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THE ORGANIZATION AND OPERATION OF THE SAVANNAH RIVER PLANT'S GROUNDWATER MONITORING PROGRAM*

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INTRODUCTION

The Savannah River Plant (SRP) is operated by Du Pont for the Department of Energy (Figure 1). The plant has been operating since 1952 and is one of the largest industrial facilities in the nation. Its function is to produce nuclear materials for the national defense. This paper describes the organization and operation of the Groundwater Monitoring Program (GMP) at the SRP.

Groundwater has been actively monitored for radiological parameters at the SRP since the commencement of site operations in the 1950s. More recently, monitoring expanded to include chemical parameters and numerous additional facilities. The GMP is a large monitoring program. Over 700 wells monitor more than 70 facilities which are spread over 300 square miles.

The program includes both Du Pont personnel and contractors and is responsible for all phases of groundwater monitoring: the installation (or abandonment) of monitoring wells, the determination of water quality (sample collection, analysis, data review, etc.), and the generation of reports.

DISCUSSION

The purpose of the GMP is to determine the groundwater quality at SRP and to report these data to the appropriate organizations. It is important for the program to produce high quality data in a timely manner. The Environmental Monitoring Group within the Health Protection Department is responsible for the GMP. This group's responsibilities include:

- Program planning
- Administering contracts
- Ensuring an effective unified program
- Efficient and timely program operation

PROGRAM ORGANIZATION

The GMP has two components (Figure 2): the Drilling Group and the Data Collection--Reporting Group. The responsibilities of these groups are described below.

DRILLING GROUP

The Drilling Group is responsible for well installations, well abandonments, soil coring and well maintenance. The parts of the Drilling Group are described below. One person (the Drilling Coordinator) manages the schedules of the others involved in drilling. The functions described below are provided by contractors, and the number of contractors working on each function can vary with program demands.

Drilling--installing or abandoning monitoring wells according to Du Pont specifications. Up to nine drill rigs, with associated support and logistical personnel, may be operating at any one time.

Independent Oversight--providing a geologist (independent of the drilling company) at each drill site to ensure that approved procedures are followed, specifications are adhered to, to document all drilling activity, to record geologic information, and to verify delivered quantities of billable goods and services.

Surveying and Mapping--determining locations and elevations of various drilling sites at SRP and plotting these sites on maps.

Well Maintenance--repair or replacement of electrical and mechanical equipment (i.e. pumps, riser pipe, etc.) associated with the monitoring wells.

The Drilling Coordinator must also coordinate group activities with the Du Pont Custodians. At SRP, each monitored facility is assigned a custodian who ensures that the facility meets environmental regulations. The custodians are from different SRP departments and a custodian may be responsible for more than one facility. Thirteen custodians work with, and receive information from, the GMP.

When a drilling project is planned, the Drilling Coordinator issues assignments to other parts of the Drilling Group. Assignments include all of the items that are needed for successful completion of the project (well site selection, site survey location, permit acquisition(s), drilling requirements, personnel and equipment availability, etc.). The Coordinator assigns a start-up date for the field operation of the project. During the field operation, the Independent Oversight is responsible for the activities of drill rigs and crews. Independent Oversight assigns a person to each active drill rig. The Drilling Coordinator reviews field activities daily and assists Independent Oversight as needed in solving problems. Upon completion of a drilling project, the coordinator checks documentation for completeness and accuracy. At this point the work is considered completed and the product (well, soil core results, etc.) is turned over to the appropriate party.

Necessary well maintenance is most often identified by water samplers during quarterly sampling. The Drilling Coordinator arranges with the maintenance contractor to provide the needed supplies and service.

DATA COLLECTION - REPORTING GROUP

The Data Collection - Reporting Group is responsible for determining groundwater quality (sampling, analyses, data review, assembling and maintaining databases, etc.) and compiling

reports. This group has a linear organization consisting of four units (Figure 2). Information and assignments pass from unit to unit until the task is completed. Each unit has a lead individual responsible for daily operations.

The advantage of modular units is that each is fully functional and independent--as the program expands, additional personnel can be added to each unit to handle the increased load. It is the responsibility of each unit to ensure that its task is completed in a timely manner and that the product or information is delivered to the next unit.

