Moving Towards Sustainable Remediation: Optimization Concepts and Strategy

Daniel M. Powell, Chief
Technology Integration and Information Branch
US EPA, Office of Superfund Remediation and Technology Innovation
Washington, DC

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Optimization History: a Recap

- **EPA Optimization starts circa 1997**
- **Remediation optimization techniques, practices & experience grow through late 90's and 2000s (ongoing today)**
- **EPA-USACE-USAF collaboration during 2000's refines practice.**
  - » Standardizations emerge. Optimization takes hold
  - » ITRC guidelines. EPA web presence established.
  - » By 2010 ~100 sites assessed with EPA mission support contract & USACE
- **"National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion' is signed 9/28/2012**

Optimization- An Expanding Concept

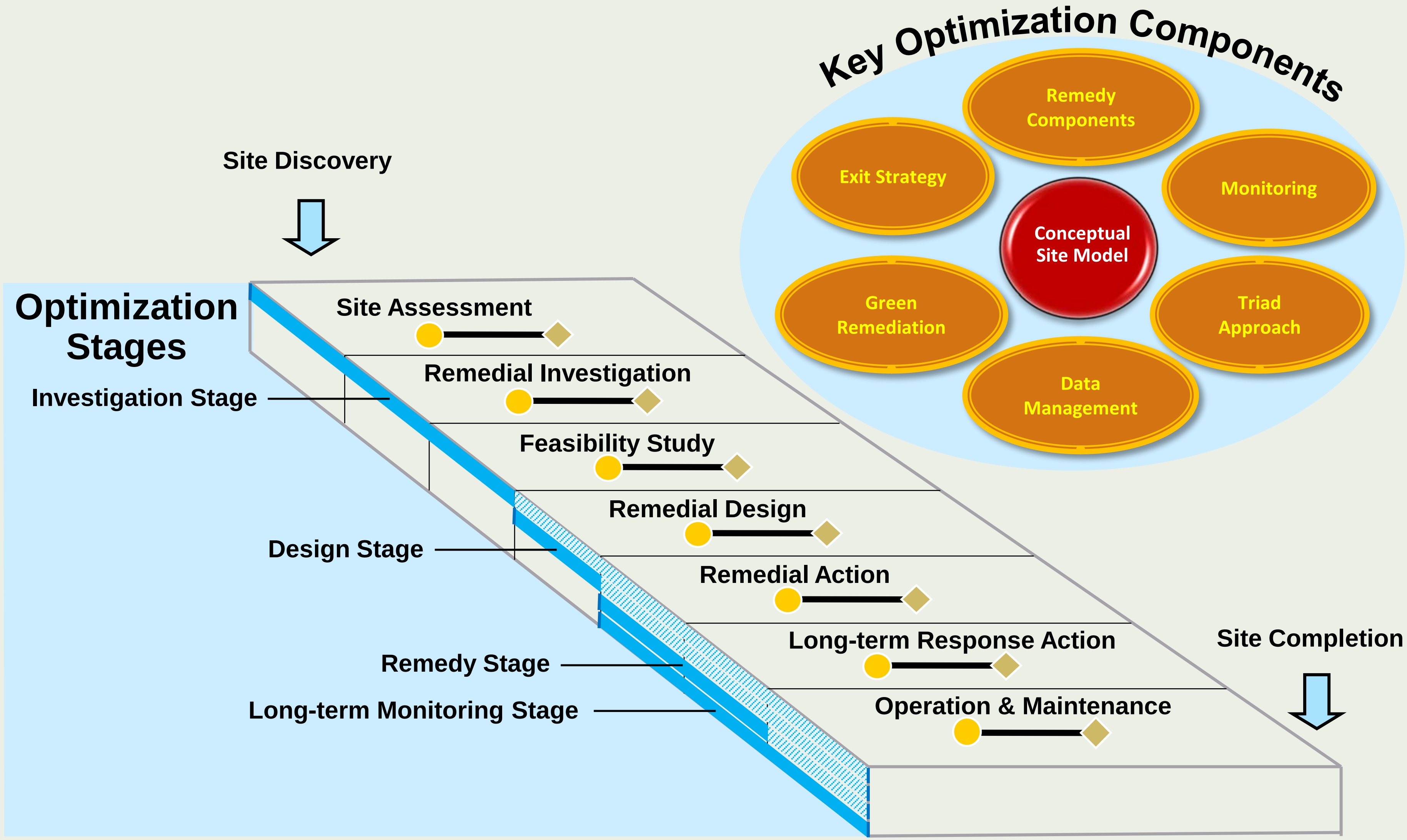
Late 1990's	2000-2011	2012 Optimization Strategy
System	Site-wide	Process/ Program
Engineering	Project Management/ Remedial strategy	Institutional change

