

# Sustainable Remediation Assessment with the BalanceE3™ Tool



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Imagine the result



# Outline

**Introduction to Green and Sustainable  
Remediation (GSR) Assessment**

**The BalanceE3™ Tool**

**Case Study**

**Summary**

# Green vs. Sustainable Remediation

## Sustainable Remediation

“A remedy or combination of remedies whose net benefit on human health and the environment is maximized through judicious use of limited resources” (SuRF, 2011)

## Green Remediation

“Considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of cleanup” (USEPA, 2010)



Green Remediation Elements identified by USEPA

# Examples of GSR Assessment

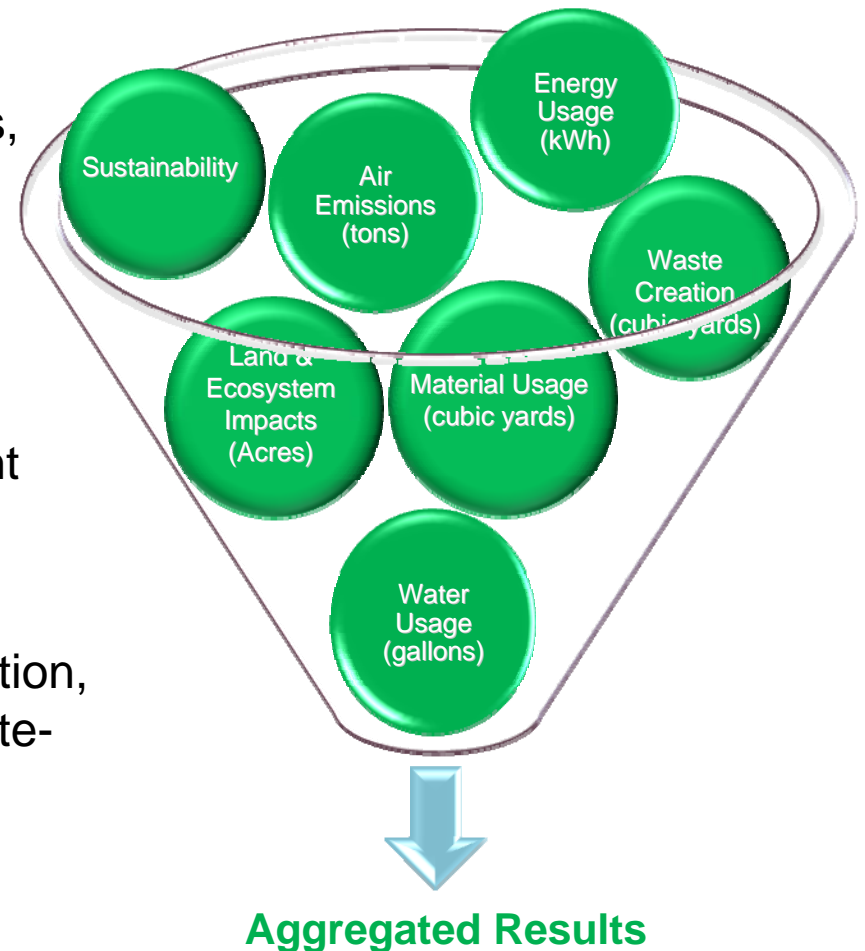
- Remedy Selection
  - Incorporate GSR into feasibility study; use as differentiator for remedy selection
  - Integrate GSR into remedy evaluation process
- Remedy Design and Implementation
  - Use FS level evaluation to guide a more sustainable design
  - Optimize or reduce environmental footprint
- Remedy Optimization
  - Continual optimization using GSR to reduce environmental footprint and H&S risks
  - Focus on key metrics and values (energy, carbon, etc.)
- Portfolio Management
  - Aggregates effect of multiple projects including greener practices and design

# Overall GSR Assessment Process

- Decide on objectives (requires stakeholder engagement)
- Choose metrics
- Decide on “boundaries” for the assessment
- Select tools
  - Vary in approach and level of detail: qualitative, quantitative or semi-quantitative
- Inventory relevant project data
- Determine assessment outcome:
  - Many results by category: lbs CO<sub>2</sub>, NPV, energy, water usage
  - Normalize to a common denominator
- Perform sensitivity analysis
- Incorporate stakeholder perspectives (metric weighting)

# Key Challenges with GSR Metrics

- Multiple approaches to quantification
  - Site conditions and possible remedial actions, implemented remedial solutions, compiled field activity information
  - Each has different degree of certainty
- Aggregation challenges
  - Diverse units, interdependent variables, different relative magnitudes, not straight forward calculations
- Weighing importance
  - May vary based on site geographic location, state of industry, stakeholder interest, site-specificity



# The BalanceE3™ Tool



# Description



- Provides a quantitative means for evaluating sustainability and green remediation concepts in remedial projects
- Offers essential information for the selection, design, evaluation and optimization of a remedy
- Technology-based modular inputs:
  - Pump & treat
  - Enhanced in-situ biological degradation
  - In-situ thermal treatment
  - Soil vapor extraction
  - In-situ chemical oxidation
  - Monitored natural attenuation
  - Capping/Covers
  - Excavation
  - Airsparge/Biosparge
  - In-situ soil mixing
  - Soil stabilization and solidification
  - Ex-situ soil treatment
  - Permeable reactive barrier
- Normalizes results to statistical z-scores and aggregates to “Balance Score”



# Modular Inputs



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Well Installation	
Well Group 1	Well Group 2
Number of mobilizations	1
<input type="button" value="add Column"/>	
Mobilization Number	1
Well Purpose	extraction
Drilling Method	Sonic
Number of Wells	2
Well Diameter (inches)	6
Borehole Diameter (inches)	14
Average Total Depth (feet)	60
Well Material	SS
Average Screen Length (feet)	20
Screen Material	SS
Screen Type	V-wire wrap
Development Method	pumping
Number of well flushings	3
Additional development required?	yes
Additional Development Method	jetting
Jetting flow rate (gpm)	2
Surge Time (min/ft screen)	30
Water Injected during surging (gallons)	60
Water Injected during drilling (gallons)	0
Saturated Thickness (feet)	50
Water in wells (1 Volume, gallons)	146.87
Drilling Cuttings Generated (ft3)	128.29

