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ENVIRONMENTAL SCIENCES DIVISION

DATA BASE MANAGEMENT ACTIVITIES FOR THE REMEDIAL ACTION PROGRAM AT ORNL: CALENDAR YEAR 1987

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

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The Remedial Action Program (RAP) Data Base would not have been possible without the cooperation of numerous investigators and agencies collecting data related to the Oak Ridge National Laboratory. The authors appreciate the willingness of these sources to share data files; acknowledgment of these contributions are made throughout this report. In addition, various users of the data base have helped to ensure its quality and have provided suggestions to improve its usefulness. The RAP Data Management staff, however, assume the responsibility for errors, omissions, or inconsistencies in this report. The authors express their appreciation to D. D. Huff, P. Kanciruk, L. E. Toran, and J. R. Trabalka for their critical review of the report.

ACRONYMS AND INITIALISMS

AA	Alternative Assessments
ASG	Automated Sciences Group, Inc.
ACD	Analytical Chemistry Division
ATDD	Atmospheric Turbulence and Diffusion Division
BMAP	Biological Monitoring And Abatement Program
BNI	Bechtel National, Inc.
C&TD	Computing and Telecommunications Division
CH2M Hill	CH2M Hill, Oak Ridge, TN
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
-CONS	Construction Data
DBM	Data base management
DIMS	Data and Information Management System
DEPTHTW	Depth to water
DEM	Department of Environmental Management
DOE	U.S. Department of Energy
EMC	Environmental Monitoring and Compliance
EPA	U.S. Environmental Protection Agency
ESD	Environmental Sciences Division
ETF	Engineering Test Facility
FS	Feasibility Study
GIS	Geographic Information System
HF	Hydrofracture
HFCONS	Construction data for hydrofracture wells
HHMS	Hydrostatic head monitoring station
HRE	Homogeneous Reactor Experiment
HASRD	Health and Safety Research Division
ID	Identification Code
ISV	In situ vitrification
MS	Monitoring station
MCI	Mining Consultants, Inc
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System

NUS	NUS, Pittsburg, PA
OHF	Old Hydrofracture Facility
OPD	Operations Division
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PA/SI	Preliminary Assessments and Site Investigations
PI	Principal Investigator
PIEZ	Piezometer
PIEZCONS	Construction data for piezometer wells
PRAP	Pre-Remedial Action Program
PRAPCONS	Construction data for PRAP Wells
PCB	Polychlorinated biphenyl
PWTP	Process Waste Treatme... Plant
PP	Priority pollutant
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Program
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigations
STRMCHK	Stream check points
SLB	Shallow Land Burial
SWSA	Solid Waste Storage Area
SWMU	Solid Waste Management Unit
TARA	Test Area for Remedial Action
TARACONS	Construction data for wells in TARA
TOC	Total organic carbon
TOX	Total organic halides
TVA	Tennessee Valley Authority
TTO	Total toxic organics
USGS	U.S. Geological Survey
UT	University of Tennessee
WAG	Waste Area Grouping
WOC	White Oak Creek
WQ	Water Quality
WQCONS	Construction data for water quality wells

ABSTRACT

Voorhees, L. D., L. A. Hook, M. J. Gentry, R. A. McCord, M. A. Faulkner, K. A. Newman, and P. T. Owen. 1988. Annual Report of Data Base Management Activities for the Remedial Action Program at ORNL: Calendar Year 1987. ORNL/TM-10694. Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn.

The Oak Ridge National Laboratory (ORNL) Remedial Action Program (RAP) was established in FY 1985 to apply corrective measures at areas contaminated with radioactive and/or hazardous chemical wastes. To achieve this goal, numerous and varied studies are being conducted to characterize the waste disposal sites. Environmental data collected in support of other programs at ORNL are also of use to RAP. Collectively, these studies are generating a voluminous amount of data on a scale unprecedented for ORNL. A computerized Data and Information Management System (DIMS) was developed for RAP to (1) provide a centralized repository for data pertinent to RAP and (2) provide support for the investigations and assessments leading to the long-term remediation of contaminated facilities and sites.

The current DIMS and its role in supporting RAP during CY 1987 are described. The DIMS consists of three components: (1) the Numeric Data Base, (2) the Bibliographic Data Base, and (3) the Records Control Data Base. This report emphasizes the Numeric Data Base, including its development, organization, and accessibility, and also summarizes the status of other activities associated with management and use of such data (i.e., quality assurance, geographic information system, records control, and bibliographic information). The types of numeric data currently available are summarized in the tables and figures. More detailed information on the contents of the RAP Numeric Data Base has been assembled on IBM PC diskettes in a menu-driven format and are available upon request.

1. INTRODUCTION

The Remedial Action Program (RAP) at the Oak Ridge National Laboratory (ORNL) was established in FY 1985 to apply corrective measures at areas contaminated with radioactive and/or hazardous chemical wastes. To achieve this goal, various studies are being conducted to characterize the waste disposal sites. Environmental data collected in support of other programs at ORNL are also of use to RAP. Collectively, these studies generate a voluminous amount of data on a scale unprecedented at ORNL. A computerized Data and Information Management System (DIMS) was developed for RAP to (1) provide a centralized repository for data pertinent to RAP and (2) provide support for the investigations and assessments leading to the long-term remediation of contaminated facilities and sites.

All known active and inactive waste management areas, contaminated facilities, and potential sources of contaminants have been divided into 20 waste area groupings (WAGs) based on geographic and hydrologic information (Fig. 1). The current regulatory compliance effort involves a sequential approach of conducting (1) Preliminary Assessments and Site Investigations (PA/SI) for each WAG, (2) Remedial Investigations (RI) and Alternative Assessments (AA) for WAGs determined to be contaminated, and (3) a single, comprehensive Feasibility Study (FS) for determining corrective actions to be implemented at the contaminated WAGs.

The PA/SI phase of the program is being conducted by ORNL with limited subcontracted assistance. The RI, AA, and FS phases of the program (collectively referred to as the RI/FS process) are being implemented with significant subcontracted assistance. Field investigations for this RI/FS process are not expected to begin until mid-1988. The RI/FS subcontractor, Bechtel National, Inc. (BNI), will create an RI/FS Data Base to manage data generated by their studies. Such data will ultimately be incorporated into the RAP DIMS.

1.1 PURPOSE AND SCOPE

This report summarizes the status of the DIMS and its role in supporting RAP during calendar year 1987. The DIMS consists of three

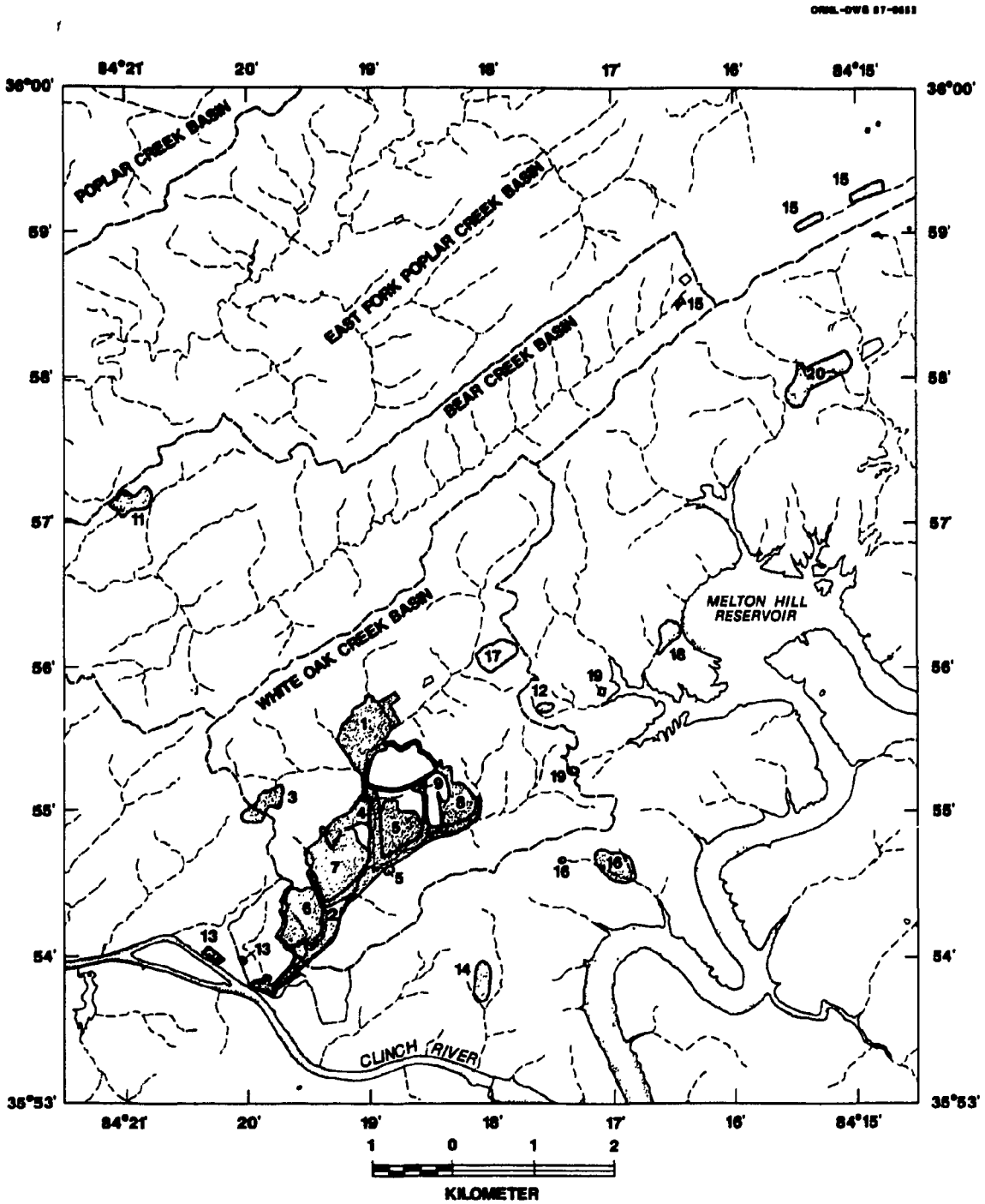

Fig. 1. Oak Ridge National Laboratory's active and inactive waste management areas, contaminated facilities, and potential sources of contaminants have been divided into 20 waste area groupings (WAGs).

components: (1) the Numeric Data Base, (2) the Bibliographic Data Base, and (3) the Records Control Data Base. The Numeric Data Base is the primary subject of this report. Specific topics include (1) a brief review of staff positions and their general responsibilities; (2) a description of data management services and accessibility; (3) the design of the data base, including its management system, organization, and development; (4) the current contents of the data base; and (5) quality assurance measures implemented to ensure the accuracy and security of the data. Other activities associated with the management and use of such data (i.e., quality assurance, geographic information system, records control, and bibliographic information) are also briefly described.

The types of numeric data currently available are summarized in the tables and figures. A more detailed synopsis of the contents of the RAP Numeric Data Base has been assembled on IBM PC diskettes in a menu-driven format and is available upon request. A description of the structure and contents of the diskettes is presented in this report.

Several previous reports about data management activities for RAP have been published, although most (except Voorhees et al. 1986) have been issued in the ORNL RAP report (ORNL/RAP) or RAP letter report (ORNL/RAP/LTR) series. Such documents have restricted distribution and, hence, cannot be cited here. The first annual report of data management activities for RAP was issued as an ORNL/RAP report with distribution limited to the U.S. Department of Energy and its contractors, to other federal agencies and their contractors, and to agencies of the State of Tennessee. The current document, which is being issued as an ORNL Technical Memorandum (ORNL/TM), has an unrestricted distribution and can be cited in any document. Because not everyone can refer to the earlier publications, this annual report is written as a "stand-alone" document, incorporating pertinent information collected since the publication of the last unrestricted document (Voorhees et al. 1986). Consequently, portions of this document were taken from previous RAP data management reports. All subsequent annual reports on numeric data management activities for RAP will be issued as ORNL/TMs.

2. DATA BASE MANAGEMENT STAFF AND SERVICES

2.1 MANAGEMENT STAFF

The RAP Numeric Data Base is operated within the Environmental Sciences Division (ESD) at ORNL. Data base management (DBM) staff supporting the program in CY 1987 included a task leader, three data coordinators, and a Geographic Information System (GIS) operator. The DBM task leader (1) defines the needed data management activities by interacting with program management and technical staff, (2) initiates each task and ensures that all day-to-day operations proceed as expected, and (3) ensures that the data are organized and formatted so as to be compatible with the requirements for conducting assessments of alternatives for long-term stabilization of contaminated sites.

To be aware of current and future data base needs of RAP, the DBM task leader reviews current year work plans and other planning documents. The program's monthly reports are also reviewed, with an emphasis to identify tasks that will generate data and/or need data that are maintained in the data base. Such tasks are discussed with the appropriate investigator and/or RAP Manager to ensure the timely, efficient handling of the data.

The data coordinators carry out day-to-day data management operations, including (1) keeping a log of all data received, (2) supervising data entry, (3) conducting the data verification and quality assurance procedures, and (4) providing printouts and/or manipulations of data as requested by management and technical staff. The coordinators thus do a small amount of programming and occasional keyboarding (extensive keyboarding is performed under arrangement with other ORNL divisions), as well as prepare summary statistics for program progress reports.

The GIS operator assists in the generation of graphic displays of spatially oriented data. The operator's tasks include (1) building and maintaining data files of base maps for areas being investigated, (2) plotting spatially oriented data maintained in the RAP Numeric Data Base to verify their accuracy, and (3) assisting in the geographic analysis of data (e.g., calculating areas, distances, etc.). The GIS operator, in

cooperation with other staff at ORNL, has developed the software necessary to transfer data from other graphic display systems used at ORNL to the GIS in ESD. In addition, commercial software for converting GIS data from one standard format to another was purchased and installed on ESD's VAX 11/750.

Occasionally, we use a computer programmer to provide data manipulation and program development beyond that performed by the data coordinators. For example, during the early stages of RAP, a computer programmer developed an automated system for copying and manipulating data produced by ORNL's Analytical Chemistry Division (ACD) so that (1) staff time needed to transcribe data from printed report sheets would be minimized and (2) errors in transcription would not compromise the accuracy of the data. Although ACD instituted a new data management system this year (described in Sect. 3), we still occasionally retrieve from magnetic tape data that are based on the old data management system.

2.2 SERVICES

2.2.1 Data Analyses

Data analyses are the responsibility of those who collect the data, but data management staff assist in such analyses upon request. Summary statistics (e.g., minimum, maximum, mean, standard deviation, etc.), plots, graphs, and a wide variety of other outputs are available using the current software system (Sect. 3.1). Specific capabilities of the software are discussed with the Principal Investigator (PI) at the time of the request. Specialized data analyses and plots not supported by the data management software are handled on a case-by-case basis. For some tasks, it is expected that DBM staff will provide the necessary product; for others, it is more efficient and cost effective to have DBM provide only the formatted data as input to other investigative teams.

As the program matures and the size and complexity of the data base increases, DBM's role in data analyses is expected to expand. The DBM staff will be most familiar with the RAP Numeric Data Base as a whole and will be able to provide analyses that integrate the data from various tasks of the program. Such analyses require staff who are thoroughly familiar

with all data sets in the data base so they can assist in hypothesis testing as well as display and manipulation of spatial information. For example, it would be desirable to couple hydrologic flow data for the ORNL site with the results of the contaminant surveys in White Oak Creek or to analyze the results of the aquatic toxicity and in-stream monitoring studies in relation to the sources of potential contamination.

2.2.2 Geographic Information

The GIS (Sect. 3.1) has been used to produce large-scale plots of the locations of piezometer and water quality wells drilled for RAP. These plots, required by state and federal regulators, were scaled to existing topographic base maps and produced as Mylar overlays. Data sets of other geographic features that have been developed for other projects by the Geographic Data Systems Group at ORNL can be very useful to RAP. A computer code for transferring and reformatting these digitized data sets to the GIS in ESD was completed this past year. As more base geographic data sets become available, the GIS will prove to be a valuable tool for analyzing and presenting site characterization data. These analyses will emphasize the spatial orientation of the data. For example, the GIS will allow a PI to specify a spatially defined subset of data for groundwater wells whose locations can be plotted to any scale. Furthermore, using the GIS to draw maps to scale and checking the product against well defined reference points is an effective means of verifying spatially oriented data.

The GIS can also be used to display simultaneously multiple classes of data such as well locations, WAG boundaries, and sampling transects. These analyses are particularly useful to multidisciplinary projects such as RAP.

2.2.3 Products and Data Accessibility

Printouts of raw and intermediate data sets, as well as computer access to the data, are provided routinely to the PIs for information and verification purposes (Sect. 3.3). In addition, ORNL staff may request data on various electronic media and related products in any of several formats including, but not limited to the following:

- direct read access to SAS data libraries (see Sect. 5.2, Data Security);
- computer data tapes in specified format for export to another mainframe computer;
- copies of data sets on PC diskettes in Lotus 123, dBASE III PLUS, PC-SAS, or ASCII format;
- selected data in specified format for direct inclusion in reports;
- generic printouts of selected data;
- summary tables of precipitation or flow data for selected sites;
- plots of groundwater elevation (well hydrographs);
- maps of ORNL showing locations of various types of wells; and
- maps of ORNL showing sampling locations for a particular study.

Eighty-five requests for data from the RAP Numeric Data Base, mostly from ORNL staff, were filled as of December 30, 1987 (see Appendix A). Requests originating outside ORNL (e.g., the Environmental Protection Agency or Tennessee Department of Health and Environment) must have RAP management approval.

3. DATA BASE MANAGEMENT SYSTEM AND DESIGN

The data base management system, described initially in Voorhees, et al. (1986), is designed to take advantage of the power of computer systems as an aid in acquiring, checking, and processing data so that accurate information will be available for analysis and assessment. The system's design was based primarily on anticipated applications and appropriate data management software.

3.1 DATA BASE MANAGEMENT SYSTEM

3.1.1 Hardware

The following computer hardware systems are used for managing ORNL's RAP Numeric Data Base:

- two IBM 3033s utilizing an OS/MVS operating system,
- two DEC VAX 8600s and a VAX 11/750 utilizing a VMS operating system,
- 1600/6250 BPI tape drives,
- six IBM or IBM-compatible PCs,
- three Tektronix graphics terminals,
- a Calcomp 60-in. digitizer,
- a Calcomp 36-in. color pen plotter,
- a Versatec 36-in. black-and-white electrostatic plotter,
- an Imagen laser printer/plotter, and
- a Tektronix 8.5- by 11-in. color ink-jet plotter.

In addition, numerous other hardware items (e.g., micro-computers, mini-computers, word-processing systems, PCs, terminals, printers, plotters, digitizers, and modems) are used by RAP staff.

3.1.2 Software

The data base principally uses SAS[1] software (Version 5.16) installed on the IBM and VAX mainframe computers. All SAS products are also installed on five of the PCs. Software packages other than SAS are used to manage information related to lengthy descriptive documentation of the data sets, bibliographic information, administrative/record-keeping tasks, and some forms of data entry. For these tasks, software such as dBASE III PLUS, Lotus 123, and WordPerfect are used. Files created in dBASE and Lotus can be transferred directly into PC-based SAS data sets and subsequently uploaded to a mainframe computer.

SAS is a popular and accepted scientific data management/analysis software package with over 20,000 installations worldwide. The primary strength of SAS is its ability to combine data management with extensive statistical and graphics capabilities, a combination essential for the management of scientific data. In addition, SAS is highly versatile in handling information, in both its data management and report-writing capabilities. The system's specific capabilities can be found in the numerous user's guides (e.g. SAS 1985a, 1985b, 1985c) published by the SAS Institute. With SAS, files can be produced in various formats for transfer to other computer systems and for specialized data analyses and graphic displays not offered by SAS itself. Although SAS is not truly a data management system per se (e.g., it lacks built-in capabilities for producing hierarchical or relational file structures), it is well adapted to manage data because it has extensive statistical and graphics capabilities not found in most data management systems. In addition, SAS can be operated through an interactive or batch mode.

The GIS was installed by ESD in November 1986. The GIS, which can be used to analyze and present spatially oriented data, is based on ARC/INFO[2] software installed on the ESD VAX 11/750. ARC/INFO allows the user to combine and subset descriptive data associated with spatially defined data.

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[1]SAS is a registered trademark of SAS Institute, Inc., Cary, N.C.

[2]ARC/INFO is a registered trademark of Environmental Systems Research Institute, Redlands, Calif.

Complete graphic and mapping capabilities are also contained within the ARC/INFO software. In addition, ARC/INFO will allow data exchange with several other GISs, including the U.S. Geological Survey (USGS) Digital Line Graph, U.S. Bureau of the Census Geographic Base File/Dual Independent Map Encoding (GBF/DIME), and ORNL Geographic Data Systems. Software to convert ARC/INFO formats to and from those used by Autocad- and Intergraph-based GISs have been installed on the ESD VAX. Because the ESD VAX is connected to the ORNL DECNET network, data can be readily transferred on-line from other ORNL computers (e.g., VAX 8600s, IBM 3033s and DEC-10).

3.2 ORGANIZATION OF THE DATA BASE

The RAP Numeric Data Base serves as a central repository for technical data generated by the program. Such data are currently being used to evaluate the condition of the environment as it relates to ORNL's past waste management practices and research activities; ultimately, analyses based on the data will be used to justify any corrective action. Therefore, the data base is designed so that data are available not only to those who are responsible for conducting a specific study but also to other staff within the program. For example, results from the scoping surveys (one-time sampling efforts) of groundwater and surface water contaminants and from surveys of groundwater elevations are important not only independently but also collectively in determining the placement of the water-quality monitoring wells required by federal regulations.

The general structure of the Numeric Data Base consists of a collection of SAS libraries, with each library containing one or more SAS data sets. For example, data from Cerling's contaminant scoping surveys reside in the SAS library named ENVSCI.LDV25255.SAS.CERLINGV. This library currently contains three SAS data sets: FIELD, ACD, and EXTRACT (field data and analytical chemistry data from scoping surveys and data from an experimental extraction study, respectively). Organizing the data by investigator allows a PI for a particular task to access easily his or her own data while maintaining restricted access to the other data within the project. However, some types of data, such as precipitation and

surface discharge, come from several sources and may be applicable to several tasks; such data are cataloged in separate libraries.

Because a user of the data will be more interested in the type of data rather than who conducted the study, we have grouped the SAS libraries/data sets into the following categories:

- well construction,
- groundwater,
- surface water,
- precipitation,
- contaminant characterization,
- biological monitoring,
- technology demonstrations, and
- miscellaneous.

These categories will be modified accordingly, as data are received from BNI. Depending upon the needs of the project, the data base can be easily reorganized. However, the less complicated a system remains, the easier it is to maintain and document. Current contents of the data base are discussed further in Sect. 4.0.

3.3 DATA PROCESSING

Several data processing steps must occur from the time the data are collected until they become part of the RAP Numeric Data Base (Fig. 2): data are collected, encoded, entered, and verified. Data collection, encoding, and entry are described in general in Sects. 3.3.1 through 3.3.3. Data verification is a component of quality assurance and is therefore a part of each data processing step. Section 3.3.4 presents some specific examples of data processed to date. Experience has shown that, in most cases, it is advantageous to define a data flow routine with procedures specific to a task and to follow the procedures carefully until an alternative method can be shown to result in improved quality assurance (see Sect. 5.1).

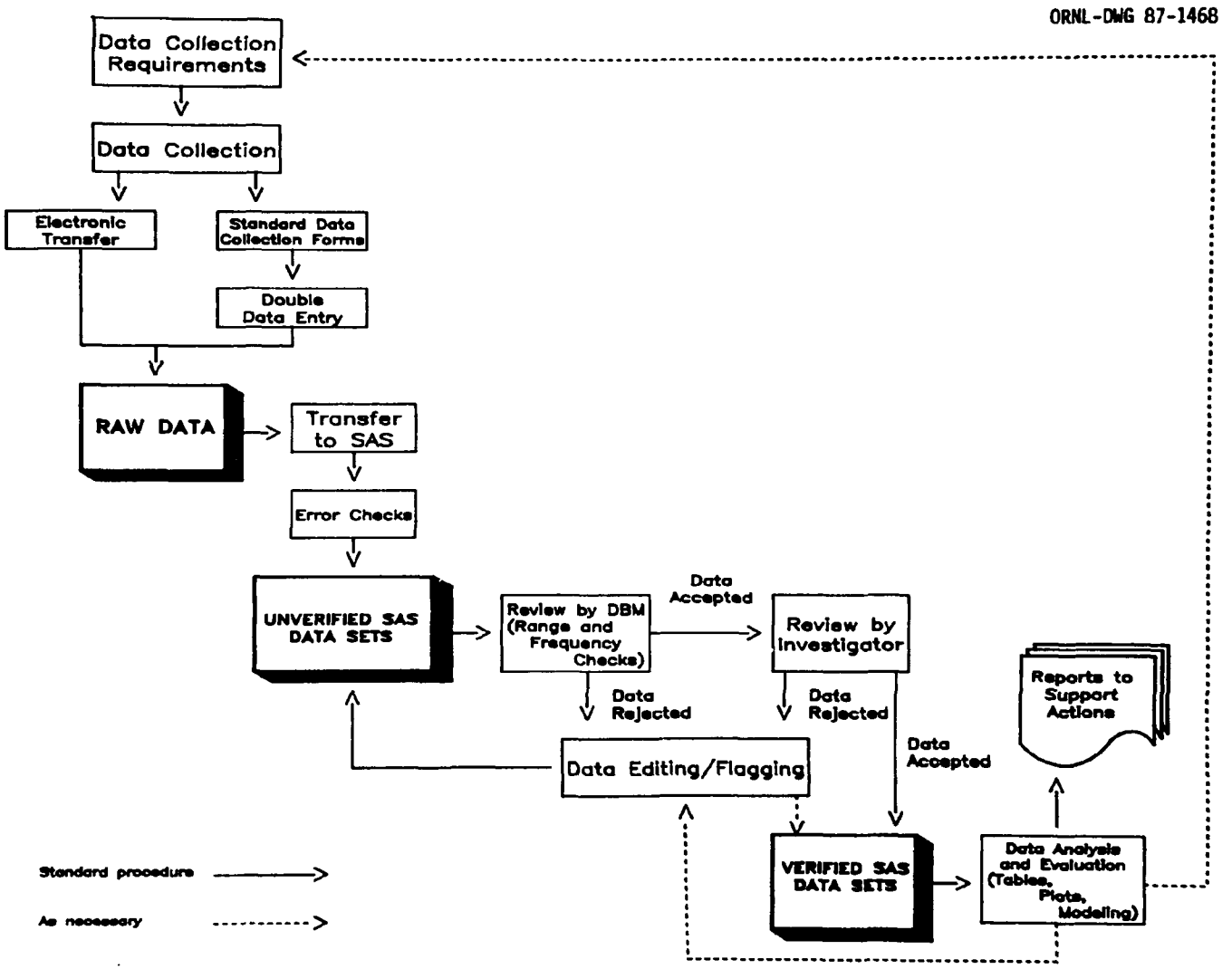

Fig. 2. Generalized flow diagram for processing data.

