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MARTIN MARIETTA

ENVIRONMENTAL RESTORATION PROGRAM

Data Base Management Plan for the Remedial Investigation/Feasibility Study at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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Energy Systems Environmental Restoration Program
ORNL Environmental Restoration Program

Data Base Management Plan for the Remedial Investigation/Feasibility Study at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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DATA BASE MANAGEMENT PLAN

FOR THE

REMEDIAL INVESTIGATION/FEASIBILITY STUDY AT

OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENNESSEE

Bechtel Job 19118

REV.: 1 DATE: NOV 14 1993

CONCURRENCE: _____ 10/4/93
D. Gottholm, Automation Technology Supervisor — Date

CONCURRENCE: _____ for CRJ 10/1/93
C. R. Johnson, Technical Support Lead — Date

CONCURRENCE: _____ 10/4/93
O. E. El-Messidi, Project Quality Assurance Manager — Date

CONCURRENCE: _____ 10/4/93
D. K. Cowser, Operations Manager — Date

APPROVED BY: _____ 10/4/93
J. R. Kannard, Program Manager — Date

CONCURRENCE: _____ 11/4/93
L. A. Hook, ORNL Environmental Sciences Division
ORNL RI/FS Data Base Manager — Date

CONCURRENCE: _____ 11/8/93
A. S. Will III, Environmental Restoration Program
RI/FS Project Manager — Date

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ACRONYMS

ATS	Automation Technology Supervisor
CADD	computer aided design and drafting
CASE	computer assisted system engineering
DBM	data base management
DEC	Digital Equipment Corporation
ES&H	environmental, safety, and health
FOF	Field Operations Facility
IBM	International Business Machines
MDL	Microstation Development Language
OREIS	Oak Ridge Environmental Information System
ORNL	Oak Ridge National Laboratory
OU	operable unit
PC	personal computer
PDCC	Project Document Control Center
PP	project procedure
QA	quality assurance
QC	quality control
RI/FS	remedial investigation/feasibility study
SWMU	solid waste management unit
TSL	Technical Support Lead
WAG	waste area grouping

EXECUTIVE SUMMARY

This Data Base Management (DBM) Plan has been prepared for use by Bechtel National, Inc. (Bechtel) and its subcontractors in the performance of the Oak Ridge National Laboratory (ORNL) Remedial Investigation/Feasibility Study (RI/FS) program activities. The RI/FS program is being performed under subcontract to Martin Marietta Energy Systems, Inc. (Energy Systems), the contractor operating ORNL for the Department of Energy.

This DBM Plan defines the procedures and protocol to be followed in developing and maintaining the data base used by Bechtel and its subcontractors for RI/FS activities at ORNL; describes the management controls, policies, and guidelines to be followed; and identifies responsible positions and their Energy Systems functions. The Bechtel RI/FS data base will be compatible with the Oak Ridge Environmental Information System and will include data obtained from field measurements and laboratory and engineering analyses. Personnel health and safety information, document control, and project management data will also be maintained as part of the data base. The computerized data management system is being used to organize the data according to application and is capable of treating data from any given site as a variable entity. The procedures required to implement the DBM Plan are cross-referenced to specific sections of the plan.

1. INTRODUCTION

1.1 PURPOSE

The purpose of this Data Base Management (DBM) Plan is to define the procedures and protocol to be followed in developing and maintaining the data base for the Remedial Investigation/Feasibility Study (RI/FS) at Oak Ridge National Laboratory (ORNL). The RI/FS data base will be compatible with the Energy Systems Environmental Restoration Program's Oak Ridge Environmental Information System (OREIS) and will include data obtained from field measurements and laboratory and engineering analyses. Personnel health and safety information, document control, and project management data will also be maintained as part of the data base.

The data base will provide a centralized repository for all site characterization and physical data generated for the RI/FS project and facilitate report generation and the manipulation, analysis, and display of environmental data. The DBM plan will

- provide general guidance for collecting, encoding, and entering data; and
- provide the mechanism to ensure that information is maintained at Bechtel National, Inc. (Bechtel) and is transferred to the ORNL RI/FS data base to support risk assessments, hydrogeologic and environmental analysis and evaluation, and evaluation of remedial action alternatives.

The computerized data management system being used to organize the data according to application is capable of treating data from any given site as a variable entity.

The DBM Plan is supplemented by a series of RI/FS project procedures (PPs) that provide specific details concerning data collection, encoding, and entry (PP 1501, PP 1503.1, PP 1603, PP 1603.1). In addition, the RI Plan for each waste area grouping (WAG) or operable unit (OU) will contain a WAG- or OU-specific DBM Plan or appendix that will reference this programmatic DBM Plan and will discuss deviations (if any) and any additional DBM activities specific to the WAG or OU.

1.2 OBJECTIVES

The objectives of this DBM Plan are to provide guidance on how data and documentation will be stored and maintained to

- assist investigators in identifying the extent of radioactive or chemical contamination in the environment,
- assess the extent of previous migration of radioactive and hazardous wastes and the potential for continuing migration,

- document the basis for remedial action recommendations,
- provide for easy access to data when needed for current or future analyses, and
- permit data management interfaces between Bechtel and ORNL.

2. DATA BASE MANAGEMENT TEAM AND SERVICES

2.1 TEAM

The DBM team will consist of the Technical Support Lead (TSL), Automation Technology Supervisor (ATS), systems analysts, data coordinators, and computer-aided design and drafting (CADD) operators. Data coordinators will typically be assigned to a specific WAG, OU, or other unit. Additional support staff will be provided for data input or output and as needed.

2.1.1 Technical Support Lead

The TSL is responsible for overall management and coordination of the DBM team. Specific responsibilities will include

- ensuring that data management is accomplished in accordance with all applicable plans and procedures;
- planning and providing for equipment and personnel to meet the DBM needs of the project;
- resolving quality assurance (QA) audit findings beginning with factual accuracy meetings and ending with signed-off corrective action process reports; and
- ensuring that the integrity of the data base is maintained.

2.1.2 Automation Technology Supervisor

The ATS provides day-to-day supervision of systems analysts, data coordinators, and other data entry and Automation Technology personnel working on the RI/FS Project. Specific responsibilities include

- maintaining data base operations and implementing modifications by interacting with the client, project management, technical staff, office Automation Technology, and data management staff;
- interpreting requests for data base changes and ensuring accurate implementation;
- ensuring that the data are organized and formatted to be compatible with the requirements for conducting risk and alternatives assessments at ORNL;
- providing data base reports and printouts to data users;
- providing technical guidance in the use of computer software for data analysis;

- reviewing requests for hardware and software to ensure compliance with Bechtel standards;
- overseeing the installation of equipment including application of inventory control tags, updates to the inventory data base, and completion of any custodial agreements by end-users;
- participating in project meetings to provide advice and offer recommendations on automation topics;
- conducting strategy-level specification of user needs for system development through computer assisted system engineering (CASE) methodology; and
- providing user support for problems with ORACLE, PC applications, and network communications.

2.1.3 Systems Analysts

Systems analysts will provide data manipulation, systems maintenance, and programming support and development. Specific tasks will include

- supporting existing applications programs,
- developing programs to further automate data handling and processing,
- maintaining project hardware and software systems,
- revising and developing data analysis programs, and
- providing support for data coordinators when necessary.

2.1.4 Data Coordinators

The data coordinators will perform the day-to-day DBM operations. These activities will include

- coordinating environmental data collection activities;
- supervising data entry performed by permanent or part-time employees;
- conducting data verification and assisting QA efforts related to project data management;
- ensuring that data are complete, properly validated, and flagged with proper validation codes;

- providing reports and manipulations of data as requested by management and technical staff; and
- providing input to the TSL and/or ATS (as appropriate) on WAG and OU data base requirements and modifications.

