Comparison of Environmental Evaluation Tools and Incorporation of Monetized Socioeconomic Damages for Sediment Remediation Projects

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May 25, 2017

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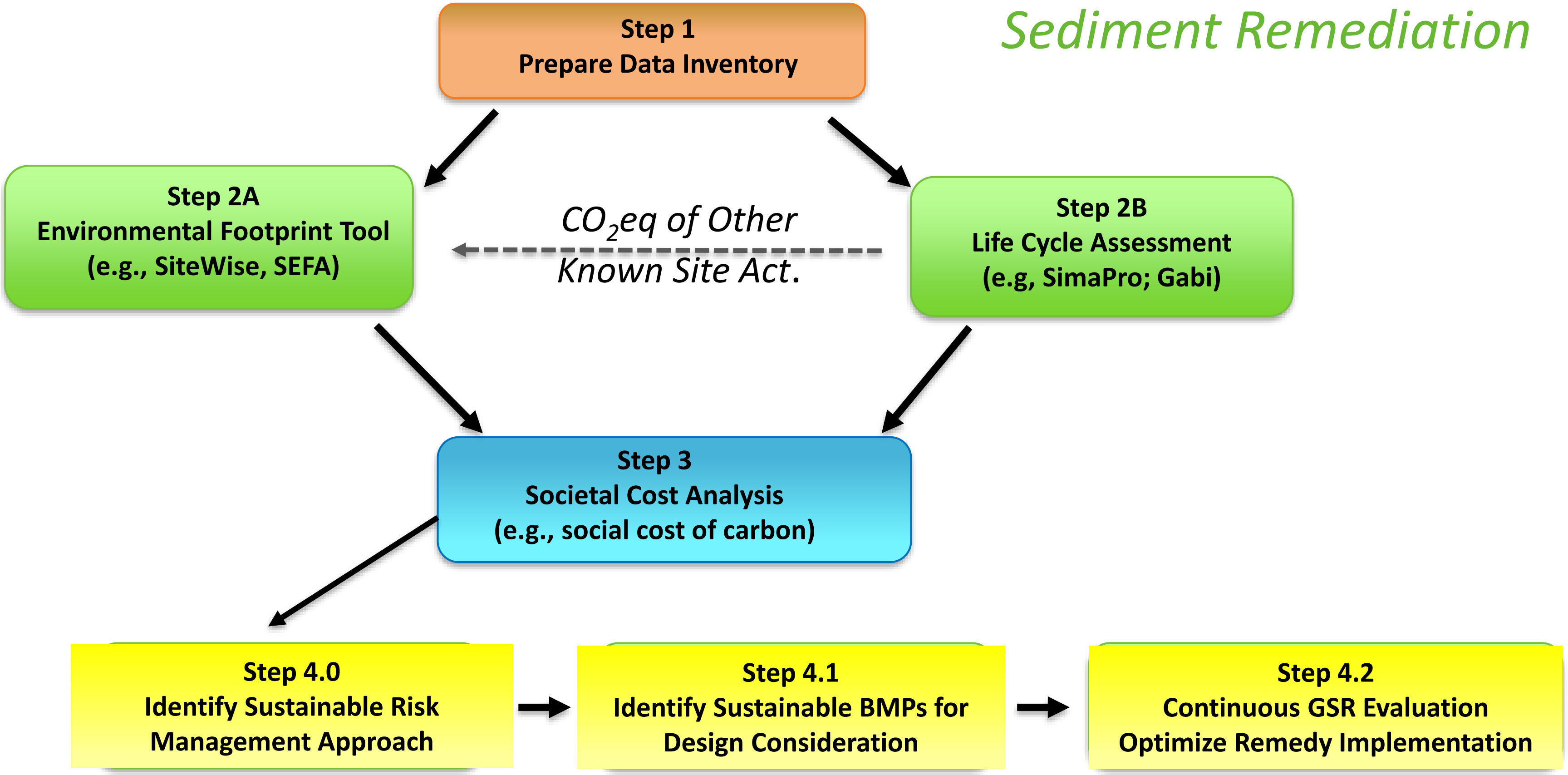
Battelle's Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies

Miami, Florida
May 22-25, 2017

Outline

- Two Options for Sediment Remediation Sustainability Assessments
  - Env. Footprint evaluation
  - Life cycle assessment (LCA)
- Incorporate societal cost analysis
- Case Study
- Sensitivity Analysis & Data Gaps
- Takeaways

