

Collaborative Decision Analysis for Facilitating Stakeholder Agency Dialogue in Resource Management

ERDC

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**US Army Corps
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Overview

- Environmental management is important
 - ▶ Implications for environment, society, economics.
- A successful decision making process is critical
 - ▶ E.g., cost is only one criterion of many
 - ▶ Consensus on type/importance of criteria is key
- We need more-sustainable approaches
 - ▶ Due to greater public involvement, increased regulation, a desire for “greener” solutions, and complex tradeoffs.

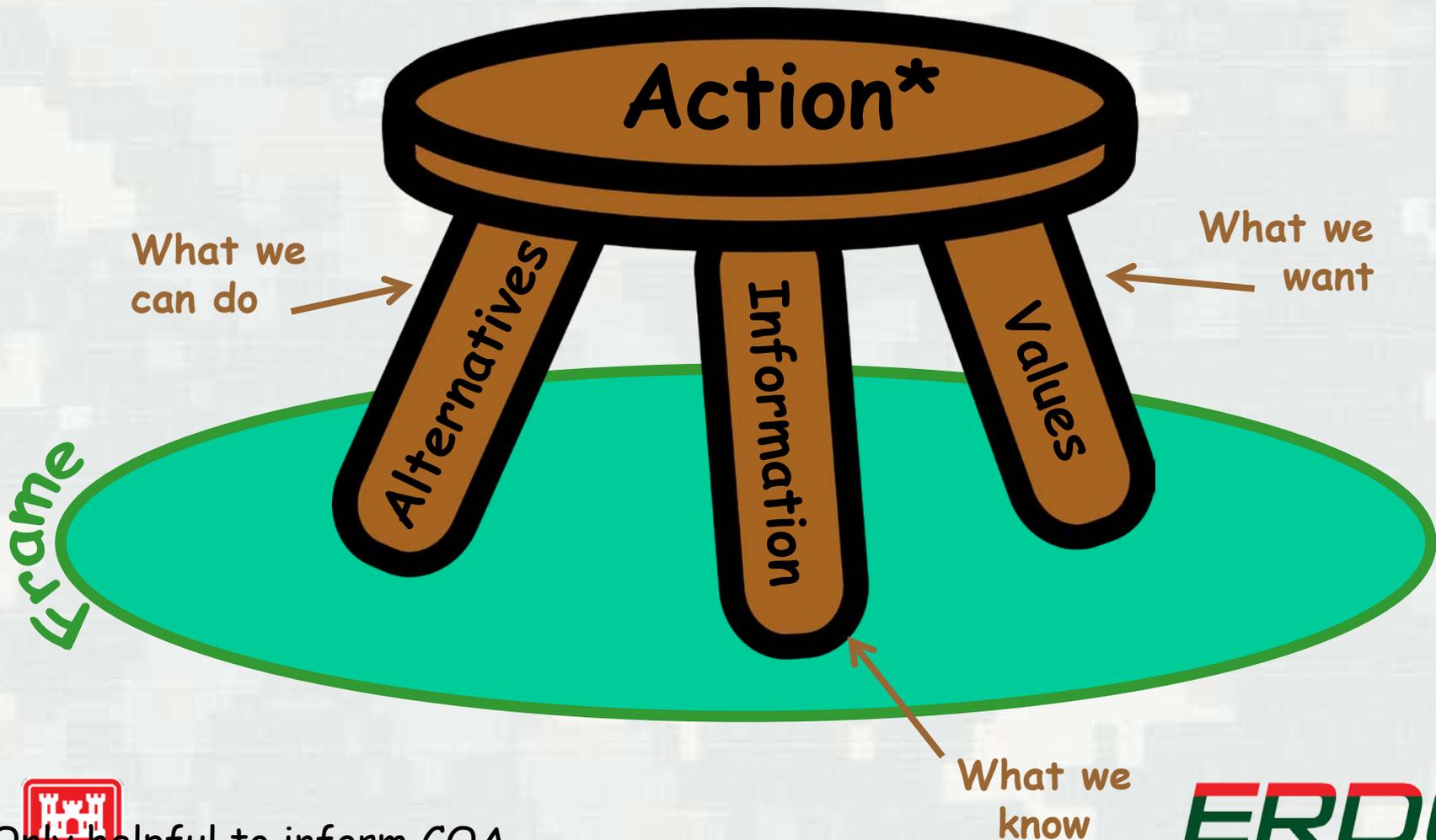


Stakeholders

- Technology stakeholders with **diverse backgrounds** and representing different organizations.
- Negotiate in early phases of the systems **life-cycle** including requirements and alternatives.
- An **evolving understanding** of goals, objectives, and alternatives.
- Different **risk perceptions, risk appetites.**