3.3.1 Data Collection

Sites known or suspected to be contaminated are being studied through the analysis of existing and newly collected data. Several factors contribute to the types and amount of data to be collected, including the extent of the site, the concentrations and volumes of disposed contaminants, the geologic setting of the site, the propensity for contaminant migrations, and potential health hazards. Spatial and temporal aspects of data collection must be appropriately considered to correctly identify the existence, nature, extent, and sources of contamination. Site characterization of subsurface conditions often requires an iterative process of data collection and analysis as indicated in Fig. 2.

In addition to data generated by the ongoing investigations, existing technical data must be considered. These data are being incorporated into the data base only if (1) they are necessary for site characterization or development of the Feasibility Study and (2) adequate documentation for these data is available. Minimum criteria for documentation include the following (when applicable):

- sampling data,
- sampling location and description,
- sampling depth and increment,
- collection technique,
- field preparation technique,
- laboratory preparation technique, and
- laboratory analytical method.

If the data are in an existing data base, documentation on the encoding and format of that data base is required.

Although the characterization studies are and will continue to be conducted by numerous ORNL staff and their subcontractors, the development of the data sets is controlled by organizing and entering the data into common, standardized formats and by providing identifiable sampling and analysis documentation.

3.3.2 Data Encoding

Subsequent use of the data depends completely upon the documentation of the data set, from its finest level of detail to the overall organization of the data base. The difficulty of obtaining complete and accurate data from field studies is well recognized. Use of standard data collection forms whenever possible is encouraged to promote consistency regardless of the data's origins. Forms can and have been developed through the cooperative efforts of the PI and the data base management staff.

Currently within RAP there are more than 150 corrective action sites with widely varied characteristics. Therefore, unique and concise identification codes (IDs) are assigned to all the sites and samples. Key identifiers such as sample IDs or well numbers are cross-referenced between the various data sets with site names, coordinates, and other identifiers in the site descriptor files. The ability to link data sets using key identifiers eliminates the need to store redundant information in each record and allows the data base to be flexible enough to incorporate additional components into the system as needed without disturbing the existing files

3.3.3 Data Entry

Data for RAP are generated by a variety of sources, including the PIs, subcontractors (e.g., Mining Consultants, Inc.), USGS, Oak Ridge Associated Universities, ORNL's Analytical Chemistry Division (ACD), ORNL's Environmental Monitoring and Compliance (EMC) Department, and ORNL's Waste Operations Control Center. It is recommended that double data entry be used for all manually entered data, and every effort is made to receive the data from the various sources in electronic form (e.g., via PC diskette or access to a file on a mainframe computer). Double data entry refers to keying the data twice (preferably by different individuals) and electronically comparing the files for errors.

There are several other principles to consider regarding data entry. When routine manual entry of data is required, labeled and formatted entry screens should be used. The screens should parallel the data collection

forms and be formatted accordingly. Establishing this practice will allow the data collection forms to serve jointly as data entry forms, thereby eliminating the need for recopying the data and minimizing errors in data transcription. All full-screen entry procedures should contain automatic and programmed functions for data entry and maintenance. The functions can include (1) verification (e.g., range-checking) at the time of entry before continuation to the next field; (2) use of predefined codes with full descriptors in separate files; (3) error messages; and (4) automatic entry and retention of repetitious field values.

3.3.4 Examples of Data Processing

3.3.4.1 Analytical chemistry data

Most of the data collected to date consist of chemical analyses performed by ACD. Until early 1987, ACD used System 1022 to report results of the chemical analyses. Transfer of these data into a verified SAS data set is described by Voorhees et al. (1986).

ACD now uses a software system called AnaLIS for reporting the results of chemical analyses. The following general example briefly describes how these data are transferred to the RAP Numeric Data Base. The PI collects samples and submits them to ACD for analysis. ACD performs the analyses, records the results using AnaLIS installed on their own VAX computer, and sends a printout of the raw data to the PI. Data related to RAP are retrieved daily from AnaLIS through the use of charge account numbers of specific RAP activities. The data are electronically transferred first to the VAX 8600 and then to the IBM 3033s, where they are incorporated into the SAS format. Information on the extraction procedures, analytical methods, and task leader of the work are added to the data set as necessary. Although by this stage the data sets have already passed through several computerized evaluations by DBM staff (e.g., checks for missing values, erroneous data, and inconsistencies), they are considered unverified. The data are therefore further subjected to SAS programs to check for impossible or unrealistic values (Sect. 5.1). The PI responsible for the data is then given (1) printouts of the data, including summaries, and (2) computer access to the SAS data set; the PI is asked to verify the

data within a specified time period (generally 2 weeks, but this time can vary depending on the extent of the data set). This verification procedure generally consists of visually checking the data and data summaries for questionable entries. For example, a ^{137}Cs concentration of 20,000 Bq/L may be possible, but questionable, for the specific system being studied. After the PI has checked the SAS data set, any noted errors or irregularities in the data are corrected or appropriately flagged. The verification of each observation is indicated in the data set. When all observations in the data set have been verified, the data set is considered to be part of the verified SAS data base.

3.3.4.2 Quality Assurance/Quality Control (QA/QC) for chemical analyses

As an independent evaluation of ACD's ability to provide accurate chemical analyses, control samples (i.e., known constituents) are routinely submitted to ACD for analysis. The results from these analyses are compared with known concentrations in the samples. A SAS library has been established to document the results of this study.

The ACD raw data are received by DBM on forms produced on Lotus 123; the forms are completed by the project PI. A separate data form has been developed for each type of analysis to minimize repetitive entry by the PI and to reduce the possibility of human error (see Appendix B). Receipt of the completed data form is recorded in a log. Because of the limited volume of data for this study, the PC version of SAS is being used to create the data sets. Data are entered by DBM staff directly into SAS data sets using data entry screens designed to match the Lotus forms. The SAS data sets are stored initially on the PC hard disk and subsequently uploaded to the IBM 3033s.

Analytical results from a single sample are entered into a data set, printed, and visually checked against the original data form. Next, the data set containing the results from an individual sample is added to a cumulative file containing the results from all samples of that particular standard (e.g., trace elements, radiological elements, or organic compounds). These cumulative data sets are periodically printed for

verification by the PI (Sect. 5.1). Comparisons can then be made between the expected results and the results reported by ACD.

3.3.4.3 Precipitation and surface discharge data summaries

It is difficult to quickly compare data of precipitation and surface discharge in the Oak Ridge area because these data are currently collected and managed by several investigators using a variety of methods and data management software. In an effort to make these data more readily available, we have established procedures for assembling summaries of the data in a common format.

Total daily precipitation data from more than 20 sites in the Oak Ridge vicinity have been organized into a series of SAS data sets by DBM staff. Compilation of such information has been useful not only to those investigators who need precipitation data in general but also to those who provide data so that they can compare their monitoring results (as a part of quality assurance) with those collected at other local sites. Eleven sites currently represented in the data summary are managed by EMC; nine are managed by various investigators in ESD; two, by USGS; and one, by the Atmospheric Turbulence and Diffusion Division (ATDD) of the National Oceanic and Atmospheric Administration in Oak Ridge. A description of the contents of the precipitation data sets is presented in Section 4.4.

Data are provided to DBM electronically as draft data sets by the tenth day of each month; EMC staff provide SAS data sets, whereas ESD, USGS, and ATDD staff provide ASCII files. The data are then assembled into a single SAS data set and returned to the contributors within 5 days for their review. The USGS and ATDD data are considered provisional until published on an annual and monthly basis, respectively; therefore, the two groups do not participate in review of the data at this time. EMC and ESD staff are allowed 10 days to review the data, after which time DBM is notified of any suspect values to be flagged. With staff adhering to this schedule, the precipitation data summary is never more than 6 weeks out of date, if all systems are operating normally.

In addition to the precipitation data itself, a SAS data set has been created to record descriptive information for each monitoring station. This data set contains information such as station coordinates, elevation,

type of gage, smallest unit of measurement, frequency of data collection, administrative contact person, and technical contact person. Investigators desiring more detailed data than those given in the data summary can request it from DBM staff, who will retrieve it from the original source.

Similar procedures and data sets have been established for surface discharge monitoring conducted in the vicinity of ORNL. Mean daily discharge data have been assembled from three sites monitored by EMC and six sites monitored by USGS. Data from six additional USGS sites in the vicinity of the Oak Ridge Reservation (ORR) are also in the RAP Data Base. A description of the contents of the surface discharge data sets is presented in Section 4.3.

3.3.4.4 Water-level data

Over 330 piezometer wells have been installed by RAP. Data obtained from these wells have been used to formulate a groundwater monitoring plan to support site surveillance and compliance with applicable federal regulations.

Groundwater level measurements are recorded for each well approximately every two to three weeks. Field data sheets, which contain well identification number, date and time of measurement, depth to water (DEPTHTW), and comments by the field personnel, are machine copied and provided to DBM for data entry. These field sheets are then sent to the Data Entry group of the Computing and Telecommunications Division (C&TD), where personnel type ASCII files, using double entry verification. The file is transferred electronically to DBM's IBM 3033 computer area and is written as a temporary SAS data set. This data set is printed and given to the field personnel to be checked against their field sheets. Concurrently, the data set is subjected to the following SAS error-checking routines:

- Any observations with missing values for DEPTHTW are printed with comment variable to see if there is an appropriate explanation (e.g., "dry well"),
- Any observations for which DEPTHTW exceeds the total depth of the well are printed,

- Any observations in which DEPTHTW exceeds a specified value from the previous measurement are printed,
- Any duplicate entries for a well are printed, and
- Any observations falling outside a specified range of sampling dates are printed.

Printouts of these potential errors in the data set are provided to the PI so they can be resolved. After all errors have been corrected, a permanent SAS data set is created and appended to the cumulative SAS piezometer data set.

4. DATA BASE CONTENTS

Data in the RAP Numeric Data Base reside within several SAS libraries, each containing numerous SAS data sets. The library names may reflect who conducted the study, where the data originated, or what general type of study was conducted. We have grouped the libraries into the following categories:

- well construction,
- groundwater,
- surface water,
- precipitation,
- contaminant characterization,
- biological monitoring,
- technology demonstrations, and
- miscellaneous.

The contents of the Numeric Data Base are discussed with respect to this organization (Sects. 4.1-4.8). In addition, we also discuss our development of SAS format files (Sect. 4.9) and functions of the GIS (Sect. 4.10).

For those individuals who wish to see more detail about the data sets, we have prepared a synopsis of the RAP DIMS on IBM PC diskettes that is available upon request. Sect. 4.11 lists the hardware requirements for using this resource and describes the system, along with examples of its contents.

4.1 WELL-CONSTRUCTION INFORMATION

More than 1100 observation wells have been drilled in the vicinity of ORNL during its 40-year history. As indicated by Fig. 3 (which shows all but a few of the wells, which are located outside of the area depicted) a fairly broad coverage exists for the ORNL area. The wells were drilled at different times and for different purposes, with the result that there is some variation in the parameters recorded during construction. Construction data (-CONS) for these wells have been recorded in seven SAS

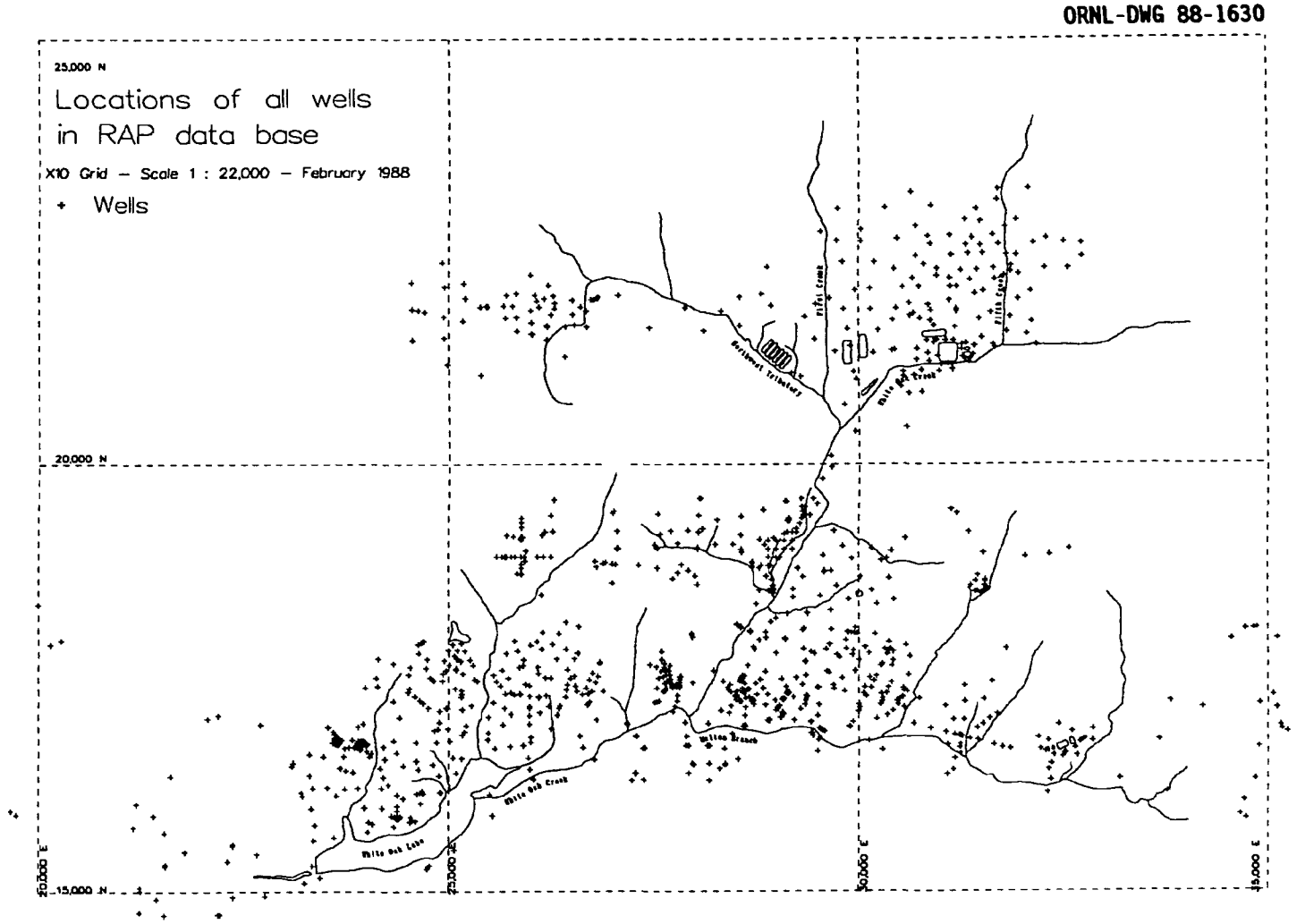

Fig. 3. Locations of all wells in the Remedial Action Program Numeric Data Base.

data sets (Table 1) based on the general installation date and/or general purpose. In addition to the wells in Table 1, USGS has installed another 28 wells (U-series wells), for which we do not yet have the construction information.

Nearly all of the older, pre-RAP (PRAP) wells (Table 1, PRAPCONS) that remain are located in the vicinity of the Solid Waste Storage Areas (SWSAs) and the Pits and Trenches Area (Fig. 4). Many of the older wells in the ORNL Main Plant Area (Fig. 1, WAG 1) have been destroyed or damaged by construction activities. Thus, more than 330 piezometer (PIEZ) wells had to be installed by RAP to obtain basic geologic and hydrologic data as an aid in determining suitable locations for and design of water quality monitoring wells required by the Resource Conservation and Recovery Act (RCRA) (Table 1, PIEZCONS).

The piezometer well locations were selected to supplement the available information from existing wells in the burial grounds and to establish a basic network for gathering groundwater data in other WAGs (Fig. 5). Most of the wells were shallow, drilled only until aquifer inflow was detected. Some wells, however, were drilled to reach deeper aquifers to determine the potentiometric heads of water-bearing zones at these levels and to determine vertical hydraulic gradients; at some locations, pairs of piezometer wells were installed for these purposes.

The hydrofracture wells (HF) are located in four distinct areas (Fig. 6) associated with the experimental and operational hydrofracture sites in Melton Valley (Table 1, HFCONS). As with the older (PRAP) wells discussed above, the information for these wells came from various documented and undocumented sources, including ORNL and USGS publications, borehole geophysical logs, and personal communications.

In accordance with the Environmental Protection Agency (EPA) regulation (40 CFR, Part 265, Subpart F), 22 water quality (WQ) wells have been installed adjacent to three impoundment areas (3524, 3539-3540, and the 7900 ponds) (Fig. 7). The wells can be classified as upgradient (reference) or downgradient, depending on their position in relation to the general direction of groundwater flow. These wells (Table 1, WQCONS) were sampled quarterly for one year and are now being sampled semiannually

Table 1. SAS data sets of well-construction parameters

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
ENVSCI.MAF25255.SAS.ERFU2	Well construction data.			
PIEZCONS	Construction data on piezometer wells installed by RAP.	05DEC85 - 21JUL87	331	33
WQCONS	Construction data on water quality wells installed by RAP.	19JUL85 - 08NOV85	22	35
PRAPCONS	Construction data on monitoring wells installed before establishment of RAP.	1949 - 1983	667	32
HHMSCONS	Construction data on hydrostatic head monitoring stations installed by RAP.	17MAR86 - 25SEP86	19	41
HFCONS	Construction data on hydrofracture wells installed before establishment of RAP.	1959 - 1984	89	27
CERCONS	Construction data on water quality wells installed by RAP to comply with CERCLA.	08JAN85 - 15MAR85	13	24
TARACONS	Construction data on wells installed by RAP in the Test Area for Remedial Action study area.	13MAR87 - 15APR87	13	32

[a]RAP = Remedial Action Program; and CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.

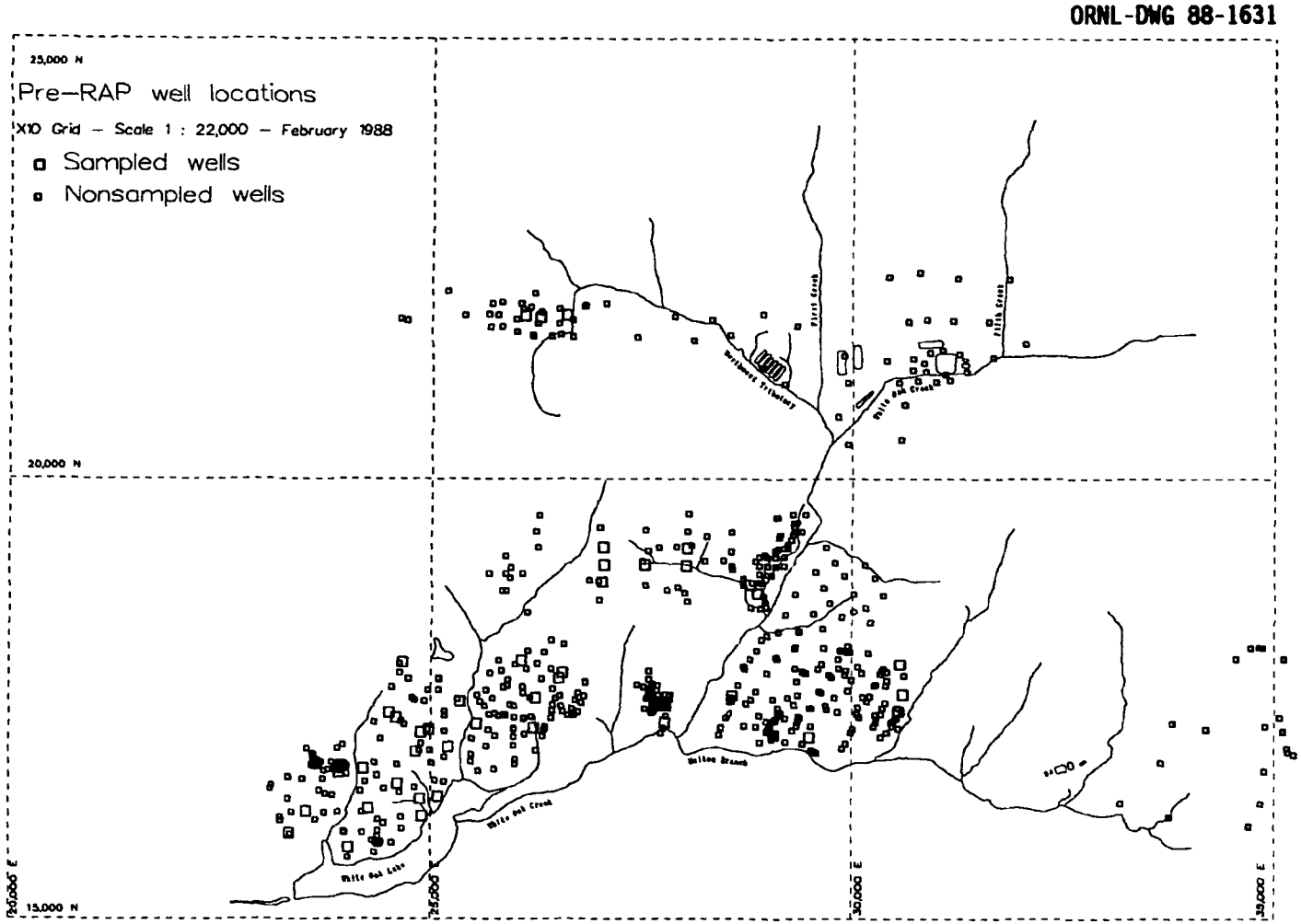

Fig. 4. Locations of wells installed before the establishment of the Remedial Action Program. Selected wells were sampled by the Remedial Action Program for water quality; some were monitored to determine water-level elevations.

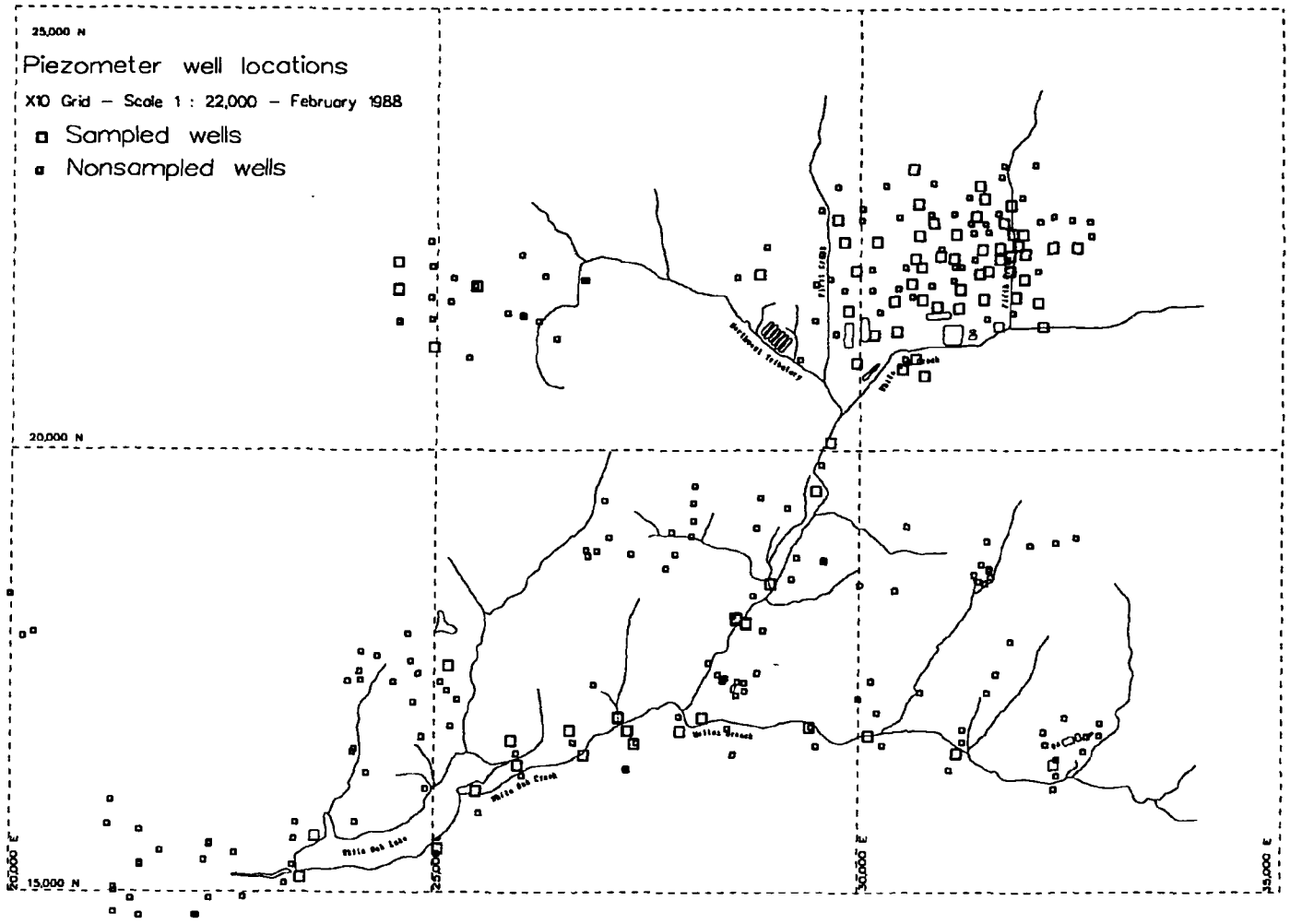

Fig. 5 Locations of piezometer wells installed by the Remedial Action Program. Although these wells were designed to determine water-level elevations, some were sampled to indicate general water quality.