Optimization defined

- Efforts at any phase of the removal or remedial response to identify and implement specific actions that improve the effectiveness and cost-efficiency of that phase. Such actions may also improve the remedy's protectiveness and long-term implementation which may facilitate progress towards site completion. To identify these opportunities, regions may use a systematic site review by a team of independent technical experts, apply techniques or principles from Green Remediation or Triad, or apply other approaches to identify opportunities for greater efficiency and effectiveness

National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion (OSWER Directive 9200.3-75)

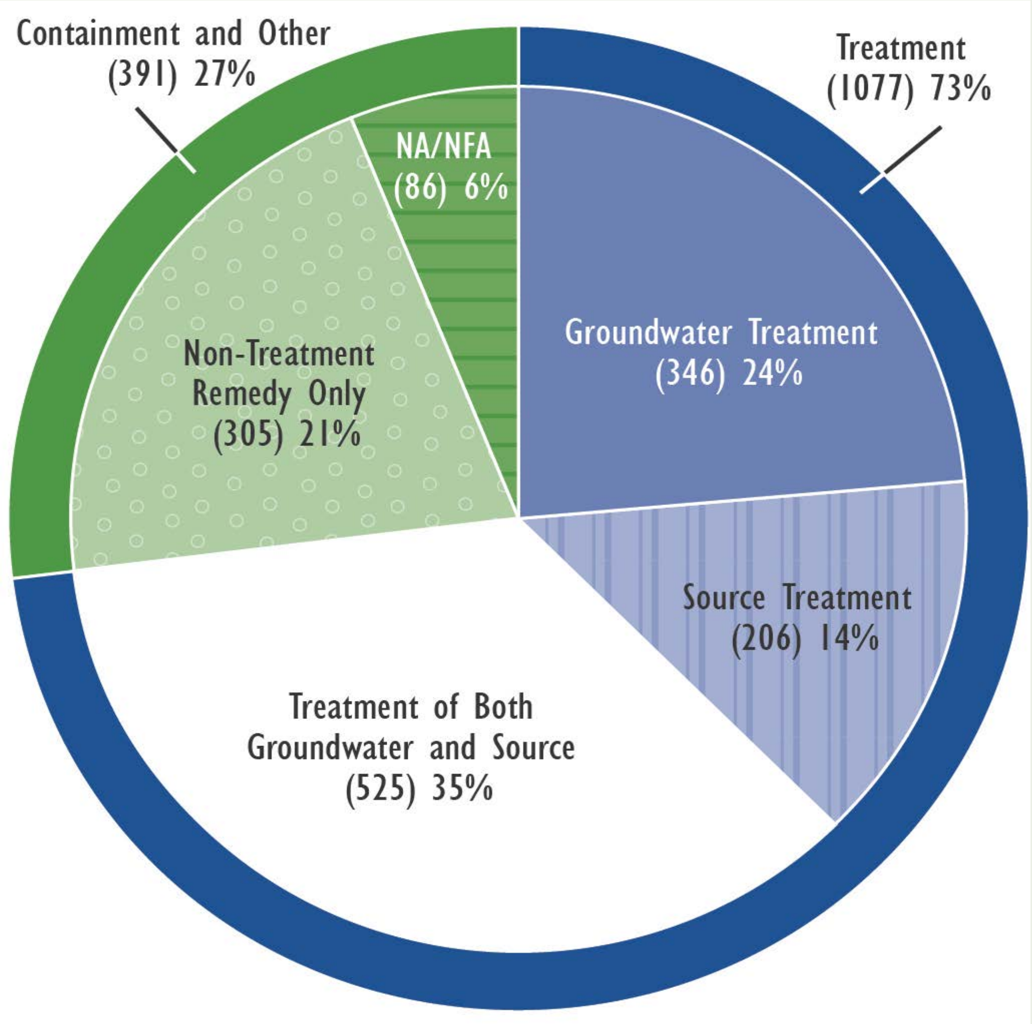
"Any Phase"


Key Optimization Components
Remedy Components
Exit Strategy
Monitoring
Conceptual Site Model
Green Remediation
Triad Approach
Data Management
Site Discovery
Optimization Stages
Site Assessment
Remedial Investigation
Investigation Stage
Feasibility Study
Remedial Design
Design Stage
Remedial Action
Long-term Response Action
Site Completion
Remedy Stage
Operation & Maintenance
Long-term Monitoring Stage

