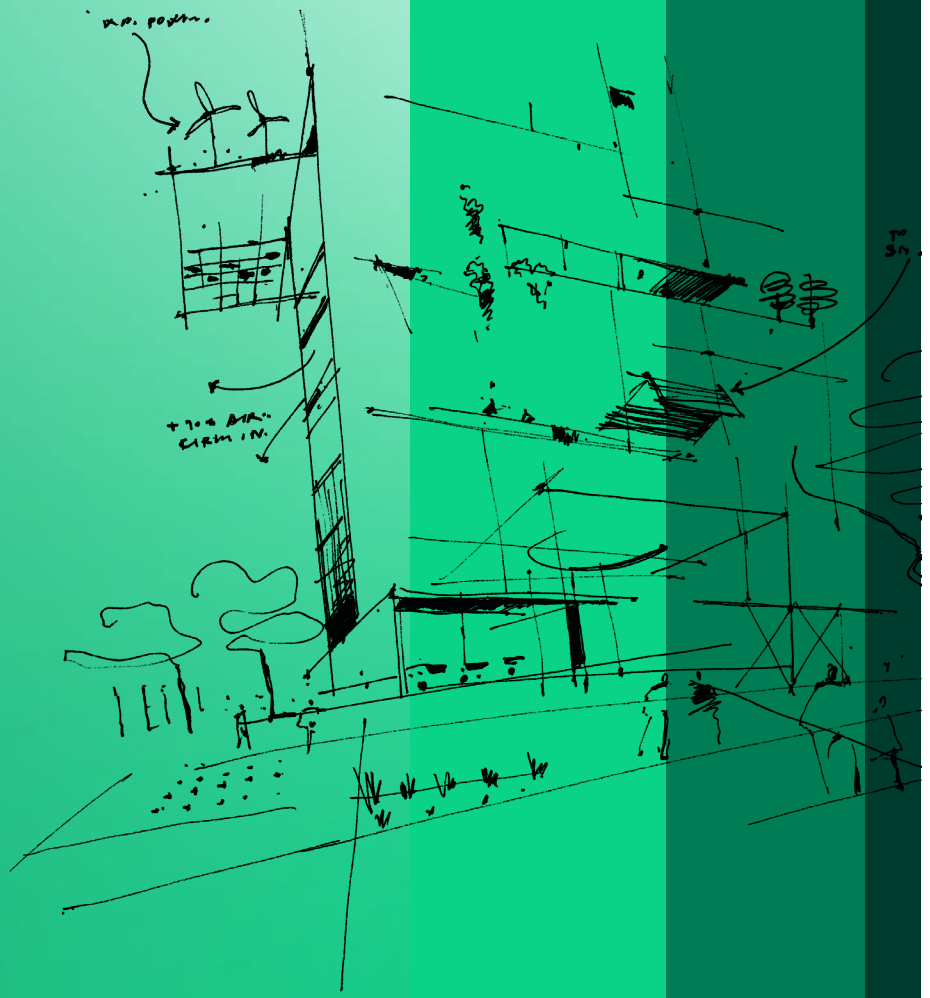
Jacobs Challenging today. Reinventing tomorrow.

Tracking Sustainable Remediation

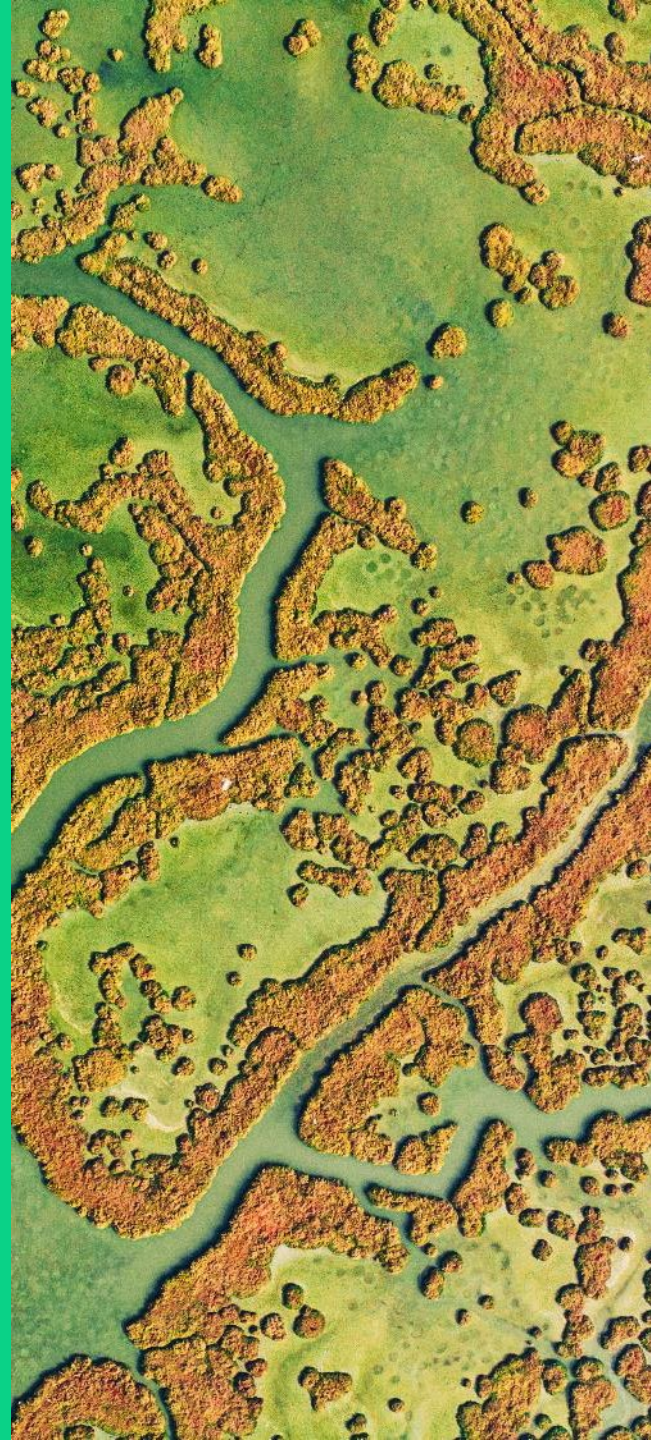
Betsy Collins, P.E., ENV SP, LEED Green Associate



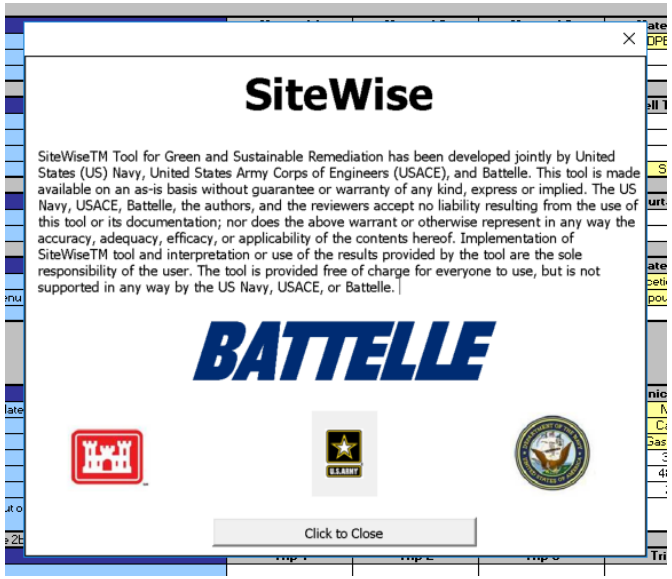
Agenda

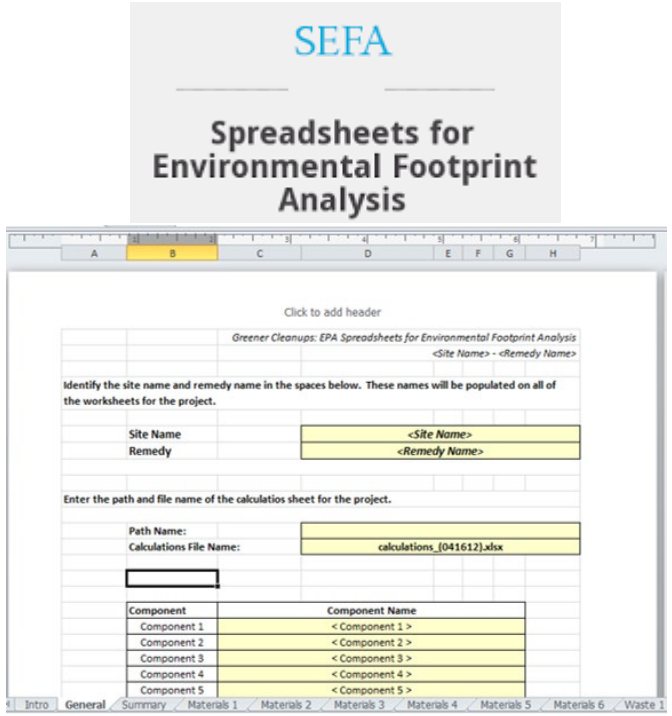
- Footprint Analysis Tools Background
- Best Uses of SiteWise and SEFA
- Case Studies
- Key Takeaways

