A Demonstration of Two Long-Term Monitoring Optimization Methods

FRTR Meeting

John Kingscott
For
Kathleen Yager

U.S. EPA
Technology Innovation Office

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Project Overview

- EPA, AFCEE, and USACE project to showcase the use of two methods for optimizing ground water monitoring networks
- Goals:
  - To improve the understanding of statistical and geostatistical approaches to long-term monitoring optimization (LTMO) techniques
  - Provide case study examples of how methods are applied
  - Understand if there are differences between the 2 methods
- Two methods attempt to answer questions of
  - how many wells are required (spatial)?
  - how frequently wells should be sampled (temporal) to achieve monitoring objectives (e.g., define plume boundary or otherwise meet DQOs)?

Project Design

- Showcase the application of the two LTMO methods at 3 sites with existing ground water monitoring networks
  - Fort Lewis Army Depot in Washington
    - GW sampling since 1995
    - 72 monitoring wells
  - McClellan Air Force Base OUD in California
    - GW sampling since 1984
    - 51 monitoring wells
  - Long Prairie Superfund Site in Minnesota
    - GW monitoring since 1996
    - 44 monitoring wells
  - All sites had chlorinated solvent contamination

Project Design, cont.

- Initial evaluation of site information 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 reduce network
- Each team also considered increases to spatial and temporal sampling at 2 sites (based on concerns that well networks were not adequate in certain areas)

LTMO Methods Included in Project

- Monitoring and Remediation Optimization Software (MAROS)
  - Free software developed by AFCEE and GSI
  - Employs spatial and temporal data analysis techniques to determine sampling locations and frequency
  - 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

LTMO Methods, cont.

- Parsons' 3-Tiered Monitoring Network Optimization (MNO)
  - Employs a 3-tiered approach to designing well networks
    - 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 algorithm to determine frequency)
    - 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, cont.

- Primary differences between MAROS and MNO
  - MNO incorporates a qualitative review as a preliminary step in screening data
  - Geostatistics in MNO are 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

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 (Sampling events per year)	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)

Summary and Observations

- Two methods identified potential for significant reduction in monitoring well networks – average of 36% reduction
- Cost savings will be 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 facilities reluctant to implement due to other perceived concerns (delineation of other contaminants, required effort to negotiate changes with regulators, costs of implementing changes)

Summary, cont.

- Costs for performing LTMO relatively low – estimated at $10K per site with 30 wells (both MAROS and MNO)
- 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 from analysis
  - Minimum of 20-30 wells in each aquifer layer required
  - Minimum of 4 sampling events required
- Methods show promise, but have not been widely used (AF seems to be biggest user)
- Methods need broader acceptance from regulatory community; a matter of building awareness
- Data consolidation is time consuming
- Future LTMO analysis simplified once initial data consolidation complete and provides easy and consistent storage of future monitoring data

Next Steps

- Draft report anticipated August 2003
- Expert review to be conducted
- Considering collaboration with the USACE on preparation of a report on LTMO methods
  - Primary purpose is to provide a thorough discussion of statistical/geostatistical methods
  - Report scope to be developed over summer and may expand beyond statistics
  - Will consider LTMO needs and currently available guidance documents
  - USACE plans to coordinate with EPA and other Federal agencies
  - For more information contact Dave Becker USACE (402-697-2655) or Kathy Yager US EPA (617-918-8362)