Remedial Alternatives Screening by Incorporating Sustainability Metrics and using Weighting Triangle Decision Support System

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Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies
May 22-25, 2017 | Miami, Florida

Presentation Overview

- Brief Background
  - Incorporating Green and Sustainable Remediation (GSR) into CERCLA Remedy Evaluation
- Proposed Decision Model for Remedial Alternatives Screening
  - Incorporate GSR Metrics into CERCLA Remedy Screening
  - Weighting Triangle Decision Support System
- Case Study
  - Application of Proposed Decision Model
  - Application of Weighting Triangle

GSR and CERCLA Remedy Evaluation

- EPA's August 2016 Memorandum
  - Consideration of greener cleanup activities should be carried out consistent with CERCLA, NCP, and EPA guidance
  - Recommends approaches to consider greener cleanup activities throughout remedy selection process including remedial investigations/ feasibility studies (RI/FS')
  - Footprint analysis may help inform an RI/FS' remedial alternative evaluation criteria
  - Provides guidance on how greener cleanup activities may be evaluated as part of **Short-term Effectiveness Criterion.**
- Navy's GSR Guidance
  - Navy's Optimization Policy requires that GSR practices be considered and implemented during all phases of remediation
  - Footprint analysis to be conducted using the SiteWise™ tool.
  - Provides guidance to map GSR metrics into existing CERCLA regulatory framework

Mapping of GSR Metrics into CERCLA Regulatory Framework – Navy GSR Guidance

SUSTAINABILITY METRICS	BALANCING CRITERIA					MODIFYING CRITERIA	
	LONG-TERM EFFECTIVENESS	REDUCTION IN TOXICITY, MOBILITY, OR VOLUME	SHORT-TERM EFFECTIVENESS	IMPLEMENTABILITY	COST	STATE ACCEPTANCE	COMMUNITY ACCEPTANCE
Energy Consumption			X		X	X	X
GHG Emissions	X		X			X	X
Criteria Pollutant Emissions	X		X			X	X
Water Impacts/Use	X		X		X	X	X
Ecological Impacts	X		X			X	X
Resource Consumption	X		X		X	X	X
Worker Safety			X		X	X	X
Community Impacts			X			X	X
Cost of Remedy					X		

CERCLA Remedy Screening Criteria

- Effectiveness
  - Effectiveness (short and long-term) in protecting human health and the environment
  - Reductions in toxicity, mobility, or volume through treatment
- Implementability
  - *Technical feasibility:* Ability to construct, reliably operate, and meet technology-specific regulations
  - *Administrative feasibility:* Ability to obtain approvals from other offices and agencies; availability of equipment/ services
- Cost
  - Capital costs
  - O&M costs

Decision Model for Remedial Alternatives Screening

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Decision Model for Remedial Alternative Screening

Step 1

- Incorporate GSR Metrics into **Effectiveness** criterion
  - Long-term effectiveness
  - Short-term effectiveness

Step 2

- Score **each remedial alternative** based on Effectiveness, Implementability, and Cost

Step 3

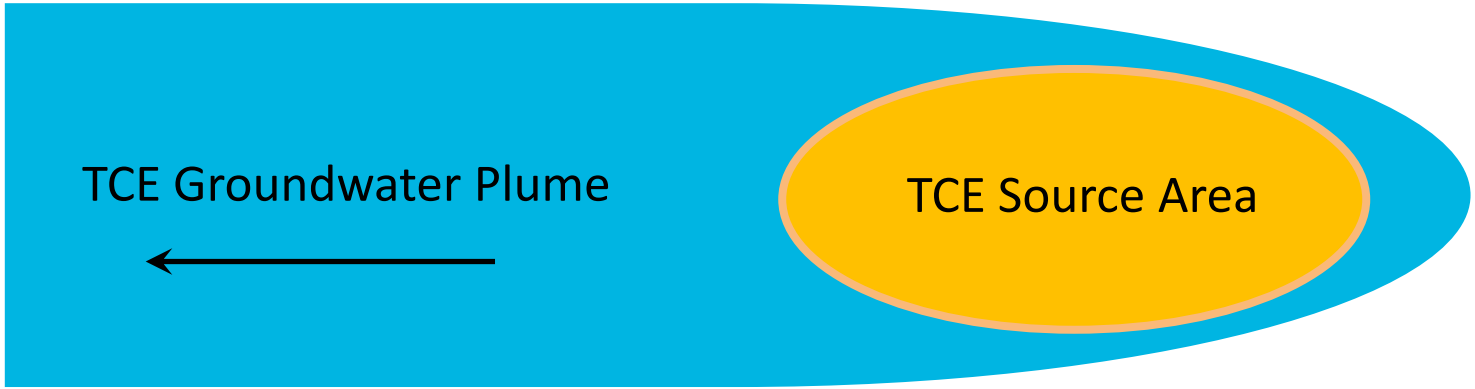
- Analyze results using Weighting Triangle Decision Support System