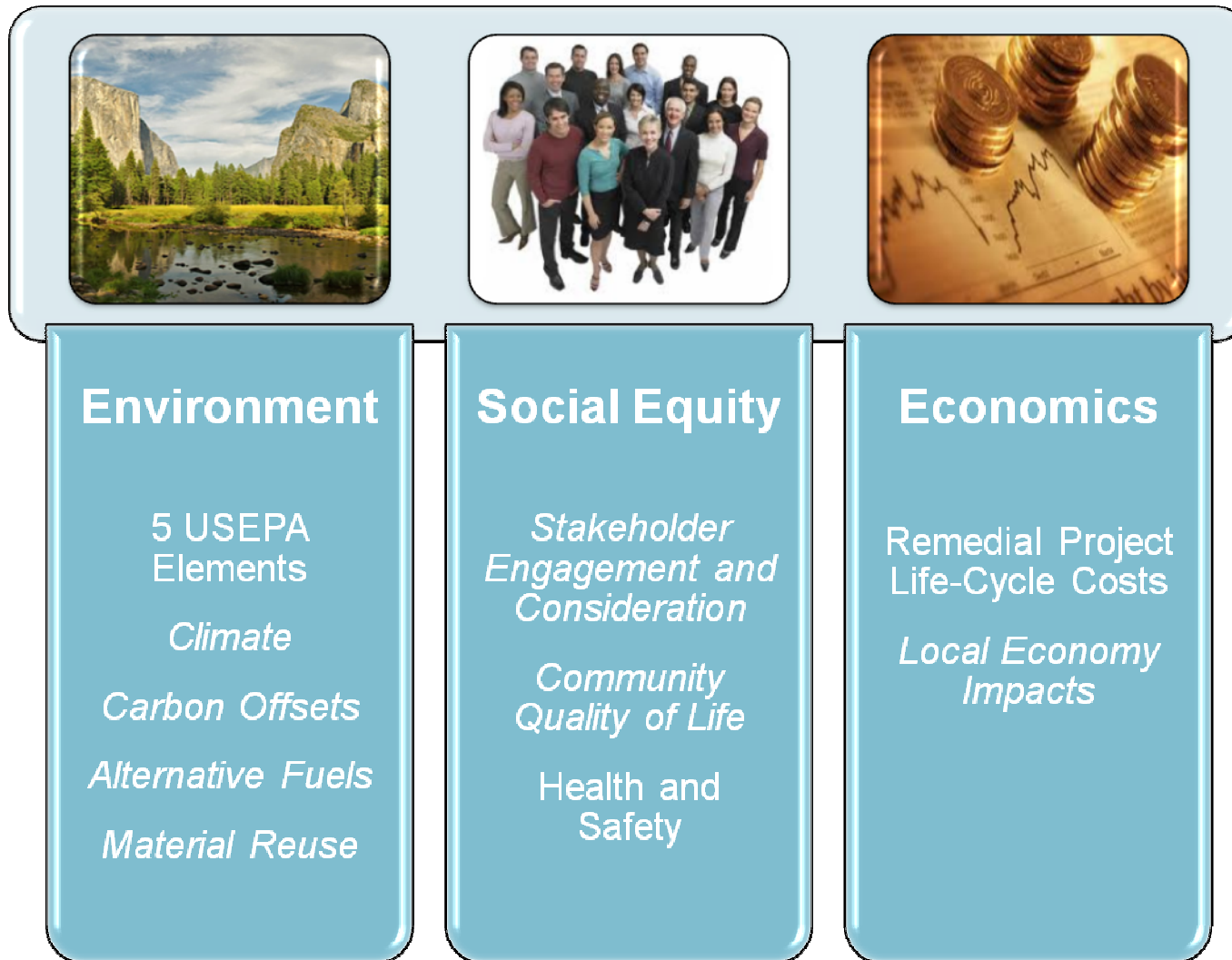
Rigorous assessment can be run with basic or detailed inputs

Inputs carry forward through modules (e.g., wells – installed, O&M, abandonment)

More precise inputs will result in more precise results

Uniform data entry with drop-down menus, library values, and defaults

# Measuring Sustainability



# Stewardship



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- [-] ZVI
- [-] Reference Tables
- [-] In situ Thermal
- [-] Stewardship
  - [-] Energy
  - [-] Emissions
  - [-] Water Use
  - [-] Materials and Waste
  - [-] Land and Eco
  - [-] Local Economy
  - [-] Stakeholder Involvement
  - [-] Quality of Life
  - [-] Project Management
  - [-] Excavation
    - [-] ExcavationTechnologyMod
- [-] Technologies
  - [-] Item 15
    - [-] CoversTechVeg
    - [-] CoversTechGeneric
    - [-] Complete Excavation
    - [-] CoversTechSitePrep
    - [-] Focused Excavation
    - [-] CoversTech
    - [-] Focused Excavation with S
    - [-] CoversTechGeneric
    - [-] WellheadSystem
  - [-] Insitubiotreatment
    - [-] WellheadSystem
    - [-] WellInstallation
      - [-] WellInstallationAdc

## Stewardship add Row

### Questions

1. Will the project involve interfacing with the public? Yes
- "2. Is project budget allocated for Public Involvement and Community Outreach? Yes
3. Does the project have a public relations plan or similar document? Yes
- Are low-income communities present near your project site? No
4. Is the effect on low-income communities considered as part of the selected remedial alternative? N/A
5. Is written material available to distribute to the surrounding community that educates on the site's activities, and the public outreach schedule? Yes
- "6. Are there regularly scheduled public meetings regarding the site's activities? Yes
7. Is there a process in place to review and use input and provide feedback to the public? No

### Response Ideas to consider

Most projects will involve some aspect of public involvement. Many projects require a public involvement plan as part of project planning.

EPA Community Involvement and Outreach Guidance: [http://www.fortordcleanup.com/adminrec/ar\\_pdfs/AR-ESCA-0079/Appendices/Appendix\\_D.pdf](http://www.fortordcleanup.com/adminrec/ar_pdfs/AR-ESCA-0079/Appendices/Appendix_D.pdf) The project managers should have a clear understanding of the history of environmental and political decisions in the immediate community. What does the community value? What has worked/failed in the past? What political climate is the project in?