Sustainability Assessment:
Sediment Remediation



Study Question

- *How do the outcomes compare?*

Step 2A
Footprint Evaluation Tool

Step 2B
Life Cycle Assessment

Case Study w/ Two AOCs

Site Background

- Location
  - Coastal inlet connected to the Atlantic Ocean
  - Two Areas of Concern (AOCs)
- Contaminants
  - PCBs: 50 to 3,600 mg/kg
  - PAHs and heavy metals also present
- Sources
  - Former transformers
  - Releases during site operations or building demolition

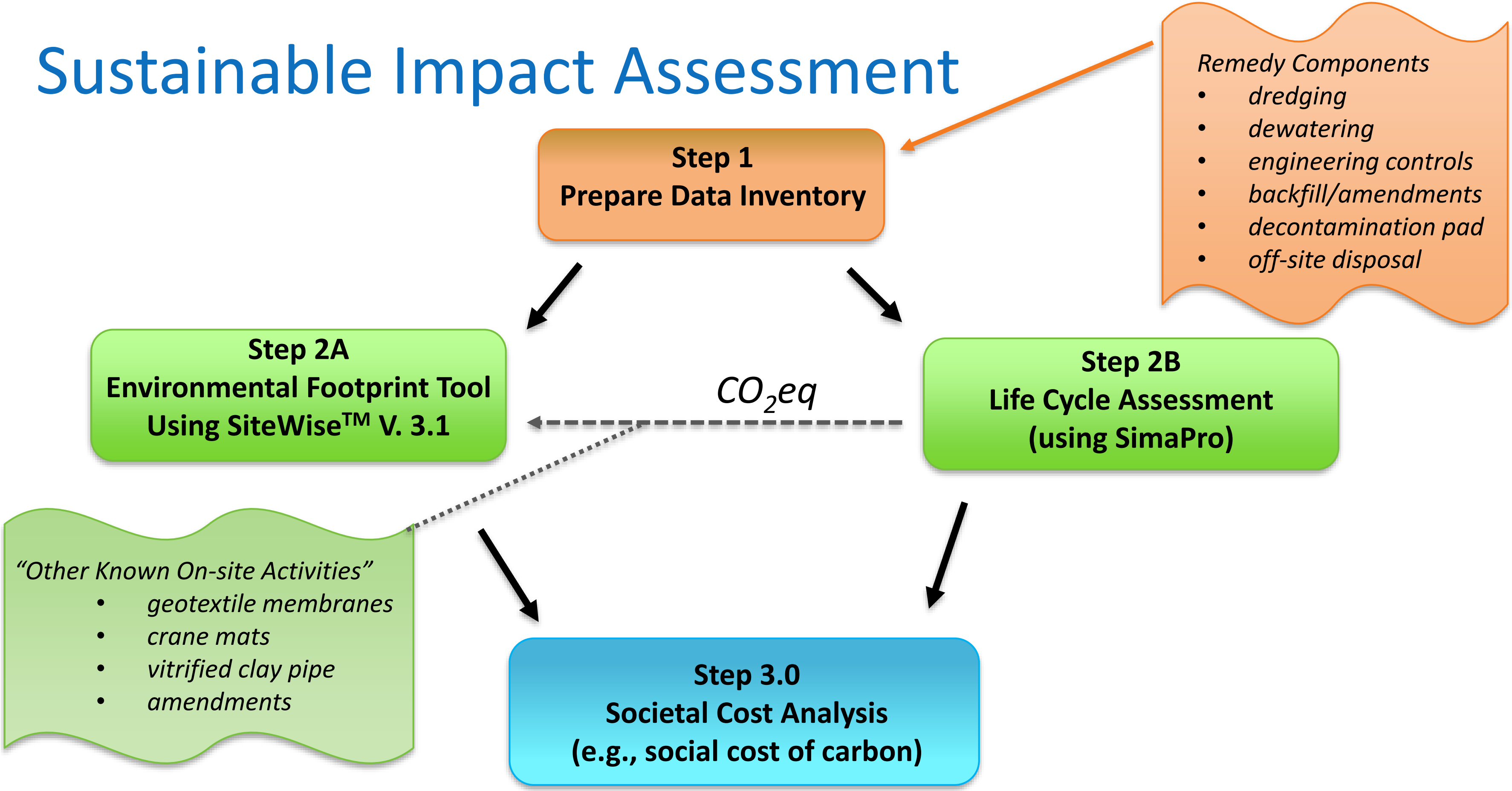
USGS WAUSP Website

Site Characteristics

- Socio-economic
  - Former industrial area
  - Up-and-coming neighborhood
- Ecological
  - Impacted species: invertebrates, sport fish, piscivorous birds, humans
  - Fish consumption advisory currently in place; recreational water sports are allowed

