Sustainability Analysis of Soil and Groundwater Remediation Alternatives for Site 45, MCRD Parris Island

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Outline

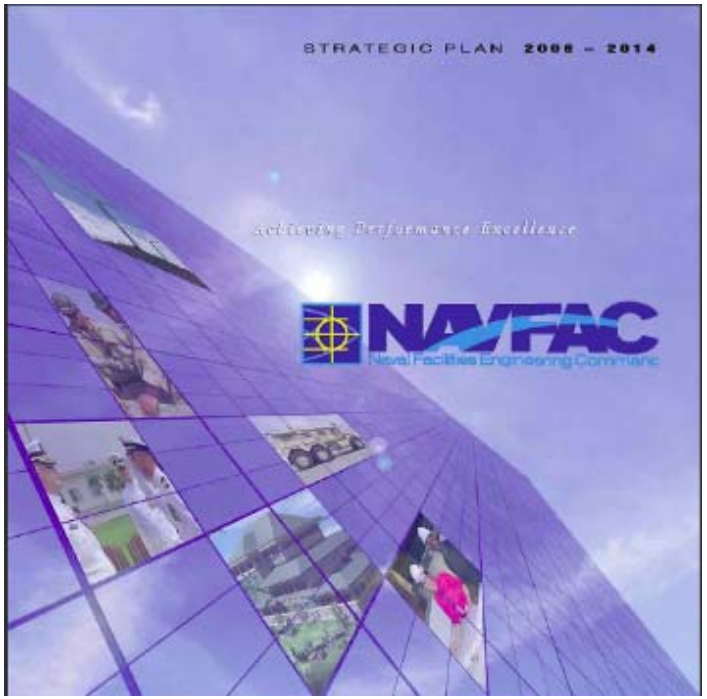
- Introduce GSR
  - Navy Perspective
- SiteWise™
  - Battelle
- Field Application of Sustainability Tool
  - Marine Corps Recruit Depot Parris Island, South Carolina
- Remedy Selection

Navy Perspective

- **Executive Orders 13423 and 13514**
- **Department of Defense (DoD)**
  - **"The DoD Components shall consider and implement green and sustainable remediation opportunities when and where they make sense."**
  - **Optimization = Green and Sustainable Remediation**
    - Effective use of natural resources and energy
    - Reduce negative impacts on environment
    - Minimize/eliminate pollution at its source
    - Protect the community
    - Reduce waste

NAVFAC Strategic Plan

- New Strategic Plan
  - 2010 to 2017
- Readiness
- Performance
- Sustainability
  - Land, Infrastructure, and Equipment
  - Energy Security, Energy Efficiency, and Environmental Stewardship



Implementation

- **No Accepted Protocol**
- **NAVFAC Optimization Workgroup**
  - **Developing a strategy to apply GSR to remediation process**
    1. Select sustainability metrics
    2. Determine evaluation method
    3. Weigh each metric
    4. Reduce footprint of remedial components
  - **Green and Sustainable Remediation Fact Sheet**

Environmental Footprint

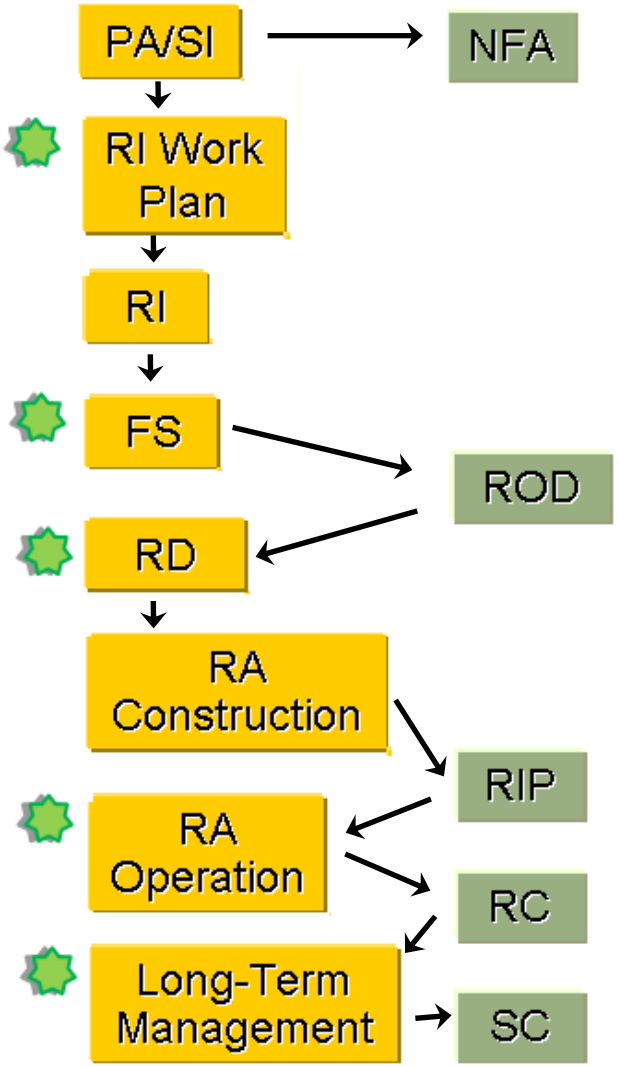
- Impacts on media and society that are a result of the remedial action
- Focus on reducing carbon emissions
  - Environmental Footprint = Carbon Footprint
- Should also consider impacts to the remediation site

