

# Panel Discussion

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## INTRODUCTION

The U.S. Geological Survey's (USGS) Office of Water Data Coordination (OWDC) has lead responsibility for coordinating water-data acquisition activities of the federal government, under authority of OMB Circular A-67. Having major input the OWDC is the Interagency Advisory Committee on Water Data (IACWD), chaired by the chief hydrologist of the USGS. The IACWD is composed of representatives of 31 federal agencies that acquire or use water data and oversees 6 subcommittees with numerous working groups.

One of the IACWD subcommittees is that on ground water. The general mission of the subcommittee is to disseminate information on ground-water data and associated matters between federal agencies, and between the federal and private sectors. As part of this effort, the subcommittee organized this session to give ASTM symposium participants an overview of federal efforts and needs in the area of standardization of field methods in ground-water contamination studies. The session was planned to inform symposium attendees of the current state of the art in guidelines, regulations, and research concerned with standardization. It was also intended to provide a framework of thoughts and problems in these areas via presentations by federal agency representatives concerned with guidelines and standards (U.S. Geological Survey), regulations and standards (EPA, NRC), and the user's viewpoint (SCS, BuRec).

Presentations were made by USGS, EPA, SCS, ARS, and NRC followed by a panel discussion involving these presenters and the audience. The panel discussion was chaired by Gene Hamilton, past chairman of the ASTM D-19 Committee on Water.

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## FIELD METHODS FOR STUDYING CONTAMINATED GROUND WATER: A U.S. GEOLOGICAL SURVEY PERSPECTIVE

To understand the perspective of the U.S. Geological Survey (USGS) with regard to the standardization of field methods for the study of ground-water contamination, it is first necessary to understand the nature and mission of the survey. The three operating divisions within the USGS are the National Mapping Division, the Geologic Division, and the Water Resources Division. It is the Water Resources Division that is most involved with ground-water studies, although the specialized skills found in the other divisions are called upon when needed.

The USGS, through the Water Resources Division, has the principal responsibility within the federal government of providing the hydrologic information and understanding needed to achieve the best use and management of the nation's water resources. It is noteworthy that "management" refers to the actions of other agencies, and "regulation" is not within the mission of the U.S. Geological Survey. It is the survey's role to provide the hydrologic information and understanding to those agencies, both federal and state, who are the regulators and managers.

The USGS collects data for two reasons: (1) it is clearly in the public interest that data be collected in an unbiased, objective manner, particularly if there is a need for long-term continuity

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in the data collection program; or (2) the data are needed to help in understanding a critical water-resources issue of national or regional importance.

### **Ground-Water Quality Studies in the Geological Survey**

Ground-water contamination is clearly an area of critical national concern, and the USGS is addressing this problem in each of its three program areas: the Federal Program, the Federal-State Cooperative Program, and the other Federal Agencies Program. These three programs differ in the sources of their funding, in the role the U.S. Geological Survey plays, and in the objectives of the work. In all the programs, however, the USGS is involved in all scientific aspects of ground-water contamination studies—from basic research to resource appraisal.

#### *Federal Program*

About one third of the operating funds of the Water Resources Division are appropriated directly by congress to support a research program and several high priority topical programs; one of these topical programs is the Toxic Chemical Waste/Ground-Water Contamination Program. To this element of its federal program and pertinent research projects, the USGS is directing approximately \$10 million toward the study of ground-water contamination. These funds are being used to look at the occurrence, movement, and fate of organic and inorganic chemicals in a variety of hydrogeologic environments. A basic component of this work is the development and evaluation of both laboratory and field methods. Methods development and evaluation is particularly emphasized in the work at three interdisciplinary field studies being supported by the Toxic Chemical Waste Program: sewage effluent at Cape Cod, Massachusetts, an oil spill at Bimidji, Minnesota, and wood-treatment chemicals at Pensacola, Florida. Four of the papers in this symposium are the products of the Geological Survey's Federal Program.