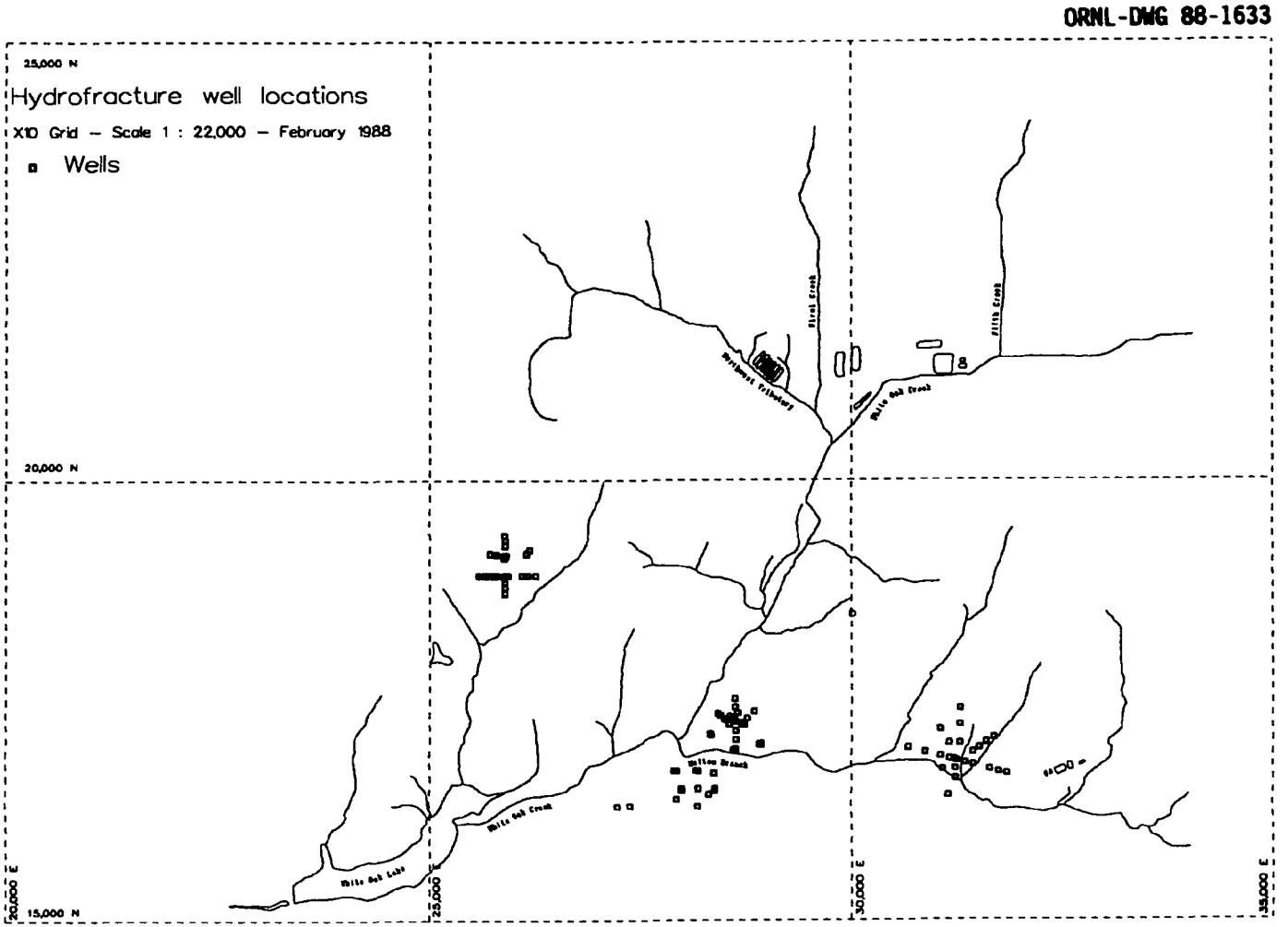

Fig. 6. Locations of hydrofracture wells installed before establishment of the Remedial Action Program.

ORNL-DWG 88-1634

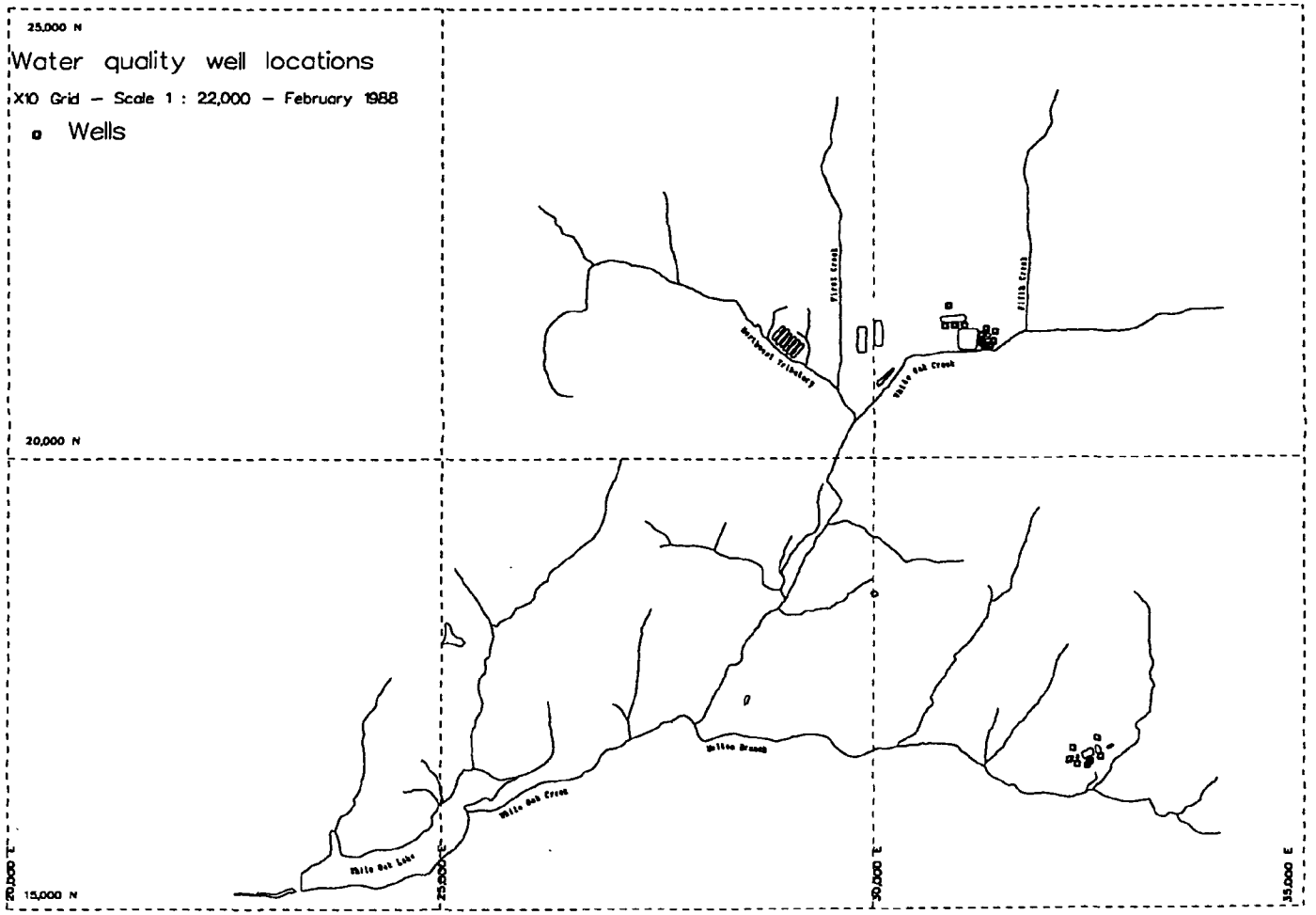

Fig. 7. Locations of water quality wells installed in 1985 by the Remedial Action Program for compliance with the Resource Conservation and Recovery Act; 85 more, in various stages of development, are a part of a total of more than 250 water quality wells to be installed at the perimeters of the Waste Area Groupings.

(Sect. 4.2.2). There are 85 additional water quality wells, in various stages of development, that are part of a total of more than 250 to be installed at the perimeters of the WAGs. Construction information for these wells will be entered into the data base as they are completed.

A series of hydrostatic head monitoring stations (HHMS) have been installed in the Pits and Trenches Area and SWSA 6 in order to characterize water levels, geology, and water quality in and surrounding these waste management areas (Table 1, HHMSCONS). An additional 11 hydrostatic head monitoring wells are in various stages of development. Each HHMS consists of a cluster of three telescoping wells of varied depths, approximately 25 ft apart (Fig. 8). The deepest well was drilled to approximately 400 ft; the depths of the intermediate and shallow wells are approximately 200 and 80 ft, respectively. Data from these wells are providing information on the vertical and lateral distribution of hydraulic head and thus characterize deeper flow systems that have potential for transporting groundwater contaminants. These data will support two- and three-dimensional groundwater simulation models and will supplement the ORNL groundwater monitoring network in general.

Thirteen wells installed to meet the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) are located adjacent to three impoundments: the 3513 pond, the Old Hydrofracture Facility (OHF) pond, and the Homogeneous Reactor Experiment (HRE) pond. Thirteen wells were also installed in the Test Area for Remedial Action (TARA) located in SWSA 6 (Fig. 9) for the purpose of studying trench closure alternatives. Data sets on the construction of these wells have been established (Table 1, CERCONS and TARACONS).

4.2 GROUNDWATER

Groundwater hydrology and water quality data sets in the RAP Numeric Data Base are described in Table 2. Additional groundwater data exist for selected areas at ORNL (e.g., SWSA 6) and will eventually be incorporated into the RAP Data Base.

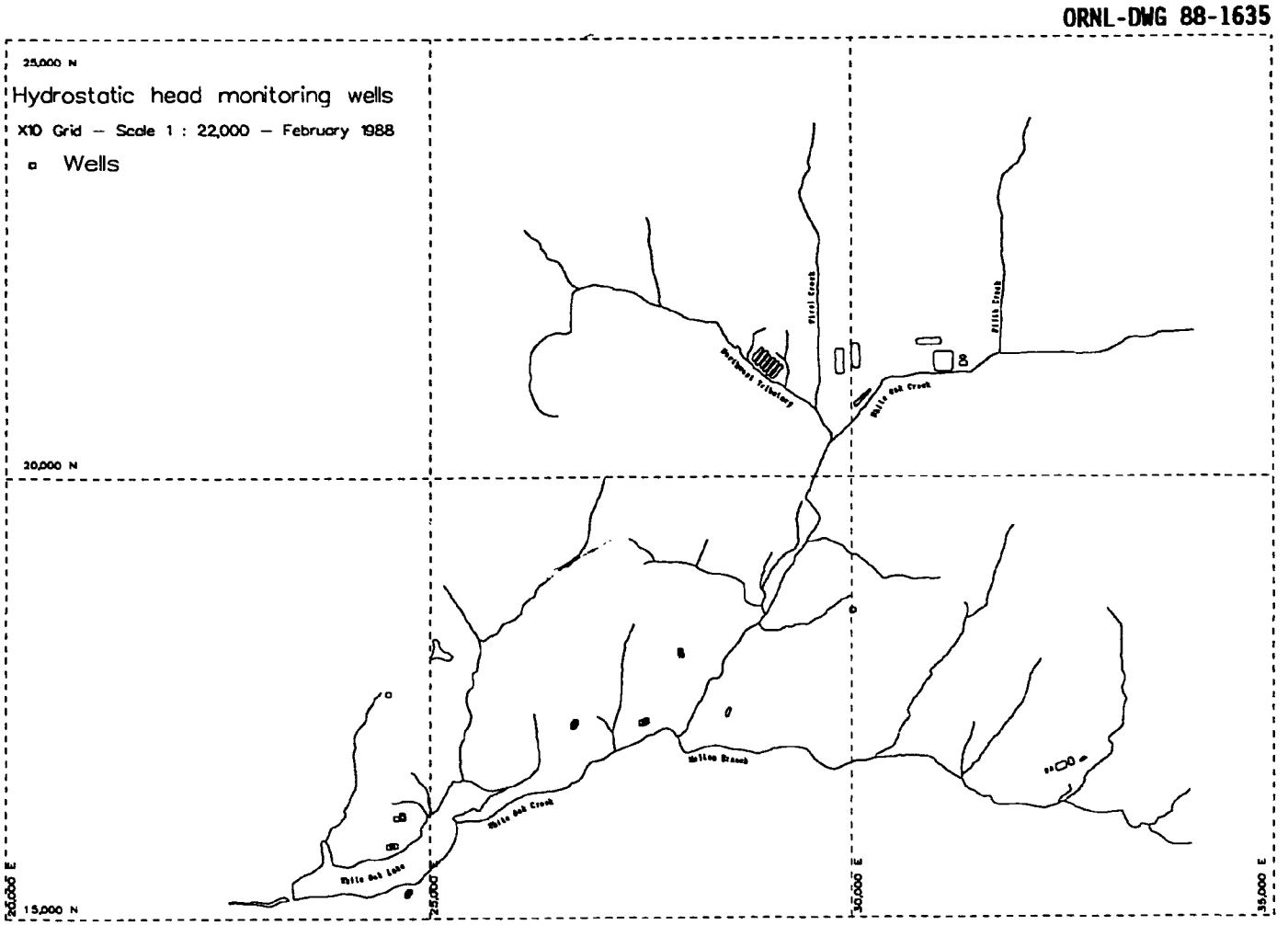

Fig. 8. Locations of hydrostatic head monitoring station wells installed by the Remedial Action Program through September 1986; 11 more are in various stages of development.

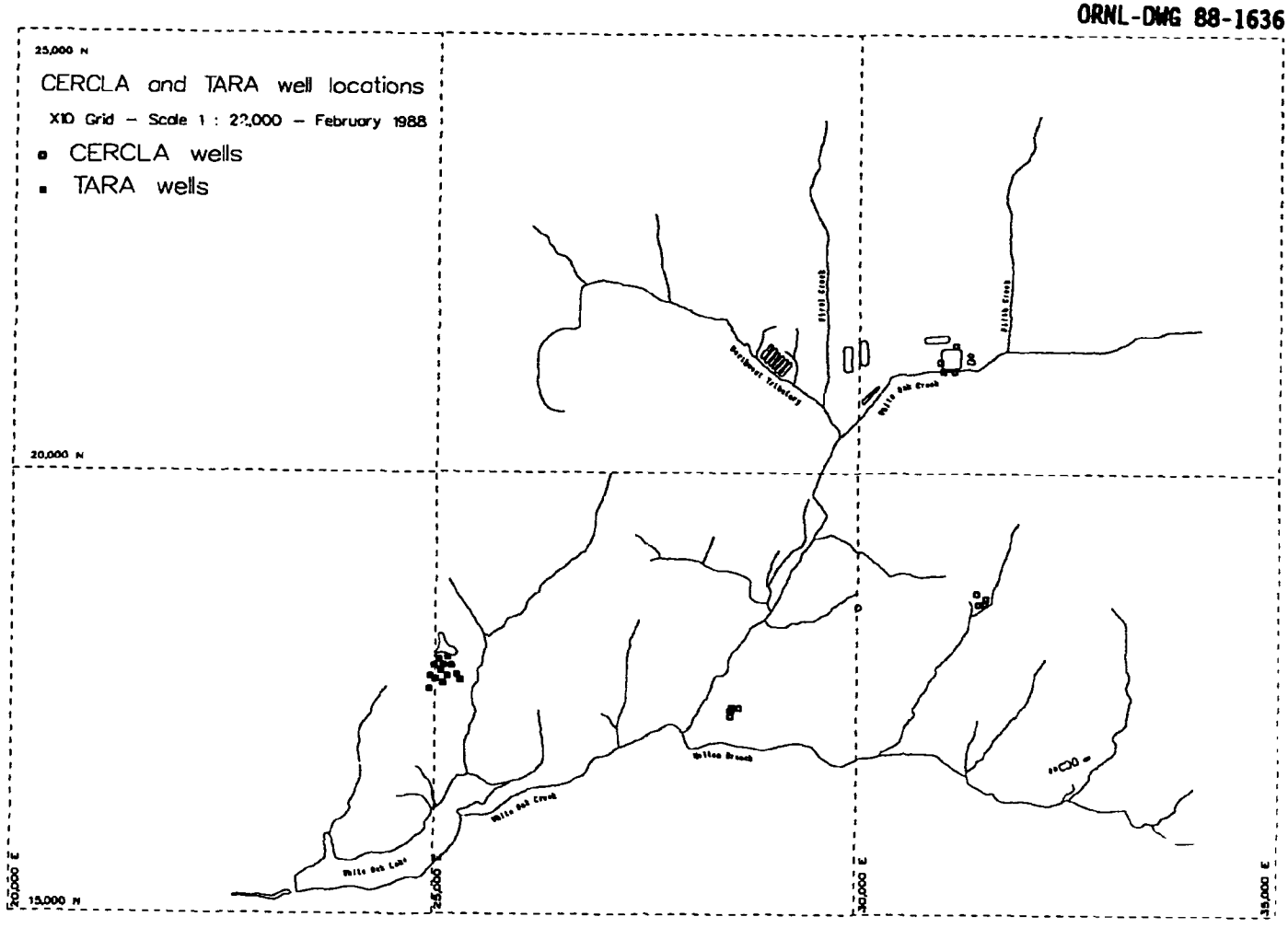

Fig. 9. Locations of wells installed for compliance with the Comprehensive Environmental Response, Compensation, and Liability Act and for the technology demonstration activities on Test Area for Remedial Action.

Table 2. SAS data sets of groundwater data

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
ENVSCI.MAF25255.SAS.ERFU2	ORNL water-level measurements.			
PIEZDAT	Depth to water measurements conducted at piezometer wells.	28AUG85 - 10DEC87	8,915	10
STRMCHK	Records of wet or dry conditions at various seeps or stream check points; data used in support of depth to water measurements.	18JUL86 - 03DEC87	236	8
ENVSCI.LDV25255.SAS.GSWELLS	USGS water-level measurements for wells equipped with continuous recorders.			
CY85	Calendar year 1985 data	01OCT85 - 31DEC85	3,890	7
CY86	Calendar year 1986 data.	01JAN86 - 31DEC86	21,089	7
CY87	Calendar year 1987 data.	01JAN87 - 31DEC87	28,550	7
ENVSCI.LDV25255.SAS.KETELLEV	Groundwater contaminant scoping survey, ORNL Main Plant Area and SWSA 3.			
ACD1	Results of anion, cation, alkalinity, volatile organic, total organic carbon, and radiological analyses.	15APR86 - 21OCT86	3,938	18
FIELD1	Sample date, well IDs, pH, specific conductance, and temperature results.	15APR86 - 21OCT86	56	9
ENVSCI.LDV25255.SAS.MCCRAC	Groundwater contaminant scoping survey, White Oak Creek floodplain.			
ACD2	Results of anion, cation, alkalinity, volatile organic, total organic carbon, and radiological analyses; also includes sample date, pH, specific conductance, and temperature results.	20JUN87 - 07JUL87	1,108	20

Table 2. continued

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
ENVSCI.LDV25255.SAS.TORAN	Groundwater samples taken from 19 HHMS wells.			
ACD1	Results of cation, anion, total organic carbon, and radiological analyses.	23FEB87 - 31JUL87	986	30
ENVSCI.LDV25255.SAS.STANSV	Characterization of groundwater quality around the Waste Holding Basin (pond 3513) and ponds associated with the Old Hydrofracture Facility and the Homogeneous Reactor Experiment.			
GDW_M	Groundwater monitoring well samples analyzed for cations, anions, fecal coliforms, mercury, polychlorinated biphenyls, pesticides, phenols, and radiological activity.	06FEB85 - 13JAN86	1,664	29
W_COMP_M	Groundwater monitoring well samples analyzed for dissolved oxygen, pH, specific conductance, temperature, total organic carbon, and total organic halides. Multiple sample results were used to compare wells.	06FEB85 - 13JAN86	745	29
IKN.RIFSRCRA.SASDATA	RCRA water quality monitoring wells established for detection of groundwater contamination; data provided by EMC/ORNL.			
FIELD85	Specific conductivity, pH, and temperatures.	18SEP85 - 02JAN86	756	9
DIS85	Dissolved metals; filtered samples.	18SEP85 - 07JAN86	418	13
TOT85	Total metals, organics, anions; unfiltered samples.	18SEP85 - 07JAN86	1,402	14

Table 2. continued

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
FIELD86	Specific conductivity, pH, and temperatures.	17MAR86 - 10DEC86	924	9
DIS86	Dissolved metals; filtered samples.	17MAR86 - 10DEC86	495	13
TOT86	Total metals, organics, anions; unfiltered samples.	17MAR86 - 10DEC86	1,734	14
FIELD87	Specific conductivity, pH, and temperature.	09MAR87 - 16MAR87	438	9
DIS87	Dissolved metals; filtered samples.	09MAR87 - 17MAR87	264	13
TOT87	Total metals, organics, anions; unfiltered samples.	09MAR87 - 17MAR87	816	14

[a]ORNL - Oak Ridge National Laboratory;
USGS - U.S. Geological Survey;
SWSA - Solid Waste Storage Area;
HHMS - Hydrostatic Head Monitoring Station;
RCRA - Resource Conservation and Recovery Act; and
EMC - Environmental Monitoring and Compliance;

4.2.1 Groundwater Hydrology

Periodic depth-to-water measurements have been and continue to be made at the piezometer wells installed by RAP and at selected older wells (Table 1, PIEZCONS and PRAPCONS, respectively). The objectives of such monitoring are to (1) determine the configuration of the water table, the directions of groundwater movement, and both the lateral and the vertical hydraulic gradients in the WAGs; (2) assess short-term water level changes resulting from periods of precipitation (aquifer recharge) and drought; (3) determine the amount of seasonal fluctuation of the water level in wells; and (4) track long-term water level trends in representative wells to detect effects of climatic change and human activities. The period of record and number of observations for each well are listed in Appendix C, Table C.1. Wells in WAG 1 were installed first and hence have the longest period of record; objectives 1-3 have been accomplished in this area, and monitoring in WAG 1 will probably be reduced to a few representative wells to study long-term trends. Water-level monitoring in most other WAGs will be continued through May 1988; monitoring for long-term trends will be dependent on the availability of funding. Hydrographs for two typical wells in WAG 1 are shown in Figs. 10 and 11. The data points are irregularly spaced because water levels were measured initially at approximately biweekly intervals, with the frequency changing to monthly as the network of wells expanded. A polynomial interpolation algorithm was used to connect the data points, thereby approximating the changes in water level that occurred between measurements. The hydrographs presented are for illustrative purposes only and are not meant to be used for a rigorous interpretation of the data.

In addition to the periodic water-level measurements made by ORNL, USGS operates continuous water-level recorders on approximately 90 wells in the ORNL vicinity (Fig. 12). Monitored wells include the HHMS wells, the USGS U-series wells, and a few of the PRAP wells (see Sect. 4.1). Daily mean water levels, calculated from hourly unit values, are retrieved from the USGS computer system in Nashville. The number of observations for

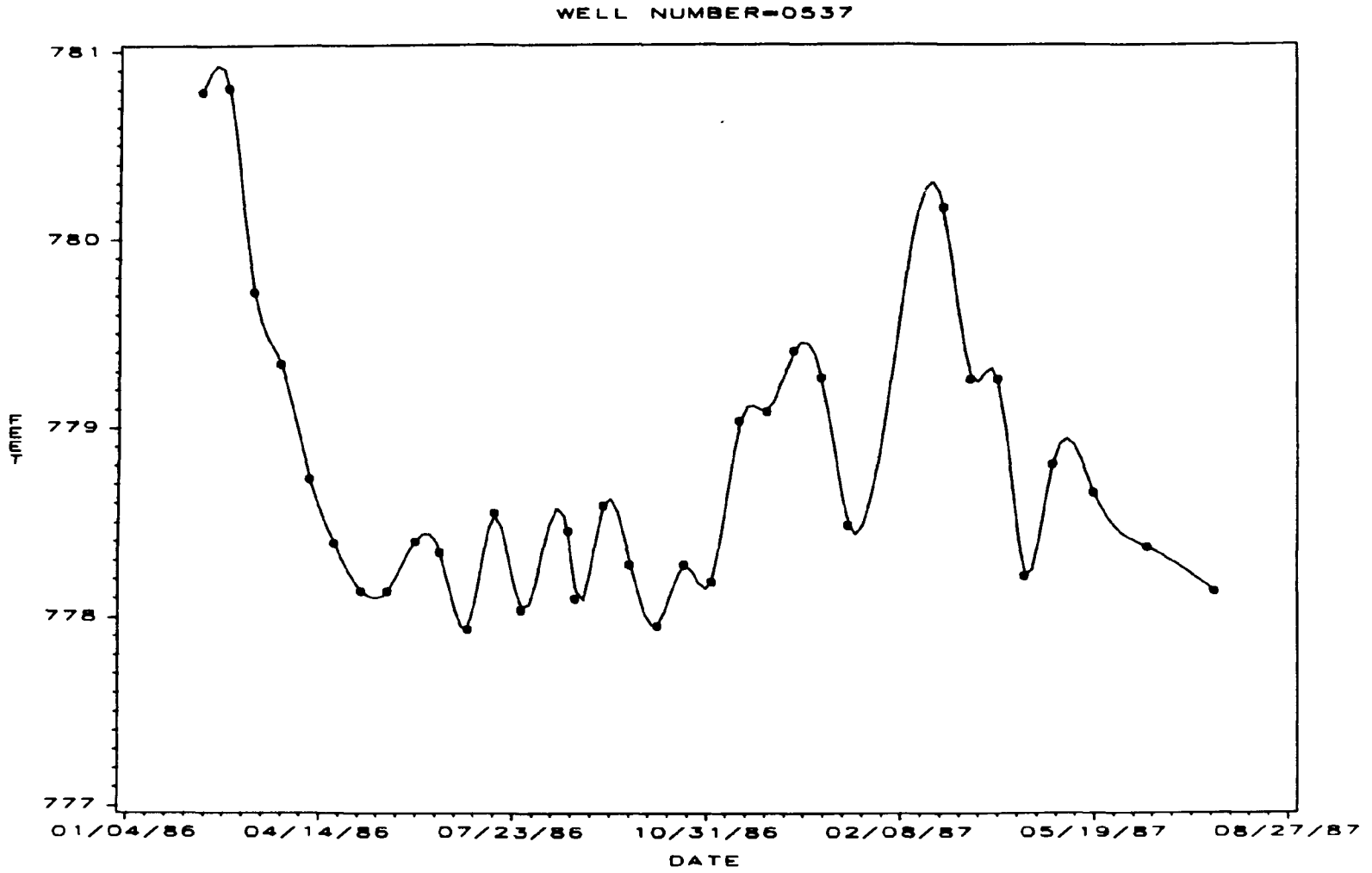

Fig. 10. Hydrograph from piezometer well no. 0537 located near First Creek and Building 1503.