Decision Analysis



*  Only helpful to inform COA

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Tools to Facilitate Stakeholder Engagement

- *Structured stakeholder engagement*
 - ▶ To define and weight the decision criteria.
- *Life-cycle assessment*
 - ▶ E.g., tradeoffs between local contam. & global climate.
- *Assessment of environmental impacts & benefits*
 - ▶ Systematic evaluations across +/- on all criteria.
- *Formal decision analysis*
 - ▶ To combine science and preference to transparently rank project alternatives.



Why Bother?: Decision Making Challenges

- “Humans are quite bad at making complex, unaided decisions” (Slovic et al., 1977).
- A variety of psychological biases tend to skew our rationality.
- We can only keep a few factors in ‘working memory’ at a time, so are liable to miss considerations without decision aids.
- Individuals respond to complex challenges by using intuition and/or personal experience to find the easiest solution.
- Groups can devolve into entrenched positions resistant to compromise
- “There is a temptation to think that honesty and common sense will suffice” (USACE IWR-Drought Study p.vi)



Multi-Attribute Utility/Value Theory Basics

(after Dyer)

- Seeks the performance of alternatives on objectives explicitly in terms of utility/value functions. Assessment of these function incorporates information about the range over which the alternatives vary.
- Weights of objectives can be specified directly or by pair wise comparison.
- Steps Followed:
 - Decide the overall objective (goal) of the decision
 - Develop a hierarchy of objectives
 - Identify unique, measurable attribute (measure) for every sub-objective. Specify the utility curves for each of these measures.
 - Identify the alternatives available
 - Estimate the performance of every alternative on every measure.
 - Assign weights to objectives by direct assessment or tradeoff analysis.



MCDA Process

(1) Identify objectives

Purchase a safe and reasonably priced vehicle.



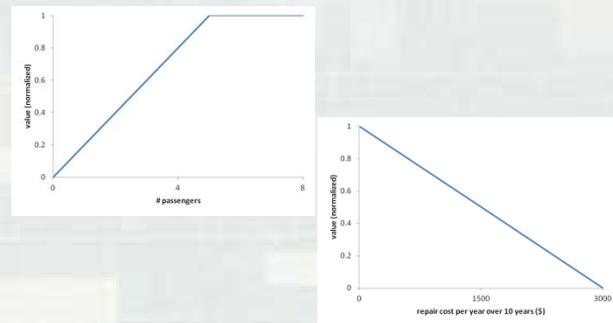
(2) Identify criteria

Cost
Resale Value
Repair Cost
Fuel Efficiency
Passenger Space
Style and Comfort
Safety

(3) Identify metrics

Cost : \$K
Resale Value: \$K in 3yrs
Repair Cost \$/yr per10yrs
Fuel Efficiency: EPA mpg est
Passenger Space : # seats
Style and Comfort: 1-5 rating
Safety: NHTSA rating

(4) Develop value f(x)



(5) Elicit weights

Cost (25%)
Resale Value After Three Years (5%)
Repair/Maintenance Cost Per Year (5%)
Fuel Efficiency (15%)
Passenger Compartment Space (15%)
Style and Comfort (5%)
Safety Rating (30%)

