Interstate Technology & Regulatory Council (ITRC) Remediation Management of Complex Sites: Case Studies and Guidance

HOPE LEE

Pacific Northwest National Laboratory

December 17, 2014
Outline

Risk Informed Endpoints
  Background
  DOE
  Federal Agencies
  Define the problem
  Tradeoffs
  Development of Framework (2013- )
  Why do we need one?
  How do we apply it?
  Path forward

Office of Soil and Groundwater Remediation
  AFRI (2009- )
  ASCEM (2009- )
  Strategic Plan (2014)
  SciOps (2014)

Remediation Management of Complex Sites: ITRC
An **endpoint** is:

- risk-informed remediation goal or scenario permitted by regulations
- protective of human health and the environment
- scientifically and technically defensible
- based on systematic, objective understanding of the contamination issue and a holistic remediation approach.

An endpoint framework enables establishing a path for cleanup that may include intermediate remedial milestones and transition points and/or regulatory alternatives to standards-based remediation.

*All approaches for reaching an endpoint **REMAIN** protective of human health and the environment and meet regulatory requirements*
Resources: History

**USACE**: Technical Impracticability Assessments: Guidelines for Site Applicability and Implementation”, Phase II Report, March 2004

**ESTCP**: Alternative Endpoints and Approaches Selected for the Remediation of Contaminated Groundwater (ER-200832)

**ITRC**: Assessing Alternative Endpoints Technical and Regulatory Overview and Remedial Approaches to Address Draft Groundwater Cleanup Challenges: Remediation Risk Management (RRM); Risk Management for Site Remediation (RRM-1)

**DoD** guidance documents (NAVFAC Risk Management, Optimizing Remedies, Optimization Policies)

**DOE** guidance (site specific documents)


**NRC** report (2012) Alternatives for Managing the Nations Complex Contaminated Groundwater sites

DOE Cleanup Goals

- Reduce the life-cycle costs and accelerate the cleanup of the Cold War environmental legacy
- Reduced the EM legacy footprint by 40 percent by the end of 2011, leading to approximately 90 percent reduction by 2015
Why Do We Need Alternate Endpoints?

Remaining cleanup challenges are complex in contaminant type (radionuclides and metals) and location (deep, fractured rock).

\[\text{Total} = 294,000\]

\[\text{NPL} 32B, \text{RCRA-CA} 45B, \text{UST} 16B, \text{DOD} 35B, \text{DOE} 35B, \text{Civilian Agencies} 19B, \text{States & Private} 30B, \text{RCRA-CA} 3,800, \text{NPL} 736\]


~ 300,000 sites
~ $200 billion
Framework For Considerations in Defining and Achieving Remediation Endpoints

Technical Basis for Remediation → Systems-based Assessment → Systems-based Management

- Regulatory Input and Stakeholder Involvement
- Risk Assessment
- Cost Evaluation

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Where is the endpoint framework applicable?

At all sites but especially complex ones with technical limitations to groundwater restoration

- Extensive, recalcitrant, or long-lived contamination
  Presence of non-aqueous phase liquid (NAPL), relatively immobile contaminants, metals and radionuclides

- Complex hydrogeological setting
  Highly heterogeneous, low permeability geology, any environment difficult to characterize

- Other site specific circumstances
How do we get there … risk considerations

- Risk needs to be evaluated at multiple levels and integrated for a holistic view of choosing alternate end state
  - Human Health
  - Ecological

- Balance current needs and drivers with future land use

- Cognizant of dollars saved versus risk reduction

- Are there high-consequence hazards where risk is always too great
Tradeoffs for Alternate Endpoints

Competing influences of risk, cost, and technical defensibility in meeting remediation decision objectives

- High risk, complexity, and cost with little to no regulatory acceptance
  - e.g. Enhanced attenuation

- Scientific and technically defensible with minimal risk but costly and limited regulatory acceptance
  - e.g. Pump-and-Treat

- High risk and complexity but less costly and regulatory acceptable
  - e.g. Permeable reactive barriers

- Scientifically and technically defensible with minimal risk or cost and regulatory acceptable
  - e.g. Surface barrier; in situ bioremediation

Increased Scientific and Technical Defensibility

Increased Cost

Decreased Uncertainty/Risk

Decreased Regulatory Acceptability

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How do we achieve these goals?