The basic components of an outreach plan are: an assessment of needs, an inventory and evaluation of ongoing efforts, and an action plan to implement activities over and above current efforts (EPA, 2003).

Project managers should evaluate whether low-income communities are present in the vicinity of the project. What's the poverty level in your town?: <http://aspe.hhs.gov/poverty/09poverty.shtml> Map populations living in the vicinity of your project: Enviomapper: <http://www.epa.gov/compliance/whereyoulive/ejtool.html>

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations, and policies. (EPA, 1998)

Consider making an effort to offer written materials in other languages or have translators available. Consider using alternate media such as the internet. Consider offering technical assistance to assist with understanding technical documents.

### Notes

## StewardshipReferences add Row

### References

USEPA, 2008. Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites. Office of Solid Waste and Emergency Response Technology Primer; EPA 542-R-08-002. April.

USEPA, 2008. Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites. Office of Solid Waste and Emergency Response Technology Primer; EPA 542-R-08-002. April.

Environmental Protection Agency. 1998. Final Guidance For Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses. EPA Working Group, Federal Activities. Revised April 1998.

Environmental Protection Agency. 1998. Final Guidance For Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses. EPA Working Group, Federal Activities. Revised April 1998.

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# Health and Safety



## Inherent Risks

- Motor Vehicle Accident Risk
- Injection Reagents
- Construction Activities
- Sampling Preservatives

## Site-related Risks

- Site Setting
- Climate
- Topography

## Technology-related Risks

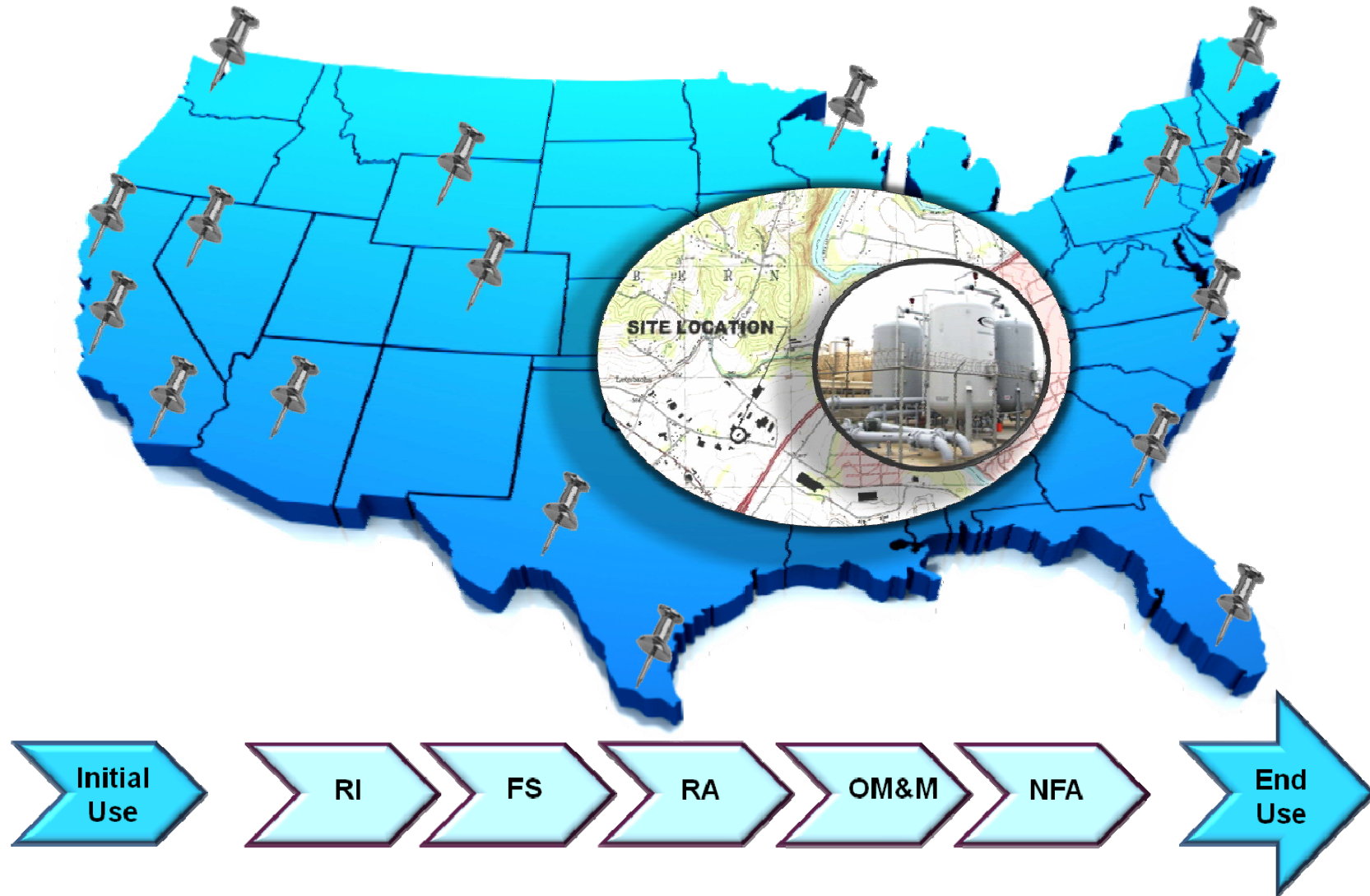
- Chemical Exposure
- Physical Hazards
  - Noise
  - Tool/Equipment Injury

## Hazard Assessment and Risk Control (HARC) Process for ARCADIS H&S Program

Hazard Type	Hazard and Hazardous Activities	Overall Risk (Comments attached to cells explain Medium and High Risk rankings)
PS	Personal - stress - working long hours	Low
PS	Violence in the workplace	Medium
PS	Working alone	Medium
TR	Motor vehicle operation - driving in unfamiliar locations	High
TR	Motor vehicle operation - fatigue or lack of alertness from driving early or late in the day	High
TR	Motor vehicle operation - roadway and traffic hazards of driving motor vehicles	Medium
BLD	Entering and exiting hallways and running into others	Low
BLD	Furniture failure	Medium
PS	Travel - personal safety	Low
PH	Uneven or slippery terrain - slips, trips and falls	Low
PH	Ionizing radiation - gamma, beta, x-ray, etc.	Low
PH	Non-ionizing radiation - ultraviolet, microwave, laser, infrared, etc. - exposure to	Low
BIO	Insects - ticks, bees, wasps, spiders, black flies, mosquitos - bites or stings	Medium