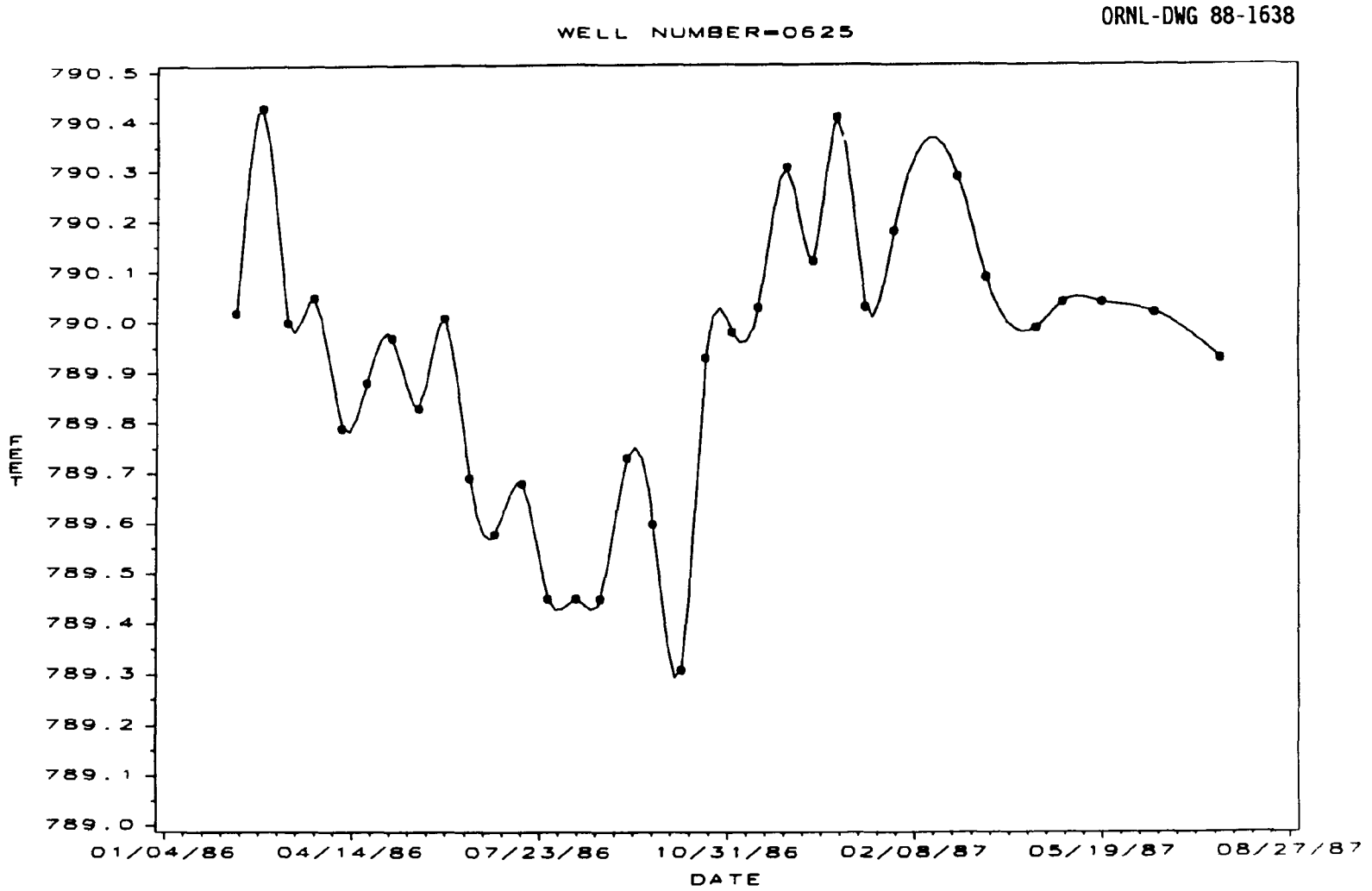

Fig. 11. Hydrograph from piezometer well no. 0625 located between Building 4501 and Central Avenue.

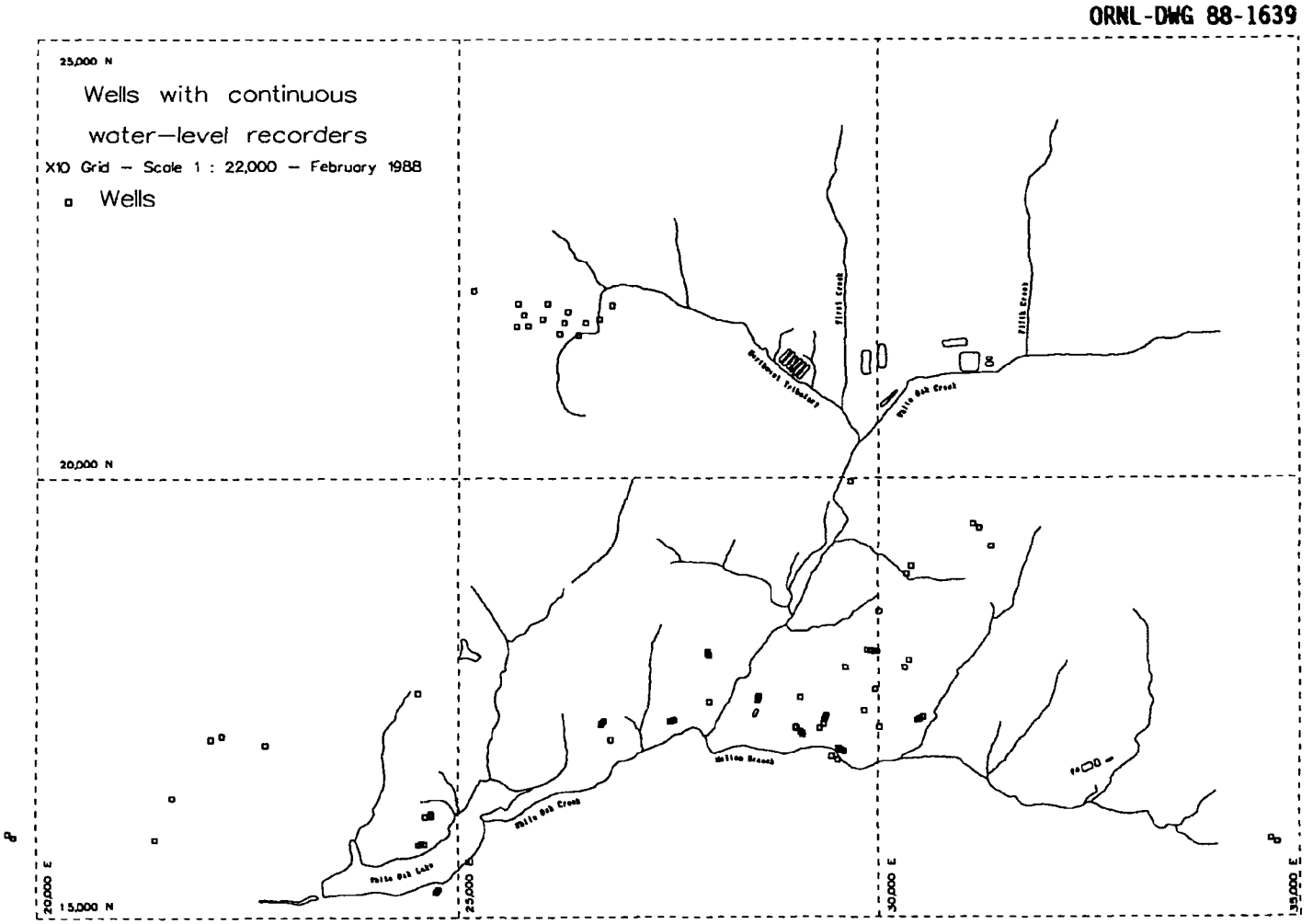

Fig. 12. Locations of wells with continuous water-level recorders.

these wells in the RAP Data Base, which are organized by calendar year, are presented in Appendix C, Table C.2.

In conjunction with the water level measurements, ORNL has been periodically observing selected seeps and stream check points (STRMCHK) in the ORNL area (Table 2). Such qualitative information are used in the study of groundwater hydrology, particularly for developing water-table contour maps.

4.2.2 Groundwater Quality

Groundwater quality at ORNL has been studied through both regulatory monitoring programs (routine sampling) and scoping surveys (one-time sampling efforts). The groundwater contaminant scoping surveys listed in Table 2 were conducted by R. H. Ketelle for the Main Plant area (WAG 1) and SWSA 3 (WAG 3); by D. W. McCrackin for the White Oak Creek floodplain (WAG 2); and by L. E. Toran for the Pits and Trenches area (WAG 7), SWSA 6 (WAG 6), and near White Oak Lake (WAG 2). Ketelle and McCrackin analyzed unfiltered water samples taken from the piezometer wells installed by RAP (Appendix C, Table C.1). Locations of these wells are indicated on Fig. 5. Water samples from this one-time sampling effort were analyzed for cations, anions, alkalinity, volatile organics, total organic carbon (TOC), and radionuclides. Field pH, specific conductivity, and temperature were also recorded. Toran also conducted a one-time sampling of the 19 HHMS wells shown in Fig. 8. Toran's samples were filtered and analyzed for alkalinity, cations, anions, TOC, fluorescein (drilling fluid tracer) and radiological contaminants, as well as field pH, specific conductivity, redox, and temperature.

F. G. Taylor also conducted a contaminant scoping survey that included groundwater samples. Because he sampled cores from White Oak Lake as well as seeps from the SWSAs and the Pits and Trenches Area, his study is discussed further in Sect 4.5 (Contaminant Characterization).

Water quality wells installed by the RAP (Table 1, WQCONS; Fig. 7) are monitored by ORNL's EMC Department in accordance with EPA regulation (40 CFR Part 265, Subpart F). The data, which are organized by calendar year, are grouped according to the types of analyses: (1) dissolved metals in

filtered samples; (2) total metals, organics, and anions in unfiltered samples; and (3) pH, specific conductivity, and temperature. The 22 existing wells were monitored quarterly for a period of one year and are currently being monitored semiannually. Water quality wells being installed at the perimeters of the WAGs (Sect. 4.1) will also initially be monitored quarterly for one year.

Wells installed around pond 3513, OHF, and HRE (Table 1, CERCONS; Fig. 9) were monitored for a period of one year, beginning February 1985, in compliance with CERCLA. The samples were analyzed for cations, anions, fecal coliforms, Hg, PCBs, pesticides, phenols, and radiological contaminants. Multiple sample results for dissolved oxygen, pH, temperature, specific conductance, TOC, and total organic halides (TOX) were used to compare wells. Sampling was discontinued in 1986. Because the 1985 monitoring indicated potential contamination by RCRA-listed toxic metals and fecal coliforms, sampling was resumed in 1987. These data have not yet been incorporated into the data base. Corresponding studies to characterize the contents of the pond sediments and water are discussed in Sect. 4.5.

4.3 SURFACE WATER

Surface water hydrology and water quality data sets in the RAP Numeric Data Base are described in Table 3. Surface water quality is also studied as part of ORNL's Biological Monitoring and Abatement Program (BMAP) (Sect 4.6). Additional surface water data exist for selected areas at ORNL (e.g., SWSA 6) and will eventually be incorporated into the RAP Data Base.

4.3.1 Surface Water Hydrology

Data on surface discharge in the Oak Ridge area are collected and managed by staff in ESD, EMC, and the USGS using a variety of methods and data management software. Average daily flow from three EMC stations and six USGS stations (Fig. 13) related to RAP are assembled by DBM into SAS data sets organized by calendar year. The raw EMC data are total flows read once a day, whereas the USGS data are average daily flows calculated

Table 3. SAS data sets of surface water data

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of Variables
IKN.RIFSFLOW.SASDATA	Daily surface discharge data and surface water chemistry data collected by EMC/ORNL and USGS.			
FLOW_LOC	Station description information	--	26	23
FLOW85	Calendar year 1985 flow data.	01JAN85 - 31DEC85	2,314	4
FLOW86	Calendar year 1986 flow data.	01JAN86 - 31DEC86	3,344	4
FLOW87	Calendar year 1987 flow data.	01JAN87 - 31DEC87	5,396	4
SWCHM85	Calendar year 1985 water chemistry data.	01JAN85 - 31DEC85	5,211	9
SWCHM87	Calendar year 1987 water chemistry data.	02JAN87 - 31DEC87	6,646	9

[a]EMC = Environmental Monitoring and Compliance;
ORNL = Oak Ridge National Laboratory; and
USGS = U.S. Geological Survey.

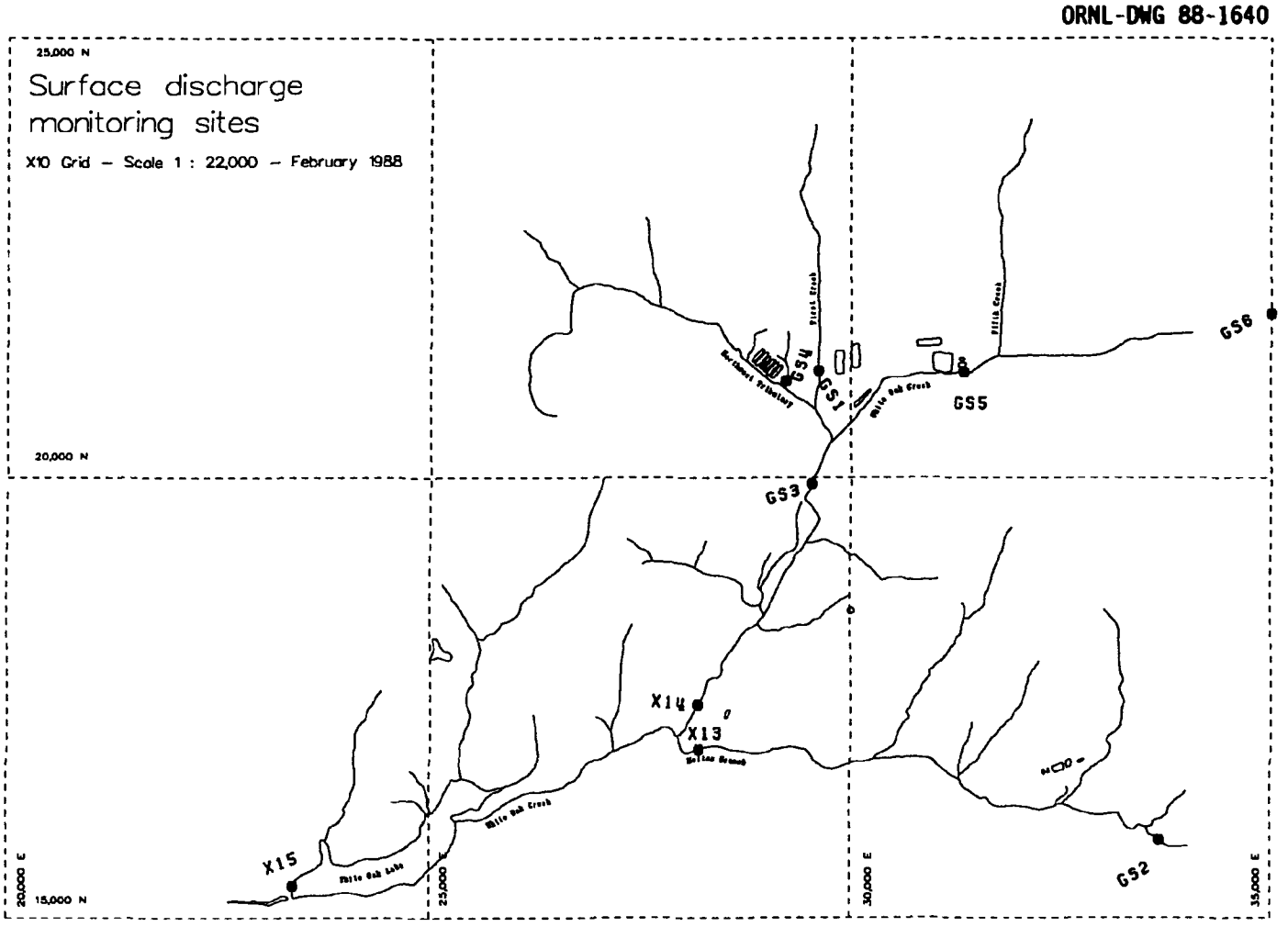

Fig. 13. Locations of surface discharge monitoring sites for which data exist in the Remedial Action Program Numeric Data Base.

from stage height readings made at 15-minute intervals. Data from six additional USGS stations in the vicinity of the ORR are also included in the data base. The period of record for observations in the RAP Data Base by station ID is shown in Table 4. In addition to the flow data, a SAS data set was created to record descriptive information (type of gage, collection frequency) for each monitoring station.

4.3.2 Surface Water Quality

The EMC Department routinely monitors water quality at three surface water sites in White Oak Creek and its tributaries and nine point source discharges, in accordance with the National Pollutant Discharge Elimination System (NPDES) permit issued to ORNL. Summaries of the NPDES data are published quarterly by EMC (e.g., Daniels, et al. 1987). Monitoring sites are shown in Fig. 14. The data set describing the surface water stations (see Sect. 4.3.1) defines the station IDs; the water chemistry data are organized by calendar year in the RAP Data Base.

4.4 PRECIPITATION

Precipitation data in the Oak Ridge area are collected and managed by several investigators using a variety of methods and data management software. Total daily precipitation data from eleven EMC, nine ESD, two USGS, and one ATDD sites (Fig. 15) are assembled into SAS data sets organized by calendar year (Table 5). The period of record for observations for each site in the RAP Data Base is shown in Table 6. In addition to the precipitation data, a SAS data set was created to record descriptive information for each monitoring site. Selected information from this data set is presented in Table 7.

4.5 CONTAMINANT CHARACTERIZATION

Initial site investigations focused on the use of scoping surveys to characterize the environment with respect to the presence of radionuclides and hazardous chemicals. In addition to the groundwater scoping surveys

Table 4. Number of surface discharge values (mean daily flow) in the Remedial Action Program Numeric Data Base

Site ID[a]	Station name[b]	Number of observations by year		
		1985	1986	1987
GS1	FIRST CREEK	-	-	329
GS2	MELTON BRANCH NEAR MELTON HILL (CENTER 7)	275	365	360
GS3	WOC BELOW MELTON VALLEY DR. (7500B)	275	365	360
GS4	NORTHWEST TRIBUTARY	-	-	249
GS5	PARSHALL FLUME: WHITE OAK CREEK	-	31	365
GS6	WHITE OAK CREEK NEAR MELTON HILL[c]	-	-	-
GS7	BEAR CREEK AT STATE HIGHWAY 95	306	365	360
GS8	BEAR CREEK AT PINE RIDGE NEAR WHEAT	-	98	360
GS9	BEAR CREEK NEAR WHEAT	-	98	365
GS10	BEAR CREEK TRIB AT BEAR CREEK RD NEAR WHEAT	-	98	360
GS11	BEAR CREEK TRIB NEAR WHEAT	-	98	360
GS12	BEAR CREEK TRIB AT HWY 95 NEAR WHEAT	-	98	360
X13	MELTON BRANCH ABOVE WHITE OAK CREEK CONFLUENCE	365	280	250
X14	WHITE OAK CREEK ABOVE MELTON BRANCH CONFLUENCE	365	280	250
X15	WHITE OAK CREEK AT WHITE OAK DAM	365	280	250

[a]The U.S. Geological Survey site IDs are as follows:

GS1 = 03536450	GS4 = 03536440	GS7 = 03538270	GS10 = 035382672
GS2 = 03537100	GS5 = 03536380	GS8 = 03538273	GS11 = 035382677
GS3 = 03536550	GS6 = 03536320	GS9 = 035382673	GS12 = 03538272

Sites labeled X13, X14, and X15 are monitored by the Oak Ridge National Laboratory.

[b]These specific station names are used in the data sets.

[c]New station; data will be provided when available.

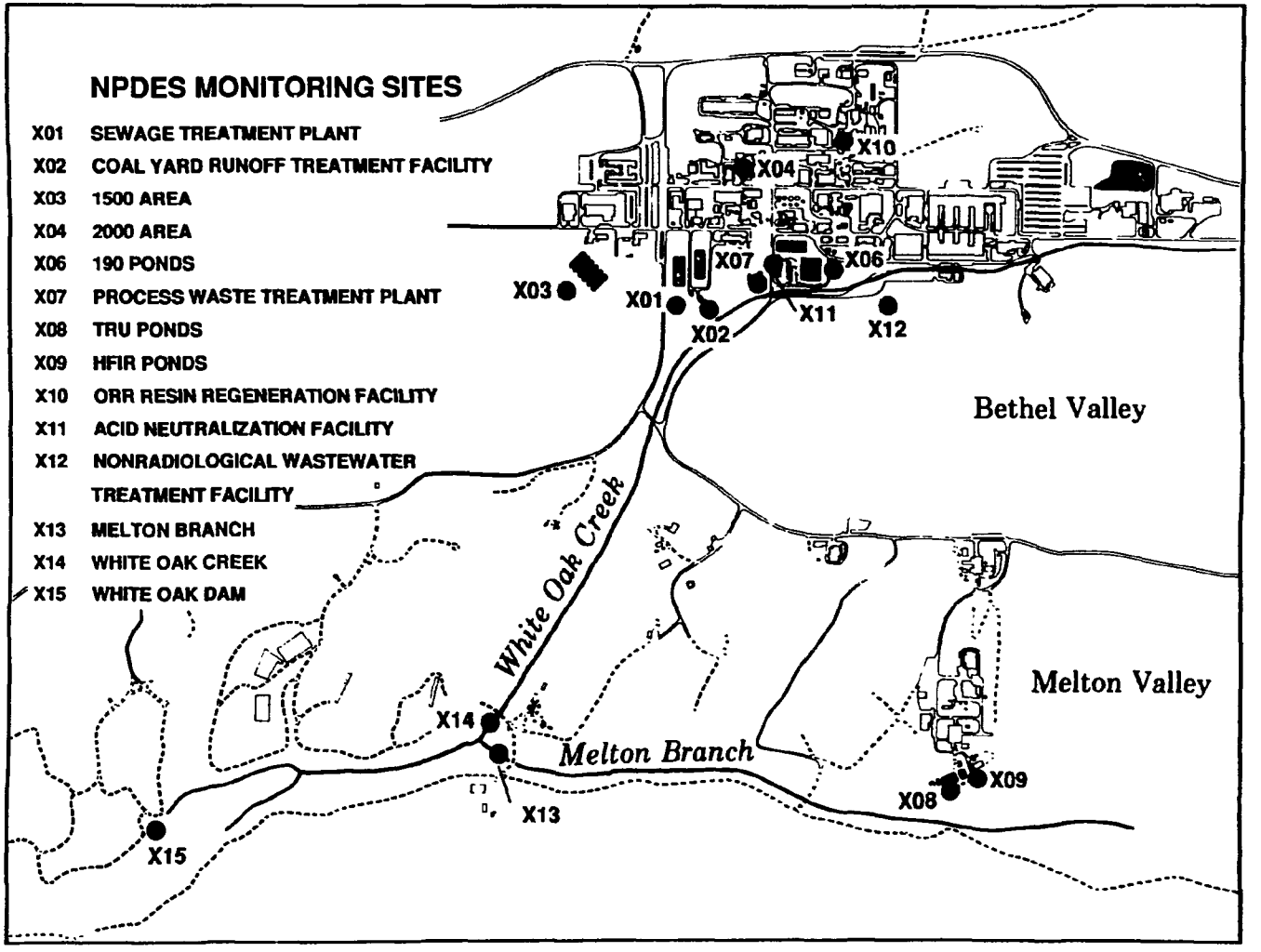

Fig. 14. Locations of monitoring sites for the National Pollutant Discharge Elimination System permit.