Optimization and Sustainability

- **Environmental Footprint Reduction/Sustainability**
  - Optimization offers the ability to address:
    - Energy use
    - Air/water impacts
    - Materials/waste
    - Land and Ecosystems/land reuse
- **Program Sustainability**
  - Optimization offers the ability to address:
    - Reduced budgets/staffing while maintaining protectiveness
    - Requirements for LTRA sites/ controlling costs (e.g., project management)
    - Continued workload and expectations
    - Complex sites: Disappearing "low hanging fruit"
    - Adapting to evolving technologies and knowledge

Remediation: The "Big Picture"- Remedy Types at National Priority List Sites



Total number of sites with remedies = 1,468, 1982-2011

Groundwater Remedy Types Recently Selected in Superfund

- Groundwater pump and treat still common, but we see more in situ treatment remedies
- Monitored natural attenuation is used either alone or in combination
- Concept of "adaptive management" gaining ground: Actively monitoring operating systems to determine optimal transition time and place between remedy components

Remedy Type and Technologies	Total (FY09–11)	Percent (FY09–11)
Groundwater Pump and Treat	**44**	**12%**
In Situ Treatment of Groundwater	**78**	**21%**
Bioremediation	49	13%
Chemical Treatment	27	7%
Air Sparging	14	4%
Permeable Reactive Barrier	8	2%
In-Well Air Stripping	2	1%
Multi-Phase Extraction	2	1%
MNA of Groundwater	**56**	**15%**
Groundwater Containment (VEB)	**6**	**2%**
Engineered (Constructed) Wetland	**3**	**1%**
Other Groundwater	**177**	**49%**
Institutional Controls	173	48%
Alternative Water Supply	13	4%
Engineering Controls	2	1%

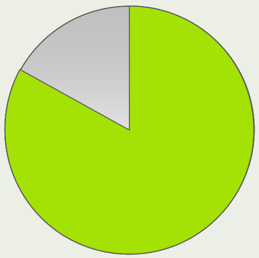
National Strategy Focuses on Implementing Optimization Lessons Learned from Previous Studies

- **Technical**
  - Access to technical expertise to regularly evaluate performance
  - Maintain accurate, updated conceptual site models, understanding of data gaps
  - Improve data management; consistency
  - Ensure clear articulation of remedial action objectives, exit strategies; revisit/ review throughout project life cycle
- **Programmatic**
  - Better tracking of recommendations, cost savings
  - Assess/address contractor incentives to reduce costs; improve competition
  - Incorporate more regular technical reviews throughout project life cycle
  - Maintain emphasis on independent third party perspective

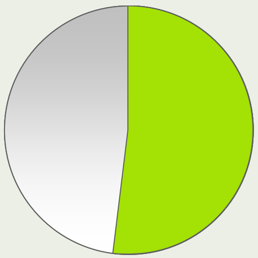
Optimization: Revisiting long-term remedies

Analysis of 52 of 150 optimized sites in Superfund

- Cost savings



83% cost savings opportunities

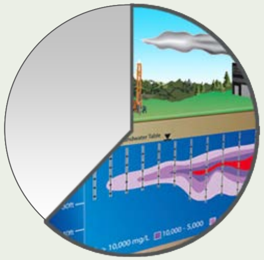


52% cost savings opportunities > $1 million

- Improved protectiveness

19% eliminate or confirm no ecological exposures

33% eliminate or confirm no human exposures



62% improve or confirm control of plume migration

Similarly positive findings for the other 98 optimized sites…

**More than 40% of sites evaluated recommended additional characterization.

Combined with trends toward increased use of *in situ* remedies - indicates need for high-resolution site characterization.

