REPORT ON THE STATUS OF IMPLEMENTING SITE-SPECIFIC ENVIRONMENTAL DATA COLLECTION PROJECT PLANNING AT THE DEPARTMENT OF ENERGY'S (DOE) OFFICE OF ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT (EM)

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ABSTRACT

The Department of Energy (DOE) is faced with a huge, highly publicized, and costly environmental challenge. In any decision making process that establishes when, where, and how to cleanup or manage wastes, environmental data are essential. Equally important is the definition and determination of project completion which also relies on environmental data. Recognizing that environmental data are both essential and costly, various planning processes have been developed, enhanced, and implemented by DOE and other agencies. This presentation briefly describes these programs and the status of activities to improve planning and efficiency of environmental restoration, waste management, and technology development activities across DOE.

PLANNING OF ENVIRONMENTAL DATA COLLECTION

In the early stages of an environmental restoration project, the data are needed to tell where the contamination is, what it is, and how much there is. As the project nears completion, environmental data again are needed to determine when project goals have been met, i.e., when the site meets the criteria for "clean." Thus, determination of project completion also relies on environmental data.

Based on U.S. Environmental Protection Agency (US EPA) experience, environmental sampling and analysis may account for 20 percent of the total clean-up cost. This suggests that $40 billion may be spent on environmental sampling and analysis at DOE weapons sites over the next 30 years. This large potential outlay of funds demands that every effort be made to ensure that only necessary data are collected and that they be collected in a cost-effective manner. Collecting redundant or extraneous data wastes resources and severely limits the clean-up progress. The practice is particularly costly because the "total waste" goes beyond the mere cost of the unneeded sampling and analysis. It includes the costs of unnecessary planning, data review, and maintenance of excess laboratory capacity.

DEALING WITH DATA UNCERTAINTY

Inherent in any process to improve the quality and efficiency of environmental decisions is the recognition at the outset that the data will have some uncertainty, no matter how carefully the data are obtained. Any environmental measurement can do no more than estimate the true condition. Elements contributing to uncertainty must be identified, quantified, understood, and managed in collecting environmental data. Elements contributing to uncertainty, variability, and error include:

- Theoretical modeling;
- Heterogeneous materials;
- Sample Representativeness;
- Sample handling;
- Analysis;
- Data recording/transcription/reporting; and
- Data validation/assessment.

Historically, efforts to estimate error have focused almost exclusively on the analytical step and have ignored the other potentially much larger sources.

ADAPTATION OF DQO PROCESS AND OBSERVATIONAL APPROACH

Recognizing that environmental data are both essential and costly support to decision making, the US EPA developed the DQO Planning Process. This process focuses on the necessity of up-front planning and connecting data collection to the specific decision to be made. It forces program and line management, regulators, and public participants to address questions they traditionally have not considered. The process provides these groups a means for understanding precisely how the data will be used, the kinds of data needed, and for accepting the fact that the risk of error can be managed but never eliminated. The process leads to selection of a level of risk in making a wrong decision that is acceptable and a corresponding sampling and analysis plan that limits data collection to essential information consistent with the accepted risk level.

The Observational Approach is another useful tool which has been applied in DOE for some time. When applied to sampling and analysis project planning, for example, it involves: 1) designing a preliminary sampling and analysis plan, 2) collecting a small amount of data (i.e., enough to estimate existing conditions), and 3) revising the sampling and analysis plan, based on preliminary results. The process of sampling and analysis planning, implementation, and revision is iterated as many times as necessary to achieve the optimal sampling and analysis plan. This approach generally is applied to sampling and analysis project planning where hazards are known and extreme variability (e.g., heterogeneity) is expected. The Observational Approach emphasizes the inevitability of decision error and recognizes monitoring and management of variability within an anticipated range of conditions. This approach stresses the fact that the "best way" to understand a complex problem is to start addressing it. Data collection is only relevant to the extent that it will effect the selection among alternatives.

Both the DQO Planning Process and Observational Approach recognize that data are relevant only to the extent that they are helpful in selecting an action or making a decision, e.g., which of two engineering alternatives is technically feasible and more cost-effective. The integration of these two planning processes to produce an enhanced planning process was completed in early spring 1992. The purpose was not to define and require a rigid framework, but to provide a process that assists in identifying the sequence and inputs necessary for decision making. DOE's need for an enhanced planning process results from the complexity of problems at DOE Weapons Complex facilities. These problems frequently involve a variety of waste types at large sites with multiple activities that must be understood and addressed in a carefully developed sequence within the constraints imposed by various local, state, and federal compliance agreements, permits, and regulations. The merging and enhancement of the DQO Planning Process and the Observational Approach have produced what we call the Streamlined Approach For Environmental Restoration, or SAFER. SAFER is based on and consistent with EPA guidance and requirements.

