Achieving Groundwater Monitoring Optimization at SRS: A Core Team Process Based on Rigorous Technical Assessment – 15273

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ABSTRACT

The optimization of groundwater monitoring at Savannah River Site (SRS) was achieved through a core team process based on the application of a comprehensive, technical evaluation of individual regulated groundwater units.

Groundwater monitoring at SRS is required at dozens of waste sites and includes about 4,000 samples annually. The expected longevity of groundwater contamination and associated groundwater monitoring and reporting constitutes a significant long-term cost to the environmental management budget. The core team, consisting of representatives from the Department of Energy (DOE); U.S. Environmental Protection Agency (USEPA); and the South Carolina Department of Health and Environmental Control (SCDHEC), recognized that monitoring needs for individual plumes evolve as remediation work progresses.

The technical evaluation plan was generally based on the availability of many years of monitoring data. In addition, it was recognized that the well network, sampling frequency, and analytical suite had been the same for years and warranted evaluation to determine if the existing monitoring was meeting the current objectives. In order to systematically evaluate monitoring at eighteen different groundwater units, SRS developed a decision-logic analysis using flow sheets to address five areas of optimization identified with core team agreement, including: (1) current monitoring vs regulatory requirements, (2) spatial optimization, (3) temporal assessment, (4) analyte assessment, and (5) reporting assessment.

The evaluation resulted in SRS proposing changes in the spatial, temporal, analyte, and reporting aspects of groundwater monitoring for fifteen of the eighteen individual groundwater units evaluated. Overall, these changes have resulted in annual savings of $370K to date, with an additional $200K in annual savings pending.

Early and frequent core team deliberations helped ensure the success of this optimization effort. The technical evaluation was conducted after receiving core team buy-in for the goals and methods of the project. Technical evaluations for each unit were proposed to the regulators in unit-specific regulatory submittals. The technical justifications and core team decisions were all documented and implemented in accordance within the framework of the SRS Federal Facility Agreement or Resource Conservation and Recovery Act (RCRA) Permit process. This optimization approach can be expected to be highly successful for sites with rich historical data sets and where the requirements in regulatory monitoring plans can be negotiated.

INTRODUCTION

A comprehensive environmental characterization, remediation, and monitoring program has been implemented at the SRS. Operational facilities have groundwater monitoring conducted to meet various state and federal requirements. Historical waste sites and groundwater contaminant plumes are characterized, remediated, and monitored in compliance with the RCRA permit requirements and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process [1, 2]. Regulatory monitoring requirements vary for individual groundwater units. For RCRA units, groundwater monitoring is conducted to satisfy the compliance monitoring and corrective action requirements of the South Carolina Hazardous Waste Management Regulations and specific Part B Permit conditions. For CERCLA units, groundwater monitoring is required early in the CERCLA process as part of contaminant characterization as well as later in the process to assess the effectiveness of the selected groundwater remedies.

Groundwater monitoring at SRS is extensive. Plumes from eighteen various waste units and general areas are identified and shown Figure 1. Volatile organic compounds (VOCs) and tritium are the most common contaminants exceeding regulatory standards (maximum contaminant levels [MCLs]). However, depending on the source, metals and other radionuclides are also known to be present. The footprint size of groundwater contamination at SRS is approximately 5,000 acres. Approximately 4,000 groundwater samples are taken each year from over 3,000 wells. These samples generate about one million data records per year including field measurements (i.e., water table elevation) and analytical results for over 200 individual constituents. Multiple aquifer units are monitored with sampling depths ranging from surface samples in wetlands to monitoring wells screened as deep as 120 m (400 ft) below ground surface.

Based on the current size of the monitoring program and the expected longevity of groundwater contamination, the associated groundwater monitoring and reporting constitutes a significant long-term cost that represents an increasing proportion of the environmental management budget as surface waste units are closed. Therefore, a comprehensive evaluation of the monitoring program was conducted to identify areas where monitoring could be optimized.

