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Annual Report of Data Base Management Activities for the Remedial Action Program at ORNL: Calendar Year 1986

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Publication No. 2864

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MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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ENVIRONMENTAL SCIENCES DIVISION

ANNUAL REPORT OF DATA BASE MANAGEMENT ACTIVITIES FOR THE REMEDIAL ACTION PROGRAM AT ORNL CALENDAR YEAR 1986

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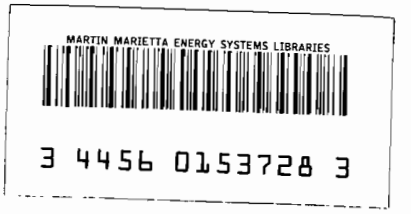

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ABSTRACT

VOORHEES, L. D., L. A. HOOK, M. A. FAULKNER, M. J. GENTRY, T. C. CLOWER, and R. A. McCORD. 1987. Annual Report of Data Base Management Activities for the Remedial Action Program at ORNL: Calendar Year 1986. ORNL/RAP-11. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 80 pp.

The Oak Ridge National Laboratory (ORNL) Remedial Action (RA) Program was established in FY 1985 to provide 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; these ongoing studies will result in the collection of voluminous data on a scale unprecedented for the ORNL site. A computerized data base is being developed to manage these data effectively. The data base is being constructed to (1) provide a centralized repository for site characterization data generated for the RA Program and (2) facilitate report generation and the manipulation, analysis, and display of numeric data.

This report summarizes the current Data Base Management (DBM) system and its role in supporting the RA Program during calendar year 1986. This is accomplished by (1) defining the DBM team and their general responsibilities; (2) describing the design of the data base including its management system, organization, and development; (3) listing the current contents of the data base; (4) discussing quality assurance measures implemented to ensure the accuracy and security of the data; and (5) briefly discussing other activities associated with data management for the program.

1. INTRODUCTION

The Oak Ridge Reservation was established in 1941 as part of the "Manhattan Project" to produce the atomic bomb. A portion of the reservation, now designated as the Oak Ridge National Laboratory (ORNL) site, was selected for the development of a prototype reactor and reprocessing facility for the production of plutonium. Consequently, from its beginning, ORNL has generated large quantities of fission-product, uranium, and transuranic waste solutions, as well as solid radioactive wastes. Although it was originally anticipated that the mission of ORNL would be short-lived (1 to 2 years), the facilities were subsequently expanded to provide for peacetime applications of nuclear power and other energy technologies. Today, ORNL continues to generate not only large quantities of radioactively contaminated waste but also a wide variety of nonradioactive hazardous wastes, all of which are regulated by numerous environmental laws and regulations.

The Remedial Action (RA) Program at ORNL was established in FY 1985 to comply with applicable federal and state environmental regulations. To achieve this goal, numerous and varied studies are being conducted to characterize the waste disposal sites; these ongoing studies will result in the collection of voluminous data on a scale unprecedented for the ORNL site. A computerized data base is being developed to manage these data effectively. The data base is being constructed to (1) provide a centralized repository for all site characterization data generated for the RA Program and (2) facilitate report generation and the manipulation, analysis, and display of numeric data.

1.1 PURPOSE AND SCOPE

This report summarizes the current Data Base Management (DBM) system and its role in supporting the RA Program during calendar year 1986. This is accomplished by (1) defining the DBM team and their general responsibilities; (2) describing the design of the data base, including its management system, organization, and development; (3) listing the current contents of the data base; (4) discussing quality assurance measures implemented to ensure the accuracy and security of the data; and (5) briefly discussing other activities associated with data management for the program.

Several previous reports regarding the RA Program Data Base have been published (Cushman 1985; Voorhees et al. 1986a, 1986b; Voorhees and Faulkner 1986). Although the reader can refer to these earlier publications for information on the historical development of some of the data sets and the data base in general, this annual report is written as a "stand-alone" document.

2. DATA BASE MANAGEMENT TEAM AND SERVICES

2.1 MANAGEMENT TEAM

The DBM system is operated within the Environmental Sciences Division (ESD) at ORNL by a task leader, three data coordinators, a Geographic Information System (GIS) operator, and a computer programmer. The task leader (1) defines the needed DBM tasks 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 RA sites.

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

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

The GIS operator assists in the generation of graphic displays of spatially oriented data. Tasks include building and maintaining data files of base maps of areas being investigated, plotting spatially oriented data maintained in the RA Program Data Base to verify their accuracy, and assisting in the geographic analysis of data (e.g., calculating areas, distances, etc.). Because the GIS in ESD has operating software which is different from the other graphic display systems at ORNL, the GIS operator, in cooperation with other staff at ORNL, must also develop the software necessary to transfer data from these sources and to reformat the data specifically for our GIS.

The computer programmer provides data manipulation and program development beyond that performed by the data coordinators. For example, during the early stages of the RA Program, much of the computer programmer's efforts consisted of developing 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 is minimized and (2) errors in transcription do not compromise the accuracy of the data. The programmer also provides support to the data coordinators when necessary.

2.2 SERVICES

The DBM activity is designed to provide for a complete, well-documented, verified data base for the RA Program. This requires that print-outs of raw and intermediate data sets, as well as computer access to the data, be provided routinely to the principal

investigators (PIs) of a task for information and verification purposes (Sect. 3.3). In addition, DBM staff provide data in various formats upon request from program staff. Requests originating outside ORNL (e.g., the Environmental Protection Agency or Tennessee Department of Health and Environment) must be made through official channels. Twenty-seven requests for data and information were fulfilled throughout 1986 (see Appendix A).

Although data analyses are primarily the responsibility of those who collect the data, DBM 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 PI at the time of the request. Specialized data analyses and plots not supported by the data management software are handled case by case. 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. For example, results from the groundwater contaminant scoping survey and from groundwater-level measurements are routinely provided to the Energy Division (Ketelle et al. 1986) for the generation of well hydrographs (see Fig. 1) and groundwater surface contour maps (see Fig. 2).

Although the ESD only recently acquired its GIS (Sect. 3.1), the system has been used to produce large-scale plots of the locations of piezometer and water quality wells drilled for the RA Program. These plots, required by state and federal regulators, were scaled to