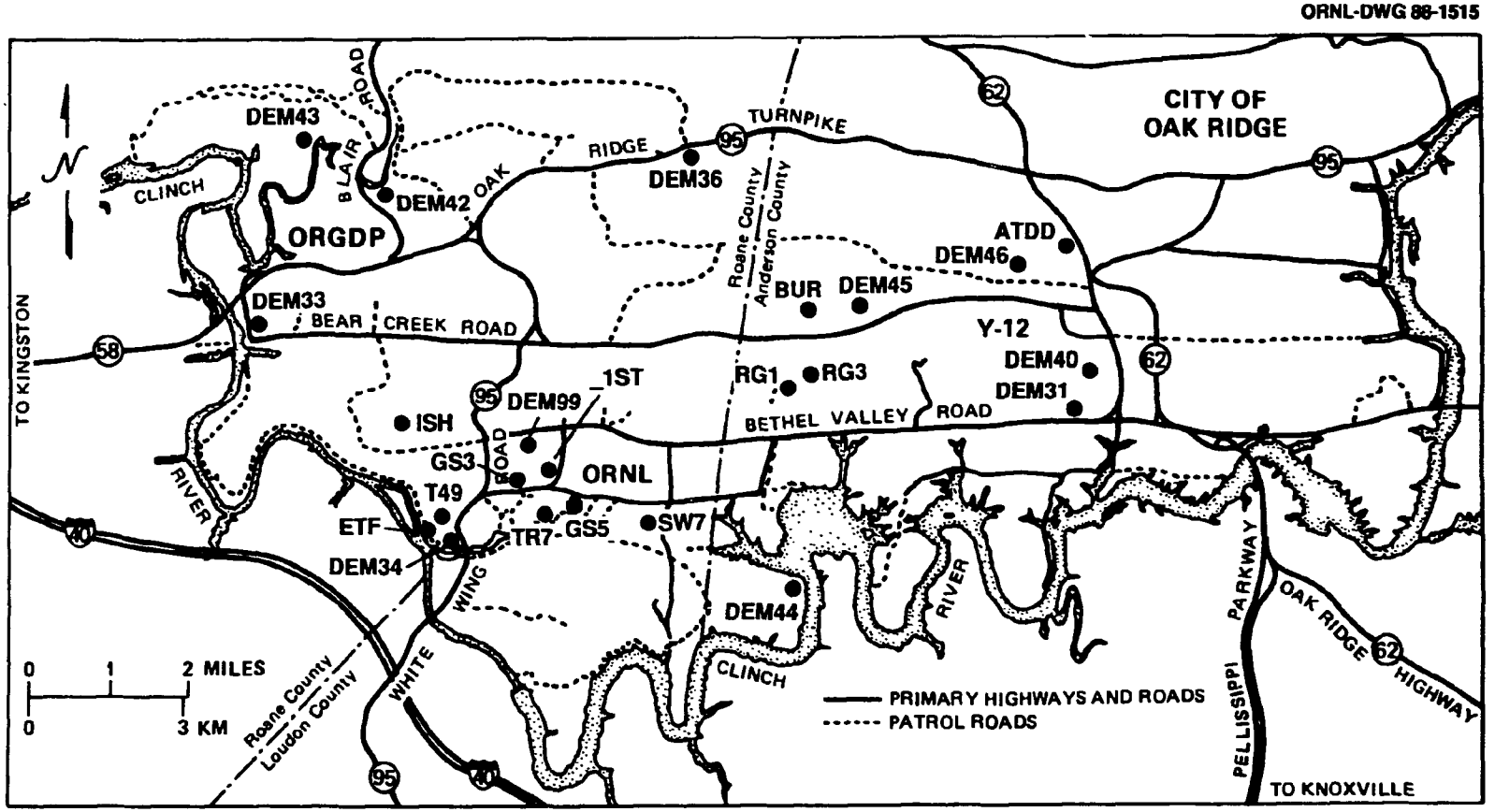

Fig. 15. Locations of precipitation monitoring sites for which data exist in the Remedial Action Program Numeric Data Base.

Table 5. SAS data sets of precipitation data

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
ENVSCI.LDV25255.SAS.PRECIP	Daily precipitation data collected by ESD/ORNL, EMC/ORNL, and USGS.			
PCIP_LOC	Station description information.	--	23	22
CY76	Calendar year 1976 data.	01JAN76 - 31DEC76	732	5
CY77	Calendar year 1977 data.	01JAN77 - 31DEC77	730	5
CY78	Calendar year 1978 data.	01JAN78 - 31DEC78	730	5
CY79	Calendar year 1979 data.	01JAN79 - 31DEC79	730	5
CY80	Calendar year 1980 data.	01JAN80 - 31DEC80	875	5
CY81	Calendar year 1981 data.	01JAN81 - 31DEC81	1,095	5
CY82	Calendar year 1982 data.	01JAN82 - 31DEC82	1,459	5
CY83	Calendar year 1983 data.	01JAN83 - 31DEC83	2,190	5
CY84	Calendar year 1984 data.	01JAN84 - 31DEC84	2,280	5
CY85	Calendar year 1985 data.	01JAN85 - 31DEC85	2,920	5
CY86	Calendar year 1986 data.	01JAN86 - 31DEC86	6,761	5
CY87	Calendar year 1987 data.	01JAN87 - 31DEC87	5,646	5
ORT51_60	Oak Ridge Townsite, 1951-1960 data.	01JAN51 - 31DEC60	3,653	5
ORT61_70	Oak Ridge Townsite, 1961-1970 data.	01JAN61 - 31DEC70	3,652	5
ORT71_75	Oak Ridge Townsite, 1971-1975 data.	01JAN71 - 31DEC75	1,826	5

[a] ESD = Environmental Sciences Division;
ORNL = Oak Ridge National Laboratory;
EMC = Environmental Monitoring and Compliance; and
USGS = U.S. Geological Survey.

Table 6. Precipitation data (daily totals) in the Remedial Action Program Numeric Data Base

Site ID[a]	Site name[b]	Number of observations by year												
		1950 to 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
_1ST	FIRST CREEK	--	--	--	--	--	--	--	--	--	--	--	--	184
ATDD	ATDD/NOAA	9,125	366	365	365	365	366	365	365	365	366	365	365	365
BUR	BEAR CREEK BURIAL GD	--	--	--	--	--	--	--	--	--	--	365	365	365
DEM31	KERR HOLLOW	--	--	--	--	--	--	--	--	--	--	--	297	112
DEM33	GALLAHER (NEAR K-25)	--	--	--	--	--	--	--	--	--	--	--	288	149
DEM34	WHITE OAK DAM	--	--	--	--	--	--	--	--	--	--	--	293	149
DEM36	OAK RIDGE TURNPIKE	--	--	--	--	--	--	--	--	--	--	--	302	112
DEM40	Y-12 (EAST)	--	--	--	--	--	--	--	--	--	--	--	317	138
DEM42	BLAIR ROAD (K-25)	--	--	--	--	--	--	--	--	--	--	--	320	145
DEM43	K-25 PERIMETER	--	--	--	--	--	--	--	--	--	--	--	307	149
DEM44	DOSAR FACILITY	--	--	--	--	--	--	--	--	--	--	--	326	149
DEM45	Y-12 (WEST)	--	--	--	--	--	--	--	--	--	--	--	283	149
DEM46	SCARBORO FACILITY	--	--	--	--	--	--	--	--	--	--	--	75	137
DEM99	MET TOWER C	--	--	--	--	--	--	--	--	--	--	--	--	242
ETF	SWSA 6	--	--	--	--	--	143	365	365	365	365	365	365	365
GS3	USGS/SWSA 3	--	--	--	--	--	--	--	--	--	85	365	365	365
GS5	USGS/SWSA 5	--	366	365	365	365	366	365	365	365	366	365	365	365
ISH	ISH CREEK	--	--	--	--	--	--	--	12	365	366	365	365	365
RG1	WALKER BRANCH GAGE #1	--	--	--	--	--	--	--	176	365	366	365	365	365
RG3	WALKER BRANCH GAGE #3	--	--	--	--	--	--	--	176	365	366	365	365	365
SW7	CENTER 7 CREEK WSHED	--	--	--	--	--	--	--	--	--	--	365	365	365
TR7	TRENCH 7	--	--	--	--	--	--	--	--	--	--	365	365	181
T49	49 TRENCH (SWSA 6)	--	--	--	--	--	--	--	--	--	--	--	303	365

[a]Site IDs were assigned by the Remedial Action Program.
[b]These specific site names are used in the data sets.
ATDD = Atmospheric Turbulence and Diffusion Division;
K-25 = Oak Ridge Gaseous Diffusion Plant;
NOAA = National Oceanic and Atmospheric Administration;
SWSA = Solid Waste Storage Area; and
USGS = U.S. Geological Survey.

Table 7. Station descriptions for precipitation-monitoring sites generated from the SAS data set

Site ID[a]	Site name[b]	Type of gage	Collection frequency	Smallest unit of measure
_1ST	FIRST CREEK	BELFORT WEIGHING	10 MINUTES[c]	.01"
ATDD	NOAA/ATDD OAK RIDGE	BELFORT WEIGH & STICK GA.	HOURLY	.01"
BUR	BEAR CREEK BURIAL GD	BELFORT WEIGHING	10 MINUTES[c]	.01"
DEM31	KERR HOLLOW	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM33	GALLAHER (NEAR K-25)	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM34	WHITE OAK DAM	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM36	OAK RIDGE TURNPIKE	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM40	Y-12 (EAST)	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM42	BLAIR ROAD (K-25)	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM43	K-25 PENMETER	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM44	DOSAR FACILITY	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM45	Y-12 (WEST)	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM46	SCARBORO FACILITY	BELFORT HEATED TIP BUCKET	10 MINUTES	.01"
DEM99	MET TOWER C	MRI TIPPING BUCKET	HOURLY	.01"
ETF	SWSA 6	BELFORT WEIGHING	10 MINUTES[c]	.01"
GS3	USGS/SWSA 3	BELFORT WEIGHING	DAILY	.01"
GS5	USGS/SWSA 5	ELECT. TIPPING BUCKET	DAILY	.01"
ISH	ISH CREEK	BELFORT WEIGHING	10 MINUTES[c]	.01"
RG1	WALKER BRANCH GAGE #1	BELFORT WEIGHING	10 MINUTES[c]	.01"
RG3	WALKER BRANCH GAGE #3	BELFORT WEIGHING	10 MINUTES[c]	.01"
SW7	CENTER 7 CREEK WSHED	BELFORT WEIGHING	10 MINUTES[c]	.01"
TR7	TRENCH 7	BELFORT WEIGHING	10 MINUTES[c]	.01"
T49	49 TRENCH (SWSA 6)	BELFORT WEIGHING	10 MINUTES[c]	.01"

[a]Site IDs were assigned by the Remedial Action Program.
[b]These specific site names are used in the data sets.
ATDD = Atmospheric Turbulence and Diffusion Division;
K-25 = Oak Ridge Gaseous Diffusion Plant;
NOAA = National Oceanic and Atmospheric Administration;
SWSA = Solid Waste Storage Area; and
USGS = U.S. Geological Survey.
[c]Data are stored in breakpoint format; level of resolution is 10 minutes.

discussed in Sect. 4.2.2, several other studies have been or are being conducted to characterize contaminants in the ORNL area (Table 8).

Drill cuttings taken during the installation of the first set of water quality wells were analyzed for pesticides, organics, and radiological contaminants. Because we have not yet received the well construction data and the corresponding field data file for the drill cutting samples from the WAG perimeter water quality wells, results of these analyses are not indicated in Table 8 even though we do have results on more than 60 samples. Drill cuttings taken during installation of wells around impoundments 3513, OHF, and HRE were analyzed for radioactivity only.

One of the first field studies in the program to characterize the environment over a broad area of the ORNL complex was conducted by F. G. Taylor in 1985. A total of 31 PRAP wells (Fig. 4), 4 seeps, and 3 cores from White Oak Lake were analyzed for metals, organic compounds, and radionuclides. Results from this preliminary contaminant scoping survey were used to characterize the environmental contamination and to assess ORNL's remedial action needs and priorities.

In 1985, T. E. Cerling also conducted a contaminant scoping survey which focused on streambed materials and water in White Oak Creek and tributaries. The objectives of his study were to provide a basis for ranking areas in need of corrective action and to identify sites where further studies are needed to characterize contaminant migration in the White Oak Creek watershed (Fig. 16). The samples were analyzed for metals, anions, pesticides, organics, and radionuclides. Cerling continued to sample additional streambed sediments and a few selected PRAP wells (Fig. 4) in 1986 and in the spring of 1987 to evaluate whether there are continuing releases of contaminants within WAGs at ORNL. The primary purpose of the WAG scoping survey was to provide information requested in the ORNL Hazardous Waste Facility's draft permit under provisions of Section 3004(u) of RCRA. The results of Cerling's studies supported (1) recommendations to regulatory agencies about WAGs that require cleanup under RCRA and (2) a ranking of the WAGs based on the magnitude of potential releases.

Table 8. SAS data sets on contaminant characterization studies

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
ENVSCI.LDV25255.SAS.HUFFV	Characterization of soil (drill cuttings) at water quality wells installed by RAP.			
ACD1	Pesticide, semi-volatile organic, and radiological analyses.	16JUL85 - 22AUG85	3,471	18
FIELD1	Date sampled, well ID, sample ID, and core sample depth.	16JUL85 - 22AUG85	39	9
ENVSCI.LDV25255.SAS.STANSV	Characterization of soil (drill cuttings) at wells installed around impoundments 3513, OHF, and HRE.			
SOIL	Well drilling cuttings analyzed for radiological activity.	07JAN85 - 13MAR85	26	20
ENVSCI.LDV25255.SAS.TAYLORV	Contaminant scoping survey of wells and seeps in the Solid Waste Storage Areas, the Pits and Trenches, and in sediment cores from White Oak Lake.			
ACD1	Cations, organics, mercury, and radiological analyses results.	09JUL85 - 07NOV85	10,141	19
FIELD1	Field data including sampling date and location, sample type, sample ID, sample depth, etc.	09JUL85 - 07NOV85	120	13
ENVSCI.LDV25255.SAS.CERLINGV	Contaminant scoping surveys of streambed materials and water.			
ACD	Cations, anions, mercury, pesticides, organics, and radiological analyses results; a few alkalinity, Polychorinated biphenyls, and pH results.	19JUL85 - 14MAY87	17,617	22

Table 8. continued

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
FIELD	Field data including sampling date and location, sample type, sample ID, etc.	19JUL85 - 14MAY87	768	16
ENVSCI.LDV25255.SAS.STANSV	Characterization of pond water and sediments at impoundments 3513, OHF, and HRE.			
POND_W	Pond water, analyzed for dissolved oxygen, pH, specific conductance, temperature, total organic carbon, total organic halides, cations, anions, fecal coliforms, mercury, polychorinated biphenyls, pesticides, phenols, and radiological activity.	26JAN85 - 27JUN85	142	21
SEDI	Pond sediments analyzed for cations, mercury, polychorinated biphenyls, pesticides, and radiological activity.	14NOV84 - 15NOV85	823	21
ENVSCI.LDV25255.SAS.TANKS	Characterization of inactive waste storage tanks and their contents.			
TANKINFO	Description of inactive waste storage tanks.	--	33	25

[a]RAP = Remedial Action Program;
OHF = Old Hydrofracture Facility; and
HRE = Homogeneous Reactor Experiment.

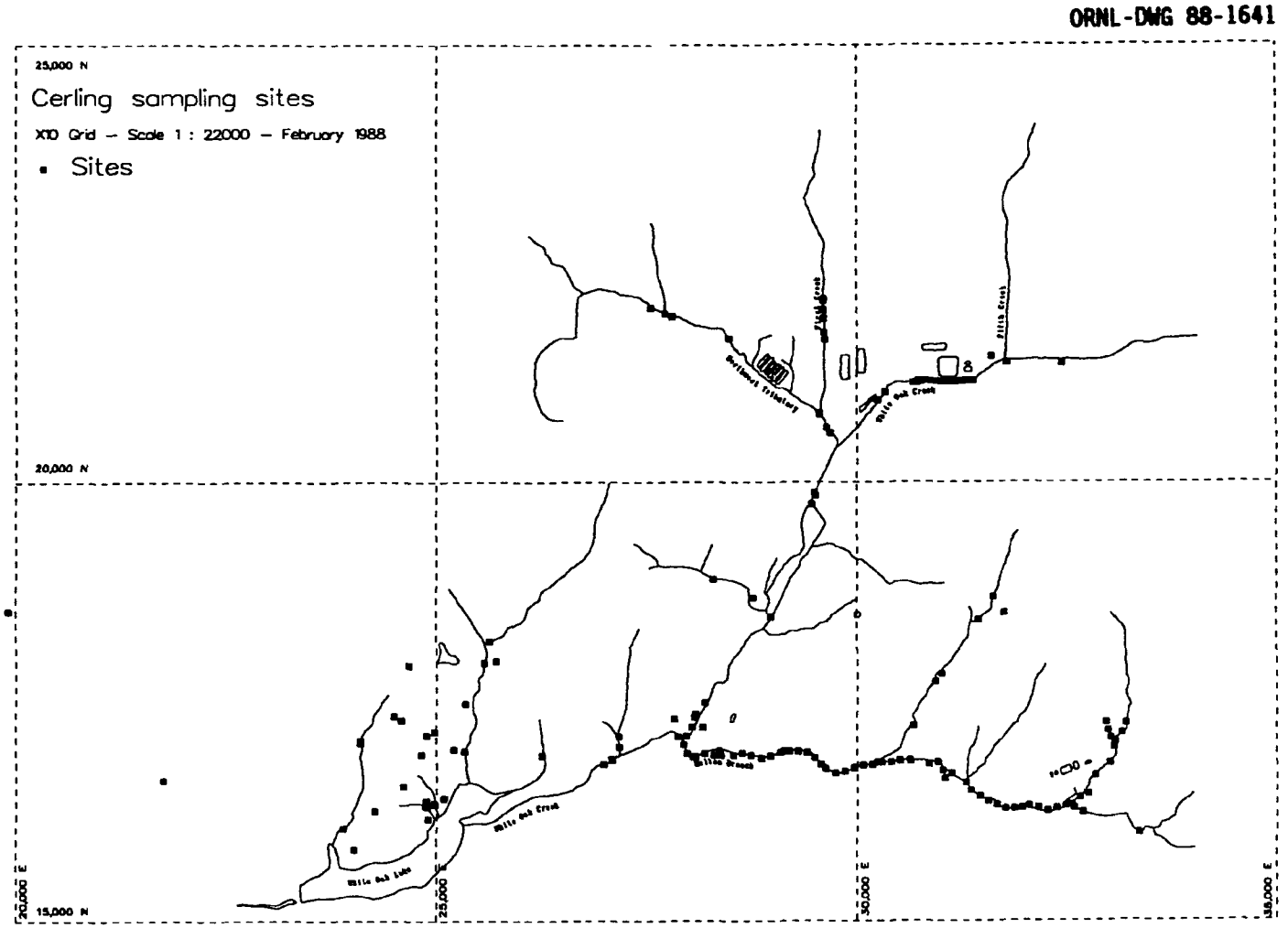

Fig. 16. Sampling locations for Cerling's contaminant scoping study to detect continuing releases of contaminants.

Characteristics of pond water and sediments at impoundments 3513, OHF,and HRE were studied by R. G. Stansfield and C. W. Francis in 1985. Sediment samples were analyzed for cations, Hg, PCBs, pesticides, and radiological activity; water samples were analyzed for these same parameters plus dissolved oxygen, pH, specific conductance, temperature, TOC, TOX, and fecal coliforms. Data on groundwater quality surrounding the ponds is contained in data sets identified in Sect. 4.2.2.

The inactive waste storage tanks at ORNL will be sampled in 1988. A data set of general information about these tanks (e.g., tank location, age, size, configuration) has been created. Field sampling data and results of the analyses will be stored in two additional data sets.

4.6 BIOLOGICAL MONITORING

As a condition of the NPDES permit issued to ORNL on April 1, 1986, a Biological Monitoring and Abatement Program (BMAP) was developed for White Oak Creek (WOC), selected tributaries, and the Clinch River. The BMAP consists of the following seven major tasks: (1) toxicity monitoring; (2) bioaccumulation monitoring of nonradiological contaminants in aquatic biota; (3) biological indicator studies; (4) instream ecological monitoring; (5) assessment of contaminants in the terrestrial environment; (6) radioecology of WOC and White Oak Lake; and (7) contaminant transport, distribution, and fate in the WOC embayment-Clinch River-Watts Bar Reservoir system. The objectives and results for the first nine months of these studies are presented in Loar et al. (1987). SAS data sets that have been incorporated into the RAP Data Base on these subjects are listed in Table 9. Many of the sampling sites are used for more than one study (Fig. 17). Thus, having these data in a common data base and format will allow information from one study to be easily related to another, and with all data in the RAP Numeric Data Base.

Table 9. SAS data sets on the Biological Monitoring and Abatement Program studies

SAS library/ SAS data set	Description of library/data set	Time Period	Number of observations	Number of variables
ENVSCI.LDV25255.SAS.LOAR	Data from the Biological Monitoring and Abatement Program.			
WCBEN1A	WOC benthic invertebrate data from monthly samples.	05MAY86 - 05OCT86	2,310	13
WCFLD1A	WOC benthic invertebrate data from monthly samples, including substrate conditions, water temperature, and stream stage.	05MAY86 - 05OCT86	288	20
WC85CHM	WOC fish population study: water conditions.	22MAY85 - 29SEP86	54	19
WC85SHK	WOC fish population study: collection specifics.	22MAY85 - 22SEP86	123	20
WC85FSH	WOC fish population data: fish collected.	22MAY85 - 29SEP86	8,990	16
WOCCHEM	WOC toxicity bioassay results: water chemistry.	20MAR86 - 25MAR87	1,260	15
WOCCCD	WOC toxicity bioassay results: Ceriodaphnia survival and reproduction.	21MAR86 - 25MAR87	192	19
WOCFHM	WOC toxicity bioassay results: fathead minnow survival and growth.	27MAR86 - 26MAR87	766	12
WOCB_IND	WOC fish: physiological stress indicators.	19NOV86 - 06MAY87	98	40

[a]WOC = White Oak Creek.

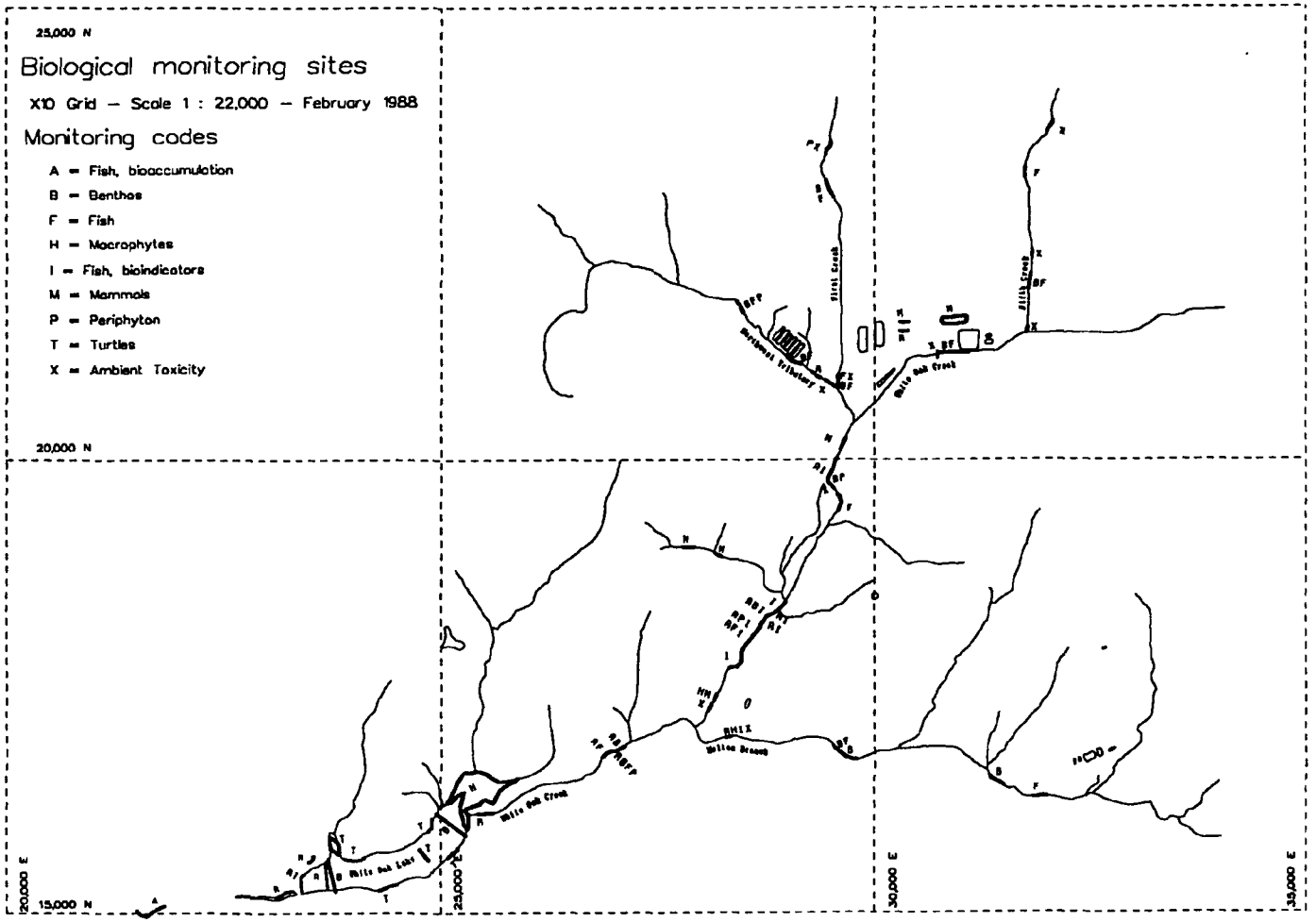

Fig. 17. Sampling sites for the Biological Monitoring and Abatement Program studies.