2.1.5 CADD Operators

CADD operators will assist project technical specialists in analysis of data supplied by the data base and generation of graphic displays, including spatially oriented data. Tasks will include

- building and maintaining data files of base maps of areas being investigated,
- plotting spatially oriented data maintained for verification and base map creation,
- graphing and charting of data,
- assisting in the geographic analysis of data, and
- providing general CADD support as required.

2.1.6 Project Document Control Center

The Project Document Control Center (PDCC) will provide day-to-day operation and maintenance of RI/FS records as specified in PP 1110.6. Specific responsibilities include

- receiving data transmittals and verifying completeness;
- entering and updating record management information in a Documentation Requirements and Subcontractor Requirements Summary form; and
- generating reports for management and maintaining files.

2.2 SERVICES

The DBM function will provide an accessible, comprehensive, documented, and verified data base for the Bechtel Team and Martin Marietta Energy Systems, Inc. (Energy Systems). DBM needs and status will be coordinated at regular Bechtel staff meetings and at frequently scheduled WAG/OU coordination meetings. The DBM team will routinely provide standard

data reports and will provide special data updates as requested and upon approval by the appropriate Task (WAG) Lead or by the Program Manager or designee.

Although data analyses are primarily the responsibility of the technical specialists who define the need for the data, the DBM Team staff will assist in such analyses as appropriate. In particular, the staff will provide assistance with statistical analyses, plots, and graphs of data sets to assist in assessing and interpreting data. Section 8.6 addresses validation requirements and software development guidelines to be followed during specialized programming activities.

Periodic data listings (i.e., reports) may be requested by the ORNL WAG Manager or designee during the evolution of the project to evaluate the progress of various aspects of the project, confirm data types and table structures, etc.

3. DATA BASE MANAGEMENT SYSTEM

3.1 BECHTEL COMPUTER SYSTEM

3.1.1 Home Office VAX Computer System

Bechtel's Oak Ridge office computer system includes

- a VAX cluster consisting of two VAX 8350s and two VAX 4000s;
- eight 622-MB RA82 disk drives;
- three 1.2-GB RA90 disk drives;
- nine 381-MB RF31 disk drives;
- two 1-GB RF72 disk drives;
- one 1600/6250 BPI tape drive;
- five 8-mm tape drives;
- one TK50 tape drive;
- two RD40 read-only optical disks;
- a Digital Equipment Corporation (DEC) Pathworks network consisting of more than 200 International Business Machines (IBM)-compatible personal computers (PCs), 3 plotters, and more than 40 printers;
- more than 150 alphanumeric terminals; and
- 40 terminal servers accommodating VT terminals, printers, and modems.

All of this equipment is located in the Oak Ridge office. Specific input/output devices for the data base are located in the RI/FS project area, and an AT&T network provides communication links among all the equipment. Standard software available for project use includes ORACLE, SAS, WordPerfect, 2020, Lotus, Harvard Graphics, and Reflections. EPA software available on individual project personal computers includes GEO-EAS, SCOUT, and GEOPACK. Modeling software used on the RI/FS project is listed in Appendix A.

3.1.2 Field Operations Facility Computer System

Bechtel's Field Operations Facility (FOF), located at ORNL Building 6556, White Oak Avenue, contains a computer system that includes

- a VAX 3100 server-computer with 24 MB of memory,
- one 105-MB disk drive,
- three 625-MB disk drives,
- one 75-MB TK50 tape drive,
- ten Intermec 9460 Trakker bar code readers,
- two Intermec bar code printers,
- one alphanumeric terminal,
- more than 10 IBM or compatible PCs connected to the server with a DEC Pathworks network, and
- two system printers.

All of this equipment is located at the FOF. ORACLE software, receiving daily information from bar code readers, is used for sample tracking. In addition, WordPerfect, Harvard Graphics, and Lotus 1-2-3 are provided to FOF users on the local network. Data are transferred to Bechtel's main office by means of floppy disks, TK50 tapes, or 9600-baud modem connections.

3.1.3 ORACLE Data Base Management System

ORACLE's Relational Data Base Management System will be used for storage, manipulation, and reporting of data. This system allows custom design of a relational data base structure to fit project requirements. ORACLE's query language command structure allows online query with extensive reporting capabilities. The Bechtel Environmental Integrated Data Management System (BEIDMS) Manual for the RI/FS Project contains the ORACLE CASE Dictionary and the Entity Relationship (ER) Diagram. The CASE Dictionary is a single repository that contains all of the definitions and descriptions of codes and tables that make up the data base. All elements stored in the repository are subject to management control, ensuring consistent use of common functions. Codes and definitions that are specific to the RI/FS Project are maintained in the CASE Dictionary, and the appropriate relationships as specified in the ER Diagram are constantly maintained as the data base is developed. The BEIDMS Manual for RI/FS is maintained and controlled by the ATS and contains current printouts of the applicable portions of the CASE Dictionary for the RI/FS data base and the ER Diagram.

3.1.4 ORACLE Software

ORACLE's Computer Assisted Systems Engineering tools are utilized to ensure a complete and integrated system design. ORACLE tools presently being used include

- SQL*Menu 5.0
- SQL*Forms 3.0
- SQL*Plus
- SQL*Loader
- PRO*C precompiler
- SQL Assist

Additional ORACLE tools and commercial software with integration capabilities with ORACLE may also be utilized to enhance the data management capabilities.

3.1.5 SAS Software

SAS, one of the systems used to analyze data related to the ORNL RI/FS project, is highly versatile in its data management and report writing capabilities. It combines data management with the statistical and graphical capabilities essential for scientific data analysis. SAS can produce files in various formats for transfer to other computer systems and for specialized analyses and graphic displays not offered by SAS itself.

The Bechtel office uses the most current versions of the SAS software, and additional modules will be purchased as required. All IBM computer SAS data sets are directly transferable to the VAX computer system in Bechtel's office through the SAS import/export format.

3.1.6 Graphical Display Software

Site maps and graphic representations of data will be handled primarily by Intergraph's Microstation software. Various PC software packages such as Siteworks, Surfer, and gINT will be used to display specific contours, isopleths, and other graphic representations of analytical and survey data as appropriate. These packages will be used in combination with ORACLE to perform necessary data base analyses and to allow characterization data to be linked with site maps. FORTRAN and C compilers are also available for special program requirements. Many Bechtel-developed programs will help RI/FS project personnel analyze data both graphically and numerically (see Appendix A).

3.1.7 Personal Computers

The Bechtel office has standardized IBM compatibles for PC work. PCs have standard word processing capabilities, spreadsheets, data base programs, terminal emulation programs,

data transfer programs, and operating systems as required for individual users. These software packages will be used as appropriate to supplement ORACLE and SAS in selected administrative and engineering computer applications.

Many standard engineering analysis programs have been used on PCs in the Oak Ridge office. These programs include

- MODFLOW, a three-dimensional, finite difference groundwater flow model (U.S. Geological Survey);
- SWMM, a stormwater management model (Environmental Protection Agency);
- ISC, a Gaussian steady-state plume model;
- HELP, a hydrologic evaluation of landfill performance model; and
- CREAMS, a chemicals, runoff, and erosion model (Agricultural Management Systems).

These and other programs are discussed in Sect. 7.

3.1.8 BENET Computer Network

BENET enables Bechtel's Oak Ridge office to integrate its computers into a local network to exchange, share, and otherwise optimize usage of data. The network also allows access to additional resources when necessary (IBM mainframe, UNIVAC, and other VAXs at other Bechtel offices).

3.1.9 Electronic Mail and Other Interfaces

Electronic mail and phone utilities are available on the Bechtel computer system, and any valid user can gain access by logging onto the system. On alphanumeric terminals, access requires no special procedures; on PCs, access requires using a protocol software to emulate a DEC terminal. Mail messages can be sent to any single user or list of users on the system, even if they are not currently using the system. The phone utility allows using the computer system for interactive communications. Word processing software, spreadsheet software, commercial software, and all other Bechtel software are available on demand for any valid user on either the VAX or PC. All communications will have security measures to prohibit access by unauthorized personnel.

