteria (Pre-Remedy)

3. What is the scale of the source zone or plume?

4. What contaminant concentration reduction is needed?

5. Do the key site constituents readily attenuate relative to the travel time to receptors?





Sources: Dschanz / Wikimedia Commons; Public Domain

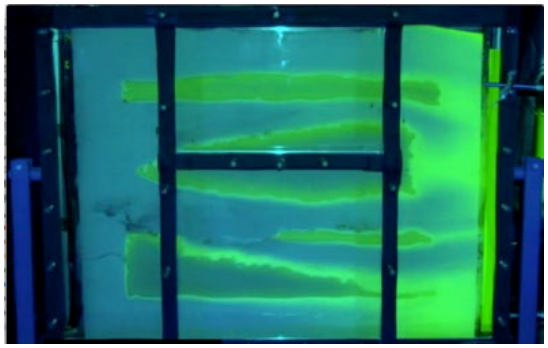
Remediation Potential Assessment
Key Criteria (Pre-Remedy)

3. What is the scale of the source zone or plume?

Al Silonov / Wikimedia Commons

4. What contaminant concentration reduction is needed?

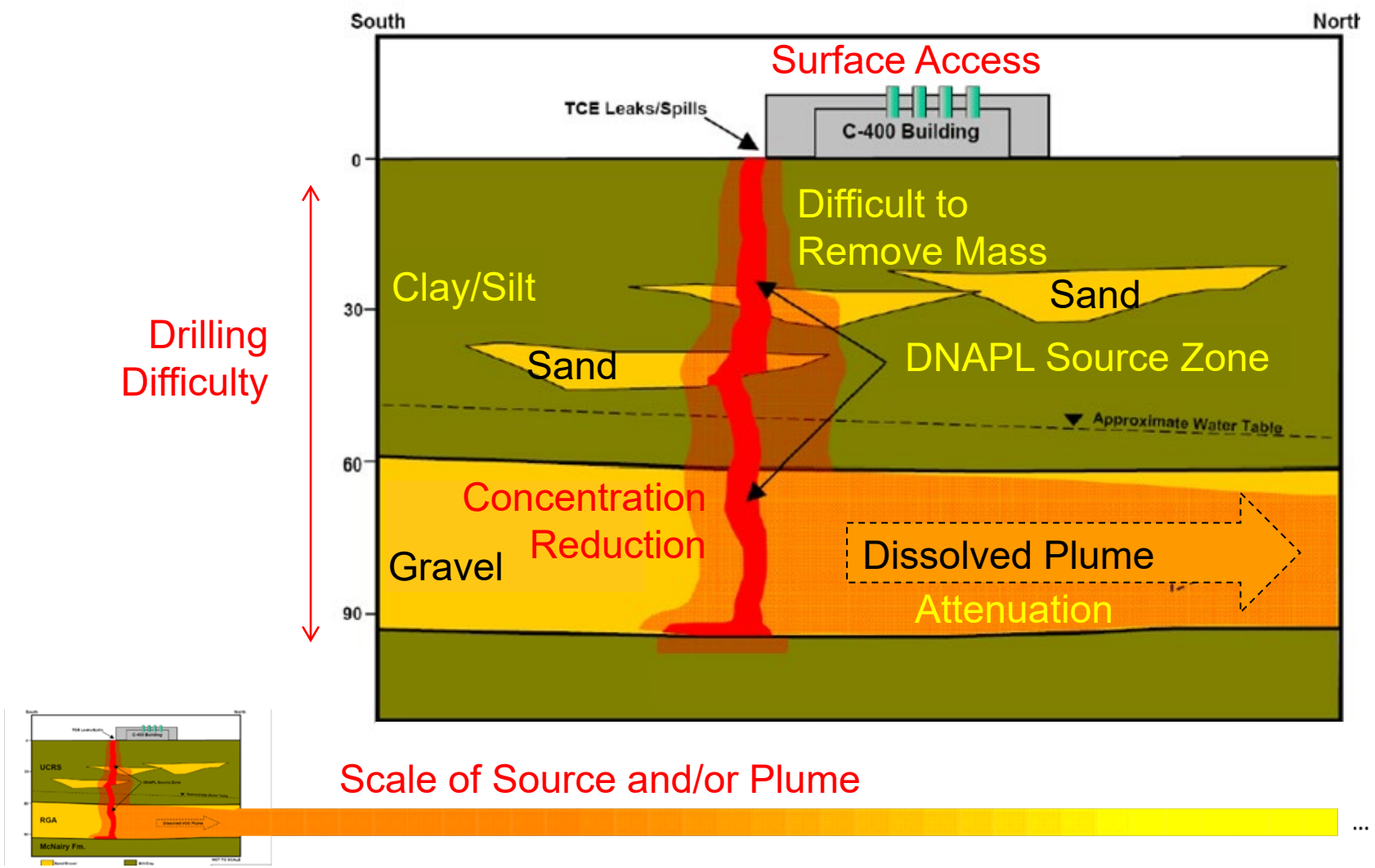
5. Do the key site constituents readily attenuate relative to the travel time to receptors?



L. Donor., T. Sale, CSU

6. Does difficult-to-remove mass exist at the site?

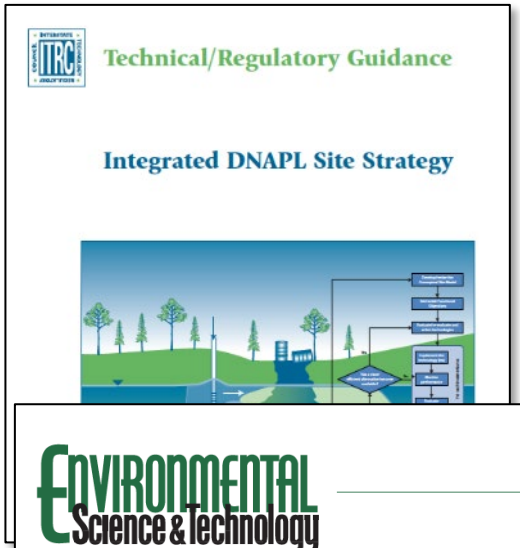
Case Study: Paducah Gaseous Diffusion Plant, Kentucky



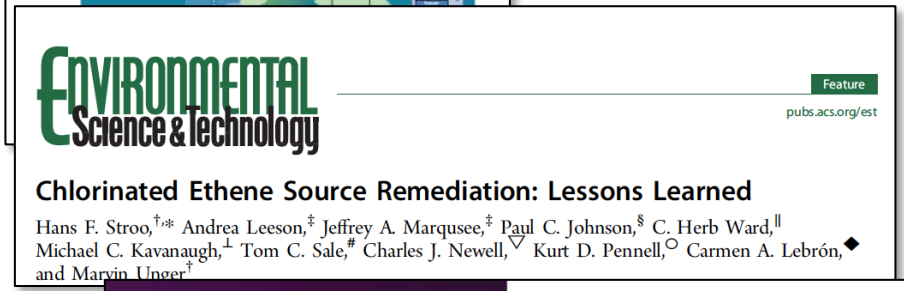
ITRC RMCS-1, Figure 43 (DOE 2010a)

Remediation Potential Assessment Key Criteria (Pre-Remedy)

7. What is the predicted performance for available remedial technologies?



2011

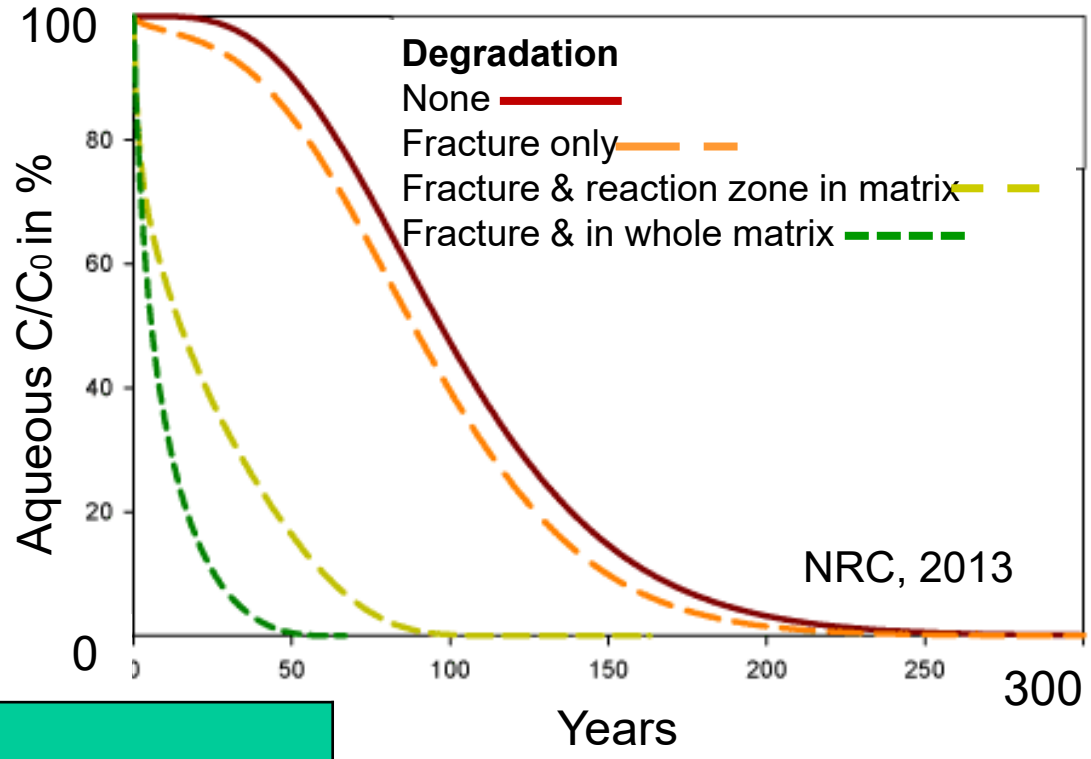


2012

2015

Remediation Potential Assessment
Key Criteria (Pre-Remedy)