4.7 TECHNOLOGY DEMONSTRATIONS

Data from technology demonstration studies have only recently been added to the data base (Table 10). These include the Shallow Land Burial (SLB) Closure demonstration and the In Situ Vitrification (ISV) study. In situ vitrification is a potential technique for immobilization and closure of various ORNL contaminated sites. A 25-ton mass of vitrified material was produced in the field within a scale model of an old seepage trench to which stable strontium and cesium had been added as surrogates for ^{90}Sr and ^{137}Cs. Data were collected to analyze the performance of the test, and samples were taken to determine the leaching characteristics of the waste form produced in the field.

The purpose of the SLB Closure study is to demonstrate and evaluate stabilization and closure techniques at a low-level solid waste disposal site at ORNL. The techniques include dynamic compaction, in situ grouting, and covering for a group of waste disposal trenches at TARA in SWSA 6. We only recently started to incorporate data from this study into the data base. Current data include construction information on wells installed in the area under investigation and on associated water levels and water quality.

4.8 MISCELLANEOUS STUDIES/DATA SETS

Data sets which do not conveniently fit into any of the categories established for the RAP Data Base are listed in Table 11. These include regulatory standards, general information about the WAGs and Solid Waste Management Units (SWMUs), results from a QA/QC study of ACD laboratory analyses, and results of a study by Cerling to compare three extraction procedures.

4.9 FORMAT FILES

Although almost anything can be computerized in some kind of format, often it is not practical to maintain lengthy character fields in a data

Table 10. SAS data sets on technology demonstration studies

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
ENVSCI.IJL25255.SAS.SLB	Data associated with the SLB Closure demonstration.			
WATEREL	Water elevations for the SLB site wells.	21MAY87 - 14JAN88	757	8
WELLWQ	Results of cation and anion analyses of water from SLB site wells.	18NOV87 - 23NOV87	555	30
TARACONS	Construction data on wells used for the SLB demonstration.	01JAN77 - 15APR87	15	32
ENVSCI.LDV25255.SAS.ISV	Data associated with the ISV demonstration.			
OFFGAS	pH, dissolved and total solids, total and soluble alpha and beta measured at various sample points in the offgas scrubbing system.	25JUN87 - 05AUG87	108	14
ACD_GAS	Chemical analysis of offgas scrubbing solutions and filters.	25JUN87 - 05AUG87	3,735	30
ACD_RCK	Elemental composition of the "wastes" before and after vitrification.	--	1,470	30
ORNLOFFG	Temperatures, flow rates, CO and CO_2 concentrations at various points in the offgas scrubbing system measured over time during the ISV field demonstration.	14JUL87 - 19JUL87	248	15
SOIL	Temperature measured at thermocouples at center of the ISV site.	14JUL87 - 19JUL87	5,280	8

Table 10. continued

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
TEMP10	Temperature measured at thermocouples placed 10 feet from center of the ISV test site.	14JUL87 - 28AUG87	10,738	8
TEMP7	Temperature measured at thermocouples placed 7 feet from center of the ISV test site.	19JUL87 - 28AUG87	738	8
POWER	Electric power consumed during the demonstration.	14JUL87 - 19JUL87	76	9

[a]SLB = Shallow Land Burial; and
ISV = In situ vitrification.

Table 11. SAS data sets on related miscellaneous studies

SAS library/ SAS data set	Description of library/data set[a]	Time Period	Number of observations	Number of variables
ENVSCI.MJG25255.SAS.RAPDBM				
WAG_INFO	Descriptive information about the Waste Area Groupings and Solid Waste Management Units.	--	253	9
IKN.RIFSRCRA.SASDATA				
STAND	EPA Interim Primary Drinking Water Standards for analyses of water from RCRA wells. Parameters without standards are flagged.	--	31	4
ENVSCI.MJG25255.SAS.LARSEN	Chemical analysis results from QA/QC study conducted on ACD lab results.			
RAD	Radiological results from samples including milk, liquid food, soil and water.	26FEB86 - 20JAN87	135	21
ORGANIC	Halocarbons in water results.	28AUG86 - 11DEC86	70	22
TR_ELEM	Trace elements found in various substances (e.g. citrus leaves, water, coal fly ash, river & estuarine sediments).	12MAY86 - 03FEB87	487	20
ENVSCI.LDV25255.SAS.CERLINGV	Comparison of three extraction procedures for streambed materials.			
EXTRACT	Cations analyzed for comparison of extraction procedures.	--	1,970	22
FIELD	Field data including sampling date and location, sample type, sample ID, etc.	--	768	16

[a]EPA - U.S. Environmental Protection Agency;
RCRA - Resource Conservation and Recovery Act;
QA/QC - Quality Assurance/Quality Control; and
ACD - Analytical Chemistry Division.

set that will be printed routinely. In such cases, codes are assigned to represent a data entry. For example, "04A" is the standard NPDES code for 4,6-Dinitro-2-methylphenol. SAS format files have been added to the data base so that chemical names can be displayed in several ways: with ACD's abbreviation, the full name of the element or compound, the NPDES code, the Priority Pollutant code, or the Chemical Abstract Service number. Also, format files have been written to refer to the geologic unit of a core segment and to the pipe and screen materials used in the construction of the piezometer and water quality monitoring wells. These files are listed in Table 12.

4.10 GEOGRAPHIC INFORMATION SYSTEM DATA

Because several grid coordinate systems are used for the ORNL vicinity, a major concern in dealing with geographic data for RAP is that those who provide and/or receive such data know (1) which grid is used and (2) how to convert from one grid system to another. This topic is addressed in Sect. 4.10.1 followed by a discussion of the GIS data files developed for RAP (Sect. 4.10.2)

4.10.1 Grid Coordinate Systems

Several map coordinate systems may be applied to ORR including the ORNL (X-10) Grid, the Y-12 Grid, the Oak Ridge Gaseous Diffusion Plant (K-25) Grid, the Administrative Grid (AGS), Tennessee Lambert State Plane, and latitude/longitude (lat/long) coordinates. Conversion from one system to another is not a simple matter; the accuracy of the conversion depends in part on the number and accuracy of control points used in developing the transformation equations. We identified three different sets of transformation equations that have been used at ORNL: those developed by (1) USGS (Webster et al. 1980), (2) Tennessee Valley Authority (Chappell 1985, TVA 1985, TVA 1986), and (3) ORNL/C&TD Geographic Data Systems Group (E. P. Tinnel, personal communication). The three sets do not have the capability to do the same conversions (eg., conversion from the X-10 Grid to lat/long). However, in cases where similar types of conversions could

Table 12. Format files for defining data entries for selected variables

Data set	Member name	Description of file[a]
ENVSCI.LDV25255.SASFMTS	(PPFMT)	File for converting from NPDES to PP codes; can be used with ACD SAS data sets
	(CASFMT)	File for converting from NPDES to CAS codes; can be used with ACD SAS data sets
	(NAMEFMT)	File for converting from abbreviations to full chemical names; can be used with ACD SAS data sets
	(DETECT)	File defining detection limits for organic compounds; can be used with ACD SAS data sets
	(GFMT)	File for printing geounit when used with the WQCONS and PIEZCONS SAS data sets
	(SFMT)	File for printing pipe material and screen material when used with the WQCONS and PIEZCONS SAS data sets

[a]NPDES - National Pollution Discharge Elimination System;
PP - Priority Pollutants;
ACD - Analytical Chemistry Division;
CAS - Chemical Abstracts Service;
WQCONS - Construction data for water quality wells; and
PIEZCONS - Construction data for piezometer wells.

be made, preliminary calculations showed that the results of the conversions were quite different.

DBM staff and members of C&TD worked together in testing the accuracy of the three transformation systems for the area under investigation by RAP. Six clearly defined reference points (e.g., USGS monuments, Tennessee Lambert State Plane tic marks) were located on an X-10 Grid map; the points were purposely selected to range over the ORNL part of ORR because transformation errors increase when the equations are applied to areas away from the points used initially to develop the transformation. These coordinates on the X-10 grid were converted into lat/long coordinates using equations developed by (1) USGS, (2) TVA, and (3) ORNL. The lat/long coordinates were plotted on an overlay for the USGS Bethel Valley quadrangle map and visually checked for accuracy with respect to the defined reference points. The USGS lat/long coordinates were consistently east of the reference points. The lat/long coordinates from the ORNL and TVA conversions appeared to be in much better agreement with the reference points; overall, those from the TVA conversions appeared to be the most accurate.

For the following reasons, RAP adopted the TVA equations (Chappell 1985, TVA 1986) for converting coordinate systems applied to the ORNL region of ORR: (1) the equations developed by TVA appear the most accurate in conversions from the X-10 Grid to lat/long coordinates; (2) TVA equations are part of re-survey work for the recently updated S-16A map which covers several square miles around ORNL, (3) the equations are documented; and (4) they include all of the possible conversions to be applied to ORR, with the exception of conversion from Tennessee Lambert State Plane to lat/long coordinates. This conversion, however, is well known and is available through the GIS at ESD or C&TD.

All location data in the RAP Data Base are entered and retained in the original form. For example, if a location is surveyed in the X-10 Grid or if a sampling point is read off a map drawn in the Y-12 Grid, then those data are retained in the data set as X-10 and Y-12 grid coordinates, respectively. The conversion of location data from one grid system to

another or from two grid systems into a third (such as lat/long coordinates) is done at the time it is needed.

4.10.2 GIS Data Sets

Although the library of GIS data sets developed for RAP is still fairly small, preparations are being made to incorporate base map data from both BNI and TVA. GIS data sets developed for RAP include:

- WAG boundaries,
- streams and water bodies in WOC watershed, and
- buildings and roads in the main plant area of ORNL (WAG 1).

Several other geographic data files have been developed from the SAS data sets; these include locations of SWMUs, observation wells, precipitation and surface discharge monitoring stations, and field sampling sites.

BNI is in the process of digitizing topography, roads, buildings, utilities, streams, and water bodies for the area under investigation by RAP. When completed, copies of these data sets will be transferred to the RAP Data Base. Also, preparations are being made to receive copies of TVA's recently revised S-16A map.

4.11 SYNOPSIS OF THE DATA AND INFORMATION MANAGEMENT SYSTEM

For those individuals who wish to see more details about the data sets, we have prepared a synopsis of the RAP DIMS on IBM PC diskettes that is available by contacting:

Larry D. Voorhees
Building 1505, MS-036
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6036
(615/574-7309; FTS/624-7309)
ORNL e-mail: LDV

4.11.1 System Description and Requirements

The synopsis was written using dBASE III Plus and compiled using the Clipper program developed by Nantucket Software. The dBASE software does not need to be installed on the PC used to execute the synopsis, nor does

the user need to know how to operate dBASE. An IBM or IBM-compatible PC is required to operate the program. The PC must have a hard disk drive with 500 KB (Kilobytes) of available storage. The following procedures describe how to install the programs and files onto the hard disk:

1. Insert RAP DATA INSTALLATION DISK # 1 into Drive A;
2. At the A: prompt, type **INSTALL**, press the Enter key, and follow the instructions on the screen
   (this creates needed subdirectories on the hard disk and copies files to these subdirectories; you will be instructed when to insert RAP DATA INSTALLATION DISK # 2);
3. A message will appear, indicating that the installation procedure is complete.

To execute the RAP Synopsis do the following:

1. At the C: prompt, type **CD\RAPDB**, which changes the directory to the RAPDB subdirectory;
2. Type **RAP**;
3. When the "Welcome" screen appears (Fig. 18), follow the instructions on the screen.

4.11.2 Synopsis Contents

A hierarchical structure was used to organize the synopsis, branching from introductory overviews to descriptions of the structure of specific data sets and partial listings of their contents. A series of menus allows the user to select a subsequent menu or return to the previous menu, ultimately returning to DOS, as illustrated in Fig. 19. After the introductory "Welcome" screen (Fig. 18) appears, the user can select the Bibliographic Data Base, the Records Control Data Base, or the Numeric Data Base from the Main Menu (Fig. 19, inset A). Objectives are presented for the Bibliographic and Record Control data bases, as well as listings of data field definitions and sample records (Fig. 19, insets B and C).

Like this document, the synopsis focuses on the Numeric Data Base. Figure 19 (insets D-H) also illustrates the menu selections for one branch of the synopsis, i.e., construction information for the piezometer wells installed by RAP. This illustration culminates with screens showing the

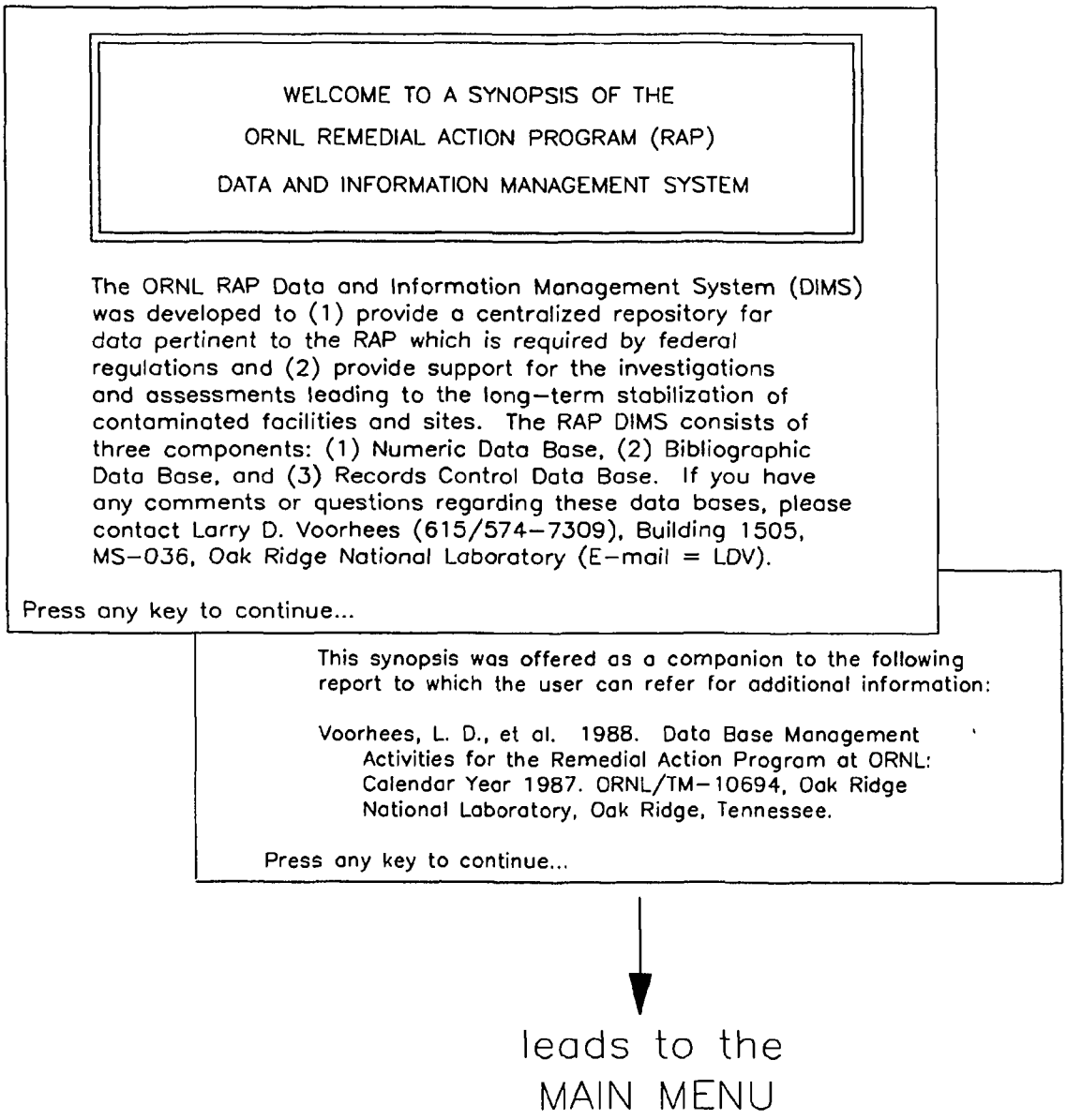

Fig. 18. First screen of the synopsis for the Data and Information Management System.

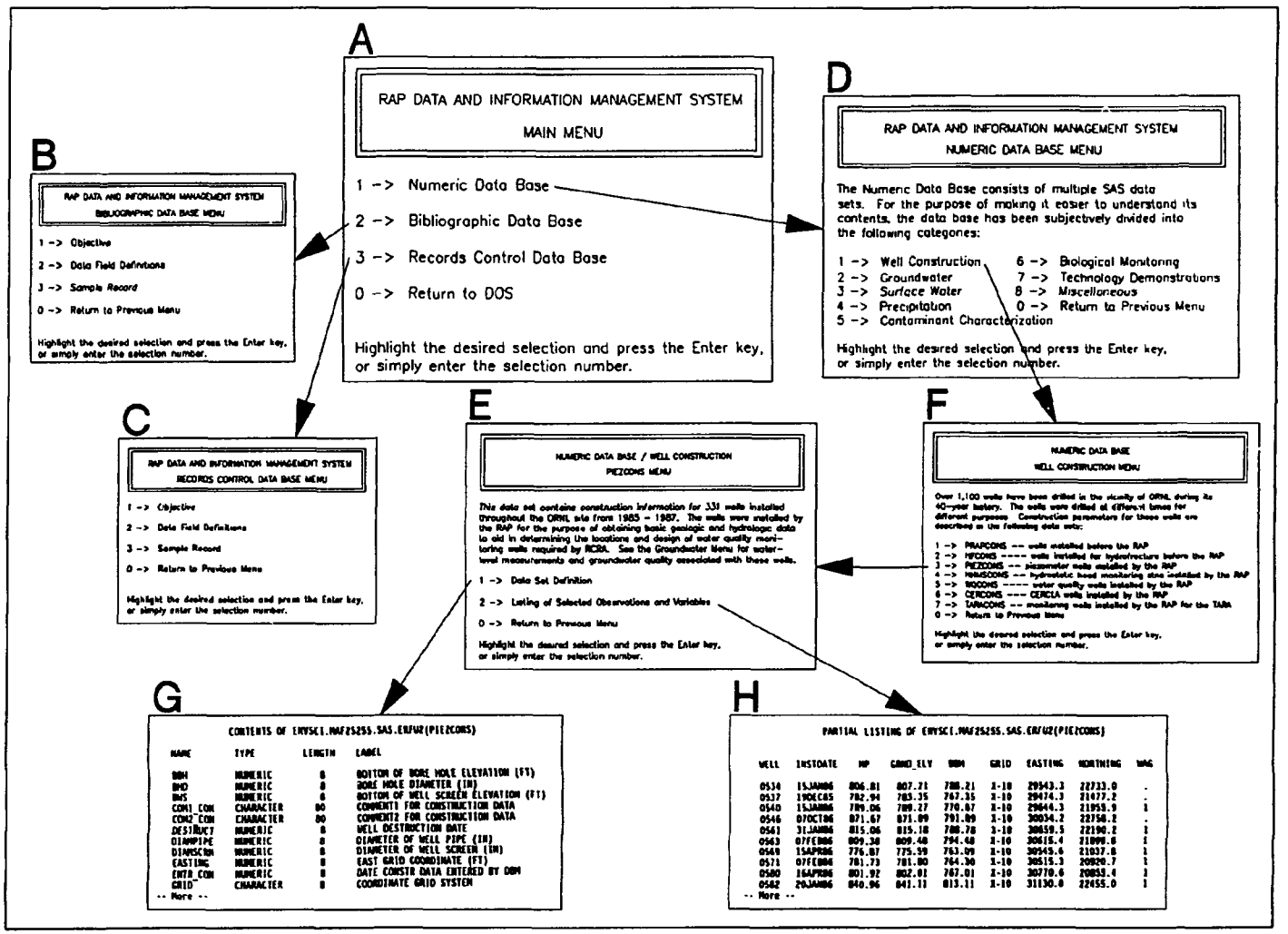

Fig. 19. The synopsis for the Data and Information Management System consists of a series of menus allowing the user to select one of several options.

contents of a data set (i.e., variable names, types, lengths, and labels) and a partial listing of the data set using selected variables. This synopsis has over 60 branches, most of which terminate as illustrated, except when initial data acquisition is still in progress.

As the RAP Numeric Data Base increases in size and complexity, this synopsis should prove very beneficial, not only to the occasional user of RAP data, but also to the RAP data management staff.

5. QUALITY ASSURANCE AND DATA SECURITY

Ensuring QA for a project subject to state and federal regulations is extremely important. RAP involves a wide variety of remedial action sites and is being implemented by numerous personnel from several ORNL divisions as well as by subcontractors. While the task leaders in the program are responsible for developing their own QA procedures, the responsibility for QA ultimately resides with each person in the program. For example, the PIs are responsible for developing procedures for sampling, instrument calibrations, etc. Several measures have been instituted by DBM staff to ensure that the data generated by the various activities have been accurately recorded in the data base and are protected from accidental or unauthorized access.

5.1 QUALITY ASSURANCE/QUALITY CONTROL

At the heart of QA/QC for data base management is the establishment of complete documentation of the data base, including descriptions of the data sets, data base organization, and support programs. Such documentation is developed during the establishment of the data handling procedures, in the data sets themselves, and in reports such as this.

In the strictest sense, QA refers to the accuracy of the data with respect to predefined limits set for environmental sampling. For example, pH for a particular study might be expected to fall within a range of 3.0 to 10.0; computer range checks can be defined to check for impossible values. QC refers to the requirement that predefined procedures be followed during collection, recording, and analysis of the data. Adhering to well defined QA/QC procedures is integral to all stages of data handling. Because it is impossible to discuss data processing without mentioning QA/QC procedures, many of the measures taken by DBM staff to ensure the accuracy of the data have already been discussed in previous sections of this report.

Data pass through three stages of classification on their way to becoming part of the RAP Numeric Data Base: (1) raw data, (2) unverified

SAS data sets, and (3) verified SAS data sets (Sect. 3.3; Fig. 2). A formal logging procedure has been established for all incoming data. Once the data have been written as SAS data sets, either by electronic file transfer or double data entry, they are verified using a variety of techniques. These include visual checks for completeness of the data and system checks using programming statements and plotting procedures offered by the SAS system. For example, scattergrams of the data can be plotted to identify possible outliers for further scrutiny, or range tests can be used to detect impossible or unrealistic values. Frequency procedures are used to tabulate the existence of all current values of a variable. Use of the GIS (Sect. 2.2) is especially effective for verifying spatially oriented data. When appropriate, data quality checks are established in cooperation with the staff producing the data. Staff responsible for the data are also asked to inspect the contents of the SAS data sets for unreasonable entries before such data become part of the verified data base. Examples of the records for this data verification step are provided in Figs. 20 and 21.

Although a high degree of accuracy can be obtained by using well established QA techniques, another test of data quality occurs during continued use of the data. It is at this time when one may observe questionable data that may not be detected during the verification process. When such data are identified, DBM staff are notified so that the data in the verified data set can be corrected or flagged appropriately. Documentation of these changes which includes recording the variable name, old value, new value, reason for change, and who approved the change is permanently retained.

5.2 DATA SECURITY

The RAP Numeric Data Base is designed to protect the integrity of the stored data. The SAS data sets are stored on mass storage volumes on the IBM-3033 systems. The volumes are backed up weekly on magnetic tape. Access to the files is controlled under the AFC2 security system installed on the ORNL computer system. Only DBM staff are allowed to make changes in the SAS data sets, and a permanent record is kept of all such changes.

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

January 30, 1987

F. G. Taylor

Verification of Data in the Remedial Action Program Data Base

All site characterization data resulting from studies which pertain to ORNL's Remedial Action (RA) Program are to be maintained in a central computerized repository. As you are aware, data from your investigations currently reside in this repository. Because this information, which becomes part of the official record for meeting state and federal regulations, may be used by RA Program staff over the next several years to assist in meeting programmatic objectives, it is imperative that these data sets be as accurate as possible.

We are implementing this verification process as the data sets are being built, and not necessarily waiting until a particular data set is complete. Please review the attached printout(s) of your data to ensure that the information is recorded correctly.

* If you find any errors, make appropriate notations directly on the printout(s) and return them to Les Hook (Bldg. 1505, MS-038) for correction.

* If you find the information to be correct, please sign and date the attached form(s), which indicates that the data have been reviewed for accuracy, and send to me.

The RA Program Data Base currently resides on the IBM 3033s. You have been given read privileges for the results from your investigations. If you desire further inspection of these data, please access the SAS library as indicated on the attached form(s).

We recognize that when working with the data in subsequent analyses, errors may be noted; such errors should be brought to our attention as soon as possible so that appropriate corrections can be made to the data set.

Please respond to this request by February 13, 1987. If you have any questions please contact either myself or Les Hook (4-7977). Thank you.

L. D. Voorhees, 1505, MS-036, ORNL (4-7309)

Attachments

Fig. 20. Request to have data verified by the principal investigator.

VERIFICATION OF ORNL

REMEDIAL ACTION PROGRAM DATA

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The following data have been reviewed for accuracy and can be listed as part of the ORNL Remedial Action Program's Verified Data Base:

LIBRARY NAME ENVSCI.LDV25255.SAS.TAYLORV

DATA SET NAME ACD1

DATA ENTERED AS OF December 2, 1986

Reviewed and approved by F. H. Taylor

Date 4"/84

++

RETURN TO: L. D. Voorhees
Bldg. 1505, Rm 286
MS-036
(4-7309)

Fig. 21. Form used to signify the completion of data verification.

Other program staff may read or copy data sets, provided they have the proper password, but they are not able to alter the data. Before the data have been incorporated into the verified data base, only the responsible PI and the DBM staff have access to the data; after the data have been incorporated into the verified data base, the RAP Manager directing the study may also have read-only access to the data. All other requests must first be approved by the phase manager responsible for the data. This protection scheme allows staff to perform their own data manipulations or analyses on duplicated files without jeopardizing the integrity of the original data sets, and it reduces the likelihood of uninformed or improper interpretation of the data.