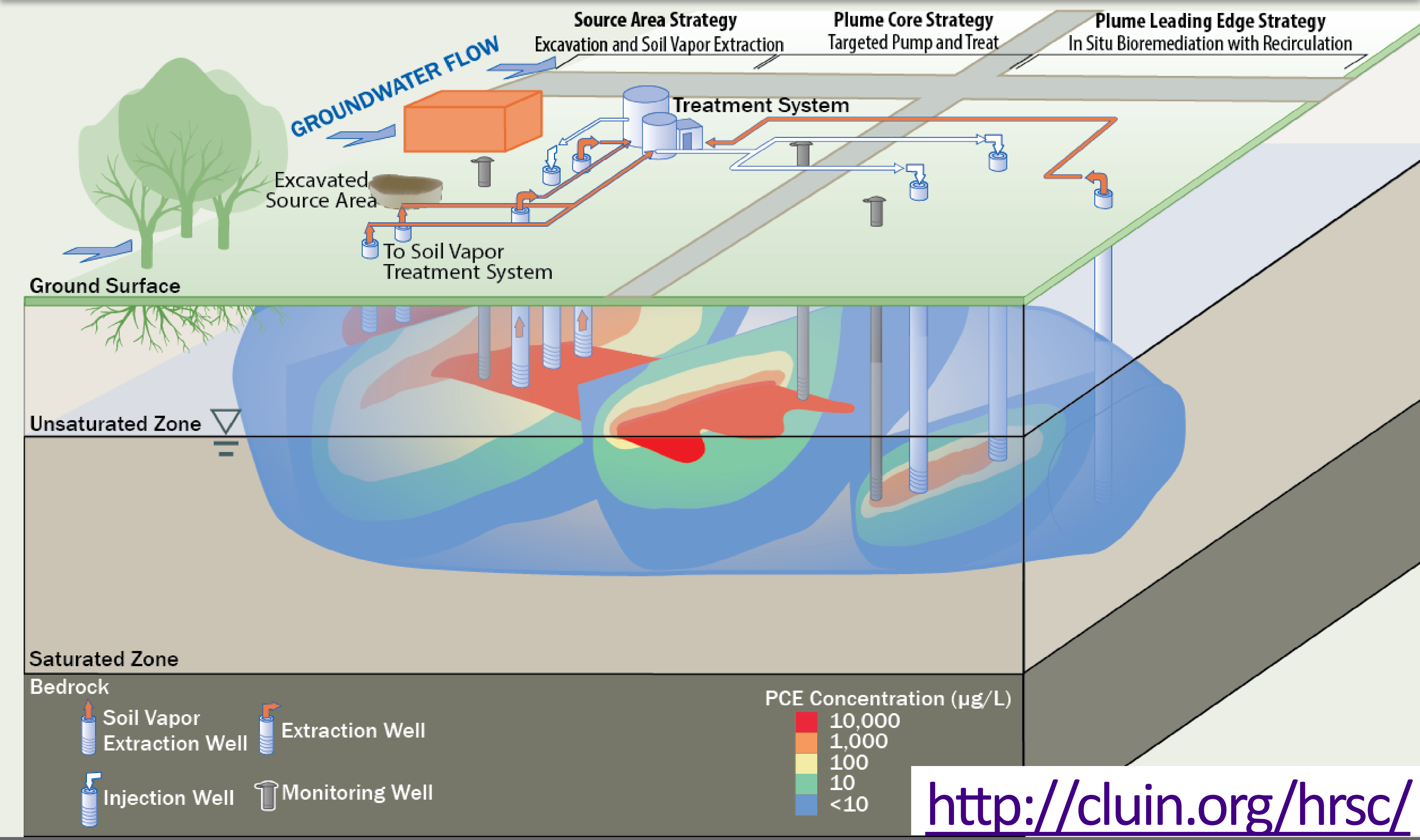
New Technologies Drive Project Management Changes

- Use of improved field sampling and analytical technologies yield abundant, reliable, and relatively inexpensive field data
- Traditional cycle of demobilizing to update the conceptual site model negates benefits of real-time information, use of CSM as a tool to actively guide decision making (linear vs. living model)
- A dynamic work strategy (DWS) is needed to identify and eliminate data gaps and test the CSM, in the field
- So we now begin with systematic planning to develop baseline CSM, identify data gaps, and develop DWS

High-Resolution Site Characterization

- Site heterogeneities control contaminant distribution and transport and fate
- High-res site characterization ensures scale of site measurements (i.e., location, number, and type of samples and data points) is appropriate for scale of heterogeneity by accounting for site variability
- Method provides the degree of detail required to understand:
  - Exposure pathways, fate of contaminants, contaminant mass distribution and flux by phase and by media, and how remedial measures will affect the problem
- A growing portfolio of new technologies & practices

HRSC: Improved site characterization and remedy design, operation and performance tracking