DISCUSSION

Methods

Regulatory drivers for SRS groundwater monitoring were assessed to understand the scope of the program. Groundwater monitoring is required by RCRA post-closure care permit conditions at five hazardous waste management facilities, which are regulated by the SCDHEC. Groundwater monitoring is required as part of a Record of Decision (ROD) to satisfy RCRA/CERCLA commitments for thirteen operable units. SRS also has groundwater monitoring for operational facilities, SRS-wide environmental monitoring, and other RCRA/CERCLA groundwater units with future regulatory decisions. The initial optimization evaluation included the eighteen RCRA permitted and RCRA/CERCLA operable units that had specific regulatory requirements (Figure 1). Phase II of the optimization will include evaluation of thirteen additional groundwater units that are not RCRA permitted or RCRA/CERCLA operable units.

Figure 1. Contaminated Groundwater Areas and Specific Regulated Units

The decision-making process at SRS is guided by the application of environmental restoration principles, which are grounded in accurately and concisely defining the problem, and determining the preferred response to the problem. The first principle is building an effective core team, which comprises those individuals with the responsibility and authority to make decisions. Core team meetings (scoping meetings) provide the forum for communication and affirmation of common project understanding and direction prior to the execution of technical work. The core team process was established at SRS in 1998, consisting of representatives from DOE, USEPA, and SCDHEC. The core team functions as the decision makers for each of the RCRA/CERCLA operable units, and also comes to agreement on programmatic issues affecting all operable units. Scoping meetings are the forum for these decisions, with a scoping summary prepared by the DOE contractor used as the vehicle to succinctly communicate the issue, potential problem, and a range of potential solutions. Multiple scoping meetings are held during the course of investigation and proposed remedy selection, as shown below in Figure 2.

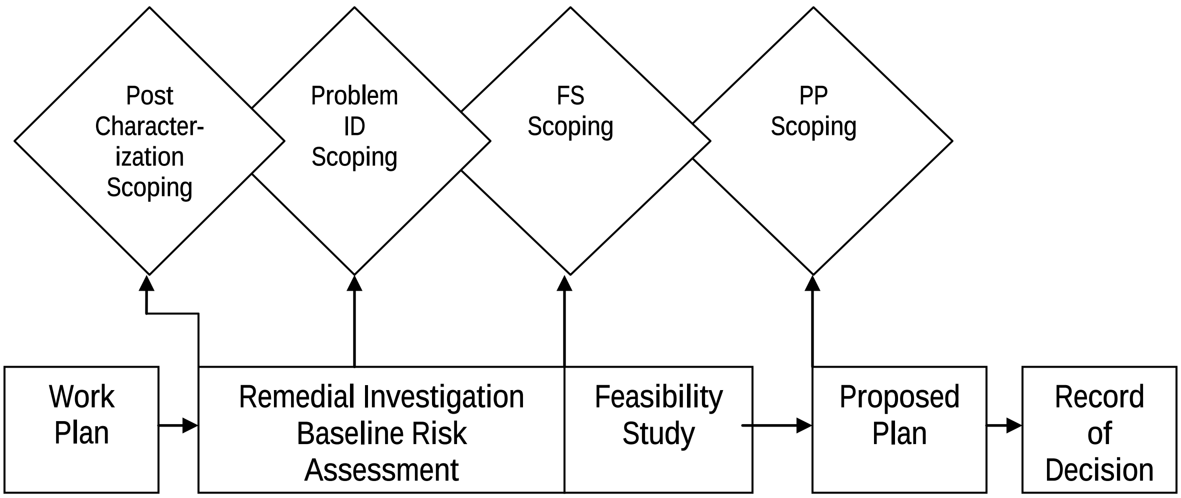

Figure 2. Relationship of scoping meetings to the CERCLA Process

Groundwater (and surface water) monitoring is based on a set of clearly defined objectives for which monitoring data are collected to specifically fulfill those objectives. Typically, these objectives directly support regulatory decision-making. The design of the monitoring plan (e.g., number of wells, frequency of sampling, laboratory analysis, reporting frequency) is tied to the data quality objectives and management of uncertainties in order to make project decisions. The regulatory decisions and the project objectives may vary depending on the type or the stage of the project.