SiteWise™

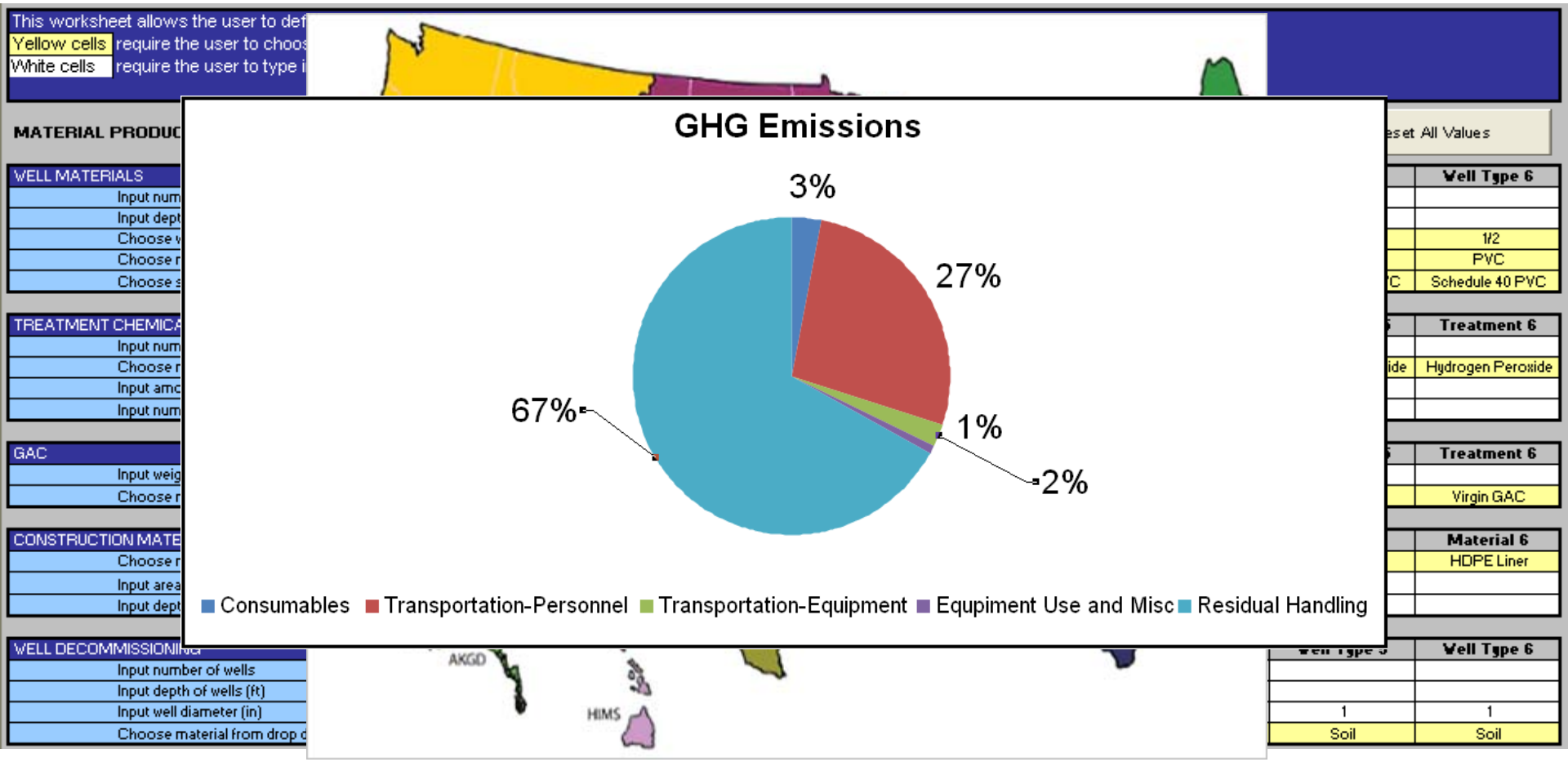
- **Collaborative Effort**
  - **Developed by Battelle, Navy, and USACE**
  - **www.ert2.org**
- **Quantifies the environmental footprint of each remedial alternative**
  - **Sustainability Metrics**
- **User Friendly**
  - **Tool consists of a series of excel spreadsheets**
  - **Input spreadsheet is broken into phases**
    - Remedial Investigation
    - Remedial Action Construction
    - Remedial Action Operation
    - Long Term Monitoring

When to Consider Using SiteWise™

- **Sustainability should be considered as part of a Remedial Action (RA)**
- **Remedy Selection**
  - **Greatest opportunity to reduce environmental footprint**
- **Select remedy that protects human health and the environment**
  - **Select remedy with smallest footprint**