http://cluin.org/hrsc/

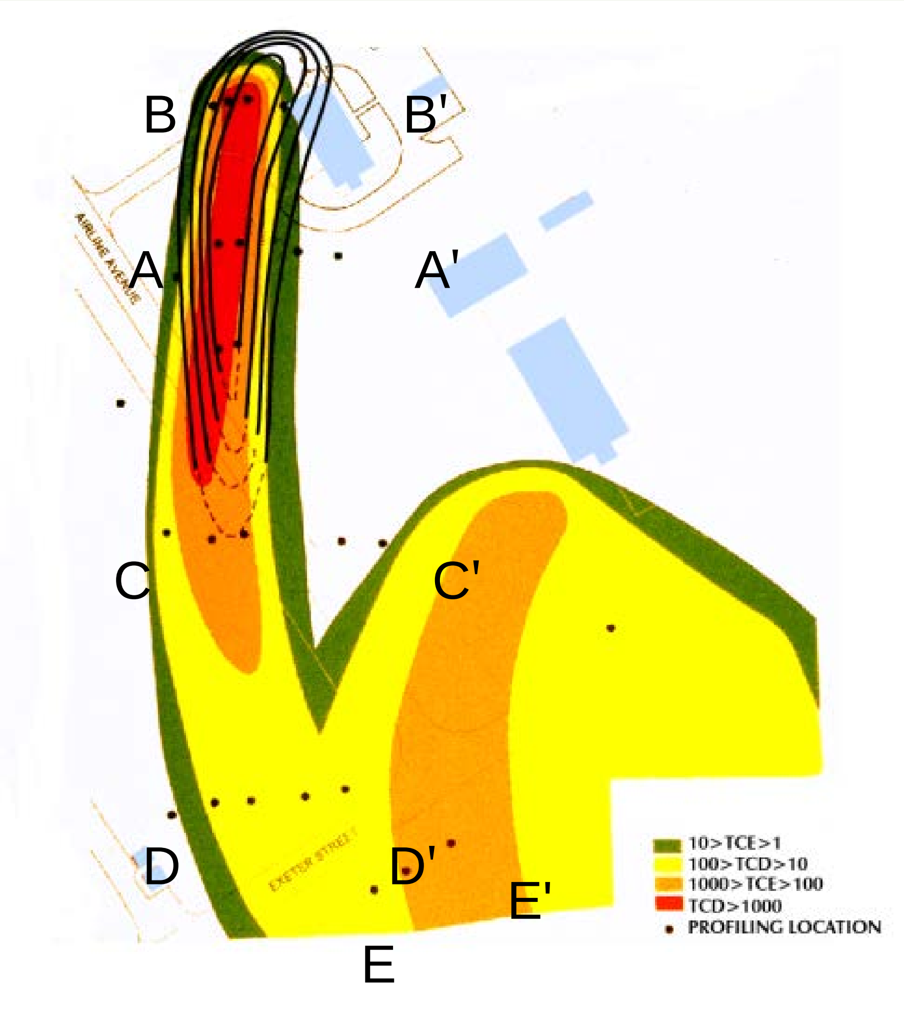
Green *Remediation* Starts with Effective *Characterization*

- **Green remediation is a "life cycle" concept (assessment to close-out/reuse)**
- **Characterization occurs throughout life cycle of project**
- **High resolution or optimized assessment and investigation processes can support green remediation can minimize footprints by:**
  - » Reducing energy use, material consumption, waste generated, carbon during field sampling events (moderate impact, may be greater impact)
  - » Reduce need for repeated events (moderate to significant impact)