STREAMLINED APPROACH FOR ENVIRONMENTAL RESTORATION (SAFER)

In adapting the DQO Planning Process and the Observational Approach to produce SAFER, DOE's objectives were to:

- enhance the focus on planning and scoping aspects of sampling and analysis projects;
- assure participation and consensus from key stakeholders (viz., the public, regulators, and DOE project managers).
- converge early on a remedy (bias for action);
- link data collection directly to the decision making needs;
- explicitly recognize and manage uncertainty; and
- collect information as planning and remediation proceed, then apply it directly and efficiently.

The SAFER Framework is depicted in Figure 1. It is subdivided into the same three phases as the CERCLA and RCRA regulatory frameworks, namely: 1) planning, 2) assessment and selection, and 3) implementation. The planning phase consists of five iterative steps and the consideration of early action alternatives. It begins with the development of a conceptual model of the environmental contamination problem, proceeds on through development of remedial objectives for probable conditions, and ends with development of the decision rule and an optimal sampling and analysis project design. The assessment and selection phase consists of four steps, provided the planning phase was performed satisfactorily. This phase begins with collection and assessment of data, in accordance with the sampling and analysis project design. If the data assessment determines that the site has not been adequately characterized, the planning phase must be revisited. However, if the data assessment determines that the site has been adequately characterized, the next steps are to develop and evaluate alternatives for achieving the remedial objectives, select a remedy (addressing known conditions), develop contingency plans (covering other conditions likely to be encountered), and document the remediation decision rule. If an expedited or early action remedy is identified, sampling and analysis may be tied directly and rapidly to monitoring the remedial action. The implementation phase focuses on implementing the selected remediation decision rule while continually monitoring for any deviations, i.e., conditions that would cause the stakeholders to change their view of the problem. If a deviation is detected and it is among those that had been anticipated during contingency planning, the appropriate contingency plan is used in refining the decision rule. If the deviation encountered had not been anticipated, then it becomes a new problem. The decision rule must be revised to address these newly recognized site characteristics.

INTEGRATING SITE-SPECIFIC APPLICATIONS OF DQOs AND SAFER AT DOE

Specific data collection planning processes, e.g., DQO Process and SAFER, were originally developed to meet environmental restoration needs under Superfund (Comprehensive Environmental Resource, Compensation, and Liability Act, i.e., CERCLA). For this reason, guidance document terminology and historical model projects frequently relate to cleanup projects. Current activities include several site-specific restoration projects at Savannah River and Oak Ridge. Examples from these projects serve to illustrate and emphasize specific details and considerations to help in applying enhanced planning tools to environmental data collection. However, SAFER guidance is equally applicable to Resource Conservation and Recovery Act (RCRA) processes. The specific upfront planning and statistical emphasis of the DQO planning are also directly applicable to research, development, demonstration, and testing of alternative technologies. This is done to assure a quantitative definition and effective measurement of "success" in evaluating alternative technologies for characterization, remediation, etc. Table I summarizes the locations of various site-specific activities and the associated environmental restoration, waste management, or technology development program area.

SAFER PILOTS

Over the last two years cooperative efforts of the Offices of Environmental Restoration (EM-40), Technology Development (EM-50), and Environmental Guidance (EH-24/Office of Environmental, Safety, and Health) have developed and introduced SAFER as an enhanced planning tool to support environmental programs. A recent aspect of this project is the initiation of Interagency Pilot studies. These pilots were described to the Field Offices by Thomas Grumbly, Assistant Secretary for Environmental Management, in his formal request for site-specific nominations. These SAFER Pilots will include expedited and focused support from DOE headquarters, the specific Field Offices involved, site regulators, and public participants to streamline project planning and implementation.

RESTORATION PROJECTS

Planning efforts at Oak Ridge demonstrate how a clear and rapid consensus identification of a conceptual model and the assessment of the need (or lack of need) for additional data focuses action. At the start of the project several contaminants were thought to be significant. However, through the use of historical data, polychlorinated biphenyls and mercury were eliminated as potential health threats appropriate for action under a Record of Decision. Cesium, the remaining initially identified contaminant of concern, is present at potentially hazardous concentrations, but buried by deep river sediment. The main potential route of exposure would involve dredging or other restoration actions that would mobilize the