8. What is the predicted time frame for achieving interim and site objectives?



Model/Analysis
USEPA REMChlor or REMFuel Model
Natural Attenuation Software
Matrix diffusion
Concentration vs. time First order rate calculations

Remediation Potential Assessment
Matrix of Evaluation Criteria

- Evaluate each criteria as high, moderate or low
- Weight criteria to reflect relative importance
- Assess conclusion

Evaluation Criteria	Likelihood of Achieving Remediation Objectives		
	High	Moderate	Low
Access	✓		
Drilling feasibility	✓		
Scale		✓	
Concentration reduction			✓
Attenuation	✓		
Difficult-to-remove mass			✓
Technology performance	✓		
Time frame		✓	
Total checked:	4	2	2

ITRC RMCS-1, Table 7

Remediation Potential Assessment
Matrix of Evaluation Criteria

- Evaluate each criteria as high, moderate or low
- Weight criteria to reflect relative importance
- Assess conclusion

Evaluation Criteria	Likelihood of Achieving Remediation Objectives		
	High	Moderate	Low
Access		✓	
Drilling feasibility	✓		
Scale		✓	
Concentration reduction			✓
Attenuation		✓	
Difficult-to-remove mass			✓
Technology performance			✓
Time frame			✓
Total checked:	1	3	4

ITRC RMCS-1, Table 7

Remediation Potential Assessment
Key Criteria (Post-Remedy)

- Has the existing remedy been effectively operated and maintained?
- Are aquifer conditions or contaminant sources adequately characterized? Have they changed?
- Are concentrations reductions occurring at the rate anticipated?
- Does the selected remedy adequately address contaminants and/or hydrogeologic conditions?
- Can interim and/or site objectives (and contaminant-specific cleanup levels) be met with other technologies within a reasonable time frame?

Remediation Potential Assessment Summary

- Screening tool - provides a valuable process; does not produce a default decision
- You answer eight technical questions and use Weight-of-evidence to assess if site is likely to achieve remediation objectives
- Allows flexibility and site-specific input in an iterative process
- Goal: Determine if…
  - Site objectives are likely attainable OR
  - Remediation potential is low – Adaptive Site Management will be important

Q&A Break

Follow ITRC

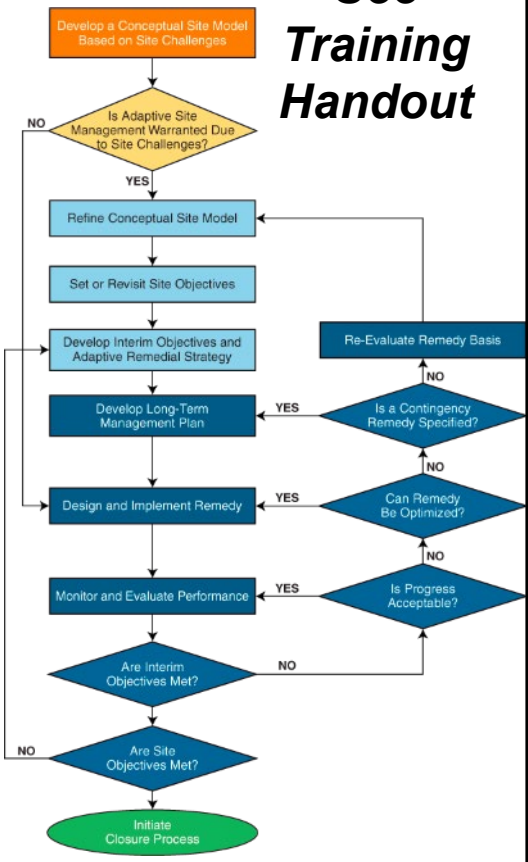
Chapter 2. Site Challenges

Chapter 3. Remediation Potential Assessment

Chapter 4. Adaptive Remedy Selection

Chapter 5. Long-Term Management

See Training Handout



Today's Road Map

- Site challenges
- Remediation Potential Assessment
- Questions and answers
- Adaptive remedy selection
- Long-term management
- Preparing you to take action
- Questions and answers

Learning Objective

Chapter 2. Site Challenges

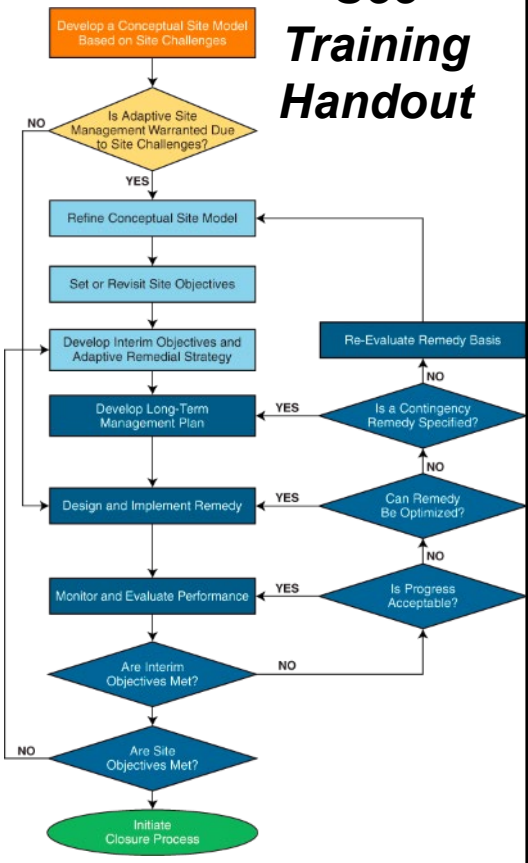
Chapter 3. Remediation Potential Assessment

Chapter 4. Adaptive Remedy Selection

Understand and apply adaptive site management principles

Chapter 5. Long-Term Management

See Training Handout



ITRC RMCS-1, Figure 1

Adaptive Remedy Selection

Poll Question

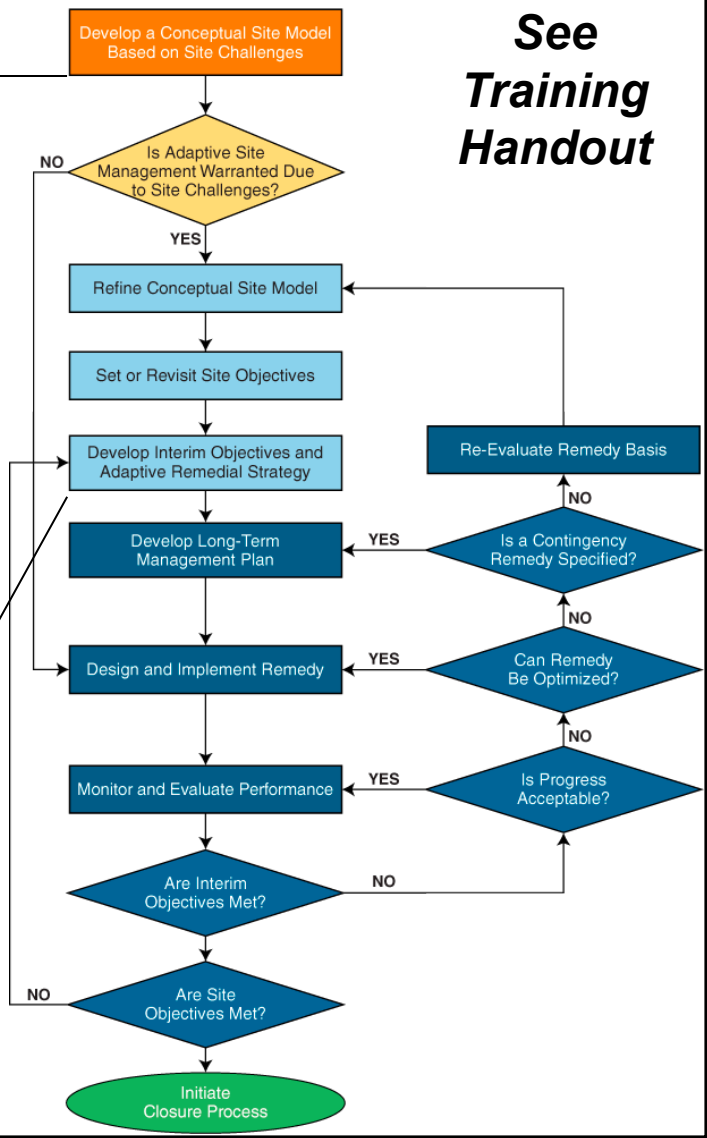
Use Adaptive Site Management? (Remediation Potential Assessment)

