

Multi-Criteria Decision Analysis for Identifying Sustainable Remediation Alternatives

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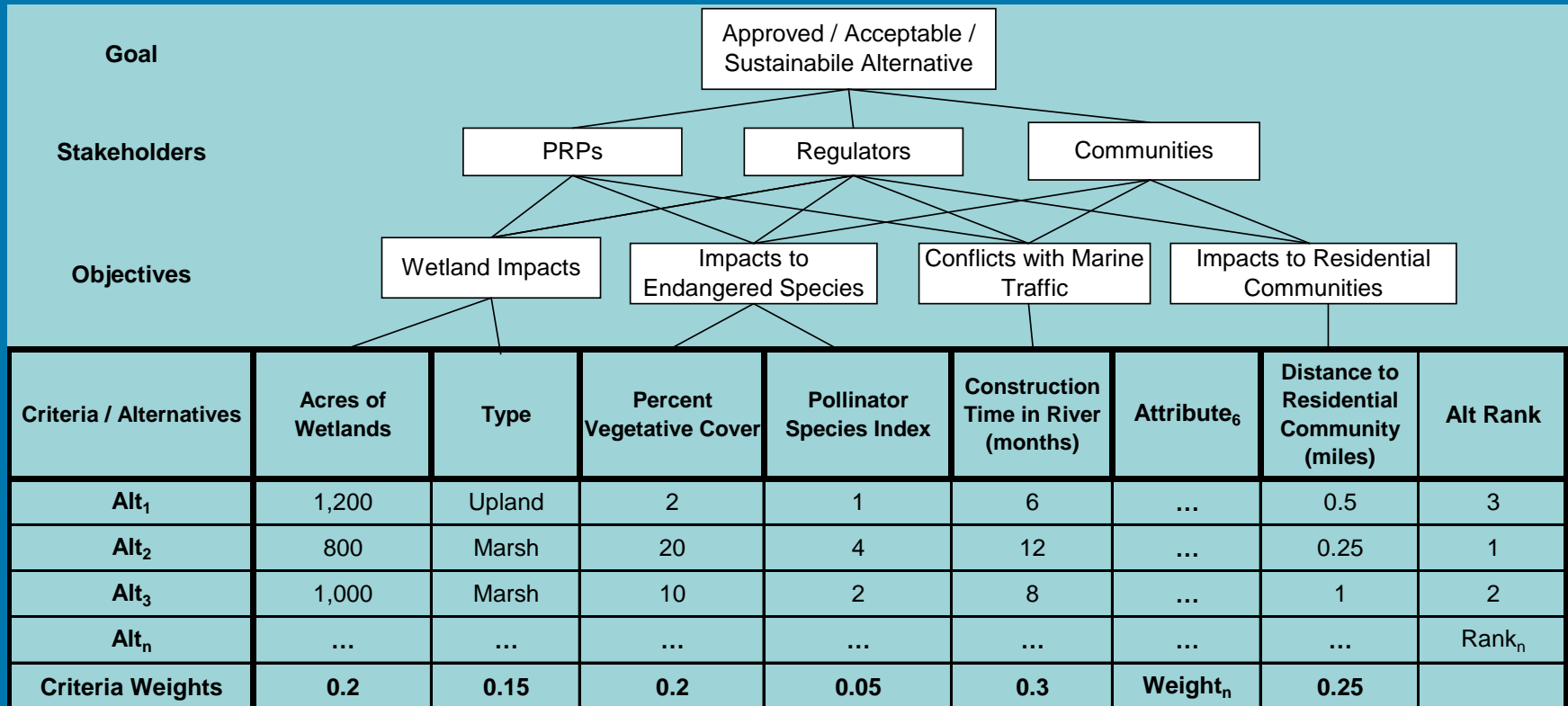
Presentation Topics

- Need for Multi-Criteria Decision Analysis in Remedy Selection
- MCDA Approach
- Case Study Introduction
- Criteria Weighting Exercise
- Results