Green *Remediation* Starts with Effective *Characterization*

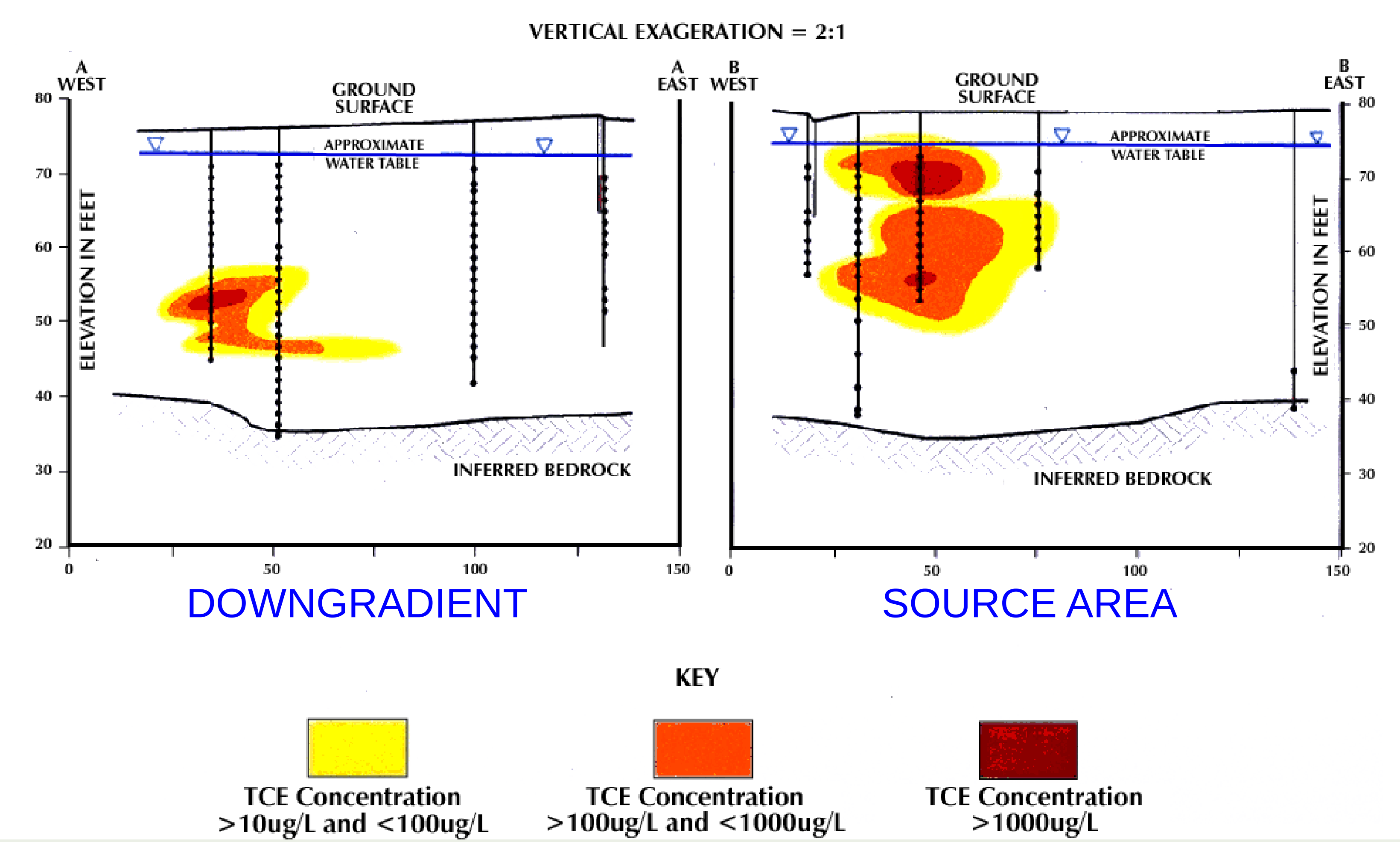
- **High resolution or optimized assessment and investigation processes can support green remediation, can minimize footprints by: *(cont.)***
  - Impacting efficiency of clean-ups
    - Reducing amount of material excavated, footprint and energy use of excavation
    - Improve source treatment – more effective targeting (e.g., oxidants, surfactants, heat, etc.)
    - Improved (optimized) operation of treatment and monitoring systems
    - Remediation timelines
    - ***BIG IMPACT***