Remedial Component	Sustainability Assessment Input Parameters	AOC-1	AOC-2
Excavation	Excavator operation, steel sheeting, and transport of sediment	X	
Dredging	Excavator/crane operation, watercraft/barge operation, and transport of sediment	X	X
In Situ Treatment	Watercraft/barge operation, conveyor belt system for distribution, activated carbon		X
Dewatering	System materials, including activated carbon, polyvinyl chloride pipe, geotextile membrane, coagulant, and raw materials (i.e., gravel)	X	X
Waste Disposal	Transport of excavated sediment, water, and debris; and landfill operations	X	X
Restoration	Excavator and loader operation, and raw materials (i.e., soil, gravel and sand)	X	X
Engineering Controls	Silt/turbidity curtain materials (i.e., geotextile membrane, polyethylene pipe, polystyrene, and steel) plywood, filter log, and raw materials (i.e., asphalt and gravel)	X	X

Sustainable Impact Assessment



Sustainable Impact Assessment

Societal cost analysis:

- Normalization into one unit for ease of comparison

	Footprint Evaluation					LCA Evaluation				
Remedial Component	CO_2 Emissions	Total SO_x Emissions	Total PM_{10} Emissions	Monetized Global Impacts	Allocation of Impacts	CO_2 eq	SO_2 eq	PM_{10} eq	Monetized Global Impacts	Allocation of Impacts
Area of Concern 1										
Mobilization/ Engineering Controls	$ 1,654,174.82	$ 623,683.45	$ 122,896.34	$ 2,400,754.61	78.29%	$ 1,673,516.93	$ 624,632.14	$ 122,988.39	$ 2,421,137.47	68.69%
Dewatering	$ 429,380.22	$ 110,308.61	$ 15,122.46	$ 554,811.29	18.09%	$ 840,275.91	$ 193,325.37	$ 29,907.37	$ 1,063,508.65	30.17%
Dredging AOC 1	$ 1,902.73	$ 249.00	$ 37.18	$ 2,188.91	0.07%	$ 2,013.91	$ 614.91	$ 126.68	$ 2,755.50	0.08%
Excavation	$ 5,654.34	$ 1,441.77	$ 147.09	$ 7,243.19	0.24%	$ 2,755.16	$ 817.26	$ 190.65	$ 3,763.07	0.11%
Reconstruction and Stabilization	$ 17,665.66	$ 5,690.30	$ 1,110.97	$ 24,466.93	0.80%	$ 4,607.86	$ 1,841.15	$ 434.15	$ 6,883.16	0.20%
Waste Disposal	$ 57,881.44	$ 5,436.34	$ 13,758.19	$ 77,075.97	2.51%	$ 18,458.51	$ 6,953.30	$ 1,469.13	$ 26,880.94	0.76%
Area of Concern 2										
Mobilization/ Engineering Controls	$ 127,858.08	$ 48,026.34	$ 9,476.81	$ 185,361.23	15.66%	$ 129,605.12	$ 48,289.10	$ 9,489.42	$ 187,383.64	13.62%
Dewatering	$ 589,671.95	$ 145,505.86	$ 21,072.96	$ 756,250.77	63.90%	$ 699,085.98	$ 161,580.38	$ 25,024.33	$ 885,690.70	64.35%
Insitu	$ 160,440.82	$ 27.27	$ 1.47	$ 160,469.55	13.56%	$ 170,973.40	$ 37,886.84	$ 12,302.23	$ 221,162.47	16.07%
Dredging	$ 5,144.42	$ 673.23	$ 100.53	$ 5,918.18	0.50%	$ 5,445.01	$ 1,662.55	$ 342.51	$ 7,450.07	0.54%
Reconstruction	$ 9,805.90	$ 1,753.23	$ 282.79	$ 11,841.92	1.00%	$ 1,240.47	$ 543.15	$ 124.99	$ 1,908.61	0.14%
Waste Disposal	$ 47,711.41	$ 4,487.83	$ 11,357.71	$ 63,556.95	5.37%	$ 49,906.34	$ 18,799.67	$ 3,972.09	$ 72,678.09	5.28%

