Best Practices for Treatment Optimization

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Office of the Deputy Assistant Secretary of Defense for Environmental Management and Restoration

July 23, 2025

WEBINAR RULES

- Please use the **chat** function for general discussion and answering check-in questions.
- Please use the **react** function to engage throughout the webinar.
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Note: This training is being recorded, and the recording will be posted online at https://www.denix.osd.mil/derp/. The views and opinions expressed in this presentation are those of the presenters and do not necessarily reflect the official position, policy, or endorsement of the Department of Defense (DoD).

AGENDA

Topic	Speaker(s)
Welcome and Opening Remarks	**Brian Jordan,** Office of the Deputy Assistant Secretary of Defense for Environmental Management and Restoration (ODASD(EMR))
Overview of DoD Component Treatment Optimization Processes	**Carl Harms,** U.S. Army Corps of Engineers (USACE) **Nathan Delong,** Naval Facilities Engineering Systems Command (NAVFAC) **Dr. Kent Glover,** Air Force Civil Engineer Center (AFCEC) **Dennis Shepard,** Alaska Department of Environmental Conservation (DEC)
Optimization Data Needs	**Carl Harms,** USACE **Dustin McNeil,** Colorado Department of Public Health and Environment (CDPHE)
Metrics to Evaluate Treatment Optimization	**Nathan Delong,** NAVFAC
Treatment Optimization Success Stories	**Dennis Shepard,** Alaska DEC **Dr. Kent Glover,** AFCEC
Open Discussion	**Brian Jordan,** ODASD(EMR)
Closing Remarks	**Brian Jordan,** ODASD(EMR)

SPEAKERS

- **ODASD(EMR): Brian Jordan** has over 28 years of experience in DoD cleanup programs and munitions response. His career includes 25 years of work in the USACE environmental programs, and he transitioned to ODASD(EMR) in the fall of 2021. He holds a degree in chemistry from too long ago to be relevant. Just so you are warned, he enjoys talking about data and initiatives to improve data management.
- **USACE: Carl Harms** is an environmental engineer at the Environmental and Munitions Center of Expertise (EM CX). He provides environmental engineering support for a broad range of DoD efforts, including environmental restoration, guidance programs, and training and mentoring. Carl is the EM CX's main point of contact (POC) for cleanup remedy optimization and value engineering. Carl worked as an environmental engineer in private consulting prior to joining USACE. He is a Professional Engineer licensed in the State of Nebraska.
- **NAVFAC: Nathan Delong** is the acting Installation Restoration Program Manager at NAVFAC Headquarters and is responsible for the Navy's Optimization guidance, policy, and reporting. He also provides program management for the Naval Installation Restoration Information Solution, which is the authoritative data repository for all the Navy's Environmental Restoration Program analytical data, geospatial data, and documents. During his time working for the Navy, he has also spent time as a Remedial Project Manager (RPM) and as an Environmental Compliance Engineer. Prior to joining NAVFAC, he worked in the private sector as an Environmental Field Engineer. He holds a M.S. in Environmental Engineering from George Washington University and a B.A. in Engineering from Lafayette College.

SPEAKERS (CONTINUED)

- **AFCEC: Dr. Kent Glover** is the Air Force subject matter expert (SME) for Remedial Systems Engineering and provides leadership in remedy selection, implementation, performance evaluation and optimization. He also provides expertise in contaminant fate-and-transport modeling and innovative technologies for characterization and remediation of complex sites and emerging contaminants. Before coming to the Air Force in 2010, he was a Principal Scientist for several engineering firms and served in the U.S. Geological Survey as a hydrologist. He holds a Ph.D. and M.S. in Environmental Science and Engineering from Colorado School of Mines and a B.S. in Watershed Science from Colorado State University.

- **Alaska DEC: Dennis Shepard** is a Geologist with the DEC in the Contaminated Sites Program. He serves as the state's Defense and State Memorandum of Agreement (DSMOA) Program Manager. Dennis has worked in the environmental field for more than 20 years, first as a lead Staff Geologist for an environmental consulting company and then the last 13 years as a Project Manager in the DoD Section of DEC's Contaminated Sites Program. During his career he has served as the state's RPM on two Superfund listed sites and oversaw implementation of both active and passive remediation approaches for contaminated sites. He has a B.S. in Geology from the University of Alaska, Fairbanks and has lived and played in Alaska for the last 45 years with his wife Ronda and two children (Amber and Gavin).

- **CDPHE: Dustin McNeil** is the Unit Leader of CDPHE's Federal Facilities Remediation and Restoration Unit and serves as the primary state POC for Colorado's DSMOA. Dustin has been with CDPHE since 2018, overseeing investigations and remedial actions at Federal Facility and Superfund sites in Colorado. He previously worked for 17 years as a Geologist and Project Manager, conducting investigations and remedial actions at private sector and DoD sites nationwide under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA). He has a B.S. in Natural Resource Management from Colorado State University and has lived in Colorado since 1996.

DEFENSE ENVIRONMENTAL RESTORATION PROGRAM (DERP) OVERVIEW AND WEBINAR GOALS

DERP OVERVIEW

- DoD is committed to protecting human health and the environment and conducts cleanup under Federal law through the DERP.[1]
- DERP addresses hazardous substances, pollutants or contaminants, and munitions [2] at active installations, Formerly Used Defense Sites (FUDS) properties,[3] Base Realignment and Closure (BRAC) locations, [4] and National Guard sites in the United States.[5]
- DoD conducts cleanup under CERCLA and its DERP authorities (e.g., as a lead agency).
  - Response actions pursuant to DERP must comply with CERCLA.
  - DoD may also conduct cleanup pursuant to other applicable federal laws (i.e., RCRA Corrective Action).

[1] DERP (10 U.S. Code [U.S.C.] sections 2700-2711) and CERCLA (42 U.S.C. sections 9600-9675)

[2] Munitions are addressed at closed (non-operational) ranges under the Military Munitions Response Program.

[3] FUDS are properties that were formerly owned by, leased to, or otherwise possessed by the United States and under the jurisdiction of the Secretary of Defense prior to October 17, 1986.

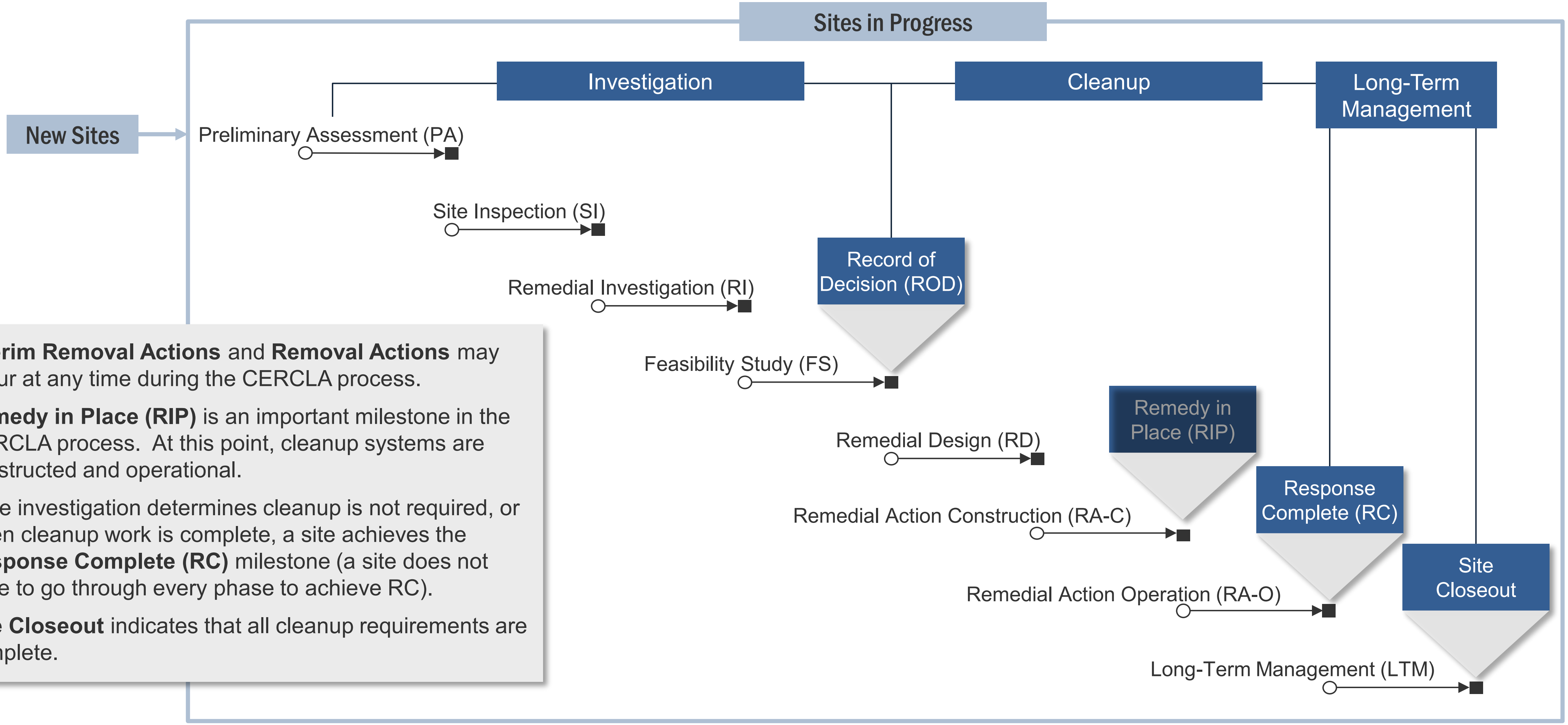
[4] BRAC locations were authorized for closure or realignment by Congress under one of the five BRAC rounds.

[5] Pursuant to Section 312 of the National Defense Authorization Act for Fiscal Year 2024, National Guard sites are now eligible for cleanup under DERP.

DERP PROCESS: GENERAL

- DoD must follow the CERCLA cleanup process to identify, investigate, and respond to releases.
- Cleanups under CERCLA or RCRA Corrective Action will substantively satisfy the requirements of both programs.
- All cleanup actions are prioritized using a long-standing nationwide risk-based approach.
- DoD works with Federal, State, and local governments and the public to select its cleanup actions.
- For more information visit: https://www.denix.osd.mil/derp/.

DERP PROCESS: PHASES AND MILESTONES



- **Interim Removal Actions** and **Removal Actions** may occur at any time during the CERCLA process.
- **Remedy in Place (RIP)** is an important milestone in the CERCLA process. At this point, cleanup systems are constructed and operational.
- If the investigation determines cleanup is not required, or when cleanup work is complete, a site achieves the **Response Complete (RC)** milestone (a site does not have to go through every phase to achieve RC).
- **Site Closeout** indicates that all cleanup requirements are complete.