Yes

Refine Conceptual Site Model

Set or Revisit Site Objectives

Develop Interim Objectives and Adaptive Remedial Strategy

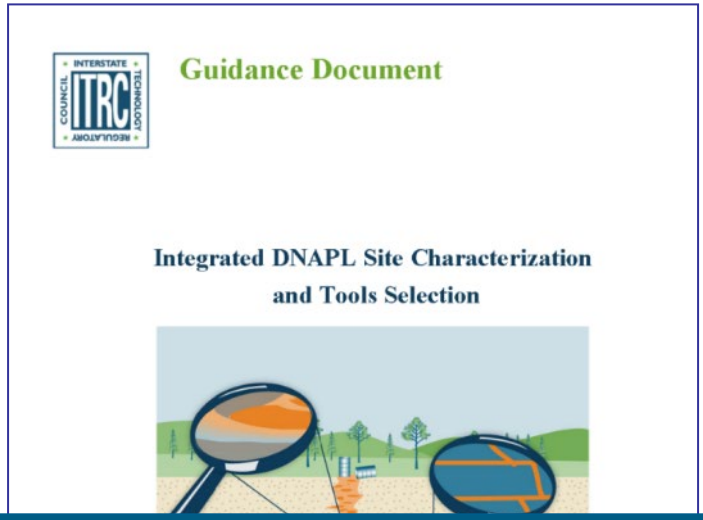


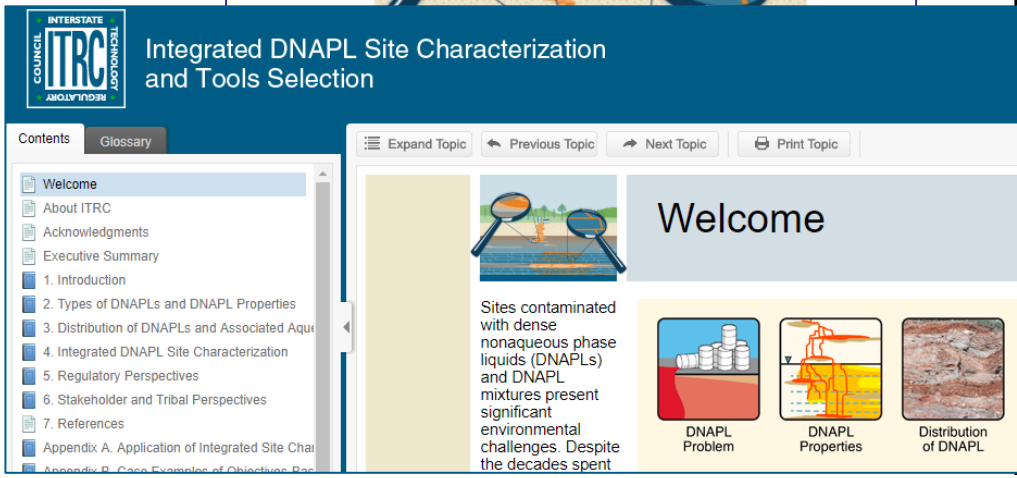
See Training Handout

ITRC RMCS-1, Figure 1

Refine Conceptual Site Model

- Prior to revisiting remedy
  - Are site challenges described?
  - What inhibited remediation progress?
  - What are data gaps?
- Tools for remedy evaluation





ITRC ISC-1 2015
http://www.itrcweb.org/DNAPL-ISC_tools-selection/

ITRC RMCS-1, Appendix B

Conceptual Site Model
Australia Case Study

Phase	Source		Proximal Plume		Distal Plume	
Permeability/ Transmissivity	Low	High	Low	High	Low	High
Soil vapor						
DNAPL			NA	NA	NA	NA
Groundwater						
Sorbed						

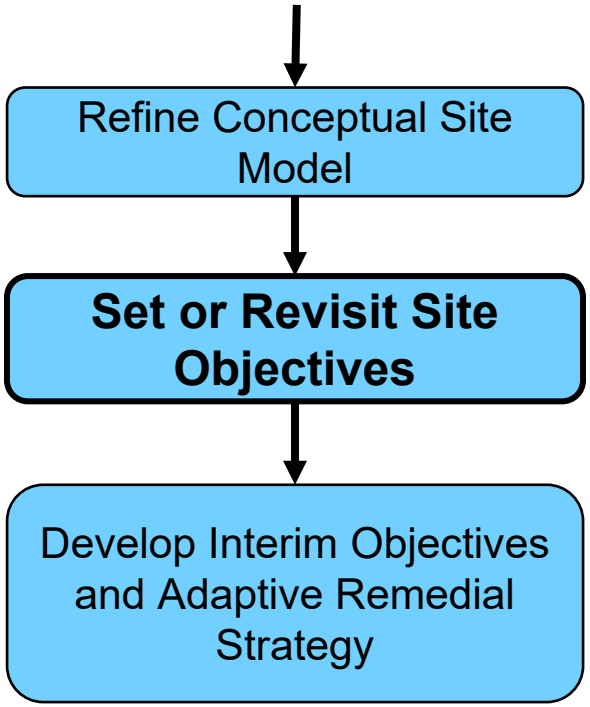
LEGEND
Equivalent aqueous concentration (mg/L)

- HIGH (>1,000)
- MODERATE/HIGH (100-1,000)
- MODERATE (10-100)
- LOW (1-10)
- NOT APPLICABLE (NA)

20-Compartment model summarizing the conceptual site model of contaminant mass at the site. ITRC RMCS-1, Figure 69 and Appendix B

Set or Revisit Site Objectives

- **Site objectives** are overall remedial expectations, including protecting public health and the environment
- **Set** site objectives
  - Consider complexities
  - Consider different geologic or operable units, source area and plume -- “site segments”
- **Revisit** site objectives
  - If progress is insufficient despite optimization

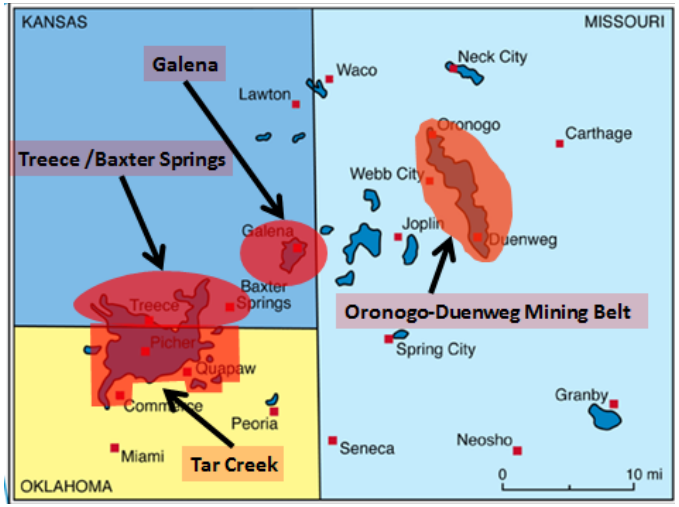


ITRC RMCS-1, Figure 1

Site Objectives at Complex CERCLA Sites

Poll Question

- Protect human health and environment
- Meet Applicable or Relevant and Appropriate Requirements (ARARs) or criteria for ARAR waiver
  - Inconsistent application of state standards
  - Fund balancing
  - Equivalent performance
  - Interim measures
  - Greater risk
  - Technical impracticability (TI)



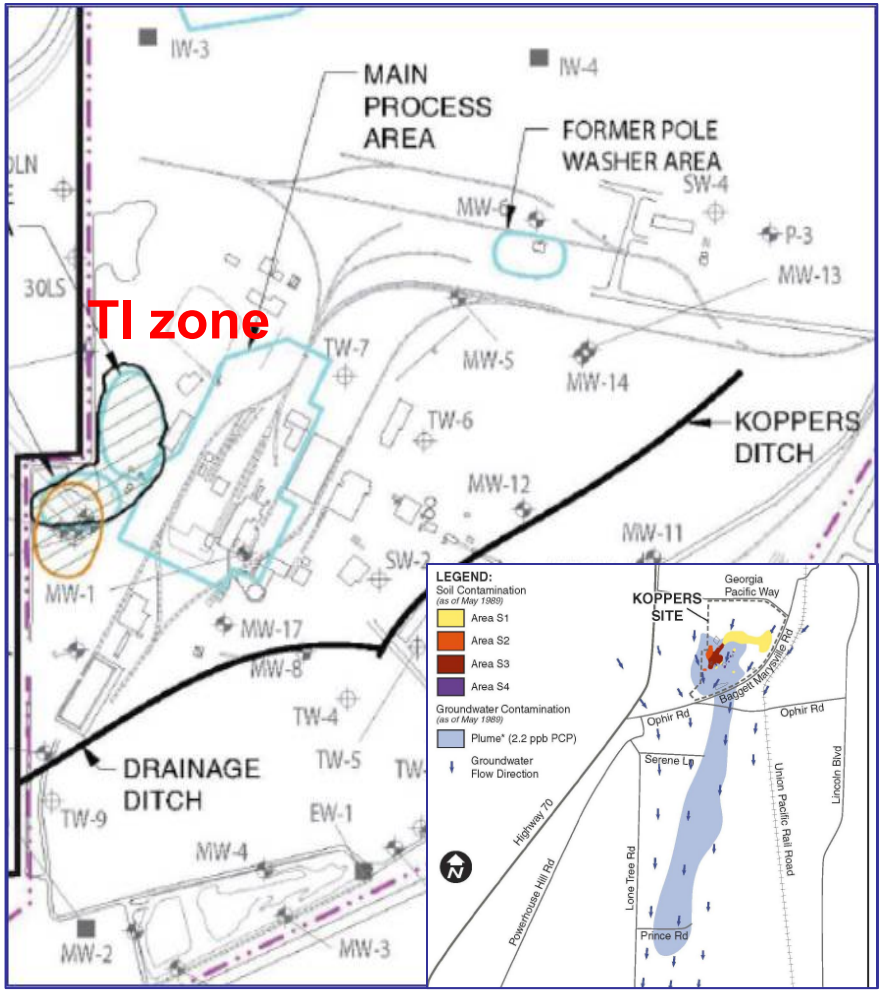
TI waiver at Tri-State Mining District (Oklahoma, Kansas, Missouri)

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act

ITRC RMCS-1 Chapter 4, 40 CFR 300.430(f)(1)(ii)(C), USEPA 1993, 2012

Case Study: ARAR Waiver at a Wood Treatment Facility, Oroville, California

- Complexities
  - Recalcitrant creosote and pentachlorophenol DNAPL
  - Drinking water aquifer
- Record of Decision amendment included TI waiver
  - Groundwater goal within 4-acre area is containment, not restoration