Comparison of AOC Primary Impact Contributors

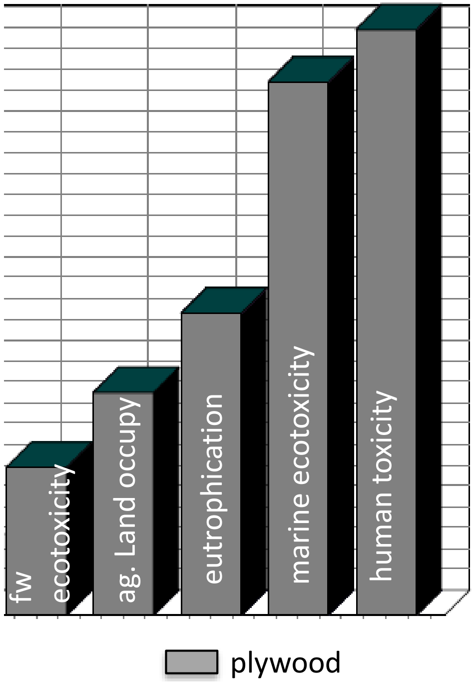
- AOC-1 Engineering Controls
  - Consumes more raw materials (e.g., gravel and plywood)
  - Requires less linear footage of the turbidity/silt curtain
- AOC-2 Dewatering
  - Consumes more coagulant*
  - Generates less wastewater
  - Requires a smaller dewatering pad (consisting of PVC pipe and geotextile membrane)

**coagulant also in situ treatment major impact component, not the watercraft/barge operation*

Sensitivity Analysis & Data Gaps

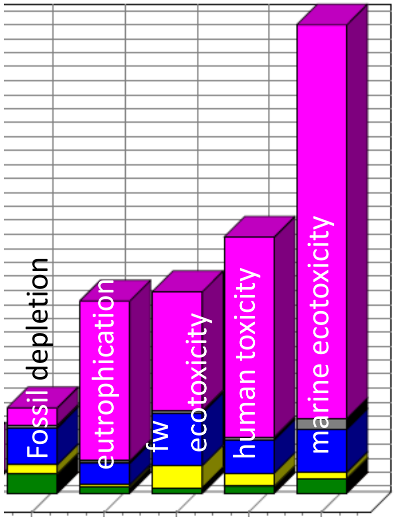
Engineering Controls
LCA Sensitivity Analysis: Plywood