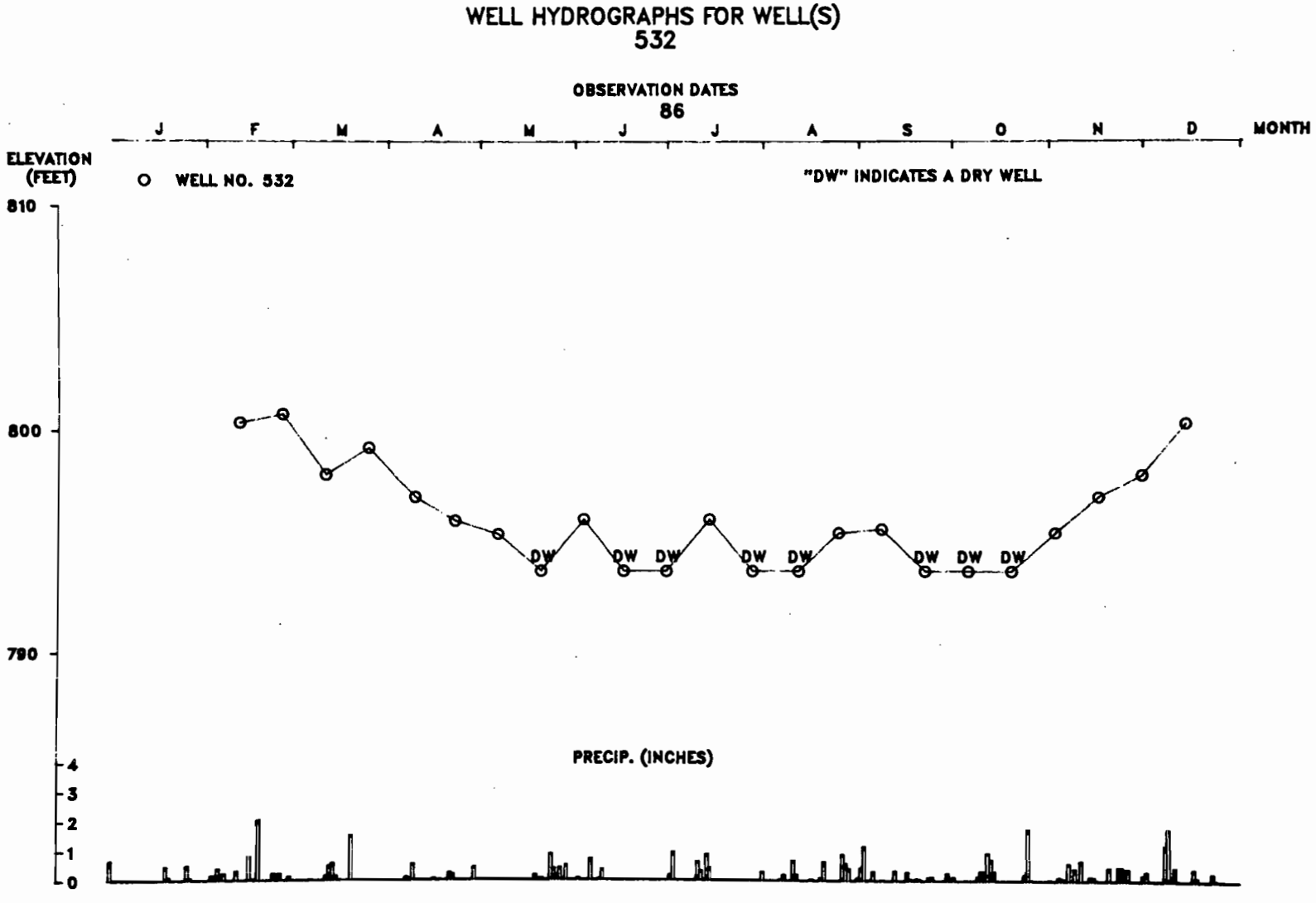

Fig. 1. Example of well hydrograph from groundwater characterization study.

ORNL-DWG 87-1467

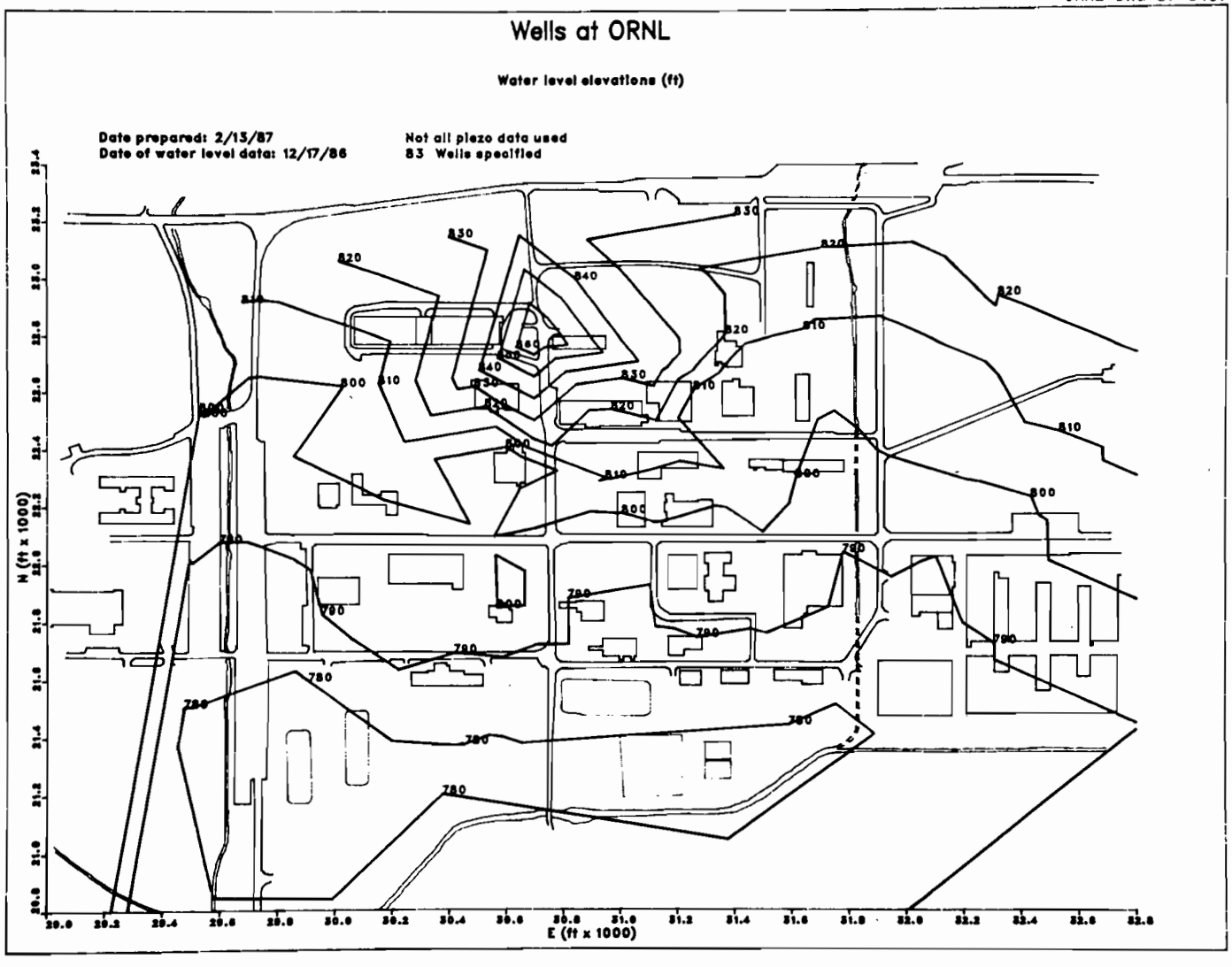

Fig. 2. Groundwater surface contour map of main plant area for December 17, 1986.

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 will be very useful to the RA Program. Progress has been made in developing the computer code for transferring and reformatting these digitized data sets to the GIS in ESD. Once such geographic data sets are 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 groundwater well data whose locations can then be plotted to the scale of an existing RA Program map. 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 multiple classes of data simultaneously, such as well locations, waste area group boundaries, and sampling transects. These analyses are particularly useful to multidisciplinary projects such as the RA Program.

As the RA Program matures and the size and complexity of the data base increase, it would be desirable to expand DBM's role in data analyses. No other group will be as familiar with the entire data base as the DBM staff, and it will be especially important to provide analyses that integrate the data from various tasks of the program. Such analyses require the involvement of staff who are thoroughly familiar with all data sets in the data base to assist in hypotheses testing, 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. The DBM staff would work closely with the PIs collecting the data.

3. DATA BASE DESIGN

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

The RA Program Data Base serves as a central repository for all site characterization data. Such data will be 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 must be 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 groundwater and surface water contaminant scoping surveys and from surveys of groundwater-level measurements are important not only independently but will also be used collectively to determine the placement of water-quality monitoring wells required by federal regulations. Information in the data base must be available for assessments of alternatives for long-term stabilization of the RA sites. The flexibility and versatility of the data base design will help ORNL staff implement state and federal regulatory requirements as they arise.

3.1 DATA BASE MANAGEMENT SYSTEM

The data base principally uses the Statistical Analysis System (SAS)* installed on the ORNL tandem IBM-3033 computers. Information related to lengthy descriptive documentation of the data sets, bibliographic information, administrative/record-keeping tasks, and some forms of data entry are handled using software packages other than SAS. For these cases, software such as dBASE III PLUS, Lotus 123, and Word Perfect 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. In addition to its compatibility with IBM computers and several minicomputers (e.g., VAX and Data General), SAS is available for the IBM PC/XT and AT microcomputers. The primary strength of SAS is its ability to combine data management capabilities with extensive statistical and graphics capabilities 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. Using SAS, files can be produced in various formats for transfer to other computer systems and for the very specialized data analyses and graphic displays

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*SAS is the registered trademark of SAS Institute, Inc., Cary, North Carolina.

not offered by SAS itself. Although SAS is not a true data management system per se (e.g., it lacks built-in capabilities for producing hierarchical and relational file structures), such data management systems do not have the extensive statistical and graphics capabilities of SAS. SAS can be operated through a sophisticated interactive mode or through a batch mode.