#### *Federal-State Cooperative Program*

Funds for the Federal-State Cooperative Program are appropriated by congress with the stipulation that they must be totally matched by state or local funds. The Cooperative Program comprises about one half of the total program of the Water Resources Division. Within this program, work elements are identified jointly by the U.S. Geological Survey and officials of the 800 or so cooperating agencies. Obviously, the work within the Cooperative Program is directed toward local, regional, or statewide problems that are also of national interest. More than 300 current projects in this program, with a budget of about \$30 million, have a ground-water quality component. Two papers in this symposium are products of the Cooperative Program.

#### *Other Federal Agencies Program*

In the other Federal Agencies Program, the U.S. Geological Survey is reimbursed for work performed for other federal agencies. It is within this program that the USGS may at times act as a consultant, generally as part of water-supply or environmental-impact studies on federal lands. Little or no consulting work has been done on federal lands containing contaminated ground water because most agencies are interested in "turn-key" operations including both identification and cleanup of contaminated sites, and such work is best left for the private sector. Nevertheless, a few site-specific studies have been done for the Department of Defense and an existing memorandum of understanding with the Environmental Protection Agency calls for the survey to review the work of private contractors at "superfund" sites.

## Standardization of Field Techniques

Across this broad spectrum of work, the U.S. Geological Survey faces the same problems as any other organization dealing with field investigations of contaminated ground water: where and how to sample. The USGS takes very seriously its unique role within the federal government as an unbiased, scientific, fact-finding agency. From this perspective as a scientific agency, the survey recognizes the need to address the problems associated with assuring that field methods for ground-water contamination studies yield consistent and accurate data. Whether this goal of consistency and accuracy is achieved through guidelines or standards is, from the perspective of a nonregulatory agency, only a debate over semantics. In point of fact, the USGS attempts to achieve these goals through an understanding of the site-specific hydrogeology and geochemistry, a field and laboratory quality-assurance program, and an exacting peer review of the plans of study and the reports.

Techniques for obtaining ground-water field data for contaminant studies are rapidly changing. This can be attested to by the number and titles of the presentations at this symposium, by papers published in many of the technical journals, and by the existence of a journal titled, *Ground Water Monitoring* that contains not only technical papers but also a myriad of advertisements for field equipment, supplies, and services. Because of this present state of flux, "standards" may be too rigid a word to apply to any set of existing field techniques. Certainly some type of guidelines are needed, but they must be based on scientific understanding, and they must be applied with enough flexibility to ensure that they meet the purpose and scale of the field problem.

Examples of various types of field problems include site-specific studies and general monitoring. A site study may be in an area of known contamination or in a potentially contaminated area; these are two very different types of problems and require different field techniques. Similarly, a monitoring program designed to protect a well field is quite different than one designed to collect regional water-quality data. For each of these problems, we still have to decide where and how to sample. Indeed, the questions of "where" and "how" to sample are the underlying theme of this symposium. Tentative answers will be given in the papers that follow; the remainder of this paper will expand upon the questions and present an overview of the general problem.

## Obtaining Representative Water Samples

Inherent in all ground-water sampling is the assumption that the water removed from the well is representative of the water remaining in the aquifer and, therefore, will tell us something about the chemistry or biology of the water in the aquifer at the time and place of sampling. This rather basic assumption is fundamental to all ground-water field studies. Another assumption is that if we sample in more than one location we can infer what is happening in the aquifer, not only over space, but with the proper selection of sampling points, over time as well.

### *Where to Sample*

The proper location of sampling points is essential to any field study; mislocated wells are probably the most common problem identified when evaluating contaminant-monitoring schemes. Wells are misplaced because they may be in the wrong direction with respect to the movement of a contaminant away from a source, because they may be too shallow or too deep to detect the contaminant, or because they may be too far from the source of the contamination. Other factors that result in misplaced wells are a disregard or misunderstanding of the time required for contaminants to reach the water table, and incomplete knowledge of the physical and chemical processes that retard the movement of contaminants both in the unsaturated and saturated flow regimes. Proper well location requires an understanding of the source of the contaminant, the local hydraulic gradient, the nature of the geologic materials, and the way water and contaminants move through those materials.

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Accurate water levels must be obtained and referred to a common datum in order to determine the direction of ground-water flow. Often this may require wells at multiple depths to detect vertical gradients. Natural and artificial sources of discharge and recharge must be identified, and the way they function and affect the hydraulic gradient must be understood.

