Summary and Lessons Learned from the Navy’s Complex Remediation Sites

Mike Singletary, P.E.
Senior Environmental Engineer
NAVFAC Southeast, Jacksonville, FL
Presentation Overview

• Overview of Navy Environmental Restoration Program
• Portfolio Optimization and shifting focus from individual site reviews to portfolio-wide evaluation
• Unique challenges posed by complex sites
• Adaptive Site Management
• Complex Site example
Navy Environmental Restoration Progress

FY18 Snapshot of Navy Program

CTC – cost to complete; FY – Fiscal year; EOY – end of year; RC – response complete RA-O – remedial action operation
IRP – Installation Restoration Program; LTM – long-term monitoring; MGMT – long-term management

4,415 Sites (EOY17: 4,498 Sites)
RC: 3,632 (82.3%)
$4,655M CTC = $2,661M (IRP) + $1,994M (MRP)
183 sites are currently not projected to meet RC goal by 2021

- Estimated RC dates range between 2021 and 2061
- Phase 4 to 7 CTC estimated at approximately $1B (RA Construction through LTM)

**DERP Management Goals**

- Achieve RIP or RC at 100% of sites by end of FY2014
- Achieve RC at 90% of sites by end of FY2018 and at 95% of sites by end of FY2021

DERP – Defense Environmental Restoration Program; RIP – remedy in place; RC – response complete; DNAPL – dense non-aqueous phase liquid
Navy Optimization Policy and Guidance

• DON “Policy for Optimizing Remedial and Removal Actions at all DON Environmental Restoration Sites”, April 2012

• Guidance for Optimizing Remedy Evaluation, Selection, and Design, March 2010

• Guidance for Optimizing Remedial Action Operation, October 2012

• Guidance for Planning and Optimizing Monitoring Strategies, November 2010
Navy Optimization Program Success

- Initial optimization studies focused on individual sites
- Significant cost avoidance achieved through systematic optimization at multiple project phases
- Cost avoidance reaching point of diminishing returns
- Shifting optimization focus to portfolio analysis
  - Develop broader findings and recommendations
  - Better inform policy and guidance for future optimization efforts

Source: G. Coghlan, NAVFAC HQ
Navy Portfolio Optimization

Phase I
- Focus: 32 complex IRP sites with Total CTC ~ $300M

Status:
- Working with FECs/RPMs on tailoring and implementing recommendations
- Continued engagement at stakeholder partnering meeting
  - NB Kitsap Bangor Site A and F, and Jackson Park—biweekly/monthly calls with RPMs & regulators
  - ABL Sites 1, 5 and 10 continue quarterly calls with project team

- Challenges
  - Majority of recommendations involved changing the path of the remedy (i.e., ROD amendment, ESD, and/or site reopening)
  - Must obtain buy-in from both internal Navy and regulators – very difficult

Phase II
- Focus: 25 complex IRP sites and 15 lower risk sites with Total CTC ~ $340M
- Sites with high CTC and RC > 2021 (complex sites)
- Sites with potential for accelerated closure (e.g. petroleum sites, dilute/stable groundwater plumes)

Status:
- Ongoing data review in collaboration with RPMs and Contractors
  - Site 70 Seal Beach (1-mile long, 200-ft deep CVOC plume) – transitioning to passive approach & under negotiation with regulators
  - Yuma (CVOC & 1,4-Dioxane plume) – working with team on alternative approach to P&T
Two Broad Categories of Navy Complex Sites

• Pump and treat containment systems

• In situ treatment trains including extended MNA
Issues Common to Complex Sites

- Lack of consensus on CSM, RAOs, and site priorities
- Insufficient plan for managing site uncertainty
  - Traditional linear regulatory framework
  - Lack of flexibility in RODs and decision documents
- Contracting issues
- Remedy transitioning
  - Active to passive treatment
  - When does in situ treatment end and MNA begin?
  - “Points of diminishing returns”/asymptotic conditions
- Agreement on the role of MNA in long-term remedies
  - Reasonable timeframe
  - Risk management approach vs. “treatment technology”
  - Stand-alone remedy vs. part of a treatment train
Summary of Navy Portfolio Optimization

• Restoration timeframes estimated at >30 years for complex sites (actual timeframes typically greater)

• Source reduction technologies (e.g. bioremediation, ISCO) typically implemented with natural attenuation and other passive technologies to treat/control downgradient plume

• Few opportunities to accelerate overall remediation timeframes
  • Inherent technical difficulties prevent site closure, meeting MCLs
  • DNAPL, complex geology, contaminant back diffusion

• Long-term monitoring/management drive costs (RAO/LTM)

• Guidance needed to determine when to transition sites from active treatment to natural attenuation or long-term passive management
Portfolio Optimization (Cont.)