3.2 BECHTEL–ENERGY SYSTEMS COMPUTER SYSTEM INTERFACE

3.2.1 SAS Import/Export Formats

The Bechtel RI/FS data base will be compatible in structure and content with the ORNL RI/FS and the Energy Systems OREIS data bases. The transfer of ORNL-generated environmental data to Bechtel and the receipt of Bechtel RI/FS data transferred to ORNL are the responsibility of ORNL RI/FS Data Base Management. Once received by ORNL, the data will be transferred to the Energy Systems OREIS to meet Energy Systems and Federal Facilities Agreement (FFA) reporting requirements. Periodic interface meetings will be held among representatives of the three data bases to maintain compatibility and to ensure that data base structure and content requirements are being met.

3.2.2 Data Transmission

Data transfers between Bechtel and the Energy Systems computer systems follow these guidelines:

- Fully defined SAS data sets or other suitable export format will be used to transfer characterization data and other data as appropriate.
- Non-SAS data will be transferred in ASCII format accompanied by sufficient documentation to define the data type, structure, and format.
- 1200/2400/9600-baud modems and normal phone lines may be used for electronic transfer of relatively small amounts of data.
- If quantities of data exceed manageable size for electronic transfer, the data will be transferred on PC diskettes or magnetic media.

3.2.3 Transfer of Project-Developed Models and Computer Programs

Any graphics, text, or new programs developed and funded through this project will be the property of Energy Systems, and this information will be transferred to Energy Systems with adequate documentation upon request in electronic or paper format, contingent on project requirements.

4. DATA BASE ORGANIZATION AND CONTENT

4.1 DATA BASE ORGANIZATION

Characterization of a contaminated waste site requires collection and analysis of hydrogeologic, geologic, environmental, and engineering data. Usually a large volume of data already exists, but more may be needed for adequate characterization. The setup and organization of the characterization data base must therefore allow inclusion of both existing and future information, and the structure should permit optional performance of data base reports, manipulations, and analyses.

The contaminated sites at ORNL, including all known active and inactive waste management areas, contaminated facilities, and potential sources of contaminants, have been divided into several WAGs and subdivided into OUs. The WAGs have been categorized on the basis of geographic and hydrologic information; initial characterization efforts have used scoping surveys and site-specific studies to determine potential groundwater and surface water contamination.

To effectively set up and organize the RI/FS data base and allow for later changes in the process with minimal effect on performance and schedule, several aspects of data management must be specified as completely as possible:

- data types;
- computer systems and products involved;
- data handling techniques;
- data flow;
- data users and use of data;
- documentation and tracking requirements; and
- definition, tracking, and processing of analytical techniques and algorithms used in data interpretation.

Existing data from the ORNL RI/FS data base and data resulting from scoping surveys and other studies have been cataloged and stored under the name of the principal investigator who conducted the study and by data type. The existing acceptable data (based on criteria in Sect. 8.5) will be reorganized for consistency with the RI/FS data base described in this section. In addition, because each WAG is considered to be a collection of solid waste management units (SWMUs), all future characterization data will include a WAG/OU or SWMU identifier code or codes to allow the data to be geographically sorted by WAG/OU and SWMU. Data types will be used to organize and store information from characterization tasks; the data base will also include other technical and management data required to complete the RI/FS process. Appendix B shows the various tasks with their breakdown, method of data collection, data type, anticipated output, and data analysis.

4.2 DATA BASE CONTENT

As discussed in Sect. 4.1, the RI/FS data base will be organized by data type and will accommodate both existing data and data to be collected in the future. The definitions of data base tables and codes are contained in the project ORACLE CASE dictionary.

- surface survey data
  - civil survey,
  - geophysical survey,
  - surficial site screening,
- hydrogeologic and geologic characterization data
  - boring and well,
  - piezometric monitoring,
- hydrologic characterization data
  - surface water flow,
  - seepage flow,
  - precipitation and infiltration analyses,
- contaminant characterization data
  - groundwater sample,
  - surface water/leachate sample,
  - sediment sample,
  - soil sample,
- biotic characterization data
- sample tracking data
  - sampling event notification,
  - sampling event specifics,
  - chain of custody,
  - laboratory analyses and validation scheduling and tracking,
- personnel health and safety data
  - radiological exposure,
  - bioassay,
  - medical exam,
  - chemical exposure,
  - personnel training records,
- engineering data
  - bench-scale tests,
  - engineering analysis,
- document control data
  - document control registers,
  - data deliverables registers,
- project management data
  - project controls, and
  - WAG cost and schedule.

5. DATA ACQUISITION

5.1 DATA COLLECTION

5.1.1 Data Collection Methods

Existing and new data will be managed within the DBM system to facilitate characterization of sites known or suspected to be contaminated with radioactive and/or hazardous chemical wastes and to track project activities. Data types to be collected include those identified in Sect. 4.2. General collection methods for these data types are discussed in the following subsections. Specific collection methods for each subset of data types are presented in Appendix B and discussed in PPs 1501, 1603, and 1603.1, and 1637.

5.1.1.1 Characterization data

Characterization data will be obtained from field measurements and laboratory analyses of field samples. Types of characterization data to be collected include those associated with

- surface surveys,
- hydrogeologic and geologic characterization,
- hydrologic characterization,
- contaminant characterization,
- biotic characterization, and
- sample analysis.

Characterization data are collected through land surveying; aerial photography; geophysical surveys; surficial site screening; borehole soil and rock samples; piezometric monitoring; and analyses of air, water, and sediment samples. Sampling plans will be defined so that the field data are adequate for assessment of field conditions and can be used for accurate identification of the presence, nature, and extent of contamination. WAG- and OU-specific sampling plans will be developed as part of each RI Plan. Laboratory analyses of field samples will produce data that define site conditions and identify the analytical parameters of concern.

5.1.1.2 Personnel health and safety data

Personnel health and safety data will be obtained from radiological and chemical exposure information, bioassay documentation, medical exams, and training records. Data collection methods include thermoluminescent dosimeter measurements, urine analysis, required personnel submittals, and laboratory analyses. Additional health and safety information to be documented is described in the project Environmental, Safety, and Health Plan, and data base content and format are defined in the CASE Dictionary.

Because adverse health effects from contact with hazardous materials may take many years to become evident, personnel health and safety data will be retained as required by 29 CFR Pt. 1910.120 and DOE Orders 5480.11 and 5480.70. Personnel health and safety data will be maintained in a separate, restricted-access data base (discussed in Sect. 8.2).

5.1.1.3 Engineering data

Engineering data types include data registers of bench-scale test results, underground storage tank leak testing results, analytical parameters, and analytical models and results. Bench-scale testing will include treatability and materials testing activities to aid in identification, screening, and evaluation of remedial action technologies. Engineering analyses will include identification of analysis parameters, computer input for parameters identified by modeling, and resultant computer output.

5.1.1.4 Document control data

Document control data types include document control registers of historical and current reports provided by Energy Systems to Bechtel; reference documents; data transmittal, collection, and request forms; calculations; correspondence; and other documents in the project document control files. These documents will be collected and tracked within PDCC. Documents in the document control data base will be coded to permit sorting by key words, WAG or OU, author, and other data base fields. Unique document tracking numbers are assigned to all data collection and deliverable documents before they are transferred to the data base. These numbers are tracked in data base tables to facilitate retrieval.

5.1.1.5 Project management data

The project management data base consists of registers of project control cost and schedule data. The data will include both planned and actual schedules, budgets, and funds associated with specific tasks and will form the basis for the monthly project status reports prepared for Energy Systems.