A Brief History



Public domain footprint analysis tools





SiteWise

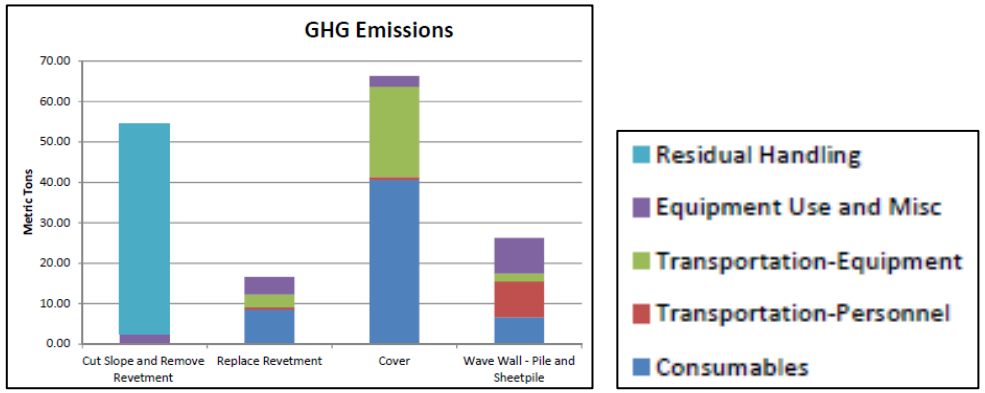
Inputs

Component	Component Alias
Component 1	Remedial Investigation
Component 2	Remedial Action Construction
Component 3	Long-Term Monitoring
Component 4	Component 4

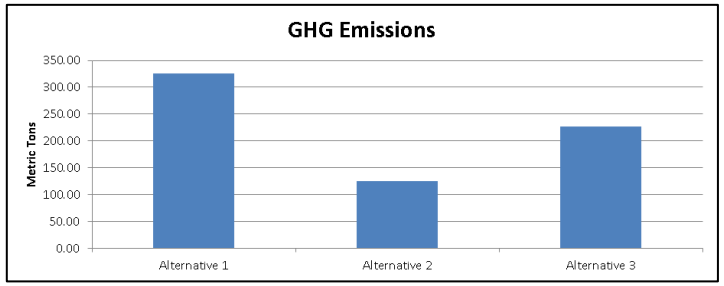
BULK MATERIAL QUANTITIES	Material 1	Material 2
Choose material from drop down menu	Bentonite	Virgin GAC
Choose units of material quantity from drop down menu	pounds	pounds
Input material quantity	165,000	300

PERSONNEL TRANSPORTATION - ROAD	Install	O&M
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No
Choose vehicle type from drop down menu*	Light truck	Light truck
Choose fuel used from drop down menu	Gasoline	Gasoline
Input distance traveled per trip (miles)	30	150
Input number of trips taken	20	12
Input number of travelers	1	1
Input estimated vehicular fuel economy (mi/gal) (Input only if known for the vehicle selected, otherwise a default will be used by the tool)		
DRILLING	**Event 1**	**Event 2**
Input number of drilling locations	5	25
Choose drilling method from drop down menu	Sonic Drilling	Direct Push
Input time spent drilling at each location (hr)	5.00	5.00
Choose fuel type from drop down menu	Diesel	Diesel
OPERATOR LABOR	**Install**	**O&M**
Choose occupation from drop-down menu	Construction laborers	Construction laborers
Input total time worked onsite (hours)	200.0	48.0
RESIDUE DISPOSAL/RECYCLING	**Soil Residue**	**Residual Water**
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No
Input weight of the waste transported to landfill or recycling per trip (tons)	20.0	16.0
Choose fuel used from drop down menu	Diesel	Gasoline
Input total number of trips	4.0	2.0
Input number of miles per trip	100.0	300.0

Outputs



Remedial Alternatives	GHG Emissions	Energy Usage	Water Usage	Electricity Usage
Alternative 1	High	High	Low	High
Alternative 2	Medium	Medium	Low	Low
Alternative 3	Medium	Medium	High	Low



SEFA

Inputs

Component	Remedy Component Names*
Component 1	Site Investigation
Component 2	Remedial Investigaiton
Component 3	Remedial Action
Component 4	< Component 4 >
Component 5	< Component 5 >
Component 6	< Component 6 >

Personnel Transportation

Participant	Number of Roundtrips to Site	Roundtrip Distance to Site (miles)	Mode of Transportation*	Transport Fuel Type*	Total Distance Transported (miles)	Default Fuel Usage Rate**	Fuel Usage Rate Override**	Fuel Used for Personnel Transport**
John Doe	10	20	Car	Gasoline	200	25		8
Samantha Doe	1	40	Light-Duty/Passenger Truck	Gasoline	40	18.9	25	1.6
Airplane Travel	1	13028	Airplane	Diesel	13028	45		289.5

Materials Use and Transportation

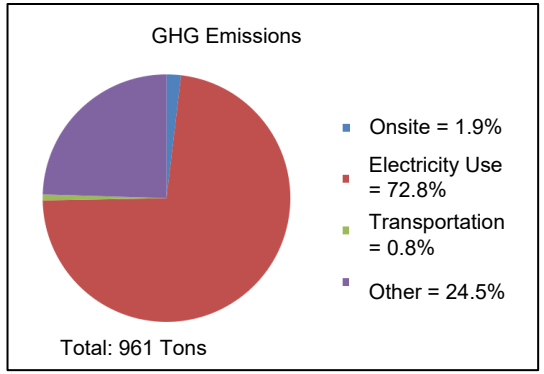
Material Type*	Unit	Quantity	Tons	Is the Material Refined or Unrefined?**	Material Source: Virgin, Recycled, or Reused?**	Calculate Item Footprint?**
Ethanol, Corn, 95%	lb	10000	5	Refined	Virgin	Yes
Ethanol, Corn, 95%	lb	10000	5	Refined	Virgin	No

Materials Use and Transportation

Material Type*	Default One-way Distance to Site (miles)	One-way Distance to Site Override (miles)	Number of One-way Trips to Site	Include Return Trip in Calculations?	Total Distance Transported (miles)
Ethanol, Corn, 95%	500	200			200
Ethanol, Corn, 95%	500	200			200

Outputs

Core Element		Metric	Unit of Measure	Metric Value
Materials & Waste	M&W-1	Refined materials used on site	tons	
	M&W-2	Percent of refined materials from recycled or waste material	percent	
	M&W-3	Unrefined materials used on site	tons	
	M&W-4	Percent of unrefined materials from recycled or waste material	percent	
	M&W-5	Onsite hazardous waste generated	tons	
	M&W-6	Onsite non-hazardous waste generated	tons	
	M&W-7	Percent of total potential onsite waste that is recycled or reused	percent	
Water		Onsite water use (by source)		
	W-1	- Source, use, fate combination #1	millions of gals	
	W-2	- Source, use, fate combination #2	millions of gals	
	W-3	- Source, use, fate combination #3	millions of gals	
	W-4	- Source, use, fate combination #4	millions of gals	
Energy	E-1	Total energy use	MMBtu	
	E-2	Total energy voluntarily derived from renewable resources		
	E-2A	- Onsite generation or use and biodiesel use	MMBtu	
	E-2B	- Voluntary purchase of renewable electricity	MWh	
	E-2C	- Voluntary purchase of RECs	MWh	
Air	A-1	Onsite NOx, SOx, and PM10 emissions	lbs	
	A-2	Onsite HAP emissions	lbs	
	A-3	Total NOx, SOx, and PM10 emissions	lbs	
	A-4	Total HAP emissions	lbs	
	A-5	Total GHG emissions	tons CO_2e	
Land & Ecosystems	Qualitative description			



Flexibility Allows for User -Defined Emissions Factors

- Increase footprint accuracy
  - For products with a known emissions factor
  - Updated/preferred values
- May be particularly important outside of the USA