Sample Collection Unit

The Sample Collection Unit receives sampling assignments in advance for each calendar quarter. The assignments are specified on pre-printed chain-of-custody forms, one form for each well. The chain-of-custody form specifies analyses to be run, sample bottle types, preservation methods for each sample, and the name and address of the laboratory that will analyze the samples. The Sample Collection Unit is responsible for setting the exact sampling dates, ordering the needed supplies from the analytical laboratories (bottles, shipping containers, etc.), and for notifying the laboratories of projected shipping dates. In addition, the sampling contractor is responsible for noting any maintenance problems with the wells and for reviewing the schedule for inconsistencies.

Laboratories Unit

Four contract laboratories supply analytical services. The GMP requires a minimum of four laboratories to handle the sample load, provide QA/QC and to screen samples for off-plant shipment. The responsibilities of the laboratories are:

Primary Analytical Laboratory--This laboratory performs the majority of analyses for the program and transmits the results via computer disk.

Secondary Analytical Laboratory--This laboratory performs QA/QC analyses and serves as a back-up laboratory for the program. It has the capability to serve as the primary analytical laboratory in the event the primary lab is unable to perform.

Tertiary Analytical Laboratory--This laboratory performs QA/QC work, it is not required to be capable of serving as a primary lab.

SRP Radiological Laboratory--This laboratory performs on-site radioactivity analyses to ensure that Department of Transportation regulations for off-plant shipment of radioactive material are followed.

In addition, other laboratories may be used for specific types of analyses. For example, two Du Pont-operated laboratories at SRP provide bacterial analyses and analyses for several volatile organics, and a contract is being established with a laboratory to provide specific radionuclide analyses.

The laboratories do not interact with each other and hence do not require any intragroup coordination. Each laboratory can anticipate its analytical load. Each laboratory forwards its results to the Data Management Unit at the end of every month.

Each laboratory has designated a single individual who is responsible for interfacing with Du Pont. These individuals are responsible for addressing any questions that arise and ensuring

that the analytical results are completed as requested and on schedule. Each of these individuals maintains contact with the Sample Collection Unit and the Data Management Unit to ensure the smooth operation of the system.

Data Management Unit

The Data Management Unit receives, collates and reviews data from various sources (laboratories, field personnel, drilling documentation, etc.), organizes this data into a "report ready" format, produces a sample schedule for succeeding quarters and compiles necessary program documentation, such as well construction or maintenance records. All of this work is accomplished within strict time constraints.

Reports and Documentation Unit

The Reports and Documentation Unit is responsible for compiling and issuing periodic reports of water quality analyses, well inventory and locations, and proposed sampling schedules.

PROGRAM OPERATION

After new wells are installed, they are added to the sampling and analytical schedules. Wells are typically sampled quarterly (every three months).
Each quarter the data must be collected, analyzed, reviewed, and reported, and a sampling schedule must be generated for the next quarter. It is important that this quarterly process not be "a race to generate numbers". The data must move smoothly from the Sample Collection and Laboratories Units to the Data Management and Reporting Units, and the data from one quarter must be incorporated, via feedback loops, into later quarters' sampling schedules. Information from any quarter can also identify additional activities for the drilling program, such as well maintenance, well abandonment, or additional well installations (see Figure 3). The successful operation of the GMP depends on careful selection of analyses to be performed and the extensive use of computers.

DETERMINATION OF THE SAMPLE SCHEDULE

The sample schedule identifies which analyses will be performed on the groundwater samples for each quarter. These analyses ultimately determine what is reported as the water quality for each monitored facility. Too few analyses or inappropriate analyses result in a weak report. Too many analyses result in excessive program costs. To assist in the selection of analytical parameters, the sampling guide (a set of rules) was established to guide the why, what and when of sampling (Figure 4). The sampling guide is divided into three categories:

- Detection Monitoring--For new wells, the initial identification of the constituents in the groundwater.
- Assessment of Identified Constituents--Once a constituent has been identified as exceeding a threshold concentration or flag value, the constituent is monitored. The concentration of the constituent determines the frequency of monitoring.
- Detection Monitoring for Specific Constituents--Constituents likely to be seen at specific sites, selected from knowledge of a site's use or contents.

These categories determine the sample parameters and frequency for the sample schedule. The rules are applied to all monitoring wells in the program. The advantage of applying a single set of rules to all facilities is twofold. First, all of the monitored facilities are governed by the same rules--the GMP is consistent; yet the schedule for each facility is unique because it is

determined by past analytical results and site history. And second, the entire program can be altered by changing the rules (sample frequency, flag values, or other changes required by changing regulations)--the GMP is flexible.

