Long-Term Monitoring Optimization Approaches and Considerations

Dave Becker, P.G.

US Army Corps of Engineers
Hazardous, Toxic, and Radioactive Waste Center of Expertise, Omaha, Nebraska

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Presentation Overview & Purpose

• Purpose: Familiarize Environmental Staff with Current Trends and Tools for Optimizing Long-Term Monitoring Programs as Part of an Overall Project Planning Process (Project Planning Doesn’t End at the ROD)

• Overview
  – Background
  – Identify Qualitative and Quantitative Methods of Optimization for Monitoring Programs
  – Describe Important Considerations
  – Introduce Available Tools, Including New EPA/USACE Guidance
  – Describe Recent Demonstration Project

• Co-Authors: Kathy Yager, EPA; Carolyn Nobel, Parsons; John Anthony, Mitretek
LTMO Background

- DoD Spends Millions of Dollars Each Year on Monitoring - Typically $10Ks - $100Ks / Site
- Many LTM Programs Not Evaluated Carefully Since Remedy Implemented
- Conditions Change Over Time (for Better or Worse)
- Periodic Evaluations of LTM Programs Necessary and Beneficial
LTMO Overview

- Optimization is NOT Just Reductions in Program; Must Match LTMO Program to Objectives
  - Consider Decisions to be Made (and When)
  - Collect Only Needed Data – No More, No Less

- Four Focus Areas for Optimization - Common Sense
  - Reduce or Increase Frequency of Sampling
  - Reduce / Increase Number of Locations (or Change Locations)
  - Reduce or Increase List of Analyses
  - Consider Sampling Technique

- Two Primary Approaches
  - *Qualitative*
  - *Quantitative*
Qualitative Approach to LTMO

Evaluation Strategies

Qualitative evaluations based on professional judgment, intimate knowledge of site, decision rules, heuristic methods.
Considerations for Qualitative Analysis

• Temporal Analysis – Experienced Professional Makes Recommendation for Sampling Frequency Based on:
  – Frequency of Data Assessment by Project Team (How often does the team assess the data?)
  – Rate of Contaminant Migration (Generally Faster = More Frequent) and Proximity to Receptor
  – Rate / Nature of Contaminant Concentration Change
    • Concentration Trend Slope, Variability in Concentrations
  – Time to Take Action if Monitoring Indicates Problem
  – Public Concerns / Regulatory Requirements
Considerations for Qualitative Analysis, Continued

• Spatial Analysis - Experienced Professional Makes Recommendation for Sampling Locations Based on:
  – Use of Well as Sentinel for Exposure Point
  – Past Well Performance (Goes Dry, Poor Construction)
  – Proximity to Other Wells in Same Aquifer
  – Proximity to the Known Plume Boundary
    • Near Source - Assess Impact of Source Control
    • Near Leading Edge of Plume (Lateral & Vertical) to Assess Migration / Capture
Qualitative Analyses: Adjust Analytical Program

• During RI or RFI, Analyses are Run for Broad Range of Contaminants to Characterize Release
• Determine Trends in Detected Compounds after Remedial/Corrective Action Initiated
• Focus on Risk Drivers and True Site Contaminants, Others of Interest to Treatment
  – Reduce to Analyses for These (?)
  – Add Analyses if Appropriate
  – Update Analytical Methods
  – Can Screening Methods Satisfy Data Needs?
Qualitative Analyses: Reconsider Sampling Approach

- Low-Flow Sampling, Diffusion Bag Sampling, Others
- Dedicated Equipment vs. Moving and Decontaminating Pumps, etc.
- Timing of Sampling (Avoid Weather Extremes, Better Access to Wells)
Quantitative Approach to LTMO

Evaluation Strategies

Quantitative evaluations based on statistical, mathematical, modeling or empirical evidence and applied to sampling frequency and network
Quantitative LTMO Approaches

• Sample Frequency – Quantitative Temporal Analysis
  – Evaluate Nature and Strength of Statistical Trend
• Compute Measure of Variability, Periodicity
  – Rule-Based Decision Tree to Recommend Sampling Frequency Based on Trend, Variability, Average Concentration (e.g., Cost-Effective Sampling)
  – Simulation Approach - Recommend Sampling Frequency Based on Observed and Projected Rate of Concentration Change
Quantitative LTMO Approaches, Continued