The GIS was installed by ESD in November 1986, and a two-week training course was held. The GIS, which can be used to analyze and present spatially oriented data, is based on ARC/INFO* software installed on the ESD VAX 750. ARC/INFO allows the user to combine and subset descriptive data associated with spatially defined data. Complete graphic and mapping capabilities are also contained within the ARC/INFO software. In addition, ARC/INFO will allow data exchange with several other GIS systems, including the U.S. Geological Survey (USGS) Digital Line Graph (DLG) format, U.S. Census Bureau Geographic Base File/Dual Independent Map Encoding (GBF/DIME) format, and the ORNL Geographic Data Systems format. Because the ESD VAX 750 is connected to the ORNL DECNET network, data can be readily transferred on-line from other ORNL computers [Scientific and Technical Computing (STC) 8600s, Computing and Telecommunciations Division (C&TD) DEC-10, and IBM 3033s]. Data can also be added to the GIS via digitized entry on the GIS 60-in. digitizer.

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*ARC/INFO is a product of Environmental Systems Research Institute, Redlands, California.

Several graphics devices are available for displaying output from ESD's GIS. These include a 34-in. color pen plotter, a 36-in. black and white electrostatic plotter, and an 8.5- by 11-in. color ink-jet plotter. These devices can produce both final report quality products and large, working products.

3.2 ORGANIZATION OF THE DATA BASE

The approach to studying the contamination problems at ORNL dictates how the data base must be organized. All known active and inactive waste management areas, contaminated facilities, and potential sources of continuing releases of contaminants to the environment have been geographically and hydrologically categorized into 20 waste area groupings (WAGs). The current regulatory compliance effort involves a sequential approach of conducting (1) Preliminary Assessments/Site Investigations for each WAG, (2) Remedial Investigations/Alternative Assessments for WAGs determined to be contaminated, and (3) a single, comprehensive Feasibility Study for determining corrective actions to be implemented at the contaminated WAGs.

Initial efforts to characterize the WAGs and the individual solid waste management units (SWMUs) within a WAG boundary generally have focused on the use of scoping surveys (i.e., a one-time sampling effort to determine potential contamination of groundwater and surface water). If the data from the scoping surveys do not indicate a continuing release of contaminants, then efforts will be made to receive federal authorization to remove the WAG and its associated SWMUs from the list of sites requiring corrective action. However, if contamination is

detected, then a comprehensive Remedial Investigation of the WAG must be conducted to determine the source of contamination. Results from such studies will play a significant role in the selection of the preferred corrective action.

ORNL's approach to implementing the RA Program focuses on the concept of WAGs; therefore, the data base should be organized by WAG. The data collected to date, however, are primarily the result of scoping surveys and pertain to several WAGs. Such data have been cataloged according to the PI conducting the study. For example, data from Cerling's contaminant scoping surveys reside in the SAS library named ENVSCI.BST25255.SAS.CERLING. This library currently contains four SAS data sets: FIELD1, FIELD2, ACD1, and ACD2 (field data and analytical chemistry data from 1985 and 1986 studies, respectively). Therefore, the general structure of the data base can be thought of as multiple SAS libraries, with each library containing one of more SAS data sets.

It is anticipated that data resulting from the Remedial Investigation studies conducted for each WAG will be cataloged according to the WAG under investigation; that is, a permanent SAS data library will be established for each WAG. Data resulting from each task of the Remedial Investigation for a particular WAG will be stored as separate SAS data sets within the appropriate SAS library. Organizing the data in this manner will allow 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. Accessing data from other tasks would not be possible without getting authorization from the

appropriate PI and/or project coordinator. 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.

3.3 DATA PROCESSING

Several data processing steps must occur from the time the data are collected until they become part of the centralized RA Program Data Base (Fig. 3); data are collected, encoded, entered, and verified. Data collection, encoding, and entry are described in general in Sect. 3.3.1 through 3.3.4; data verification is a component of quality assurance and is therefore a part of all data processing steps. Section 3.3.5 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 specific to a task. The key is to define the procedures and adhere to them until it can be shown that an alternative method would result in improved quality assurance techniques (see Sect. 5).

3.3.1 Data Collection

Sites known or suspected to be contaminated are being characterized through the analysis of existing and newly collected data. Several factors contribute to the types and amount of data to be collected; these include the extent of the site; concentrations and volumes of disposed of contaminants; geologic setting of the site; propensity for contaminant migration; and potential health hazards. Spatial and temporal aspects of data collection must be appropriately considered to correctly identify the existence, nature, extent, and

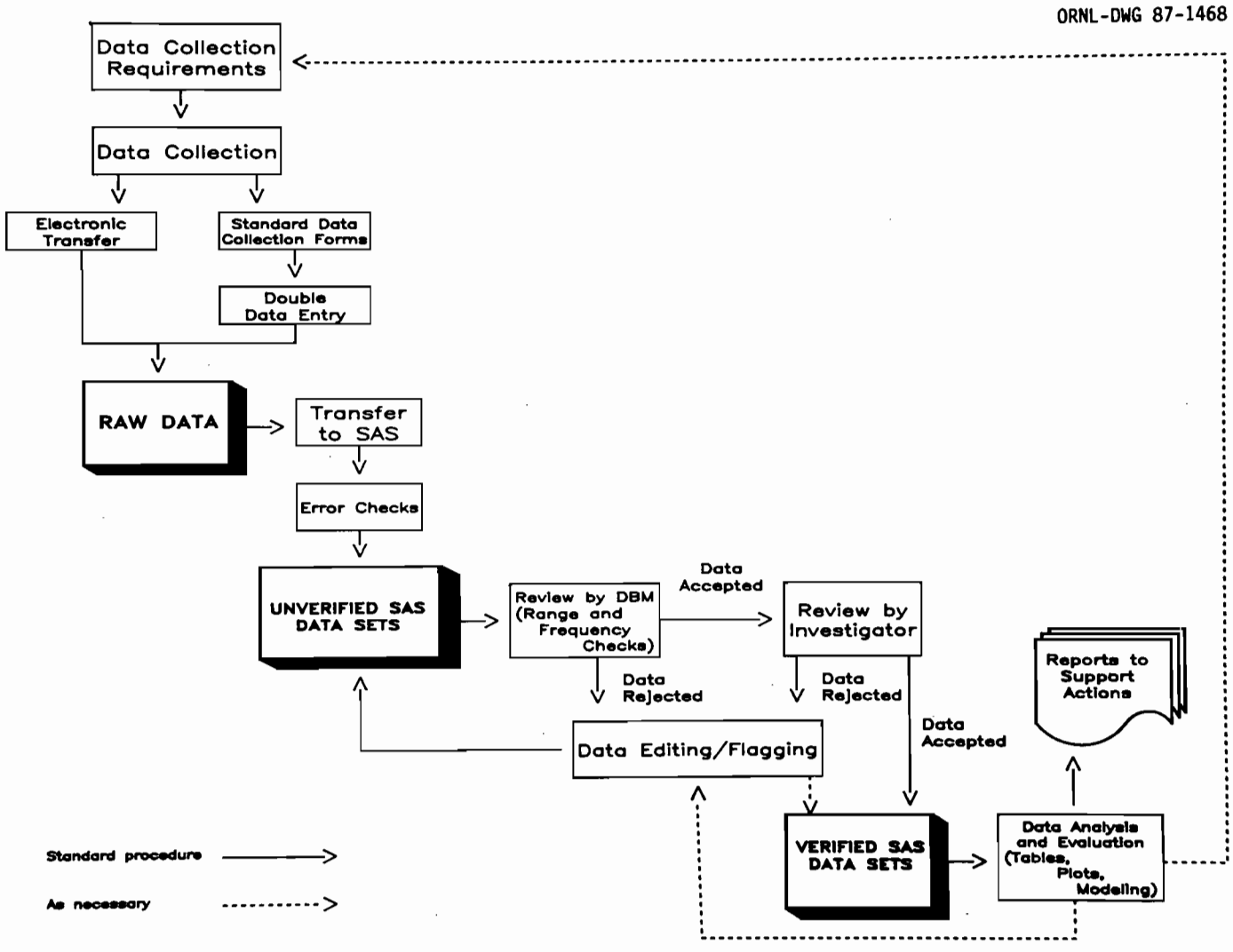

Fig. 3. Generalized flow diagram for processing data.

sources of contamination. Site characterization of subsurface conditions often requires an iterative process of data collection and analysis as indicated in Fig. 3.

In addition to data generated by the ongoing Remedial Investigation studies, 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 date;
- 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 is encouraged whenever possible, to promote consistency regardless of the data's origins. Forms can be developed through the cooperative efforts of the PI and the data base management staff.