It is important to note that the sample guide is a guide, not an unyielding directive. The purpose of this guide is to establish a baseline of water quality analyses, a baseline that can be added to (or subtracted from) as technical expertise or regulations dictate.

The sampling and analytical schedules are based on the sampling guide, requests of facility custodians, and regulatory requirements. The actual steps involved in determining a schedule are as follows:

- Computer programs review past analytical results and compare them to the sampling guide (frequency, flag values, etc.) to determine a tentative schedule for the coming quarter.
- Each custodian receives a tentative schedule prior to the beginning of the quarter. The custodians review the schedule to see that it complies with legal requirements and that it includes appropriate analyses. Custodians then request any necessary changes that must be made in the schedule.
- Samples from certain wells require special packing or labels to satisfy Department of Transportation (DOT) shipping regulations. The Chain-of-Custody forms highlight these requirements for the field personnel.
- The level of the QA/QC effort (i.e. the type of analysis and the number of analyses) is determined. Wells are chosen randomly to fulfill this requirement.
- Technical review for appropriateness of analytical parameters.

When the above steps are complete, the any necessary changes are entered into the computer and a final schedule is generated. The schedule is printed by the computer and serves as the Chain-of-Custody form containing all of the appropriate information (Figure 5).

- Analyses requested
- Preservatives and containers
- Lab address
- DOT requirements

The importance of a computer-generated chain-of-custody form, pre-printed with the appropriate information, must be stressed. If a large program is to be operated successfully, all of the sections must be using the same set of requests. Having the computer generate a single form containing all pertinent information enables the GMP to be controlled from one document, eliminating transmission errors and simplifying sample tracking.

DATA MANAGEMENT

New data are received from two sources (the Sample Collection Unit's field logs and the analytical laboratories) and are entered into the computer. The data from the field logs and the analytical laboratories are cross-referenced by well name to highlight any inconsistencies in the data identifiers (i.e. well names, sample dates, units, etc.). The results from the analytical lab are then cross-referenced with the sample schedule and with the field data to determine if analyses are missing or if unrequested analyses were received.

Each month's new data are stored in a temporary or preliminary database. This database is used to print Monthly Reports for review by the facility custodians. This report lets the custodians have field analytical data as quickly as possible and enables them to assist in the data review process. Custodians receive only the information pertaining to their facilities. Any results that exceed the appropriate threshold levels or have changed from the previous measurement are identified in the Monthly Reports. These threshold levels, known as flag values, have no regulatory significance. They are intended only to assist with data interpretation and scheduling. There are two flag levels for each sample parameter. Flag #1 is the detection limit (or regional background level), and Flag #2 is typically half of the Drinking Water Standard or slightly above the regional background level. Parameters that exceed flag levels are automatically scheduled for resampling in the next quarter. If resampling confirms the flag value exceedance, that parameter remains on the schedule indefinitely for annual or semi-annual analysis. If three successive sampling episodes fail to confirm a flag value exceedance, that parameter is dropped from the schedule except for its biennial inclusion in comprehensive analyses.

While the custodians are reviewing their Monthly Reports, the Data Management Unit runs computer programs to screen the analytical results for abnormal values. The programs fall into two categories, quantitative and qualitative. The quantitative approach determines if the results are consistent with past analytical values and if any value is greater than twice, or less than half of a previous result. The qualitative approach determines if the value for a specific sample parameter is consistent with other values from the same well (i.e. Total Organic Halogen vs. Gas Chromatograph Mass Spectrometer Volatile Organic Analysis, field pH vs. laboratory pH, conductivity vs. ionic content, etc.).

The steps listed in the two previous paragraphs identify any analytical results that must be individually reviewed. This review includes: sampling anomalies, analytical errors or data handling errors. If an analytical error is suspected, the laboratory is asked to review its work and records for errors. No alterations to the database are made without proper documentation.

After the Data Management Unit is satisfied that a month's data are correct, the data are considered final and are entered in the permanent database.

REPORTS AND DOCUMENTATION

The Report and Documentation Unit provides reports and maintains the necessary documentation of the Groundwater Monitoring Program. The Data Management Unit also operates this unit.