- What has been done at other sites
- Interagency collaboration
- Lessons Learned
- Technology/expertise transfer

Resources available include:

- Assessing Alternative Endpoints for Groundwater Remediation at Contaminated Sites
- EPA policy and guidance
- ITRC overview document and training
- Navy Alternative Restoration Technology Team workgroup
- AFCEE and Army initiatives
- ESTCPs’ Alternative Endpoints and Approaches for Groundwater Remediation

- Regulatory and stakeholder engagement
- Risk-informed understanding and defensibility
- Robust long-term management of residual contamination
# Policy & Technical Needs for Remediation and Alternate Endpoints

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Key Issues</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific and Technical</td>
<td>Understand the nature and magnitude of problems to determine which risks</td>
<td>• Systems-based Approaches for Remediation and Decision Support</td>
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<tr>
<td></td>
<td>are most critical and establish priorities for remediation needs</td>
<td>• Characterization vs. Predictive Understanding</td>
</tr>
<tr>
<td></td>
<td>and closure requirements</td>
<td>(e.g., mass flux based conceptual models)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Technologies vs. Remedial Strategies</td>
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<td></td>
<td></td>
<td>• Point source vs. Systems-based Monitoring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Active/Passive Remediation Efforts–Transition and Exit Strategies.</td>
</tr>
<tr>
<td>Regulatory</td>
<td>Based on scientific and technical understanding, determine what must be</td>
<td>• Risk-informed definition of regulatory requirements</td>
</tr>
<tr>
<td></td>
<td>accomplished through cleanup efforts</td>
<td>• Priorities based on protection of human health and the environment</td>
</tr>
<tr>
<td>Institutional and Closure</td>
<td>Define what end state or condition would constitute progress or completion</td>
<td>• Process to effectively define end states</td>
</tr>
<tr>
<td>Management</td>
<td>of cleanup</td>
<td>(from scientifically and technically defensible understanding)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Clearly defined and credible cleanup scope of work to achieve risk-based</td>
</tr>
<tr>
<td></td>
<td></td>
<td>end states</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Transition complex sites to LTM or MNA</td>
</tr>
<tr>
<td>Budget and Resource Allocation</td>
<td>Allocate limited resources (i.e., federal budget dollars) to provide</td>
<td>• Risk-informed choices to prioritize resources,</td>
</tr>
<tr>
<td></td>
<td>benefit to society (e.g., reduced risk, recovered resources, etc.)</td>
<td>drive ‘cleanup demand’ and complete site cleanup</td>
</tr>
</tbody>
</table>

**Risk-Based Alternative End Point Strategies for Site Closure and/or Long-Term Management**

Technically-based approaches to achieve alternative end point strategies, which are risk-based, cost-effective, sustainable, and protective of public health and environment.
How do we achieve alternative endpoints?
- What has been done at other sites
  - Lessons Learned
  - Technology/expertise transfer
- Interagency collaboration
- Regulatory and stakeholder engagement

What are the benefits?
- Risk-informed understanding and defensibility
- Common expectations and acceptable terms (between agencies and contractors) for remedial performance
- Meet regulatory requirements despite technical challenges & limitations
- Robust long-term management of residual contamination, cognizant of human health and environment
- Leverage resources

Collaborative effort: DOE, DoD, site personnel
Provides structured, “systems-based” approach, consistent with the CERCLA and RCRA, to facilitate remediation decisions and reach remediation endpoints at complex sites where restoration may be uncertain, require long time frames, or involve progressive and adaptive management approaches.

Collaborative effort: DOE, site personnel
Remediation Endpoints for Complex Site Closure
ITRC Remediation Management of Complex Sites

TEAM LEADERS
  • Carl Spreng
  Colorado Department of Public Health and Environment
  • John Price
  Washington Department of Ecology

PROGRAM ADVISOR
  • Rula Deeb
  Geosyntec Consultants
Outline

• Scope of the project/team
• Survey results (selected ?s)
• Current work scope
  • Charge
  • Tech Reg
  • Case Studies
  • Document status
  • Flow Chart
• Path forward
What is the project?