5.1.2 Anticipated Data Sources

Technical data required to support site characterizations, risk analyses, or alternatives assessments will be obtained from planned remedial investigations and from investigations previously performed by ORNL personnel. Anticipated sources of technical data include information presently in the ORNL RI/FS data base, field data, and data resulting from laboratory or engineering analyses from previous or planned remedial investigations. These sources include, but are not limited to,

- project/field logbooks;
- bar code readers;
- sample data collection sheets and logs;
- chain-of-custody records;

- receipt-of-sample forms;
- laboratory data, calculations, and graphs; and
- engineering calculations.

5.1.3 Required Documentation

Typical documentation required for characterization data sets will include

- sample type;
- sample matrix;
- WAG and SWMU identifiers;
- sampling date and time;
- sampling location;
- sampler's Energy Systems badge number;
- sampling depth and increment for field samples;
- field preparation techniques;
- laboratory preparation techniques;
- laboratory analytical methods;
- laboratory analysis data;
- laboratory receipt, preparation, and analysis dates;
- laboratory quality control (QC) procedures and data; and
- chain of custody.

Additional data documentation will be provided by PDCC, as described in Sect. 6.1.1. Specific documentation will depend on the type of data being collected and is defined in the implementing procedures on data collection (PPs 1501 and 1637).

5.2 DATA ENCODING

The project CASE dictionary includes definitions of identification codes that permit the ASCII output files to be read and used by other systems. Project procedures define standardized data collection forms, data entry screens, and bar coding that will facilitate data collection and identification (PPs 1501, 1603, and 1603.1).

5.2.1 Data Identification Codes

A bar code sample identification and tracking system developed by Bechtel has been implemented for identifying characterization data and laboratory samples. The system facilitates automated data entry and rapid generation of sample tracking reports for immediate verification by field personnel. Bar code labels are attached to each sample container and consist of unique numbers. The system is designed to prevent entry of erroneous data so that

sample collection and chain-of-custody information rarely needs to be revised. Details concerning bar code system use and data base content are contained in PPs 1603 and 1603.1.

This system will allow for compatibility between identification codes for existing data sets and additional data sets obtained as part of the RI. Specific code descriptions for new data will be developed jointly by Energy Systems and Bechtel DBM personnel.

5.2.2 Data Collection Forms

Field data and other pertinent information will be collected and documented using standardized data collection forms that match data base tables and computer data entry screens. The data collection forms will be designed to reduce repetition of information necessary to define a data set. Sample data collection forms and instructions concerning their use are included in PP 1637.

5.3 DATA ENTRY

5.3.1 Numeric and Text Data

5.3.1.1 Automatic data entry

To the extent possible, data entry will be automated with bar codes, bar code labels, and bar code readers and electronic sampling instruments. When available, sampling instruments with the capability to electronically transfer data to PCs will be used to further automate data collection. Results of the laboratory analyses will be electronically entered into the RI/FS data base whenever possible. Analytical results stored in the data base will be verified against hard-copy data packages to ensure an exact correspondence and documented using the electronic data transfer verification form described in PP 1503.1. All automated data entry into ORACLE tables will be done with ORACLE's SQL*LOAD utility.

5.3.1.2 Manual data entry

Manual entry of data will be accomplished by a combination of direct entry by the engineer or technician collecting the data in the field or laboratory and entry of the data from collection forms by clerical personnel at the FOF, main Oak Ridge office, or subcontractor offices. Direct data entry in the field will be used whenever possible to permit immediate verification of the data in electronic format by the engineer or technician who would otherwise write the data on data collection forms.

When direct entry is not possible, double entry or 100% data verification against hard copies will be used for all data entered from forms. For double data entry, the data are keyed twice, preferably by different individuals, and the files are compared electronically to locate discrepancies. Data entry screens will parallel data collection forms and will be formatted accordingly. All full-screen entry procedures will contain automatic and

programmed functions for data entry, including verification (e.g., range checking) at the time of entry and before continuing to the next field; use of predefined codes, with full descriptors on separate files; error messages; and automatic entry, calculation, and retention of repetitious field values. Labeled and formatted data entry screens will be used for routine entries. All data collection forms will be verified by appropriate technical specialists involved with data collection before the forms are submitted to the DBM team for entry. Field-entered data will be transferred to the Oak Ridge office either electronically or by magnetic media. When the data are field-entered in ORACLE format, the full-screen capability with associated preprogrammed formatting for entry will be used.

5.3.2 Graphic Data

Graphic data can be converted from manual drawings with optical scanners, when required, by Bechtel's office in Norwalk, California, or by a variety of vendors. The graphic data will be vectorized to meet project requirements. Those manual drawings that are impractical for scanning will be digitized on Intergraph Microstation graphic work stations. Digitizing of a manual drawing with Bechtel software will create an ASCII data file with coordinate values that can be used later for engineering manipulation or posting into three-dimensional contours, models, or other required output. Multiple drawings can be displayed to create new composite drawings with Intergraph's layering and reference file system capabilities. These overlays can be mixed or matched to any scale, rotation, or combination.

ASCII data files are converted to CADD locations via programs developed in the Microstation Development Language (MDL). Validation of these programs is performed according to the methods described in Sect. 8.6 and in accordance with the Bechtel Oak Ridge office CADD procedure CADD-001, Sect. 4.1.2, which requires proving and testing the MDL programs by 100% manual verification. The ASCII files are 100% manually verified against the source of the data in accordance with procedure CADD-008, Sect. 3.0, before the files are electronically processed into CADD using the MDL programs.

5.4 LINKING DATA FILES

The RI/FS data base architecture will be generated utilizing ORACLE's CASE tools to ensure that the appropriate relationships exist between the tables. This will ensure the ability to integrate the resulting data sets in a fully relational data base.

6. DATA MANAGEMENT

6.1 DATA PROCESSING

Data flow is discussed and further defined in PP 1501 and in Bechtel drawing 99-SK-01, "Data Collection and Handling Flowchart" (see Appendix C). This process will be as efficient and automated as possible, and adherence to the defined procedures will be required for each data set. A new data management method will be implemented only if it is shown to yield improved quality or better performance while maintaining compatibility with existing data and only after procedures have been modified to reflect the new method.

6.1.1 Data Protocol and Flow

The RI/FS data base will consist of existing and newly collected data. Existing data (if in digital form) will be transferred to the data base electronically or by manual entry. As discussed in Sect. 5.3, new data will be entered directly into the data base. Data will be manually entered by using data entry screens, and data input will be verified by double entry, 100% verification, or statistical and graphical analysis. Data fields will be used to track who entered the data and when and who checked the data. Digitally transferred data will undergo error-checking routines (inherent in both data transfer and data loading software) to verify correct and complete transfer, and data base contents shall be compared with hard copies of the original data.

As data files are developed from previous ORNL investigations and from new laboratory and field studies, data transmittal forms are prepared and sent through PDCC. The forms list all data sets or reports that are attached or that were transmitted electronically. Each file is managed by PDCC through the following steps.

- When data transmittals are received, receipt of all listed data and laboratory reports is verified and the transmittal form acknowledging receipt is signed.
- The date and transmittal number are stamped on the transmittal and the data report or data collection form.
- The transmittal number is entered on labels of associated floppy diskettes.
- Transmittals and laboratory data reports are copied in accordance with a distribution schedule provided by the TSL, and the original data and related transmittals are filed in the appropriate project data control file. Distribution includes the TSL, the ATS, and the designated responsible technical specialist.
- Data transmittal information is entered in the PDCC data tracking data base.

- Document sorts are provided for cross-checking completeness of working files and for retrieving lost or missing reports.

When electronically transferred data (raw data files) are uploaded to the data base, a hard-copy printout will be prepared to aid in verification of transmission. All data records are compared with hard-copy printouts to ensure exact correspondence, and 100% verification is performed for certain data types (such as laboratory analytical results). Summary statistics and record counts are other data verification tools.