The various stages can be divided into two main phases: pre-remedy characterization and post-remedy monitoring. The objectives of these phases are fundamentally very different. Pre-remedy characterization identifies the nature and scope of the problem and selects an appropriate remedy, while the post-remedy monitoring determines the effectiveness of that remedy. Pre-remedy characterization usually consists of groundwater samples collected from a significant number of wells over an extensive area, and analyzed for a broad spectrum of potential contaminants. Post-remedy monitoring includes long-term monitoring of groundwater conditions, typically from a focused area of a few pertinent wells, and a reduced list of relevant contaminant analyses. The key objective of the post-remedy monitoring is to demonstrate whether or not groundwater conditions are corresponding with the expectations of the remedy [3]. It is important to recognize that the groundwater monitoring plan may change significantly for a particular unit as the remedy matures or changes. For example, if an active bioremediation system is shut down and the remedial action continues as monitored natural attenuation (MNA), the various biogeochemical parameters used to monitor the effectiveness of the bioremediation system may no longer be needed.

At most the eighteen units identified for evaluation, the groundwater monitoring conducted is post-remedy (closure) monitoring for mature plumes. However, even those units for which the final corrective action or remedy have not been chosen have well characterized and well monitored plumes.

In order to optimize (right-size) the groundwater monitoring and reporting, a comprehensive technical approach was applied to each of the groundwater units. Current groundwater sampling, analysis, and reporting practices were evaluated to identify opportunities for optimization and project cost avoidance/reduction.

A decision logic analysis using flow charts was developed to guide an organized systematic evaluation of groundwater monitoring optimization opportunities for the eighteen individual groundwater units. The evaluation was conducted in the following five areas:

- Current Monitoring vs Regulatory Requirements;
- Spatial Optimization;
- Temporal Assessment;
- Analyte Assessment; and
- Reporting Assessment.

An example flow chart depicting the decision logic used to identify opportunities in the spatial redundancy evaluation is presented in Figure 3.

The elegance of this decision analysis is in the tailoring of the evaluation to the specific monitoring program and hydrogeologic conceptual site model at each unit. Therefore, it can be applied to both simple units with monitoring at just a few wells, and complicated regimes with multiple affected aquifer zones and hundreds of wells. Statistical approaches are generally more useful at sites with large monitoring well networks.

In conducting the evaluation of the spatial distribution of the monitoring network, the specific objectives and requirements of the monitoring plan are considered in formulating the questions to be assessed. For example in the figure below, these questions are tailored to a monitored natural attenuation remedy, with predominantly physical attenuation processes, such as for tritium. Thus, some of the key objectives of the remedy (prevent MCL exceedances in surface water, and prevent deeper aquifer contamination) are captured in the questions. If an active groundwater treatment system was being evaluated as part of the monitoring objectives, then an example question might be “Is the predicted capture zone supported by empirical data?”.