TI zone at the Koppers Oroville, California wood treatment facility

ITRC RMCS-1 Figure 7, USEPA 2013a

CERCLA Sites
Alternate Concentration Limits

- Alternate concentration limits can be used in groundwater only if
  - Groundwater discharges to surface water
  - No statistically significant increase in concentrations downstream
  - No exposure to off-site contaminated groundwater prior to discharge
- No recent case studies identified

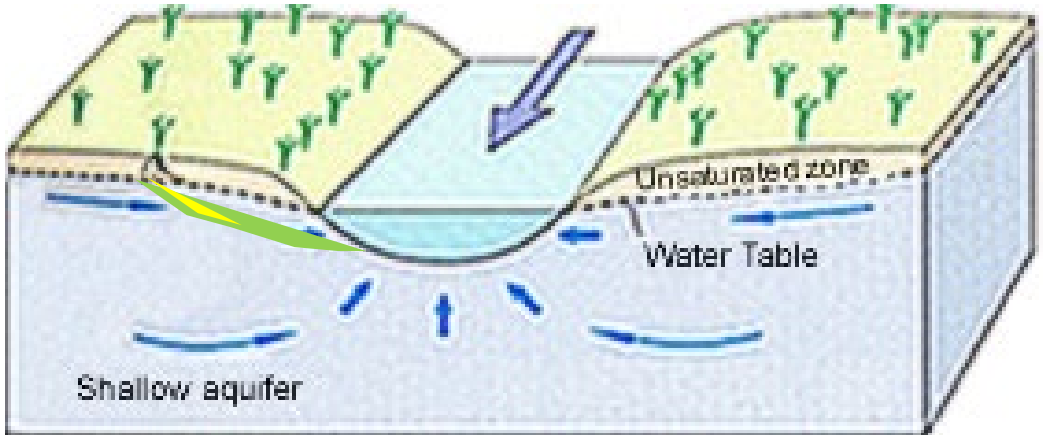


Image from U.S. Geological Survey

CERCLA Section 121(d)(2)(B)(ii), USEPA, 2005b

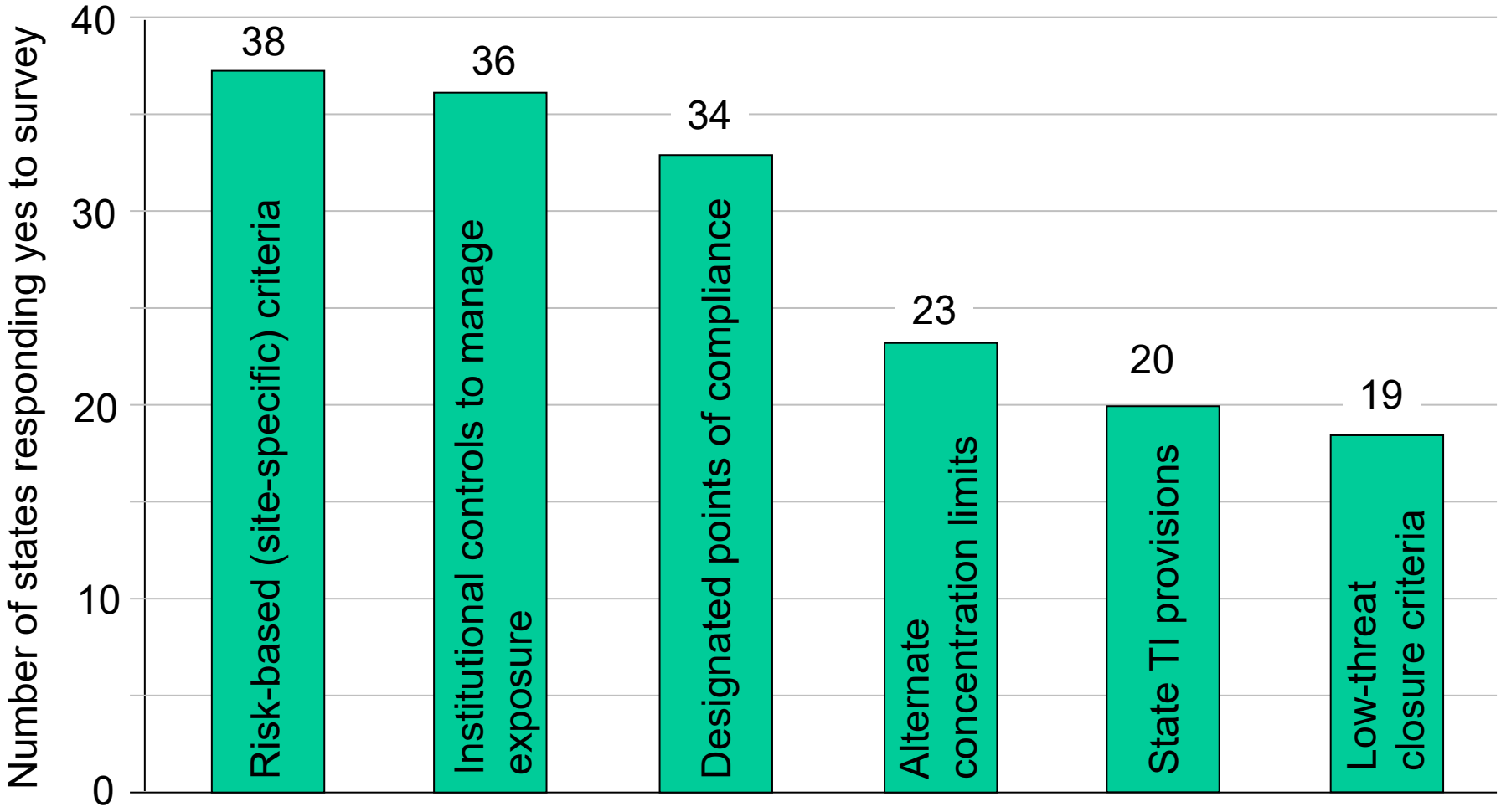
RCRA and Other State Programs
ITRC Survey

- Team surveyed states about their approaches
  - RCRA, Brownfields, Underground Storage Tank programs
  - Responses from 40 states
- Does your state allow the following to meet site objectives…
  - …as a primary means?
  - …after the original selected remedy fails to reach site objectives within the planned remedial time frame?

ITRC RMCS-1 Figures 3-4, Appendix A

RCRA – Resource Conservation and Recovery Act (for hazardous waste management)

RCRA and Other State Programs

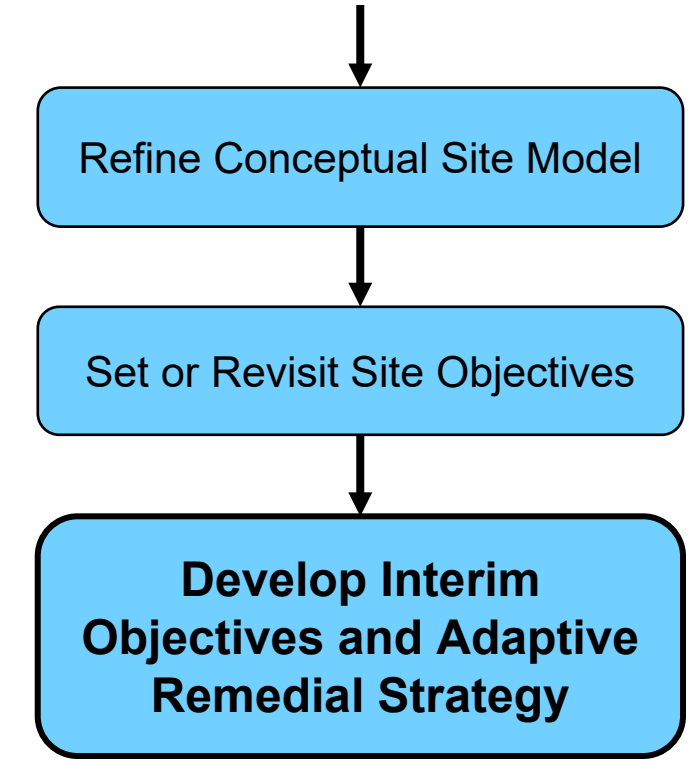


ITRC RMCS-1 Figures 3-4, Appendix A

Develop Interim Objectives and Adaptive Remedial Strategy

Poll Question

- **Interim objectives** are intermediary goals that guide progress towards achieving site objectives
- **Adaptive remedial strategy** is a combination of technologies and approaches to meet interim objectives



ITRC RMCS-1, Figure 1

Interim Objectives

- Should be Specific Measurable Attainable Relevant and Timebound (SMART)
  - Contaminant mass flux or discharge decrease by [x]% within [#] years
  - Target degradation rates met within [#] years
  - Capping to prevent direct exposure
- Guide short-term decisions and actions
  - Optimization
  - Technology transitions
- Meeting interim objectives → progress

ITRC IDSS-1, 2011; ITRC MASSFLUX-1, 2010

Select Adaptive Remedial Strategy
Step 1. Identify Options

- Biological treatment
- Chemical treatment
- Thermal treatment
- Removal
- Enhanced extraction
- Source flux reduction
- Contaminant mass flux reduction
- Pump and treat
- Permeable reactive barriers
- Enhanced attenuation
- Monitored natural attenuation
- Hydraulic containment
- Passive hydraulic barrier
- Discharge zone treatment
- Vapor intrusion mitigation
- Institutional controls
- Alternative water supply

Options	Description and References
In situ biological treatment	Applying an amendment into the aquifer to bioremediate a targeted volume (ITRC 2002, 2008, Parsons 2004, USEPA 2000, DOE 2002)
Source flux reduction	Applying remediation or containment to reduce the flux of contaminants moving from the source zone to the plume (ITRC 2008b, 2010b, Looney et al., 2006)
Institutional controls	Applying administrative restrictions to prevent contaminant exposure or other actions that would negatively impact contamination (USEPA 1997a, 2009b, 2010a, ITRC 2016b)

ITRC RMCS-1 Table 10 for complete listing

Select Adaptive Remedial Strategy
Step 2. Compare Remedial Approaches

- Follow regulatory process
  - Assess using threshold and balancing criteria for CERCLA, RCRA sites
- Additional considerations due to complexities
  - How does each remedial approach address complexities?