• Remediation of groundwater to a condition allowing for UU/UE remains a significant challenge

• A 2012 NRC committee examined cleanup efforts nationally and reported that at least 126,000 sites across the country have residual contamination at levels inhibiting site closure with an estimated “cost to complete” of $127 billion. Of these sites, roughly 10% are “complex”

• Conventional remedies and approaches are often difficult to apply successfully at complex sites
Survey Results …

9. The percentage of remediation sites that are complex is

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0-5%</td>
<td>1.8%</td>
<td>2</td>
</tr>
<tr>
<td>6-10%</td>
<td>23.2%</td>
<td>26</td>
</tr>
<tr>
<td>11-25%</td>
<td>33.0%</td>
<td>37</td>
</tr>
<tr>
<td>26-50%</td>
<td>17.0%</td>
<td>19</td>
</tr>
<tr>
<td>51-75%</td>
<td>9.8%</td>
<td>11</td>
</tr>
<tr>
<td>&gt;75%</td>
<td>1.8%</td>
<td>2</td>
</tr>
<tr>
<td>No opinion/don’t know</td>
<td>13.4%</td>
<td>15</td>
</tr>
</tbody>
</table>

answered question 112
skipped question 5
14. The following contaminant-related challenges usually make for a complex site [adapted from ITRC January 2012] (check all that apply)

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form of the contamination in the environment (e.g., dissolved, sorbed, present as a light or dense nonaqueous-phase liquid [NAPL])</td>
<td>92.7%</td>
<td>102</td>
</tr>
<tr>
<td>Depth and lateral extent of contamination (e.g., regional contamination from acid mine drainage or from various sources discharging into receiving surface water body)</td>
<td>91.8%</td>
<td>101</td>
</tr>
<tr>
<td>Transformation potential or degradability by biotic or abiotic processes</td>
<td>64.5%</td>
<td>71</td>
</tr>
<tr>
<td>Partitioning properties, including NAPL dissolution rate, aqueous solubility, volatility, and adsorption affinity for NAPL</td>
<td>80.0%</td>
<td>88</td>
</tr>
<tr>
<td>Mobility factors such as interfacial surface tension, viscosity, and specific gravity</td>
<td>74.5%</td>
<td>82</td>
</tr>
<tr>
<td>Presence of persistent and ubiquitous anthropogenic contaminants (such as DDT, polycyclic aromatic hydrocarbons)</td>
<td>65.5%</td>
<td>72</td>
</tr>
</tbody>
</table>

answered question 110

skipped question 7
16. The presence of any of the following hydrogeologic conditions usually make for a complex site (check all that apply) [adapted from ITRC Jan 2012]

<table>
<thead>
<tr>
<th>Condition</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contamination in multiple geologic units</td>
<td>88.2%</td>
<td>97</td>
</tr>
<tr>
<td>Contamination in “deep” units</td>
<td>72.7%</td>
<td>80</td>
</tr>
<tr>
<td>Subtle variations in geology within limited vertical and horizontal distances</td>
<td>47.3%</td>
<td>52</td>
</tr>
<tr>
<td>Anisotropy</td>
<td>47.3%</td>
<td>52</td>
</tr>
<tr>
<td>Preferential geologic formations</td>
<td>48.2%</td>
<td>53</td>
</tr>
<tr>
<td>Fractures and fault zones</td>
<td>85.5%</td>
<td>94</td>
</tr>
<tr>
<td>Highly heterogenous aquifers</td>
<td>73.6%</td>
<td>81</td>
</tr>
<tr>
<td>Deep alluvial basins</td>
<td>30.0%</td>
<td>33</td>
</tr>
<tr>
<td>Karst aquifers</td>
<td>63.6%</td>
<td>70</td>
</tr>
<tr>
<td>Fractured bedrock aquifers</td>
<td>80.0%</td>
<td>88</td>
</tr>
<tr>
<td>No opinion/no experience</td>
<td>4.5%</td>
<td>5</td>
</tr>
</tbody>
</table>

answered question 110
skipped question 7
17. A remediation/restoration time frame greater than the following usually makes for a complex site

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 years or longer</td>
<td>11.2%</td>
<td>12</td>
</tr>
<tr>
<td>30 years or longer</td>
<td>28.0%</td>
<td>30</td>
</tr>
<tr>
<td>60 years or longer</td>
<td>5.6%</td>
<td>6</td>
</tr>
<tr>
<td>100 years or longer</td>
<td>14.0%</td>
<td>15</td>
</tr>
<tr>
<td>Restoration time frame does not determine whether a site is a complex site</td>
<td>46.7%</td>
<td>50</td>
</tr>
</tbody>
</table>

Share your understanding of a "reasonable" time frame in years?