# Evaluation Scope and Scale

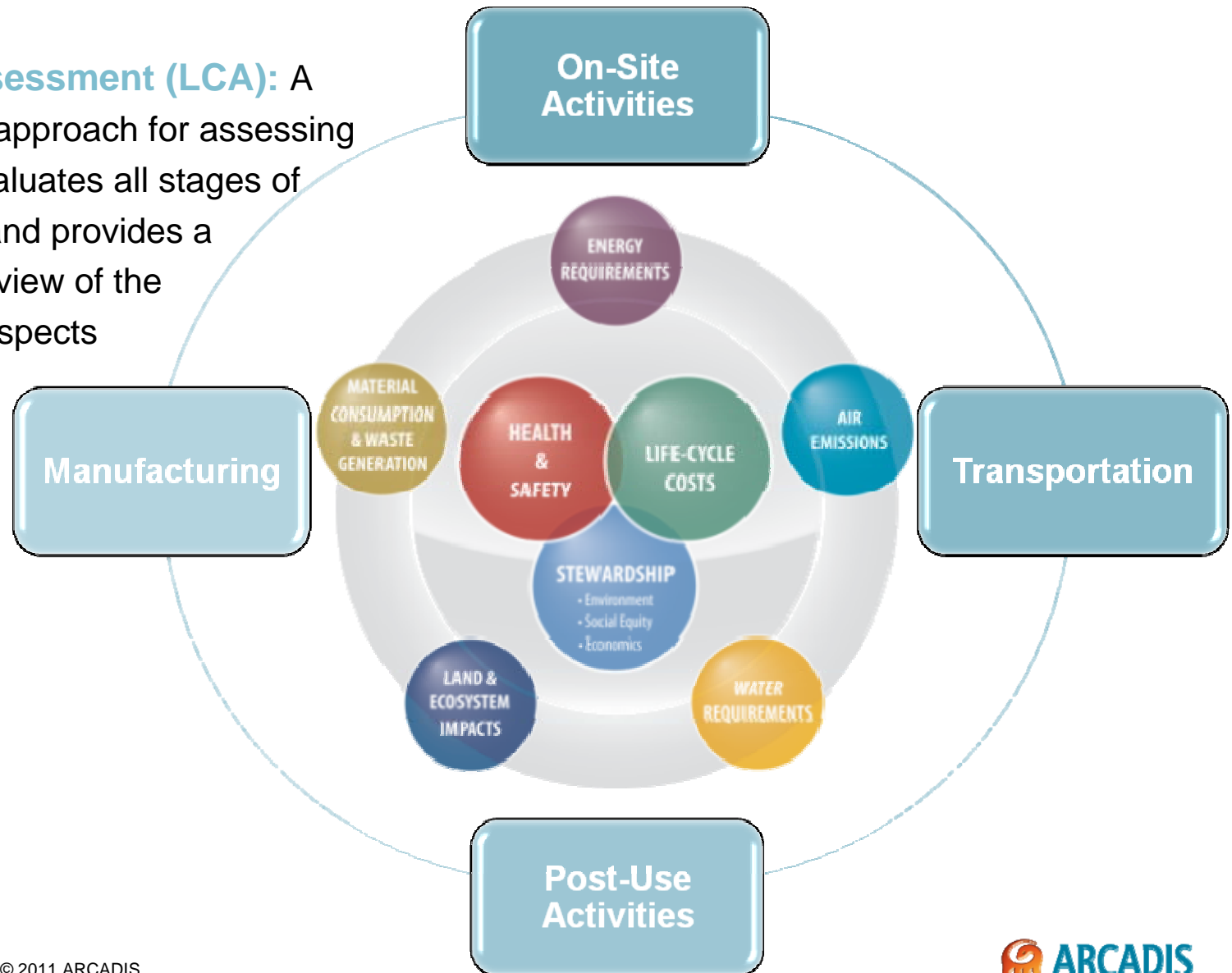


*The Continuum*

# Evaluation Boundaries

**Life-Cycle Assessment (LCA):** A cradle-to-grave approach for assessing systems that evaluates all stages of a product's life and provides a comprehensive view of the environmental aspects of the product or process.

(USEPA National Risk Management Research Laboratory (NRMRL) LCA Definition)



# Case Study

## Using The BalancE3™ Tool

# Overview

## Site setting

- Superfund site in Florida (EPA Region 4)
- Former wood treating facility, creosote
- Groundwater impacts: DNAPL PAHs
- Soil impacts: dioxins/furans