SiteWise™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Consumables
Transportation-Personnel
Transportation-Equipment
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Residual Handling

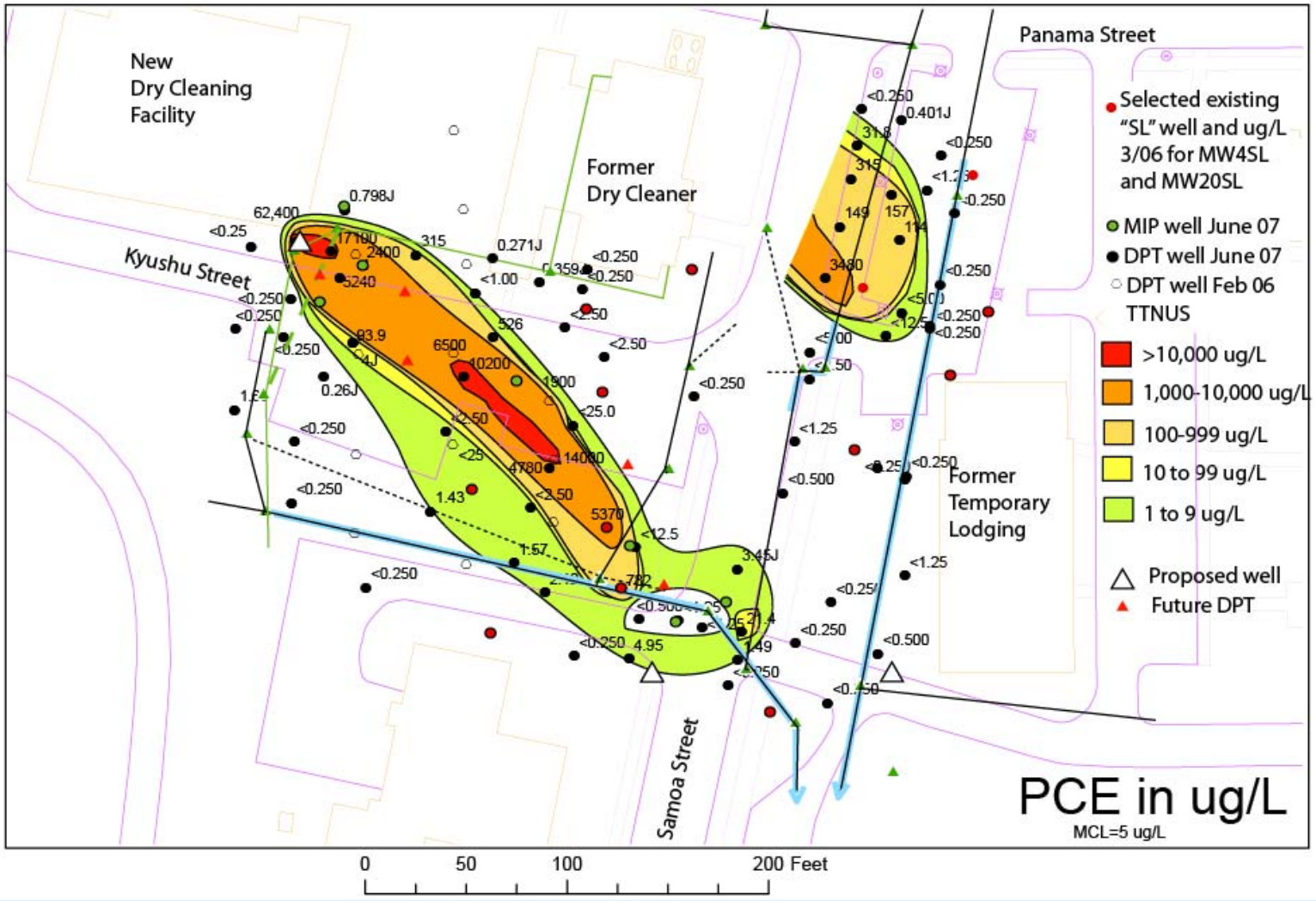
SiteWise™

- **Sustainability metrics (in the Tool)**
  - **GHG Emissions**
  - **Energy Usage**
  - **Air Emissions**
  - **Accident Risk**
- **Qualitative Impacts (outside the Tool)**
  - **Water Usage**
  - **Community Impacts**
  - **Resource Consumption**
    - Landfill Space Consumed

MCRDP Parris Island, South Carolina

- Chlorinated Solvent contamination at a former dry cleaning facility
  - 1994 PCE release
- Remediation strategies
  - Excavation
  - Pump and Treat
  - MNA
  - ISCO
  - EZVI
- Sustainability analysis was conducted to support a Feasibility Study (FS)

PCE Plume at Site 45



Assumptions

- Only major Remedial Activities were considered
  - Well installation
  - System construction and operation
  - Monitoring
- Remedy Specific
  - Shallow excavation was paired with each groundwater-only remediation technique
  - All alternatives include Monitoring and LUCs