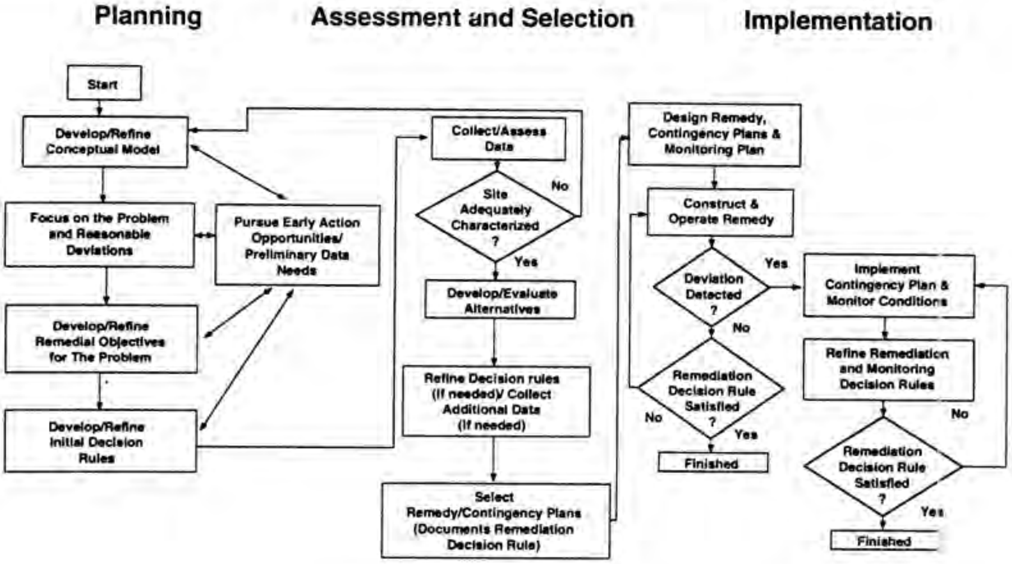

Fig. 1. SAFER framework.

TABLE I
Site-Specific Project Planning Applications

Facility	Technical Support	SAFER Pilot	Technology Development	Process Knowledge
Hanford (Richland, WA)	X	X	X	X
Savannah River (Aiken, GA)	X	X		X
Oak Ridge (Oak Ridge, TN)	X	X		
Pantex (Amarillo, TX)			X	
Mound (Miamisburg, OH)		X		

cesium currently buried under deep water sediment in the Clinch River.

A decision to take no remedial action will result in minimal exposure and public risk. In addition, the government will realize significant savings in resources by eliminating sampling and analysis of river sediment to collect additional data (>\$100K), the extremely high cost of any of the remedial alternatives, and the elimination of long term research to identify an ecological monitoring endpoint (estimated at \$30 million) as part of restoration activities. This data collection was eliminated because the stakeholders agreed that they had all the necessary data to make a defensible decision that the no action alternative would protect public health.

PROJECT PLANNING APPLICATIONS TO WASTE MANAGEMENT

Although the terminology of the various planning approaches is generally directed at remedial application (i.e., CERCLA), waste management projects are equally applicable. The Hanford, Washington site has successfully applied the DQO Process and other planning approaches to several RCRA project areas. An example is a sampling program that initially required characterization of over 600 waste streams. Based on negotiations with the State of Washington Regulator to determine specific concerns, i.e., define the problem, all parties agreed that no more than 40 waste streams might require characterization. The remaining waste streams required no further characterization because of the volumes introduced and the original agreement defining the regulatory concern and accepted endpoint were.

Additional project areas at Hanford involve the highly publicized waste tanks. Sampling and analysis of these tanks costs approximates \$1,000,000 per core sample. We are working to identify and gain acceptance of phased data collection that provides only data needed to accomplish specific waste handling actions. For example, pumping waste does not require complete characterization of the materials. Essential data is restricted to health and safety parameters and minimal physical (particle size, viscosity, etc.) and chemical (chloride, total activity, etc.) measurements. Cutting back on unnecessary analyses represents a saving of resources and frees up valuable (generally irreplaceable) laboratory capacity.

A current priority problem in the Office of Waste Management (EM-30) is the acceptance and use of process knowledge to support transportation, storage, and treatment decisions. A pilot project to treat containerized materials was conducted at Hanford based upon process knowledge that was verified by sampling and analysis procedures. The regulators are comfortable if defining the contents of drums based upon process knowledge can be verified by limited sampling and analysis of selected drum contents. If the prediction of drum contents based on process knowledge compared to sampling and analytical data is not within acceptable limits of variation, then the frequency of sampling and analysis is increased to provide acceptable assurance of project control. The accuracy of the process knowledge appropriately dictates its reliability and acceptance for use. Similar expanded pilots and guidance documents to assist in site-specific application of this approach are being developed cooperatively by EM-30 and the Office of Compliance and Site Coordination (EM-20).