$$\sum_{m=1}^M w_m = 1$$

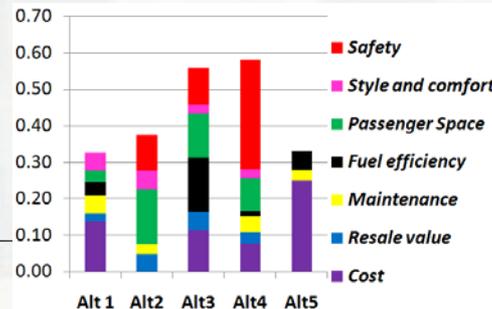
(6) Generate alternatives

Honda
BMW
Audi
Volvo
Toyota

(7) Score alternatives

	Alt 1	Alt2	Alt3	Alt4	Alt5
Cost	0.136	0	0.114	0.076	0.25
Resale value	0.023	0.048	0.05	0.033	0
Maintenance	0.05	0.028	0	0.042	0.028
Fuel efficiency	0.038	0	0.15	0.015	0.053
Passenger Space	0.03	0.15	0.12	0.09	0
Style and comfort	0.05	0.05	0.025	0.025	0
Safety	0	0.1	0.1	0.3	0

(8) Calculate MCDA



(9) Analyze sensitivity

- Evaluate score and weight parameters that most influence our preferences for alternative x over y
- Vary scores/weights within a plausible range (e.g. better 10%)

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Project Overview

- Problem context
- Regional Solution Team (RST) approach
- Multi Criteria Decision Analysis (MCDA) process
- Results
- Conclusions & Insights



Problem Context



Horseshoe Bend (Kent, WA)

- 1.9mi levee, rebuilt 1996
- Rehab needed, many different stakeholders
 - ▶ Flood control
 - ▶ Environmental
 - ▶ Tribal interests
 - ▶ Economic
 - ▶ Recreation



Long Island Sound DMMP

- DMMP requested by Governors of Connecticut and New York after the EPA designated changes to open water dredged-material disposal sites in LIS.
- Issue: **Stakeholders disagree**
 - States, Harbormasters, Marinas, Yacht Clubs, Boat Yards, Cargo Terminals, Power Plants, Military Facilities, State Piers, Ferry Terminals, Dredgers, etc.
- Result: **\$15M** and **3 yrs later** states & stakeholder fights reach US congress and process told to start over...



LIS: stakeholder engagement

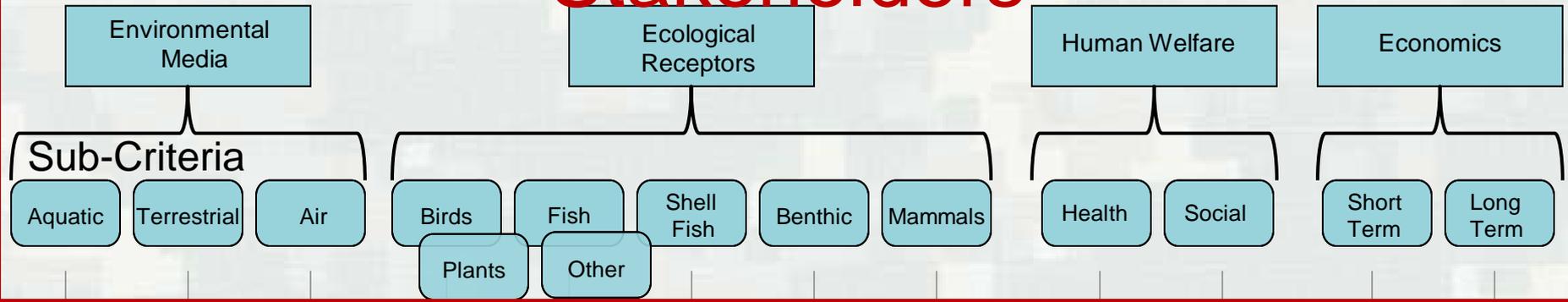
- The process calls for Federal agencies to **seek public input** regarding development of the LIS DMMP.
- **Earlier attempts** at generating criteria focused on site-specific screening constraints; **did not comprehensively address stakeholder values**.
- The Corps has been hosting a series of **Working Group meetings** aimed at establishing a list of evaluation criteria based on stakeholder interests and concerns.