6. OTHER INFORMATION-RELATED RESOURCES

6.1 AERIAL PHOTOGRAPHS

Aerial photography has been used extensively in analyses of local and regional land-use changes. Studies of aerial photographs taken over a period of time can reveal not only how the land was used in the past but also how the many interrelated characteristics of the environment (including land cover, aquatic habitats, soils, geology, and hydrology) may have been affected by land-use practices. For this reason, a collection of aerial photographs of ORR has been amassed to support the RAP studies. Photographic information should be useful to RAP investigators studying contamination at historical waste disposal sites and in determining alternative approaches for corrective action. In addition, anyone requiring knowledge of historical land-use practices on the ORR should find this resource useful.

A total of 391 aerial photographs of ORR and its immediate vicinity were obtained from TVA for the following years: 1939, 1945, 1952, 1967, 1974, 1981, 1984, and 1985. For most years, considerable overlap of the photographs allows stereoscopic viewing. Specific information regarding dates of the photographs, scales of the prints, spatial coverage, and quality of the prints is presented in Table 13.

The photographs are available at the ESD branch of the ORNL library, in Building 1505. Because the photographs and their corresponding index maps are of varying sizes, they are specially stored. Users should request the information from the librarian.

6.2 BIBLIOGRAPHIC DATA BASE

BNI was selected to provide technical assistance to ORNL for implementing the RI/FS Phase of the RAP (i.e., characterizing the nature and extent of contamination and evaluating alternatives for site cleanup).

Table 13. Descriptive information on aerial photographs of the Oak Ridge Reservation

Year	Month/Day	Scale	Number of Photos	Comments
1939	November-December	Contact prints and 1" = 3,600'	26	Enlargements very poor quality; contact prints used to create index map.
1945	April 5-13 August 9	Unknown	88 9	Coverage very spotty, limited to the vicinity of the Clinch River; unable to create an index map for this year.
1952	April 30	1" = 3,600	20	Good prints.
1967	Dates vary, primarily March 2	Primarily 1" = 2,000' but scale not uniform throughout series	38	Monoscopic coverage in Cave Creek quadrangle indicated in orange on the index map.
1974	April 19	Originally 1" = 2,640', enlarged to 1" = 1,000'	19	Monoscopic coverage in Cave Creek quadrangle indicated in orange on the index map.
1981	February 25	1" = 1,000'	87	No comments.
1984	November 7	1" = 1,000'	56	Coverage available only for southern part of reservation.
1985	March 18	1" = 1,000'	48	Coverage available only for northern part of reservation.

In order for BNI to efficiently and economically perform the required tasks, ORNL needed to provide a wide variety of information immediately upon initiation of the subcontract and will need to continue to assist BNI throughout the contract period by responding to their information needs. To meet these requirements, the Information Research and Analysis Section of the Health and Safety Research Division at ORNL initiated the development of a computerized bibliographic data base and hard copy reference collection in Novemb[illegible]986. The RAP Bibliographic Data Base contains all reports published by RAP (226 through December 31, 1987) as well as other documents pertinent to the program. This resource will be of great value to program staff and ORNL in general.

Comprehensive literature searches of the data base and copies of reports in the reference collection are available upon request by contacting the following:

Park T. Owen
Building 2001, MS-050
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6050
(615/576-0568; FTS/626-0568)
ORNL e-mail: OWEN or PTO

6.3 RECORDS CONTROL DATA BASE

Development of a RAP Records Control Data Base and archive was initiated in late 1987. This record system, which is required by federal regulations, will be used for logging, identifying, and correlating project records and for assisting in the search and retrieval of archived records.

The Bibliographic Data Base contains citations to published documents, such as technical reports, journal articles, conference papers, etc. The Records Control Data Base will contain all other types of programmatic documents/records that need to be permanently retained. Examples of items that will be retained in this system include field and laboratory logbooks,

well logs, chain of custody records, correspondence, project plans, permits, etc.

The data base is established on a PC system utilizing dBASE III Plus software and the Clipper compiler. The system was developed in cooperation with BNI so that records generated during the RI/FS phase of the program can be easily incorporated into the RAP DIMS.

7. REFERENCES

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Webster, D. A., J. S. Beatty, P. M. Benjamin, and W. M. Tranum. 1980. Water-level Data for Wells in Burial Ground 6, Oak Ridge National Laboratory, Tennessee, 1975-1979. USGS Open-File Report 81-57. U.S. Geological Survey, Knoxville, Tenn.

APPENDIX A

LOG OF REQUESTS FOR INFORMATION
FROM THE NUMERIC DATA BASE OF THE REMEDIAL ACTION PROGRAM

Table A.1. Log of requests for information from the Remedial Action Program Numeric Data Base

Req. no.	Requester	Affiliation[a]	Request[a,b]	Product supplied	Date filled
1	Nix	ORNL/DEM	Information on site 3512 and "Cs-field" data which may be in data base.	Data base contents	12/05/85
2	Beegly	ORNL/ESD	ACD data from Taylor's scoping survey.	Printout	01/06/86
3	Southworth	ORNL/ESD	Organic and inorganic data from Cerling's and Taylor's studies.	Printout	01/16/86
4	Cerling	U. of Utah	Cerling's WOC survey data files.	Tape	02/26/86
5	Southworth	ORNL/ESD	Organic and Hg data from Cerling's study.	Printout	02/13/86
6	Francis	ORNL/ESD	OHF, HRE, and 3513 data.	Printout	04/14/86
7	Huff	ORNL/ESD	Radionuclide data for specified sites.	Printouts	05/02/86
8	Gammage	ORNL/HASRD	Organic data for Taylor's survey samples 122 and 180.	Printout	05/09/86
9	Huff	ORNL/ESD	Piezometer well construction data.	Printout	06/03/86
10	Cerling	U. of Utah	Update of Cerling's WOC survey data.	Tape	06/23/86
11	Norman	ORNL/OPD	Bibliography.	Copy of report	06/26/86
12	Solomon	ORNL/ESD	Piezometer well construction data.	Printout	07/22/86
13	Switek	ORNL/ESD	SWSA4 & SWSA5 piezometer well construction data.	Printouts	07/23/86
14	Sale	ORNL/ESD	Bibliographic references for Clinch River Studies.	References	07/24/86
15	Lee	ORNL/ENERGY	Tower C precipitation data for Jan-Mar 1986.	Plots	07/31/86

Table A.1. continued

Req. no.	Requester	Affiliation[a]	Request[a,b]	Product supplied	Date filled
16	Lee	ORNL/ENERGY	Flow data for Melton Branch.	Printout	08/05/86
17	Ketelle	ORNL/ENERGY	Piezometer well water chemistry data.	Printout/Data file	08/12/86
18	Blasing	ORNL/ESD	Precipitation data.	Printout	09/30/86
19	Clapp	ORNL/ESD	Pits and trenches well data.	Data file	09/30/86
20	Clapp	ORNL/ESD	Pits and trenches well data.	Data file	10/07/86
21	Southworth	ORNL/ESD	Metal data on fish.	Printout	10/17/86
22	Huff	ORNL/ESD	Piezometer well data.	Printout	10/22/86
23	Huff	ORNL/ESD	Plots for piezometer well data.	Plots	11/24/86
24	Baughn	MCI	Piezometer well data.	Printout	12/11/86
25	Cerling	U. of Utah	Update of Cerling's data set.	Printout	12/18/86
26	Huff	ORNL/ESD	Measure point elevations on piezometer well.	Printout	12/22/86
27	Moore	ORNL/ESD	Listing of construction data on PRAP wells.	Printout	01/09/87
28	Perry	Martin Marietta	Status (active/inactive) of all wells at ORNL.	Information	01/12/87
29	Loar	ORNL/ESD	Water quality, stream flow data for WOC and Melton Branch.	Plots/Printout/data file	03/02/87
30	Arnseth	UT/ESD	Piezometer well water chemistry data.	Data file	01/21/87
31	McCrackin	UT/ESD	Piezometer well data.	Data file	01/29/87
32	Boegly	ORNL/ESD	Cerling's 1986 data.	Printout	02/02/87
33	Huff	ORNL/ESD	Organic data from Cerling's study for specified sites.	Printouts	02/10/87
34	Tuggle	ORNL/C&TD	Listing of all wells sampled.	Printout	02/11/87

Table A.1. continued

Req. no.	Requester	Affiliation[a]	Request[a,b]	Product supplied	Date filled
35	Beaudoin	ORNL/ESD	Water-level data from HHMS.	Printout/xerox copy	03/06/87
36	Ketelle	ORNL/ENERGY	Volatile organics data.	Printout	03/11/87
37	Huff	ORNL/ESD	Radioactivity concentrations in scoping survey samples.	Printout	03/18/87
38	Boegly	ORNL/ESD	Cerling's 1986 data.	Printout	03/16/87
39	Maskarinec	ORNL/ACD	Pb contamination levels at ORNL sites.	Printout	03/19/87
40	Baughn	MCI	Coordinates for wells in WAGs 7, 8, & 9.	Data file	03/31/87
41	Cerling	U. of Utah	Flow data (MS2, MS3, MS4 & PWTP) for 1984-86.	Printouts/data file	04/16/87
42	Railsback	ORNL/ESD	Daily surface discharge for 7500 Bridge.	Printout/data file	04/06/87
43	Loar	ORNL/ESD	PCB and TTO data for BMAP	Plots/Printout	04/24/87
44	Sobocinsky	U. of Utah	Surface discharge for PWTP 1986 precip from ETF 1/81-1/87.	Printout	04/27/87
45	Toran	ORNL/ESD	Water-level data from pits & trenches area.	Printouts/data file	04/28/87
46	Huff	ORNL/ESD	1986 precipitation data for all sites monitored by ESD.	Printout	05/21/87
47	Moore	ORNL/ESD	ORNL coordinates for 10 USGS wells.	Printout	05/21/87
48	Hyde	ORNL/OPD	Water-level data for specified wells.	Printout	06/08/87
49	Huston	ORNL/ESD	Precipitation data for Walker Branch 11/86-4/87.	Data file	06/11/87
50	Bunch	ORGDP/Proc Suppt	Precipitation data for sites near ORGDP.	Data file	06/16/87

Table A.1. continued

Req. no.	Requester	Affiliation[a]	Request[a,b]	Product supplied	Date filled
51	Norman	ORNL/OPD	USGS well location data.	Printout	06/12/87
52	Kocher	ORNL/HASRD	USGS surface discharge data.	Printout	06/30/87
53	Dreier	ORNL/ESD	Water-level data for HHMS from 1/87 to present.	Data file	07/15/87
54	McCrackin	ORNL/ESD	Piezometer well water quality data.	Printout/data file	07/23/87
55	King	ORNL/ESD	May precipitation data for Bear Creek Burial Ground.	Data file	07/22/87
56	Iglar		Water level and construction data available for well IDs 657-664 and 761-763.	Printout	08/05/87
57	Toran	ORNL/ESD	Precipitation data for specified sites for 8/1/86-5/31/87.	Data file	08/11/87
58	Arnseth	UT/ESD	Read privileges on RCRA monitoring wells data.	Read privileges RCRA	08/17/87
59	Sherwood	UT consultant	Listings, summary tables of WOC watershed precip data from 5/86 to 4/87.	Data files/tables	08/20/87
60	Sherwood	UT consultant	Listing, summary tables for WOC watershed surface flow data from 5/86 to 4/87.	Data files/tables	08/20/87
61	Clapp	ORNL/ESD	Water-level data for specified wells.	Data file	08/20/87
62	Sherwood	UT consultant	PRAP, piezometer, USGS continuous monitoring well maps for annual summary.	Graphics	09/09/87
63	Dearstone	ORNL/ESD	Precipitation data for Bear Creek Burial Ground from 5/1/87 to present.	Data file	08/28/87

Table A.1. continued

Req. no.	Requester	Affiliation[a]	Request[a,b]	Product supplied	Date filled
64	Murray	NUS/DOE	Construction and water quality data for FRAP, HF, and PIEZ wells.	Printouts	09/04/87
65	Boegly	ORNL/ESD	Digitized and map historic SWSA 1 map.	Graphics	09/22/87
66	Baughn	MCI	Construction data and water level data for specified wells near Trench 7.	Printout	09/03/87
67	Huff	ORNL/ESD	Camera-ready tables of piezometer well summary information.	Printout	09/11/87
68	Voorhees	ORNL/ESD	Overview maps of FRAP, piezometer & water quality wells.	Graphics (maps)	09/04/87
69	Ketelle	ORNL/ENERGY	Maps of piezometer wells in WAG 6, WAG 7 area.	Graphics (maps)	09/04/87
70	Toran	ORNL/ESD	Update of precipitation data for specified sites.	Data file	09/08/87
71	Dearstone	ORNL/ESD	Update of Bear Creek Burial Ground precipitation data.	Data file	09/09/87
72	Sexton	CH2M Hill	WAG 1 map with piezometer and WQ wells.	Graphics (map)	09/28/87
73	Moore	ORNL/ESD	Camera-ready table of FRAPCONS summary information.	Printout	09/11/87
74	Toran	ORNL/ESD	Lotus file of HHMS water quality data.	Data file	09/17/87
75	Dreier	ORNL/ESD	Precipitation data SWSAs 3, 5 & 6.	Data file	09/11/87
76	Nair	BNI	SAS formats for ACD NPDES codes.	SAS formats	09/17/87
77	Boegly	ORNL/ESD	RCRA well analysis data for 7900 area wells.	Printout	09/23/87
78	Huff	ORNL/ESD	Map of all RAP and associated wells.	Graphics (map)	09/16/87

Table A.1. continued

Req. no.	Requester	Affiliation[a]	Request[a,b]	Product supplied	Date filled
79	Moore	ORNL/ESD	Piezometer well construction data.	Printout	09/18/87
80	Botterman		Well location data for well #63 & #64.	Information	09/28/87
81	Moore	ORNL/ESD	Groundwater quality data for wells in ORNL area.	Printout	10/19/87
82	Blasing	ORNL/ESD/EMC	Jul-Sept precipitation data summary statistics.	Printout/table	10/21/87
83	Sturdivant	ASG	Water elevations for wells in 9000 area.	Printout	10/23/87
84	Raughn	MCI	Water level for specified wells.	Printout	11/24/87
85	Jacobs	ORNL/ESD	ISV rock and offgas data.	Printout	12/10/87

[a]ACD = Analytical Chemistry Division;
ASG = Automated Sciences Group, Inc.;
BNI = Bechtel National, Inc.;
C&TD = Computing and Telecommunications Division;
CH2M Hill = CH2M Hill, Oak Ridge, TN;
DEM = Department of Environmental Management;
DOE = U.S. Department of Energy;
ENERGY = Energy Division;
ESD = Environmental Sciences Division;
HASRD = Health and Safety Research Division;
MCI = Mining Consultants, Inc.;
NUS = NUS, Pittsburg, PA;
OPD = Operations Division;
ORGDP = Oak Ridge Gaseous Diffusion Plant;
ORNL = Oak Ridge National Laboratory;
Proc Suppt = Process Support; and
UT = University of Tennessee.

[b]BMAP = Biological Monitoring And Abatement Program;
ETF = Engineering Test Facility;
HHMS = Hydrostatic head monitoring station;
HF = Hydrofracture;
HRE = Homogeneous Reactor Experiment;
MS = Monitoring station;
NPDES = National Pollutant Discharge Elimination System;
OHF = Old Hydrofracture Facility;
PIEZ = Piezometer;
PRAP = Pre-Remedial Action Program;
PRAPCONS = Construction data for PRAP Wells;
PCB = Polychlorinated biphenyl;
PTTP = Process Waste Treatment Plant;
RCRA = Resource Conservation and Recovery Act;
SWSA = Solid Waste Storage Area;
TTO = Total toxic organics;
USGS = U.S. Geological Survey;
WAG = Waste Area Grouping;
WOC = White Oak Creek; and
WQ = Water Quality.

APPENDIX B

EXAMPLES OF DATA ENTRY FORMS USED FOR THE STUDY OF QUALITY ASSURANCE/QUALITY CONTROL FOR CHEMICAL ANALYSES

QUALITY ASSURANCE/QUALITY CONTROL FOR CHEMICAL ANALYSES

TRACE ELEMENTS IN WATER

NBS SRM: 1643b

SAMPLE ID: _____ DATE SUBMITTED: _____ LAB NO: _____

SAMPLE TYPE: _____ DATE COMPLETED: _____ REQUEST NO: _____

	EXPECTED		OBSERVED				
ANALYSIS	NBS RESULT	RANGE (1 SD)	PREFIX	LAB RESULT	UNITS	EXTRACTION	METHOD
Ag	10.0	0.4			UG/L	NONE	ICP/AA
(As)	50				UG/L	NONE	ICP/AA
(B)	96				UG/L	NONE	ICP/AA
Ba	45	1			UG/L	NONE	ICP/AA
Be	19	1			UG/L	NONE	ICP/AA
Cd	20	0.5			UG/L	NONE	ICP/AA
Co	26	0.5			UG/L	NONE	ICP/AA
Cr	18.9	0.2			UG/L	NONE	ICP/AA
Cu	22.3	0.2			UG/L	NONE	ICP/AA
Fe	101	4.1			UG/L	NONE	ICP/AA
Mn	28	1			UG/L	NONE	ICP/AA
Mo	86	1.5			UG/L	NONE	ICP/AA
Ni	50	1.5			UG/L	NONE	ICP/AA
Pb	24.1	0.4			UG/L	NONE	ICP/AA
Se	9.9	0.3			UG/L	NONE	ICP/AA
Sr	231	3.1			UG/L	NONE	ICP/AA
Tl	8.1	0.1			UG/L	NONE	ICP/AA
V	46.0	0.2			UG/L	NONE	ICP/AA
Zn	67	1			UG/L	NONE	ICP/AA
					UG/L	NONE	ICP/AA
					UG/L	NONE	ICP/AA
					UG/L	NONE	ICP/AA
					UG/L	NONE	ICP/AA

NOTE: NBS results were converted from ng/g to ug/L by multiplying the NBS reported value by 1.017.
NBS results for elements in parentheses are not certified.

COMMENTS: _____

Fig. B.1. Data entry form used for Quality Assurance/Quality Control study of chemical analyses: trace elements in water.

QUALITY ASSURANCE/QUALITY CONTROL FOR CHEMICAL ANALYSES

TRACE ELEMENTS IN RIVER SEDIMENTS

NBS SRM: 1645

SAMPLE ID: _____ DATE SUBMITTED: _____ LAB NO: _____

SAMPLE TYPE: _____ DATE COMPLETED: _____ REQUEST NO: _____

	EXPECTED		OBSERVED				
ANALYSIS	NBS RESULT	RANGE (1 SD)	PREFIX	LAB RESULT	UNITS	EXTRACTION	METHOD
Al	22600	400			UG/G		ICP/AA
(As)	66				UG/G		ICP/AA
(Ca)	29000				UG/G		ICP/AA
Cd	10.2	0.75			UG/G		ICP/AA
Co	10.1	0.6			UG/G		ICP/AA
Cr	29600	1400			UG/G		ICP/AA
Cu	109	9.5			UG/G		ICP/AA
(F)	0.09				UG/G		ICP/AA
Fe	113000	6000			UG/G		ICP/AA
Hg	1.1	0.25			UG/G		ICP/AA
K	12600	500			UG/G		ICP/AA
(La)	9				UG/G		ICP/AA
Mg	7400	200			UG/G		ICP/AA
Mn	775	48.75			UG/G		ICP/AA
Na	5400	100			UG/G		ICP/AA
Ni	45.8	1.45			UG/G		ICP/AA
Pb	714	14			UG/G		ICP/AA
(S)	11000				UG/G		ICP/AA
(Sb)	51				UG/G		ICP/AA
(Sc)	20000				UG/G		ICP/AA
(Se)	1.5				UG/G		ICP/AA
Th	1.62	0.11			UG/G		ICP/AA
Tl	1.44	0.035			UG/G		ICP/AA
U	1.11	0.025			UG/G		ICP/AA
V	23.5	3.45			UG/G		ICP/AA
Zn	1720	85			UG/G		ICP/AA
					UG/G		ICP/AA
					UG/G		ICP/AA

NOTE: NBS results for elements in parentheses are not certified.

COMMENTS: _____

Fig. B.2. Data entry form used for Quality Assurance/Quality Control study of chemical analyses: trace elements in river sediments.

QUALITY ASSURANCE/QUALITY CONTROL FOR CHEMICAL ANALYSES

PRIORITY POLLUTANT POLYNUCLEAR AROMATIC HYDROCARBONS (IN ACETONITRILE)

NBS SRM: 1647

SAMPLE ID: _____ DATE SUBMITTED: _____ LAB NO: _____

SAMPLE TYPE: _____ DATE COMPLETED: _____ REQUEST NO: _____

	EXPECTED		OBSERVED		BLANK				
ANALYSIS	NBS RESULT	RANGE (1 SD)	PREFIX	LAB RESULT	PREFIX	RESULT	UNITS	EXTRACTION	METHOD
01B	21.0	0.2					UG/ML	EPA3510	EPA8270
02B	19.1	0.1					UG/ML	EPA3510	EPA8270
03B	3.29	0.05					UG/ML	EPA3510	EPA8270
05B	5.03	0.05					UG/ML	EPA3510	EPA8270
06B	5.30	0.05					UG/ML	EPA3510	EPA8270
07B	5.11	0.05					UG/ML	EPA3510	EPA8270
08B	4.01	0.05					UG/ML	EPA3510	EPA8270
09B	5.02	0.05					UG/ML	EPA3510	EPA8270
18B	4.68	0.05					UG/ML	EPA3510	EPA8270
19B	3.68	0.05					UG/ML	EPA3510	EPA8270
31B	10.1	0.1					UG/ML	EPA3510	EPA8270
32B	4.92	0.05					UG/ML	EPA3510	EPA8270
37B	4.06	0.05					UG/ML	EPA3510	EPA8270
39B	22.5	0.1					UG/ML	EPA3510	EPA8270
44B	5.06	0.05					UG/ML	EPA3510	EPA8270
45B	9.84	0.05					UG/ML	EPA3510	EPA8270
							UG/ML	EPA3510	EPA8270
							UG/ML	EPA3510	EPA8270

NPDES CODE	ORGANIC COMPOUND
01B	Acenaphthene
02B	Acenaphthylene
03B	Anthracene
05B	Benz[a]anthracene
06B	Benzo[a]pyrene
07B	Benzo[b]fluoranthene
08B	Benzo[ghi]perylene
09B	Benzo[k]fluoranthene
18B	Chrysene
19B	Dibenz[a,h]anthracene
31B	Fluoranthene
32B	Fluorene
37B	Indeno[1,2,3-cd]pyrene
39B	Naphthalene
44B	Phenanthrene
45B	Pyrene

COMMENTS: _____

Fig. B.3. Data entry form used for Quality Assurance/Quality Control study of chemical analyses: priority pollutant polynuclear aromatic hydrocarbons in acetonitrile.

QUALITY ASSURANCE/QUALITY CONTROL FOR CHEMICAL ANALYSES

EPA CROSS-CHECK OF RADIOLOGICAL PARAMETERS

EPA CROSS-CHECK
REFERENCE NO: _____ SAMPLE ID: _____ DATE SUBMITTED: _____ LAB NO: _____

SAMPLE TYPE: _____ DATE COMPLETED: _____ REQUEST NO: _____

	EXPECTED		OBSERVED					
ANALYSIS	EPA RESULT	ERROR (1 SD)	PREFIX	LAB RESULT	ERROR (1 SD)	UNITS	EXTRACTION	METHOD
Co-60						PCI/L	NONE	GSCAN
Cs-134						PCI/L	NONE	GSCAN
Cs-137						PCI/L	NONE	GSCAN
G-alpha						PCI/L	NONE	EC-101
G-beta						PCI/L	NONE	EC-101
H-3						PCI/L	EC-189	EC-189
Ru-106						PCI/L	NONE	GSCAN
Sr-90						PCI/L	EC-184	EC-184
Zn-65						PCI/L	NONE	GSCAN

COMMENTS: _____

Fig. B.4. Data entry form used for Quality Assurance/Quality Control study of chemical analyses: U.S. Environmental Protection Agency cross-check of radiological parameters.