Currently there are more than 150 corrective action sites of widely ranging characteristics within the RA Program. Therefore, unique and concise identification codes (IDs) are assigned to all sites and samples. Key identifiers such as sample ID or well number are cross-referenced among the various data sets to site names, latitude/longitude coordinates, and other identifiers within 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 the RA Program are generated by a variety of sources, including the PIs for a study, subcontractors (e.g., MCI Consulting Engineers), the U.S. Geological Survey (USGS), Oak Ridge Associated Universities, ORNL's Analytical Chemistry Division (ACD), ORNL's Department of Environmental Management (DEM), and ORNL's Waste Operations Control Center (WOCC). 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, labelled 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 functions, both automatic and programmed, for data entry and maintenance. The functions can include (1) verification (e.g., range checking) at the time of entry and before continuing to the next field; (2) use of predefined codes, with full descriptors on 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 Quality Assurance/Quality Control for Chemical Analyses

Because the RA Program was established to provide corrective measures in areas that have been contaminated with radioactive and hazardous chemical wastes, many of the investigations involve analytical chemical analyses. The majority of these analyses are performed by the ACD at ORNL. In an effort to independently evaluate 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 data set is being established to document the results of this study (Appendix B, Table B.6).

The ACD raw data are received by DBM on forms produced using the PC software package Lotus 123; the forms are completed by the PI conducting this task (see Appendix C). A separate form has been developed for each type of analysis to be reported, thereby minimizing repetitive entry by the PI and reducing the possibility of human error. 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 on the PC hard disk, and backed up on floppy diskettes.

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). Comparisons can then be made of the expected results and the actual results measured by ACD.

Should the need for report generation or graphics capabilities outgrow the PC's capacity, data can be uploaded from the PC to the IBM 3033 mainframe computer for further processing.

3.3.4.2 Precipitation Data Summary

Precipitation data in the Oak Ridge area are currently collected and managed by several investigators using a variety of methods, making it difficult to quickly compare these data across all sites. Efforts were initiated late last year to compile a summary of these data by developing a data set of total daily precipitation from 20 sites in the Oak Ridge vicinity. Compilation of such information will be useful not only to those investigators who need precipitation data in general, but also to those who provide the data so that they can compare their monitoring results (for quality assurance) to those collected at other sites. Twelve of the sites currently represented in the data summary are managed by DEM; the other eight sites are managed by various investigators in the ESD. A description of the contents of the precipitation data set is presented in Appendix B, Table B.7.

Data are provided to DBM electronically as draft data sets by the tenth of each month; DEM staff provide SAS data sets and ESD staff provide the data as ASCII files. To verify that the data have not been corrupted during transport, a comparison is made of univariate statistics generated both before and after file transfer. The data are then compiled into a single SAS data set and returned to the contributors within 5 d for their review. They are allowed 10 d to review the data, after which time DBM is notified of any suspect values so that these can be flagged appropriately. By adhering to this schedule, the precipitation data summary will never be more than 6 weeks out of date.

In addition to the precipitation data set, a second SAS data set is being created to record descriptive information for each monitoring

station. This data set also contains information such as frequency of data collection, administrative contact person, and technical contact person (Appendix B, Table B.8). Investigators desiring more detailed data than that given in the data summary can request it from the original source.

As with any new data collection effort, implementing the procedures takes time; we expect this data set to be fully functional by March or April of 1987.

3.4.4.3 Piezometer Well Data Sets

Over 200 piezometer wells were installed by the RA Program in 1986. Data obtained from these wells will be 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, who prepare them for data entry. These field sheets are sent to C&TD's Data Entry group; the data are typed into an ASCII file, 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 proofed against their field sheets. Concurrently, the data set is subjected to the following SAS error checking routines:

1. Any observations with missing values for DEPTHTW are printed with the comment to see if there is an appropriate explanation (e.g., "dry well");
2. Any observations for which DEPTHTW exceeds total depth of well are printed;
3. Any observations in which DEPTHTW exceeds a specified value from the previous measurement are printed;
4. Any duplicate entries for a well are printed; and
5. Any observations falling outside a specified range of sampling dates are printed.

Print-outs of these potential errors in the data set are provided to the PI to be resolved. After all errors have been corrected, a permanent SAS data set is created and appended to the cumulative SAS piezometer data set. The contents of this data set are described in Appendix B, Table B.4.

3.4.4.4 Analytical Chemistry Data

The majority of the data collected to date consists of chemical analyses performed by the ACD. Transfer of such data into a verified SAS data set is described in the following general example. The PI collects samples and submits them to the ACD for analysis. The ACD performs the analyses, records the results on a computer, and sends a print-out of the raw data to DBM staff. DBM sends a copy of the print-out to the PI responsible for generating the data for his or her information. DBM then transfers the ACD data electronically to the RA Program Data Base, putting the data into the SAS format and adding information such as extraction procedures, analytical methods, and task

leader directing the work. Because the samples may be analyzed by several ACD laboratories (e.g., for radionuclides, metals, organics), it was necessary to write software to convert the various outputs from each laboratory into the common SAS format. Although the data have already passed through several computerized evaluations (e.g., checks for missing values, erroneous data, and inconsistencies), they are, at this point, referred to as unverified SAS data sets. The data are further subjected to SAS programs to check for impossible or unrealistic values as additional quality assurance checks (Sect. 5). The PI responsible for the data is then given (1) print-outs of the data, including summaries, and (2) computer access to the SAS data set, and 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 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, and the final data set is incorporated into the verified SAS data base. The contents of one of the SAS data sets containing ACD data are described in Appendix B, Table B.3.

4. DATA BASE CONTENTS

Data generated within the RA Program this past year have dealt with a wide variety of topics, ranging from well construction parameters to species abundance of benthic macroinvertebrates. Ideally, all RA Program data would be included in the data base as they are generated; this is not feasible, however, because of manpower and budget constraints. Collection of data from site characterization studies has been given greater emphasis than data from technology demonstrations, site surveillance and maintenance for near-term corrective actions, biological surveys, etc. This emphasis is apparent in the degree of development of the various data sets. To ensure that all data are accounted for, procedures have been established to document the location of all data collected for the program. The bibliographic data base being developed for the program contains a variable (DATSOURC) for this purpose (Owen and Voorhees 1987; see also Sect. 6 of this report). For example, data referenced in the report by Cerling and Huff (1986) are maintained in the RA Program Data Base; therefore, the contents of DATSOURC in the bibliographic data base will be "RA Program Data Base, L.D. Voorhees, 1505 (4-7309)." Data referenced in the report by Huff and Melroy (1986), however, currently reside with Huff and will be indicated as such in the bibliographic data base; when these data become part of the RA Program Data Base, the entry for the DATSOURC variable will be changed accordingly.

More than 50 SAS data sets currently reside in the data base. Contents of a few of the various types of data sets being developed (e.g., chemical analyses, field sampling, well construction parameters, precipitation monitoring) are presented in Appendix B. Variable names, types, lengths, and labels are included in the data set descriptions.

4.1 CONTAMINANT SCOPING SURVEYS

Initial site investigations have focused on the use of scoping surveys to characterize the environment with respect to the presence of radionuclides and hazardous chemicals. Consequently, the bulk of the data acquired since the program was initiated consists of chemical analyses conducted by the ACD. Over 35,000 individual chemical analyses from 5 individual characterization/contaminant scoping surveys reside in the RA Program Data Base. With 17 variables recorded for each analysis, these data sets alone collectively contain over 600,000 entries. The names of the SAS libraries and the ACD and corresponding field data sets are given in Table 1, along with an indication of their size.