Some knowledge of the hydraulic characteristics of the rocks underlying the site is needed to estimate the rate of water movement, both vertically in the unsaturated zone and horizontally and vertically in the saturated zone. Similarly, knowledge of the regional hydrologic setting is needed to understand the vertical flow component. These data are required before the first monitoring well is installed. Depending on the purpose and scale of the sampling program, published descriptions of the hydrology and geology of the area may be sufficient to allow for intelligent estimates of the flow regime to be made. Alternately, a well inventory, which may include preliminary water sampling, supplemented by exploratory well drilling, may be required for some studies. Most likely, exploratory wells installed for general background data will not be suitable for inclusion in the final monitoring scheme. Geophysical methods may sometimes be appropriate to give a preliminary indication of the presence of contaminants, and, when used in conjunction with an exploratory well-drilling program, these methods may allow for rapid identification of the scope of the field problem.

Only after the field parameters pertinent to the problem are defined can the appropriate number and location of sampling points be selected. Too, no monitoring scheme can be installed exactly as designed on paper; preliminary results will doubtless suggest changes in drilling and sampling strategies.

### *How to Sample*

Planning the sampling strategy involves consideration of the purpose of the sampling. Although purposes vary greatly, all sampling programs have one common goal: the removal and preservation of water that reasonably represents the physical, chemical, and biologic properties of the water that remains in the aquifer. Keeping in mind that what is "reasonable" for one type of field activity may be totally inappropriate for another, we can look at the factors that affect the removal of a representative ground-water sample. These factors are: drilling method, casing material, well design, and sampling method. Sample preservation and laboratory analytical procedures are, of course, equally important but, for purposes of this discussion, are not considered field methods.

The physical installation of a well disturbs the natural environment of the aquifer. Many drilling methods introduce water or other fluids into the aquifer, and all methods permit, to varying degrees, the vertical movement of water in the bore hole during the drilling process and in the annular space surrounding the casing after the well is completed. The material used for the well casing may react with ground water. Cement or other material used to isolate the sampled zone from the remainder of the aquifer and from surface fluids, may itself introduce contaminants. The length and type of opening to the aquifer (the "screen" zone) will determine the usefulness of the sample; for some purposes a sample representing a small, one or two foot thick, zone of the aquifer may be most appropriate while for other purposes a sample integrating the entire saturated thickness of the aquifer may be desirable. The pump, bailer, or other device used to withdraw the sample may itself react with the sample or may allow gases to enter or escape from the sample. All these factors must be evaluated when choosing sampling methods that are appropriate to the purpose of the sampling program.

### **Conclusions**

One set of standard field methods cannot be developed to apply to all ground-water contaminant studies because of the high degree of variability of geologic conditions, the many different chemical

and biologic constituents that may be studied, and the widely diverse purposes of the sampling programs. This does not, however, preclude the development of guidelines based upon the need to obtain representative samples that fulfill the purpose of the sampling program. Indeed, our understanding of both the problem and the solutions to obtaining representative samples is growing at an ever accelerating rate. Every field situation can be met with an appropriate set of monitoring techniques, costs not withstanding. On the other hand, the most elaborate set of monitoring techniques will not be appropriate for all field situations. Documentation of all field (and laboratory) aspects of ground-water contaminant studies will help us interpret today's samples in light of tomorrow's developments in this dynamic area of hydrology.

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## REGULATIONS AND STANDARDS

The Environmental Protection Agency's ground-water protection program is a collective response to a series of legislative mandates. Although there is no single encompassing federal legislation directed specifically at ground-water protection, eight separate laws address, either directly or indirectly, specific sources of ground-water contamination. The Safe Drinking Water Act, which establishes national drinking water standards; and the Resource Conservation and Recovery Act (RCRA), which provides for the safe disposal of hazardous waste, are perhaps the most important.

The laws generally require the agency to promulgate and enforce regulations. The regulations interpret and translate the intent of congress into administrative policy. In the case of ground water, primary responsibility for implementing policy is seen to rest with the states.