CERCLA Nine Criteria

Threshold Criteria
1. Overall protection of human health and the environment
2. Compliance with ARARs

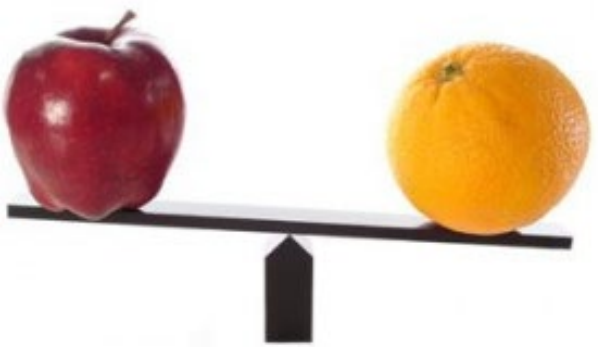
Balancing Criteria
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility or volume
5. Short-term effectiveness
6. Implementability
7. Cost

Modifying Criteria
8. State acceptance
9. Community acceptance

40 CFR 300.430(e)(9)(iii)

Select Adaptive Remedial Strategy
Step 2. Compare Remedial Approaches

- Additional considerations
  - Level of confidence in ability to implement remedy
  - Synergy with other technologies/approaches
  - Adaptability over time
  - Information gained to improve future decisions
  - Robustness of design including interim objectives, metrics, and performance monitoring data
  - Other



www.clipartpanda.com

Select Adaptive Remedial Strategy
Step 3. Remedy Selection

- Prepare a matrix of site objectives and remedies for each area of the site

Site Objectives	Selected Remedy	
	Source	Plume
Objective #1	Technology 1 Technology 2	Technology 1 Technology 3
Objective #2		
Objective #3		

ITRC RMCS-1, Table 11

Case Study: Rocky Mountain Arsenal, Colorado

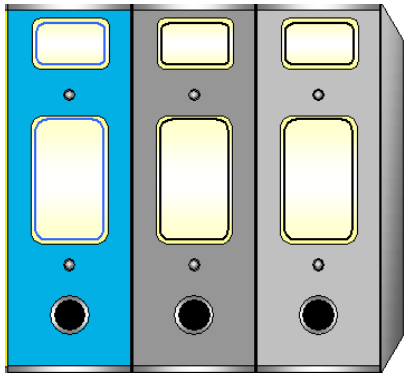
ITRC RMCS-1 Figures 26 and 27, CDPHE 2000

Rocky Mountain Arsenal, Colorado
Remedy Components

Site Objectives	Selected Remedy	
	On-Site	Off-Site
Source removal and treatment	Waste and soil treatment, stabilization Excavation Groundwater extraction and treatment	Off-post groundwater intercept and treatment system
Containment	Boundary treatment systems Slurry walls Stabilization/capping	Boundary treatment systems
Protection of human health and ecology	Capping Land use restrictions Unexploded ordnance disposal Alternate water supply	National wildlife refuge Deed restrictions Long-term monitoring Five-year reviews Trust for potable water supply and distribution Medical monitoring Biomonitoring Trust for long-term O&M

Document Remedial Approach

- Articulate how components work together
- For each component of the remedial approach
  - Describe technology
  - State interim objectives
  - State how the performance will be evaluated (performance metrics)
- Follow regulatory program requirements for documentation
- Can facilitate remedy transitions



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Engaging Stakeholders and Tribes
Stakeholder and Tribal Perspectives

- Stakeholder and Tribal concerns and values
- Gathering and organizing information
- Creating a forum
- Influencing decisions
- Advisory boards
- Technical assistance

SanjibLemar / Wikimedia Commons

Engaging Stakeholders and Tribes
Responsible Party Perspectives

- Seek out community members
- Provide them with tools to participate constructively
- Build trust for effective outreach
- Organize public meetings
- Share technical documents, information
- Work with media

Energy.gov / Wikimedia Commons

Summary
Adaptive Site Management Principles

- Refine conceptual site model
- Set or revisit site objectives
  - Survey highlights flexibility of some state programs in setting or revisiting site objectives
- Build adaptive remedial strategy
  - May need multiple technologies, phases for each site area
  - Set interim objectives to guide remedial progress
- Repeat process if remedy is not on track

Today's Road Map

- Site challenges
- Remediation Potential Assessment
- Questions and answers
- Adaptive remedy selection
- Long-term management
- Preparing you to take action
- Questions and answers

Learning Objective

Chapter 2. Site Challenges

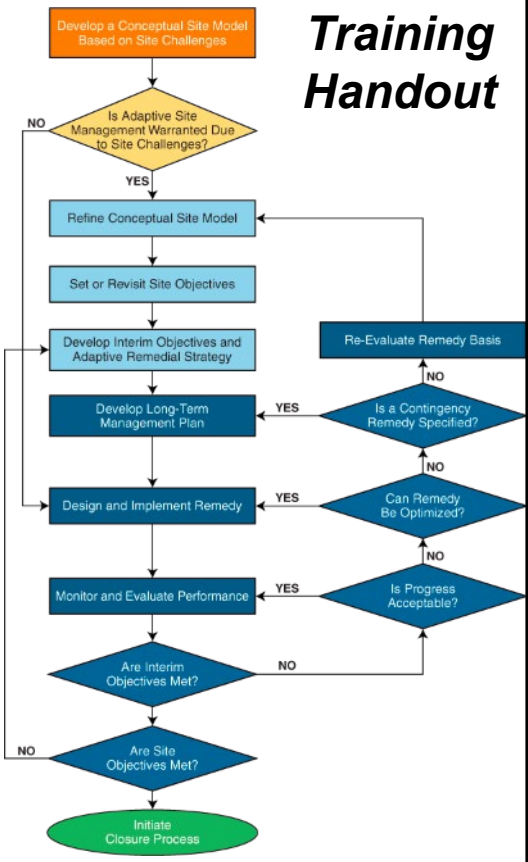
Chapter 3. Remediation Potential Assessment

Chapter 4. Adaptive Remedy Selection

Chapter 5. Long-Term Management

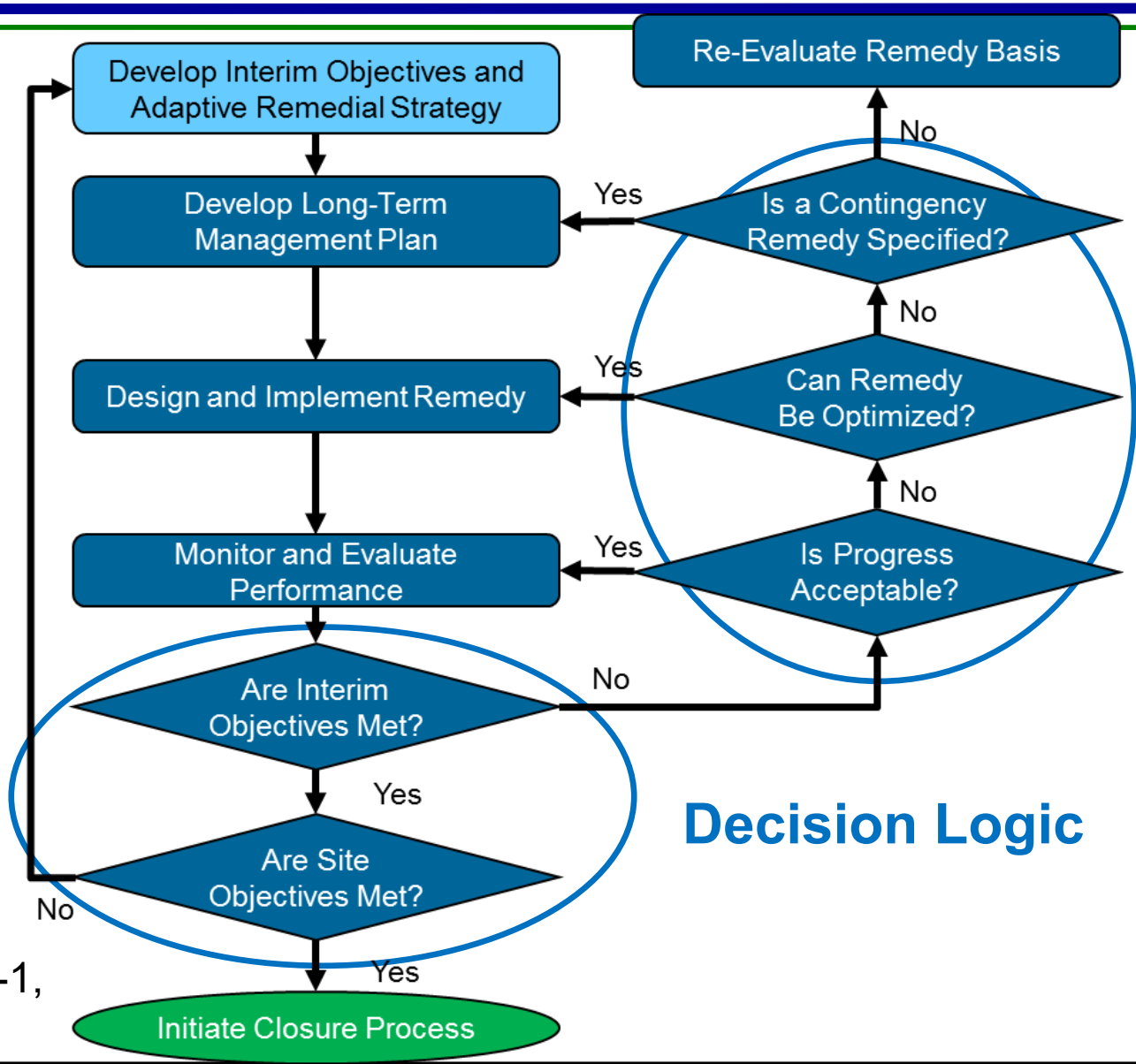
Develop a long-term performance-based action plan