AOC-1 and -2

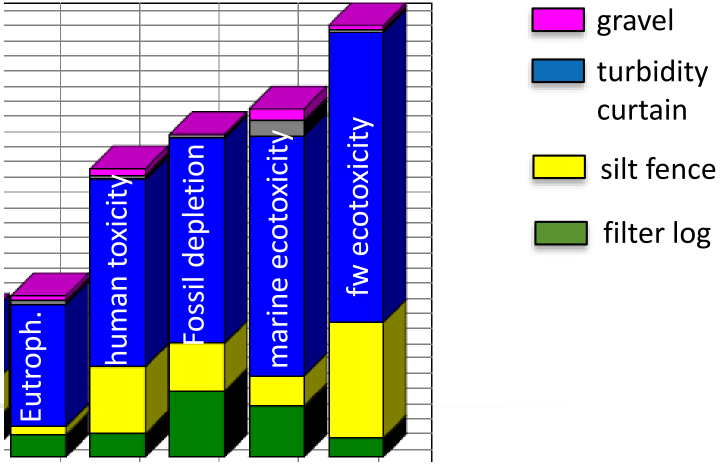


Removed plywood input

AOC-1

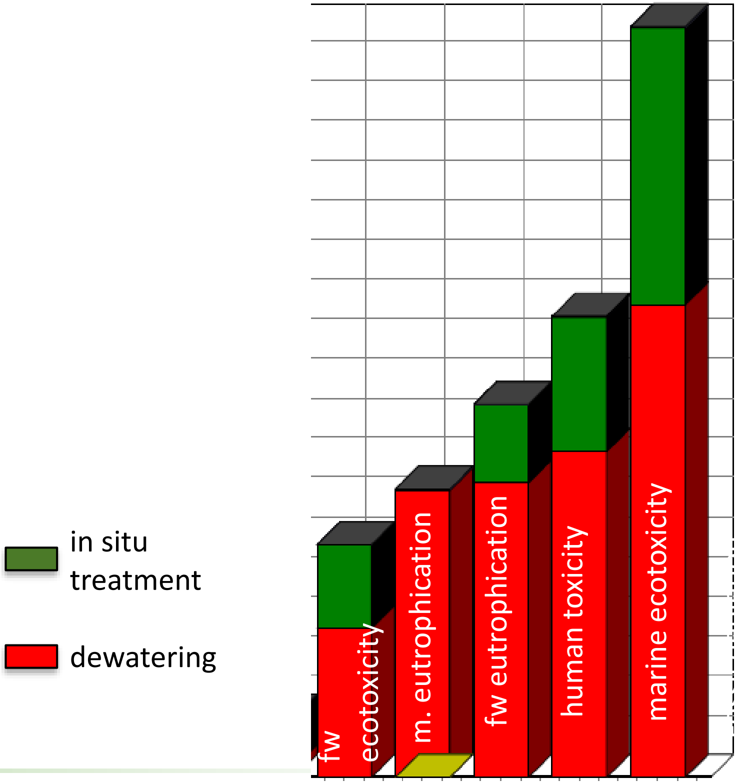


AOC-2



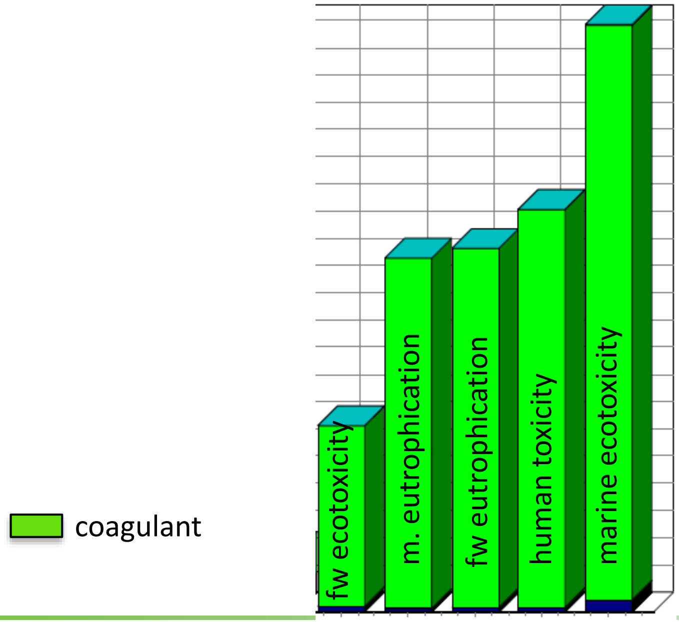
Remedial Components
LCA Sensitivity Analysis: Remove Plywood