Regulations, in turn, often require additional clarification in the form of technical guidance documents. Such is the case with ground-water monitoring. Technical guidance typically attempts to strike a balance between the needs for consistency and flexibility. As applied to ground-water monitoring, guidance has appeared thus far in two forms:

1. Minimum standards with maximum flexibility.
2. Maximum specificity with minimum flexibility.

Both approaches have resulted in problems for those concerned about developing technically credible and cost-effective ground-water monitoring programs. An alternative approach based on establishing performance standards along with an equivalency provision may offer a workable compromise solution.

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## STANDARDS, GUIDELINES, AND REGULATIONS: A USER'S VIEWPOINT

### Why SCS Is Involved with Ground-Water Investigations

Soil and water conservation is the basic mission of the U.S. Department of Agriculture's Soil Conservation Service (SCS). Through Soil and Water Conservation Districts, which are units of

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state government, SCS advises landowners and others on the best use of the land and on the best management practices (BMPs) for agricultural and nonagricultural areas. Surface and ground water are both considered because they are inseparably linked.

One special interest in ground water arises from its use for irrigation throughout the country. More than twenty-one million acres of agricultural crops receive ground water nationwide; four million of these are located in the humid eastern part of the United States. SCS's responsibilities include evaluating quantity, quality, and efficient use of ground water. They assess all recommendations for land surface treatment in light of their impact on ground water. These responsibilities require SCS to work continuously with standards and regulations.

### **Kinds of SCS Activities**

SCS specialists evaluate ground water for a wide variety of agency activities. Resource evaluations take place under river basin and watershed planning and conservation planning for individual landowners. Assessments of the potential effects of conservation measures on ground water are in the environmental impact statements required for many of the SCS's major projects. Land treatment measures to control erosion are perhaps the SCS's best known project thrust. Even these must be planned with knowledge of potential impacts on ground water. For example, the hazard of increasing the infiltration of nutrients and pesticides in the ground water is studied.

Animal-waste management is occupying an increasing proportion of the SCS workload. Land spreading, holding ponds and treatment lagoons all require due regard to protection of ground water.

Water conservation studies for multicounty or individual field-size areas look at better irrigation practices, better scheduling for pumping, and future ground-water conditions as a result of projected pumping patterns. In addition, SCS is involved in design and implementation of water-level monitoring systems and water-quality sampling.

Governmental units, private organizations, and individual landowners are advised on how to approach agriculturally related ground-water problems, how to get help, and what to have done. Once work is underway, SCS frequently provides overview on how well things are going.

SCS provides funding and guidance for field evaluations to determine the effects of agricultural nonpoint pollution on ground water and how well BMP's reduce these effects. The evaluators are other federal agencies, state agencies, universities, and consultants. SCS performs an oversight role to ensure that original objectives are attained.

SCS also performs a number of in-house evaluations of ground water for the agency and other federal agencies. Most often these involve monitoring to determine the effect of raised or lowered ground-water levels.

Landowners frequently ask SCS to provide guidance regarding the proper procedure and basic resource information needed to meet state and federal regulations intended for environmental protection.

### **Concern with Standards and Regulations**

SCS has a very active interest in state and federal regulations that relate to ground water and agriculture. The agency is pretty much on the receiving end and must be able to comprehend and implement all of the requirements. The agency must be also able to cite appropriate standards and specifications, often obtained from non-SCS sources, to be used in contracts and agreements for guidance for SCS personnel.

Ground-water studies require investigation techniques and methods. SCS is concerned with obtaining reliable answers to such questions as: (1) How long does it take nitrate to travel to the water table? (2) Are there pesticides in the ground water? (3) How much pesticide? (4) How long does it last? Of course these answers hinge on how well we can sample, measure, and interpret.

As an agency that uses ground-water technology and uses information developed by others, SCS is concerned about the reliability of the information and whether data from one area to another is comparable. Should in-house specifications be written for needed techniques or are there adequate ones available elsewhere?