TREATMENT OPTIMIZATION DEFINITION AND DOD'S INTEREST

- **Treatment Optimization**
  - Efforts to identify and implement specific actions that improve the effectiveness and cost-efficiency of the remedy
  - Actions may also improve the remedy's progress towards site completion
  - Involves balancing costs and performance to ascertain the best value
- **Key Aspects**
  - Involves independent, expert multi-disciplinary teams
  - Applies to all phases in a project's lifecycle
  - Evaluates conceptual site models (CSMs)
  - Evaluates site goals and closure and/or exit strategies
- **DoD's Interest** Treatment optimization allows the Department to:
  - Better protect the environment and public health
  - Reduce DERP program and project costs
  - Meet and exceed DoD cleanup goals
  - Implement more sustainable remedies

PARTICIPANT ENGAGEMENT

1. **Which phases of the CERCLA process would most likely include an optimization component?**
   a) PA/SI, LTM, RC
   b) RI, FS
   c) RD, RA-O

2. **When might you use design and remedy optimization in LTM?**

Please answer the check-in questions now!

Questions?

TREATMENT OPTIMIZATION TRAINING GOALS

Purpose:

- Provide a high-level overview of Treatment Optimization
- Engage with the DoD Cleanup Community, including State regulators, to discuss how the Department conducts Treatment Optimization
- Outline data and metrics evaluated during Treatment Optimization efforts
- Present successes in Treatment Optimization

Note: This training provides guidelines and an overview of Treatment Optimization but is not intended to be comprehensive. Attendees may need to consult additional resources to optimize cleanup efforts at their sites. The views and opinions expressed in this presentation are those of the presenters and do not necessarily reflect the official position, policy, or endorsement of the Department of Defense.

OVERVIEW OF DOD COMPONENT TREATMENT PROCESSES

TREATMENT OPTIMIZATION POLICIES

DoD-Wide Optimization Policies and Guidance:

DERP Manual | Office of Management and Budget Circular A 131
U.S. Environmental Protection Agenda (EPA) 5-Year Review Guidance

Dept. of the Army/USACE

- Engineer Regulation 200-3-1 (September 2020)
- FUDS Handbook, Section 4.3.10 (December 2022)

Dept. of the Navy (DON)

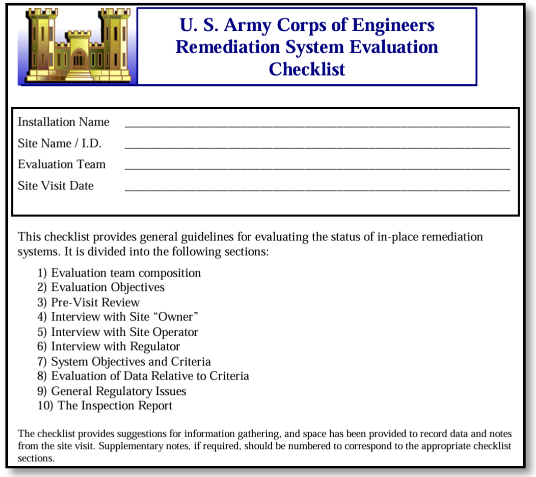
- DON Policy for Optimizing Remedial and Removal Actions at all DON Environmental Restoration Program Sites (April 2012)
- DON Environmental Restoration Program Manual (February 2018)
- NAVFAC Environmental Restoration, Navy Directive for Quality Document Review of DON Installation Restoration Program Sites (June 2018)
- NAVFAC Guidance for Remedial Alternatives Analysis (October 2020)

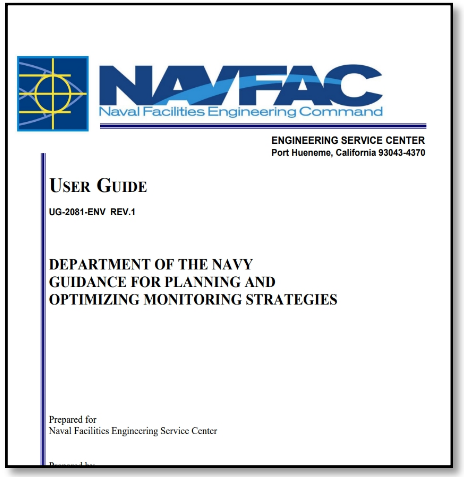
Dept. of the Air Force

- Environmental Restoration Program Optimization Guidance (August 2009)
- Policy for Refocusing the Air Force Environmental Restoration Program (February 2011)
- Department of the Air Force Instruction 32-7020, Environmental Restoration Program, Chapter 16, Performance Evaluation (May 2024)

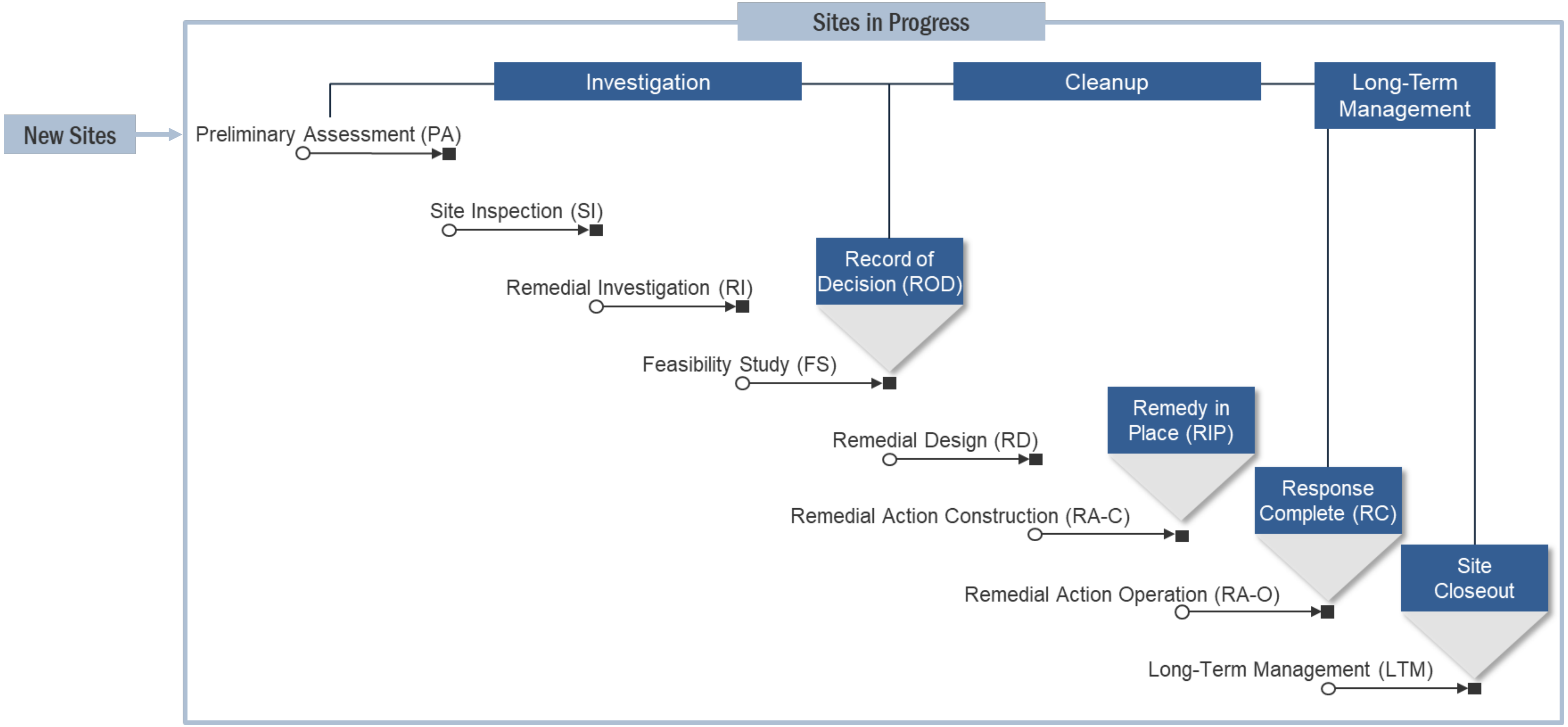
AVAILABLE TOOLS AND RESOURCES

- **ODASD(EMR) Resource** Treatment Optimization Resources Matrix
  - Compiles resources from DoD, Association of State and Territorial Solid Waste Management Officials, Interstate Technology and Regulatory Council (ITRC), U.S. Department of Energy, and EPA
  - Identifies the applicable CERCLA phase(s)
- **DoD Component Resources**
  - Remedy Optimization Checklists (USACE)
  - Remedy Optimization Factsheet (USACE)
  - Roadmap to Long-Term Monitoring Optimization (USACE)
  - Guide to Optimizing Monitoring Strategies (DON)
  - DON Optimization Webpage
  - Restoration Systems and Strategies (U.S. Air Force)
- **State Perspective** Alaska DEC refers to ITRC Optimization Resources:
  - Light Non-Aqueous Phase Liquid (NAPL) Site Management
  - Dense NAPL Site Strategy (DNAPL) Guidance Document
  - Measurement and Use of Mass Flux and Mass Discharge
  - Phytotechnology Technical and Regulatory Guidance