Adequate documentation is essential to the overall quality of the Program. The documentation covers all aspects; operating procedures, maintenance records, chain-of-custody records, QA/QC activities or anything that substantiates activities of the Program. All documentation is screened for completeness and legibility, then neatly organized. As appropriate, the documentation is included in the Quarterly Report, issued as separate reports or stored in files (i.e. field logs, driller's records, etc.).

Complete and readily accessible documentation makes report generation relatively easy, keeps the program structured and facilitates program audits.

Six reports are issued regularly:

Monthly Report

The Monthly Report consists of all recently received analytical results. It is issued so that the custodian of each facility can receive analytical data as they become available. Each custodian receives only the data pertaining to his facility and adjacent facilities of interest to him. Monthly Reports also highlight analyses that exceed flag values.

Quarterly Report

The Quarterly Report consists of the field and analytical data , QA/QC results, and documentation of all activities or procedure changes from each quarter. This report provides an official summary of the results for the quarter for all monitored facilities.

Well Inventory Report

The Well Inventory Report lists all pertinent information (installation date, locations, screen placement, etc.) about each well that is in the Program. Included with the inventory is a map of each facility that shows: the facility, the location of the wells, elevation contours and prominent landmarks. This report is issued every six months so that any changes in the Program can be included (new wells, corrections, etc.).

Map Series Report

The Map Series Report contains maps of the operating areas showing the locations of the wells in relation to facilities they monitor, the relation between different facilities within the area and prominent landmarks. This report provides a map overview so the inter-relationships between facilities, and the wells that monitor these facilities, can be recognized. This document is issued every six months.

Proposed Schedule--Annual Report

This report lists the proposed sampling and analytical schedule for the coming year. The proposed schedule contains a baseline of sampling coverage (determined by previous analytical results and the sampling guide) and any required regulatory sampling. This report is used to aid in budget preparation and to give an overview of the sampling program.

Trend Analysis Report

This report contains time vs. concentration plots for select constituents over a three year period and provides a graphic reference to aid in the interpretation of water quality. It is issued once a year.

CONCLUSION

There are two key features and three concepts that allow the Groundwater Monitoring Program to handle an active drilling program and a quarterly data acquisition system (with reports--documentation) yet contain provisions for continued growth.

Two key features allow the program to respond to deadlines; modular sections and computer usage. Each modular unit in the GMP has well-defined responsibilities, broad operational latitude and is staffed by qualified people. Extensive use of computers enables the GMP to collate and review a large amount of data, to report this information to the appropriate organizations and to generate a new sample schedule--all within strict time constraints. Both of these features, modular units and computer usage, are adaptable to allow for growth in the GMP--an important consideration in today's regulatory climate.

Three concepts, consistency, flexibility and responsiveness allow a large program to be easily defined yet adaptable to a wide variety of conditions. The Program is consistent because the sampling schedule for all of the facilities is governed by the same basic set of rules (the sampling guide). The Program is flexible because the sampling guide is used to determine a basic level of suggested parameters for each sample schedule (alter the sample guide and the focus or direction of the entire Program can change). The Program is responsive because it incorporates two feedback loops. One loop uses past analytical results from a facility to determine if the facility's water quality changes; if so, so does the sample schedule. The second loop, also a review of analytical results, determines if the monitor well is in the appropriate location. These concepts: consistency, flexibility and responsiveness enable the GMP to comply with today's requirements, to adapt to future requirements and to accommodate to changes in the environment being monitored.

The Groundwater Monitoring Program at the Savannah River Plant is one of the largest groundwater monitoring programs in the country. Since the implementation of the Program in late 1986 it has successfully operated using the format outlined in this paper. During 1987, the Program has experienced a 30 percent growth, easily accommodating the increase in all Program activities as well as the accompanying regulatory scrutiny.