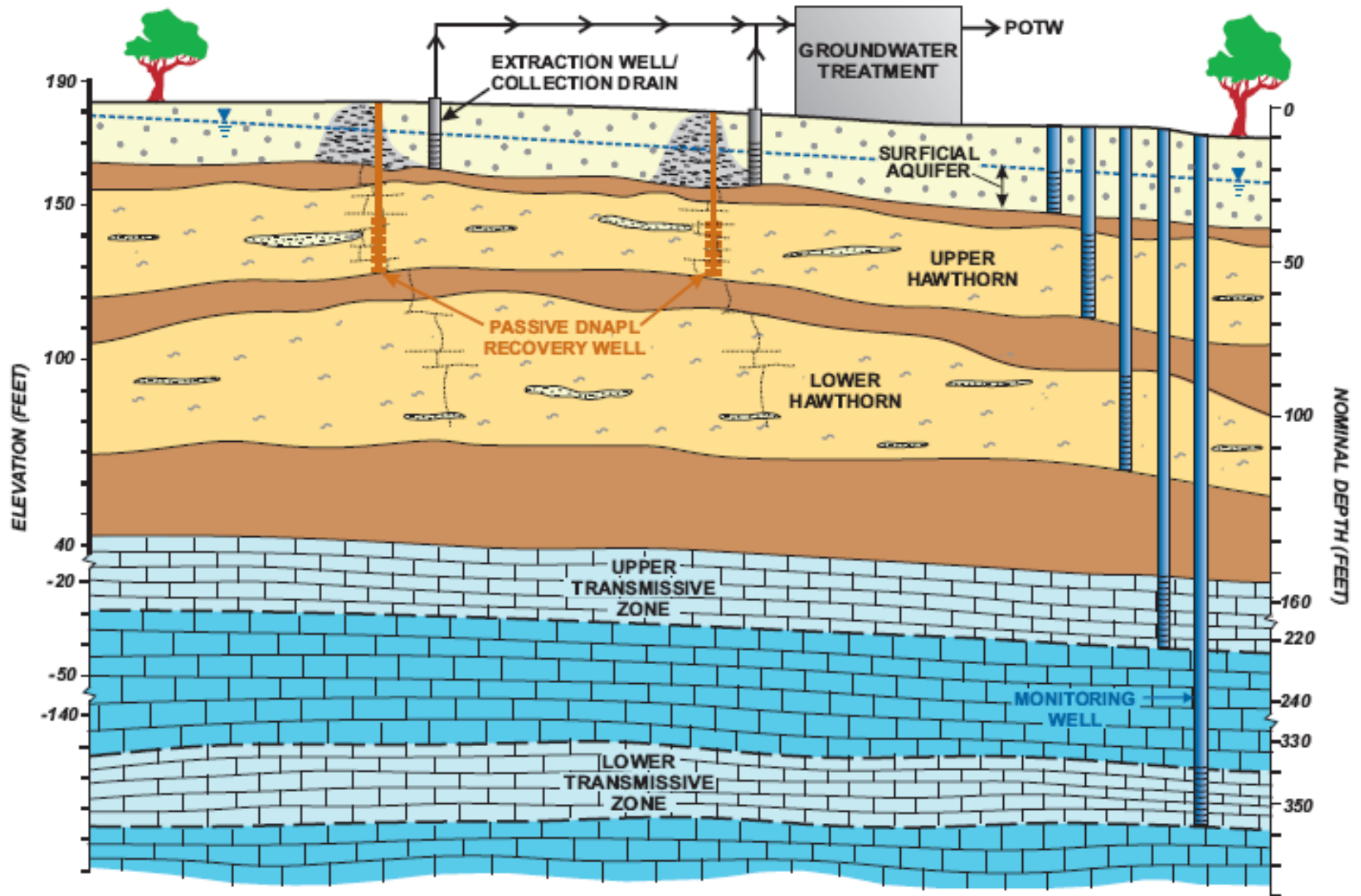
<http://protectgainesville.org>

## GSR Assessment Goals

- Perform a quantitative sustainability assessment
- Evaluate the overall environmental footprint and stakeholder/social aspects of each alternative
- Serve as a differentiator in the evaluation of the proposed remedial alternatives during the feasibility study phase



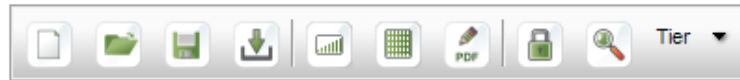
# Current Actions



# Remedial Options in FS

Main Remediation System	Proposed Lifetime (Years)	Additional Remedial Actions			
		Slurry Wall	Cover	Hydraulic Containment	Passive DNAPL Extraction
1: No action	---				
2: Current actions	> 30			X	X
<b>3A: Surficial aquifer excavation</b>	5	X	X		
<b>3B: Excavation to Hawthorn middle clay unit</b>	5	X	X		
4A: ISS/S to Hawthorn middle clay unit	5		X		
<b>4B: ISS/S to Hawthorn upper clay unit and ISBS in Upper Hawthorn</b>	5		X		
5A: Vertical flow barrier	30				X
5B: Vertical flow barrier with ISBS in Upper Hawthorn	30	X	X	X	X
<b>5C: Vertical flow barrier with ISBS in Surficial Aquifer</b>	30	X	X	X	X
<b>5D: Vertical flow barrier with ISS/S in Surficial Aquifer</b>	30	X	X	X	X

# Results in Metrics' Units



## Sustainability Assessment Tool

Weight	Evaluation Criteria	Unit	Option 3A	Option 3B	Option 4B	Option 5C	Option 5D
<input type="range" value="50"/>	Energy Usage	kWh	2,199,561	5,567,924	4,120,623	1,828,391	4,839,977
<input type="range" value="50"/>	Air Emissions	Metric Tons C	452	1,264	230	334	349
<input type="range" value="50"/>	Water Usage	Gallons	5,669,460	40,805,345	2,599,527	610	6,754,801
<input type="range" value="50"/>	Land Impacts	Acres	13	11	1.2	11	12
<input type="range" value="50"/>	Materials & Waste	Cubic Feet	117,416,117	8,906,688	2,960,303	105,716,740	142,615,184
<input type="range" value="50"/>	Stewardship	Scale	1.4	2.7	1.3	2.6	2.7
<input type="range" value="50"/>	Health & Safety	Scale	2.6	5.5	3	2	2
<input type="range" value="50"/>	Life-Cycle Costs	MMS	66.1	172.55	57.6	25.5	46.42