In general, the ACD data sets (Table 1) contain the following variables: request number (unique number for a batch of samples), customer sample identification number (unique number for an individual sample from which the sample ID is derived), name of the constituent being analyzed (e.g., Pb, ^{90}Sr), prefix, result, limits, units, extraction technique, analytical method, site ID, comments, date entered, and other variables that allow the data to be easily checked against the raw data (i.e., 1022 data base files) if needed. The FIELD

Table 1. SAS data sets for characterization/contaminant scoping surveys

Library	Data set name	Description of data set	Approx. no. of obs.	No. of variables
ENVSCI.BST25255.SAS.TAYLOR	ACD1	Analytical chemistry results for contaminant scoping survey of wells and seeps in the Solid Waste Storage Areas (SWSAs) and pits and trenches, and in sediment cores from White Oak Lake.	10,000	17
	FIELD1	Field data for contaminant scoping survey of wells and seeps in the SWSAs and pits and trenches, and in sediment cores from White Oak Lake.	120	10
ENVSCI.BST25255.SAS.CERLING	ACD1	Analytical chemical analyses of streambed materials and water in in White Oak Creek and tributaries.	11,100	17
	FIELD1	Field data for study of streambed materials and water in White Oak Creek and tributaries.	335	8
	ACD2	Analytical chemical analyses for contaminant scoping survey of Waste Area Groupings (WAGs) 11-20.	6,100	17
	FIELD2	Field data for contaminant scoping survey of WAGs 11-20.	168	7
ENVSCI.BST25255.SAS.STANS	ACD1	Characterization of pond water, sediments, and groundwater monitoring wells associated with Old Hydrofracture Facility (OHF), Homogeneous Reactor Experiment (HRE), and pond 3513.	2,500	17
ENVSCI.BST25255.SAS.HUFF	ACD1	Analytical chemical analyses of drill cores from water quality wells installed by the RA Program.	4,200	17
	FIELD1	Field data for drill cores submitted for chemical analyses.	47	7
	ACD2	Analytical chemical analyses of line chalk which may be used in monitoring piezometer wells.	33	17

Table 1. (Continued)

Library	Data set name	Description of data set	Approx. no. of obs.	No. of variables
ENVSCI.BST25255.SAS.KETELLE	ACD1	Groundwater contaminant scoping survey; chemical analyses of water samples taken from piezometer wells.	3,700	17
	FIELD1	Field data for groundwater contaminant scoping survey.	56	8
	ACD2	Chemical analyses of drill cuttings from selected piezometer wells.	252	17

data sets contain variables such as sample ID, sampling date, sampling location (e.g., ORNL grid coordinates), description or type of sample (e.g., water, gravel, drill cuttings), and sampling depth and increment if applicable.

4.2 HYDROLOGIC STUDIES

Hydrologic studies conducted for the program to date have required installing more than 200 piezometer wells, 22 water quality wells, and 19 hydrostatic head monitoring stations. Data from these wells are being used to determine the position of approximately 300 water quality wells to be installed over the next 2 years. SAS data sets that have been established for well construction parameters and water level measurements are listed in Table 2.

The Discharge Forecast Modeling Project and the Site-wide Performance Modeling Study being conducted for the program require the use of surface discharge and precipitation monitoring results. Such data are collected by the USGS and ORNL's DEM, WOCC, and PIs for selected projects. Several tasks were conducted last year to access these data sets. Precipitation monitoring was discussed in Section 3.3.4; the remainder of this section primarily addresses surface discharge data.

The WOCC at ORNL operates a real-time data acquisition system to monitor over 300 signals (e.g., surface flow, pH, conductivity, gross beta) throughout the plant site. Although the primary purpose of the monitoring system is to trigger alarms which alert the WOCC operator of

Table 2. SAS data sets regarding groundwater hydrology studies within the Remedial Action Program

Library	Data set name	Description of data set	Approx. no. of obs.	No. of variables
ENVSCI.MAF25255.SAS.ERFU2	PIEZCONS	Construction data on piezometer wells installed by RA Program.	124	21
	PIEZDAT1	Depth to water measurements and other activities (e.g., well sampled) conducted at piezometer wells monitored by A. E. Hunley	1746	8
	PIEZDAT2	Depth to water measurements and other activities conducted at piezometer wells monitored by T. Thomas	362	8
	STRMCHK	Records of wet or dry conditions at various stream check points; data used in support of depth to water measurements	63	7
	WQCONS	Construction data on water quality wells installed by RA Program	22	28
	PRAPWELL	Construction data on monitoring wells installed before establishment of RA Program; data compiled by W. J. Boegly, Jr.	614	19
	HFWELL	Construction data on hydro-fracture wells installed before establishment of RA Program; data compiled by W. J. Boegly, Jr.	89	19

potential problems, the data are stored at 3-sec intervals on a magnetic tape and subsequently condensed to 10-min averages. Data have been collected and stored in this manner for over 2 years, but until the RA Program retrieved some of the data last year, no one had ever made use of these historical records.

SAS data sets (Table 3) have been written for those parameters and time periods related to the initial work on the Discharge Forecast Modeling Project (Sale et al. 1986). Although these data sets are for a limited time period (i.e., mid-November 1985 through January 1986) and represent 1-h time intervals, raw data of the 10-min time intervals over the last 2 years are available from the WOCC. Surface water quality and stream discharge data available for specific sites are indicated in Table 4; monitoring locations are depicted in Fig. 4. Procedures have been established to write SAS data sets from these data, although it is not a trivial task to do so; the first time data are processed into a usable format invariably reveals problems (e.g., missing or erroneous data because of equipment malfunctions). Before these data can be used they must be carefully checked. Recently, changes have been made by the WOCC in data reduction and management techniques, improving the accessibility and reliability of the data.

Staff within ESD have been collecting and managing hydrologic data from selected sites throughout the Oak Ridge Reservation for a number of years. Generally, data are managed using the 1022 data base system. Procedures have been established to transfer the ESD hydrologic data into SAS data sets. Table 5 lists the SAS data sets that have been created from some of the hydrologic data collected within ESD. Although these data sets reflect only the January through June 1986 measurements,

Table 3. SAS data sets written for the Discharge Forecast Modeling Project

(Primary source of data was the Waste Operations Control Center)

Library	Data set name	Description of data set	Approx. no. of obs.	No. of variables
ENVSCI.MAF25255.SAS.WOCC	K25SIM	TVA simulation model results on SR90 concentrations at K-25 water intake	362	5
	MBBETAG	Melton Branch beta-gamma count	1878	4
	MBCOND	Melton Branch conductivity	1878	4
	MBPH	Melton Branch pH	1878	4
	MBQ	Melton Branch flow rate	1878	4
	MBTURB	Melton Branch turbidity	1878	4
	MHDAM_Q	Melton Hill Dam flow rate	1635	4
	WOCBETAG	White Oak Creek beta-gamma count	1878	4
	WOCCOND	White Oak Creek conductivity	1878	4
	WOCPH	White Oak Creek pH	1878	4
	WOCQ	White Oak Creek flow rate	1878	4
	WOCTURB	White Oak Creek turbidity	1878	4
	WODBETA	White Oak Dam beta count (Note: no gamma counts)	1878	4
	WODCOND	White Oak Dam conductivity	1875	4
	WODPH	White Oak Dam pH	1875	4
	WODQ	White Oak Dam flow rate	1875	3
	WODSR90	White Oak Dam Strontium 90	375	3
	WODTURB	White Oak Dam turbidity	1875	4

Table 4. Monitoring locations for real-time surface water quality and stream discharge data

(Numbers in the table indicate concentrator and signal for telemetry data received at the Waste Operations Control Center)[a]

	Monitoring location[b]							
Variable	WOD	WOC	MB	7500 Bridge	STP	Flume	Fifth Street	HFIR early warning
Gross beta	5/10	c	c	c				
Gross beta+ gamma		7/1	7/2	5/8	5/17	4/4	4/3	
Alpha		7/3	5/9					
Gross gamma	5/11	c	c	c				
pH	5/26	7/9	7/16	5/22		4/5	4/17	5/27
Conductivity	5/35	7/11	7/28					
Turbidity	5/36	7/26	7/27					
Water temperature	5/24	7/7	7/14					
Dissolved oxygen	5/25	7/8	7/15					
Stream discharge								
General						4/16		
High	5/23	7/6	7/13					
Medium	5/41							
Low	5/33	7/5	7/12					
Water level	5/34	7/10	7/17					
Composite	5/44							
System alarm	5/109	7/68	7/69		5/115	4/66		

[a]Data are available for 10-min intervals over approximately the past two years.

[b]WOD = White Oak Dam; WOC = White Oak Creek; MB = Melton Branch; STP = Sewage Treatment Plant; HFIR = High Flux Isotope Reactor. Monitoring locations depicted in Fig. 4.

[c]The Department of Environmental Management plans to modify the monitoring equipment at this site to collect these data.