### **The Problems with Standards and Regulations**

Standards for evaluating ground water are available from several sources such as ASTM, EPA, and USGS. Analytical techniques, especially laboratory techniques, have received the lion's share of attention in standardization. Certification of laboratories is commonplace. However, poor field procedures concerning other important facets of evaluation may create such problems that the best laboratory procedures will be unable to overcome the difficulties.

There are four facets to evaluation: (1) system design, (2) sample collection techniques, (3) analytical techniques, and (4) interpretation techniques. Chemical variations and concentrations are numerous and analytical techniques may have to be quite specific. They have to be guided by field observations that may not have been recorded. Faulty design of the field data collection cannot be remedied by the best of laboratory efforts.

The remaining three facets need more attention. Development of standards and guidelines is needed now. For example, it is well known that geology influences the movement of ground water. Where, how, and when to monitor must be based on the hydrogeology. How often have specifications in a monitoring design recognized this need? Only in a few states do regulations require hydrogeologic analysis.

It appears that the normal practice, in SCS and elsewhere, is to rely on the judgment of the geologist or engineer to integrate all the factors, create a design, and ultimately arrive at the proper interpretation. This is as it should be. However, the professionals need all the help they can get along the way from work that is performed properly and numbers that truly represent the field condition.

This example advances another problem, that of determining who is qualified. In-house, experience will tell who can do the job. But, to evaluate someone from outside the organization, a very detailed process of job, client, and proposal review is required. When in-house expertise is not available for such evaluation, there's a chance that the resulting work will be less than satisfactory.

SCS will continue to rely on its own professionals, but also will use appropriate standards and specifications that are prepared by others. Standards, promulgated by regulation or otherwise, must be in line with reality and be of such quality that they will do their intended job. A more efficient way to evaluate a person's ability to make ground-water investigations also is sought.

SCS encourages the continued development of standards and hopes the identified deficiencies will receive timely attention.

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## **AGRICULTURAL RESEARCH SERVICE APPROACH TO GROUND-WATER STUDIES**

The Agricultural Research Service (ARS) is the research arm of the U.S. Department of Agriculture. ARS research efforts are directed to answering the food and fiber needs of the nation in general. Research is directed toward specific problem areas suggested by USDA action agencies such as the Soil Conservation Service (SCS). The Agricultural Research Service budget is

predominantly directed to the areas of human nutrition, and food and plant product improvement, shipping, storage, and handling. A subdivision within the organization is concerned with soil and water conservation. This group maintains research laboratories and field data gathering centers in the major physiographic areas of the nation. The research derived from studies are published in ARS publications, technical journals, and university publications. Typical publication outlets for soil-water studies are Agriculture Research Service Technical Reports, Water Resources Research, Journal of Environmental Quality, Journal of the Soil Science Society of America and the American Society of Agronomy, Journals of the American Society of Civil Engineers, National Water Well Association's, Ground Water, and others. Ground-water research is conducted as needed within the scope of ongoing studies investigating water yield, infiltration, and the impact of land use upon water quality and quantity. A relatively small technical staff is directly involved in ground-water research. The current focus of the ARS ground-water effort is the vadose (unsaturated) zone, with particular emphasis upon the water and nutrient management in the root zone. Attention is directed to the potential for management rather than resource documentation. Most studies are directed to perched ground water or shallow regional ground water. The ARS has pioneered much work involving chemical transport with soils, infiltration through soils, deep percolation, ground-water recharge, evapotranspiration, and water yield from upland watersheds.

Since the research is problem oriented to emerging short- and long-term agricultural water needs, the approach to research is that of using recommended procedures and equipment rather than establishing fixed materials specifications and standardized procedures of research. Researchers specify the instruments and conditions of experiments in the research publications. Where appropriate, researchers use standard methods of analysis which are published, referenced, and therefore have gained wide acceptance in the scientific community.

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## WATER QUALITY AND RECLAMATION

The U.S. Bureau of Reclamation is a major water resources development agency working in the 17 western states. Activities include the development of irrigation water supplies, flood control, municipal and industrial water supplies, salinity control, improved fish and wildlife opportunities, and recreation. The agency developed a strong interest in water quality shortly after it was formed in 1902. This interest includes both surface and ground water and their reactions with natural and man-made materials encountered in water resources development. Through the years this interest has been directed most strongly towards agriculture but in recent years has included an ever increasing interest and concern in effects on human health and wildlife.