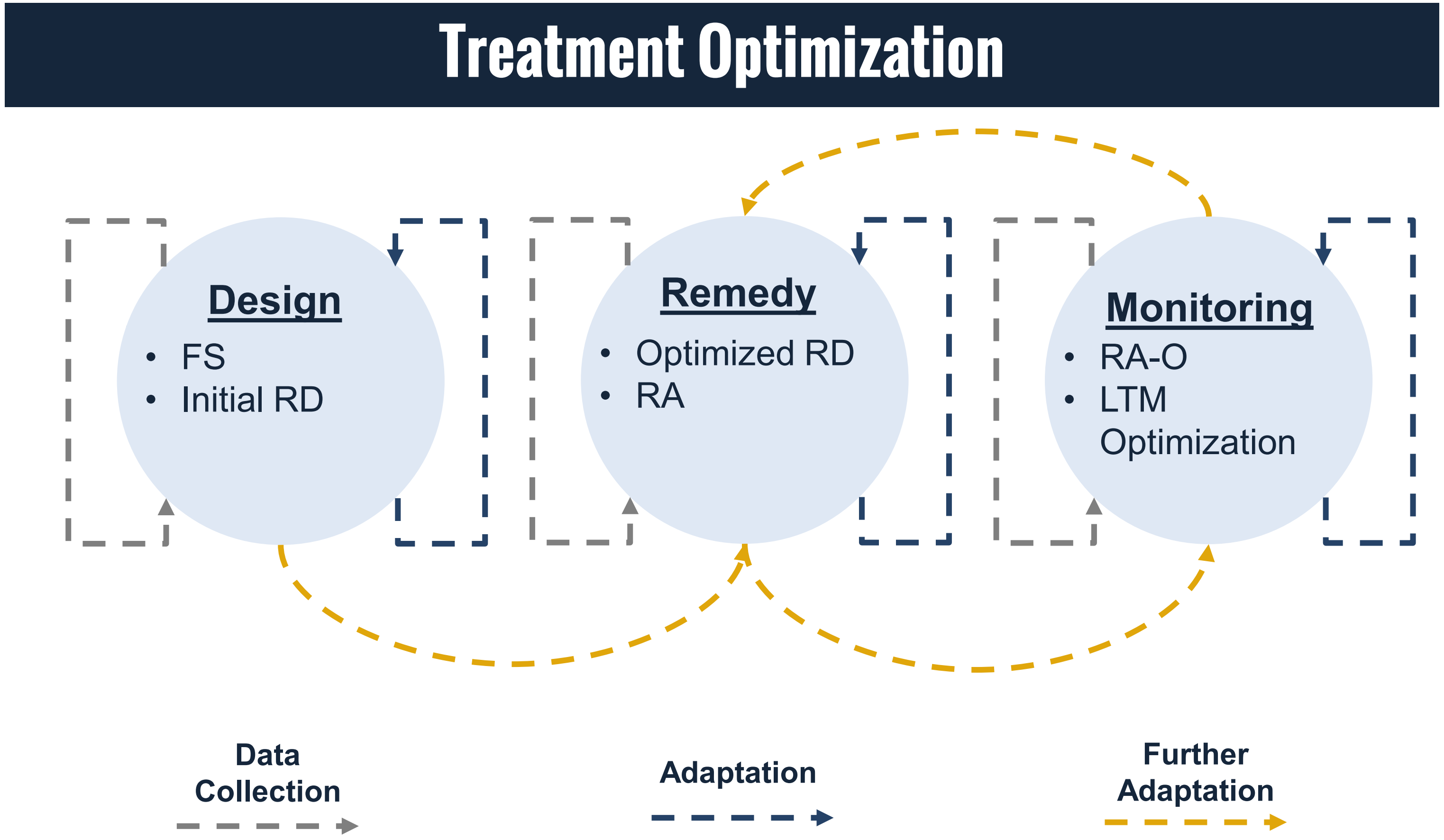




TREATMENT OPTIMIZATION CONSIDERATIONS



TREATMENT OPTIMIZATION CONSIDERATIONS



- Involves balancing costs with system effectiveness to achieve cleanup goals
- Applies to all phases in a project's lifecycle
- Should consider and adapt to changing site conditions, projected and actual costs, and stakeholder concerns
- May focus on the following stages, with each stage informing the next:
  - Design
  - Remedy
  - Monitoring

DESIGN OPTIMIZATION

<u>**Goal:**</u> Improve treatment design, enhancing operations and effectiveness while minimizing costs.

- Design optimization begins with the FS phase through the ROD and RD under CERCLA.
- It involves:
  - Evaluating existing standards, constraints, design criteria, and assumptions
  - Examining treatment components, processes, and control systems

Alternatives Panels; Independent Technical Reviews; Flexibility in FS and ROD

Remedial Alternatives Analysis (RAA) and Quality Document Review (QDR)

Technical Scoping and Reviews; Critical Process Analysis; Complex Site Initiative

Applicable or Relevant and Appropriate Requirements (ARARs); Restoration Advisory Boards (RABs)

DESIGN OPTIMIZATION (CONTINUED)

DON Design Optimization Approach:

RAA: Allows for an early and expedited optimization review of remedial alternatives to be analyzed in remedy evaluation documents.

QDR: Programmatically establishes consistent, high quality, and technically valid reviews for documents evaluating, selecting, or modifying a remedy.

Alaska DEC Perspective:

ARARs: Ensure optimized treatment system is compliant with applicable Federal and State requirements, including any substantive requirements in lieu of permits.

RABs: Assess community concerns and proposed treatment system assumptions.

Additional Considerations: Include limitations to remedy options due to site-specific issues (e.g., permafrost and wetlands); evaluation of the remedy's footprint; ability to collect data and address uncertainties; and contaminant migration in active zone water.

REMEDY OPTIMIZATION

Goal: Enhance the implementation and operation of selected remedies, ensuring cleanup objectives are effectively and efficiently achieved. Remedy optimization involves:

- Reviewing existing data and identifying data needs, including:
  - Costs associated with labor, materials, utilities, sampling, and management
  - Subsurface performance data (e.g., hydraulic, chemical)
  - Treatment performance metrics (e.g., pressure, flow, chemical)
- Evaluating performance towards cleanup goals, ability to prevent or reduce contaminant exposure and migration, and prevalence of maintenance issues.
- Refining CSM information, as needed.

Remediation System Evaluation

Guidance Documents - Optimizing Remedial Action Operation; Planning and Optimizing Monitoring Strategies

Remedy Optimization Checklists; Optimized Exit Strategy Compendium; Optimization Progress Reports and Case Studies; High-Resolution Site Characterization (HRSC)

ITRC, Internal, and Other Optimization Resources; CSM and Performance Data Reviews

REMEDY OPTIMIZATION (CONTINUED)

Air Force Remedy Optimization Approach

Performance Assessment: Validates and corrects progress toward contractual performance objectives.

Critical Process Analysis: Identifies critical remediation and fate/transport processes limiting progress of a remedial system, characterization to refine CSMs, and remedy enhancements to optimize progress.

Network Optimization: Evaluates to provide guidance for optimal and cost-effective remedy performance tracking.

Alaska DEC Perspective:

ITRC, Internal, and Other Optimization Resources: Used to determine data needs and to verify whether monitoring parameters appropriately measure progress toward cleanup goals.

CSM and Performance Data Reviews: Used to identify data gaps, reassess assumptions, and/or adjust remedy elements.

Experienced Technical Staff and SMEs: Used to assist project managers with remedy optimization efforts.

MONITORING OPTIMIZATION

<u>Goal</u>: Evaluate monitoring and system performance data more efficiently and cost-effectively. Monitoring optimization involves:

- Evaluating and adapting to changing conditions, including CSM updates
- Ensuring that optimization efforts align with overall remediation objectives (e.g., only collect necessary data; use Data Quality Objectives and Technical Project Planning; and consider timing and scope of decision-making)
- Considering the following focus areas:
  - Frequency of sampling and sampling technique(s)
  - Number and location of sampling sites
  - Type of analyses
- Developing a plan for site closure, considering:
  - Level of specificity for selected remedy
  - If monitoring points are needed to meet goals
  - Number of sampling events and statistical measures needed to meet goals

Annual monitoring costs typically range from $10,000s - $100,000s per site. Plan and prepare, sample and analyze data, validate and report.

Alaska DEC Perspective: Unique Environmental Considerations

Using the chat box…

MONITORING OPTIMIZATION (CONTINUED)

<u>Alaska DEC Perspective: Unique Environmental Considerations</u>

- **Large temperature changes through the year:**
  - Temperatures below freezing and/or below zero degrees Fahrenheit for nearly seven months each year
  - Limited field season for drilling, excavation, construction, and other optimization activities
- **Permafrost conditions present complex hydrologic considerations:**
  - Challenges and uncertainties delineating contaminant plumes
  - Significant changes in the water table each spring (e.g., sites near rivers may have 30-foot differences in their water tables between December and June)
- **Cold weather impacts on volatile organic compounds (VOCs):**
  - May present unique, operational challenges for vapor extraction technologies
  - May require exhaustion of vapors above ground surface to mitigate concentrations
- **Monitoring treatment system costs vary. Project Managers should consider:**
  - Mobilization to remote sites
  - Availability of local environmental firms
  - Short field seasons
  - Conditions to drill and access sites

PARTICIPANT ENGAGEMENT

What are some of the hurdles to performing optimization?

Please enter your answers in the chat box.

Human Resources

Funding

CSM Understanding

Contract Limits

Schedule

Data Completeness

BREAK

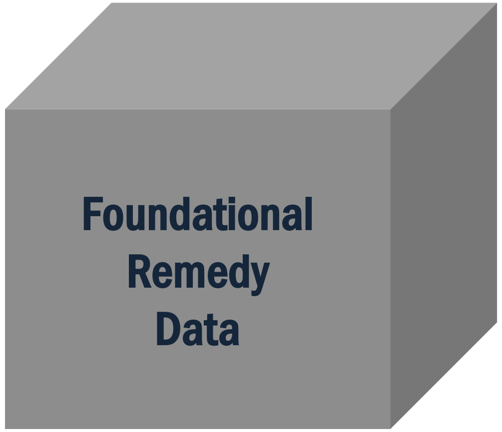
OPTIMIZATION DATA NEEDS

FOUNDATIONAL REMEDY DATA

Foundational Remedy Data includes:

- ROD(s) or Comparable Decision Document(s) (e.g., current RCRA permit)
- Changes to Selected Remedy (e.g., Amendments, Explanations of Significant Difference)
- Plans and Specifications, Design Analysis, and RA Work Plan
- Site Characterization Data (e.g., RI, Pre-Design Investigation, Bench/Pilot Test Reports, Post-Construction Subsurface Investigation Reports)
- Land-Use Control Implementation Plans (LUCIPs)
- Most Recent Five-Year Review or Periodic Review

Access to Project Data is **Key** for Independent Optimization Teams

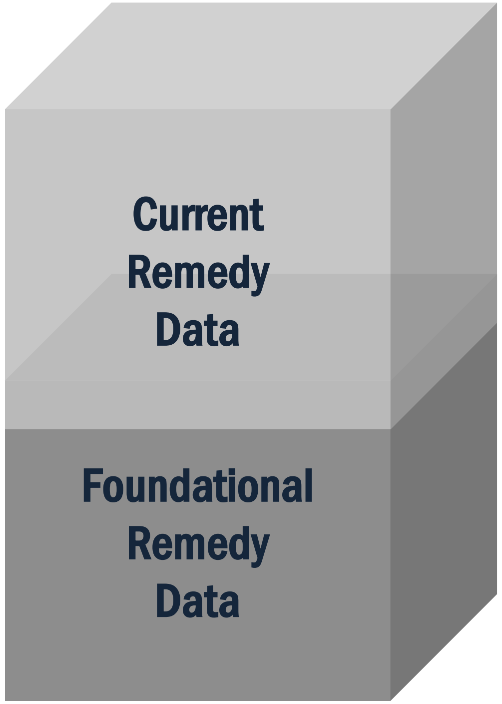


CURRENT REMEDY DATA

Current Remedy Data includes:

- Monitoring Program Quality Assurance Project Plan
- Data on Operations and Performance including Periodic Monitoring and Annual Reports
- Current Operation and Maintenance (O&M) Contract and All Modifications
- Current and Recent Past O&M Costs
- Groundwater Modeling Reports (if applicable)

Electronic database outputs are ideal!