Investigators designated by the appropriate Task (WAG) Manager to be responsible for particular data types will review all incoming data to establish whether they are required for data base entry and whether they are subject to data validation. The results of the initial screening will be documented on a data review checklist or appropriate data collection form that will be sent through PDCC to the DBM team for action. DBM staff will proceed with entry or transfer of raw data into unverified data sets.

When the raw data have been transferred into the data base, verification will be performed. Comprehensive reports will be run and the reports will be reviewed and checked for errors by the appropriate disciplines. The data coordinators will verify that the directives of PP 1501 have been followed in collecting and entering the data into the system, and technical specialists appointed by project or functional managers will verify that the data are consistent with other known data.

After verification of data entry as described in Sect. 8.5, the heretofore unverified data are designated in the data base as verified and are made accessible for restricted limited use (see Sect. 6.3.1) in data base queries and preliminary data base reports.

Validation of analytical data is performed separately from the verification described above, in accordance with PPs 1503.1 and 1503.2. After validation, the appropriate data validation codes defined in Sect. 6.3.1 are affixed to the data and entered into the data base. Hard copy printouts of the validated data and validation codes are verified against the appropriate Data Assessment Forms. After this step, the data may be accessed by authorized personnel and used for site characterization and risk assessment purposes and included as documentation in project reports. All reports of data that are run from the data base will include the appropriate validation codes.

6.1.2 Computer Information Exchange

Because of the many data base and software application products likely to be used for characterizing the ORNL WAGs, the standard transfer mechanism will be ORACLE export files, ASCII flat files, or other suitable data format. The RI/FS characterization data base will maintain all the file format and file documentation information in the ORACLE format. Electronic data transfers are tracked through PDCC and are formal transmissions between the ORNL RI/FS data management staff and Bechtel's Program Manager. Both Bechtel and ORNL keep registers of data requests and transmissions between the two systems.

Available forms of data transfer include magnetic tape, floppy disk, electronic telecommunication through a network or modem, and hard copy. The appropriate transfer form will depend on the data requested (e.g., graphics, text, reports, or analyses), the amount of data to be transferred, and the requestor's computer capabilities. Access to the data is controlled as discussed in Sect. 8; only preapproved data exchanges are possible.

6.2 DATA STORAGE

As discussed previously, the RI/FS data base will use several different software products on several different host computer systems, each with its own file format specification. RI/FS data base files for characterization, sample tracking, project controls, document control, and Environmental, Safety, and Health (ES&H) data are stored using ORACLE DBM software. The Bechtel VAX cluster is the centralized storage location for these data. The VAXs function as file servers for the other computers; they are readily networked to the other systems, have large disk storage capacity, and are the hosts of several analyses and applications.

6.2.1 Data Storage Formats

To the extent possible, the characterization data file formats for storing existing data use existing file formats defined by ORNL, but some modifications and additional fields are required to increase efficiency and traceability. Modified files are given a revised file name that can be identified as the latest version. Any modifications or additions to the data storage formats will be coordinated with ORNL as outlined in Sect. 5.2.1.

6.2.2 Data Archiving Requirements

Because the VAX allows files to be tracked by last access and last change as well as by creation date, backups can be performed according to various criteria such as file type (e.g., all DAT files) and last change date (e.g., daily backup of all files accessed or changed the previous day). Bechtel's backup procedures are discussed more fully in Sect. 8.1.

Archival is the long-term storage of digital data, usually performed by writing the files on magnetic tape. Bechtel uses both on-site and off-site archival redundancy as a safeguard. The RI/FS data base will be archived at several milestones throughout the project, including issuance of major reports. These archived data sets will be tracked in PDCC to document the data base used for the report and will serve as sources of information.

6.3 DATA ACCESS

6.3.1 Data Availability

The RI/FS data base will contain data in five specific forms:

- raw (data in the original format, as received from digital instruments or as submitted by subcontractors);
- unverified (newly entered data that have not undergone any verification);
- verified-invalid (data that have been verified and do not meet minimum QA criteria);
- verified-limited use (data that have undergone technical review for verification but may not meet minimum QA criteria); and
- verified-valid (data that have been verified and validated for technical content and reasonableness and that meet QA criteria).

All data base tables or environmental data will include a field for indicating verification status. PP 1501 explains the data verification status codes used in the data tables. Access to raw, unverified, and verified-invalid data will be restricted to protect against inadvertent use. Verified-limited use and verified-valid data will be made available to authorized users; access to all data will be controlled by use of system passwords, ORACLE access codes, and file protection schemes.

6.3.2 Data Access Control

The procedures outlined in Sect. 8.2 will be strictly enforced to control access to the data and applications. Special application authorization forms are used to track individual users, and only valid users are allowed access to the data and analysis applications. Task or program management approval is required to access unverified data; only verified and documented applications will be available for routine use.

Two levels of ORACLE data base access will be made available for specific tables: read only and read/write. Appropriate members of the DBM team will be allowed read/write access; all other valid users will have read-only access. This procedure will ensure that no accidental changes are made in the data base.

The only changes allowed in the verified data sets existing in the characterization data base will be made by the DBM team and a permanent record will be kept to document the basis and approval of all such changes. The process for changing data base content is explained in Sect. 8.3 and in PP 1501.

7. DATA ANALYSIS

7.1 ANALYSIS DEFINITION

The DBM team will provide formatted data files, statistical analyses, plots, and graphs of data sets to technical specialists to assist in data assessment, interpretation, and analyses. The following subsections discuss the general analytical activities that may be performed. The nature of collected data and the subsequent treatment to generate the anticipated outputs are summarized in Appendix B. Specific data analysis requirements will be presented in WAG- or OU-specific RI plans.

7.1.1 Surface Surveys

Three sources will provide civil survey information: traditional land surveying, existing maps or digital information on site topography and features, and photographs or digital information generated by aerial photogrammetry survey with ground control.

Several map coordinate systems may be applied to the Oak Ridge Reservation, including the X-10 (ORNL) grid, Y-12 grid, K-25 grid, administrative grid, Tennessee Lambert (state plane), and latitude/longitude coordinates. All location data in the RI/FS data base will be entered and retained in the original survey grid coordinates, and grid locations will be converted to another grid system as needed. This policy is necessary because the transformation equations may change as additional information becomes available.

Preliminary data pertaining to a site's physical, chemical, and radiological characteristics, as presented in Appendix B, will be analyzed using graphic techniques, mathematical relationships, and visual examinations to determine specific waste locations and their areal extent; depths to bedrock and zone of saturation; presence and locations of metallic objects, volatile organics, or radionuclide contamination; distressed vegetation; regional geology; and discharge zones. The information obtained from these analyses will be used to define the strategies for further, detailed field experiments and data collection at specific waste locations.

7.1.2 Hydrogeologic and Geologic Characterization

To evaluate contaminant transport processes in the geomedia and to establish a cause and effect relationship between the sources and receptors of contaminants, the properties of the geomedia must be understood and quantified. Because of the complex variables in the geomedia (e.g., soil types, bedrock strata, saturation and confinement of surface water and groundwater, and multiple sources and sinks of groundwater), quantification requires detailed data collection and analyses. Interpretation of the analyzed data will help to determine the pathways of contaminant transport from source to receptor through the geomedia.

The analysis parameters presented in Appendix B are intended to provide realistic representations of the physical properties of the geomedia. The analytical results will be used to model flow patterns and contaminant transport in the geomedia and to formulate remedial strategies for containing, decontaminating, or removing the waste.

7.1.3 Contaminant Characterization

Metallic, organic, and radionuclide concentrations throughout the geomedia, as presented in Appendix B, will be measured and stored in the data base to serve as input for modeling, statistical analysis, and decision-making functions.

Air quality characterization may involve measuring concentrations of suspended particles (e.g., from dust or soil erosion, volatile organic and inorganic toxic gases, and radionuclides) and collecting meteorological data such as temperature, wind velocities, and stability conditions. This data base can help to determine the emission rate of pollutants into the atmosphere.