• At 10 of the 11 pump and treat (P&T) systems studied, plume containment achieved and downgradient water quality improved.

• Limited opportunities to transition active P&T systems to passive management systems (e.g. PRBs):
  • Depth of contamination, construction limitations, cost-prohibitive
  • P&T required for continued hydraulic containment of plumes

• Aging infrastructure resulting in more frequent well fouling, pump failure, etc.

• Emerging contaminants could add to capital investment of P&T systems in future:
  • One P&T system will require upgrade of aboveground treatment to address emerging contaminant (e.g. 1,4-dioxane)
Adaptive Site Management

“An approach to resource management in which policies are implemented with the express recognition that the response of the system is uncertain, but with the intent that this response will be monitored, interpreted and used to adjust programs in an iterative manner, leading to ongoing improvements in knowledge and performance”

– National Research Council (NRC), 2003
Adaptive Site Management

• “Comprehensive, flexible, and iterative process that can be used to manage the remediation process”

• “Approach for dealing with difficult-to-remediate hazardous waste sites over the long term or where current technologies have proved to be ineffective”

• “Can be used to make decisions in response to remedy performance, while considering changes in site conditions, the conceptual site model, technology performance, and technological advances over time”

– Interstate Technology and Regulatory Council (ITRC), 2017
Key Site Management Questions

Tools and Analysis

- Vapor intrusion analysis
- Groundwater ingestion
- Groundwater to surface water discharge

- Mann-Kendall Analysis
- MAROS Tool
- Conc. vs. time plots and graphs
- Impacting off-site receptors?

- Is active P&T containment required?
- Continued effectiveness of P&T over long timeframes?
- Can MNA continue to prevent plume migration?
- MNA long-term sustainability?

Potential Actions

- Control risk by controlling source, pathway, and/or exposure
- Benefit to further source treatment? (e.g. predictive modeling of remedial options)

- Will a treatment barrier stop plume expansion?
- What are impacts if plume expands?

- Do shut-down test – rebound occur?
- Convert to “toe-only” pumping?
- Redesign P&T for long haul?
- Will further source treatment help?

- Pursue risk-based closure (e.g. low-threat closure guidance)
- Optimization

Potential Actions Diagram

- Is there an ongoing impact to actual receptors?
  - Yes
- Is the plume expanding?
  - Yes
- Is plume controlled by P&T or MNA?
  - P&T
  - MNA

#RemTEC
Remedy Transitions

• Remedy transitions
  – From ex-situ to in-situ treatment
  – From active to passive remedies

• ITRC team discussion about transition assessments
  – EPA and stakeholder reservations
  – Process to revise remedy would follow existing Superfund process and guidance

Transition assessment

NRC (2013) described “transition assessments” in the context of asymptotic conditions and reaching the limitations of technology effectiveness.

A transition assessment would consist of evaluating remedial alternatives in the context of remedy selection criteria, considering risk associated with residual contamination, and the costs and relative risk reduction of treatment.

Reviewers conducting the transition assessment would determine whether a new remedy is warranted or whether a transition to long-term management and/or MNA was appropriate.

NRC, 2013. Alternatives for managing the nation’s complex contaminated groundwater sites
Interim Objectives

• At complex sites, important to also establish “interim objectives” (ITRC RMCS-1) or “functional objectives” (ITRC DNAPL-1)
  – Intermediary goals that guide progress towards achieving RAOs
  – Specific, measurable, attainable, relevant and timebound (SMART) attributes
  – May be technology-specific
  – Basis for performance model predictions, metrics

• Examples:
  – Contaminant mass flux or discharge decrease by [x]% within [#] years
  – Target degradation rates met within [#] years
  – Concentration-based → e.g. Florida DEP’s Natural Attenuation Default Concentrations (NADCs)
  – Capping to prevent direct exposure
  – Documenting no “uncontrolled risk pathways”
Key Messages on Complex Sites

• Approximately 10% of all sites classified as complex (NRC 2013)
  • Navy P-OPT identified a subset of complex sites where it will be difficult to meet restoration goals within 30 years
  • P-OPT identified few opportunities to accelerate remediation timeframes

• Adaptive Site Management most suitable approach for addressing complex sites
  • P-OPT recommended phased technical approach prioritizing sites exhibiting unacceptable risk to human health and environment
  • Life cycle CSM used to guide decision-making throughout restoration process

