Overview of LTM Optimization at Air Force Facilities

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Introduction

Long term monitoring (LTM) optimization is a relatively recent technology that is useful in reducing monitoring costs on the order of 20-40%. Air Force and DoD management guidance requires optimization of remedial actions per environmental restoration programs. A variety of optimization tools and technical resources are widely available to assist Air Force facilities and their organizations. AFCEE is a major player in developing optimization tools, guidance, and case-study investigations. While the strategy and technical methodology for performing LTM optimization exists, more work is necessary to validate or confirm that the optimized monitoring network is performing effectively and as designed. In addition, information derived from studies that compare optimization tools (algorithms, software applications, etc.) and address the reproducibility of optimized solutions (modified or redesigned monitoring networks and/or remedial systems) are important to managing and applying this important technology.

Methods

While monitoring goals first and foremost must be protective of human health and the environment, another important objective is achieving sufficient data to adequately support environmental decision-making. Capturing sufficient data and accepting a tolerable level of uncertainty without significant loss of information, reduces the need for gathering or analyzing unnecessary data. Generally stated, the goal is to gather "essential" data at the expense of "nice to have" data. Reducing or eliminating redundant data can save significant monitoring funds over many years.

The key strategy involves optimizing both the number of well locations (spatial analysis) and the sampling frequency (temporal analysis). Monitoring scenarios applicable to optimization include both passive LTM networks and active remedial systems where performance and effectiveness issues are important. The major process components include: a detailed decision-path framework, electronic data management, selection of optimization tools, and the detailed temporal and spatial analysis. Other critical factors associated with a successful optimization investigation include: regulator buy-in, detailed cost analysis (i.e. costs to perform the optimization, costs associated with the original un-optimized network, cost benefits associated with operating the optimized network, etc.), reporting and product deliverables, new-system validation and performance effectiveness, duration of operation, and periodic review (3- 5 year horizon).

Particularly for optimizing the larger monitoring networks, access to a standardized electronic data resource such as AFCEE's Environmental Resources Program Information Management System (ERPIMS) is extremely important. Data management often consumes a large portion of the optimization process and if the electronic infrastructure is lacking or troublesome, inefficiencies and unnecessary labor hours can quickly erode cost savings.

AFCEE and their support contractors have developed optimization tools to help reduce data redundancy. These tools include optimization algorithms such as the Geostatistical Temporal/Spatial (GTS) Optimization Algorithm (Cameron and Hunter, 2001) and another similar approach developed by Parsons Environmental Services. Software applications include the

Monitoring and Remediation Optimization System (MAROS) developed by Groundwater Services Inc. Case studies using these tools at AF facilities include: Air Force Plant 6 GA, Loring ME, Pease NH, Edwards CA, Bolling DC, Columbus OH, Dover DE, Keesler MS, McClellan CA, Shaw SC, Vandenberg CA, and Williams AZ. To field test these tools, these installations provide a variety of hydrogeologic settings, contaminants of concern, network complexity, and remedial systems in place. As a result, significant progress has been made in optimizing monitoring well networks at AF facilities and in improving the tools themselves.

Discussion

Although case studies have advanced the technology and more experience has been gained by the practitioners performing optimizations, more thought needs to be directed towards validation and reproducibility of the results. Once an optimized network is designed and operating in place, one needs to assess whether the network is behaving as expected, i.e. is the optimized network providing sufficient data without significant loss of information.

To answer this, selective sampling of wells identified as redundant will be necessary. These selected wells should be few in number, perhaps less than 5% of the redundant network, and would be randomly assigned. Some redundant wells likely would be sampled as part of a negotiated arrangement with stakeholders. If the redundant sampling results are determined to be out of control or otherwise significantly different from the predicted concentration based on an analysis of the optimized network, then verification resampling or adjustments to the network may be warranted. Sampling of the redundant wells may be varied randomly over time to verify that optimized sampling frequencies are adequate. Depending on the network and whether there are remedial systems in place, the validation process may take place over a 3 – 5 year time horizon.

Studies comparing optimization tools to assess reproducibility of results are also important to the Air Force restoration program. Details as to how these studies will be conducted have not been decided upon yet, although a standardized approach is desirable. Clearly though, these studies would compare the number and location of essential wells, sampling frequencies, plume concentrations, cost considerations, and the like.

References

Cameron, K, and Hunter, P., 2002, Using spatial models and kriging techniques to optimize long-term ground-water monitoring networks: a case study, Environmetrics, Vol 13, 629-656.