Step 4

- Rank and screen remedial alternatives

Illustrative Case Study

TCE Impacted Groundwater Site



TCE Source Area

Groundwater TCE Plume greater than MCLs

Preliminary Remedial Alternatives

- Alternative 1: No Action
- Alternative 2: Monitored Natural Attenuation (MNA) and Institutional Controls (ICs)
- Alternative 3: Source Area Treatment using **In Situ Thermal Treatment (ISTT)**, Monitoring, and ICs
- Alternative 4: Source Area Treatment using **In Situ Bioremediation (ISB)**, Monitoring, and ICs
- Alternative 5: Source Area Treatment using **Dual Phase Extraction**, Monitoring, and ICs
- Alternative 6: Source Area and Plume Treatment, and ICs

CERCLA Remedy Screening Criterion - Effectiveness

Long-term Effectiveness

- Magnitude of **residual risk remaining from untreated waste or treatment residuals** at the conclusion of the remedial activities
- Adequacy and reliability of **controls necessary to manage treatment residuals and untreated waste**

Short-term Effectiveness

- Short-term risks posed to the **community**
- Potential **impacts on workers** and the effectiveness and reliability of protective measures
- Potential **environmental impacts** and the effectiveness and reliability of mitigative measures
- Time until protection is achieved.

Reduction in Toxicity, Mobility, or Volume Through Treatment

Mapping of GSR Metrics - Long-Term Effectiveness

Long-Term Effectiveness Considerations	Criteria/ Metrics
Magnitude of Residual Risk – Treatment Residuals	• Green House Gas (GHG) Emissions • Oxides of Nitrogen (NOx) Emissions • Sulfuric oxide (SOx) Emissions • Particulate Matter (PM) Emissions
Adequacy and Reliability of Controls – Treatment Residuals	Adequacy and reliability of controls for GHG, NOx, SOx, and PM emissions
Magnitude of Residual Risk – Residual TCE	Residual concentrations of TCE after response objectives are met
Adequacy and Reliability of Controls – Residual TCE	Adequacy and reliability controls for residual TCE