Transect Case Study: Secondary Groundwater Plume Characterization, Pease AFB, NH

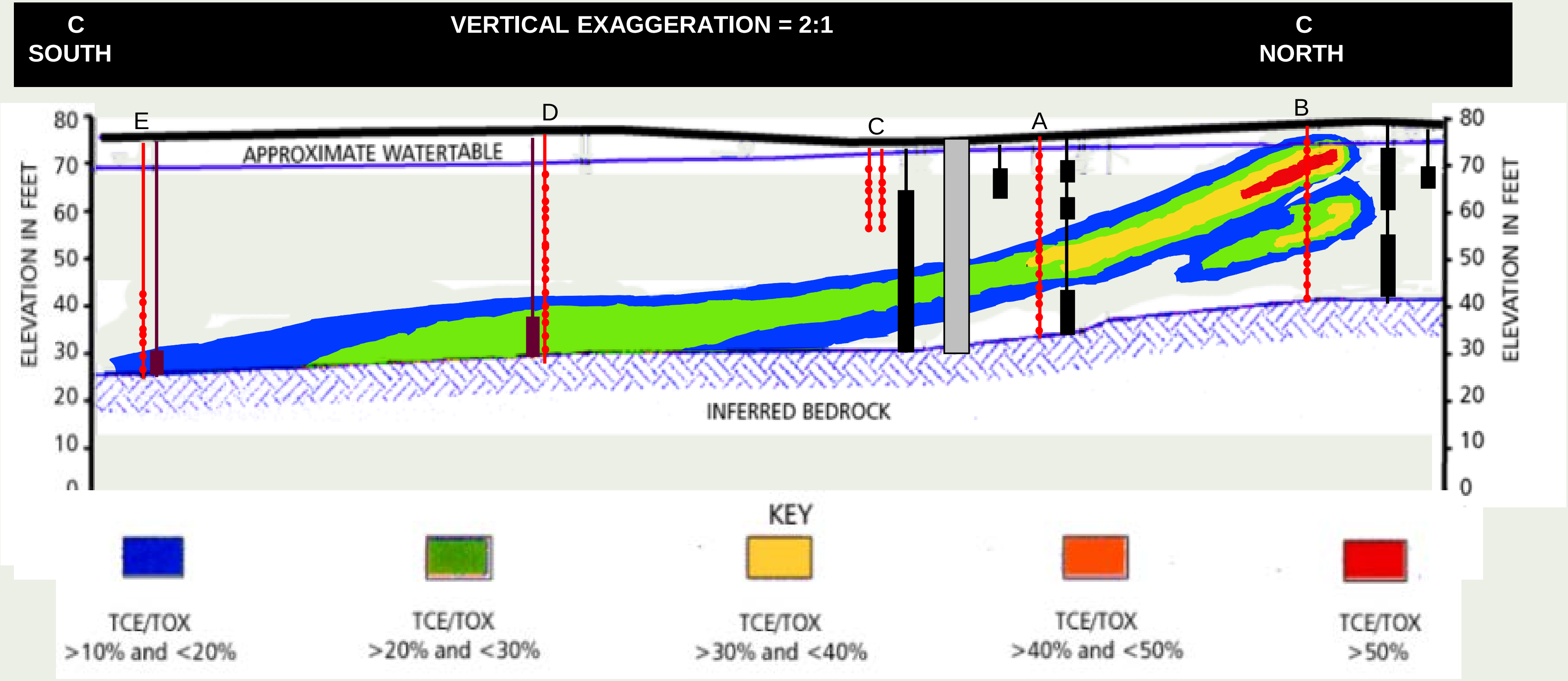


- **VOC and POL release site**
- **VOCs potentially affecting two bedrock supply wells**
  - Concern over DNAPL in bedrock
- **Prior monitoring well investigation did not accurately characterize the plume**
  - Defined as “short plume”
- **5 Modified Waterloo Profiler transects performed normal to plume axis**
  - A - A’ = Downgradient of source
  - B - B’ = Through source area
  - C - C’ / D - D’ / E - E = Downgradient plume delineation

Profiler Cross Sections Showed TCE Plume was Sinking with Distance from Source



Vertical Profiling vs. Monitoring Well



Prior Investigation Monitoring Well | Stone Profile | Stone Monitoring Well

FY 2013-14 Focus on Mining Sites

- **Scope of the problem**
  - Conceptual site models (CSM)
  - Characterization challenges
  - Clean up goals, exit strategies
- **Variable scale of site issues**
  - Mining district-wide / site-wide / OU-specific / treatment system-specific
  - Multiple watershed inputs and point of compliance determination
  - Background determinations for ecological & human health risk
  - Technical impracticability of remedies
- **Closure approaches**

Long-Term Water Treatment
Gilt Edge Mine

Anchor Hill Pit

- **Scope - OU 2: Site Water**
  - Acid Mine Drainage Collection and conveyance systems
  - Water treatment plant operation – HDS Plant
- **Site operations cost:**
  - $2 M to $2.5 M in 2012 (budget)
  - Average annual AMD generation of 97 MG

Long-Term Water Treatment
Gilt Edge Mine: Recommendations

- **1. Pre-treat remaining high-sulfate AMD in Pits**
  - Previous recommendations for a larger clarifier on WTP for high sulfate
  - After study, realized some OU1 RA issues with generating more sludge in the pits (need to dry and fill the pits for OU1)
  - Tested slowing down WTP to 100 gpm - got gypsum to precipitate in clarifier rather than filters
- **2. Upgrade Hoodoo Gulch collection facility**
  - Most vulnerable to power outage, difficult access road & snow clearing
    - Added additional tank for extra storage capacity
    - Adding Auto Start Generator
    - Will add back up pump

Long-Term Water Treatment
Gilt Edge Mine: Recommendations

- **3. Eliminate overnight staffing, reduce labor force and operate in batch mode**
  - Implemented with additional winter protections at collection facilities
    - Average water year can be ~8 months of treatment
    - Still full time staff during WTP operation
    - Working on remote control of WTP and collection pumps
- **4. Reduce Sampling Frequency**
  - Sample collection and monitoring frequencies were excessive considering history, understanding of site and field parameter sampling

Long-Term Water Treatment
Gilt Edge Mine: Recommendations

- **5. Do not add/rebuild/replace/relocate WTP and regularly evaluate collection system pumping requirements**
  - Anticipate that OU1 RA (surface waste consolidation) will:
    - Decrease average AMD generation from 97 MG to 30 MG
    - Change in WQ and collection locations anticipated
  - Wait until after the OU1 RA construction to see the resulting water quality, quantity and impacts to ground and surface water
- **6. Make Minor WTP Changes**
  - Identified the multi-media filters (just before discharge) as the most sensitive part of the plant