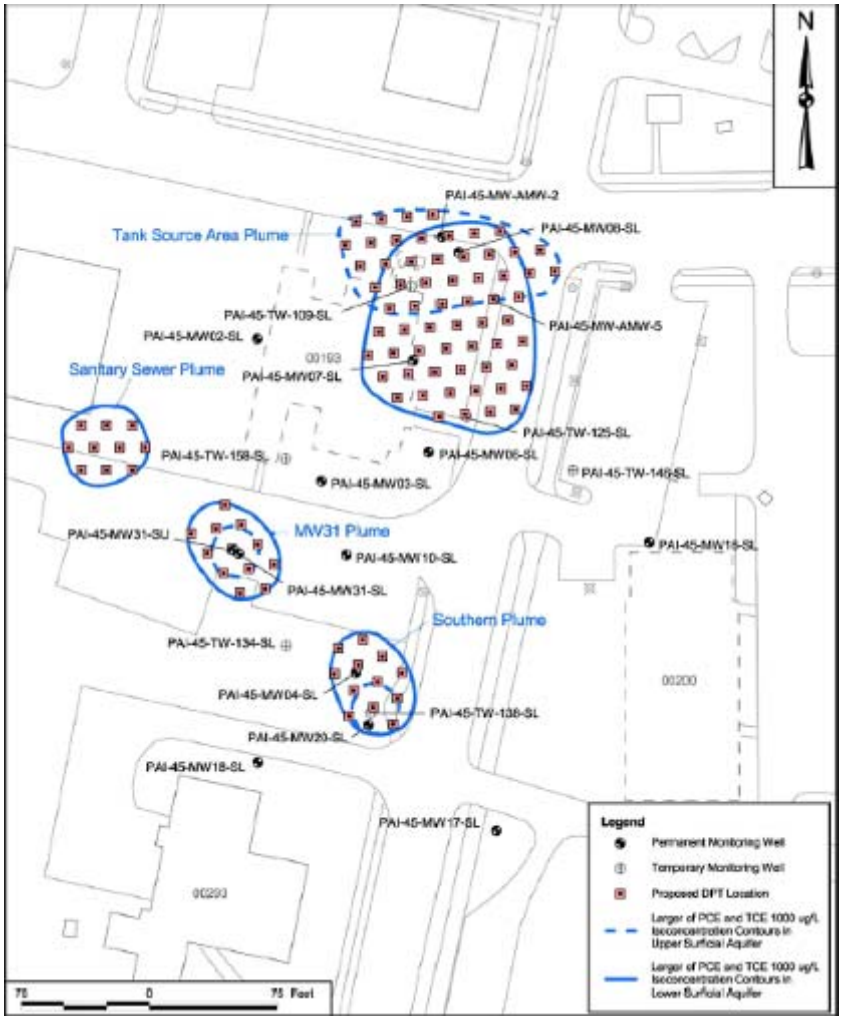
Remedial Alternatives Evaluated

Remedial Alternatives	Bio-remediation	ISCO	ISCR (ZVI)	ERH	Shallow Excavation (4 ft)	Deep Excavation (20 ft)	MNA	Monitoring	LUCs
Enhanced Bio remediation	✓				✓		✓	✓	✓
ISCO		✓			✓		✓	✓	✓
ISCR			✓		✓		✓	✓	✓
ERH				✓				✓	✓
Excavation						✓	✓	✓	✓

- **Enhanced Bioremediation**
  - –Biostimulant, shallow excavation, MNA, and LUCs
- **In Situ Chemical Oxidation (ISCO)**
  - –Fenton's Reagent, shallow excavation, MNA and LUCs
- **In Situ Chemical Reduction (ISCR)**
  - –ZVI, shallow excavation, MNA, and LUCs
- **Electrical Resistance Heating (ERH)**
  - –ERH, monitoring, and LUCs
- **Excavation**
  - –Excavate to 20ft, MNA, and LUCs