- Answered question: 107
- Skipped question: 10
19. A site becomes complex when

<table>
<thead>
<tr>
<th>Response</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remediation costs are greater than $10 million</td>
<td>3.7%</td>
<td>4</td>
</tr>
<tr>
<td>Remediation costs are greater than $20 million</td>
<td>2.8%</td>
<td>3</td>
</tr>
<tr>
<td>Remediation costs are greater than $50 million</td>
<td>1.8%</td>
<td>2</td>
</tr>
<tr>
<td>Remediation costs are greater than $100 million</td>
<td>2.8%</td>
<td>3</td>
</tr>
<tr>
<td>Remediation costs are disproportionate to benefits (i.e., risk reduction)</td>
<td>17.4%</td>
<td>19</td>
</tr>
<tr>
<td>Cost alone does not determine whether a site is complex (but may be an indicator of complexity)</td>
<td>71.6%</td>
<td>78</td>
</tr>
</tbody>
</table>

Share your understanding of a “reasonable” cost

| answered question | 109 |
| skipped question  | 8   |
20. Use of or need for a specific regulatory mechanism usually makes for a complex site (select all that apply)

<table>
<thead>
<tr>
<th>Regulatory Mechanism</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Impracticability (TI) waiver</td>
<td>51.9%</td>
<td>55</td>
</tr>
<tr>
<td>Other ARAR waivers</td>
<td>33.0%</td>
<td>35</td>
</tr>
<tr>
<td>State designated groundwater management or containment zones</td>
<td>28.3%</td>
<td>30</td>
</tr>
<tr>
<td>Alternative point of compliance</td>
<td>32.1%</td>
<td>34</td>
</tr>
<tr>
<td>Alternate concentration limits</td>
<td>36.8%</td>
<td>39</td>
</tr>
<tr>
<td>Use of a specific regulatory mechanism may be an indicator of complexity but does not determine whether a site is a complex site</td>
<td>70.8%</td>
<td>75</td>
</tr>
</tbody>
</table>

List other regulatory mechanisms that have been or could be used at complex sites: 13

Answered question: 106
Skipped question: 11
## 21. Who do you represent?

<table>
<thead>
<tr>
<th>Organization</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA</td>
<td>2.8%</td>
<td>3</td>
</tr>
<tr>
<td>State/Local Government</td>
<td>26.6%</td>
<td>29</td>
</tr>
<tr>
<td>Public/Tribal Stakeholder</td>
<td>3.7%</td>
<td>4</td>
</tr>
<tr>
<td>Private Sector</td>
<td>52.3%</td>
<td>57</td>
</tr>
<tr>
<td>DOD</td>
<td>8.3%</td>
<td>9</td>
</tr>
<tr>
<td>DOE</td>
<td>4.6%</td>
<td>5</td>
</tr>
<tr>
<td>Academia</td>
<td>2.8%</td>
<td>3</td>
</tr>
</tbody>
</table>

- Answered question: 109
- Skipped question: 8
What is the team working on?

Team Charge

• Technical and regulatory guidance document
  Compile and synthesize existing guidance
  Compile case studies
  Provide consensus on strategies to meet cleanup goals at complex sites
  Compile relevant tools to support these strategies
  Provide guidance on how these tools could be used to support specific aspects of remedy selection, implementation and long-term performance evaluation

• Existing tools and approaches may be adapted to focus on providing technical justification and implementation approaches for remedies at complex sites
Documents…

TechReg Draft Outline
• Introduction
• Challenges to closing complex sites
  Technical
  Regulatory
  Other
• Closure concepts
• Remediation strategies for complex sites
• Long-term management of complex sites
• Lessons learned from case studies
• Stakeholder considerations
• Summary and conclusions
• References

Case Studies Document
Draft

Complex Sites Flow Chart
11.06.14

Footnotes
1. Go to Complex Site Attribute Evaluation, P. #
2. Go to Transition Assessment Flowchart/Process, P. #
3. Go to flow chart on Alternative Management Approach and Selection of End State
4. Go to Long Term OM&M, P. #
Path forward & Challenges

• Challenge: Diverse members ~190 currently from wide perspectives

• Short timeline for reaching consensus, producing documents

• Spring & Fall Meetings in 2015

• Working / writing calls- weekly or bi-weekly for ALL subgroups
  • Introduction was completed by one of three sub-groups formed following the Spring Meeting in Garden Grove (March 2014)
  • Remaining section drafts to be completed by several writing group formed during and after the Fall Meeting in Las Vegas (October 2014)
  • Due dates for written sections are on or before January 31, 2015
  • The goal is to have a draft document ready for discussion by the team during the Spring Meeting (April 2015)
Questions...