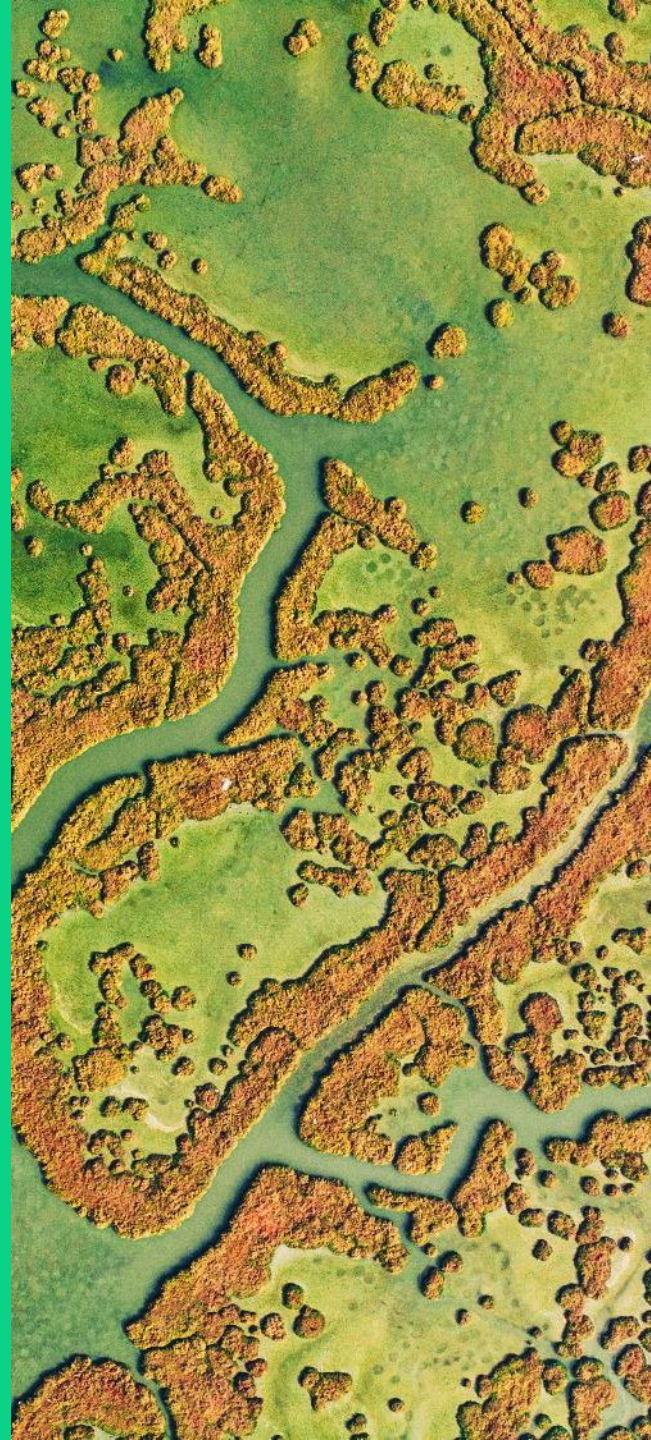
Table 1c: Impact per kg of material

Material	kg CO2 e / kg
Vegetable Oil	8.65E-01

Table 4a: Electricity use impact by State*

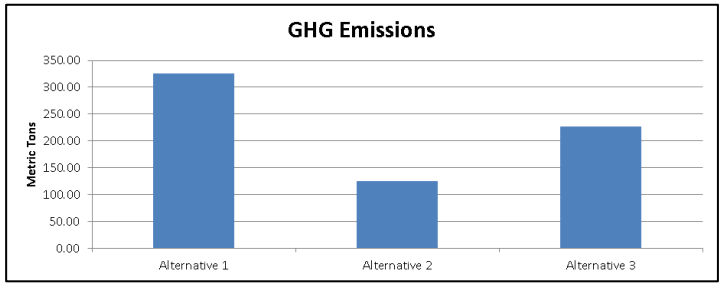
Profile Name	(lbs CO_2 / MWh)
Alaska	1302.08
Alabama	1154.31
Arkansas	1230.58
Arizona	1236.53
California	679.37
Colorado	1955.27
Connecticut	659.84

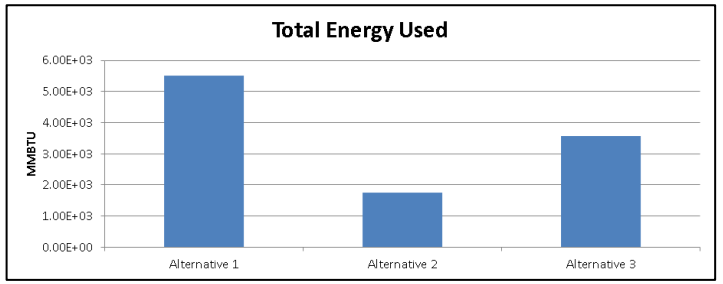
Best Uses ofSiteWise and SEFA

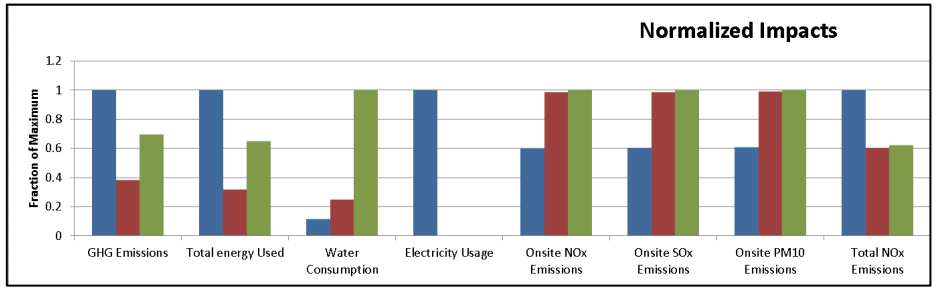


Compare Alternatives

10-15 hours per alternative







Remedial Alternatives	GHG Emissions	Energy Usage	Water Usage	Electricity Usage	Onsite NOx Emissions	Onsite SOx Emissions	Onsite PM10 Emissions	Total NOx emissions	Total SOx Emissions	Total PM10 Emissions	*Accident Risk Fatality	*Accident Risk Injury	Community Impacts	Resources Lost
Alternative 1	High	High	Low	High	Medium	Medium	Medium	High	Medium	High	High	High	user select	user select
Alternative 2	Medium	Medium	Low	Low	High	High	High	Medium	Medium	High	High	High	user select	user select
Alternative 3	Medium	Medium	High	Low	High	High	High	Medium	High	High	High	High	user select	user select

GHG emissions

Air pollutant emissions (NO_x, SO_x, PM_{10})
Resource use (water and energy)
Accident Risk

CERCLA Criteria	No Action (1)	AS/SVE, MNA, LUCs, and VIMS (2)	ISCO, MNA, LUCs, and VIMS (3)	ERD, MNA, LUCs, and VIMS (4)
Threshold Criteria				
Protection of Human Health and the Environment	❍	●	●	●
Compliance with ARARs	❍	●	●	●
Primary Balancing Criteria				
Long-term Effectiveness and Permanence	❍	●	●	●
Reduction in Toxicity, Mobility, or Volume	❍	◐	●	●
Short-term Effectiveness	❍	●	●	●
Implementability	●	❍	◐	◐
Present-Worth Cost	$0	$2.91 M	$2.18 M	$2.63 M

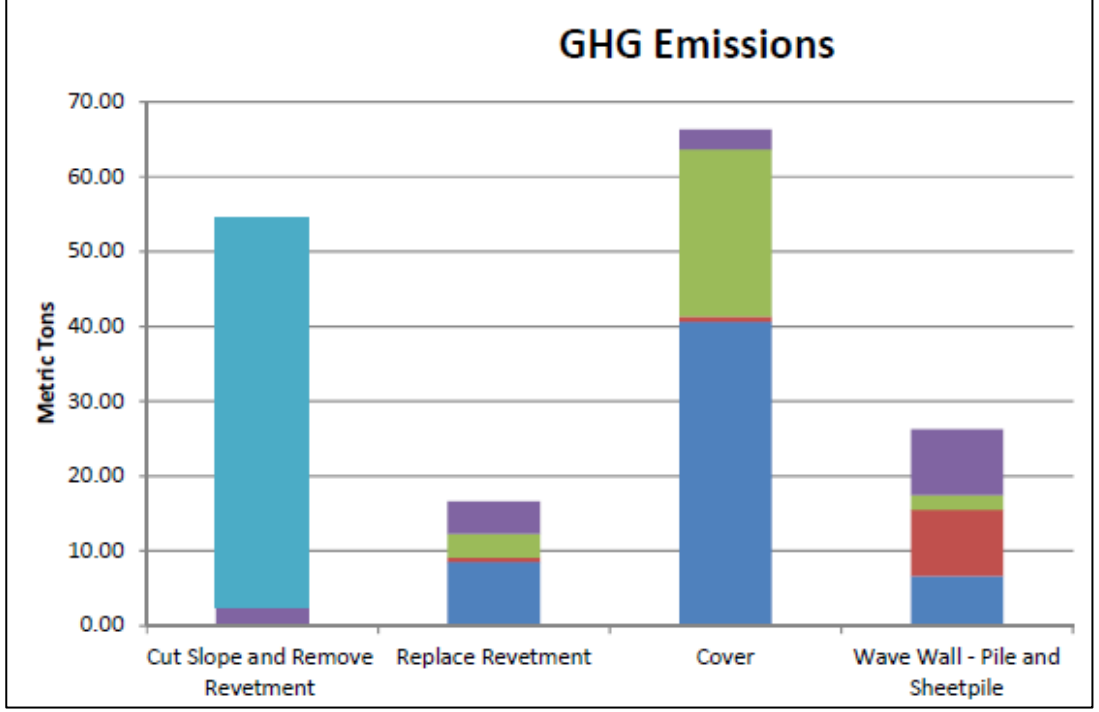
Relative Ranking: ● High ◐ Moderate ❍ Low