See Training Handout



ITRC RMCS-1, Figure 1

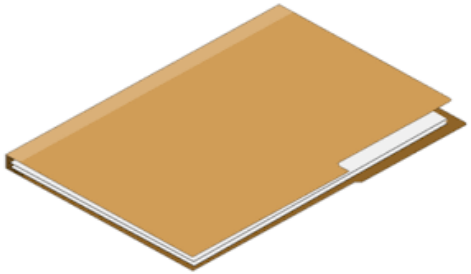
Adaptive Site Management



ITRC RMCS-1, Figure 1

Develop Long-Term Management Plan
Purpose and Value

- Learn via process (living site-specific document)
  - Identify weak links
  - Inform decision makers
  - Engage stakeholders



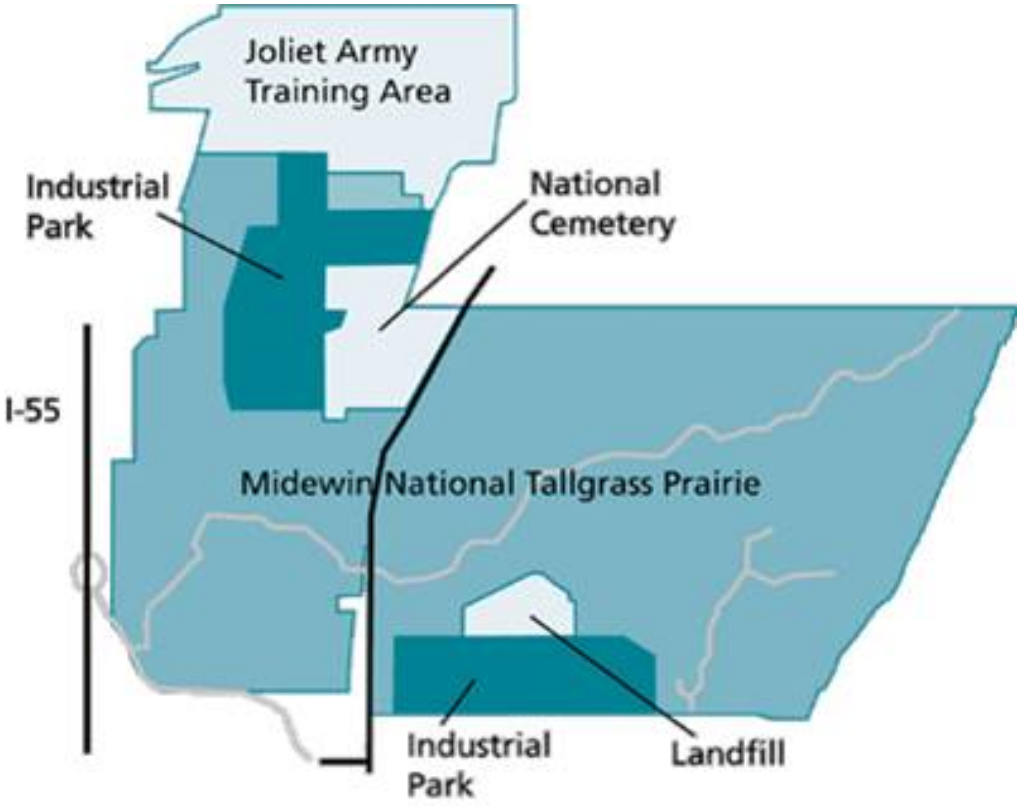
- Provide a completion strategy (many decades)
- Document remedy expectations and progress
- Expedite remedy re-evaluations and transitions
- Make timely remediation management decisions

Develop Long-Term Management Plan
Plan Components

- Completion strategy
- Description of the selected remedy
- Expected performance over time
  - Performance model predictions
- Timeline and criteria for monitoring and periodic evaluations
- Decision logic for remedy transitions
- Project risks and uncertainty

Develop Long-Term Management Plan Completion Strategy

- Path to achieve site objectives
  - Likely iterative for complex sites
  - Collaborative process
- Consider options to maximize future land use
- Consult relevant guidance



Map of proposed future uses for Joliet Army Ammunition Plant, Illinois (ITRC RMCS-1 Figure 36)

Examples: ITRC RPO-3, USEPA 2014. Groundwater remedy completion strategy

Develop Long-Term Management Plan
Project Risks and Uncertainty

- Process to identify and respond to key project risk events
  - Identify and assess potential project risks
  - Actions to reduce risk (e.g., filling a data gap)
  - Use contingency planning tools

Download risk register template:
https://clu-in.org/conf/itrc/rrm/ExampleRRMForms.docx

ITRC RRM-1, 2011
http://www.itrcweb.org/GuidanceDocuments/RRM-1.pdf

Develop Long-Term Management Plan
Describe the Selected Remedy

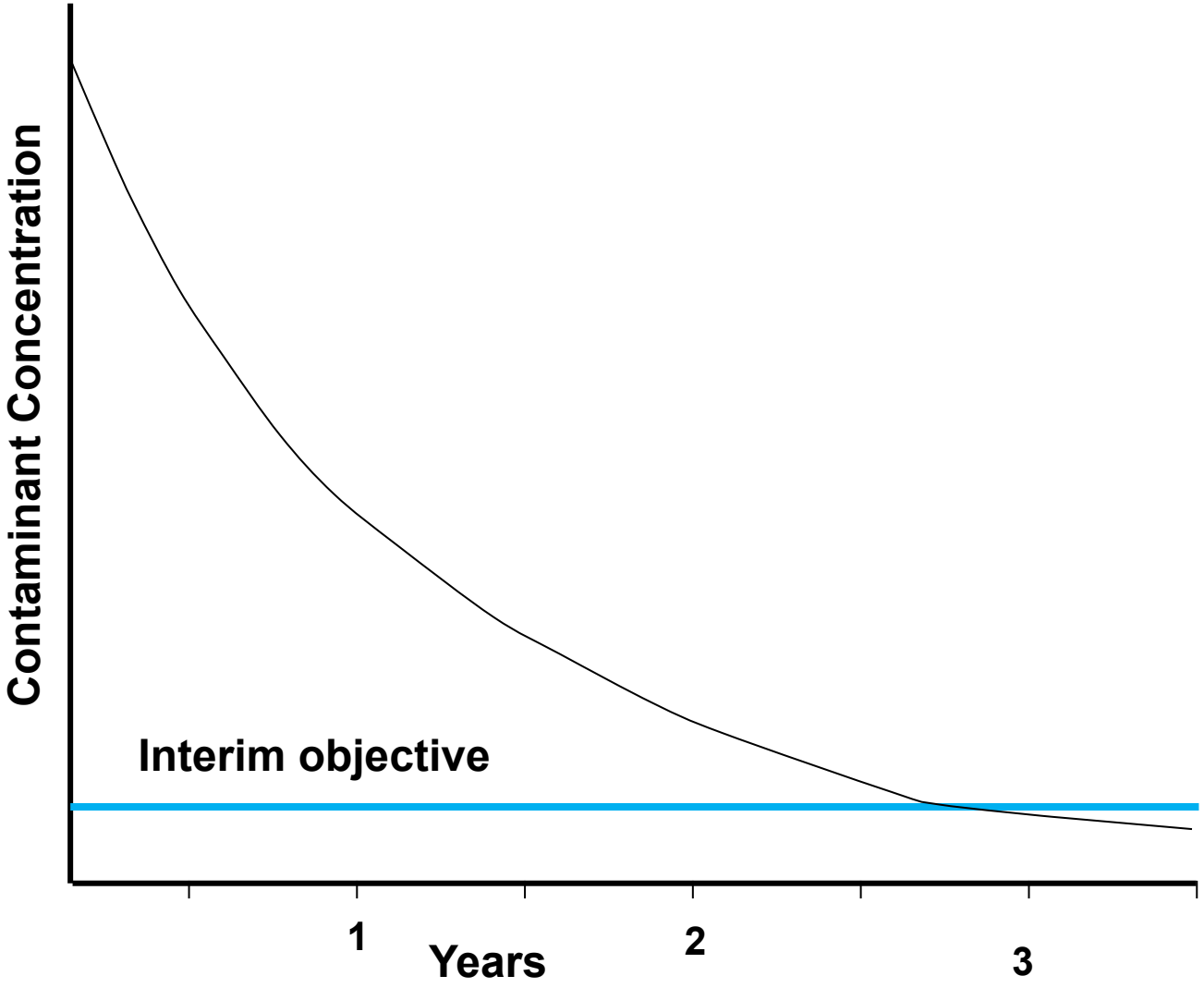
- Remedy for each site segment (e.g., plume, source area, off-site plume)
- Interim objectives, performance metrics
  - May need to set these during long-term management phase
  - Time frame predicted to meet interim objectives
- Maintenance and monitoring considerations

Develop Long-Term Management Plan
Example Description - Selected Remedy

Site Objective	Remedy Component	Interim Objective/ Performance Metric
Remediate contamination	In situ treatment	Reduce contaminant concentrations by 1 order of magnitude
Control migration	In situ treatment	Reduce mass flux from the source area by 80%
	Pump and treat	Demonstrate capture using multiple lines of evidence
Prevent exposure	Engineering controls	Maintain engineering controls and fencing per operation and maintenance plan
	Institutional controls	Deed restriction for land and groundwater use