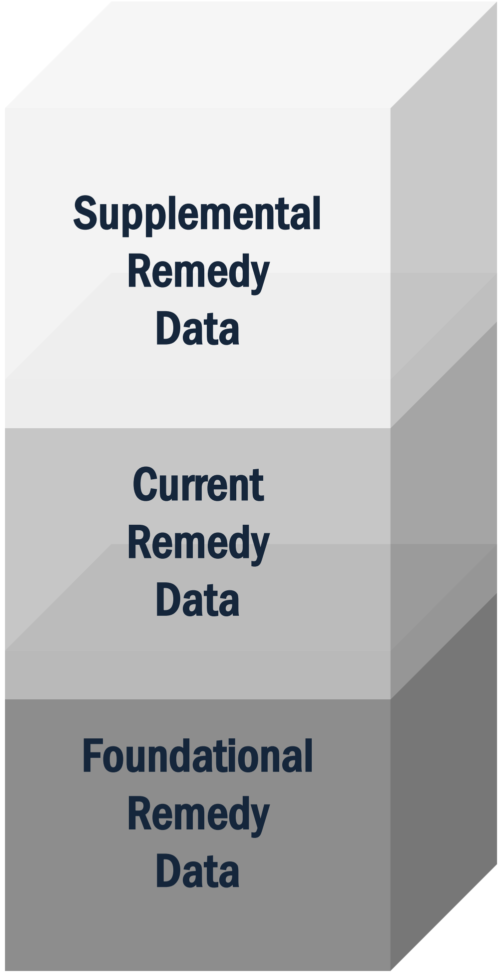


SUPPLEMENTAL REMEDY DATA

Supplemental Remedy Data includes:

- Optimization Site Visit Data (e.g., Checklists, Interview Records, Photos)
- Site Photos (if no optimization site visit)
- Regulatory Correspondence (e.g., reviews, letters, memos)
- Stakeholder Engagement
- Remedy O&M Data, which is Less Commonly Reported
  - The Optimization Team needs to know what questions to ask.
  - Refer to the Treatment Optimization Resources Matrix.

Transparency and Partnering;
Environmental Service Agreements;
Pilot Projects and Technical Innovation



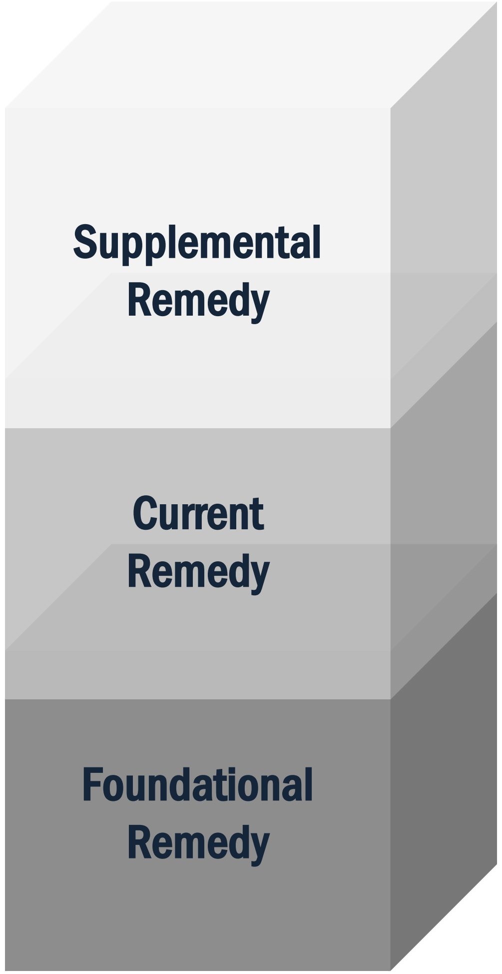
SUPPLEMENTAL REMEDY DATA (CONTINUED)

CDPHE Perspective:

- Collaborative efforts between a diverse group of stakeholders have significantly influenced DoD's decisions on cleanup strategies. At Peterson Space Force Base, these efforts encompass three key areas to ensure community health and environmental safety are prioritized:
  - **Transparency and Partnering** through coordination with interested community members, as well as Federal, state, county, and municipal organizations. Roundtable discussions also facilitated sharing technical expertise, remediation strategies, and outreach efforts to address community concerns.
  - **Environmental Service Agreements** with local municipalities to fund treatment systems. Agreements with Fountain, Security, Widefield, and Stratmoor-Hills exemplify collaborative approaches to reduce risks of contamination to these communities.
  - **Pilot Projects and Technical Innovations** through the evaluation of emerging technologies and data-driven approaches to address contamination, including collaboration on pilot studies that inform long-term remediation planning and adaptive management strategies.

PARTICIPANT ENGAGEMENT

Using the chat box…



METRICS TO EVALUATE OPTIMIZATION EFFORTS

TRACKING OPTIMIZATION EFFORTS
NORM OPTIMIZATION MODULE

- Navy optimization efforts are tracked in the Normalization of Data (NORM) Optimization Module.
  - Other DoD Components track this information in other methods.
- Record, Report, Recognize.
- Optimization can be updated any time, however…

Time	Responsibility	Action
All Year	RPM, Regulator(s), Navy Contractor	Identify, discuss, and approve potential optimization opportunities.
Mid to Late May	RPM	Add and/or update optimization events in the NORM Optimization Module.
Late May to Early June	Optimization and Technology Innovation (OTI) Work Group Member	Review ongoing optimization events for completeness and accuracy, and work with RPM to answer questions and make necessary edits.
Mid June to Early July	RPM, NORM POC, BRAC Program Management Office	Include optimization highlights in end-of-year budget submittal and run any applicable optimization reports.

TRACKING OPTIMIZATION EFFORTS
NORM OPTIMIZATION MODULE

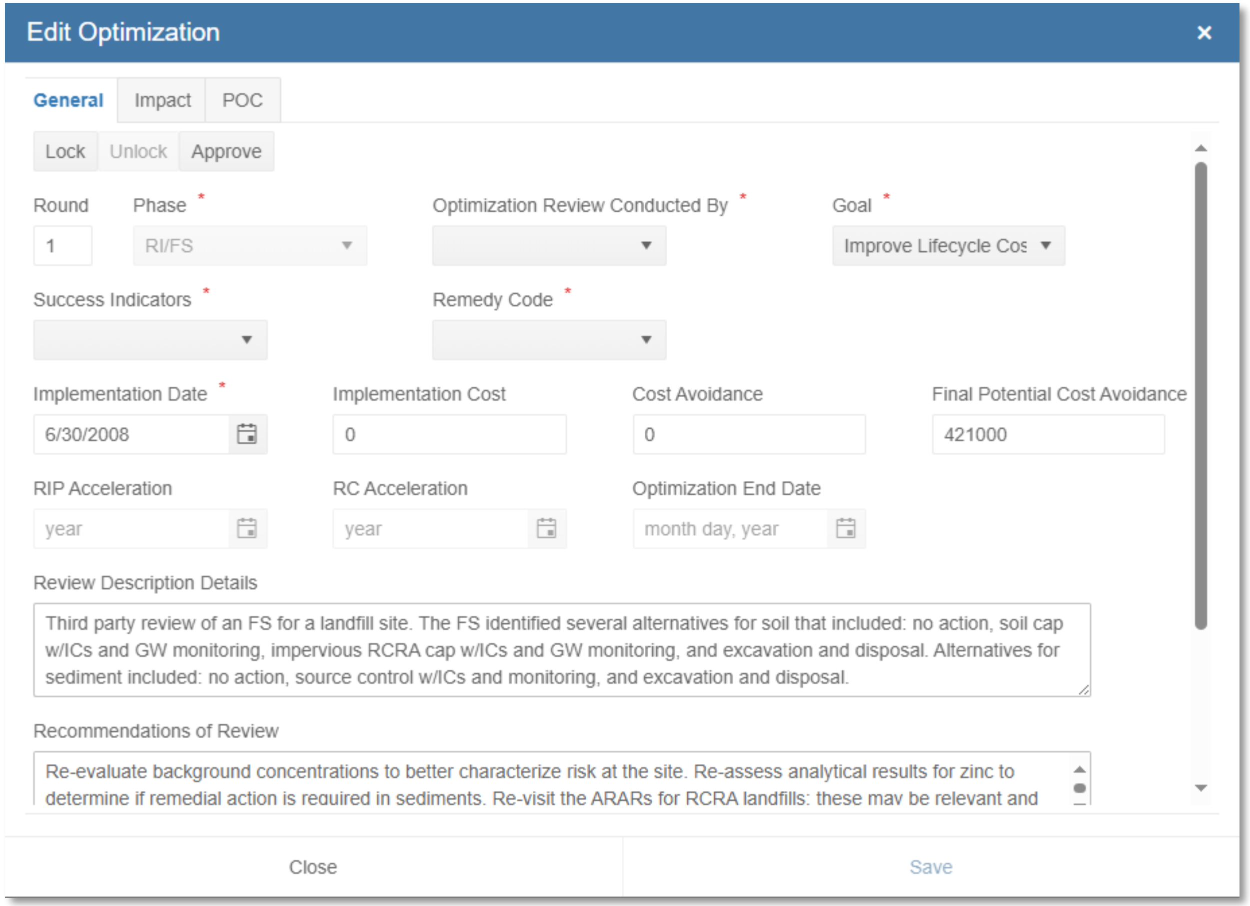
It takes a village to optimize your site…

Role	Responsibility
Navy Contractor	• Assist the RPM, as necessary, in evaluating optimization opportunities in all phases of the CERCLA process. • Provide estimated calculations and other relevant data to support optimization tracking and reporting.
Navy RPM	• Identify optimization efforts. • Provide and update optimization data in the NORM Optimization Module (e.g., annually, or as necessary).
Regulators	• Identify potential optimization opportunities. • Review data supporting optimization and provide comments.
Navy OTI Work Group Member	• Provide annual quality control and quality assurance for optimization efforts within the member’s specific region to ensure accuracy and completeness of the data.
Navy Echelon III Technical Support SMEs	• Review documents in accordance with QDR and RAA policies. • Provide recommendations on potential optimization efforts at relevant sites.
NAVFAC Headquarters	• Analyze and consolidate optimization data from the NORM module. • Report optimization efforts to Assistant Secretary of Navy and Chief of Naval Operations during the End of Year Budget Submit.