GSR Metrics

Mapping of GSR Metrics - Short-Term Effectiveness

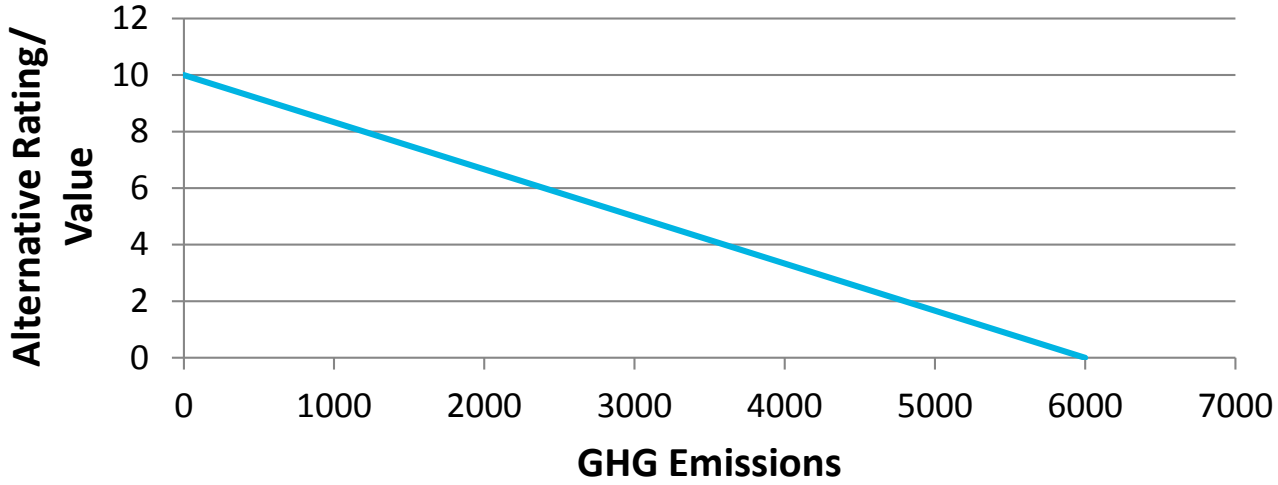
Short-Term Effectiveness Considerations	Criteria/ Metrics
Worker Protection	• Injury risk to workers • Fatality risk to workers
Environmental Impacts	• Energy consumption • GHG Emissions • NOx, SOx and PM Emissions
Community Protection	Potential impacts to community due to remedial action implementation
Time Until Remedial Response Objectives are Achieved	Estimated time until remedial goal for TCE is attained

GSR Metrics

Rating of Remedial Alternatives

– Scale: 0 to 10

– In general, simplified linear value functions used for rating remedial alternatives (Grelk et al. 1998)



Scoring of Remedial Alternatives

Effectiveness Score =

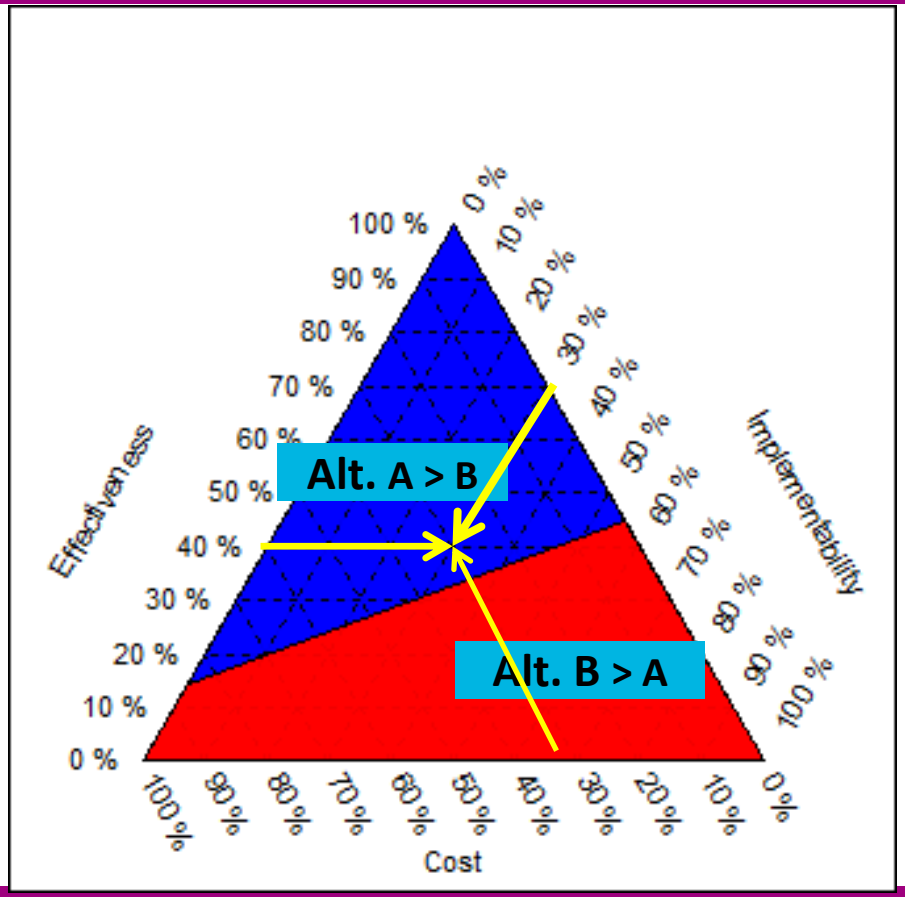
Rating for Long-Term Effectiveness
+
Rating for Short-Term Effectiveness
+
Rating/ Values for Reduction in Toxicity/Mobility/Volume Through Treatment