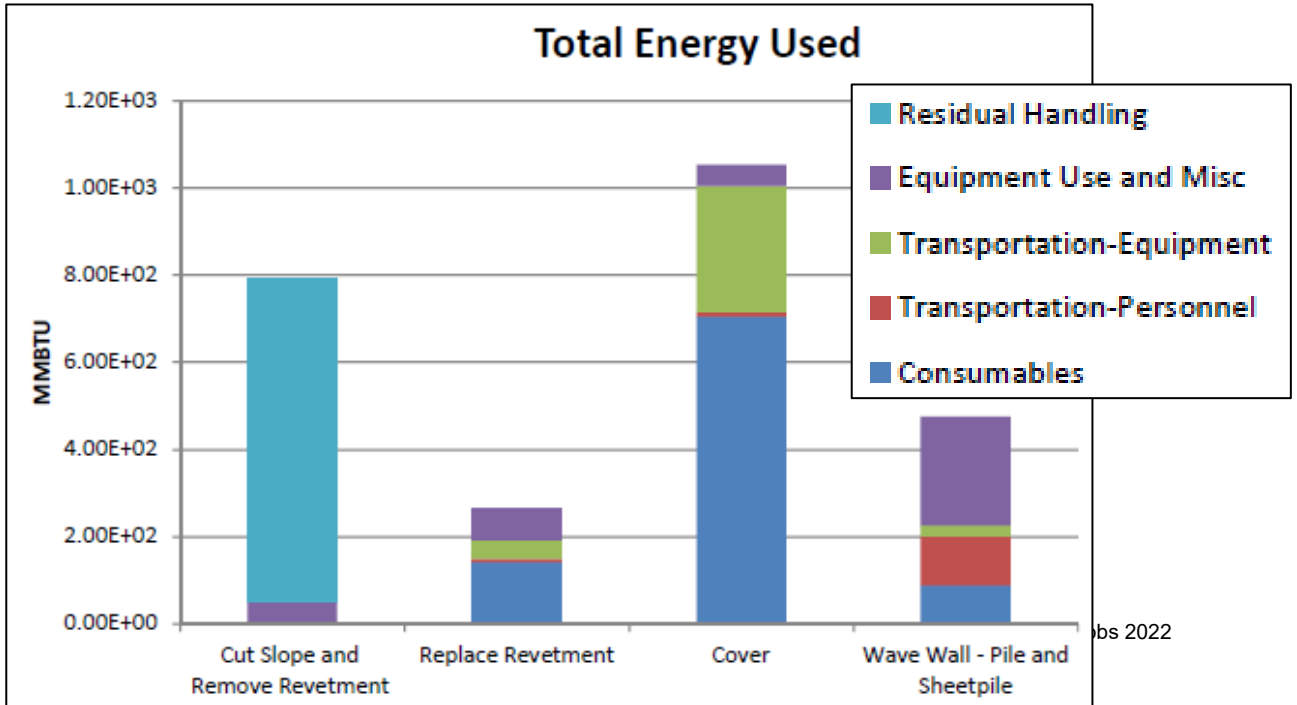
Rankings are provided as qualitative descriptions of the relative compliance of each alternative with the criteria

Evaluate Individual Alternatives

- Consumables
  - Identify onsite soil that can be used as backfill
  - Evaluate alternate materials with lower footprints
- Residual handling
  - Additional delineation to reduce removal volume
  - Identify closer disposal facility
- Transportation of equipment
  - Evaluate transportation via rail

8-10 hours per alternative





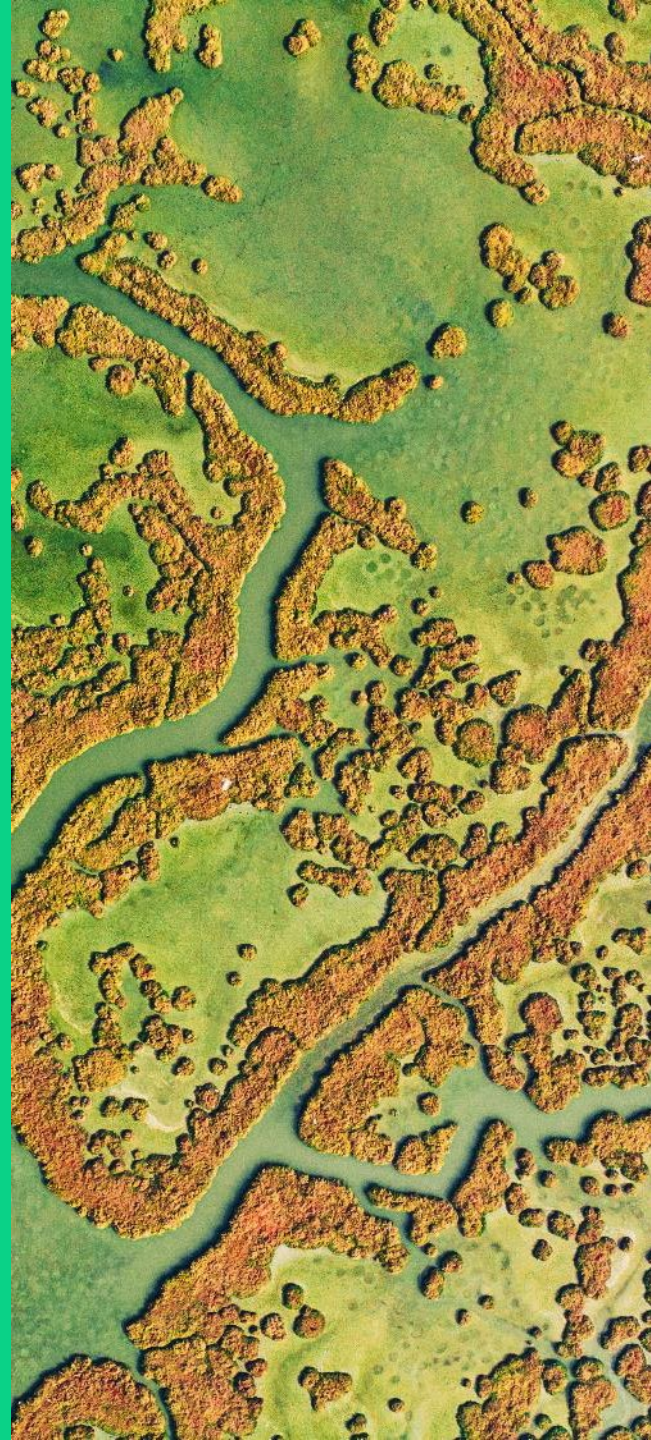
Calculate Savings

<1 hour per BMP

- Best Management Practice Implemented:
  - Select local waste disposal facilities to minimize transportation impacts.
- Action:
  - Disposed of aqueous waste in an on-site groundwater treatment plant versus at an off-site facility.
- Associated Impacts:
  - Avoided 26,000 road miles per year
  - Reduced road congestion and traffic through neighborhoods

Estimated Annual Reductions	
From SiteWise™	GHGEmissions (metric tons)
	47
	Energy Used (MMBTU)
	600
Actuals	Cost
	$100,000

Case Study 1



Site Background

- Debris disposal area
  - Investigated since 1998
- Potential risk identified due to:
  - Metals in soil
  - Surface and subsurface debris

Remedy Evaluation

- *Alternative 1: No Action (not analyzed)*
- Alternative 2: Removal and Offsite Disposal
- Alternative 3: Low Permeability Soil Cover

	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Alternative 2 - Removal and Offsite Disposal	Low	Low	High	Low	Low	Medium	Medium	Medium
Alternative 3 - Low Permeability Soil Cover	High	High	High	High	High	High	High	High

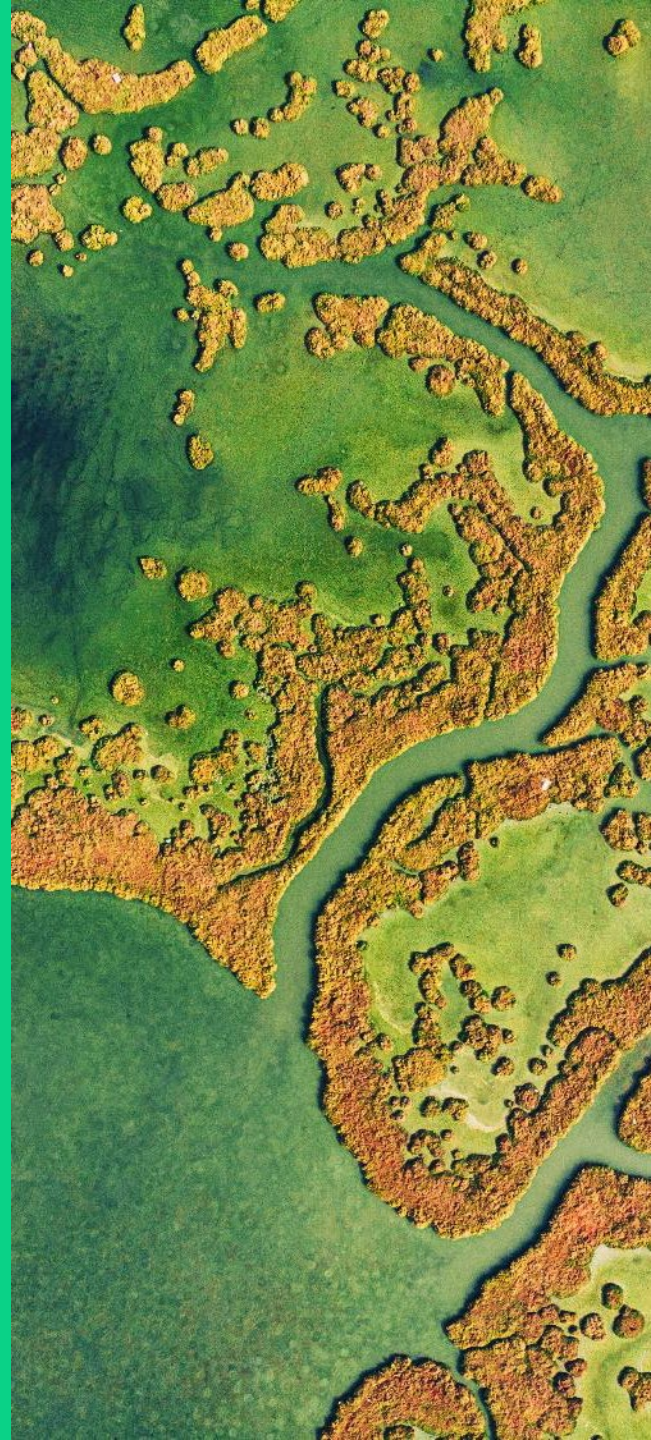
Remedy Evaluation

- *Alternative 1: No Action (not analyzed)*
- Alternative 2: Removal and Offsite Disposal
- Alternative 3: Low Permeability Soil Cover