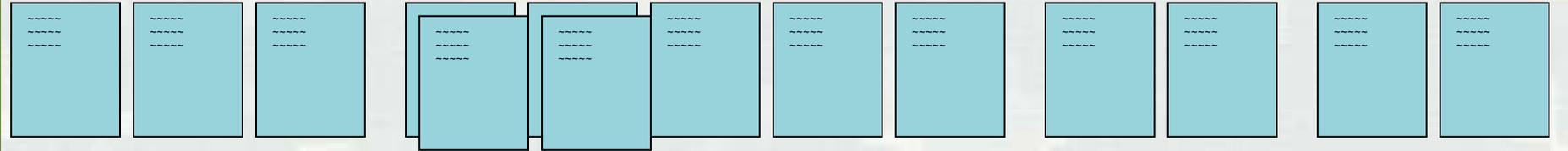
LIS: structure of the decision model

Stakeholders

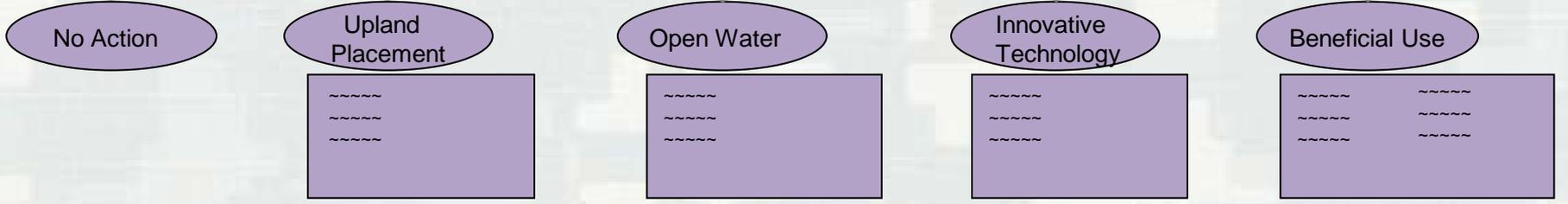
Criteria



Metrics



Alternative Placement Sites (3x)*



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Use of the decision model

- Individual stakeholder organizations will “weight” the criteria and sub-criteria (which are defined by the metrics) to determine relative priorities and tradeoffs.
- District staff will perform technical assessments to “score” the placement sites for each region of Long Island Sound against these metrics.
- The stakeholder weights and technical scores will be combined through the MCDA model to rank the placement sites in each LIS region. Results will be reported as one component of the final LIS DMMP.



Horseshoe Bend

Regional Solution Team

- Pilot to engage Green River SWIF stakeholders in collaborative effort
- Members invited based on jurisdiction & historic involvement – key first hurdle
- Project objectives:
 - ▶ Correct deficiencies in Horseshoe Bend Levee to provide flood protection & environmental benefits
 - ▶ Provide an opportunity for regional stakeholders and the Corps to work together in a regional team (RT) to develop system solutions
 - ▶ Develop a process that identifies/develops tractable holistic alternatives
 - ▶ Inform Green River System-Wide Improvement Framework (SWIF) with regard to deficiencies & authorities