ITRC RMCS-1 Table 12; ITRC IC-1 2016

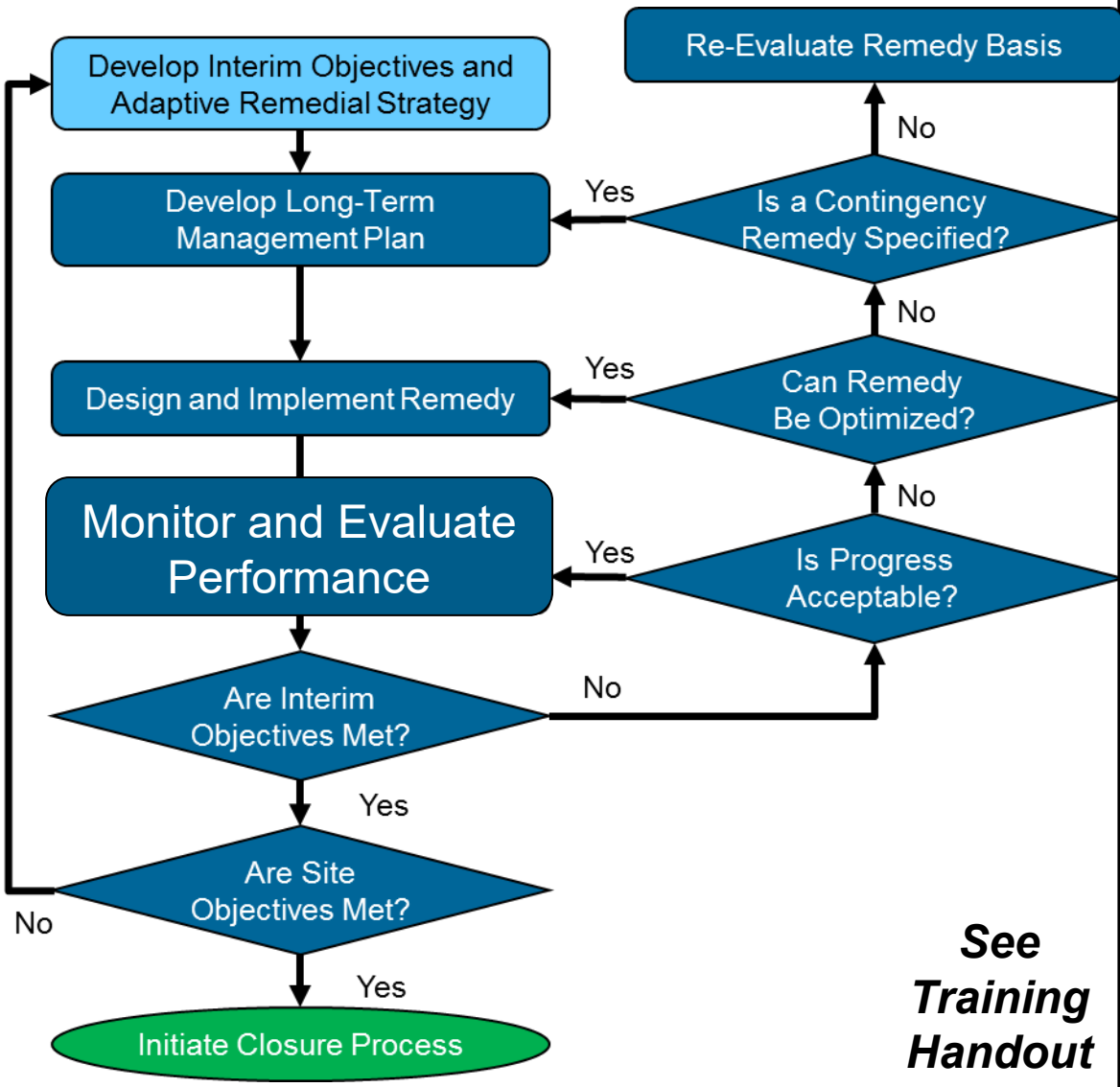
Develop Long-Term Management Plan
Example - Performance Model Prediction



ITRC RMCS-1, Figure 6; ITRC GRO-1, 2016; ITRC GSMC-1, 2013

Monitor and Evaluate Performance

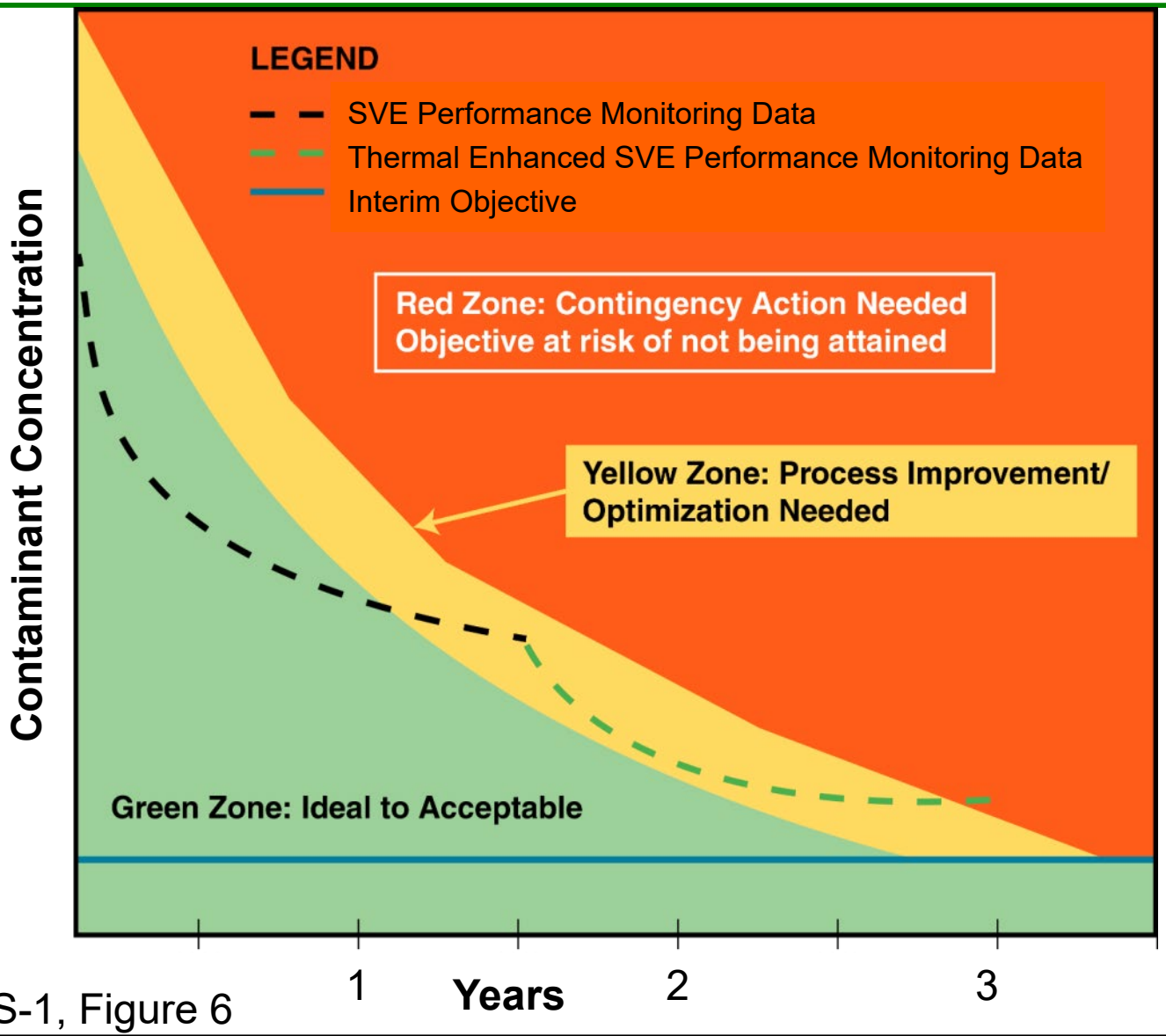
- Schedule for monitoring and periodic evaluations stated in long-term management plan
- Monitoring program aligned with performance objectives