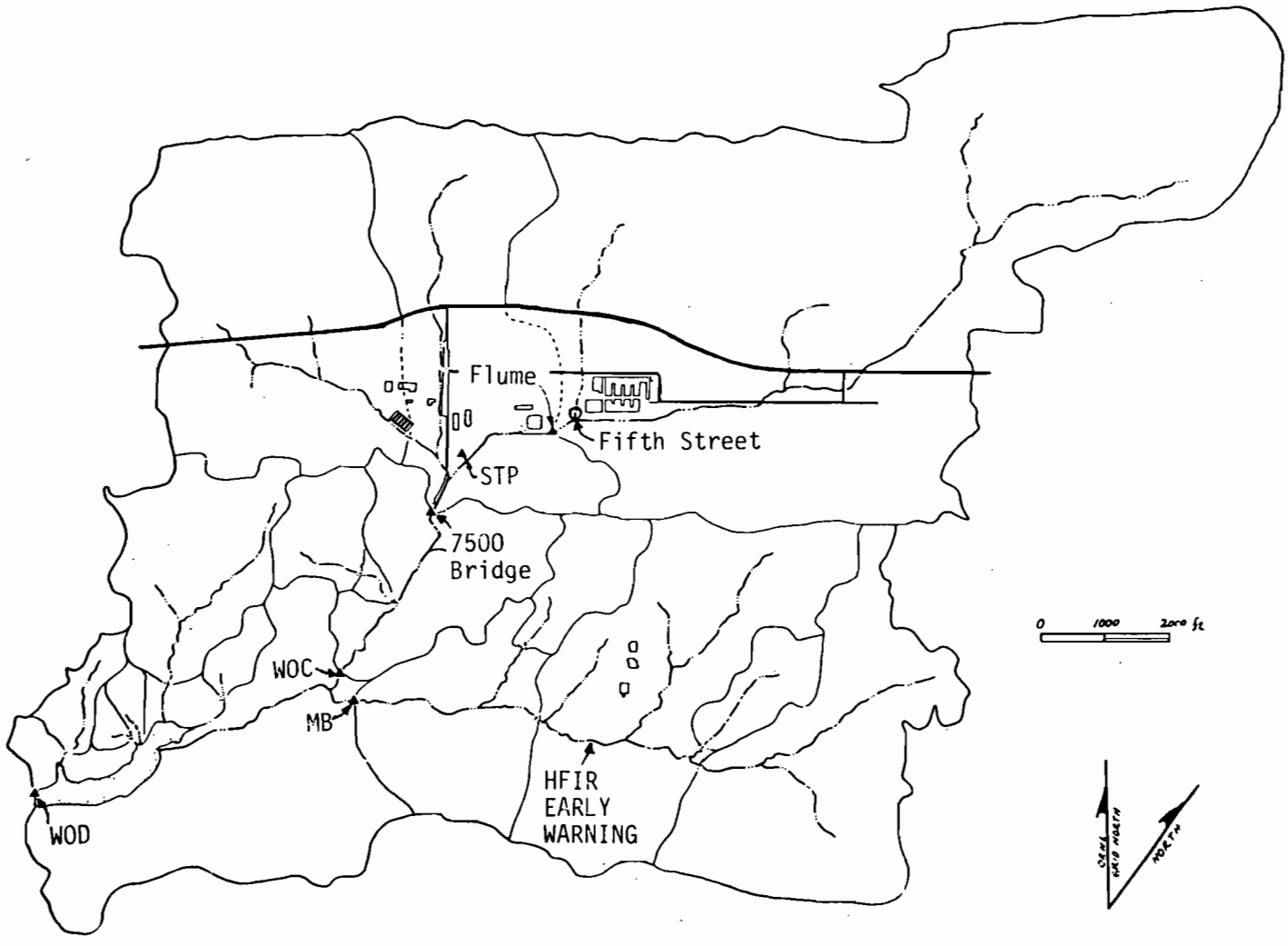

Fig. 4. Locations monitored for surface water quality and stream discharge by the Waste Operations Control Center; see Table 4 or variables monitored.

Table 5. SAS data sets written from selected hydrologic data collected by staff within ESD

Data set name	Description of data set[a]
F7WELL.SAS	Depth to water measurements at wells installed at proposed SWSA 7 area (23 wells)
WELCON.SAS	Well constants (e.g., measuring point elevation, ground surface elevation) used to derive groundwater surface elevation at proposed SWSA 7 area (23 wells)
F7PREC.SAS	Precipitation recorded at the proposed SWSA 7 area
F7C86.SAS	Streamflow measurements at one site at the proposed SWSA 7 area
S4WELL.SAS	Depth to water measurement at wells installed at SWSA 4 (20 wells)
S4CNST.SAS	Well constants (e.g., measuring point elevation, ground surface elevation) used to derive groundwater surface elevation at SWSA 4 (20 wells)
MS186.SAS	Streamflow measurements at the MS1 site at SWSA 4
T2A86.SAS	Streamflow measurements at the T2A site at SWSA 4

[a]January through June 1986; established to demonstrate the procedures for transferring data from the 1022 data base system to SAS.

establishing the transfer procedure for the three principal types of data (i.e., wells, streamflow, and precipitation), will facilitate the creation of additional SAS data sets when needed.

DEM collects and manages a large amount of data each year in accordance with regulatory requirements. Although these data are available to the RA Program, we are not allowed direct access to their computer system because it also contains classified, sensitive information. Thus, to make use of their environmental monitoring data we must maintain duplicate files in our data base. Until formal arrangements have been made for us to routinely receive copies of data collected by DEM, we will continue to duplicate only those data sets necessary to the RA Program tasks. Data sets obtained from DEM in 1986 are listed in Table 6; this primarily includes surface discharge data from White Oak Dam, White Oak Creek, and Melton Branch for the period January 1985 through June 1986, and ^{90}Sr results from grab samples taken in response to the ^{90}Sr spill is late November/early December 1985.

4.3 DATA SETS BEING DEVELOPED

Several other tasks within the RA Program this past year have resulted in the collection of a variety of data and information. These data sets, which are currently being developed, include

- chemistry data for water used in aquatic toxicity studies;
- toxicity test results for fathead minnow;
- toxicity test results for daphnia;
- field data for characterization of benthic macroinvertebrate communities in White Oak Creek and its tributaries;

Table 6. SAS data sets provided by the Department of Environmental Management at ORNL

Library	Data set name	Description of data set	Approx. no. of obs.	No. of variables
ENVSCI.LDV25255.SAS.FLOW	FLOWD85	Daily flow rate for monitoring stations MB1, STP, WOC, and WOD for Jan. 1-Dec. 31, 1985	1633	9
	FLOWD86	Daily flow rate for monitoring stations MB1, STP, WOC, and WOD for Jan. 1-June 6, 1986	555	6
	FLOWW85	Weekly flow rate for monitoring stations MB2, NWT, PWTP, HRT, FLUME, EAST SEEP, WEST SEEP, 1505, 190 PONDS, and 7500 BRIDGE for Jan. 1-Dec. 31, 1985	529	5
	SPC1	Radionuclide monitoring by DEM associated with the Nov/Dec 1985 SR-90 spill	2872	9

- results of characterization of benthic macroinvertebrate communities in White Oak Creek and its tributaries;
- tank survey studies; and
- regulatory standards.

4.4 SUPPLEMENTAL INFORMATION

Although almost anything can be computerized in some kind of format, often it is not practical to maintain lengthy character fields in a data set that will be printed routinely. In such cases, codes are assigned to represent a data entry. For example, "04A" is the standard National Pollution Discharge Elimination System (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: ACD's abbreviation, the full name of the element or compound, the NPDES code, the Priority Pollutant (PP) code, or the Chemical Abstract Service (CAS) code. Also, format files have been written to refer to the geologic unit of a core segment and for the pipe and screen materials used in the construction of the piezometer and water quality monitoring wells. These files are listed in Table 7.

Table 7. Format files for defining data entries for selected variables

Data set	Member name	Description of file
ENVSCI.BST25255.SAS.FORMATS	(PPFMT)	File for converting from NPDES[a] to PP[b] codes; can be used with ACD SAS data sets
	(CASFMT)	File for converting from NPDES to CAS[c] 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
ENVSCI.MAF25255.FORMAT.WELL	(GEOU)	File for printing geounit, pipe material and screen material when used with the WQCONS and PIEZCONS SAS data sets

[a]National Pollution Discharge Elimination System.
[b]Priority Pollutants.
[c]Chemical Abstract Service.

5. QUALITY ASSURANCE AND DATA SECURITY

The RA Program at ORNL involves a wide variety of remedial action sites and is being implemented by numerous personnel from several ORNL divisions. Maintaining quality assurance for a project driven by state and federal regulations is extremely important. Several measures have been instituted by DBM staff to ensure that the data generated by the various tasks have been accurately recorded in the data base and are protected from accidental or unauthorized access.

5.1 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

At the heart of QA/QC for data base management is the establishment of complete documentation of the data base, including data set descriptions, data definitions, and descriptions of data base organization and support programs. Such documentation is developed as data handling procedures are established and the data sets are built.