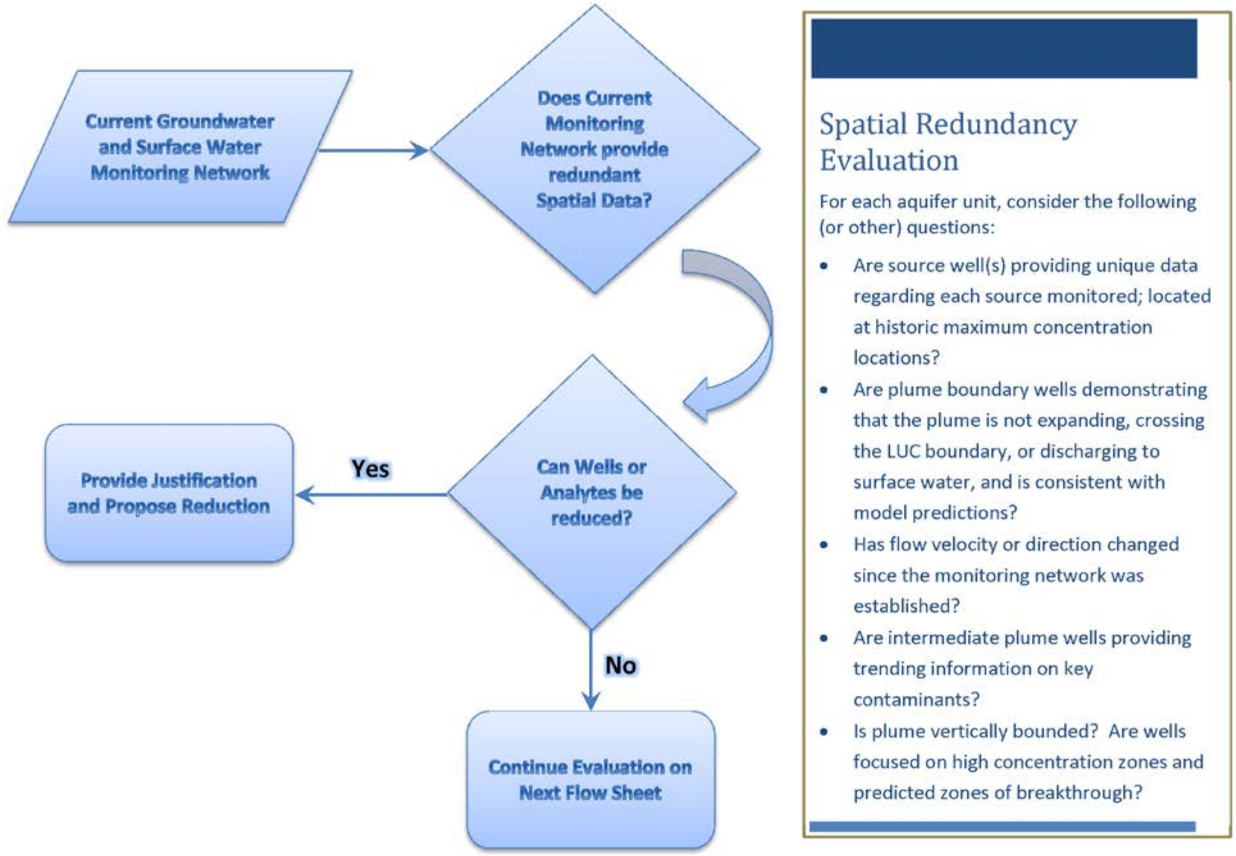

Figure 3. Decision Analysis for Evaluation of Spatial Distribution of Monitoring

Results

Prior to conducting the evaluation, a core team meeting was held to discuss the objectives and technical approach of the groundwater monitoring optimization on a program level in order to get the regulators' input into the process. This early communication of the goals of the optimization paved the way for future detailed discussions, on an individual operable unit basis, of the technical evaluation and recommendations. The results of the monitoring and reporting optimization evaluation for the eighteen groundwater units were presented in a summary report [4], but the optimization rationale and recommendations for each operable unit were typically presented in a regulatory-required document such as an annual effectiveness monitoring report.

For each groundwater unit, the following metrics are summarized in Table I below: 1) proposed changes to the number of monitoring wells sampled; 2) reductions/increases in the monitoring frequencies; 3) reductions/increases to the monitored analytes; and 4) changes in reporting frequencies. In addition, an estimated annualized cost savings was also determined. Overall, recommendations were made for fifteen of the eighteen units.