Removal Action Alternative Comparison

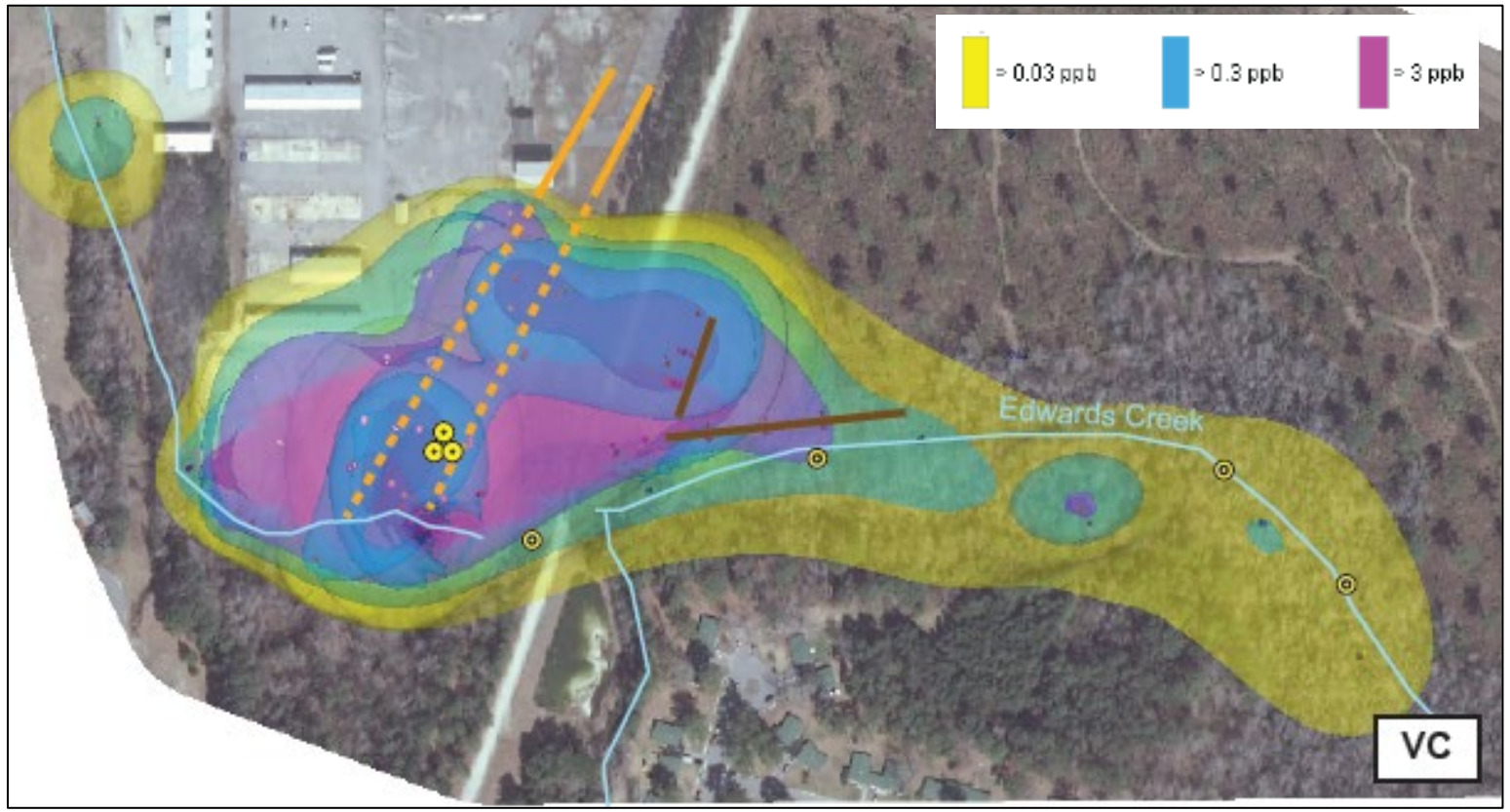
Alternative	Effectiveness	Implementation	Cost	Environmental Footprint
Alternative 1 – No Action	Least Effective	Easiest	Least Expensive	None
Alternative 2 – Removal and Offsite Disposal	Most Effective	Moderately Easy	Moderately Expensive	Smallest Footprint (Active Alternatives)
Alternative 3 – Low-Permeability Soil Cover	Effective	Moderately Easy	Moderately Expensive and Most Expensive of the Three Alternatives	Largest Footprint of the Three Alternatives

Case Study 2

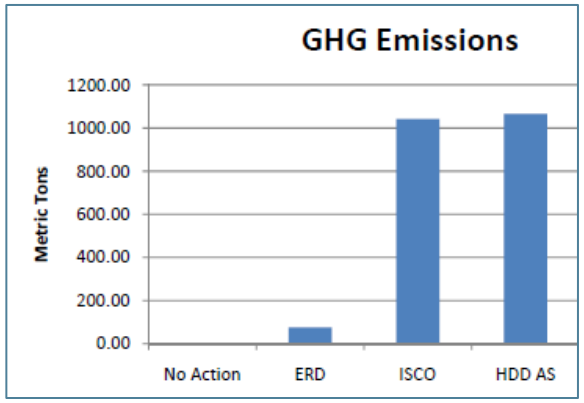


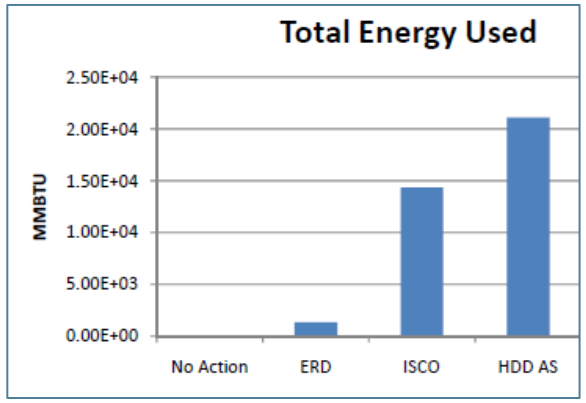
Site Background

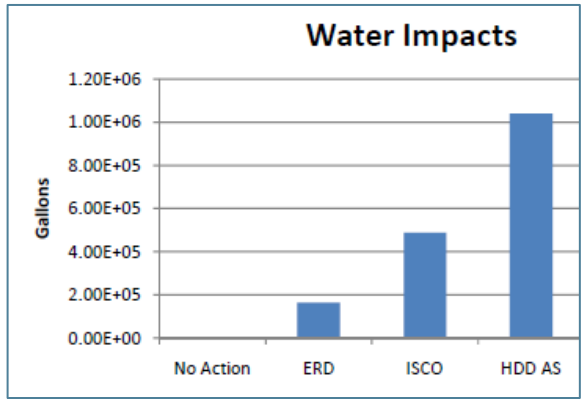
- Former motor pool
  - Investigated since 1996
- 1,1,2,2-TeCA, TCE, and daughter products in groundwater
  - Concentrations indicative of DNAPL
  - Constituting principal threat waste