• Long-term passive management appropriate long-term goal for most complex sites
  • Focus remedial efforts on sites with uncontrolled risks
  • Long-term cleanup goals (e.g. MCLs) achieved through natural attenuation
  • Interim institutional controls to prevent exposure
  • Continuously update CSM and optimize remedy

• Transition assessments to select new remedies or transition to long-term management
  • P-OPT recommended additional RPM guidance on transition assessments and development of new tools
  • Case studies demonstrating successful transition assessments (e.g. NWIRP McGregor)
Complex Site Example - Former NWIRP
McGregor, TX
Former NWIRP McGregor

- Naval Weapons Industrial Reserve Plant (NWIRP) McGregor used until 1995 as a bomb and rocket motor manufacturing facility
- Isolated industrial sites located on 9,700 acres, 20 miles west of Waco, Texas
- Ammonium perchlorate and chlorinated solvents released into the environment through “hog out” operations of rocket motors
- Property transferred property to City of McGregor in 1995
- Leased portions of property to industrial and agricultural companies
  - SpaceX static rocket test and launch/landing facility
- Navy maintains cleanup responsibility/liability and continues active remediation and long-term monitoring on properties through access agreements
Former NWIRP McGregor Property
Life Cycle Optimization Timeline

- Initial optimization efforts to improve automation and remote monitoring of fluidized bed reactor (FBR) (2004-05)
- Evaluate attenuation capacity of groundwater to surface water pathway (2014-15)
- Groundwater re-classification from Class II to Class III (increase cleanup level X100) and reduce size of Plume Management Zone (PMZ) (2016)
- Risk evaluation of ecological surface water exposure to perchlorate (2016)
- Transition groundwater collection and FBR system to a series of passive in situ bio-barriers (2017-2020)
NWIRP McGregor

- B-Line Trench – 2,950’ long, 12-15’ deep
- C-Line Trench - 1,425’ long, 15-18’ deep
- Pump station maintains groundwater elevation to prevent discharge to unnamed tributary
Conceptual Site Model

- Streams and tributaries at the facility experience both gaining and losing conditions
- Majority of precipitation occurs in Spring
- Perchlorate attenuated through dilution and mixing within dynamic system
- Dilution study conducted in 2014-15 to evaluate perchlorate concentrations along GW/SW flow path
Groundwater Treatment System

- Interceptor trench system and aboveground water storage
  - Lagoon A – 10.8M Gal
  - Soil Cell A – 1.2M Gal
  - Soil Cell B – 1.5M Gal
  - Soil Cell C – 1.7M Gal

- Fluidized bed reactor
  - Treats up to 400 gpm
  - Discharges directly to outfall or to aboveground storage
Perchlorate Influent History

- Overall decreasing perchlorate influent concentrations from 2000 to 2016
- Resulting from combination of source removal, flushing, and mixing with un-impacted groundwater
Transition Assessment

• Goal to transition from aggressive pump and treat technology to passive in situ remediation
  • Reduce O&M, monitoring, and energy costs
  • Rely on in situ containment of the perchlorate plume

• Navy negotiated with TCEQ to temporarily shut down treatment system during 2016-17

• Continue to monitor groundwater and surface water quality in evaluating attenuation capacity

• Pilot test in situ bio-borings to control perchlorate migration from source

Source: NAVFAC SE 2017
Focused treatment on remaining perchlorate hot spot
Bio-barrier Performance Monitoring

GAM-42 (Upgradient Well)

GAM-43 (Downgradient Well)
## Groundwater Re-classification

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<th>Medium</th>
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<th>Ecological (µg/L)</th>
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<tr>
<td>Surface Water</td>
<td>--</td>
<td>&gt;8,000</td>
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**TCEQ’s PCLs Onsite Area PMZ**

Station Creek Basin

Southern Boundary of PMZ

Former NWIRP McGregor

Southern Boundary of PCLE Zone

Texas A&M Property
Complex Site Management Summary

• Life-cycle optimization achieved through a combination of management approaches
  • Groundwater re-classification resulted in less stringent perchlorate cleanup standard (5,100 µg/L vs. 51 µg/L)
  • Developed natural attenuation conceptual model (e.g. flushing and mixing in groundwater/surface water system)
  • Transitioning pump and treat system to passive in situ bioremediation of plume
  • Ecological risk assessment documented no adverse impacts to sensitive receptors from exposure to perchlorate in surface water
• Long-term adaptive site management approach will result in significant annual cost avoidance while maintaining protection of human health and environment
### Points of Contact

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<tr>
<th>NAVFAC Southeast: Mike Singletary, P.E.</th>
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<tbody>
<tr>
<td><a href="mailto:michael.a.singletary@navy.mil">michael.a.singletary@navy.mil</a></td>
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### Questions?

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