Demonstration of Two Long-Term Monitoring Optimization Methods

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Project Overview

- EPA, AFCEE, and USACE project to showcase 2 methods for optimizing ground water monitoring

- Goals:
  - Improve understanding of statistical and geostatistical methods for LTMO
  - Provide case study examples
  - Understand differences between methods

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Project Team

- Kathy Yager, US EPA OSRTI
- Dave Becker, US ACE HTRW CX
- Javier Santillan, AFCEE
- John Anthony, Mitretek Systems
- Carolyn Nobel, Parsons
- Julia Aziz, GSI

LTMO Methods

- Monitoring and Remediation Optimization Software (MAROS)
  - Free software developed by AFCEE and GSI
  - Employs spatial and temporal data analysis techniques
  - Objectives are to minimize monitoring locations and reduce sampling frequency without significant loss of information
  - Spatial analysis based on 2-D sampling reduction method (Delaunay method)
  - Temporal analysis based on a modified Cost Effective Sampling (CES) method – developed by LLNL
  - Can be used by individual with basic statistical knowledge

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LTMO Methods

- Parsons' 3-Tiered Monitoring Network Optimization (3-Tiered LTMO)
  - Employs a 3-tiered approach
    - Qualitative evaluation (hydrostatigraphy, locations of potential receptors, direction and rate of contaminant migration)
    - Mann-Kendall statistical analysis to determine trends in each well (combined with decision tree to retain/remove/reduce)
    - Spatial analysis using geostatical kriging error predictions
  - 3 tiers are combined for recommended sampling network
  - Requires trained hydrogeologist and geostatistician
  - Has been applied at multiple AF sites across country

LTMO Methods

- Primary differences between MAROS and MNO
  - MNO incorporates a qualitative review as a preliminary step in screening data
  - Geostatistics in MNO could be considered more robust
  - MNO considered to be more flexible because a trained geostatistician and hydro make final recommendations
  - MAROS designed to be simple and easy to use – MNO must hire geostatistician/hydrogeologist
  - MAROS also evaluates data sufficiency, plume trend, size, shape, and movement

Project Design

- Two long-term ground water monitoring optimization methods showcased

- Two methods attempt to answer the following questions
  - how many wells are required (spatial)?
  - how frequently should wells be sampled (temporal)?
    - e.g., define plume boundary or otherwise meet data quality objectives

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Project Design

- 3 sites with existing GW monitoring networks evaluated
- Fort Lewis Army Depot in Washington
  - GW sampling since 1995, CVOCs
  - 72 monitoring wells
- McClellan Air Force Base OUD in California
  - GW sampling since 1984, CVOCs
  - 51 monitoring wells
- Long Prairie Superfund Site in Minnesota
  - GW monitoring since 1996, CVOCs
  - 44 monitoring wells

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Project Design

- Evaluation of site data and consolidation of ground water monitoring data
- Meetings with site managers and regulators to discuss objectives and ground rules for optimization of well network early in process
- Each optimization team worked independently to evaluate GW monitoring network
- Teams evaluated both redundancy and data deficiency

Results, Spatial Analysis (number of wells per site)

Site	Original Number of Wells	Parson's Result (percent reduction)	MAROS Result (percent reduction)
Fort Lewis	72	69 (4 %)	57 (21 %)
McClellan	51	21 (59 %)	41 (20 %)
Long Prairie	44	26 (41 %)	32 (27%)

Results – Reduction in Total Sampling Events Per Year

Site	Original Sample Frequency (events/yr)	Parsons Results (percent & cost reduction/yr)	MAROS Results (percent & cost reduction/yr)
Fort Lewis	180	110 (39% & $36,500)	113 (37% & $34,600)
McClellan	34	17 (50% & ?)	31.5 (7% and ?)
Long Prairie	51	36 (30% & $4,000)	24 (53% & $6,700)

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Summary and Observations

- Two methods identified potential for significant reduction in monitoring well networks – average of 36% reduction
- Cost savings lower on a percentage basis (because many monitoring costs are fixed)
- Based on initial feedback from regulators & facilities, results appear reasonable and have potential for being implemented
- Some reluctance to implement due to other perceived concerns (co-located plumes, negotiation with regulators, implementation costs)

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Summary and Observations

- Costs for performing LTMO relatively low ~ $10K per site with 30 wells (both methods)
- Methods have potential for increasing certainty that monitoring network is adequate (by evaluating both over sampling and undersampling)
- No consistent differences between methods identified: qualitative review may be most significant difference
- Some problems identified with MAROS plume trend analysis (consistent at all sites, but minor problem)

Lessons Learned

- Larger sites with more wells more likely to benefit
  - Minimum of 20-30 wells in each aquifer layer required
  - Minimum of 4 sampling events required
- Methods show promise, have not been widely used
- Methods need broader regulatory acceptance
- Data consolidation time consuming
- Future LTMO simplified once initial data consolidation complete. Provides consistent storage of future data

Next Steps

- Final report expected this summer
- Internet seminar on project results this fall
- Potential LTMO workshops
- Follow-on project – LTMO Roadmap
  - Overview of all LTMO methods
  - Explanation of method applicability (which method should I use at my site?)
  - Information on common red flags with the methods
  - USACE, USEPA, Parsons, Mitretek
  - Draft roadmap this summer

All reports available at cluin.org and frtr.gov/optimization

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Discussion

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