- Network Optimization – Quantitative Spatial Analysis
  - Ranking Approaches
    - Use Geostatistical or Other Weighting Techniques to Evaluate the Contribution of Each Well to Plume Definition
    - Identify Areas of High Uncertainty
  - Simulation Approaches
    - Coupled Transport Simulations with Numerical Optimization Algorithms to Minimize Error in Plume Definition
    - Consider Additional Well Locations
    - Identify Areas for Additional Wells
    - Wells that Contribute Little=Candidates for Removal
Combining Qualitative and Quantitative Approaches

- Quantitative Results Must be Reviewed Qualitatively by Technical Staff for Appropriateness
  - Consider Site Hydrogeology
  - Address Stakeholder Needs
  - Consider Recent and Future Changes
    - Production and Land Use
    - Impacts of Climate, Other Factors
  - Qualitative Review May “Trump” Quantitative Results
Additional Considerations

• Process In-Place to Periodically Assess Existing Data
• Flexible Decision Documents
• Data Management Improvements
  – Manage Data Electronically
  – Reporting Requirements
What LTMO Tools Are Out There?

MAROS Decision Support System
for Optimizing LTM Programs

Cost-Effective Sampling

PARSONS
3-Tiered LTMO

Navy and Marine Corps Working Group

Optimizing Remedial Action Operations
and Long Term Monitoring

Geostatistical Temporal/Spatial (GTS) Optimization Algorithm
MAROS

Monitoring and Remediation Optimization Software

- Simple statistical and heuristic tools
  - Cost-Effective Sampling for Frequency Analysis
  - Delauney Triangle Method to Assess Network
- Not mathematical optimization
- Modular
- Simple database input
- Employed after site characterization and remediation activities are largely complete
- Free Software: Available at: http://www.gsi-net.com/software/Maros.htm
Geostatistical Temporal-Spatial (GTS) Algorithm

- Emphasizes decision-logic framework
- “Plug-in” architecture
- Uses ‘semi-objective’ geostatistical and trend optimization methods
  - Variogram = spatial correlation measure
  - Locally-Weighted Quadratic Regression (LWQR)
    - Used for both spatial regression & fitting time series trends
- Prototype free software
Parsons’ 3-Tiered LTMO At A Glance

3-Tiered Monitoring Well Network Optimization

- Establish Baseline
- Data Compilation
- Site Screening

- Qualitative Evaluation
- Temporal Statistical Analysis
- Spatial Statistical Analysis

Monitoring Distribution & Frequency Recommendations

USACE HTRW Center of Expertise
EPA / Air Force Sponsored Demonstration Project of Tools

• Demonstration of Two Approaches to Monitoring Optimization
  – “Three-Tiered” Monitoring Optimization - Parsons
    • Use Professional Judgment (Qualitative Evaluation)
    • Trend Analysis for Frequency, Location Selection
    • Geostatistical Analysis
  – MAROS 2.0 Optimization - Groundwater Services Inc.
    • Evaluate Plume Stability through Moment Analyses
    • Use Trend Analysis and Cost Effective Sampling Approach
    • Use Delauney Triangle Approach to Location Analysis
    • Power Analysis

• Compare Recommendations, Cost, Savings at 3 Sites
  – Army, Air Force, EPA Superfund
Overall Demonstration Project Results

• Both Approaches Resulted in Savings (from <$5,000/year - ~$40,000/year) at the 3 Sites
  – Offset Costs for LTMO Analysis in Short Time
• Both Tools Useful
• Must Include Human Judgment
  – Tools Just That, Not Replacement for Professional
  – Objective Analysis Meant to Prompt Thinking, Discussion
New Guidance: Roadmap to LTMO

Available at: http://www.cluin.org/download/char/542-r-05-003.pdf

- Co-sponsored by EPA and USACE
- Lays out Seven-Step Process to LTMO
- More Information (and Web Links) for Tools
Presentation Summary

• Monitoring Optimization Can Conserve Funds, Address Data Gaps
• Part of Overall Systematic Project Planning
• Optimization Includes Assessment of:
  – Frequency, Location
  – Analyses, Sampling Methods
• Approaches include Qualitative, Quantitative
• Tools Include:
  – MAROS, GTS
  – Three-Tiered Approach
  – New Guidance – Roadmap to LTMO