7.1.4 Waste Migration

Contaminant releases from the source areas into media, intermedia transfer, and transport in media will be quantified by developing appropriate models to address the uncertainty inherent in the source term and complexity of hydrogeology (e.g., fractured media) and by using verified and validated state-of-the-art generic models.

Bechtel's two- or three-dimensional flow and contaminant transport models can be used to study the fate of contaminant transport in the geomedia. Biotic transport mechanisms to receptors such as human populations and individuals and flora and fauna will be modeled using the capabilities listed in Appendix A. Modeling will be used to perform pathway analysis and risk assessment and to devise strategies for remedial action and may be used to assess repository performance after a containment option has been chosen.

7.1.5 Pathway Analysis

The pathway analysis will identify contaminants and their sources and will estimate exposure to potential receptors. Exposure scenarios for various individuals will be identified, and reasonable maximum exposure will be calculated for pathways through groundwater, surface water, sediment, soil, air, and biota. Bechtel's modeling capabilities will be used for the analyses and will focus on reasonable maximum exposure to an individual as opposed to a whole population.

7.1.6 Risk Assessment

The risk to an individual and the likelihood of such risk will be analyzed on the basis of information gathered as described in previous data analysis. The analysis will include

- selection of contaminants of potential concern,
- exposure assessment,
- toxicity assessment, and
- risk characterization.

Carcinogenic and noncarcinogenic human health effects will be evaluated, and SAS statistical procedures will be used extensively in addition to other models listed in Appendix A.

7.1.7 Personnel Exposure

The personnel dosimetry data base will be used primarily for tracking and reporting. Data from numerous sources will be entered, sorted, and summarized to provide a mechanism for ensuring that procedural requirements for work in hazardous materials areas are met. Data will also be used to produce summary reports for regulatory agencies and to provide annual exposure histories of individual employees.

Personnel exposure data and bioassay results will be summarized and reported in a variety of formats for evaluating cumulative exposure, comparing exposures of employees in similar work classifications, and comparing data with as low as reasonably achievable goals. Dosimetry results, medical approvals for work with hazardous materials and for wearing respiratory protection, respirator-fit qualifications, and training records will be tracked to ensure that employees are qualified to work in hazardous areas and to schedule retraining. PP 1501.2 defines data base content.

7.1.8 Waste Treatability

When the types of extent of contamination have been determined, studies may be conducted to evaluate appropriate remedial technologies. Organic chemicals can be broken down by biological, chemical, or thermal methods, and toxic organics can be separated from nontoxic materials by physical or chemical separation. Toxic inorganic materials can be transformed to nontoxic or less toxic compounds. For radiological waste, treatability studies may evaluate immobilization and chemical and thermal treatment processes.

7.2 ANALYSIS APPROACH

7.2.1 Data Analysis System

SAS is available on Bechtel's VAX cluster and on project PCs and will be used to perform data reduction and analyses. This system will provide statistical, graphics, and report writing capabilities for data processing; specific details can be obtained from the *SAS Procedures Guide*. Graphics capabilities will also be used for specific data analyses and representation tasks.

7.2.2 Modeling Programs

The stored data may be used for computational purposes to define the hydrogeologic characteristics of the geomedia. These data may be input to complex FORTRAN-based models for studying waste migration in geomedia. Such analyses will be performed on Bechtel's VAX cluster or on PCs. Other computational, statistical, and graphics capabilities at Bechtel are discussed in Sect. 3.1.

7.3 ANTICIPATED OUTPUT

Types of output anticipated are listed in Appendix B. The output will provide information on waste location, surrounding geomedia, atmosphere, human habitat, and flora and fauna to help determine a remedial action strategy. The output will also provide information on the feasibility of containment and treatment alternatives.

8. QUALITY ASSURANCE AND DATA SECURITY

8.1 REQUIREMENTS FOR DATA BACKUP

Backup procedures will prevent data loss from accidental modification or deletion or from equipment failure. Any data modified or entered during the normal working day will be copied to tape daily, and all data on the system will be copied to tape or disk weekly and sent off site for protection against office destruction (e.g., by fire); these tapes and disks are rotated out of the office biweekly. Bechtel's system management procedures are explained in Bechtel's *Automation Technology Procedures and Standards*. An appointed steering committee including project representation oversees implementation and control of these procedures.

8.2 CONTROLLING ACCESS TO DATA

Access to data files on the computer system will be restricted as required by the project. Standard user name and password protection will be applied: the user can have read, write, execute, and/or delete access, depending on validation of the user's identity at two levels (user identification code and access control list). Only a limited number of people will be given more than read access privileges. The data base can be accessed during normal working hours or as necessary for completion of approved project priority work. The office computer system meets all the requirements for an unclassified computer security program as specified in DOE Order 1360.2A.

Access to certain sensitive information, such as personnel health and safety data, will be limited to the ES&H Manager or designee and the data base systems analysts.

8.3 PROCEDURES FOR CONTROLLING DATA CHANGES

Access to data for the purpose of modification will be limited to the DBM team and will require use of standard data modification forms and prior approval by the TSL. Modification forms require authorization from task (WAG) or functional managers, conform to standard document control procedures, and are maintained by PDCC (PP 1501). As a data control feature, an audit trail of the modified data, change dates, and names of users making the changes will be maintained.

8.4 METHODS FOR CONTROLLING ACCURACY OF DATA INPUT, COLLECTION, AND TRANSFER

Integrity of data input is ensured through standard methods, including double entry and rechecking of newly entered data by the originator. At a minimum, data base content must be proven to correspond exactly to the raw data as received and as documented in PDCC. When possible, electronic input devices (e.g., bar coding, Ultrasonic Ranging and Data System) will be used. Electronic data will be transferred by several means such as magnetic media (e.g., tapes, floppies) for a large volume of data. If the data are transferred in this manner, the transmitter will validate the data by using a verify option when creating the copy. Small amounts of data will be transferred with several protocol programs (e.g., Cross Talk, Reflections, Kermit); all of these programs use extensive error checking and retransmission of data if errors are encountered.

8.5 PROCEDURES FOR VERIFYING DATA BASE CONTENT

Usefulness of data will be based on intended use, method of collection, and validation status. Validated and/or verified data will be categorized (flagged) into three general classifications.

- Data that meet minimum QA criteria are verified-valid.
- If it is uncertain whether minimum QA criteria are met, data are verified-limited use.
- Data that do not meet minimum QA criteria are verified-invalid.

These classification categories, discussed in Sect. 6.3.1, are determined by technical specialists reviewing the data. Data deemed to meet the minimum QA criteria include data collected, analyzed, and documented using standard, approved procedures. These data are accompanied by documentation that demonstrates the following.

- Sampling objectives were clearly defined, and the data were collected to meet appropriate regulatory, reporting, confirmation, characterization, or monitoring goals.

- Sampling design demonstrates that appropriate media were sampled, appropriate parameters were measured, appropriate samples were taken at the right place and time, and the samples yielded representative results.

- Sample collection followed approved procedures and protocols (in accordance with the sampling and analysis plan) to obtain reliable and reproducible results.

- Data reporting included sufficient supporting information to allow clear interpretation.

- QA/QC procedures were clearly documented and implemented.

Existing data will be verified in accordance with PP 1502 and PP 1503.1. New data will be validated and verified by ensuring that PPs 1503.1 and 1503.2 are followed and by using guidelines set forth by the Environmental Protection Agency.

Data for which it is uncertain whether minimum QA/QC criteria are met include data originally collected for screening activities or documentation purposes. These data may not have followed strict QA/QC procedures, may have been analyzed by less precise techniques, or may have been reported with inadequate supporting documentation or analytical protocols. However, these data can be used to indicate follow-up collection as necessary, fill in gaps in other data for adequate characterization of problem areas, or indicate areas where further data collection is not necessary.