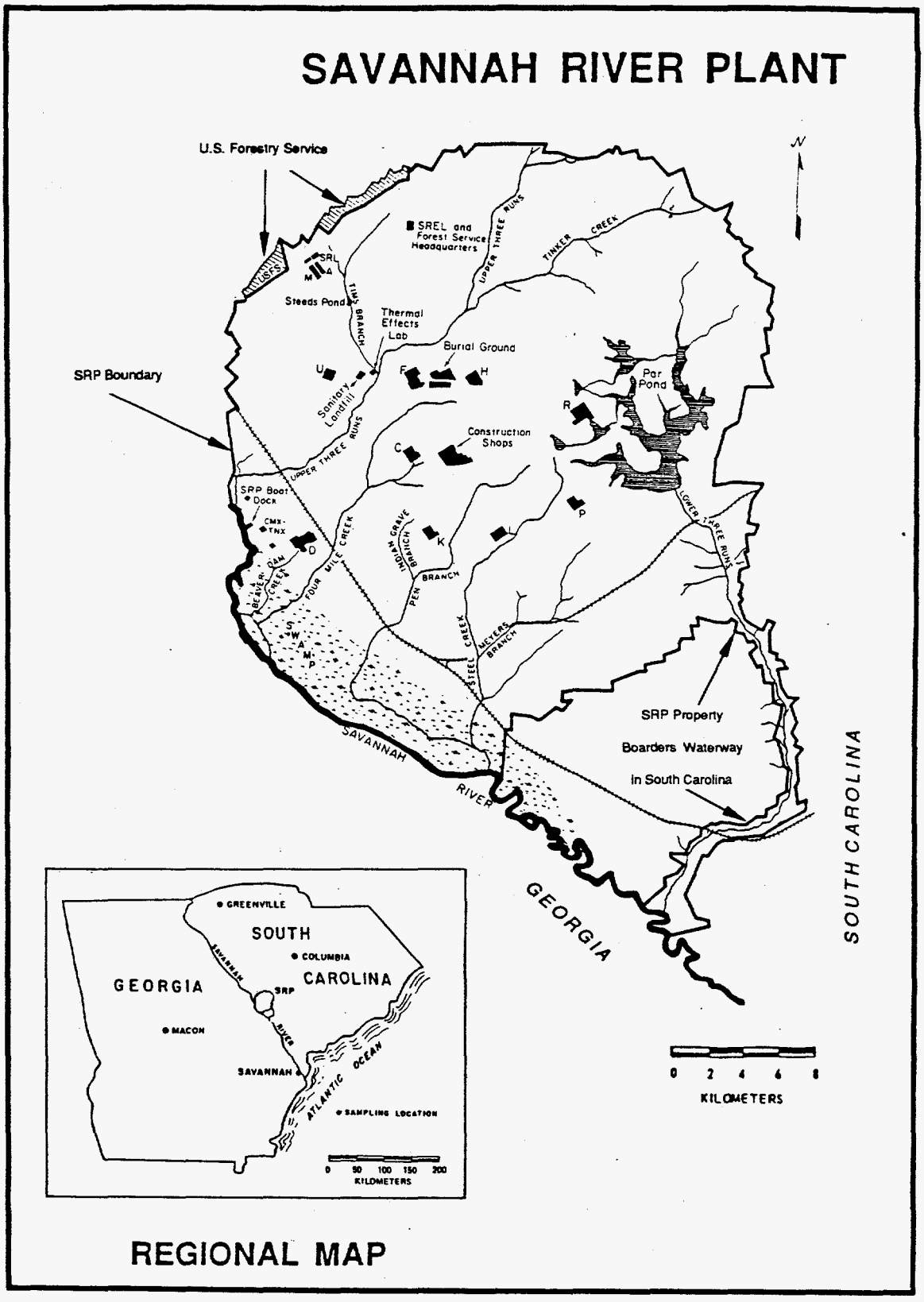

Figure 1. Savannah River Plant Site.