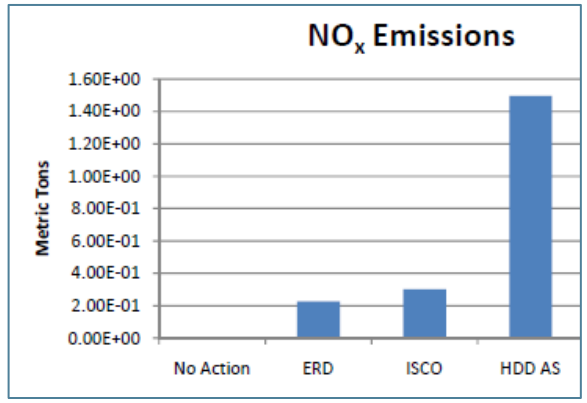


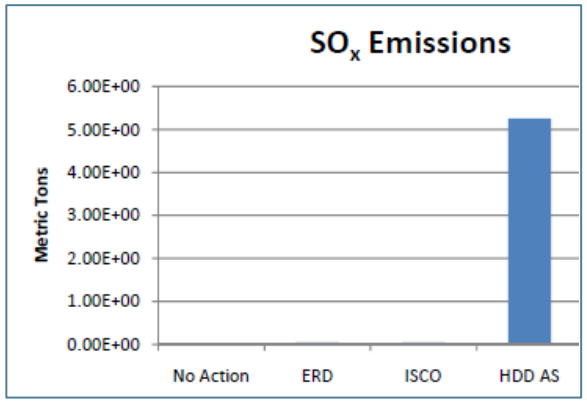
Remedial Evaluation

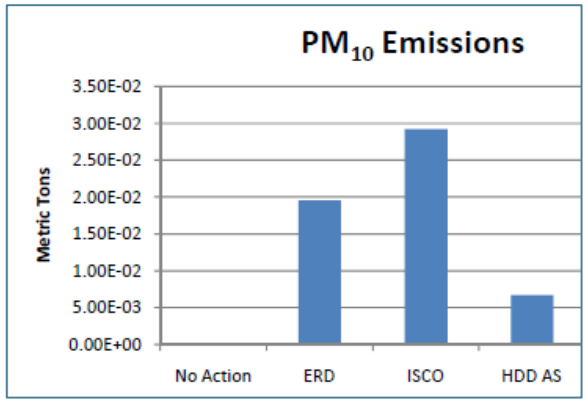


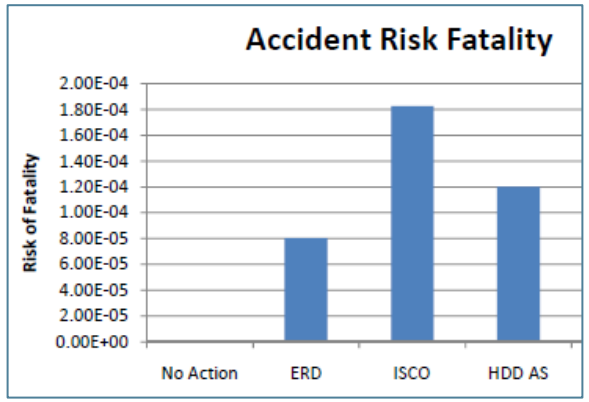


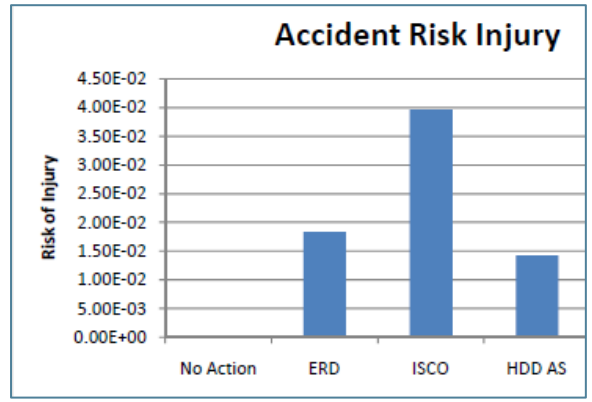








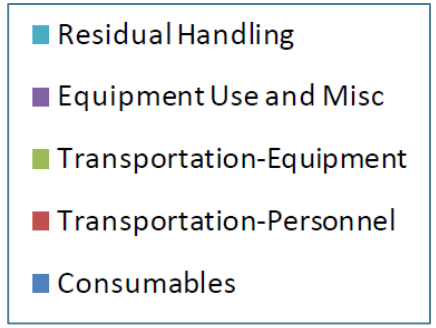


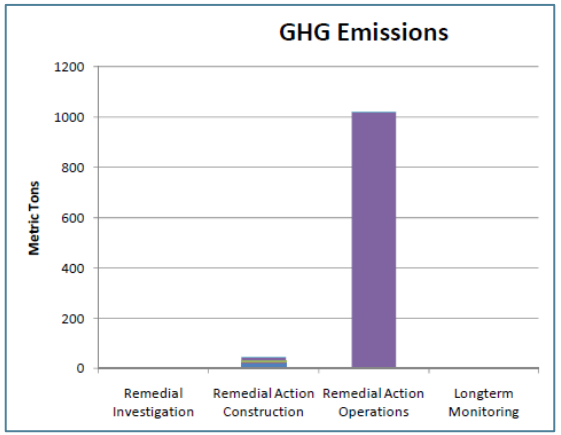


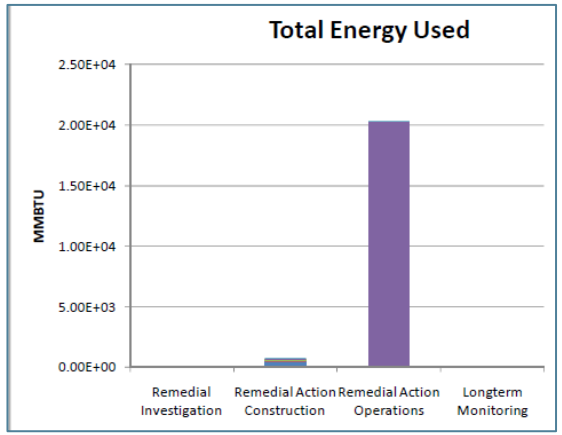
Remedial Evaluation

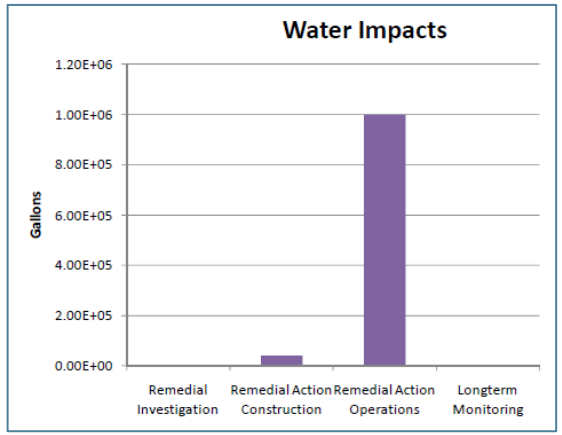
Alternative	Effectiveness	Implementation	Cost	Environmental Footprint
Alternative 1 - No action	*Least*	*Easy*	*None*	*None*
Alternative 2 – ERD	Effective	Moderate-Hard	Low-Moderate	Low-Moderate
Alternative 3 – ISCO	Effective	Moderate-Hard	Most expensive	Moderate
Alternative 4 – HDD AS	Effective	Moderate	Least expensive	Highest

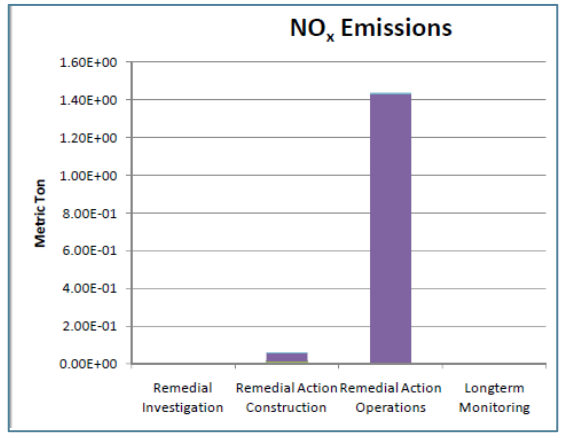
Remedial Design and Implementation

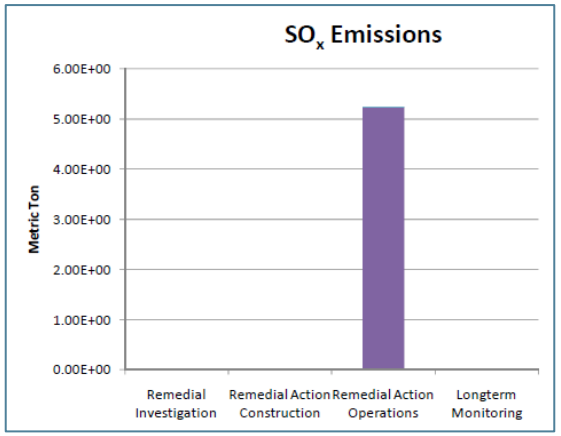


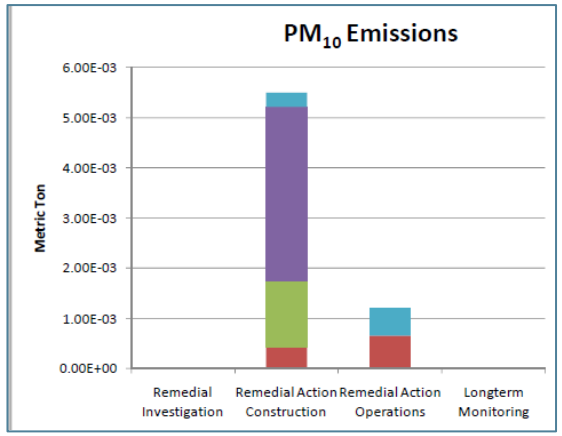


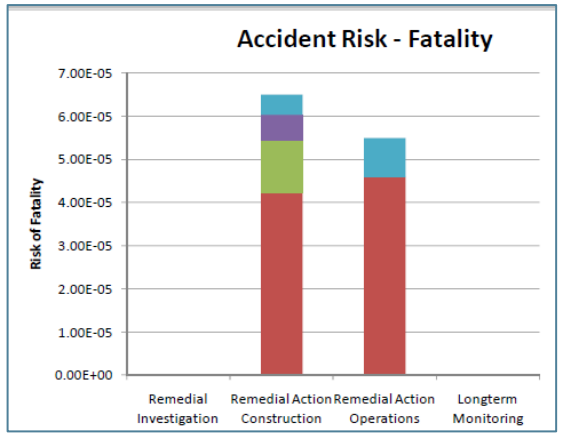


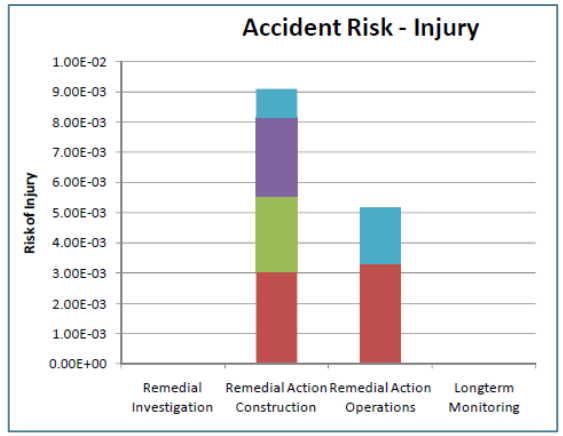












Remedial Design and Implementation

- AS milestones for system shut-down
  - COC reduction to below 100 µg/L within 50 feet of AS wells
  - COC reduction demonstrates asymptotic trends