Need for Multi-Criteria Decision Analysis

- Identify Strategic Alternatives that Maximize Net Environmental Benefits
- Solicit Community Involvement and Increase Public Acceptance and Awareness
- Achieve Stakeholder Convergence (not consensus) on a Final Solution
- Provide Transparent Analysis of Social, Economic and Environmental Aspects of Competing Strategic Alternatives

Conceptual Summary of MCDA Approach



Case Study Project

Hard Rock Mining Remediation and Restoration

Background Information

- Mine in continuous operation for over 50 years and includes approximately 5 square miles of land
- Includes open pit area, operating mill and mill tailings area
- Open pit is approximately 3/4 mile in diameter and 1/2 mile deep
- Approximately 150 million tons of potentially acid generating overburden waste rock has been placed within the mine site
- CERCLA RI/FS is being performed at the site

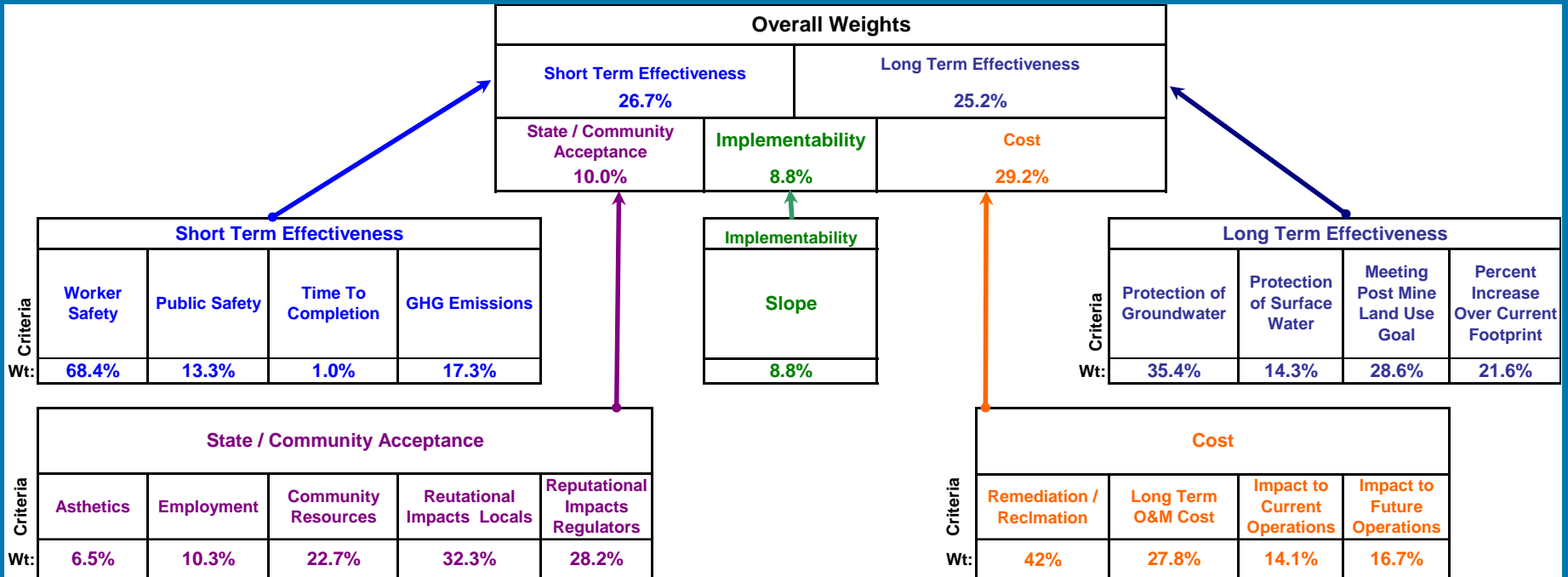
Project Goals

- Minimize environmental liabilities while addressing environmental issues associated with overburden rock piles
- Incorporate green remediation criteria into CERCLA FS Process
- Provide transparent results for communicating with regulatory agencies and community
- Achieve regulatory approval of the optimum Alternative