In the strictest sense, QA refers to the accuracy of the data with respect to predefined limits set for environmental sampling (e.g., pH for a particular study might be defined to fall within a range of 3.0 to 6.0). QC refers to the requirement of following predefined procedures for collecting, recording, and analyzing the data. Adhering to well-defined QA/QC procedures is an integral part of all aspects of data handling. The PI is responsible for developing his or her own QA procedures (e.g., sampling protocols, instrument calibrations, etc.). Since it is impossible to discuss data processing without touching on QA/QC procedures, many of these measures taken by DBM staff

to ensure the accuracy of the data have already been discussed in previous sections of this report.

Data are handled as three different data sets before they become part of the RA Program Data Base available for interpretation: (1) raw data, (2) unverified SAS data sets, and (3) verified SAS data sets (Sect. 3.3; Fig. 3). 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. An example of the records for this data verification step is provided in Figs. 5 and 6.

Although a high degree of accuracy can be obtained by using well-established Q/A techniques, the real test of data quality comes during analysis of the data. It is at this time when one usually encounters questionable data. When such data are identified, the

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.

Larry D. Voorhees

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

Attachments

Fig. 5. Request for data verification 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. D. Taylor

Date 2/11/87

++

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

Fig. 6. Form used to signify the completion of data verification.

DBM staff should be notified so that the data in the verified data set can be corrected or flagged appropriately.

5.2 DATA SECURITY

The RA Program data management system 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. Other program staff may read or copy data sets, provided they have the proper password, but are not able to alter the data. Before the data have been incorporated into the verified data base, only the responsible PI and DBM staff have access to the data; after the data have been incorporated into the verified data base, the RA Phase Manager directing the Remedial Investigation study may also have read-only access to the data. All other requests must first be approved by the RA 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 reduces the likelihood of uninformed or improper interpretation of the data.

6. OTHER INFORMATION-RELATED RESOURCES

6.1 BIBLIOGRAPHIC DATA BASE

A subcontractor (or team of subcontractors) will be selected to provide technical assistance to ORNL for characterizing the nature and extent of contamination and for evaluating alternatives for site cleanup. In order for the subcontractor to perform the required tasks, it will be necessary for ORNL to provide a wide variety of information immediately upon initiation of the contract and to continue to assist the subcontractor throughout the contract period by responding to their information needs. To meet these requirements, a computerized bibliographic data base and hard copy reference collection is being developed within the Information Research and Analysis (IR&A) Section of the Biology Division at ORNL. This effort was initiated in November 1986; the formal plan to meet the objectives of the task was published in January 1987 (Owen and Voorhees 1987).

6.2 AERIAL PHOTOGRAPHS

Stereo-pair aerial photographs of the Oak Ridge Reservation and immediate vicinity were obtained as a result of an FY 1986 RA Program task. The photographs cover several years (i.e., 1939, 1945, 1952, 1967, 1974, 1981, 1984, and 1985). Because this resource will be useful to program staff and subcontractors performing characterization and assessment studies, the photographs are being cataloged over the next few months and will be made available through a controlled access system, such as the ORNL/ESD library.

7. REFERENCES

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APPENDIX A

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

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

Request number	Requester	Affiliation	Request	Product supplied	Date Filled
1	Carroll Nix	ORNL/DEM	Information on site 3512 and "Cs-field" data which may be in data base	Data base contents	12/05/85
2	Bill Boegly	ORNL/ESD	ACD data from Taylor's scoping survey	Printout	01/06/86
3	George Southworth	ORNL/ESD	Organic and inorganic data from Cerling's and Taylor's studies	Printout	01/16/86
4	Thure Cerling	U. of Utah	Cerling's WOC survey data files	Tape	02/26/86
5	George Southworth	ORNL/ESD	Organic and Hg data from Cerling's study	Printout	02/13/86
6	Chet Francis	ORNL/ESD	OHF, HRE, and 3513 data	Printout	04/14/86
7	Dale Huff	ORNL/ESD	Radionuclide data for specified sites	Printout	05/02/86
8	Dick Gammage	ORNL/HASRD	Organic data for Taylor's survey samples 122 and 130.	Printout	05/09/86
9	Dale Huff	ORNL/ESD	Piezometer well construction data	Printouts	06/03/86
10	Thure Cerling	U. of Utah	Update of Cerling's WOC survey data	Tape	06/23/86
11	Roy Norman		Bibliography	Copy of report	06/26/86
12	Kip Solomon	ORNL/ESD	Piezometer well construction data	Printouts, data file	07/22/86
13	John Switek	ORNL/ESD	SWSA4 and SWSA5 piezometer well construction data	Printouts	07/23/86
14	Mike Sale	ORNL/ESD	Bibliographic references for Clinch River Studies	References	07/24/86

Table A.1. Continued

Request number	Requester	Affiliation	Request	Product supplied	Date Filled
15	Don Lee	ORNL/ENERGY	Tower C precipitation data for Jan.-Mar. 1986	Plots	07/31/86
16	Don Lee	ORNL/ENERGY	Flow data for Melton Branch	Printout	08/05/86
17	Dick Ketelle	ORNL/ENERGY	Piezometer well water chemistry data	Printout and data file	08/12/86
18	T. J. Blasing	ORNL/ESD	Precipitation data	Printout	09/30/86
19	Roger Clapp	ORNL/ESD	Pits and trenches well data	Data file	09/30/86
20	Roger Clapp	ORNL/ESD	Pits and trenches well data	Data file/ floppy disk	10/07/86
21	George Southworth	ORNL/ESD	Metal data for WOC/WOL fish	Printout	10/17/86
22	Dale Huff	ORNL/ESD	Piezometer well data	Printout	10/22/86
23	Dale Huff	ORNL/ESD	Plots for piezometer well data	Plots	11/24/86
24	Dan Bond		Piezometer well data	Printout	12/11/86
25	Thure Cerling	U. of Utah	Update of Cerling's data set	Printout	12/18/86
26	Dale Huff	ORNL/ESD	Measure point elevations on piezometer wells	Printout	12/22/86

APPENDIX B

EXAMPLES OF CONTENTS OF SAS DATA SETS BEING DEVELOPED FOR THE REMEDIAL ACTION PROGRAM

Table B.1. Names, types, lengths, and labels of variables in HUFFV.WQCONS data set

Name	Type	Length	Label
BBH	NUMERIC	8	BOTTOM OF BORE HOLE ELEVATION (FT)
BHD	NUMERIC	8	BORE HOLE DIAMETER (IN)
BWS	NUMERIC	8	BOTTOM OF WELL SCREEN ELEVATION (FT)
COM1_CON	CHARACTER	80	COMMENT1 FOR CONSTRUCTION DATA
COM2_CON	CHARACTER	80	COMMENT2 FOR CONSTRUCTION DATA
COM3_CON	CHARACTER	80	COMMENT3 FOR CONSTRUCTION DATA
COM4_CON	CHARACTER	80	COMMENT4 FOR CONSTRUCTION DATA
COM5_CON	CHARACTER	80	COMMENT4 FOR CONSTRUCTION DATA
DESTRUCT	NUMERIC	8	WELL DESTRUCTION DATE
DIAMPIPE	NUMERIC	8	DIAMETER OF WELL PIPE (IN)
DIAMSCRN	NUMERIC	8	DIAMETER OF WELL SCREEN (IN)
EASTING	NUMERIC	8	EAST GRID COORDINATE
ENTR_CON	NUMERIC	8	DATE CONSTR DATA ENTERED BY DBM
GEO_UNIT	CHARACTER	8	GEOLOGIC UNIT/FORMATION
GRID	CHARACTER	8	COORDINATE GRID SYSTEM
GRND_ELV	NUMERIC	8	GROUND SURFACE ELEVATION (FT)
HYDRCOND	NUMERIC	8	HYDRAULIC CONDUCTIVITY (M/DAY)
INSTDATE	NUMERIC	8	WELL INSTALLATION DATE
LAT	CHARACTER	8	LATITUDE
LON	CHARACTER	8	LONGITUDE
MPC	NUMERIC	8	MEASURE POINT CORRECTION (FT)
NORTHING	NUMERIC	8	NORTH GRID COORDINATE
PIPE_MAT	CHARACTER	8	PIPE MATERIAL
SCR_MAT	CHARACTER	8	SCREEN MATERIAL
SI	NUMERIC	8	SEQUENTIAL INDEX
SSZ	NUMERIC	8	SCREEN SLOT SIZE (IN)
STATUS	NUMERIC	8	WELL STATUS
TOC	NUMERIC	8	TOP OF CASING ELEVATION (FT)
TS	NUMERIC	8	TOP OF SEAL ELEVATION (FT)
TSP	NUMERIC	8	TOP OF SAND PACK ELEVATION (FT)
TWS	NUMERIC	8	TOP OF WELL SCREEN ELEVATION (FT)
WELL	CHARACTER	8	WELL IDENTIFIER
WELLNUM	CHARACTER	6	ORIGINAL WELL IDENTIFIER