Implementability Score = Rating for Implementability

Cost Score = Rating for Cost

Weighting Triangle Tool

Weighting Triangle Tool



– Calculation of "Screening Index ***(SI)***"

$$SI = (W_E * Eff_{score}) + (W_I * Imp_{score}) + (W_C) * (Cost_{score})$$

– W_E, W_I, W_C = relative weights for effectiveness, implementability, and cost criteria

– Eff_{score} = *Effectiveness score*

– Imp_{score} = *Implementablity score*

– $Cost_{score}$ = *Cost score*

Hofstetter et al. 2000 and Pre Consultants 2000

Screening of Source Area Remedial Alternatives

- Alternative 3: Source Area Treatment using **In Situ Thermal Treatment (ISTT)**, Monitoring, and ICs
- Alternative 4: Source Area Treatment using **In Situ Bioremediation (ISB)**, Monitoring, and ICs
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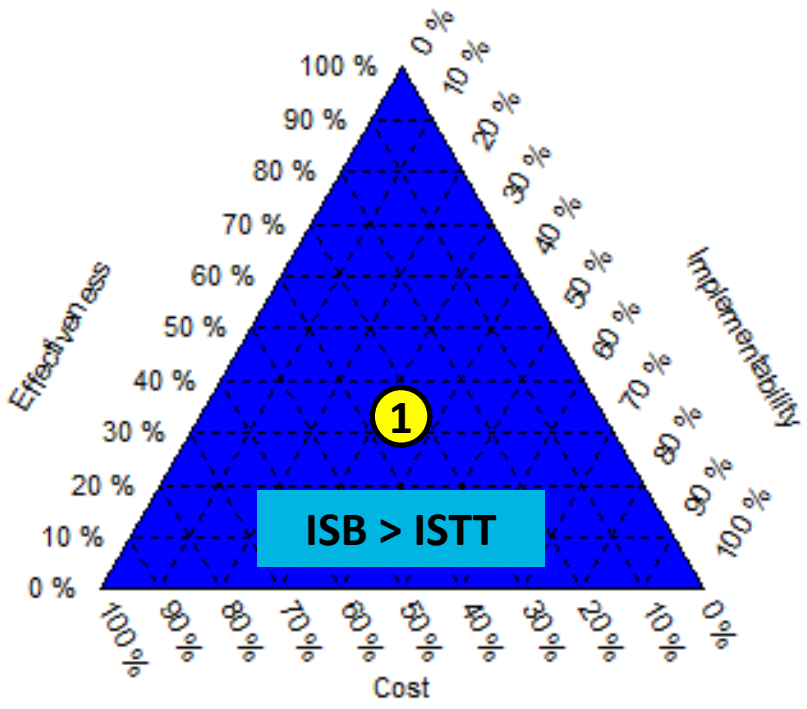
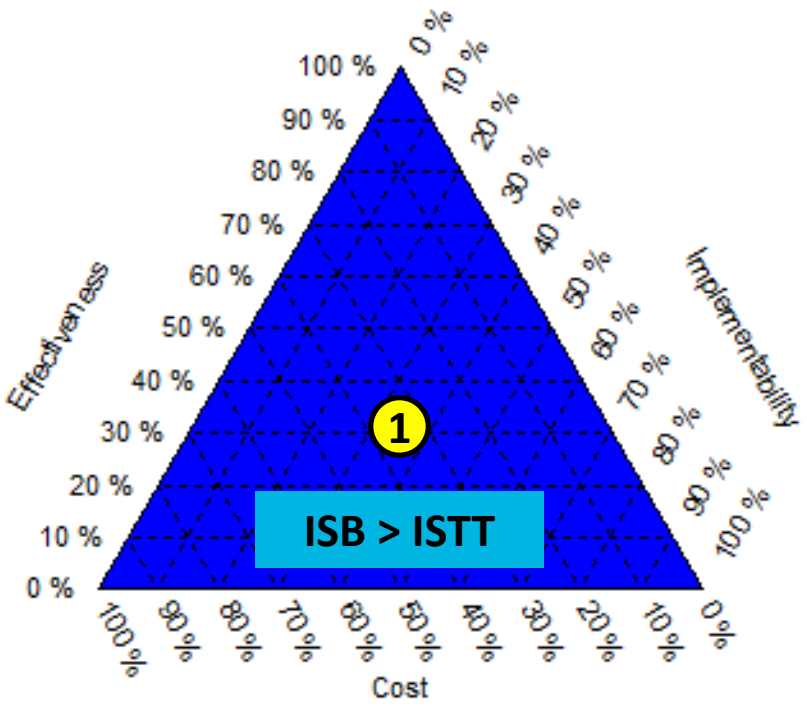
Comparison - Source Area ISB and Source Area ISTT