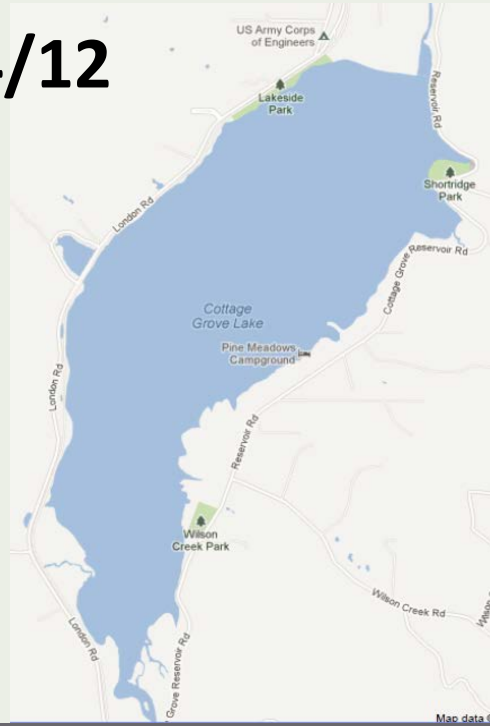
Gilt Edge Mine: Lessons Learned

- **Opened conversation lines for State and EPA and Site Contractor**
  - On issues that had been assumed for a long time (that we had to have 24 hour staffing)
  - On issues where we had been spinning our wheels (moving the WTP now or later)
- **Third Party Benefits–**
  - Bring experience from many other sites
  - Listen to operations staff's observations
  - Ask questions that had not been asked before
- **2013 Work Plan**
  - ~ $350K less than 2012

Clarifier in HDS system

Black Butte Mine

- ♦ Hg mining operation 1880's-1969
- ♦ Significant work completed under Removal
- ♦ RI Optimization focused on CSM, streamlini principal study question/data collection
- ♦ Site visit 1/10/12, recommendations 2/24/12

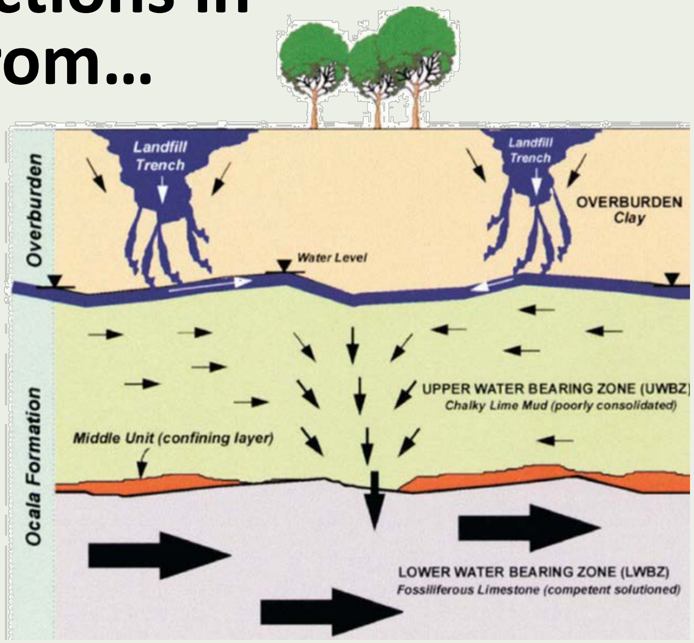


Black Butte Mine

- **Preliminary Findings**
  - Leverage existing data, update CSM, DMA for analytical
  - Evaluate media and source control at BBM/Garoutte Creek
  - Reservoir restoration longer term
    - Watershed sources, global Hg pool, Hg in stocked fish
    - Potential reservoir management options to limit Hg methylation
  - RI contracting, systematic planning vs. work plan scoping/approval

Summary: Leveraging innovation efficient remedies with a lower environmental footprint

- **Cost effectiveness and large reductions in environmental footprints come from…**
  - » Accurate CSM
  - » Well-characterized source areas and contaminant plumes
  - » Optimal remedial strategy
  - » Adaptive management
  - » Streamlined, regular performance monitoring



- **Further footprint reductions are achieved applying green remediation best management practices**
- **As a result, we sustainably protect human health and the environment prepare sites for reuse**

Information and Resources: EPA Resources

- **Guidance Documents**
- **Free Technical Webinars**
- **Technical Bulletins**
- **Fact Sheets**
- **Completed Optimization Reports**
- **Technology Descriptions/Tools**
- **Background Information**
  - Optimization Primer
  - HSRC/Traid best practices
    - Systematic Planning
    - Demonstrations of Methods Applicability
    - Conceptual Site Models

Hazardous Waste Clean-Up Information (CLU-IN)
www.cluin.org/
Superfund Remedies Report
www.cluin.org/asr
US EPA
www.epa.gov/oswer/greenercleanups

Optimization
cluin.org/optimization

High Resolution Site Characterization
http://cluin.org/characterization/technologies/hrsc/

Thank You!

Dan Powell
powell.dan@epa.gov

EPA Office of Superfund Remediation and Technology Innovation

US EPA, Washington DC

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