Unacceptable data are those that do not fulfill these requirements. New data will be evaluated to ensure that they meet all of these criteria. Questionable or verified-limited use data will be further documented or supplemented by collecting more information as required.

8.6 DOCUMENTATION AND VALIDATION OF MODELS AND COMPUTER PROGRAMS

All standard engineering computer programs are validated and controlled in accordance with Bechtel Engineering Department procedures as described in PP 1107, "Project Engineering Procedures." This validation must demonstrate the effectiveness of the program and its conformance to Bechtel standards. Whenever possible, data output and analysis are performed by an alternative method (e.g., calculating by hand), and the results of the two methods are compared. Other technical programs will be reviewed and approved by the TSL before being used on the project. These programs will be handled in accordance with PP 1107.

Requestors of data output are responsible for providing the DBM team with appropriate algorithms to perform calculations. Output will be reviewed and verified by the requestor in accordance with PP 1107. All computer program development will follow Bechtel's *Guidelines for Software Development*.

REFERENCES

Guidelines for Software Development, Bechtel Corporation, San Francisco, California.

Environmental, Safety, and Health Plan for the Remedial Investigation/Feasibility Study at Oak Ridge National Laboratory, ORNL/ER/Sub/87-99053/3, Bechtel National, Inc., Oak Ridge, Tennessee.

Automation Technology Procedures and Standards, Bechtel National, Inc., Oak Ridge, Tennessee.

DOE Order 1360.2A, May 20, 1988.

SAS Procedures Guide, Version 6, Third Edition, SAS Institute, Inc., Cary, North Carolina.

APPLICABLE BECHTEL PROJECT PROCEDURES

Project Procedure 1501, "Data Collection, Encoding, and Entry"

Project Procedure 1502, "Verification of Existing Data"

Project Procedure 1503.1, "Receipt, Review, and Assessment of Analytical Data Quality"

Project Procedure 1503.2, "Data Review for Radiological Data"

Project Procedure 1603, "Sample Information Management System (SIMS)"

Project Procedure 1603.1, "Intermec 9460 Bar Code Reader User's Procedure"

Project Procedure 1107, "Project Engineering Procedures"

Project Procedure 1120, " Administration of RI/FS Training"

Project Procedure 1637, "Field Data Acquisition Documentation"

APPENDIX A

MODELING CAPABILITIES

MODELING CAPABILITIES

I. ATMOSPHERIC MODELS
   A. CHEMDAT 7—EPA Model for Treatment, Storage, and Disposal Facilities
   B. Industrial Source Complex (ISC) Model
   C. Valley Dispersion Model

II. SURFACE WATER MODELS
   A. HEC-1—Basin-wide rainfall/runoff modeling
   B. HEC-2—Water surface profiles in open channels
   C. FESWMS-2DH—Two-dimensional flow in a horizontal plane
   D. SNTEMP—Temperature and flow in a stream network
   E. MITEMP—Temperature in cooling ponds and lakes
   F. WASP 5.0—Water quality in aquatic systems
   G. QUAL2E—Water quality in river network
   H. CE-QUAL-R1—Water quality in reservoirs
   I. CE-QUAL-R1-V1—Water quality in river network
   J. HEC-6—Flow, sediment, scour, and deposition in open channels
   K. TABS—Flow, sediment, and constituent transport
   L. SED3D—Flow, sediment, and transport in lakes and estuaries
   M. CREAMS—Non-point-source pollution from agricultural areas
   N. SWMM Ver. 4—Urban runoff quantity and quality
   O. HSPF9—Water quality/quantity in rural/urban watersheds

III. GROUNDWATER COMPUTER MODELS
   A. One-Dimensional Princeton Unsaturated Code
   B. Two-Dimensional Princeton Unsaturated Code
   C. Hydrologic Evaluation of Landfill Performance (HELP)
   D. MODFLOW—Flow in anisotropic, heterogeneous multilayered porous medium
   E. USGS-MOC—Transport of dissolved chemical species in an anisotropic, heterogeneous porous medium
   F. SUTRA—Fluid movement and transport of either energy or dissolved substances in anisotropic, heterogeneous, saturated, or unsaturated porous medium
   G. SWIFT 386, Release 2.51—Flow, heat, and transport of radionuclides in fractured media
   H. FEMWATER—Flow in unsaturated/saturated porous media
   I. FEMWASTE—Contaminant transport through unsaturated/saturated porous media
   J. BLT—Radionuclide releases from low-level radioactive waste shallow land burial trenches
   K. GEO-EAS, Ver. 1.2.1—Statistical analysis of spatial environmental data

IV. RADIOLOGICAL DOSE MODELS

A. SOURCE 2 (Bechtel SCP NE602)—Calculation of radioactive decay/ingrowth
B. CYLSEC (Bechtel SCP NE650)—Radiation shielding model
C. PATHRISK—Calculation of risk and dose from exposure to radioactive contamination in environmental media
D. RESRAD—Calculation of dose from exposure to radioactive contamination in soil
E. QAD-GP—Gamma radiation shielding calculations
F. MSHIELD—Gamma radiation shielding calculations

APPENDIX B

DATA BASE DEFINITION

Data Base Definition

Data category	Method of data collection	Typical data (units, etc.)	Anticipated output	Analysis/comments
1. SURFACE SURVEYS	1. Existing data collection	Existing drawings/ digital information	Site feature maps	Data integration and topographic models will be accomplished using Bechtel's Intergraph graphics stations.
Civil survey	2. Aerial photo-grammetry	Aerial photos		
	3. Land survey	Digital information		
Geophysical survey	1. Electromagnetic conductivity	Terrain conductivity (mmhos/m)	Trench extent; buried metallic objects; location of conductive plumes	Contour maps that may use multilayer or buried conductor models to interpret data
	2. Magnetometer	Magnetic field intensity (gamma)	Trench extent; buried metallic objects	Contour maps that may use statistical modeling techniques or buried conductor models to interpret data
	3. Seismic	Material seismic velocities (fps)	Depth to bedrock; depth to zone of saturation	Seismic cross sections that may use two-layer or multilayer models to interpret data
	4. Ground-penetrating radar	Radar section; plot of distance vs time (seconds)	Trench extent; buried objects; contaminant plumes; seeps; depth to bedrock	Radar sections; field strip chart of radar data is marked to identify subsurface features; may also generate a plan showing location of radar targets
	5. Resistivity	Resistance of materials (ohm-ft or ohm-cm)	Depth to bedrock; conductive groundwater plumes	Contour maps from horizontal profiling or geoelectric cross sections; maps use two-layer or multilayer models to interpret the data
Aerial photograph analysis/remote sensing	1. Historical aerial photos	Photographs	Trench extent; discharge zones; distressed vegetation	Visual examination to determine waste disposal practices over time, changes in vegetation, and seasonal changes in streams
	2. Aerial remote sensing (e.g., infrared)	Typically, digital tapes	Discharge zones; distressed vegetation; regional geology	Use electronic enhancement techniques to examine surface water and vegetation, and to locate lineaments possibly associated with regional geologic structures
Surficial site screening	1. Field GC of soil gas	ppm or ppb	Volatile organics distribution	Contour maps
	2. Gamma scintillation scan	dpm, cpm, mR/h	Near-surface radionuclide distribution	Contour maps

Data Base Definition (continued)