- Engineering controls no longer a primary impact contributor

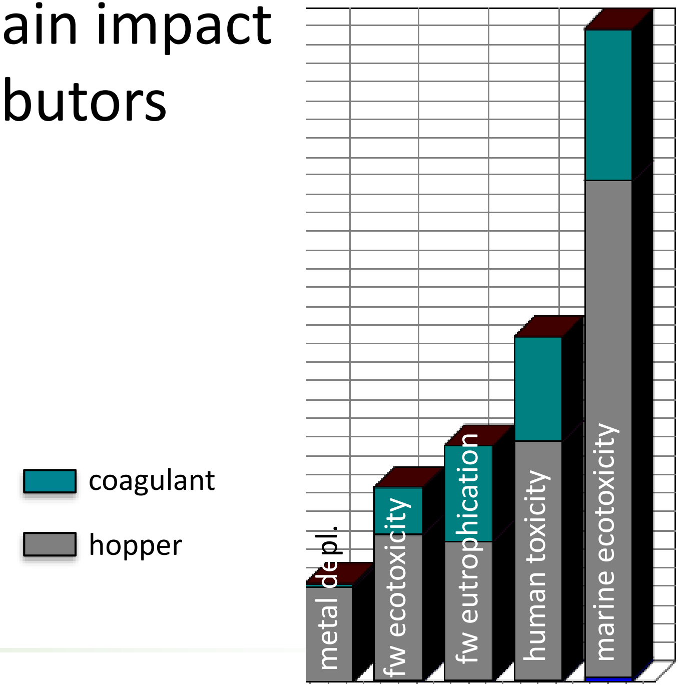


LCA Sensitivity Analysis

- Dewatering: coagulant is the main impact contributor

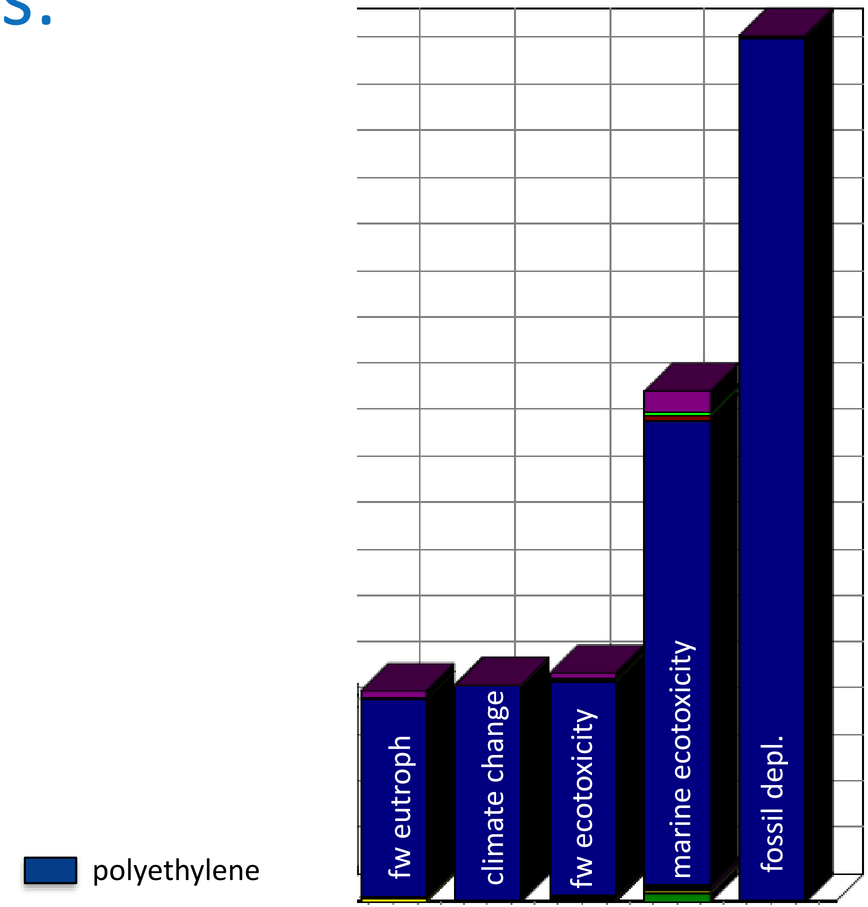


- In Situ Treatment: coagulant and hopper are the main impact contributors



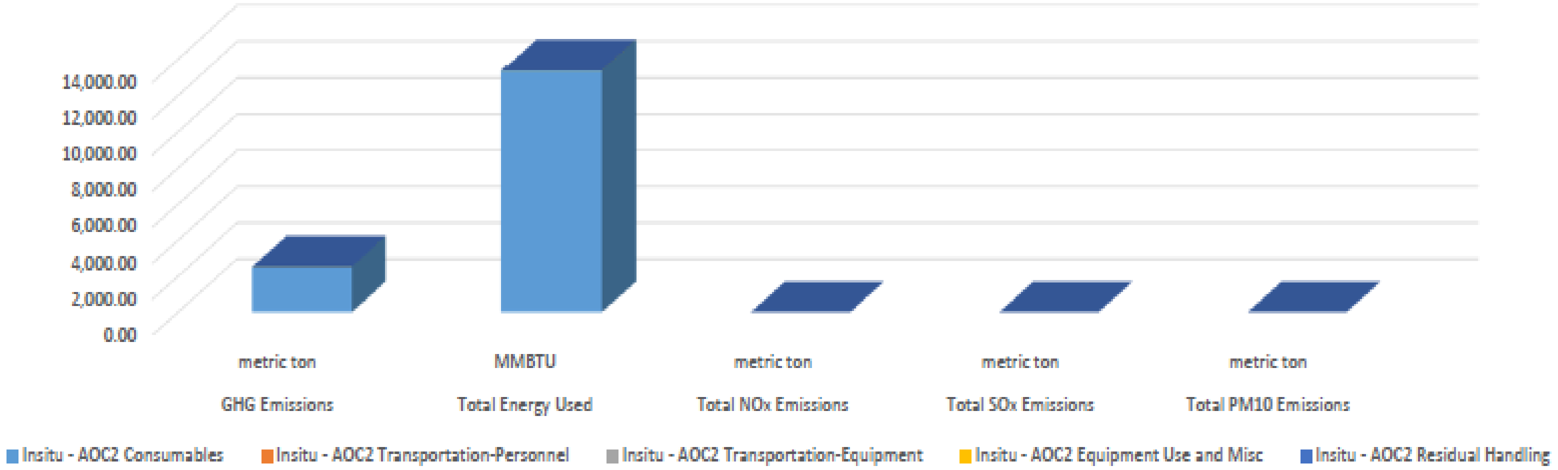
LCA Sensitivity Analysis: Dewater Component