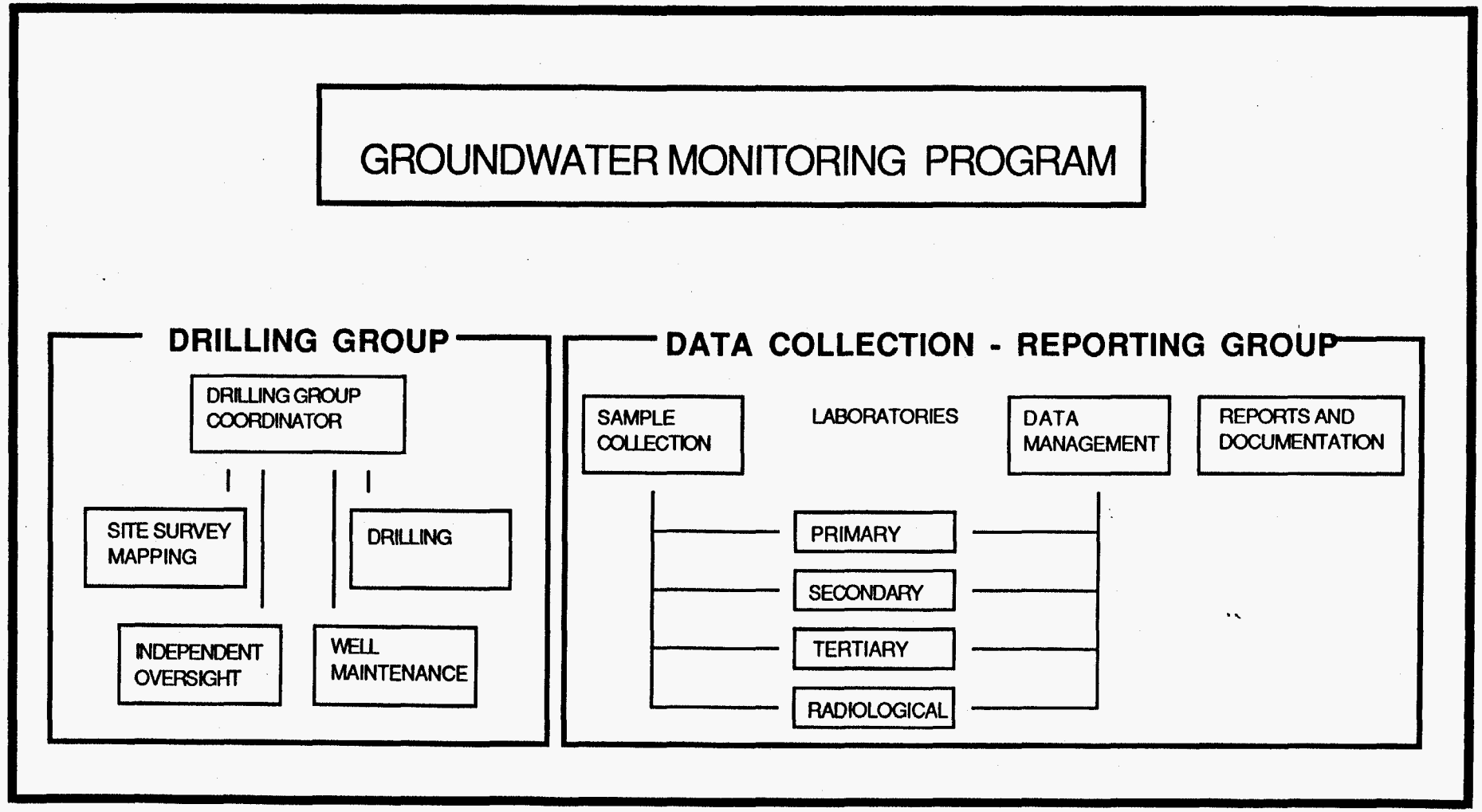

Figure 2. Operational components of the Groundwater Monitoring Program.