Data category	Method of data collection	Typical data (units, etc.)	Anticipated output	Analysis/comments
2. HYDROGEOLOGIC AND GEOLOGIC CHARACTERIZATION				
Boring and well data	1. Sample collection for lab analysis	Soil samples	Soil type, strength, density	Prepare geologic log of core including soil type; use strengths and density for engineering analyses
	2. Rock coring	Diamond core rock samples	Rock type and competence stratigraphy	Prepare geologic log of core including frequency, conditions, and orientation of fracture, lithology, mineralization, and other pertinent information
In situ permeability/ aquifer testing	1. Falling head tests	Hydraulic conductivity cm/s; ft/day; gal/day-ft^2	Hydraulic conductivity; zones of high hydraulic conductivity as potential migration pathways and for installation of monitoring wells	Simple mathematical calculation of hydraulic conductivity; contouring of hydraulic conductivity data
	2. Pressure-packer tests	psi	Isolation characteristics of aquifer	
	3. Pumping test	Hydraulic conductivity; transmissivity; storage coefficient	Aquifer properties	Depending on groundwater system, may include Theis method, Chow method, Jacob method, boundary analyses, etc.; data analyzed by semi-log or log-log plots
Piezometric monitoring	1. Periodic/continuous monitoring of groundwater (GW) elevation	Discrete water level measurements/continuous strip chart records expressed as elevation above mean sea level	GW elevation and flow gradient change	Hydrographs and potentiometric contours; determine gradient and flow direction by simple mathematical and graphical techniques
Unsaturated zone monitoring	1. Lysimeters	Pore water samples	Characterize contamination including movement in unsaturated zone	Organic, inorganic, and radionuclide analysis results
	2. Tensiometers	Measures variations in soil suction bars	Variations in soil water profile in unsaturated zone	Provide criteria; e.g., pressure for pore water sampling, characterize infiltration
Geotechnical/geochemical testing	1. Distribution coefficient	Distribution coefficient Kd; mL/g	Mobility of waste	Lab analysis using ASTM D4319; distribution ratios by the short-term batch method using source term ionic species
	2. Leachability of waste	Solubility; pH; velocity of water	Mobility and source strength of waste	Models can be used to calculate leach rate and define source team
	3. Cation exchange capacity	CEC; meq/100 g	Mobility of ionic species	Lab analysis using ASTM 805 method
	4. Soil and rock properties specific gravity; Atterberg limits; soil classification	Moisture content; porosity; grain size;	Geomedia properties	Lab tests using ASTM method

Data Base Definition (continued)

Data category	Method of data collection	Typical data (units, etc.)	Anticipated output	Analysis/comments
3. HYDROLOGIC CHARACTERIZATION				
Surface water flow	1. Weirs/recording stations	Flow rate; cfs	Surface water recharge rate	Recording data for different situations; e.g., seasonal variations, storm situations
Sediment transport	1. Sediment samples at recording stations	Mass flow rate	Sediment transport rate	Calculate sediment transport rate
Seepage flow	1. Seepage galleries installation	Seepage discharge rate; cfs	Seepage discharge rate	
Precipitation and infiltration analysis	1. Rain gauges	Automatic readouts; in./h	Runoff-to-infiltration ratio	
	2. Infiltrometer tests	Infiltration; in./h; cm/s		Analysis using Darcy's law
4. CONTAMINANT CHARACTERIZATION				
Groundwater sampling	1. Surrogate and constituent analysis of GW samples	Concentration of radionuclides, organics, BOD, COD, TOC, etc.	Contaminant distribution capacity; spatially and temporally	Contaminant distribution graphs, contours, thematic maps, and conventional pollutants present
Surface water/leachate sampling	1. Surrogate and constituent analysis of surface water (SW)/leachate	Concentration of radionuclides, organics, BOD, COD, TOC, etc.	Contaminant distribution in low flow and high flow	Contaminant distribution graphs, contours, thematic maps, and conventional pollutants present
Unsaturated zone sampling	1. Surrogate and constituent analysis of SW/leachate of unsaturated zone	Concentration of radionuclides, organics, BOD, COD, TOC, etc.	Contaminant distribution in unsaturated zone	Contaminant distribution graphs, contours, thematic maps, and conventional pollutants present
Sediment sampling	1. Radionuclide and organics analysis of sediment (collected after high flow events)	Concentration of radionuclides and organics and Btu content	Sediment transport of contaminants	Concentration distribution in sediments and Btu content
Soil sampling	1. Field organic vapor analyzer (OVA) or GC screen of soil samples	Contaminant levels (ppm or $\mu g/g$)	Gross chemical contaminant levels	Review to determine whether more analytical work required
	2. Field walkover with gamma scintillometer	counts/min	Gross radiological contaminant levels	Review to determine whether more analytical work required
	3. Field gamma scintillation screen of soil samples	Surface contamination levels (counts/min)	Gross radiological contaminant levels	Review to determine whether more analytical work required

Data Base Definition (continued)

Data category	Method of data collection	Typical data (units, etc.)	Anticipated output	Analysis/comments
	4. Field analysis of radionuclides	Exposure rate (mR/m); contamination level (dpm)	Hazard potential; contaminant distribution horizontally/vertically	Inform lab personnel of hazard potential; contours of radionuclide concentrations
	5. Lab radionuclide and organics analysis of soil	pCi/g, ppm, Btu	Contaminant levels of rad and chemicals and Btu level of soil	
Contaminants in biota	1. Field samples and laboratory analyses	Concentration (mg/L, pCi/g)	Contaminant distribution in flora/fauna study	Graphical analysis involving comprehensive study or trend analysis for long-term
Airborne emissions	1. High volume	Suspended particulates and SO_4, NO_3, Pb-24; concentrations $\mu g/m^3$/day	Emission rate	
	2. Charcoal tube	Nonpolar gas concentration	Contaminants into atmospheres	
5. BIOTIC CHARACTERIZATION				
Biota	1. Field observation/existing literature	Identification of flora/fauna	Analysis of potential remedial actions on flora/fauna	
6. PERSONNEL H&S DATA				
Radiological exposure	1. TLDs, dosimeters, air samples	Documentation of personnel exposure or nonexposure		Data analysis will involve report writing based on tabular data input
Bioassay	1. Urine analysis, whole-body counts, nasal smears			Establish fitness for field and laboratory work
Medical exams	1. Required personnel submittal			Establish fitness for field and laboratory work
Chemical exposure	1. Laboratory analysis	Establish fitness for field work		Establish fitness for field and laboratory work
Training	1. OSHA requirements	Establish fitness for field work		Establish fitness for field and laboratory work
	2. Site-specific requirements	Establish fitness for field work		Establish fitness for field and laboratory work
7. ENGINEERING DATA				
Engineering test and analysis			Access and control of needed information registers	Will include registers for bench-scale test results, analysis parameters, and analysis models and results

Data Base Definition (continued)

Data category	Method of data collection	Typical data (units, etc.)	Anticipated output	Analysis/comments
8. DOCUMENT CONTROL				
Document control	Document control		Access and control of needed information registers	Will include registers for company reports, project reports, reference documents, calculations, change control, action items, and deliverables
9. PROJECT MANAGEMENT DATA				
Project control data	Project management		Access and control of needed information registers	Will include registers of schedules, budgets, cost summaries, WAG RI estimates, and alternative cost estimates

APPENDIX C

DATA COLLECTION AND HANDLING FLOWCHART

Drawing is available in ORNL Lab Records or DOE Information Center
TG/ORNL 12/2009

NO.	DATE	REVISIONS	BY	DRAFT CH'K	ENG'R	ENG'R CH'K	PROJ ENG'R	MICRO FLMD
D	10/5/93	REVISED AND REISSUE FOR USE	RLP	JED	[illegible]	[illegible]	[illegible]	
C	9/1/92	REVISED AND REISSUE FOR USE	GWB	JMH	RNP	CAD	CRJ	
B	12/23/91	ISSUE FOR USE	TGR FOR KCL	JMH	DSH FOR WCF	CAD	CRJ	
A	11/1/91	ISSUE FOR INTERNAL REVIEW	KCL	TGR	WCF	CRJ	CRJ	

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OAK RIDGE NATIONAL LABORATORY REMEDIAL INVESTIGATION/ FEASIBILTY STUDY

DATA COLLECTION AND HANDLING FLOWCHART FOR FIELD AND ANALYTICAL DATA

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