- Removed the plywood, amendments, and hopper inputs
  - Dewatering is the main impact contributor
  - Polyethylene is the main parameter driving unsustainable impacts



Sensitivity Analysis: Dewater/In Situ Components Environmental Footprint

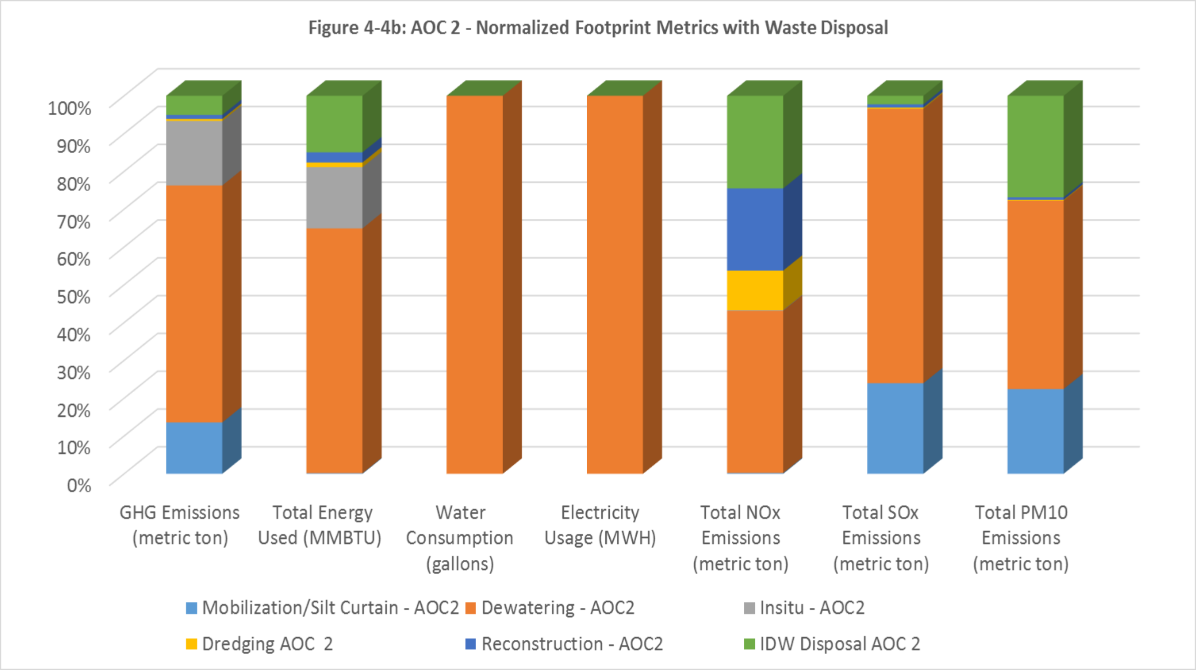
- Footprint evaluation identified amendments and polyethylene as main contributors to environmental impacts, not hopper use *(identified in LCA)*