See Training Handout

Monitor and Evaluate Performance

Compare Actual and Predicted Performance



ITRC RMCS-1, Figure 6

SVE – Soil vapor extraction

Monitor and Evaluate Performance

Periodic Evaluation Checklist Example

See Training Handout

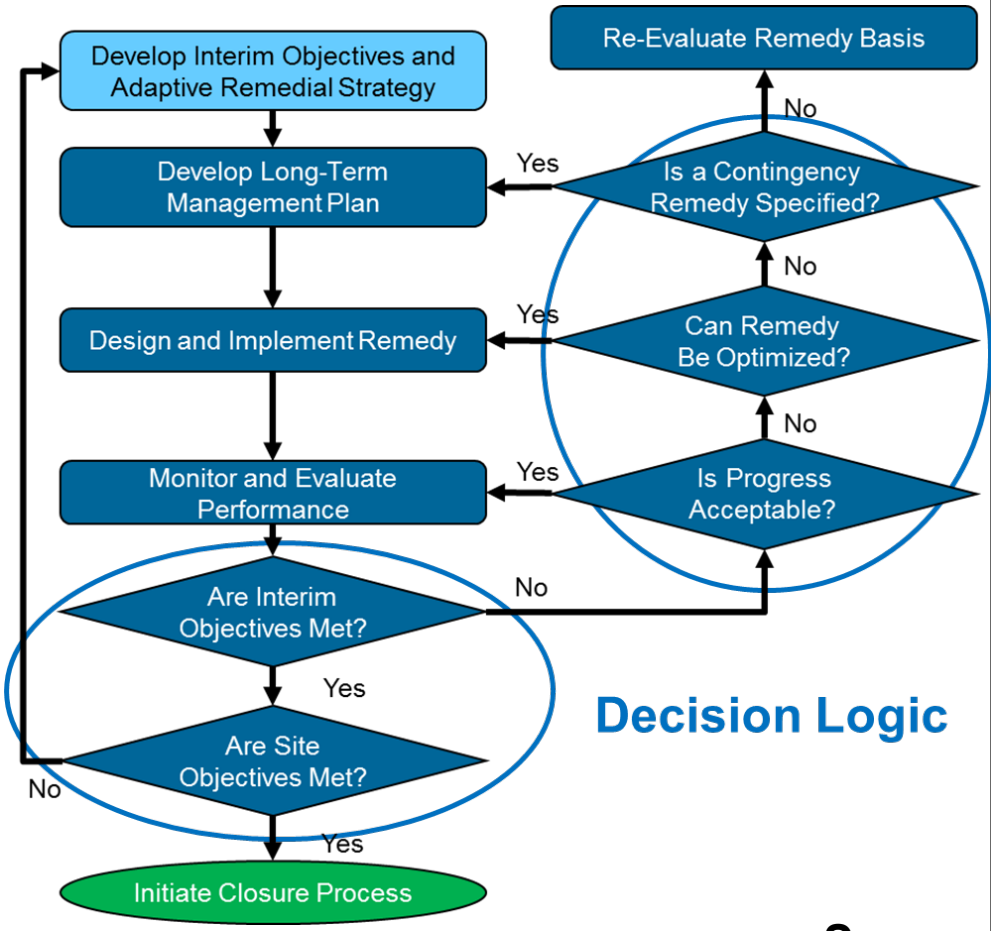
Poll Question

- Site
  - Contaminant properties known and considered?
  - Has source mass been evaluated?
  - Are plume dynamics well understood, increasing, shrinking or stable?
  - Are contaminant concentrations decreasing and on target to achieve objectives?
- Technology
  - Performance evaluation
  - Technology alternatives cost/benefit analysis

Decision Logic

Potential Outcomes of Periodic Evaluations

- Remedy/remedy phase is complete OR
- Remedy is on track OR
- Optimization is needed OR
- Revised remedial approach is warranted

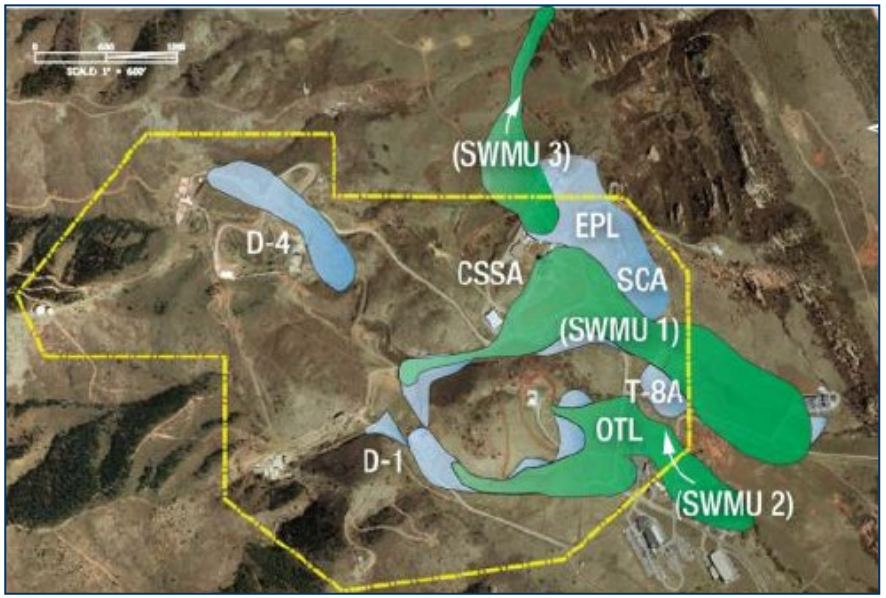


See Training Handout

ITRC RMCS-1, Figure 1

Example: Reaching Technology Limits at a Colorado Site

- TCE and NDMA in fractured rock 125 feet deep
- Enhanced in situ bioremediation for TCE
  - Reached asymptotic concentrations above action levels
- Pilot studies of other technologies ineffective
- Transitioned to MNA and institutional controls



Trichloroethylene (TCE) in bedrock (blue) and alluvial (green) aquifers after in situ bioremediation (Image from Brock 2012)

NDMA – N-nitrosodimethylamine

Long Term Management Summary

- Value of a plan
- Plan components
- Monitor and evaluate performance
- Follow decision logic

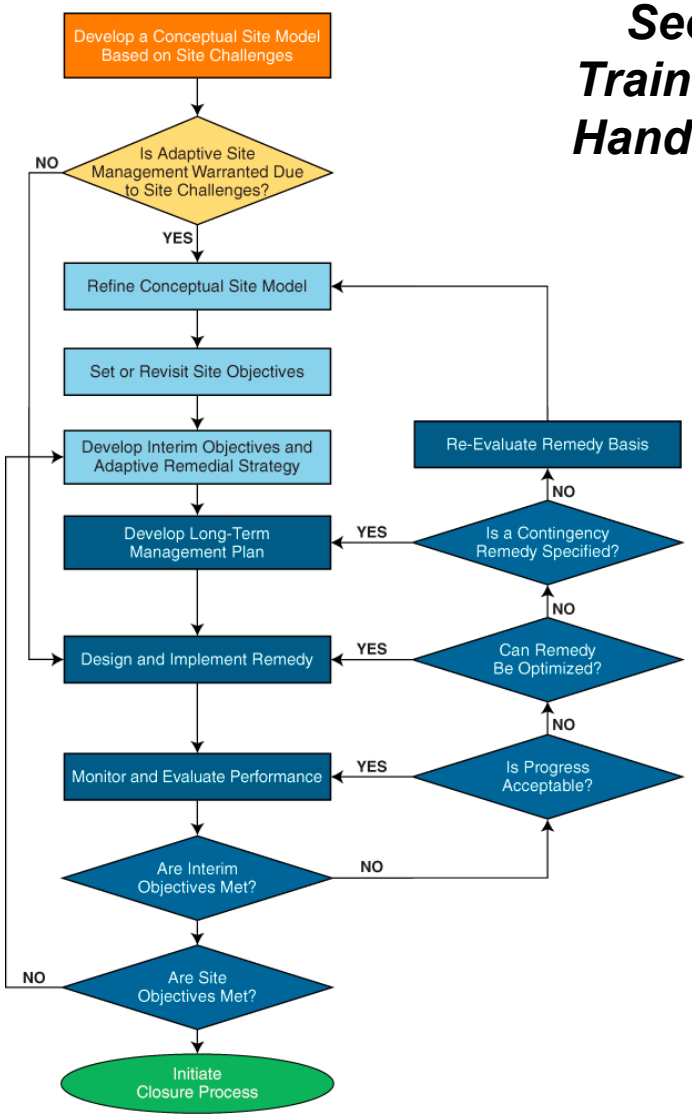
Today's Road Map

- Site challenges
- Remediation Potential Assessment
- Questions and answers
- Adaptive remedy selection
- Long-term management
- Preparing you to take action
- Questions and answers

Our Opportunity to Improve

Poll Question

- Science and technology give us options for challenging sites
- A robust and iterative conceptual site model is key to success
- Consensus-driven interim objectives help us make progress
- Adaptive site management facilitates finding an achievable path to common goal



See Training Handout

What Actions Can You Take To Make Progress at Complex Sites?

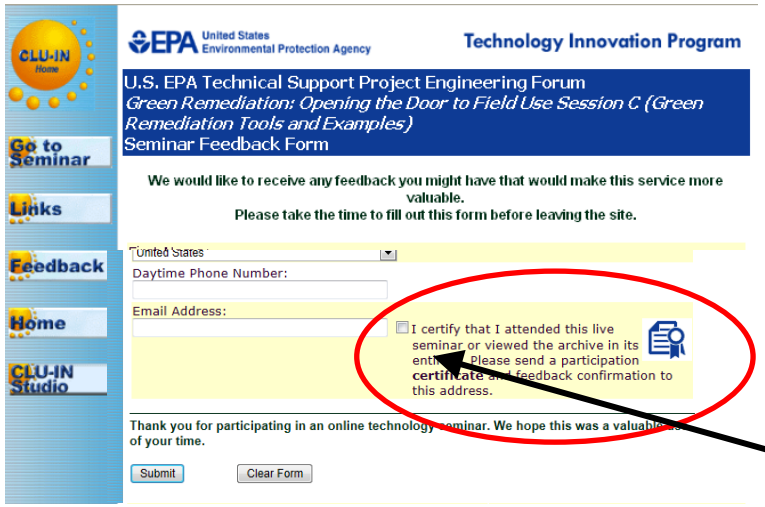
- Use and encourage use of the ITRC Guidance
- Know your site – technical and non-technical challenges
- Assess the remediation potential at your site(s)
- Apply adaptive site management principles
- Get your stakeholders involved early and develop consensus-based interim objectives
- Schedule periodic evaluations of remedy performance to track remedy progress and make improvements

Thank You

Follow ITRC

Poll Question

- **2nd question and answer break**
- **Links to additional resources**
  - http://www.clu-in.org/conf/itrc/RMCS/resource.cfm
- **Feedback form – *please* complete**
  - http://www.clu-in.org/conf/itrc/RMCS/feedback.cfm



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Fill out the feedback form and check box for confirmation email and certificate.