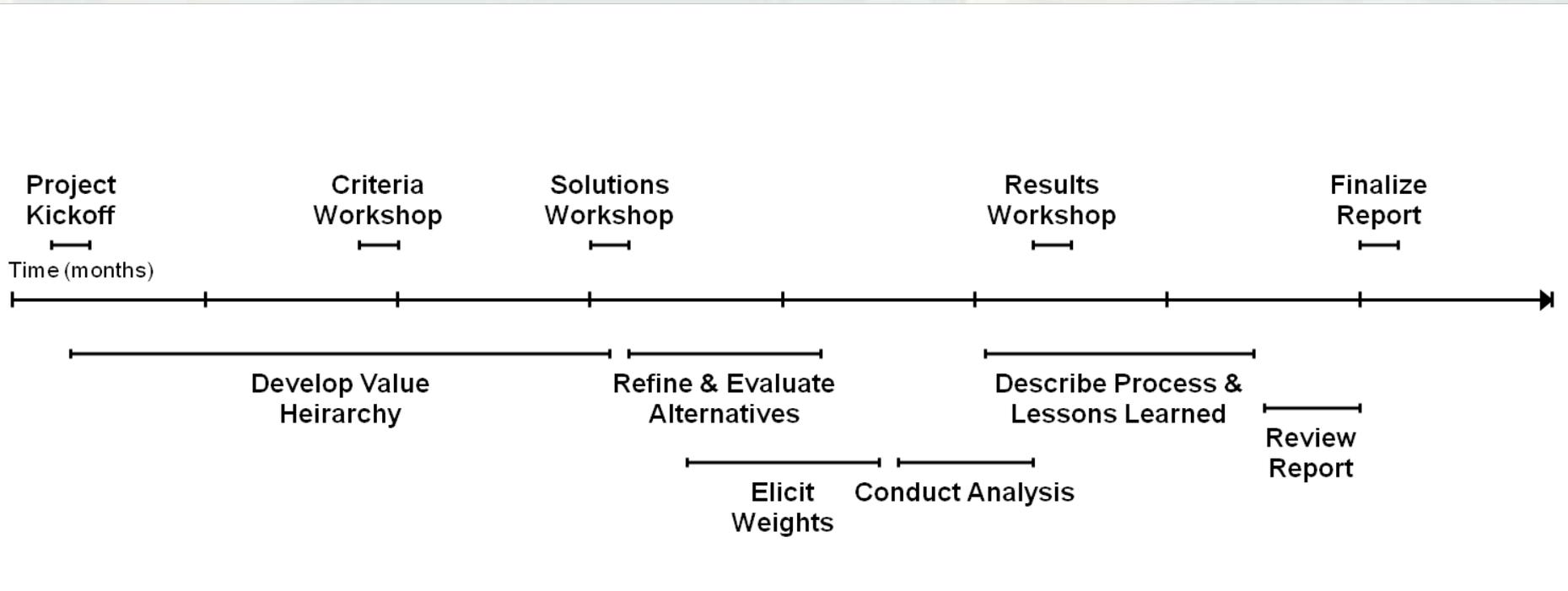
Regional Solutions Team Membership

- City of Kent, WA
- Federal Emergency Management Agency*
- King County
- King County Flood Control District
- Muckleshoot Indian Tribe
- National Marine Fisheries Service
- US Army Corps of Engineers, Seattle
- WA Dept of Ecology
- WA Dept of Fish & Wildlife
- WA Water Resource Inventory Area 9
- Puget Sound Partnership

*abstained from weighting interview



RST Timeline



Develop Value Hierarchy

- Collaboratively developed by RST
- A few ‘seed’ criteria suggested based on historic concerns
 - ▶ Flood risk, environment, recreation, etc.
- Refined and supplemented during & after Criteria Workshop



Results Workshop

- 4-5 solutions developed concurrently in small collaborative groups
 - ▶ Stationing for features based on Corps conventions
- Many proposed design features (e.g., riparian buffer) simultaneously addressed flood control & ecological considerations
- One solution “The Big Dream” returned the inside of the Horseshoe to its natural state
 - ▶ Ecologically ideal but infeasible



Refine Alternatives

Right Bank

Modify federal project alignment to include recent improvements by the City of Kent, from Station 0+00 to 11+00 and 87+00 to 98+87.

Address slope stability and toe scour through a combination of levee set back, in-place replacement, flood wall and layback, Station 0+00 to 21+00, 43+00 to 45+50, 48+00 to 50+00, 60+00 to 69+00, 74+00 to 79+00, and 86+00 to 95+00.

Install Large Woody Debris (LWD), Station 38+00 to 40+00 and 53+00 to 55+00.

Develop twenty-five foot riparian habitat buffer, Station 6+00 to 21+00.