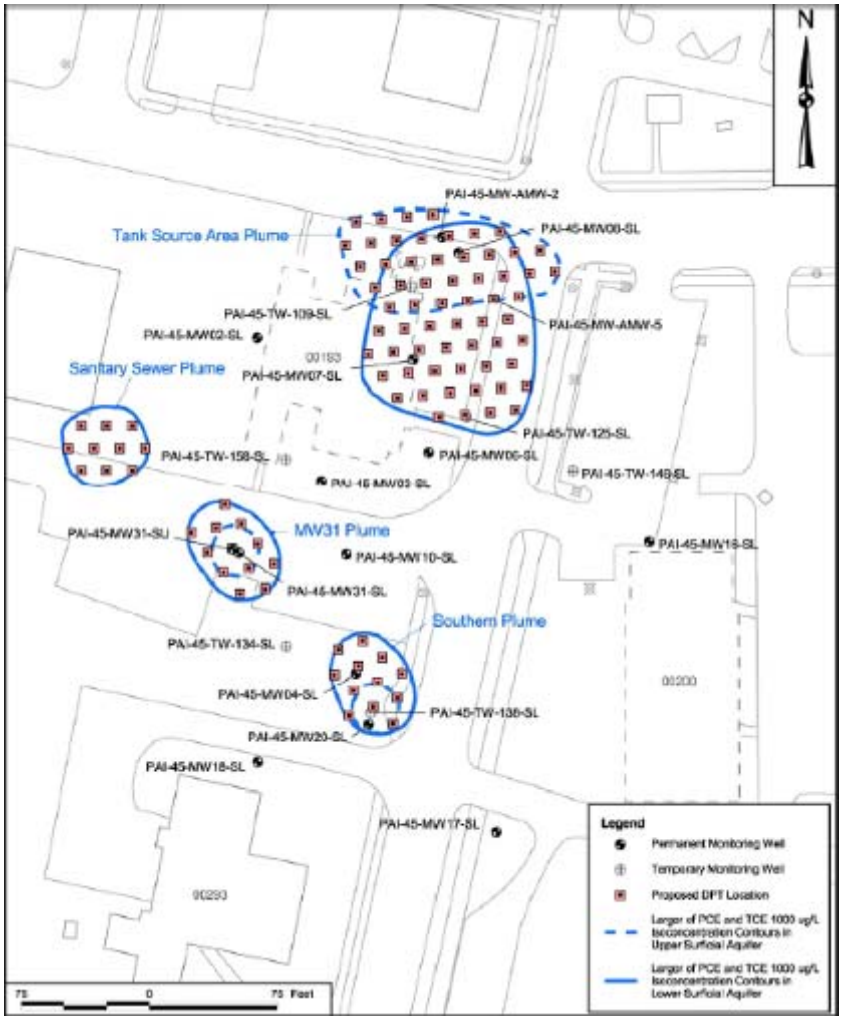
Enhanced Bioremediation

- Injections
  - 100 injection points
  - 7150 gallons of biostimulant
  - 20 ft deep
  - 10 day effort
- Transportation
  - Ship biostimulant
  - 4 crew members
- Monitoring
  - 1 year
- MNA and Excavation
- Impact Drivers
  - Biostimulant
  - Transportation
  - Equipment use during excavation



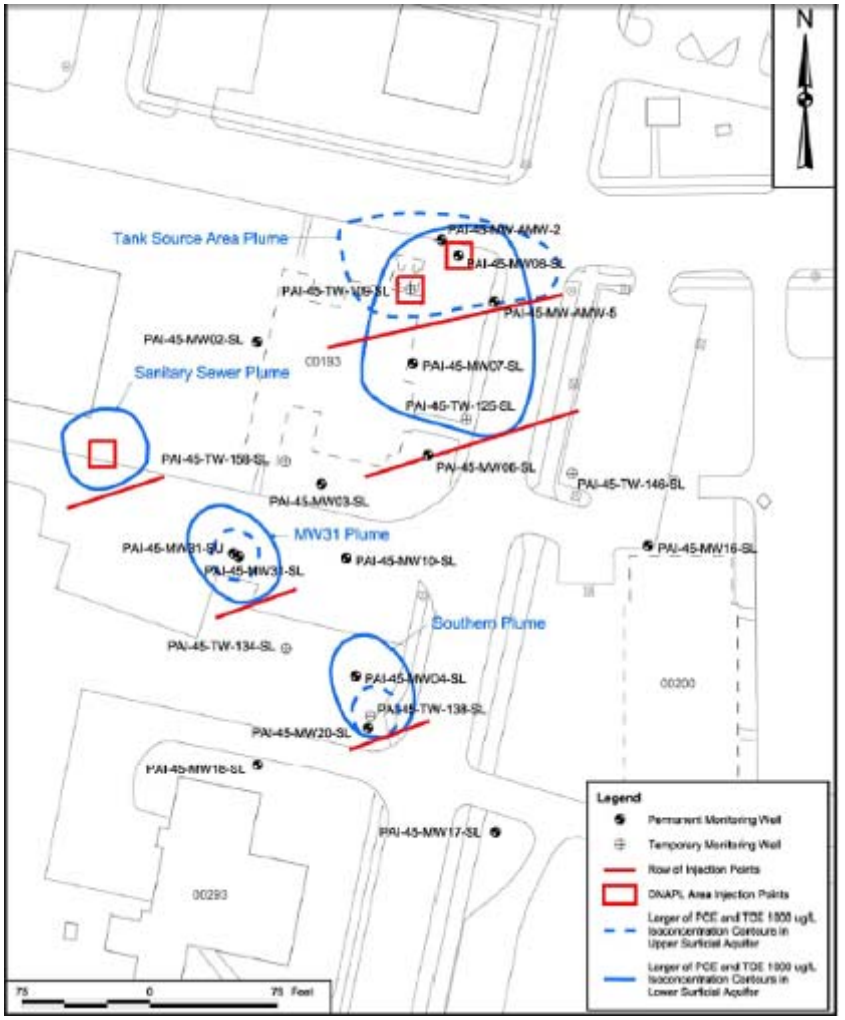
In Situ Chemical Oxidation

- Injections
  - 138 injection points
  - Multiple injection events
  - 46000 gallons of Oxidant
  - Fenton's reagent at 12.5%
  - 10 day effort per event
- Transportation
  - Ship Oxidant
  - 4 crew members
- Monitoring
  - 1 year
- MNA and Excavation
- Impact Drivers
  - Oxidant
  - Transportation
  - Equipment use during excavation