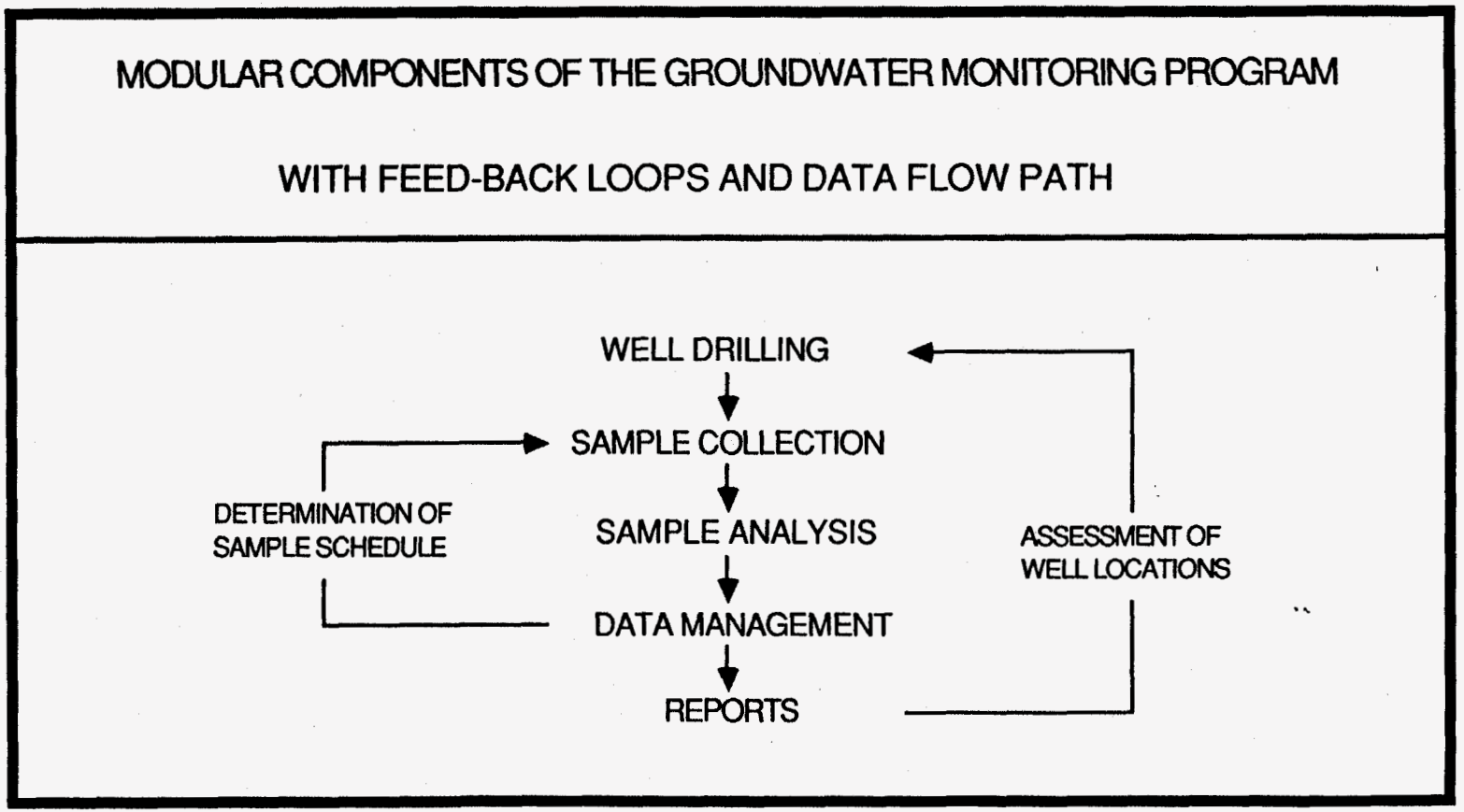

Figure 3. Components of the Groundwater Monitoring Program and data flow directions.

DETECTION MONITORING

The identification of constituents in the groundwater.[1]

- o All new wells have four quarters of Group I - II - III analysis.
- o All wells have a biennial analysis of Groups I - II - III.
- o All wells have a semi-annual analysis of Group III.

ASSESSMENT OF IDENTIFIED CONSTIUTENTS

Once a constituent has been identified as present in the groundwater, the constituent is monitored.

- o All wells at each facility have the same schedule.
- o Exceeding flag values determines sample frequency.
  - - Flag #1 is once per year.
  - - Flag #2 is twice per year.

DETECTION MONITORING FOR SPECIFIC CONSTITUENTS

In some cases, an "in-depth" analysis is required.

- o Constituents identified by:
  - - Waste site history,
  - - Indicators (i.e. TOH, gross alpha, etc.),
  - - Core investigations or
  - - Specific studies.

[1]

GROUP I - Suitability of groundwater as a drinking water supply

Arsenic	Barium	Cadium	Chromium	Fluorine
Lead	Mercury	Nitrate	Selenium	Silver
Endrin	Lindane	Methoxychlor	Toxaphene	2, 4D
Silvex	Radium	Gross Alpha	Gross Beta	

GROUP II - Establishing groundwater quality

Chloride	Iron	Manganese	Phenols	Sulfate

GROUP III - Indicators of groundwater contamination.

pH	TOC	TOH	Specific Conductance

Figure 4. Sampling Guide.