Table B.2. Names, types, lengths, and labels of variables in the HUFFV.FIELD1 data set

Name	Type	Length	Label
COMM_FLD	CHARACTER	50	COMMENTS FOR FIELD DATA
ENTR_FLD	NUMERIC	8	DATE FIELD DATA ENTERED BY DBM
MAXDEPTH	NUMERIC	8	MAXIMUM DEPTH SEDIMENT CORE (FT)
MINDEPTH	NUMERIC	8	MINIMUM DEPTH SEDIMENT CORE (FT)
SAMP_ID	CHARACTER	11	SAMPLE ID ASSIGNED BY INVESTIGATOR
SAMPDATE	NUMERIC	8	DATE SAMPLED
WELL	CHARACTER	7	WELL IDENTIFIER

Table B.3. Names, types, lengths, and labels of variables in the HUFFV.ACD1 data set

Name	Type	Length	Label
ANALYSIS	CHARACTER	10	ANALYSIS PERFORMED BY LAB
COMM_ACD	CHARACTER	30	COMMENTS FOR ACD DATA
CUSTSAMP	CHARACTER	20	"1022" INVESTIGATOR SAMPLE ID(SAMP_ID)
ENTR_ACD	NUMERIC	8	DATE ACD DATA ENTERED BY DBM
EXT	CHARACTER	12	EXTRACTION TECHNIQUE
LAB	CHARACTER	8	LABORATORY PERFORMING ANALYSES
METHOD	CHARACTER	12	METHOD OF ANALYSIS
PREFIX	CHARACTER	4	DATA QUALIFIER FOR "RESULT"
RAD_ERR	NUMERIC	8	RAD ANALYSIS ERROR (2 S.D.)
REQNO	NUMERIC	8	ACD REQUEST NUMBER
RESUL	CHARACTER	35	"1022" RESULTS (PREFIX,RESULT,UNITS)
RESULT	NUMERIC	8	RESULT REPORTED FOR "ANALYSIS"
SAMP	CHARACTER	5	ACD LABORATORY SAMPLE ID
SAMP_ID	CHARACTER	20	SAMPLE ID ASSIGNED BY INVESTIGATOR
TASK	CHARACTER	12	RAP INVESTIGATOR /TASK
TYPE_ANL	CHARACTER	20	GENERAL TYPE OF ANALYSIS
UNITS	CHARACTER	13	MEASUREMENT UNITS FOR "RESULT"

Table B.4. Names, types, lengths, and labels of variables in the ERFU2.PIEZDAT1 data set

Name	Type	Length	Label
COMMENTS	CHARACTER	80	COMMENTS
DATE	NUMERIC	8	DATE SAMPLED
DEPTHTW	NUMERIC	8	DEPTH TO WATER (FEET)
ENTERED	NUMERIC	8	DATE ENTERED
REC_BY	CHARACTER	7	INITIALS OF DATA COLLECTOR
SAMP_COL	CHARACTER	1	Y IF SAMPLE COLLECTED
TIME	NUMERIC	8	TIME MEASURED
WELLNO	CHARACTER	8	WELL NUMBER

Table B.5. Names, types, lengths, and labels of variables in the FLOW.FLOWD85 data set

Name	Type	Length	Label
CFS	NUMERIC	8	CUBIC FT PER SECOND
DATE	NUMERIC	8	DATE SAMPLED
FLAG	CHARACTER	1	WOD DATA ADJUSTED
GPM	NUMERIC	8	GALLONS PER MINUTE
HIFLOW	NUMERIC	8	HIGH FLOW WEIR (1E6 GALS/DAY)
LOWFLOW	NUMERIC	8	LOW FLOW WEIR (1E6 GALS/DAY)
MEDFLOW	NUMERIC	8	MEDIUM FLOW (1E6 GALS/DAY)
STATION	CHARACTER	3	STATION ID
TOTFLOW	NUMERIC	8	TOTAL FLOW (1E6 GALS/DAY)

Table B.6. Names, types, lengths, and labels of variables in the chemical QA/QC data sets

Name	Type	Length	Label
ANALYSIS	CHARACTER	10	ANALYSIS PERFORMED BY LAB
CERT	CHARACTER	3	EXPECTED RESULT CERT (NO/MISSING)
COMMENTS	CHARACTER	200	ADDITIONAL INFORMATION
DAT_COM	NUMERIC	8	DATE ANAYLSIS COMPLETED
DATE_SUB	NUMERIC	8	DATE SAMPLE SUBMITTED TO LAB
ENTERED	NUMERIC	8	DATE RESULTS ENTERED BY DBM
EXP_ERR	NUMERIC	8	ANALYTICAL UNCERTAINTY EXPECTED RESULT
EXP_RSLT	NUMERIC	8	EXPECTED RESULT
EXT	CHARACTER	8	EXTRACTION TECHNIQUE
METHOD	CHARACTER	10	METHOD OF ANALYSIS
OBS_ERR	NUMERIC	8	ANALYTICAL UNCERTAINTY OBS RESULT
OBS_RSLT	NUMERIC	8	OBSERVED RESULT
PREFIX	CHARACTER	4	QUALIFIER FOR OBSERVED RESULT
REQNO	NUMERIC	8	ACD REQUEST NUMBER
SAMP	CHARACTER	5	ACD LABORATORY SAMPLE ID
SAMPTYPE	CHARACTER	8	TYPE OF SAMPLE
SAMP_ID	CHARACTER	8	SAMPLE ID ASSIGNED BY INVESTIGATOR
SRM	CHARACTER	15	STANDARD REFERENCE MATERIAL
UNITS	CHARACTER	8	MEASUREMENT UNITS

Table B.7. Names, types, lengths, and labels of variables in the precipitation summary data set

Name	Type	Length	Label
DATE	NUMERIC	8	SAMPLING DATE
FLAG	CHARACTER	1	DATA QUALIFIER (E/MISSING)
PRECIP	NUMERIC	8	DAILY TOTAL PRECIPITATION (INCHES)
SITE_ID	CHARACTER	10	SITE IDENTIFICATION

Table B.8. Names, types, lengths, and labels of variables in the site description data set for the precipitation summary task

Name	Type	Length	Label
ADMIN	CHARACTER	20	ADMINISTRATIVE CONTACT PERSON
CALIB	CHARACTER	12	FREQUENCY OF INSTRUMENT CALIBRATION
COLLECT	CHARACTER	12	FREQUENCY OF DATA COLLECTION
COMMNT	CHARACTER	80	COMMENTS
DATAFORM	CHARACTER	12	FORM OF DATA STORAGE
DATE_BEG	NUMERIC	7	CONTINUOUS DATA COLLECTION BEGAN
ELEV	NUMERIC	8	ELEVATION (FT)
GAGE_TYP	CHARACTER	25	TYPE OF GAGE
GRID	CHARACTER	8	COORDINATE SYSTEM
H_WARE	CHARACTER	10	HARDWARE USED TO STORE THE DATA
LAT	CHARACTER	8	LATITUDE
LOC_NAME	CHARACTER	20	LOCATION NAME
LONG	CHARACTER	8	LONGITUDE
SAMP_INT	CHARACTER	12	SAMPLING INTERVAL
SITE_ID	CHARACTER	10	SITE IDENTIFICATION
S_WARE	CHARACTER	10	SOFTWARE USED TO STORE THE DATA
TECH	CHARACTER	20	TECHNICAL CONTACT PERSON
UNIT	CHARACTER	8	SMALLEST UNIT OF MEAS. FOR GAGE

APPENDIX C

EXAMPLES OF DATA ENTRY FORMS USED FOR THE STUDY OF QA/QC 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. C.1. Data entry form used for QA/QC 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	785	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. C.2. Data entry form used for QA/QC 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. C.3. Data entry form used for QA/QC 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. C.4. Data entry form used for QA/QC of chemical analyses: EPA cross-check of radiological parameters.

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