Use Weighting  Balance Score

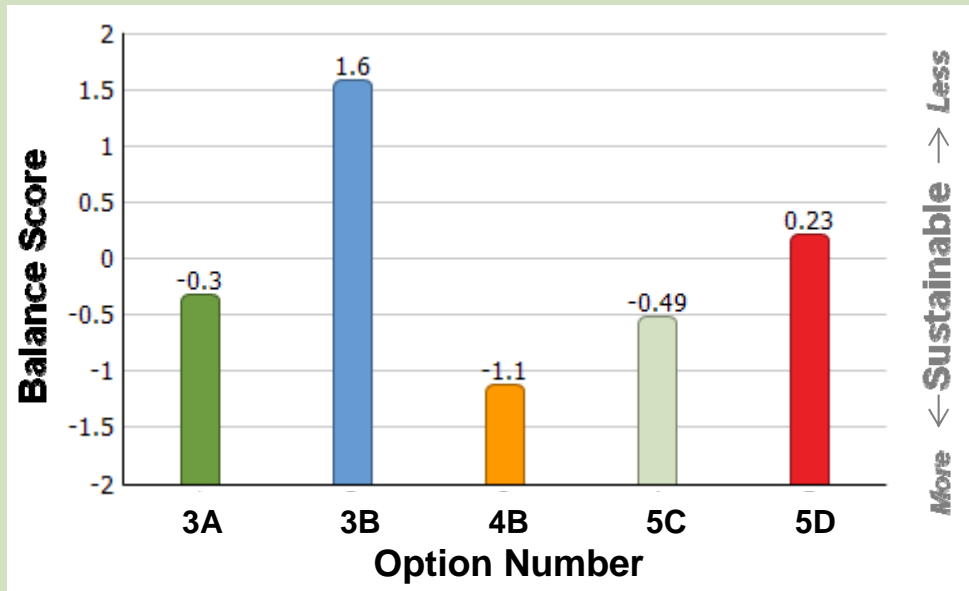
# Results in Unitless Z-scores



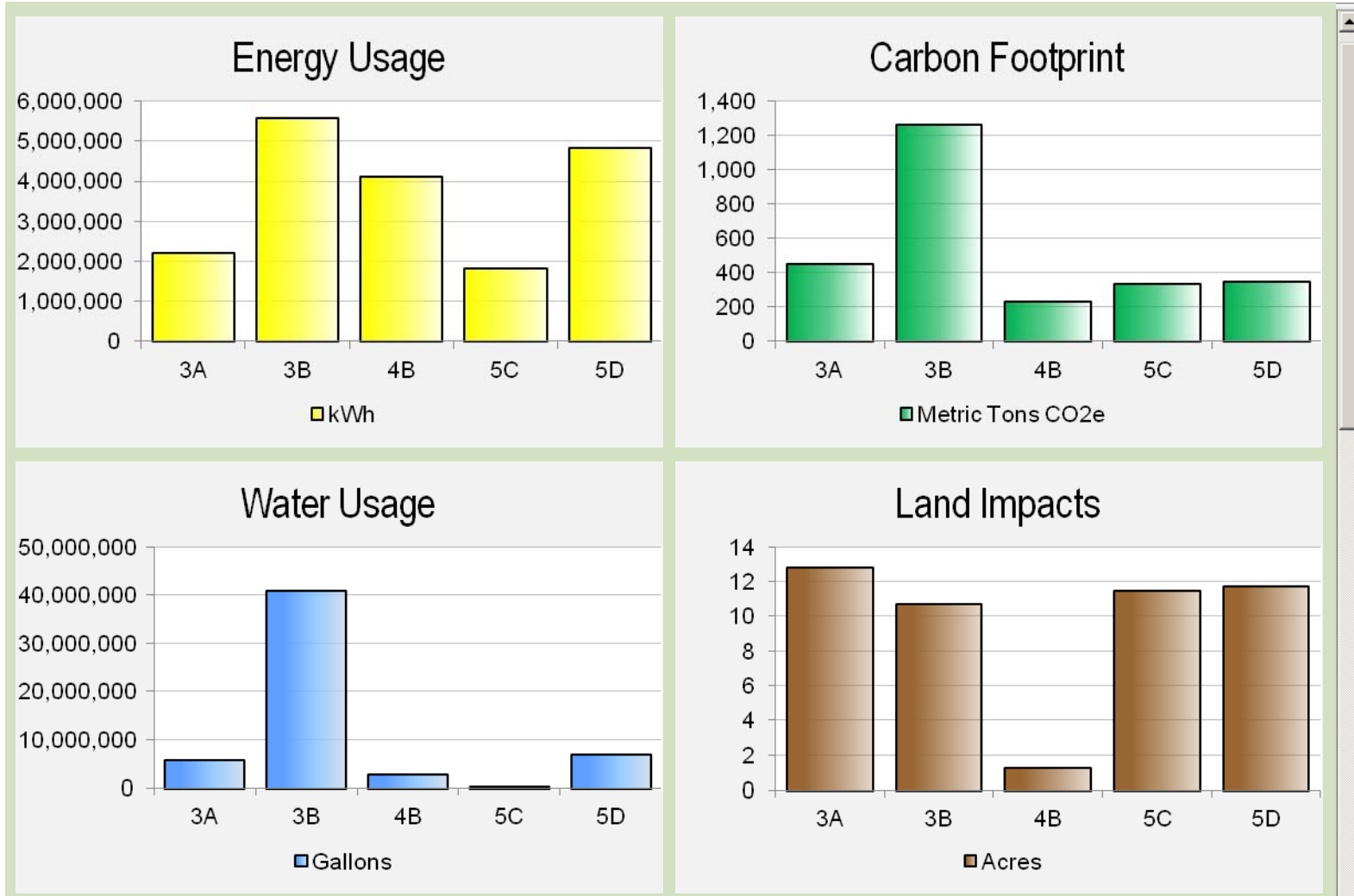
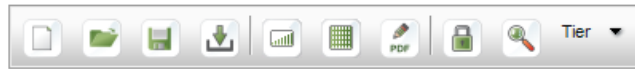
## Sustainability Assessment Tool

Weight		Evaluation Criteria	Unit	Option 3A	Option 3B	Option 4B	Option 5C	Option 5D		
	50	100.0%	Energy Usage	Unitless	-0.92	1.1	0.25	-1.2	0.69	
	50	100.0%	Air Emissions	Unitless	-0.18	1.8	-0.7	-0.46	-0.42	
	50	100.0%	Water Usage	Unitless	-0.33	1.8	-0.51	-0.67	-0.26	
	50	100.0%	Land Impacts	Unitless	0.7	0.28	-1.8	0.28	0.49	
	50	100.0%	Materials & Waste	Unitless	0.65	-1	-1.1	0.46	1	
	50	100.0%	Stewardship	Unitless	-1	0.77	-1.2	0.64	0.77	
	50	100.0%	Health & Safety	Unitless	-0.29	1.7	-0.014	-0.7	-0.7	
	50	100.0%	Life-Cycle Costs	Unitless	-0.13	1.7	-0.28	-0.84	-0.47	
Use Weighting <input type="checkbox"/>				Balance Score	Unitless	-0.3	1.6	-1.1	-0.49	0.23