WATER QUALITY MONITORING

The Savannah River (SR) Operations Office, in cooperation with Regional EPA and State of South Carolina Regulators, have started efforts to cut back on unnecessary sampling and analyses by defining the problem of interest and "absolute data needs." Of the approximately 3,400 monitoring wells on the 192,000-acre site, many are collocated within the same contaminant plumes and provide no unique information. However, essentially all the wells have been sampled on regular schedules for a very long and expensive list of analytes and radionuclides. Sample collection and laboratory analysis of each well wastes limited resources. In addition, regulatory agency resources are then spent to review this "non-essential" data. SR personnel, with regulatory support and acceptance, are decreasing this analytical burden with no negative impact on site monitoring information. For example, expensive laboratory analyses may not be necessary to address specific regulator and public concerns, e.g., direction of water flow or hydraulic control. Information adequate to answer these questions can be provide by measuring depth to ground water and conductivity. In addition, expensive and laborious chemical separations and quantification of individual radionuclides can be replaced by alpha and gross radioactivity screening. This much more cost effective approach can be implemented with no loss of knowledge on site conditions. The same DQO driven process to directly tie data collection with an information need is being applied at more of SR's 266 waste management units.

PROJECT PLANNING APPLICATIONS TO RESEARCH AND DEVELOPMENT PROJECTS

Although research,development,demonstration,testing, and evaluation of new technologies have not historically been part of formal data collection planning activities, e.g., the DQO Process, this area is ideal to develop and prove the value of alternative technologies. Research budgets have been developed and spent with insufficient emphasis on providing statistical proof at a level of confidence acceptable to regulators that a technology e.g., characterization, monitoring, or remediation, meets the required process specifications. This proof can only be developed if the data collection process is planned and managed to control error associated with sampling design, sampling, and measurement. For example, poor accuracy or precision can easily prevent recognition of superior technology because differences are not statistically defensible. Even more frequently, poor sampling design provides insufficient background or baseline condition samples resulting in inconclusive "proof" of differences. Our initial activity is to provide statistical design and interpretation support to the volatiles in arid soil integrated demonstration project.

In addition to supporting integrated demonstrations, we are committed to provide various planning, e.g., regulatory and public participation, activities and statistical support for "Expedited Site Characterization" pilots. Expedited Site Characterization is a current research program that utilizes national experts, a flexible schedule, and computerized geophysical and computer graphics technologies to rapidly assess geological features and map areas of subsurface contamination. Expedited Site Characterization focuses on effective program implementation. Our support function involves planning and assessment aspects that are essential to define and accept technical solutions.

DATA QUALITY ASSESSMENT - FUTURE PROGRAM EMPHASIS

As we get better at project planning, we must give more emphasis to data quality assessment. Once DQOs have been selected and plans for achieving them have been completed, there is a need to assess whether or not the DQOs were achieved. In essence, did we meet all of the requirements for data, quality, and confidence that are embodied in a project's DQOs? Such a data quality assessment (DQA) consists of technical and statistical reviews during and at the end of the process. It ties the information collected back to the decision rule. The key point here is that the process is not linear, but interactive. When Data Quality Objectives are set, we need to systemically test whether or not they were achieved. Adoption of the DQA Process requires modification of traditional Quality Assurance parameters (i.e., precision, accuracy, representativeness, comparability, and completeness). These indicators have significance only in terms of the overall confidence associated with the data collection activity. For example, completeness should not be a "quality characteristic" with a goal of 90% or 95%. The appropriate goal is to achieve the degree of certainty established through the DQO process. Whether a specific set of analyses was completed to a preset requirement, e.g., 90%, is irrelevant outside the context of the total error associated with data collection and the degree of uncertainty originally accepted by consensus through the DQO Process for the decision. Historically, data review processes have considered only sample handling and analysis as sources of error in the result. Since the vast majority of error or uncertainty comes from sampling design, sample collection, etc., current review procedures are inadequate, misleading, or both. As regulatory drivers consistent with this new philosophy and recognition of inherent uncertainty develop, they will require guidance necessary for implementation and appropriate training courses. All these technically complicated and politically sensitive issues are subjects of current Interagency Work Groups and "Consensus Standards Setting Organizations." DOE is an active contributor to the development and implementation of this necessary re-evaluation of the processes to collect and use environmental information.

DOE'S STRATEGY TO IMPROVE PROJECT PLANNING COMPLEX-WIDE

The purpose of these site-specific activities, e.g., SAFER pilots, is primarily to develop an independent capability within the DOE field organizations to and implement the SAFER or DQO planning process. To meet this program need, we have established four teams of experienced facilitation and statistical applications experts that are being deployed initially across DOE Complex sites with high priority, i.e., dollars and visibility, Environmental Restoration and Waste Management problems. We will build our site-wide capability from these core groups and the "hands-on" training provided from cooperative efforts with site personnel.

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