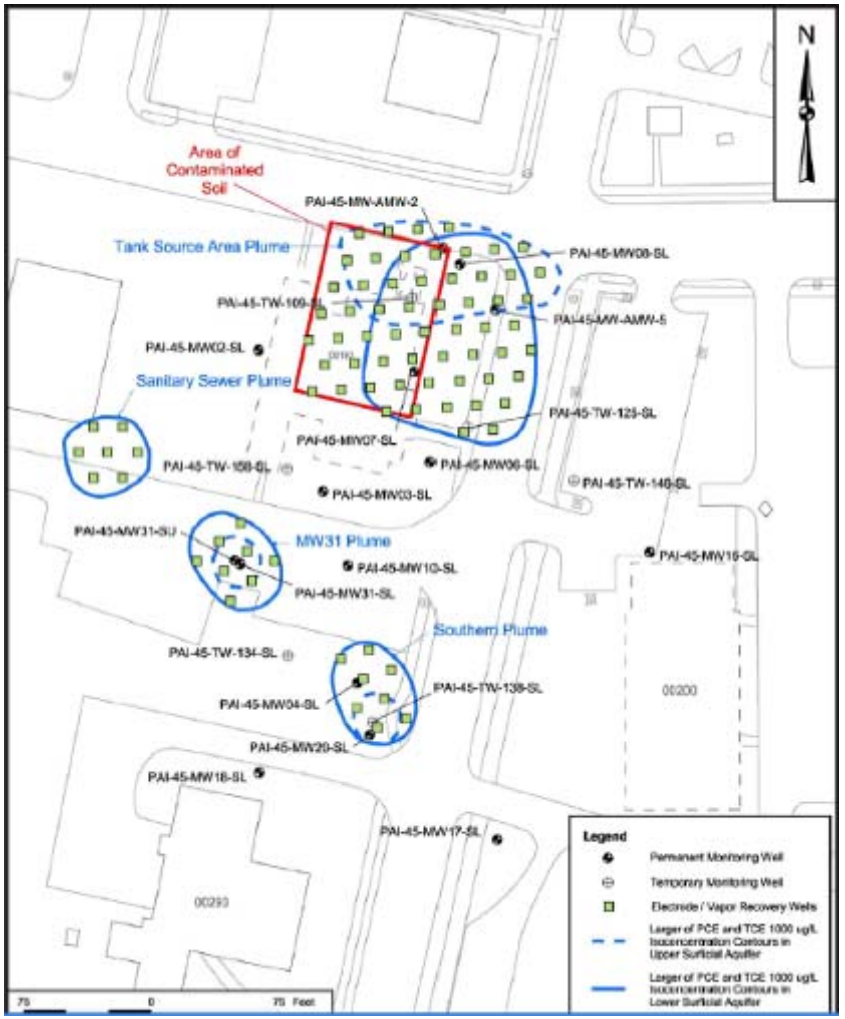
In Situ Chemical Reduction

- Injections
  - –55 soil injections
  - –41000 gallons of Iron
  - –Emulsified Zero Valent Iron (EZVI) at 17% iron
  - –10 day effort per event
- Transportation
  - –Ship EZVI
  - –4 crew members
- Monitoring
  - –1 year
- MNA and Excavation
- Impact Drivers
  - –Emulsified Zero Valent Iron
  - –Transportation
  - –Equipment use during excavation