APPENDIX C

SUMMARY OF WATER-LEVEL DATA IN THE NUMERIC DATA BASE OF THE REMEDIAL ACTION PROGRAM

Table C.1. Well-monitoring activities conducted by the Oak Ridge National Laboratory, as recorded in the Remedial Action Program Numeric Data Base

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
SB-1	04SEP86	13OCT87	31	---
SB-2	04SEP86	03DEC87	33	---
SB-20	04SEP86	03DEC87	33	---
SB-4	04SEP86	13OCT87	31	---
SB-6	04SEP86	13OCT87	31	---
T401	21JUL86	12OCT87	24	---
T403	21JUL86	12OCT87	24	---
T404	21JUL86	12OCT87	24	---
T405	21JUL86	30NOV87	26	---
T408	24JUL86	13OCT87	24	---
T411	21JUL86	12OCT87	24	---
T412	21JUL86	30NOV87	26	---
T416	24JUL86	12OCT87	24	---
T418	24JUL86	13OCT87	24	---
T419	22JUL86	30NOV87	26	---
T5-4	22JUL86	30NOV87	25	---
T6-1	21JUL86	30NOV87	26	---
T6-3	21JUL86	30NOV87	26	---
T7-10	04SEP86	03DEC87	33	---
T7-21	09JUL87	13OCT87	2	---
T7-22	04SEP86	13OCT87	31	---
T7-23	04SEP86	13OCT87	31	---
T7-24	04SEP86	13OCT87	31	---
T7-25	04SEP86	13OCT87	31	---
T7-26	04SEP86	13OCT87	30	---
T7-27	04SEP86	13OCT87	31	---
T7-29	04SEP86	13OCT87	31	---
T7-3	04SEP86	13OCT87	31	---
T7-4	04SEP86	13OCT87	31	---
T7-5	04SEP86	03DEC87	33	---
T7-6	04SEP86	13OCT87	31	---
T7-7	04SEP86	13OCT87	31	---
T7-9	04SEP86	13OCT87	31	---
WT5-1	22JUL86	19AUG86	3	---
WT5-3	22JUL86	13OCT87	24	---
WT5-4	09SEP87	09SEP87	1	---
WT5-5	22JUL86	13OCT87	24	---
WT5-8	22JUL86	30NOV87	26	---
WT7-2	04SEP86	13OCT87	31	---

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
WT7-3	12JUL86	03DEC87	27	---
WT7-4	04SEP86	03DEC87	33	---
WT7-5	18JUL86	13OCT87	25	---
WT7-5A	04SEP86	13OCT87	31	---
WT7-6	04SEP86	13OCT87	31	---
WT7-6A	04SEP86	13OCT87	31	---
WT7-7	18JUL86	13OCT87	18	---
WT7-8	18JUL86	03DEC87	27	---
0064	18JUL86	30NOV87	26	---
0065	18JUL86	30NOV87	26	---
0066	18JUL86	12OCT87	24	---
0067	25JUL86	30NOV87	26	---
0070	18JUL86	12OCT87	24	---
0083	24JUL86	13OCT87	24	---
0084	24JUL86	30NOV87	26	---
0085	23JUL86	13OCT87	25	---
0086	23JUL86	13OCT87	25	---
0088	23JUL86	13OCT87	25	---
0090	23JUL86	30NOV87	27	---
0092	23JUL86	13OCT87	25	---
0093	21JUL86	30NOV87	26	---
0094	21JUL86	12OCT87	24	---
0095	25JUL86	13OCT87	24	---
0096	24JUL86	13OCT87	25	---
0097	22JUL86	30NOV87	26	---
0098	22JUL86	13OCT87	24	---
0099	22JUL86	13OCT87	24	---
0103	21JUL86	12OCT87	24	---
0104	21JUL86	12OCT87	24	---
0114	22JUL86	30NOV87	26	---
0124	21JUL86	12OCT87	24	---
0125	21JUL86	12OCT87	24	---
0126	21JUL86	30NOV87	27	---
0182	21JUL86	30NOV87	25	---
0183	21JUL86	30NOV87	26	---
0186	24JUL86	30NOV87	26	---
0187	21JUL86	30NOV87	27	---
0191	24JUL86	30NOV87	26	---
0201	17DEC86	30NOV87	18	---
0532	11FEB86	26OCT87	38	---
0533	11FEB86	07DEC87	41	X
0534	11FEB86	26OCT87	38	---

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
0535	16JUN86	26OCT87	28	---
0536	11FEB86	26OCT87	38	---
0537	11FEB86	26OCT87	37	---
0538	10MAR86	07DEC87	38	X
0539	22SEP86	26OCT87	21	X
0540	11FEB86	26OCT87	38	---
0541	11FEB86	26OCT87	38	---
0542	11FEB86	26OCT87	39	X
0543	11FEB86	26OCT87	38	---
0544	11FEB86	26OCT87	39	X
0545	16JUN86	26OCT87	28	---
0546	28SEP87	07DEC87	4	---
0547	11FEB86	26OCT87	38	---
0548	11FEB86	26OCT87	39	X
0549	28SEP87	07DEC87	4	---
0550	11FEB86	26OCT87	39	X
0551	11FEB86	07DEC87	40	---
0552	20OCT86	26OCT87	19	---
0553	11FEB86	07DEC87	40	---
0554	11FEB86	26OCT87	39	X
0555	09APR86	26OCT87	33	---
0556	11FEB86	26OCT87	38	---
0557	11FEB86	26OCT87	38	X
0558	11FEB86	07DEC87	40	X
0559	10MAR86	13APR87	29	---
0560	10MAR86	26OCT87	48	X
0561	11FEB86	26OCT87	41	X
0562	14OCT87	01DEC87	3	---
0563	10MAR86	27OCT87	36	X
0564	23JUL87	27OCT87	4	---
0565	27MAY86	16MAR87	10	X
0566	24SEP86	27OCT87	20	---
0567	09APR86	27OCT87	33	X
0568	11FEB86	26OCT87	39	X
0569	22SEP86	07DEC87	23	---
0570	16JUN86	26OCT87	29	X
0571	16APR86	26OCT87	29	X
0572	10MAR86	26OCT87	36	---
0573	10MAR86	26OCT87	46	X
0574	15APR87	07DEC87	10	---
0575	20OCT86	07DEC87	20	---
0577	09APR86	26OCT87	34	X

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
0578	28JUL86	27OCT87	24	---
0579	11FEB86	07DEC87	40	X
0580	16JUN86	21SEP87	28	X
0581	10MAR86	26OCT87	36	---
WT7-3	12JUL86	03DEC87	27	---
0586	15APR87	07DEC87	10	---
0587	18NOV86	27OCT87	16	---
0588	10MAR86	26OCT87	45	---
0589	17NOV86	26OCT87	17	---
0590	10MAR86	07DEC87	40	X
0591	09APR86	27OCT87	32	---
0592	09APR86	27OCT87	32	---
0593	09APR86	27OCT87	33	X
0594	09APR86	27OCT87	33	X
0595	11FEB86	26OCT87	38	X
0596	10MAR86	26OCT87	46	X
0597	09APR86	27OCT87	33	X
0598	22SEP86	27OCT87	20	---
0599	11FEB86	07DEC87	40	X
0600	21OCT86	27OCT87	18	X
0601	07OCT86	27OCT87	19	---
0602	11FEB86	26OCT87	38	X
0603	17NOV86	07DEC87	19	---
0604	11FEB86	27OCT87	38	X
0605	11FEB86	25FEB86	2	---
0606	09APR86	13APR87	26	---
0607	17NOV86	26OCT87	17	---
0608	10MAR86	27OCT87	36	X
0609	15APR87	07DEC87	10	---
0610	11FEB86	27OCT87	38	X
0611	11FEB86	26OCT87	41	X
0612	11FEB86	26OCT87	40	X
0613	10MAR86	27OCT87	36	X
0614	11FEB86	26OCT87	38	X
0615	11FEB86	27OCT87	38	X
0616	04APR86	27OCT87	35	X
0617	10MAR86	07DEC87	38	X
0618	09APR86	27OCT87	33	X
0619	25FEB86	14APR87	29	---
0620	11FEB86	26OCT87	37	---
0621	25FEB86	26OCT87	37	X
0622	11FEB86	27OCT87	38	X

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
0623	11FEB86	27OCT87	38	X
0624	11FEB86	26OCT87	37	---
0625	11FEB86	27OCT87	37	---
0626	11FEB86	27OCT87	38	X
0627	11FEB86	07DEC87	40	X
0628	10MAR86	27OCT87	36	X
0629	04MAR87	07DEC87	12	---
0630	01JUL86	07DEC87	24	X
0631	22OCT86	07DEC87	21	---
0632	18NOV86	07DEC87	19	---
0633	02JUL86	07DEC87	24	X
0634	04MAR87	07DEC87	12	---
0635	22OCT86	07DEC87	21	---
0636	17JUN86	10DEC87	36	---
0637	17JUN86	10DEC87	36	---
0638	17JUN86	10DEC87	36	---
0639	08OCT86	10DEC87	28	---
0640	24SEP86	10DEC87	29	---
0641	17JUN86	10DEC87	36	---
0642	17JUN86	10DEC87	36	---
0643	17JUN86	05NOV86	11	---
0644	17JUN86	10DEC87	36	---
0645	24SEP86	10DEC87	29	---
0646	24SEP86	10DEC87	29	---
0649	17JUN86	10DEC87	35	---
0650	08OCT86	10DEC87	27	---
0651	08OCT86	10DEC87	28	---
0652	08OCT86	10DEC87	28	---
0653	08OCT86	10DEC87	28	---
0654	24SEP86	10DEC87	29	---
0655	23SEP86	10DEC87	29	---
0656	23SEP86	10DEC87	29	---
0657	09OCT86	01DEC87	22	---
0658	24SEP86	01DEC87	23	---
0659	24SEP86	01DEC87	23	---
0660	10NOV87	01DEC87	2	---
0661	24SEP86	01DEC87	23	---
0662	10NOV87	01DEC87	2	---
0663	10NOV87	01DEC87	2	---
0664	24SEP86	01DEC87	23	---
0665	24SEP86	30NOV87	23	---
0666	24SEP86	30NOV87	23	---

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
0667	24SEP86	30NOV87	23	---
0668	14OCT87	30NOV87	3	---
0669	14OCT87	30NOV87	3	---
0670	24SEP87	08DEC87	4	---
0671	24SEP87	08DEC87	4	---
0672	24SEP87	08DEC87	4	---
0673	24SEP87	08DEC87	4	---
0674	24SEP87	08DEC87	4	---
0675	24SEP87	08DEC87	4	---
0676	21JUL86	30NOV87	26	---
0678	16OCT87	30NOV87	3	---
0679	24JUL86	12OCT87	24	---
0680	24JUL86	30NOV87	26	---
0682	17JUN86	30NOV87	31	---
0683	23SEP86	30NOV87	24	---
0684	10MAR87	30NOV87	13	---
0685	17JUN86	30NOV87	31	---
0686	17JUN86	30NOV87	31	---
0687	23SEP86	30NOV87	20	---
0688	17JUN86	30NOV87	31	---
0689	17JUN86	30NOV87	31	---
0690	17JUN86	30NOV87	30	---
0691	23SEP86	07DEC87	23	---
0692	22OCT86	07DEC87	21	---
0693	22OCT86	07DEC87	21	---
0694	22OCT86	07DEC87	21	---
0695	23SEP86	07DEC87	23	---
0696	07AUG86	07DEC87	24	X
0697	22OCT86	07DEC87	21	---
0698	22OCT86	07DEC87	21	---
0699	22OCT86	07DEC87	21	---
0701	18NOV86	07DEC87	19	---
0702	23SEP86	07DEC87	23	---
0703	23SEP86	07DEC87	23	---
0704	23JUL86	08DEC87	24	X
0705	23JUL86	08DEC87	24	X
0706	30JUL86	08DEC87	24	X
0707	23SEP86	08DEC87	23	---
0709	24SEP86	01DEC87	23	---
0710	24SEP86	01DEC87	23	---
0711	24SEP86	11NOV87	21	---
0712	09SEP87	30NOV87	4	X

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
0714	24SEP86	01DEC87	23	---
0715	24SEP86	01DEC87	23	---
0716	09JUL87	30NOV87	6	---
0718	15SEP86	30NOV87	24	---
0719	21JUL86	30NOV87	26	---
0720	16OCT87	30NOV87	3	---
0721	11MAR87	30NOV87	11	---
0723	11AUG87	01DEC87	5	---
0726	11AUG87	30NOV87	5	---
0727	14OCT87	30NOV87	3	---
0728	06MAY87	30NOV87	8	X
0729	14OCT87	01DEC87	3	---
0730	10NOV87	01DEC87	2	X
0731	11MAR87	30NOV87	12	X
0732	10NOV87	30NOV87	2	---
0733	16OCT87	01DEC87	3	X
0734	15APR87	07DEC87	10	---
0735	02JUN87	02DEC87	7	X
0736	02JUN87	02DEC87	7	---
0737	02JUN87	02DEC87	7	X
0738	09SEP87	02DEC87	4	X
0739	24SEP86	01DEC87	22	X
0740	23SEP86	01DEC87	23	---
0741	24SEP86	01DEC87	23	---
0742	11AUG87	01DEC87	5	---
0743	23SEP86	01DEC87	23	---
0744	24SEP86	01DEC87	23	X
0747	11MAR87	01DEC87	12	X
0748	14OCT87	01DEC87	3	---
0749	11MAY87	01DEC87	8	---
0750	11AUG87	03DEC87	5	---
0751	14OCT87	30NOV87	3	---
0752	15APR87	07DEC87	10	---
0753	04MAR87	07DEC87	12	---
0754	04MAR87	07DEC87	12	---
0755	14OCT87	01DEC87	3	X
0756	14OCT87	01DEC87	3	---
0757	11MAY87	01DEC87	8	---
0758	11MAY87	01DEC87	8	---
0759	11MAY87	01DEC87	8	X
0760	11MAY87	01DEC87	8	---
0761	09JUL87	01DEC87	6	X

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
0762	09JUL87	01DEC87	6	---
0763	11MAR87	01DEC87	12	---
0764	15APR87	07DEC87	10	---
0765	23SEP87	07DEC87	4	---
0766	17DEC86	01DEC87	17	X
0767	14OCT87	01DEC87	3	---
0768	14OCT87	01DEC87	3	---
0769	23SEP87	07DEC87	4	---
0770	02OCT87	02OCT87	1	---
0771	02OCT87	02OCT87	1	---
0772	02OCT87	02OCT87	1	X
0773	02OCT87	02OCT87	1	X
0774	02OCT87	02OCT87	1	X
0775	02OCT87	02OCT87	1	X
0776	02OCT87	02OCT87	1	---
0777	02OCT87	02OCT87	1	---
0778	11MAY87	30NOV87	8	X
0779	11MAY87	30NOV87	8	X
0780	11MAY87	01DEC87	8	X
0781	11MAY87	01DEC87	8	X
0782	11MAY87	01DEC87	8	X
0783	11MAY87	01DEC87	8	---
0784	04JUN87	03DEC87	7	---
0785	04JUN87	03DEC87	7	---
0786	23SEP86	07DEC87	23	---
0787	08SEP87	30NOV87	4	X
0788	23SEP86	07DEC87	23	---
0789	30JUL86	07DEC87	25	X
0790	23SEP86	07DEC87	23	---
0791	23SEP86	07DEC87	23	---
0792	23SEP86	08DEC87	23	---
0793	15APR87	08DEC87	10	---
0794	23SEP86	07DEC87	23	---
0795	23SEP86	07DEC87	23	---
0796	23SEP86	07DEC87	23	---
0797	29JAN87	09DEC87	14	---
0798	29JAN87	09DEC87	14	---
0799	29JAN87	09DEC87	14	---
0800	29JAN87	09DEC87	14	---
0801	29JAN87	09DEC87	14	---
0802	29JAN87	09DEC87	14	---
0803	29JAN87	09DEC87	14	---

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
0804	29JAN87	09DEC87	14	---
0805	20MAY87	09DEC87	8	---
0895	04MAR87	07DEC87	12	---
0896	28OCT87	07DEC87	3	---
0897	04MAR87	07DEC87	12	---
0898	24SEP87	08DEC87	4	---
0899	04MAR87	07DEC87	12	---
0900	15APR87	07DEC87	10	---
0901	15APR87	07DEC87	10	---
0902	04MAR87	07DEC87	12	---
0903	15APR87	07DEC87	10	---
0904	28OCT87	07DEC87	3	---
0905	04MAR87	07DEC87	12	---
0906	23SEP87	07DEC87	4	---
0907	25SEP87	09DEC87	4	---
0908	20MAY87	09DEC87	8	---
0909	20MAY87	09DEC87	8	---
0910	20MAY87	09DEC87	8	---
0911	25SEP87	09DEC87	4	---
0912	19MAY87	08DEC87	8	---
0913	19MAY87	08DEC87	8	---
0914	24SEP87	08DEC87	4	---
0915	15APR87	08DEC87	10	---
0916	19MAY87	08DEC87	8	---
0917	24SEP87	08DEC87	4	---
0918	21MAY87	08DEC87	8	---
0919	21MAY87	08DEC87	8	---
0920	21MAY87	08DEC87	8	---
0921	24SEP87	08DEC87	4	---
0922	24SEP87	08DEC87	4	---
0923	24SEP87	08DEC87	4	---
0924	24SEP87	08DEC87	4	---
0925	24SEP87	08DEC87	4	---
0926	24SEP87	08DEC87	4	---
0952	11NOV87	30NOV87	2	---
1026	11MAY87	01DEC87	8	---
1027	11MAY87	01DEC87	8	---
1028	11MAY87	01DEC87	8	---
1029	11MAY87	01DEC87	8	---
1030	11MAY87	01DEC87	8	---
1031	11MAY87	01DEC87	8	---
1033	11MAY87	01DEC87	8	---

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
1048	11AUG87	30NOV87	5	---
1049	17NOV87	09DEC87	2	---
1050	17NOV87	09DEC87	2	---
1052	10SEP87	01DEC87	3	---
1053	14OCT87	01DEC87	3	---
1054	10SEP87	01DEC87	4	---
1055	17NOV87	09DEC87	2	---
1056	10SEP87	01DEC87	4	---
1057	10SEP87	01DEC87	4	---
1058	17NOV87	09DEC87	2	---
1059	17NOV87	09DEC87	2	---
1060	17NOV87	09DEC87	2	---
1061	17NOV87	09DEC87	2	---
1062	17NOV87	09DEC87	2	---
1063	17NOV87	09DEC87	2	---
1064	10SEP87	01DEC87	4	---
1065	10SEP87	01DEC87	4	---
1066	10SEP87	01DEC87	4	---
1067	14OCT87	01DEC87	3	---
1068	17NOV87	09DEC87	2	---
1113	15OCT87	02DEC87	3	---
1114	15OCT87	02DEC87	3	---
1115	15OCT87	02DEC87	3	---
1117	15OCT87	02DEC87	3	---
1118	15OCT87	02DEC87	3	---
1119	15OCT87	02DEC87	3	---
1120	15OCT87	02DEC87	3	---
1121	15OCT87	02DEC87	3	---
1122	15OCT87	02DEC87	3	---
1123	15OCT87	02DEC87	3	---
1124	15OCT87	02DEC87	3	---
1125	15OCT87	02DEC87	3	---
1126	15OCT87	02DEC87	3	---
1127	15OCT87	02DEC87	3	---
1128	15OCT87	02DEC87	3	---
1129	15OCT87	02DEC87	3	---
7-1	29AUG86	02DEC87	39	---
7-10	29AUG86	02DEC87	39	---
7-100	29AUG86	02DEC87	39	---
7-101	29AUG86	02DEC87	39	---
7-102	29AUG86	02DEC87	39	---
7-103	29AUG86	02DEC87	39	---

Table C.1. continued

Well ID	Water-level observations			Sampled in scoping survey (X = sampled)
	First	Most recent	Number	
7-104	29AUG86	02DEC87	39	---
7-11	24AUG86	02DEC87	39	---
7-12	29AUG86	02DEC87	39	---
7-13	29AUG86	02DEC87	39	---
7-14	29AUG86	02DEC87	39	---
7-15	29AUG86	02DEC87	39	---
7-16	29AUG86	02DEC87	39	---
7-17	29AUG86	02DEC87	39	---
7-18	29AUG86	02DEC87	39	---
7-2	29AUG86	02DEC87	39	---
7-3	29AUG86	02DEC87	39	---
7-4	29AUG86	02DEC87	39	---
7-5	28AUG85	02DEC87	39	---
7-6	29AUG86	02DEC87	39	---
7-7	29AUG86	02DEC87	39	---
7-8	29AUG86	02DEC87	39	---
7-9	29AUG86	02DEC87	39	---

Table C.2. Number of daily mean water-level values in the Remedial Action Program Numeric Data Base for wells equipped with continuous recorders

Well ID	USGS local well ID	USGS site ID	Number of observations		
			1985	1986	1987
HHMS 1-A	RN:M-1A ORNL	355447084190601	-	47	260
HHMS 1-B	RN:M-1B ORNL	355447084190501	-	146	299
HHMS 1-C	RN:M-1C ORNL	355446084190501	-	133	282
HHMS 2-A	RN:M-2A ORNL	355438084190401	-	146	270
HHMS 2-B	RN:M-2B ORNL	355438084190402	-	147	300
HHMS 2-C	RN:M-2C ORNL	355437084190501	-	147	300
HHMS 3-A	RN:M-3A ORNL	355433084191301	-	5	276
HHMS 3-B	RN:M-3B ORNL	355333084191301	-	150	289
HHMS 3-C	RN:M-3C ORNL	355433084191302	-	139	266
HHMS 4-A	RN:M-4A ORNL	355412084192601	-	-	149
HHMS 4-B	RN:M-4B ORNL	355413084192601	-	-	164
HHMS 4-C	RN:M-4C ORNL	355413084192602	-	-	180
HHMS 5-A	RN:M-5A ORNL	355408084192503	-	-	71
HHMS 5-B	RN:M-5B ORNL	355410084192401	-	-	174
HHMS 5-C	RN:M-5C ORNL	355409084192502	-	-	174
HHMS 6-A	RN:M-6A ORNL	355405084191801	-	-	195
HHMS 6-B	RN:M-6B ORNL	355406084191901	-	-	195
HHMS 6-C	RN:M-6C ORNL	355406084191902	-	-	197
HHMS 7-A	RN:M-7A ORNL	355422084193501	-	-	194
0003	RN:M-3-3 ORNL	355507084194201	92	365	365
0015	RN:M-3-15 ORNL	355503084195201	92	365	363
0023	RN:M-3-23 ORNL	355510084194301	17	-	-
0433	RN:M-5-433 ORNL	355447084184801	36	106	-
0439	RN:M-5-439 ORNL	355445084184304	92	333	345
0440	RN:M-5-440 ORNL	355447084184301	92	365	124
0441	RN:M-5-441 ORNL	355453084184502	92	212	-
0444	RN:M-5-444 ORNL	355450084183601	92	328	87
0451	RN:M-5-451 ORNL	355453084184001	92	190	-
0452	RN:M-5-452 ORNL	355450084183901	81	192	-
0458	RN:M-5-458 ORNL	355447084184303	92	365	122
0459	RN:M-5-459 ORNL	355447084184302	92	365	124
0460	RN:M-5-460 ORNL	355446084184301	92	365	124
0461	RN:M-5-461 ORNL	355445084184102	92	362	355
0462	RN:M-5-462 ORNL	355445084184103	92	365	358
0463	RN:M-5-463 ORNL	355445084184201	92	365	364
0464	RN:M-5-464 ORNL	355445084184202	92	365	363
0466	RN:M-5-466 ORNL	355445084185501	92	365	365
0467	RN:M-5-467 ORNL	355445084185502	91	365	365
0468	RN:M-5-468 ORNL	355444084185501	92	365	365
0469A	RN:M-5-469A ORNL	355447084184502	92	362	362

Table C.2. continued

Well ID	USGS local well ID	USGS site ID	Number of observations		
			1985	1986	1987
0470	RN:M-5-470 ORNL	355457084184503	92	317	360
0471	RN:M-5-471 ORNL	355456084184601	92	365	360
0472	RN:M-5-472 ORNL	355456084184501	92	365	362
0473	RN:M-5-473 ORNL	355453084183401	92	295	124
0474	RN:M-5-474 ORNL	355453084183402	92	318	124
0475	RN:M-5-475 ORNL	355453084183403	84	365	124
0476	RN:M-5-476 ORNL	355454084183401	92	365	124
0482	RN:M-3-482 ORNL	355505084194701	92	365	365
0483	RN:M-3-483 ORNL	355504084195201	92	365	365
0484	RN:M-3-484 ORNL	355505084195501	92	365	365
0485	RN:M-3-485 ORNL	355508084195201	92	365	120
0486	RN:M-3-486 ORNL	355509084194801	92	365	131
0491	RN:M-3-491 ORNL	355509084194601	92	365	153
0492	RN:M-3-492 ORNL	355507084194801	92	365	345
0493	RN:M-3-493 ORNL	355507084195101	92	365	131
0494	RN:M-3-494 ORNL	355506084195101	92	365	67
0496	RN:M-3-496 ORNL	355511084194301	92	177	-
JS-2	RN:M-3-JS-02 ORNL	355504084195801	90	206	-
T105-5	RN:M-5-T105-5 ORNL	355444084184602	43	312	328
T60-1	RN:M-5-T60-1 ORNL	355444084184502	92	333	340
T66-1	RN:M-5-T66-1 ORNL	355444084184503	92	322	365
T83-5	RN:M-5-T83-5 ORNL	355444084184601	89	192	-
UA1	RN:M-UA1 ORNL	355343084201501	-	-	244
UA2	RN:M-UA2 ORNL	355343084201401	-	6	335
UB1	RN:M-UB1 ORNL	355406084195701	-	-	251
UB2	RN:M-UB2 ORNL	355405084195801	-	-	244
UC1	RN:M-UC1 ORNL	355515084184301	-	-	240
UC2	RN:M-UC2 ORNL	355515084184201	-	-	265
UD1	RN:M-UD1 ORNL	355507084184701	-	-	273
UD2	RN:M-UD2 ORNL	355506084184701	-	-	283
UE1	RN:M-UE1 ORNL	355457084184001	-	-	258
UE2	RN:M-UE2 ORNL	355458084184002	-	-	280
UF1	RN:M-UF1 ORNL	355444084184101	-	-	281
UF2	RN:M-UF2 ORNL	355444084184201	-	-	275
UG1	RN:M-UG1 ORNL	355517084171701	-	-	275
UG2	RN:M-UG2 ORNL	355516084171801	-	-	275
UG3	RN:M-UG3 ORNL	355516084171901	-	-	238
UH1	RN:M-UH1 ORNL	355515084172401	-	-	275
UH2	RN:M-UH2 ORNL	355515084172501	-	-	217
UI1	RN:M-UI1 ORNL	355505084174201	-	-	276
UI2	RN:M-UI2 ORNL	355505084174301	-	-	273

Table C.2. continued

Well ID	USGS local well ID	USGS site ID	Number of observations		
			1985	1986	1987
U16	RN:M-U16 ORNL	355458084184001	-	356	304
U18	RN:M-U18 ORNL	355357084195801	16	365	363
U19	RN:M-U19 ORNL	355352084195701	1	313	331
U26	RN:M-U26 ORNL	355431084191001	21	365	327
U27	RN:M-U27 ORNL	355441084190101	1	357	365
U30	RN:M-U30 ORNL	355511084190101	22	365	365
U35	RN:M-U35 ORNL	355514084183901	-	337	363
U40	RN:M-U40 ORNL	355534084175101	22	365	131
U41	RN:M-U41 ORNL	355540084174201	-	345	326

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