From SiteWise™ Actuals

Estimated Annual Reductions
GHGEmissions (metric tons)
1,400
Cost
$100,000

Remedial Design and Implementation

- AS milestones for system shut-down
  - COC reduction to below 100 µg/L within 50 feet of AS wells
  - COC reduction demonstrates asymptotic trends

From SiteWise™

Estimated Annual Reductions
GHGEmissions (metric tons)
1,400
Cost
$100,000

Actuals

This is equivalent to CO_2 emissions from:

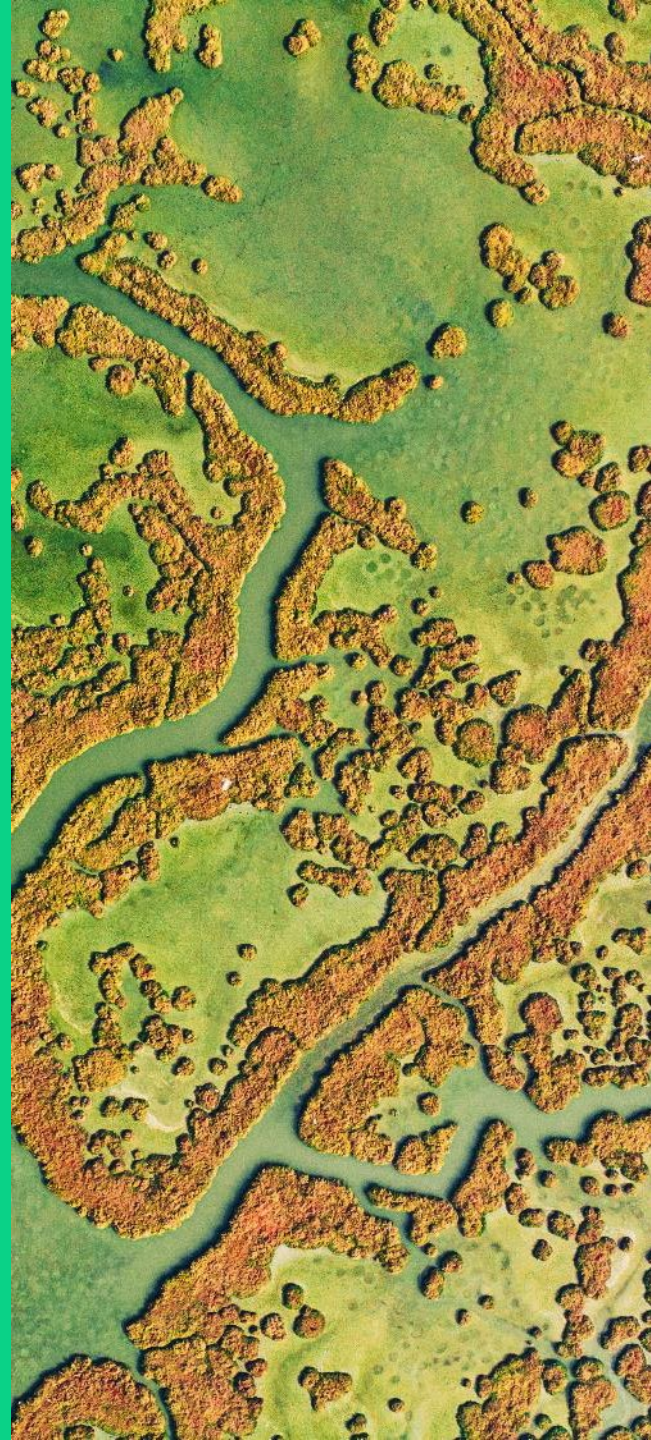
157,533 gallons of gasoline consumed

This is equivalent to carbon sequestered by:

23,149 tree seedlings grown for 10 years

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Key TakeAways



What tool should you use?

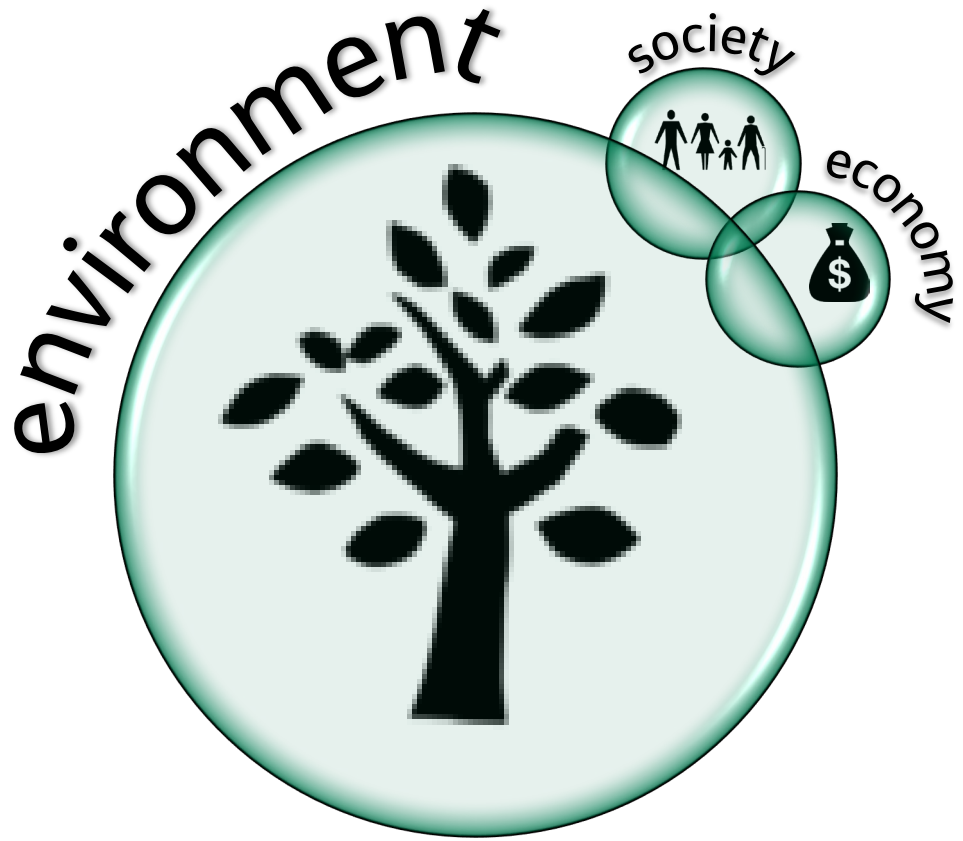
	SiteWise	SEFA
Focus	Compare multiple alternatives	Evaluate one remedial alternative's footprint
Developer	Battelle, Naval Facilities Engineering Command, US Army Corps of Engineers	EPA
Structure	Organized by remedy components	Organized by core elements consistent with EPA's Methodology
Parameters Calculated	CO2e- Energy - NOx - SOx- PM - Injury risk - Fatality risk - Lost hours	- CO2e- Energy - NOx - SOx- PM - Air toxics
Outputs	Tables and Charts	
Cost	Free!	
Software	Excel	

Considerations and Challenges

- These tools were designed to calculate the **environmental footprint** of remedial alternatives
  - What if you want to include societal impacts?
  - Or economic impacts?

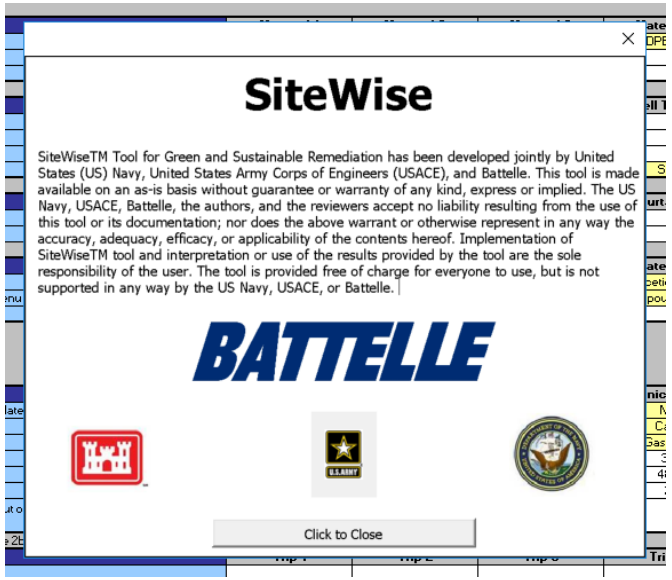
- Project Size Matters
  - Too small may be a waste of resources
  - Too complex may be beyond the scope of a footprint analysis tool