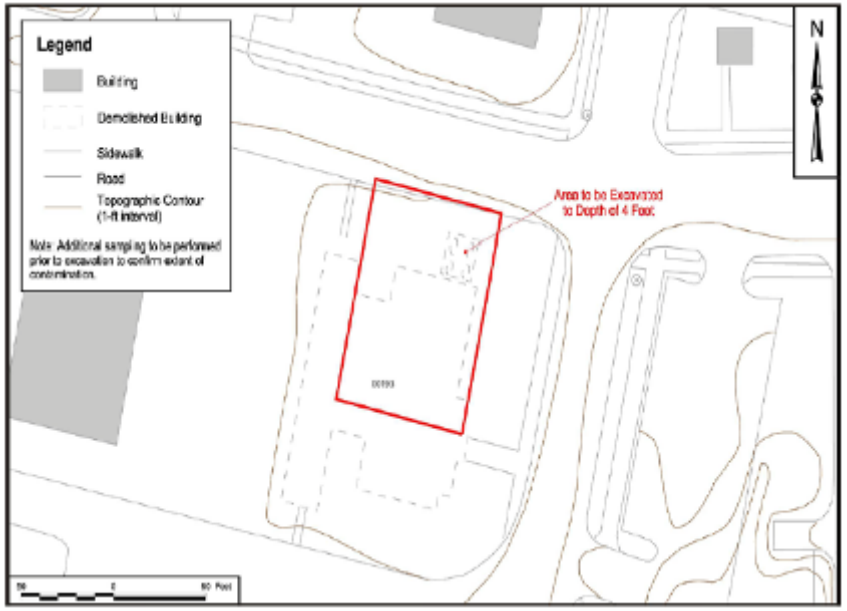
Electrical Resistance Heating

- **ERH System**
  - **Power requirement**
    - 7,612,000 kw-hr
  - **GAC**
    - 4000 pounds
- **Transportation**
  - **Residual Waste**
    - 90,000 gallons condensate water and GAC
  - **Equipment**
  - **Personnel**
- **Well Installation**
  - **85 Vapor Recovery Wells to 20 ft**
- **Monitoring**
- **Impact Drivers**
  - **Energy Use**
  - **GHG Emissions**



Excavation

- Soil: Excavate and Fill
  - –5200 yd^3
- Transportation
  - –Soil
  - –Personnel
- Earthmoving Equipment
- 9 Dewatering Wells
  - –20ft
  - –1,500,000 gallons
- GAC
  - –1500 pounds
- Monitoring
- Impact Drivers
  - –Transport and Disposal



Impact Analysis

Alternative	Impact Assessment	GHG Emissions	Energy Usage	Air Emissions	Collateral Risk	Community Impacts	Resources Lost	Water Usage
Enhanced Bioremediation	Relative Impact	Low	Low	Low	Low	Medium	Low	Medium
	Impact Drivers	Biostiumulant Production and transportation & equip during shallow GW excavation	Biostiumulant Production and transportation and equip during shallow GW excavation	Biostiumulant Production and transportation and equip during shallow GW excavation	Transportation related to long term groundwater monitoring and transportation and equip during shallow GW excavation	Disturbance due to increased traffic during shallow excavation	Landfill space for shallow excavation	Biostiumulant Production
ISCO	Relative Impact	Low	Low	Low	Low	Medium	Low	Medium
	Impact Drivers	Oxidant Prod,, transportation & equip during shallow GW excavation	Oxidant Prod., transportation & equip during shallow GW excavation	Oxidant Prod., transportation & equip during shallow GW excavation	Transportation & equip during shallow GW excavation	Disturbance due to increased traffic during shallow excavation	Landfill space for shallow excavation	Chemical Oxidant Production
ISCR	Relative Impact	Low to Medium	Low to Medium	Low	Low	Medium	Low	Medium
	Impact Drivers	ZVI production, transportation & equip during shallow GW excavation	ZVI Production, transportation & equip during shallow GW excavation	ZVI Production, transportation & equip during shallow GW excavation	Transportation & equip during shallow GW excavation	Disturbance due to increased traffic during shallow excavation	Landfill space for shallow excavation	ZVI Production
ERH	Relative Impact	High	High	High	Medium	Low	Low	High
	Impact Drivers	Electrical Usage	Electrical Usage	Electrical Usage	System Construction and Operation	Land Use Controls during the period of application	Lost groundwater	Electrical Production
Excavation	Relative Impact	Medium	Low to Medium	Medium	High	High	High	Low
	Impact Drivers	Transportation & Disposal	Transportation & Disposal	Transportation & Disposal	Excavation to 20 ft	Disturbance due to increased traffic	Landfill Space and lost groundwater	Production of PVC for wells and GAC for water treatment