Data Gap: Environmental Footprint

- Footprint evaluation also identified restoration and waste disposal as significant NO_x emission contributors

- LCA does not quantify NO_x emissions, therefore underestimated footprint



Normalization of Units

Societal Cost Analysis

- Confidence in labeling waste disposal as secondary impact contributor and not restoration

Shows difference in considering NO_x emissions

Remedial Component	Environmental Footpritnt Analysis	LCA Evaluation
Social Cost	***Allocation of Impacts***	
Area of Concern 1		
Mobilization/ Engineering Controls	65.27%	68.69%
Dewatering	28.04%	30.17%
Dredging	0.14%	0.08%
Excavation	0.43%	0.11%
Resoration	1.40%	0.20%
Waste Disposal	4.72%	0.76%
Area of Concern 2		
Mobilization/ Engineering Controls	10.38%	13.62%
Dewatering	63.58%	64.35%
Insitu	15.77%	16.07%
Dredging	0.75%	0.54%
Restoration	1.54%	0.14%
Waste Disposal	7.98%	5.28%

Takeaways

Remedial Approach Selection

Step 4.0
Identify Sustainable Risk Management Approach

- Site-specific parameters influence identification of primary impact contributors
  - AOC-1 engineering controls vs. AOC-2 dewatering
- Footprint evaluation and LCA method were comparatively similar
  - Lower cost solution = environmental footprint tool

Optimization for Sustainability

Step 4.1
Identify Sustainable BMPs for Design Consideration

- Consumables drive sustainability impacts
  - Plywood, amendments, polyethylene = future research need

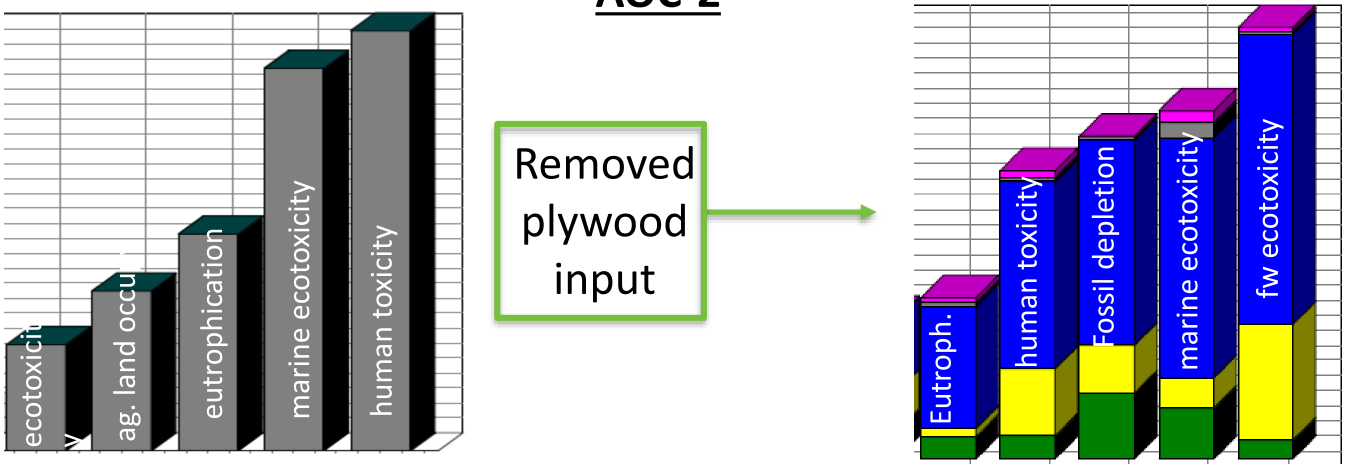
- Footprint analysis vs. LCA method not comparable in identifying secondary impact contributors
  - Normalization (monetary damages) of metrics aided decision-making process

Societal Cost Analysis for LCA

Step 4.1
Identify Sustainable BMPs for Design Consideration

- Normalizes impact categories to avoid direct comparison of one impact category to another
  - E.g., reducing human toxicity vs. freshwater ecotoxicity

AOC-2



Societal Cost Analysis: Added Value

- Ability to integrate socio-economic costs and benefits not represented by an environmental impact evaluation tool
  - Ecosystem services
  - Wetland banking
  - Property value
  - Aesthetics value

Thank You & Questions

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