TRACKING OPTIMIZATION EFFORTS
NORM OPTIMIZATION MODULE – GENERAL TAB

Business Rules:

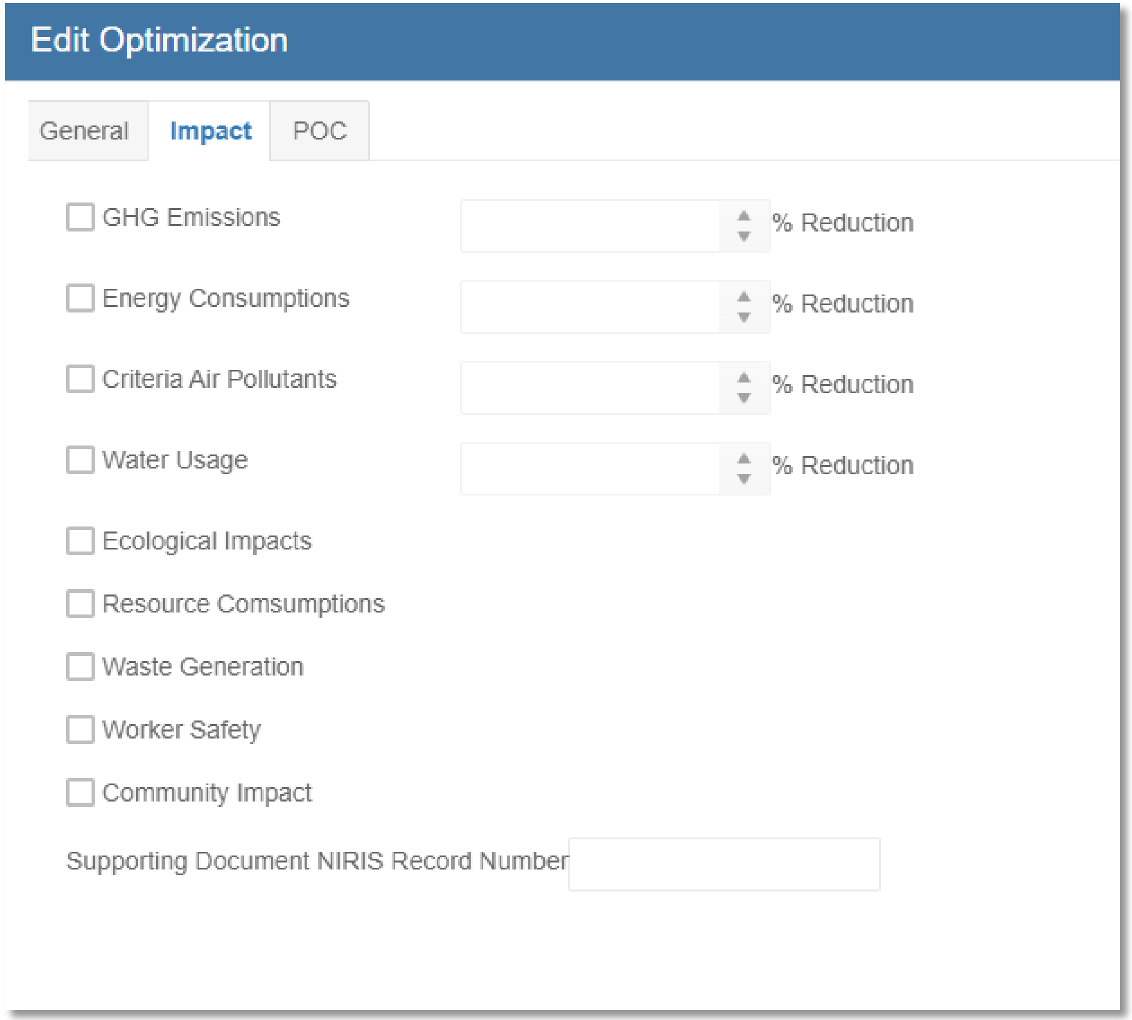
- Only have one open optimization event per phase at a time
- Focused goals to:
  - Accelerate milestones
  - Improve lifecycle cost and/or cost-to-complete (CTC)
- Report costs as totals, with annual costs for perpetuity sites multiplied by 30
- Conduct an annual third-party review of open optimization events
- “Potential” vs. “Actual” determined by Optimization End Date/Approval



TRACKING OPTIMIZATION EFFORTS
NORM OPTIMIZATION MODULE – IMPACT TAB

Business Rules:

- Estimates showing environmental, safety, and community impacts of optimization
- Identify source document to easily explore additional information



OPTIMIZATION EXAMPLES: PHASE 7

Site Information:

- Site Type: Closed Landfill
- Remedy:
  - Engineered Cap and Soil Cover
  - Land Use Controls (LUCs) and Maintenance
  - LTM Sampling
  - Five-Year Reviews
- CTC: > $2 Million
- Site Closeout Date: 12/1/2055 (perpetuity)
- Current Sampling Plan:
  - 7 Groundwater Monitoring Wells
  - Sample Frequency: Semi-Annually
- Annual Sampling Costs: ~$52,000/Year
- Analytes: VOCs, Metals, and General Chemistry Parameters

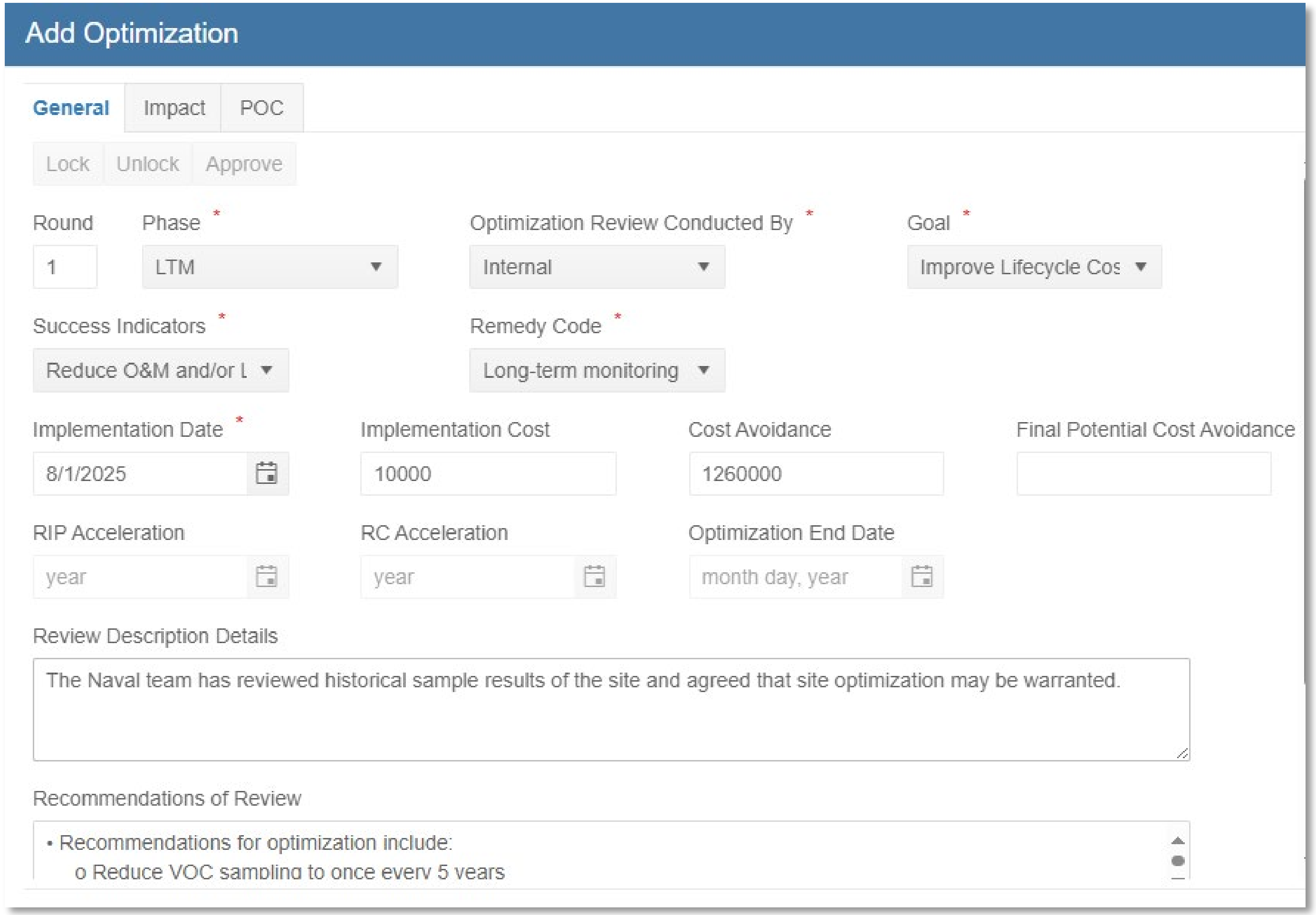
OPTIMIZATION EXAMPLES: PHASE 7

Optimization Recommendation:

- Reduce sampling frequency:
  - VOCs every 5 years
  - Metals every 2 years
- Reduce metals to specific contaminants of concern and eliminate dissolved metals

Impact:

- $42,000 per year cost avoidance
- Reduction in resources (Impact Tab)