Alternatives to Address Overburden Rock Piles

- Complete Removal and On-Site Disposal
- Partial Removal and Capping
- Re-grading and Capping
- Complete Removal and Off-Site Disposal

Case Study Results of Weighting Process



Short Term Effectiveness Criteria

Criteria	Definition	Measurement Scale
Worker Safety	Probability of at least one fatality or major injury	Percent Probability
Public Safety	Increase stability of rock piles	Percent Probability
Time	Year to complete	Years
GHG Emissions	Carbon dioxide emissions over life of project	Tons

Long Term Effectiveness Criteria

Criteria	Definition	Measurement Scale
Protection of Groundwater	5 = No or insignificant acid mine drainage 1 = Amount of acid mine drainage leads to additional remedial actions	5 to 1
Protection of Surface Water	5 = No or insignificant increase in load and zero discharge 1 = Increase in load and discharge leads to additional reclamation actions	5 to 1
Meeting Post Mine Land Use Goal	Probability of meeting forestry land use goals	Percent probability
Resulting Footprint	Percent increase over current foot print	Percent

State and Community Impact Criteria Values

Criteria	Definition	Measurement Scale
Aesthetics	Time required to blend into surrounding environment	Years
Employment	Duration of new jobs	Years
Community Resources	5 = No impact on community resources 1 = Community resources impacts due to provision of additional services	5 to 1
Reputational Impacts - Local	Number of negative written comments	Number of negative written comments
Reputational Impacts -Regulators	5 = Measurable improvement in speed of approvals or responsiveness to comments at this site or others 1 = No measured difference in approvals or responsiveness to comments	5 to 1

Cost Criteria

Criteria	Definition	Measurement Scale
Reclamation	Present Value Capital Cost	Millions of Dollars
O&M Cost	Present Value Long Term Maintenance Liabilities	Millions of Dollars
Impact to Current Operations	Percent Reduction in Efficiency	Percent
Impact to Future Operations	Number of Future Opportunities Lost	Count

Criteria Weighting Exercise

Real Time Conjoint Survey

Criteria Weighting Exercise

- Goal: simulate stakeholder/model interaction in a town hall setting
- Use electronic voting cards to choose preferred option in a decision set
- Data on preferences is used to determine weighting criteria
- Trade-offs are important
 - They are not easy

Value of the Trade-off Approach

- Organizes stakeholder intuition
 - The process provides value
- Sharpens focus on critical issues
 - Fewer elements included in the model
- Identifies areas of consensus and disagreement
- “Holistic ranking” is easier and more reliable than other techniques
- Forces people to make decisions

Criteria Weighting Exercise

- Short-term effectiveness criteria:
 - Worker Safety
 - Probability of Fatality
 - Public Safety
 - Percent Increase in Rock Pile Stability
 - Years to Completion
 - Greenhouse Gas Emissions

Example Criteria Question

Which alternative is better ?

Criteria	Option 1	Option 2
Worker Safety (Probability of Fatality)	2%	15%
Public Safety (Percent Increase in Rock Pile Stability)	90%	20%
Years to Completion	20	70
GHG Emissions (CO2 Thousand Tons)	1000	20

Criteria	Option 1	Option 2
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Public Safety (Percent Increase in Rock Pile Stability)	90%	20%
Years to Completion	20	70
GHG Emissions (CO2 Thousand Tons)	1000	20

Which is better?

- A. Option 1 is much better than Option 2 0%
- B. Option 1 is better than Option 2 0%
- C. Option 1 and Option 2 are the same 0%
- D. Option 2 is better than Option 1 0%
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Model and Results

Characteristics of Good Criteria

- Specific
- Quantifiable
- Consensus on definition
- Independent of other criteria
- Representative of major effects that are important
- No high/medium/low