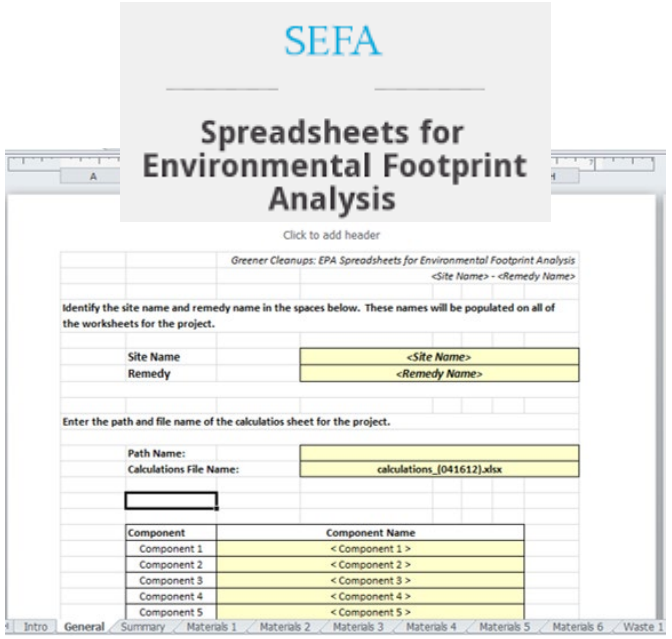
- Easy to learn/easy to use
  - Novice practitioner can make mistakes
  - Advanced practitioner can harness full power of tool



Key Take-Aways

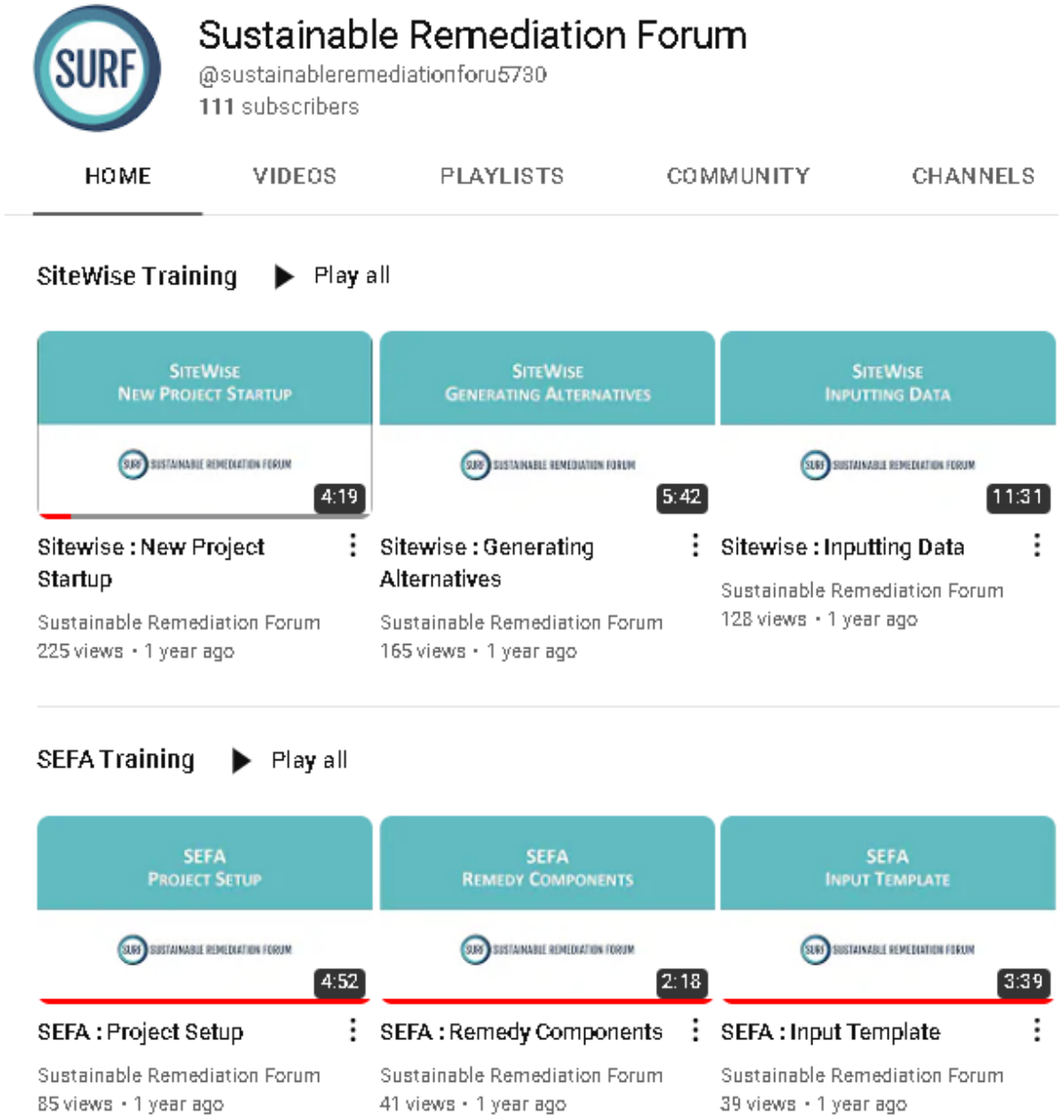
- A powerful tool with many uses
  - Compare remedies (10 – 15 hours per alternative)
  - Evaluate individual alternatives (8 – 10 hours)
  - Calculate savings (<1 hour)
- Tool flexibility improves footprint accuracy
- Benefits
  - Additional line of evidence for remedy selection
  - Identify areas of opportunity
  - Take credit for footprint reductions





Want to Learn More?

- The Sustainable Remediation Forum (SURF) developed short training videos on how to use SiteWise and SEFA.
- Trouble accessing YouTube? Contact betsy.collins@ jacobs.com for video files.



https://www.youtube.com/channel/UC6DUyfCOiRJuhgZoI_GgNGw

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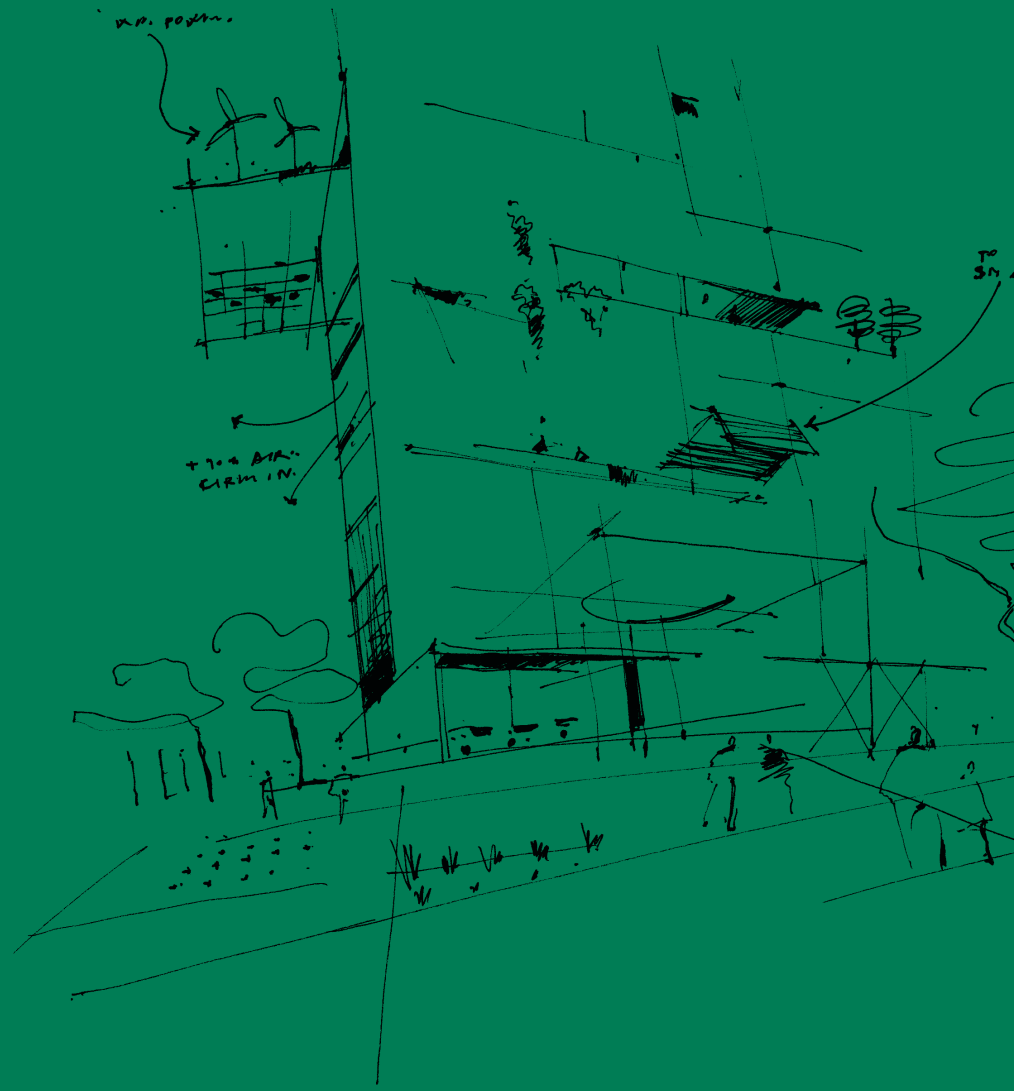

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