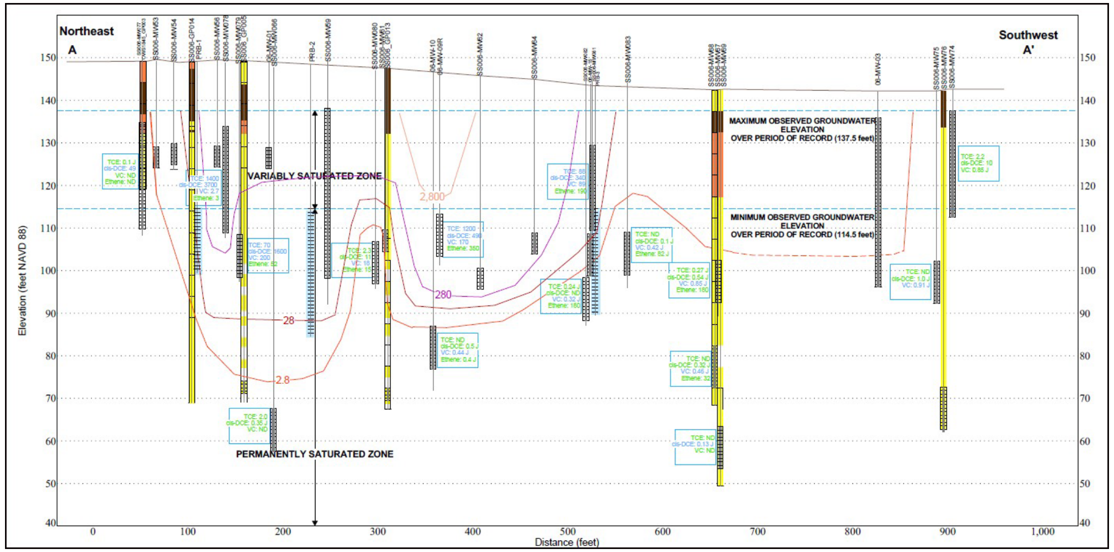


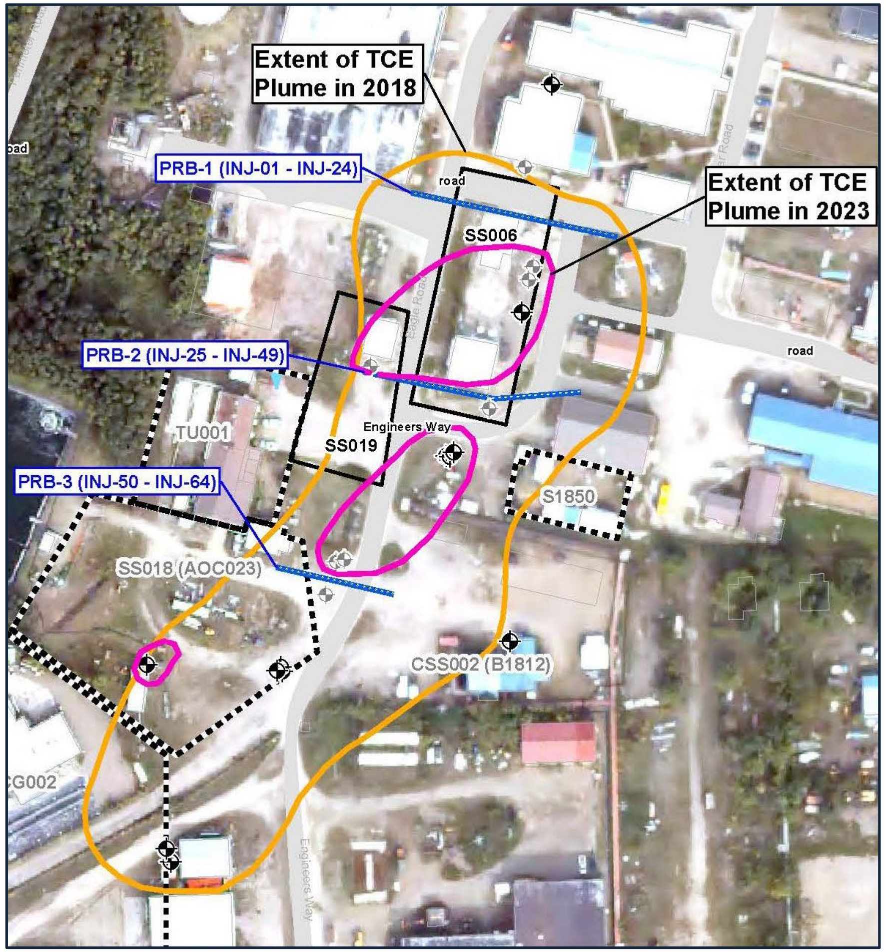
OPTIMIZATION SUCCESS STORIES

REMEDY OPTIMIZATION AT FORMER GALENA FORWARDING OPERATION LOCATION

REMEDY OPTIMIZATION AT FORMER GALENA FORWARDING OPERATION LOCATION

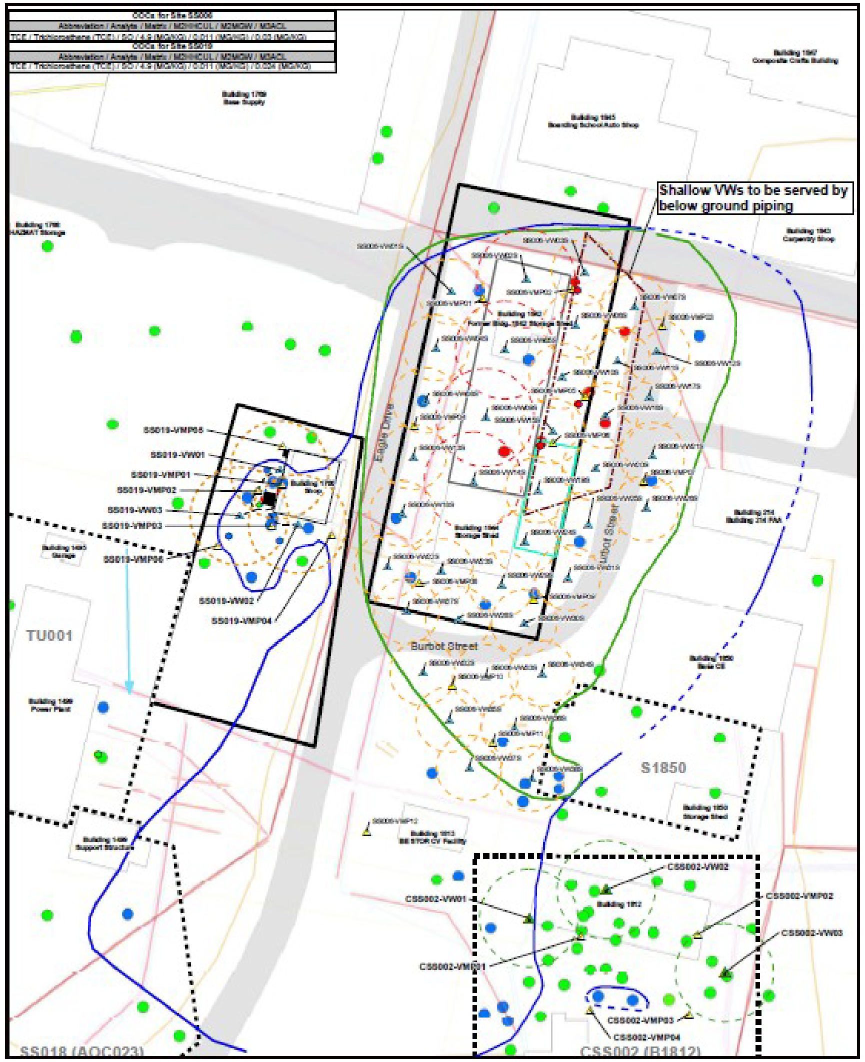
- Excavation of polycyclic aromatic hydrocarbon-contaminated soil
- Soil vapor extraction (SVE) to address chlorinated VOCs (CVOCs)
- Enhanced anaerobic bioremediation/ biogeochemical transformation with monitored natural attenuation (MNA) to address CVOC contamination in groundwater-permeable reactive barriers (PRBs)





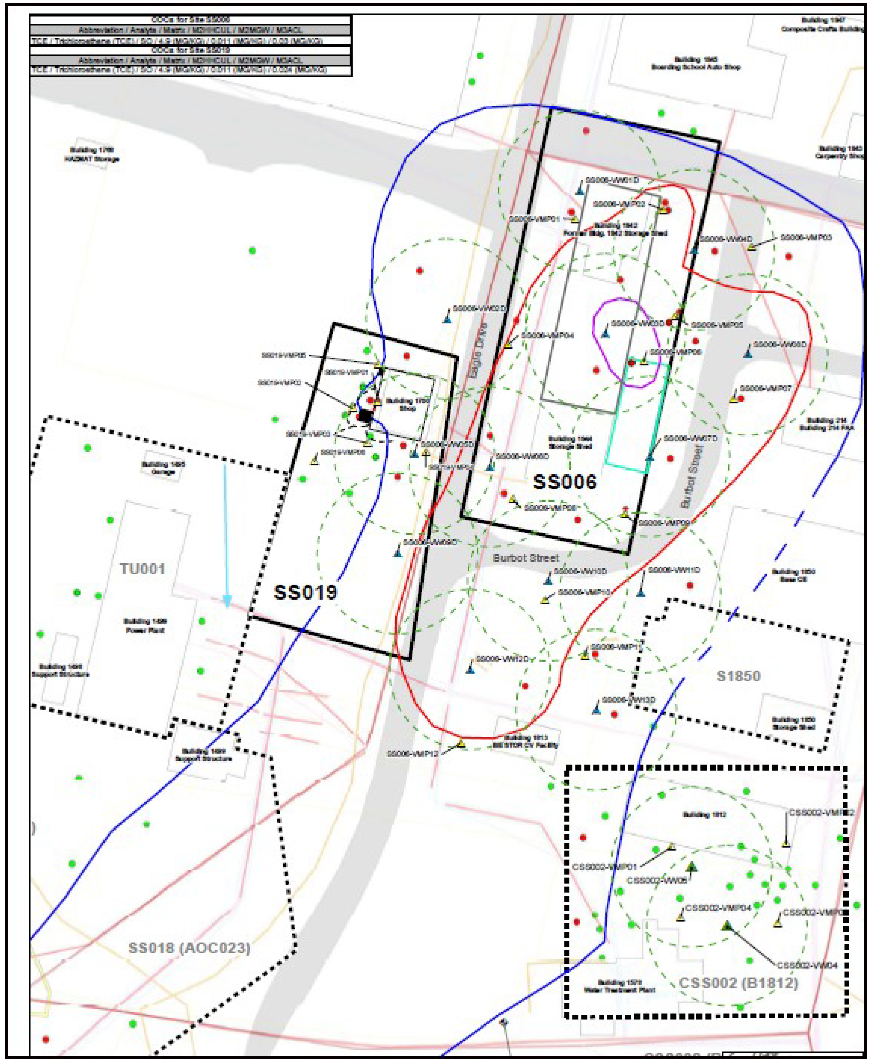
INJ: Injection
PRB: Permeable Reactive Barrier
TCE: Trichloroethylene

FORMER GALENA FORWARDING OPERATION LOCATION (CONTINUED)



←Tight clay-rich soils near the surface in the source area, fine-grain clay lenses, sorbed high concentrations of TCE at the Source area SS006, smaller radius of influence in tight formation required targeting the tight soils with more SVE wells to provide significant coverage.