TABLE I. Optimization summary for the evaluated groundwater units

Groundwater Unit	Net Wells Reduced	Well Visits Reduced	Net Analytes Reduced	Reporting Frequency Reduced
A/M Area – Central Sector	3	72	0	Y
A/M Area – W. Sector	(1)	0	(4) at 8 wells	Y
A/M Area – S. Sector	(2)	32	0	Y
A/M Area – N. Sector	(6)	6	0	Y
A/M Area – ABRP/MCB	8	0	(1) at 65 wells	Y
H-Area HWMF	6	48	1 at 197 wells	N
F-Area HWMF	3	3	1 at 145 wells	N
MWMF	16	64	0	N
Sanitary Landfill	14	66	0	Y
C-Area BRP	0	0	0	N
CMP Pits	1	13	0	N
D-Area GW	0	9	0	N
D-Area Oil Seepage Basin	0	0	0	N
General Separations Area - E	2	23	0	Y
General Separations Area - W	7	32	(1) at 1 well	Y
KLP BRPs	7	13	0	N
L-Area S. GW	0	22	(2) at 1 well	Y
R-Area BRP	0	2	0	N
R-Reactor Seepage Basin	5	21	1 at 21 wells	Y
TNX Area GW	0	0	0	N
Total	**63**	**505**		

At nine of the eighteen units evaluated, SRS recommended discontinuing monitoring at some wells due to spatial redundancy. At four of the units additional monitoring locations were proposed to address data gaps. This resulted in discontinuation of sampling at 72 wells, incorporating data from 9 existing wells into routine monitoring, and the installation of seven new wells.

The temporal assessment resulted in a recommendation that at fifteen of the units, the frequency of sampling be reduced; conversely, at a single unit, wells were recommended for sampling at an increased frequency. This resulted in a reduction of sampling frequency at 246 wells and an increase in sampling frequency of 42 wells.

Recommendations from the analyte assessment were that three of the eighteen units should discontinue monitoring for some current analytes, and three units should add analytes to their routine monitoring. This resulted in a reduction in analytes for 363 wells and an increase in analytes at 75 wells. Most of the new analyses are for 1,4-dioxane, an emerging contaminant.

The reporting assessment resulted in reductions in reporting frequency at six units, and a modification to the content at one unit in response to the shutdown of a remediation system.

Overall, recommendations were fully agreed to at five of the units, agreed to with modifications at seven of the units, denied at one unit, and still pending decision at the last two units.

The proposed recommendations identified in this evaluation, if all approved by SCDHEC and EPA, are projected to result in an average savings of approximately $700,000 per year continuing through the duration of long term groundwater monitoring. The largest area of savings was associated with reducing the reporting frequency.

Recommendations are being made for each individual unit with the specific project and core team members assigned for that unit in a meeting, and using an appropriate vehicle (such as an annual monitoring report) to document the agreed upon changes.

CONCLUSIONS

The optimization approach has been well received by the EPA and SCHDEC, with unit-specific recommendations approved for twelve of the thirteen units where decisions have been reached. The recommendations approved to date have resulted in an annual savings of $370K, with an additional $200K in annual savings pending. This high rate success can be attributed to a strong working relationship with EPA and SCDHEC. An early programmatic groundwater optimization scoping meeting helped ensure the success of this optimization effort, as the technical evaluation was conducted after getting core team buy-in for the goals and methods of the project. Subsequently, the optimization rationale and recommendations for each operable unit were typically presented in a regulatory required document such as an annual effectiveness monitoring report, and then discussed with the regulators. Phase II of the groundwater optimization will include evaluation of thirteen additional groundwater units that are not RCRA-permitted or RCRA/CERCLA operable units.

The optimization process used at SRS can be applied broadly to other DOE facilities, federal facilities, and private RCRA- or CERCLA-regulated sites. This process relies on a clear understanding and agreement on monitoring goals and objectives by all stakeholders, and is tailored to the specific characteristics of each individual unit evaluated. It can be applied to units with a few wells or hundreds of wells. Statistically-based monitoring optimization software was not used as part of this process, as a greater emphasis was placed on the empirical data and depth of technical understanding for each individual unit. The long monitoring history at SRS has contributed to a rich dataset, allowing for empirical time trend analysis to help reduce the uncertainty in decision making.

REFERENCES

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2. South Carolina Hazardous and Mixed Waste Permit, Permit number SC1 890 008 989, 2014 RCRA Part B Permit Renewal for the Savannah River Site, issued February 11, 2014, Module III – Postclosure Care and Module IV – Groundwater Requirements, Section A, M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities (initially effective on July 12, 2013), South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, Bureau of Land and Waste Management, Columbia, SC

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