GSR Metrics Considered

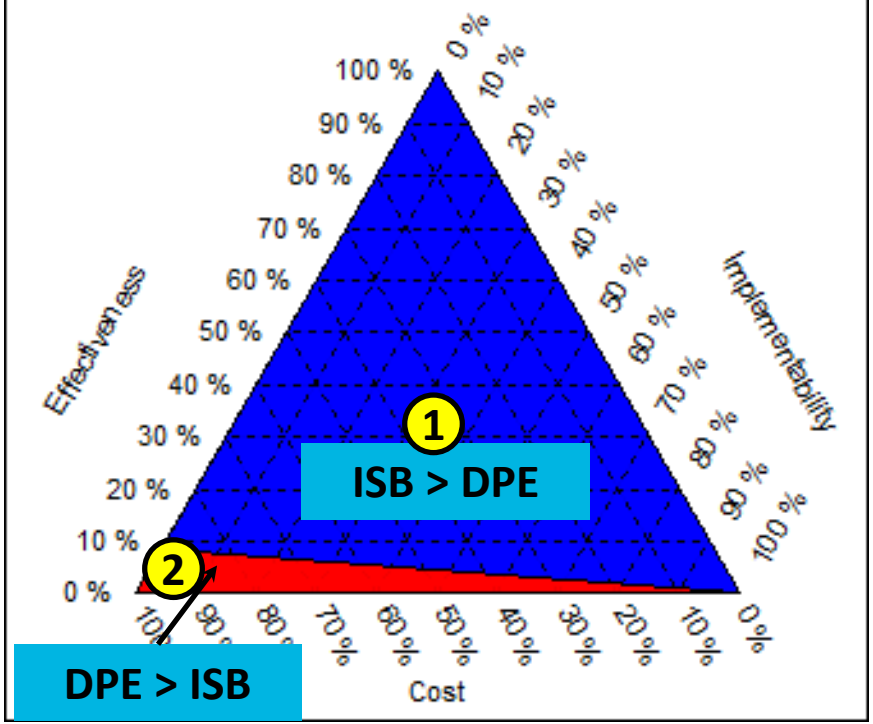


GSR Metrics Not Considered

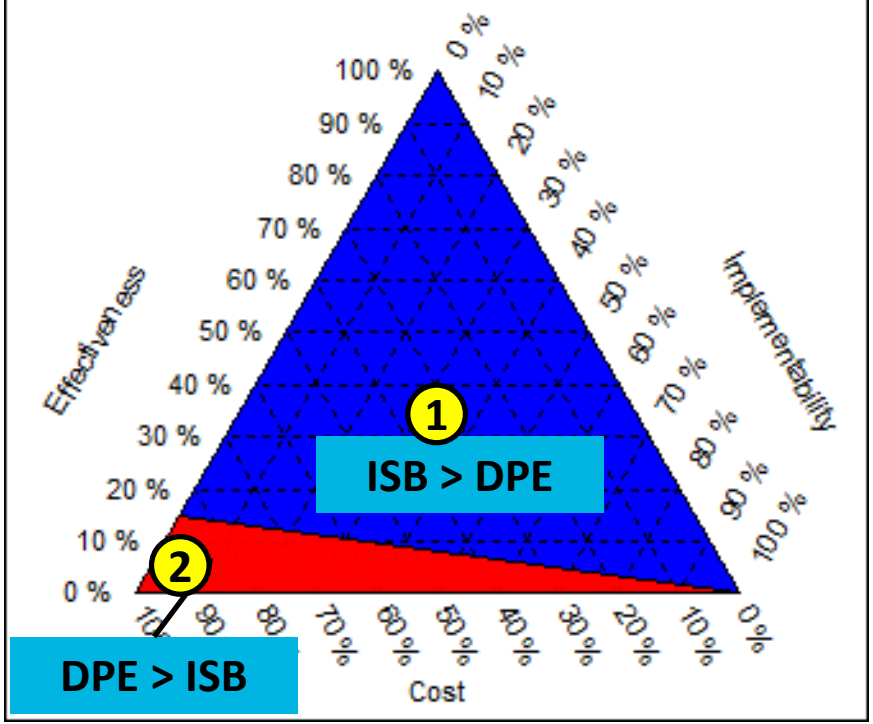


Comparison - Source Area ISB and Source Area DPE

GSR Metrics Considered



GSR Metrics Not Considered



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Mapping of GSR Metrics - Long-Term Effectiveness