Coarser grained sediments, mostly sands and gravel, at depth required fewer wells to provide overlapping coverage to address deeper CVOC contamination at the source area →



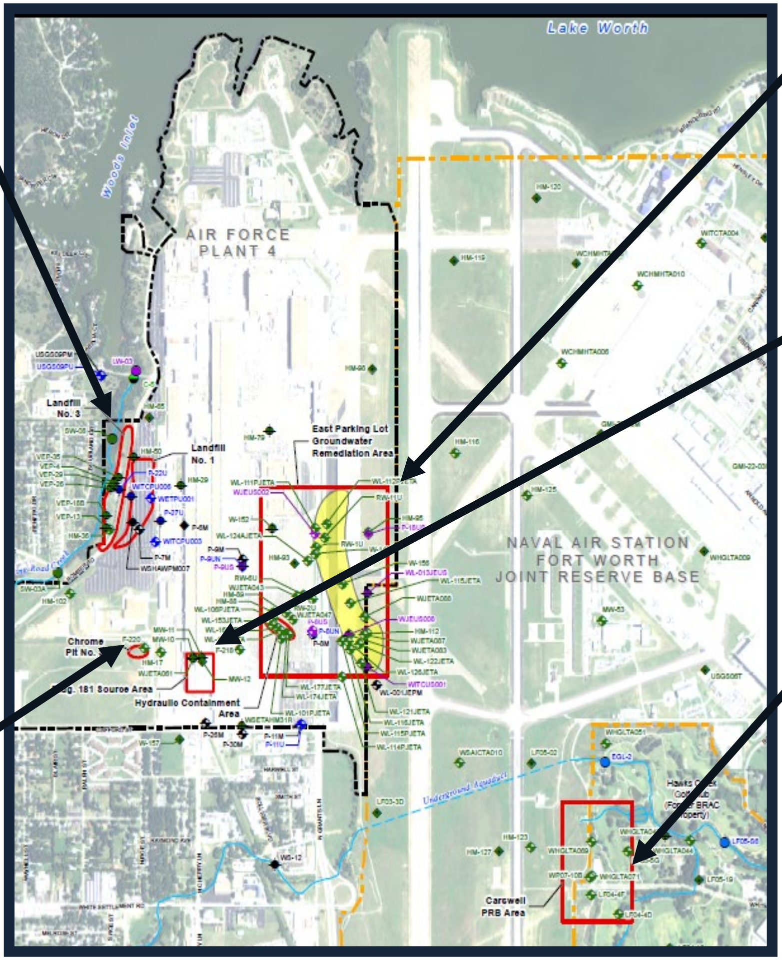
REMEDY TRANSITION AT AIR FORCE PLANT 4, FORT WORTH

REMEDY TRANSITION AT AIR FORCE PLANT 4, FORT WORTH

- Air Force Plant 4 (AFP4) manufactured military aircraft since 1942
- Several TCE and mixed NAPL source areas feed large plumes in alluvium
- Extensive history of remedial technologies at pilot and full scale. Effectiveness varied
- 2014: EPA required ROD Amendment
  - 1996 ROD not long-term protective of regional drinking-water aquifer and streams
  - Mixed chromium-TCE NAPL source not addressed

Landfills 1 and 3 Sources (LF1&3)
Excavation (1983)
P&T/French Drains (FDs) (1983-2014)
EISB (2008-2015)
DNAPL Recovery (2013-to Present)
VEP (1994-2001)
Phyto (1998)
Biowall (2004)
GCW (2008-2012)

Chrome Pit 3 Source (CP3)
Excavation (1983/1984)
ISCO (2008)
EISB (2010)



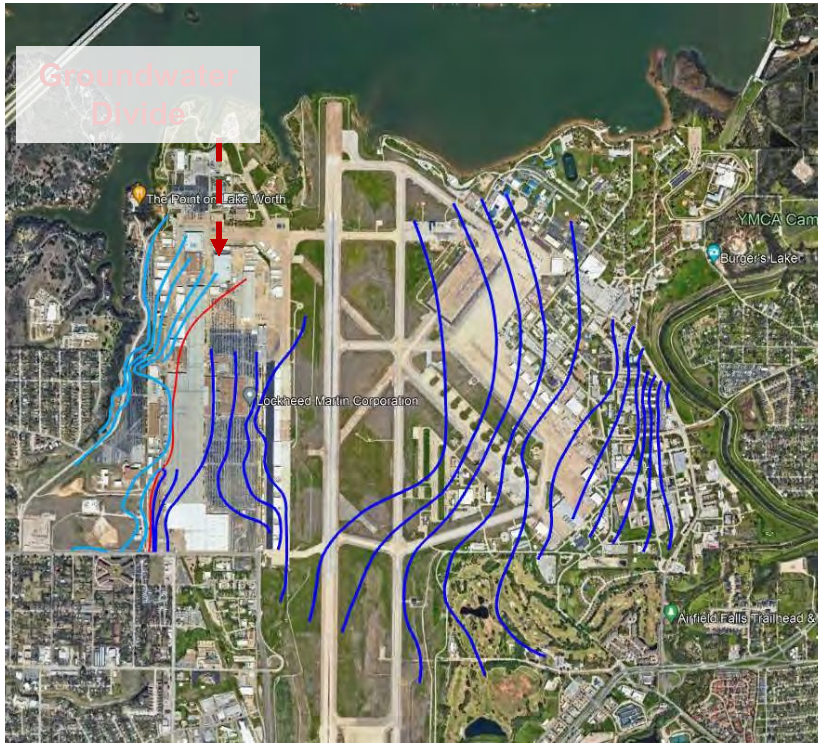
East Parking Lot Plume (EPL)
P&T (1993-2015)
EISB (2013-2018)

Building 181 Source (B181)
SVE (1993-2002)
ERH (2002-2004)
EISB (2008-2011)
ISCO (2013)

Carswell Area Plume (CWA)
P&T (1994-2002)
Phyto (1996-2005)
ZVI PRB (2002)
PRB extension & conversion to EISB (2013-2015)

EISB: Enhanced In Situ Bioremediation
ERH: Electrical Resistance Heating
GCW: Groundwater Circulation Well
ISCO: In Situ Chemical Oxidation
Phyto: Phytoremediation
P&T: Pump and Treat
SVE: Soil Vapor Extraction
VEP: Vacuum Enhanced Pumping
ZVI PRB: Zero Valent Iron Permeable Reactive Barrier

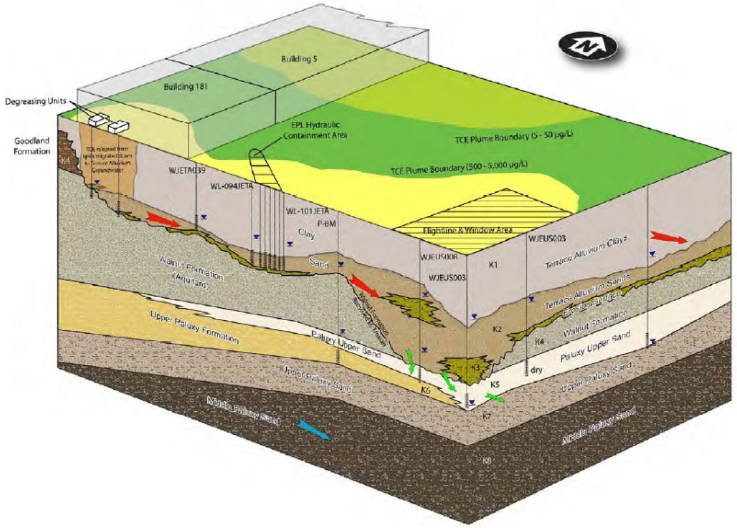
AFP4 HYDROGEOLOGY AND CONTAMINANT DISTRIBUTION

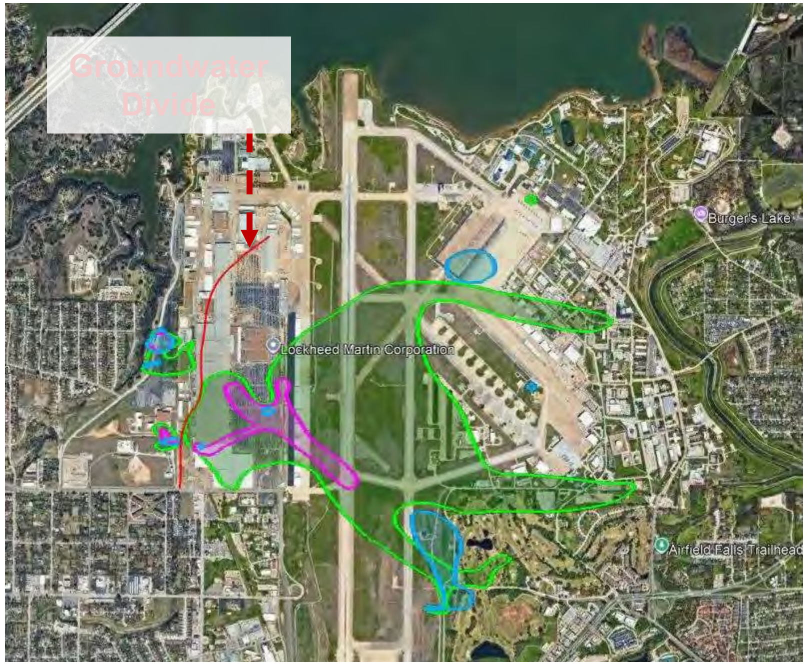


- The groundwater is divided along the west side of the assembly plant.
- The flow is east toward Farmer's Branch Creek and west toward Meandering Road Creek.

Paluxy drinking-water aquifer is protected from shallow alluvial contamination by overlying Walnut/Goodland confining unit, but:

- Weathered/fractured near LF1&3 DNAPL source area
- Unit is missing in EPL "window"





- TCE migrated from B181 to EPL
- Aggressive remediation to address DNAPL source zones
- Remediation of EPL to prevent migration through "window"
- Remediation at plume toe

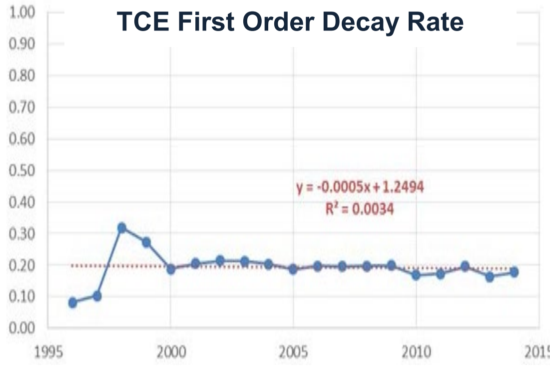
2015 AFP4 COMPLEX SITE INITIATIVE (CSI): EVALUATIONS

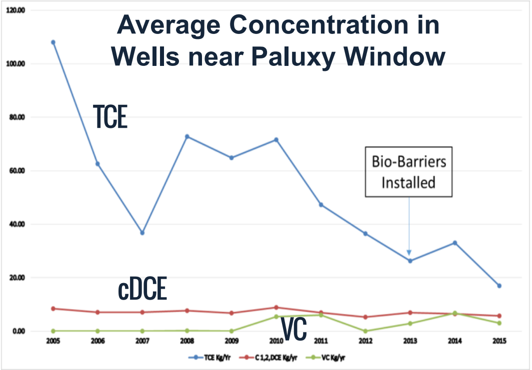
Independent Evaluations:

- Adequacy of CSM at remedial systems scale
- Critical fate-and-transport processes controlling source zone depletion and plume migration
- Remedial system effectiveness: all sources/plumes

EPL Remedies (P&T, EISB)

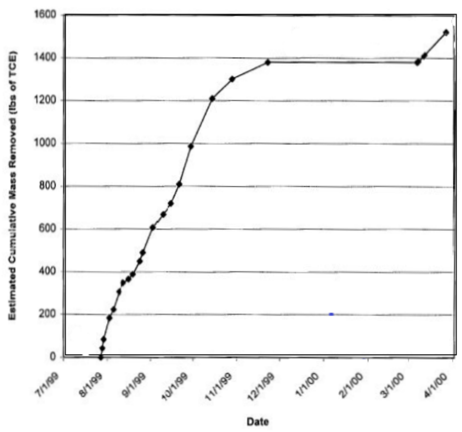
- Uniform decay rate regardless of remedial actions
- Engineered remedies have no greater impact than natural attenuation