Outside the Tool

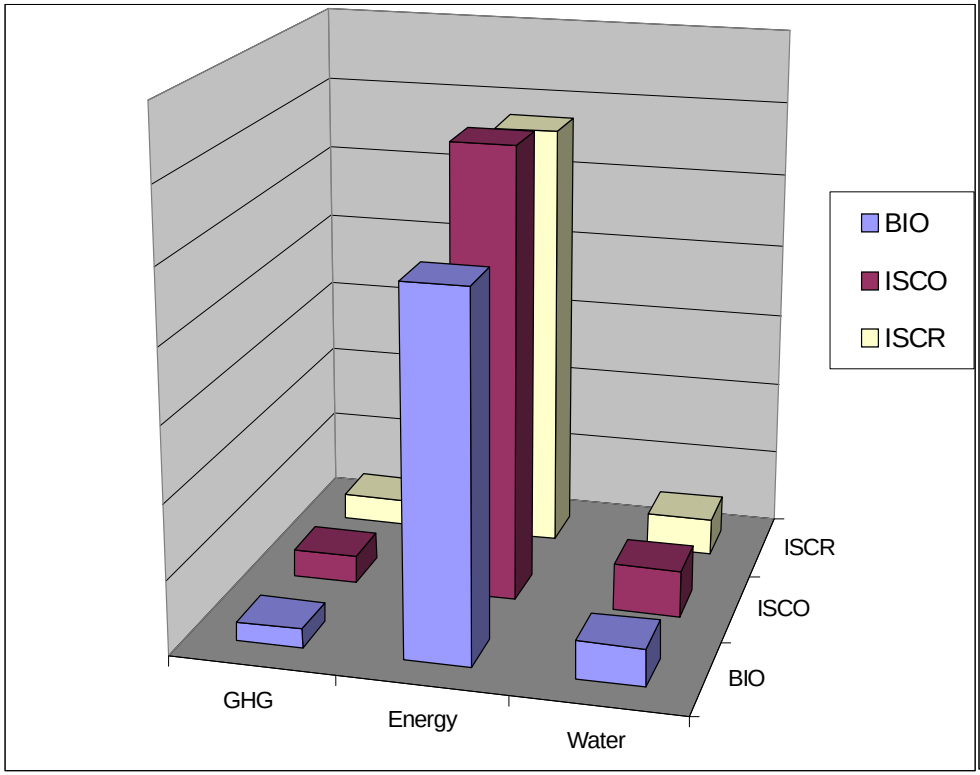
- Resource Consumption
  - Landfill space
  - Top soil
- Community Impacts
  - Traffic
  - Noise
  - Odor
  - VOC and other contaminant emission
- Ecological Impacts
  - Remediation induced changes in soil geochemistry
  - Disturbance to Surface Water and Groundwater
  - Habitat destruction
  - Invasive species

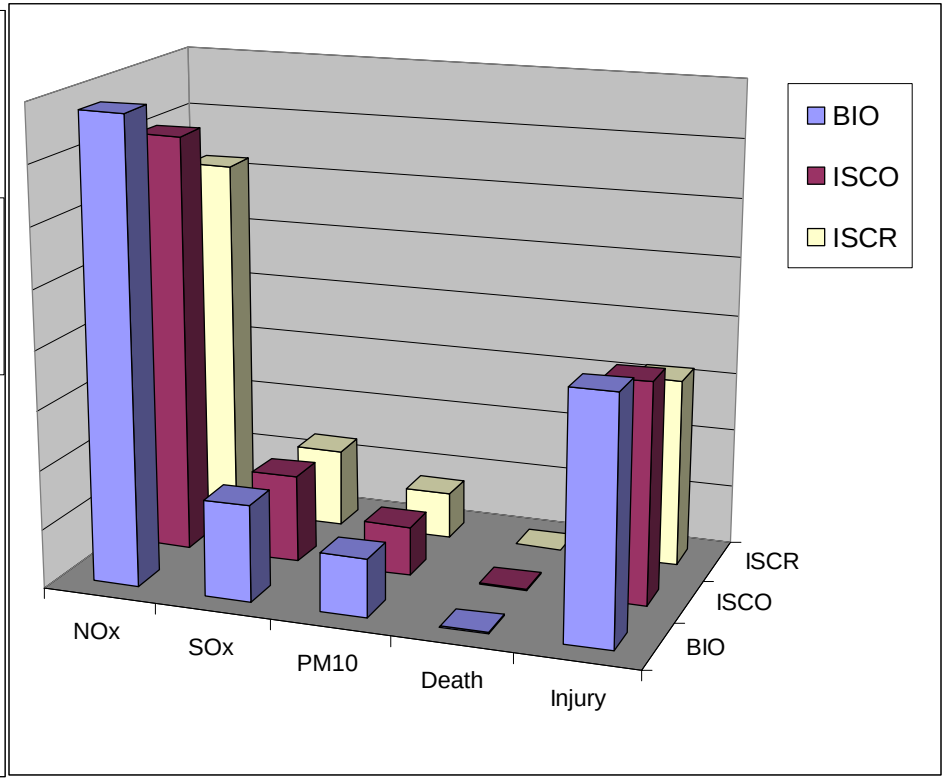
Results

- Environmental Footprint
- Bio < ISCO < ISCR < Excavation < ERH
- Enhanced Bioremediation
  - lowest calculated environmental footprint
  - most sustainable
- However, several assumptions were made
- ISCO and ISCR also could be considered sustainable options

SiteWise V1: The Contestants

GHG Energy Water NOx SOx PM10 Death Injury





Suggested Footprint Reductions

- Minimize soil excavation and transportation
  - rail shipments
- Use green fuels and/or after-treatment technologies
  - diesel oxidation catalyst (DOC)
  - diesel particulate filter (DPF)
  - selective catalytic reduction (SCR)
  - diesel multistage filter (DMFs)
- Improve efficiency of site activities
- Do more site characterization
- Optimize injections and monitoring plans

Lessons Learned

- **Greatest Footprint**
  - –aggressive and energy intensive technologies
- **Greatest risk of accidental injury**
  - –operation of large equipment
- **ISCR, ISCO and Enhanced Bioremediation Footprints**
  - –production of the material injected into the subsurface for remediation
  - –transportation of personnel and equipment

Take Home Message

- Don’t just focus on the numbers
- GSR considers
  - Environmental and Social Responsibility

Questions?

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