Long-Term Effectiveness Considerations	Criteria/ Metrics
Magnitude of Residual Risk – Treatment Residuals	• GHG Emissions • NOx Emissions • SOx Emissions • PM Emissions
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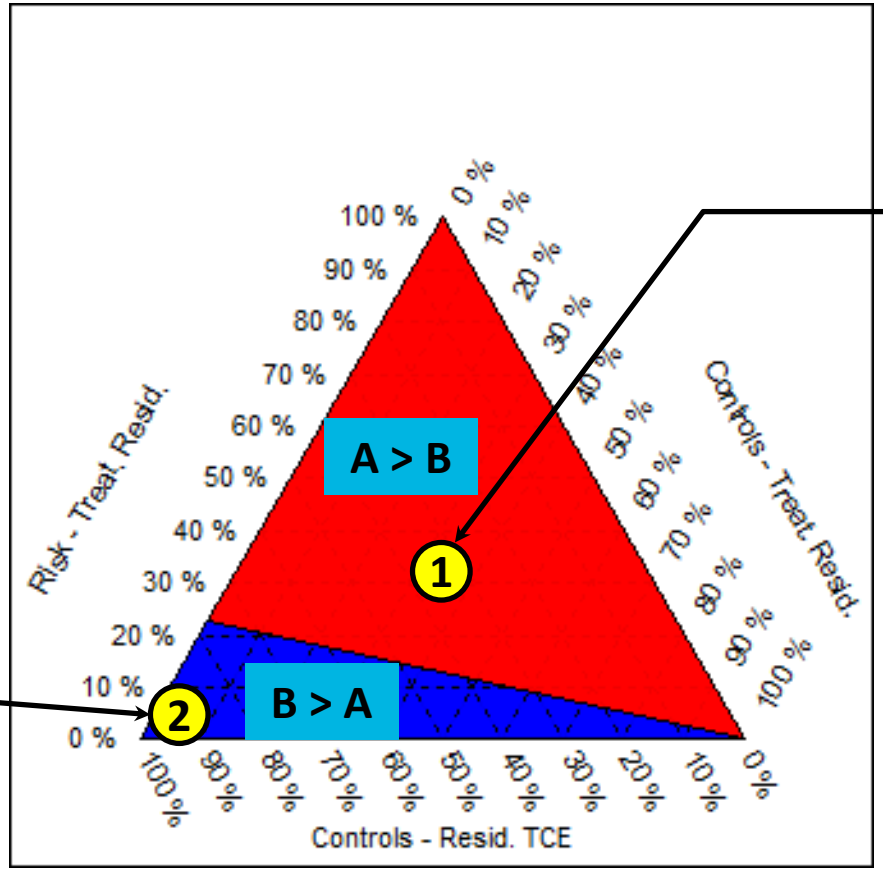
GSR Metrics