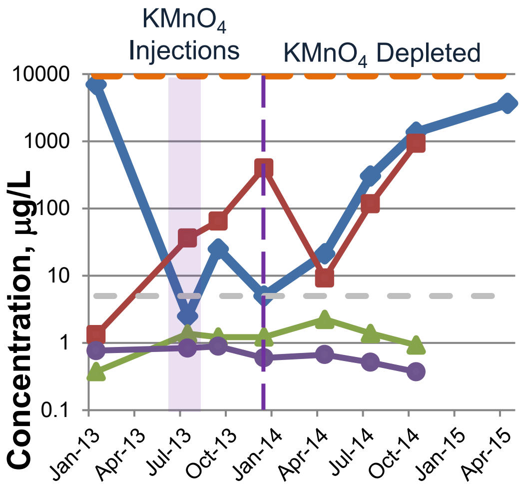




B181 Source Zone Remedies

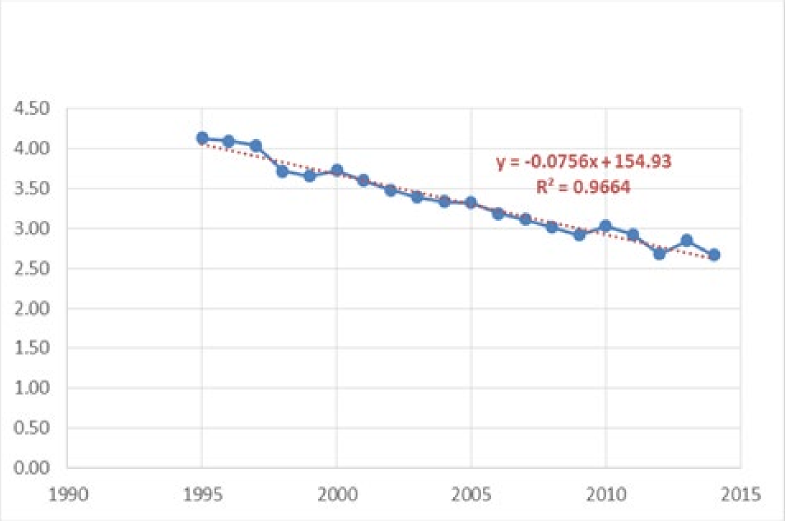
- SVE and ERH with SVE (1999-2004): 2,917 lbs. TCE removed but plateaued rapidly
- Concentration decrease: soil vapor 93%, groundwater 87%
- EISB and ISCO (2008-2013): ineffective due to rebound

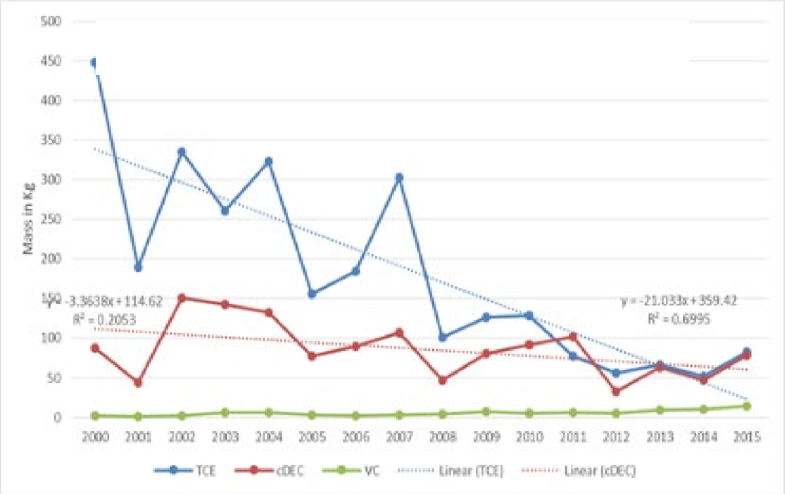




2015 AFP4 CSI : FINDINGS AND RECOMMENDATIONS

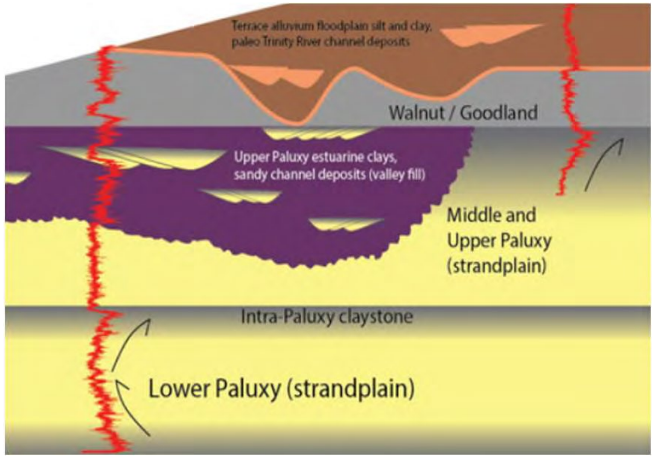
- Critical hypotheses controlling remediation: (1) source zone control, (2) back diffusion, and (3) geological containment (LF1&3, Paluxy)
- MNA transition assessment for plumes:
  - Plume scale assessment showed concentration and mass attenuate slowly to Maximum Contaminant Level (MCL) by 2040-2050, regardless of past remedies.
  - Develop remedial action objectives (RAOs) with long time to cleanup (2040+) on base where LUCs and/or institutional controls are feasible.
  - Prepare for active cleanup in off-base area targeting preferential pathways.
- Recommended CSM refinements: data gaps and HRSC of critical processes
  - Update monitoring network to improve 3-D plume definition near “window” and evaluate MNA effectiveness.
  - Conduct sequence stratigraphy mapping to demonstrate protectiveness from vertical migration through “window.”
  - Deploy HRSC to delineate preferential pathways and understand TCE mass distribution/flux and significance of matrix diffusion.
- Evaluate technical impracticability (TI) for three source areas

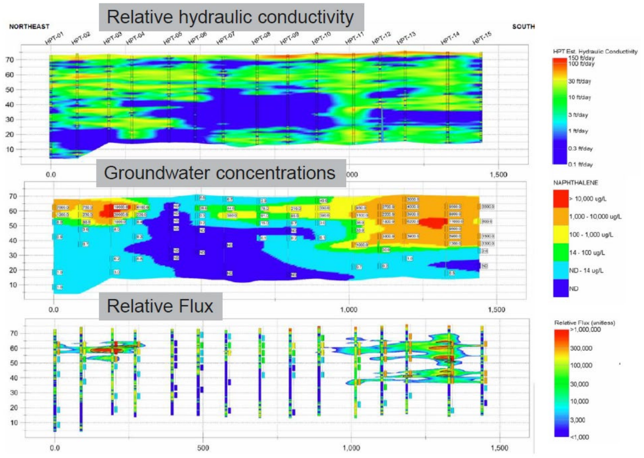




2016-2022: IMPLEMENTING CSI RECOMMENDATIONS

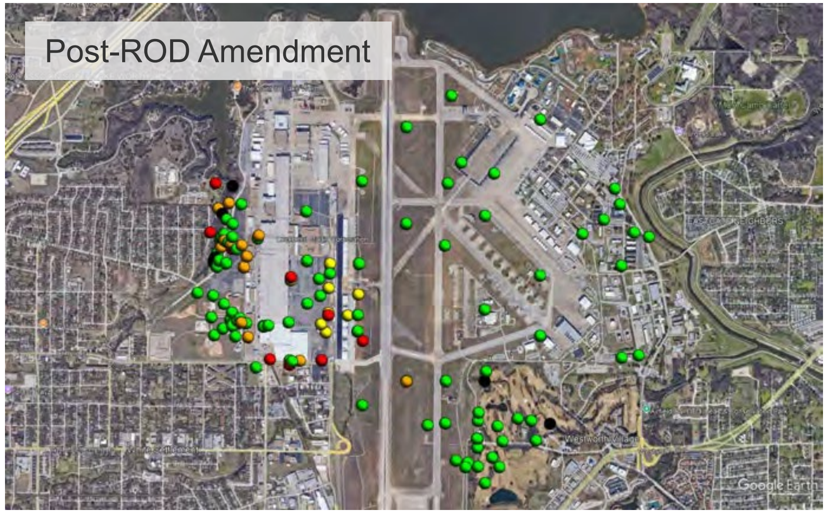
- Rework existing remediation contract with new performance objectives.
  - Fill monitoring network data gaps: Verified geological control migration to Paluxy. Provided data to evaluate natural attenuation rates/mechanisms.
  - Conduct MNA and TI evaluations, and complete Focused FS.
- Fund innovative HRSC projects to evaluate “critical process” hypotheses.
  - *Vertical migration to Paluxy regional aquifer:* Refinement of CSM by sequence stratigraphic analysis showed the upper Paluxy sandy units are encased in shale, containing deep migration through “window.”
  - *Back diffusion:* Detailed mass flux and distribution mapping showed most of the contaminant mass is associated with the immobile fraction of aquifer, minimizing the value of most active treatment technologies.
  - *LF1&3 NAPL source zone:* HRSC technology for fractured rocks improved DNAPL CSM. In situ thermal monitoring investigated natural source zone depletion (NSZD). The pilot test demonstrated the potential for low-level heating to enhance NSZD.
  - *Off-base migration control in CWA:* Hydrogeophysical tomography identified off-base preferential pathways and provided high-resolution CSM at boundary EISB system for to enable a targeted approach to off-base remediation.





TRANSITION TO MNA AND CURRENT STATUS

- 2021-2022: Focused FS and TI Evaluations
- 2023: ROD Amendment
  - Updated RAOs to MCLs
  - Control off-base migration
  - Accept on-base remediation time scales of 40-60 years
  - Changed on-base remedy from active treatment to MNA
  - TI waiver of MCLs at LF1&3 NAPL source area in bedrock with enhanced NAPL recovery effort
  - SVE, vapor intrusion control at Bldg. 181 source area
- 2024: Work plan development and implementation
  - LUCIPs
  - Sampling & Analysis Plan
- Annual MNA Performance Reports



CONCLUSION: HOW TO TRANSITION TO MNA?

- Identify critical processes for fate/transport and remedy effectiveness.
- Refine the CSM and invest in HRSC when needed.
  - Preferential pathways, natural attenuation rates, back diffusion limitations.
- Demonstrate source mass reduction/control.
- Evaluate long-term (in)effectiveness of active remedies.
- Identify area-specific, time-specific RAOs.
  - Transition to MNA where long timelines to meet RAOs are acceptable.
  - Seek TI waivers with source mass reduction/control where appropriate.
  - Focus active remedies in areas requiring short timelines for cleanup.
- Regulatory Involvement:
  - Involve regulators in technical evaluations.
  - Communicate with public and regulatory agency leadership.
  - Build a project GIS to provide a valuable communication tool.

OPEN DISCUSSION

Thank you!

Please fill out a brief survey here:

https://forms.osi.office365.us/r/6E0szmfSUp