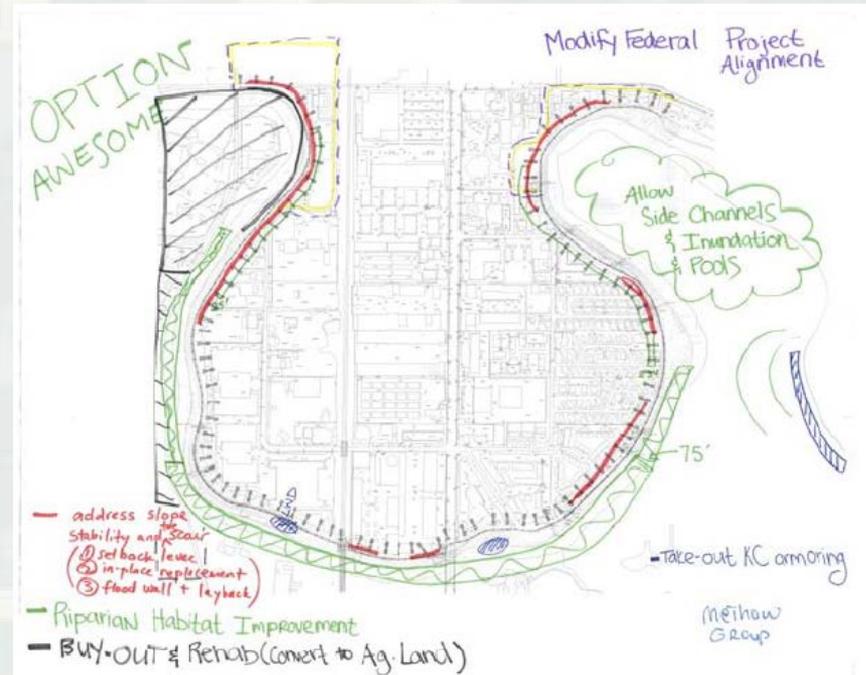
Left Bank

Allow side channels, inundation, and pools throughout "horse head" area.

Install LWD prior to "horse head" bend.

Install seventy-five foot riparian habitat improvement buffer, opposite Station 15+00 to 72+00.

Buy-out and Rehabilitation (convert to agricultural land), opposite Station ~-4+00 to 33+00 (wrecking yard).



SAMPLE



Weight Elicitation

Interview Read-Ahead

- Project to-date
- Purpose of interview
- Example transcript
- Normalizing reminder

Criteria	Ranking (1 - 8)	Score (0 - 100)
Levee Safety / Reliability	1	100
Fish / Salmon Health	2	85
Cost	3	60
Implementability	4	55
Flood Risk Management	5	40
Community Resilience	5	40
Tribal and Public Use	7	22
Water Quality	8	5

$$100 + 85 + 60 + 55 + 40 + 40 + 22 + 5 = 407$$

Levee Safety / Reliability:	100/407	=	24.6%
Fish / Salmon Health:	85/407	=	20.9%
Cost:	60/407	=	14.7%
Implementability:	55/407	=	13.5%
Flood Risk Management:	40/407	=	9.8%
Community Resilience:	40/407	=	9.8%
Tribal & Public Use:	22/407	=	5.4%
Water Quality:	5/407	=	1.2%

Team
Member
Weights



Interview Example

Main Criteria

Rank the following **Main Criteria** in order of importance, from 1 to 8. Give the criteria ranked #1 a score of 100 points. Then assign the other criteria points relative to 100 points. Remember that for these criteria and other judgments that ties are allowed and there is no set total number of points, i.e. the lowest ranked criterion does not have to have a score of 0. Evaluations should be made within the context of your agency's goals in developing a recommended action plan for the Horseshoe Bend Levee System.

Criteria	Definition	Ranking (1 - 8)	Score (0 - 100)
Community Resilience	<i>The ability of the individuals and businesses within and adjacent to Horseshoe Bend to recover from flooding.</i>		
Cost	<i>The funds required to implement and maintain the recommended action plan, and the lifetime of the solution once implemented.</i>		
Fish / Salmon Health	<i>The ability of Horseshoe Bend to support healthy fish and salmon populations.</i>		
Flood Risk Management	<i>The ability of the Horseshoe Bend Levee and associated systems within the Bend to effectively manage flood risk.</i>		
Implementability	<i>The ability to put the recommended action plan into practice considering factors not related to cost.</i>		
Levee Safety / Reliability	<i>The ability of the Horseshoe Bend Levee to perform as designed.</i>		
Tribal and Public Use	<i>The ability for tribal and public individuals to access and use the Horseshoe Bend reach of the Green River for a variety of activities.</i>		
Water Quality	<i>The ability of the Horseshoe Bend reach to support improvements in water quality aligned with Washington state water quality standards.</i>		



Stakeholder Feedback

- ▶ Interview read-ahead encouraged agency introspection
- ▶ Process allowed for open communication in a safe environment
 - Teaching & learning moments
 - Solutions focused
- ▶ Partners did not make their rankings public; transparency and understanding opportunity lost
- ▶ Process established an understanding of deficiencies:
 - slope stability, encroachments, certification issues



Lessons Learned

- ▶ Get the right composition of stakeholders!
 - King Co Technical Advising Committee
- ▶ MCDA results should be a discussion midpoint, not endpoint
- ▶ Spend more effort developing sub-criteria terms & definitions with stronger cross-agency consensus
- ▶ Sweet spot for technical brainstorming needed – here scope was too open ended – additional site/project constraints could have helped
- ▶ Develop deliberate a priori rules about level of openness/confidence for weighting interviews that match project context



What's next?