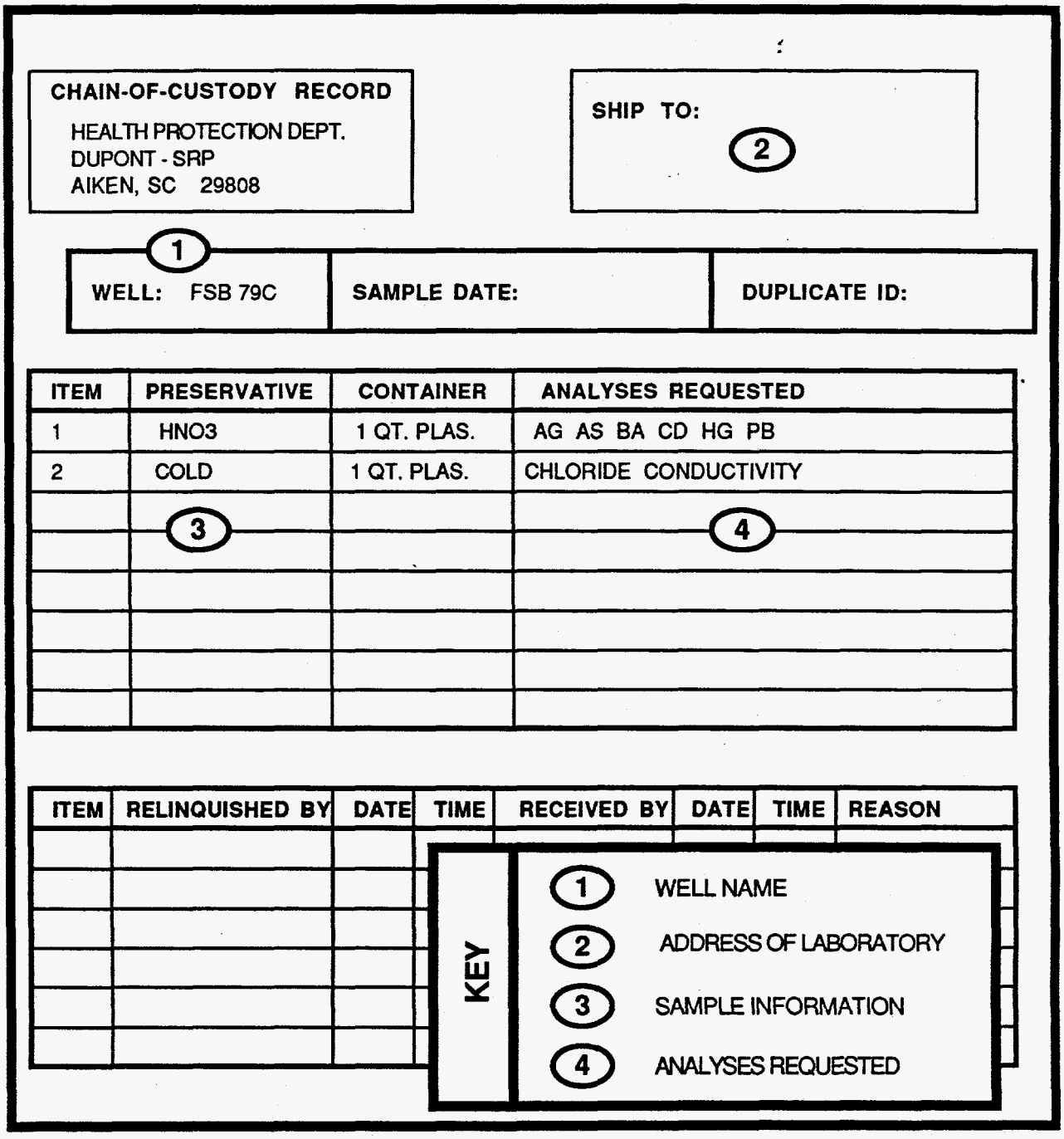

Figure 5. The computer generated Chain-of-Custody form.

The Groundwater Monitoring Program at the Savannah River Plant currently consists of over 700+ wells at 70+ sites and future growth is projected. The organization and operation of the program has been designed to support: an active drilling program, the acquisition of a large amount of repetitive data , the generation of numerous reports, associated QA/QC controls and provisions for additional growth. The design is centered around two key features, modular components and computer usage.

The modular component concept is an organizational tool that gives one group responsibility for a specific portion of the Program. This responsibility includes the operation of their segment and the coordination of operations with the other groups in Program.

Computers, the associated software programs and a simple set of rules (the sampling guide) enables the Program to accommodate large amounts of repetitive data in a timely, uniform, manner. Feedback loops are included to ensure that the new data is incorporated into future Program decisions (new sample schedules and well locations). The highly automated system: determines new sample schedules, collates/reviews incoming data and generates various reports. Six reports are issued on a regular basis, from quarterly to annual, to ensure that the Program is adequately documented.

The Program has been in successful operation for over a year and has accommodated the expected growth.