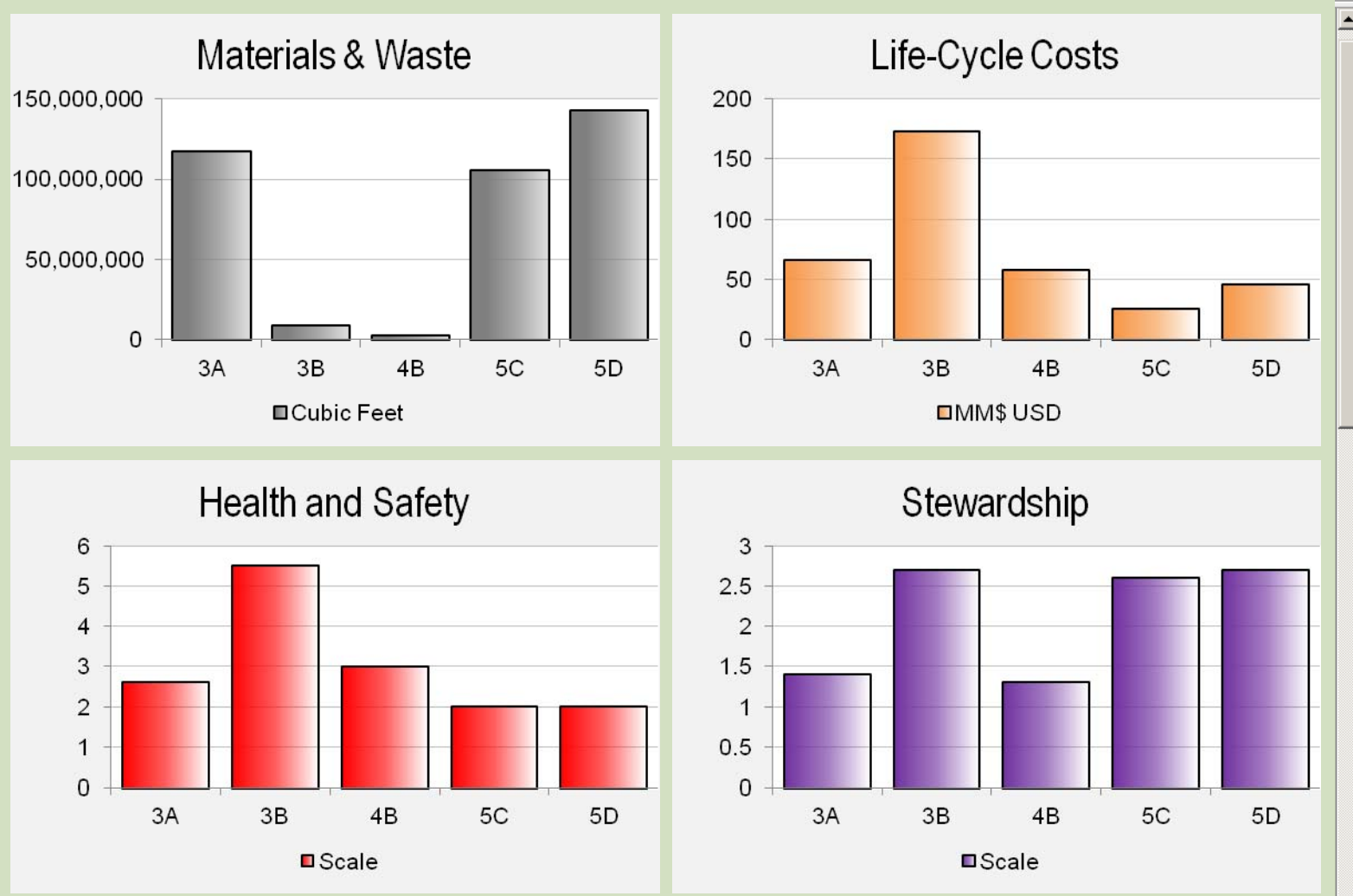
# Balance Score Output



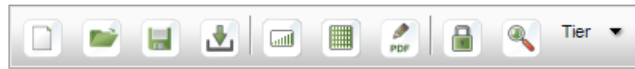
# Metrics Output



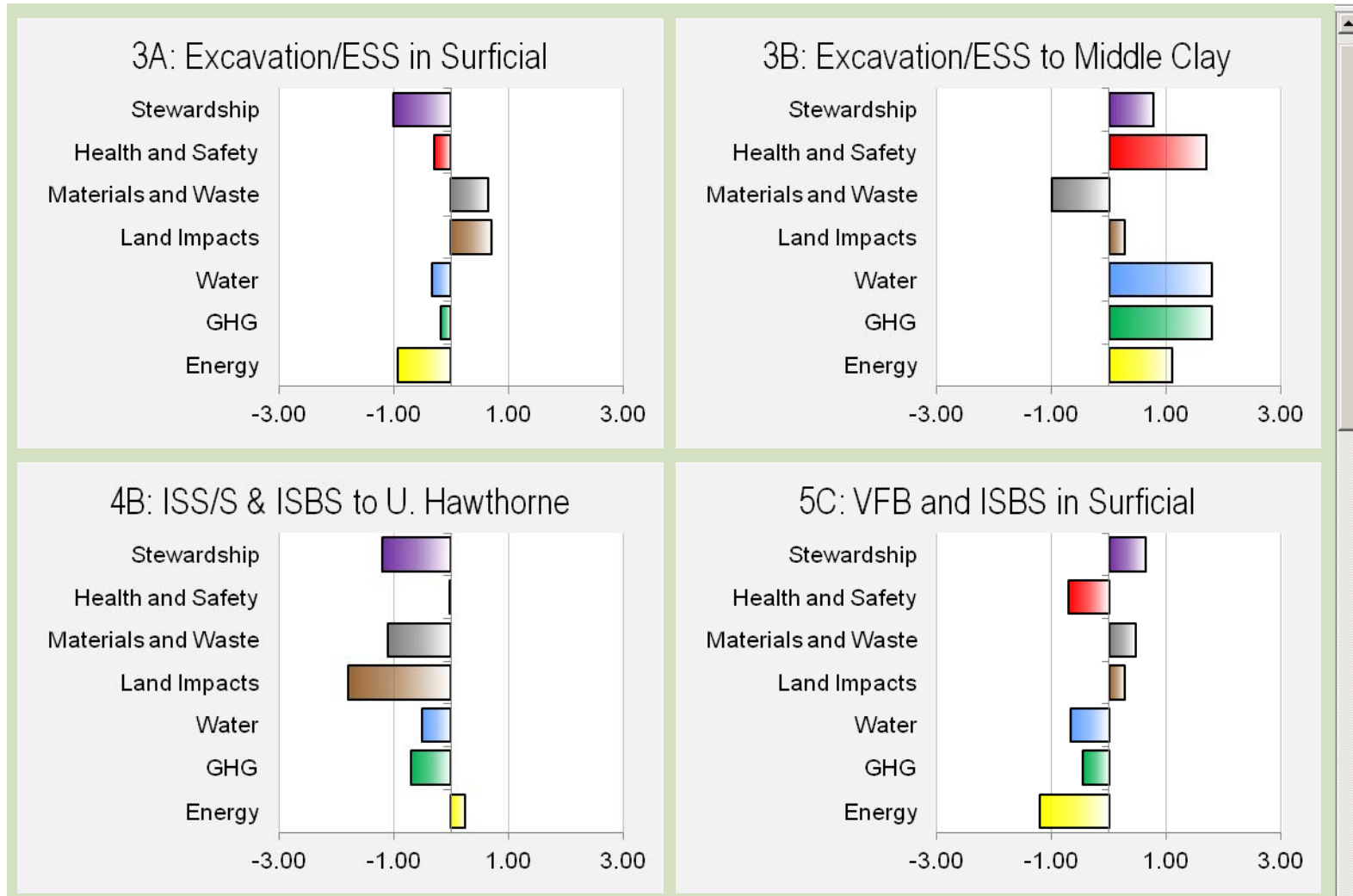
# Metrics Output



# Balance Score per Metric

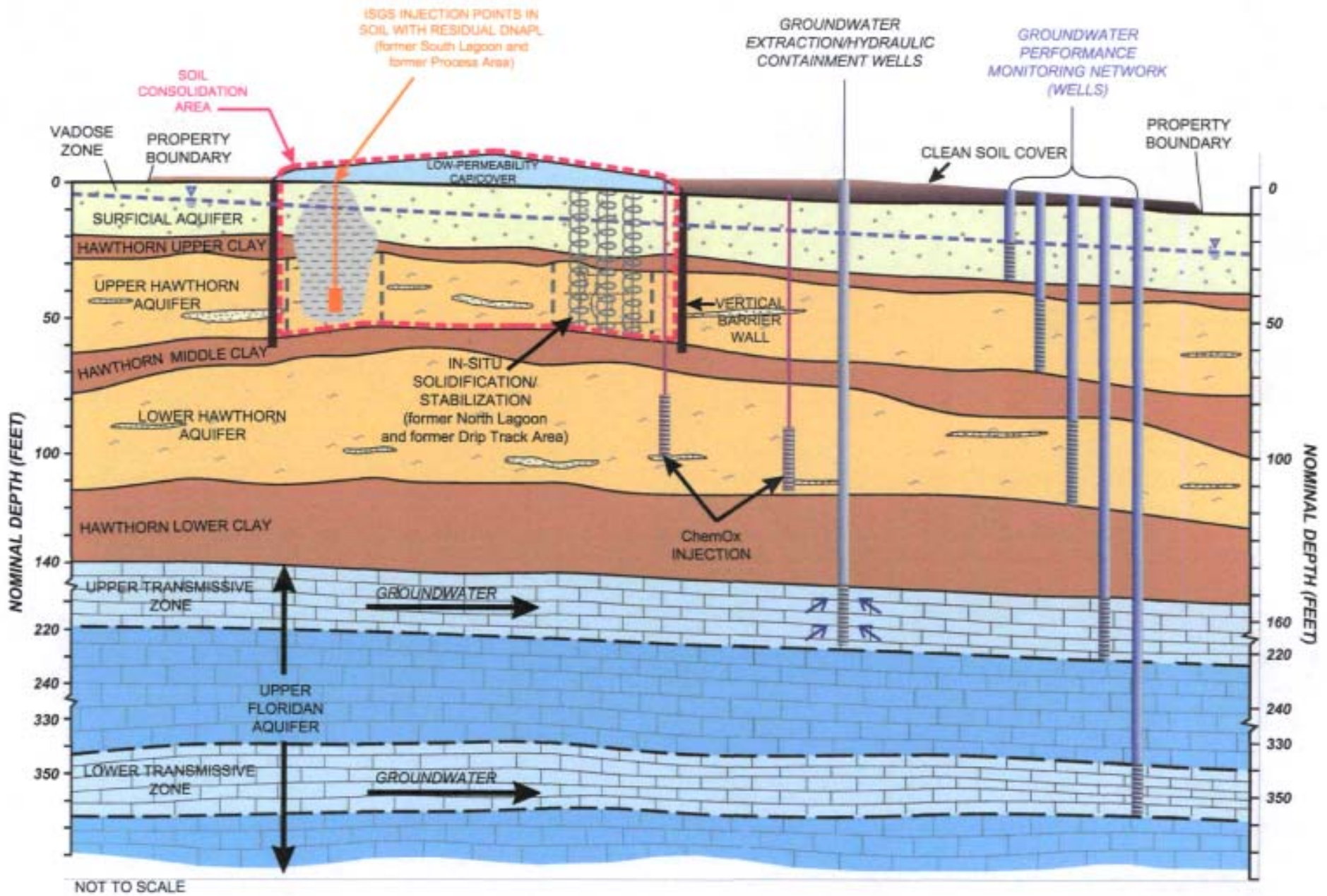


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# Selected Remedy



# GSR Assessment Outcome

## Selected Remedy

- GSR assessment results were reviewed by EPA Region 4 and taken into consideration when selecting the final remedy.
- A remedy most similar to Remedial Alternative #4B was selected for implementation.
- This remedy is now in place through a Record of Decision.

## Significant GSR elements

- Chose remedy with less environmental impacts (reduced energy, CO2 emissions)
- Chose remedy with lower health and safety risk to workers
- Analysis demonstrated that the project as a whole scored well for Stewardship - project coordinators' attention to Stewardship topics were heightened
- Difficult to differentiate stewardship benefits of different remedial options



# Summary

- New topic and continually evolving
- GSR assessment is a fundamental component of remedial decision-making
- Quantification makes success measurable and establishes validity of greener and more sustainable solutions

# Imagine the result

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