Analysis of the Effect of GSR Metrics – Long-Term Effectiveness

Comparison:

- MNA and ICs **(A)**
- Source Area and Plume Treatment **(B)**



GSR Metrics Considered and Given Equal Weight

GSR Metrics Not Considered

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Analysis of the Effect of GSR Metrics – Short-Term Effectiveness

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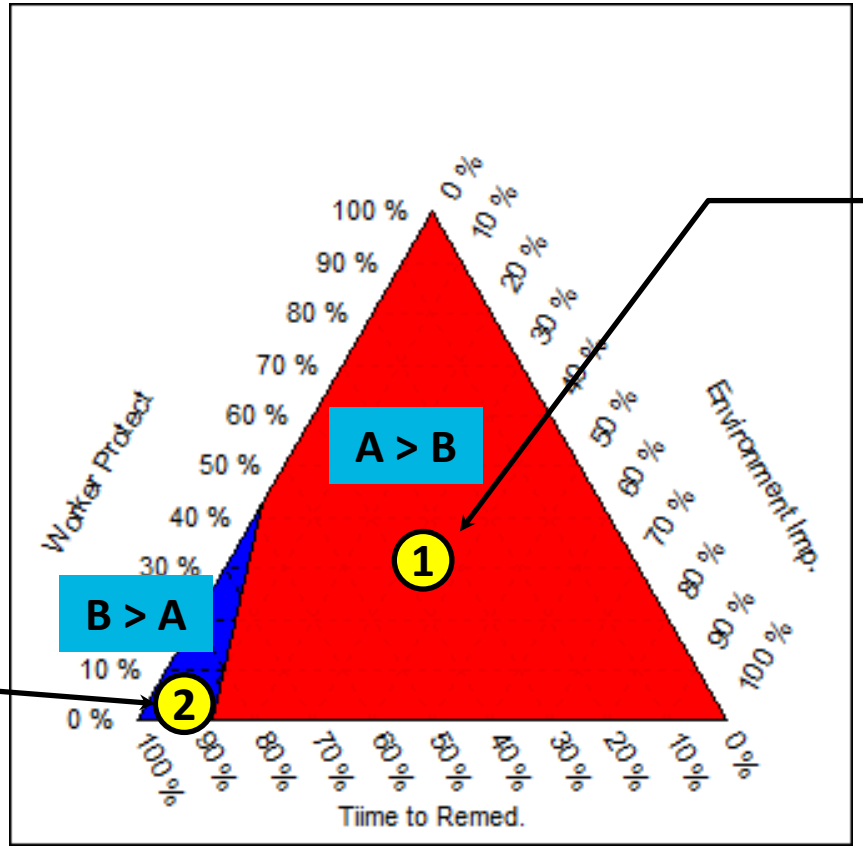

GSR Metrics Considered and Given Equal Weight

GSR Metrics Not Considered

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Conclusions

- An objective model is proposed to incorporate GSR metrics into the screening of remedial alternatives
- This model can be easily adapted to site-specific circumstances
- Stakeholders may need to agree on specifics related to mapping of GSR metrics into the CERCLA remedy evaluation criteria
- Weighting triangle decision support system can be an effective way to present the results of remedial alternative screening to different stakeholders
- The same weighting triangle can show multiple stakeholder preferences/perspectives, and will likely simplify and clarify discussion issues
- Incorporating GSR metrics and using weighting triangle makes remedial alternative evaluation more objective

Thank You!

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