- The RST principles formed a foundation for the SWIF process
 - ▶ Developed strong working relations among key stakeholders
 - Pilot helped to establish trust among SWIF PDT members
 - ▶ Horseshoe Bend is a SWIF Capital Project candidate
 - ▶ RST model criteria helped to inspire SWIF project goals
 - ▶ King County aiming for a SWIF+
 - Only flood protection is required under PL84-99
 - Can we get flood protection... AND ecological benefits... AND recreational benefits... AND others?

- King County submitting SWIF for USACE review in August



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- Linkov, I., & Moberg, E. (2012). *Multi-criteria decision analysis: Environmental applications and case studies*. Boca Raton, FL: CRC Press.



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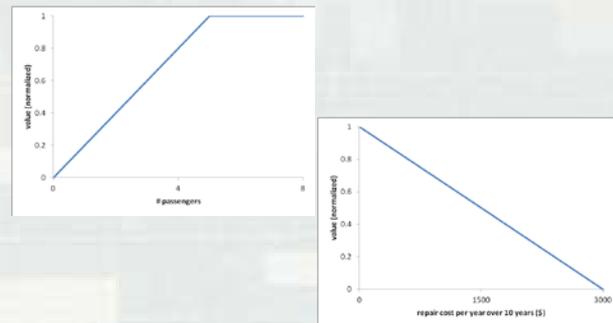
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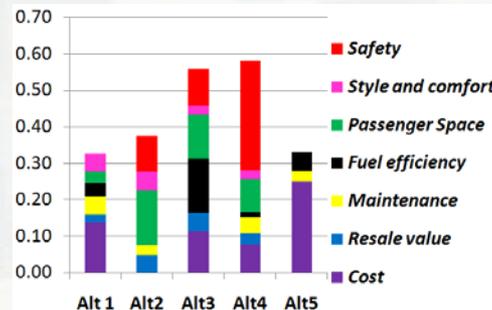
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Clearwater II

Clearwater 2 Alternative (Figure 14) includes the same measures as Clearwater 1 Alternative, as well as an additional 80 ft vegetative buffer from Station 0+00 to 72+00.

Left Bank

- Re-vegetate side channels of Horsehead Bend on King County owned land, Station 77+00 to 98+87.
- Reconnect depressional area at approximately Station 63+00 to 65+00, and bridge to eliminate fish trapping.
- Create off-channel habitat on NE Auburn drainage at approximately Station 56 to 60.
- 70 foot tree buffer from Station 29+00 to 71+00.
- Acquire abandoned agricultural land, Station 26+00 to 30+00, and return to production to compensate for lost agricultural production in agricultural district.
- Purchase auto yard. Remove road (78th Ave. South). Clean up contaminated soils. Install off-channel habitat features. Dedicate fallow land back to agricultural production.

Right Bank

- Move line of protection back to floodwall and berm from Station 87+00 to 98+87, and incorporate into Federal Levee. Purchase structures and revegetate area between old protection and new protection.
- COE repair and add LWD at Station 78+00 to 86+50.
- COE repair and add LWD at Station 66+50 to 69+50.
- COE repair and add LWD at Station 29+00 to 38+50.
- Layback levee (about 20 feet) from Station 12+00 to 29+00
- From Station 0+00 to 12+00, set back levee to existing berm and build floodwall. Area between old and new protection is replanted.
- From Station 44+00 to 50+00, move river. Excavate left bank to expand river channel capacity and fill right bank to bring slope down. Add 80 foot buffer on left bank at new river bank.
- From Station 0+00 to 16+00, create large setback.