Some typical examples of water quality concerns include: chemical compatibility of applied irrigation water with local soils and ground water, leaching and concentration of salts in return flows, effects of both natural and man-induced salinity on river systems, and effects of trace elements.

The Bureau of Reclamation approach to water-quality investigations might best be described as scientific engineering, somewhere between the pure scientific and regulatory approaches. In general, an attempt is made to understand the mechanism which causes the observed condition. Experience has shown that it is desirable to establish a range of values rather than attempt to define a single representative value for parameters of this type. As a result of this approach and philosophy, most Bureau of Reclamation investigations exceed what would typically be required by a regulatory approach.



The Bureau of Reclamation has strong capabilities in water-quality studies. All six regions have laboratories with water-quality analysis capabilities, which are certified by either EPA or USGS. The research laboratory at the Bureau of Reclamation Engineering and Research Center in Denver is equipped and manned at the leading edge of the state of the art. The Bureau of Reclamation expects to remain a strong force in the development of water-quality expertise.

While the imposition of regulatory requirements for water-quality investigations would improve the quality of many marginal programs, the development of good scientific guidelines and standards would be of more value to agencies such as the U.S. Bureau of Reclamation. The Bureau of Reclamation is very interested in participating in the development of such standards and guidelines and is pleased to have the opportunity to participate in this conference.

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## **U.S. NUCLEAR REGULATORY COMMISSION STANDARDS DEVELOPMENT FOR GROUND-WATER RELATED ISSUES<sup>1</sup>**

The U.S. Nuclear Regulatory Commission (NRC) was established by congress under the Energy Reorganization Act of 1974. The primary goal of NRC in licensing and regulating nuclear reactors is to assure the health and safety of the public and to protect the environment. Similarly, NRC has the charge of insuring safe, permanent disposal of radioactive wastes by licensing nuclear activities and facilities, and by protecting the public against the hazards of low-level radioactive emissions and releases from the licensed nuclear activities and facilities.

To accomplish this mission, the NRC staff develops Federal Regulations (Title 10 of Code of Federal Regulations), regulatory guides (guidance documents), and branch technical positions (licensing assistance information) to codify and promulgate both licensing and technical issue guidance.

The standards development program can be subdivided into waste management (for example, low-level and high-level radioactive waste disposal) and reactor siting activities. The standards are derived from licensing review experience and confirmatory research findings. The entire standards development process is oriented towards active public comment reviews (all standards are formally noticed in the *Federal Register*), and a sound technical basis for the specified guidance.

The principal ground-water contaminant issues being studied and addressed in NRC's research program are assessment of:

1. Site characterization techniques to determine ground-water flow and transport parameters for low-permeability media including partially saturated media and fractured media.
2. Monitoring strategies for shallow land-buried facilities with emphasis on ground-water infiltration through trench covers.
3. Instrumentation used to determine unsaturated-zone conditions and properties in fractured media.
4. Ground-water flow and transport models used to determine site performance at low-level and high-level radioactive waste facilities.
5. Bore-hole sealing techniques to determine if preferential pathways could develop with time.

Specific guidance is being developed to address contaminant transport modeling issues such as mechanical dispersion, molecular diffusion, and chemical interactions between the native ground

<sup>1</sup> See *Ground-Water Protection Activities of the U.S. Nuclear Regulatory Commission*, NUREC-1243, February 1987, Washington, D.C.

water, leachate (radionuclides), and geologic matrix. These studies are developed jointly with field study programs on assessing methodology and instrumentation to derive the necessary model input values. Specific field tests under review are (1) down-hole testing for fracture properties and flow conditions, (2) tracer tests in fractured media, and (3) ground-water chemical sampling in the unsaturated zone.

The waste-management standards are needed to support licensing reviews, which requires that data be collected in such a fashion that errors in measurement and uncertainties of the obtained values (for both direct and indirect methods) be quantified. Therefore, ground-water characterization data derived from the various field methods should include an error and uncertainty analysis due to both the system and the measurement method.

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