Planning for and Managing Environmental Restoration Waste

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ABSTRACT

This paper describes the approach used to support the management of environmental restoration (ER) waste. A general description is provided of the tools and techniques that have been developed and applied to produce waste generation forecast data and treatment, storage, and disposal capacity needs. The ER Program can now consistently manage ER waste streams from initial generation through ultimate disposal. Utilizing the valuable information that results from application of strategically planned systems and techniques demonstrates the ability to provide the necessary waste management support for the ER cleanup process.

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INTRODUCTION AND BACKGROUND

Martin Marietta Energy Systems, Inc., is one of the prime contractors for the U.S. Department of Energy (DOE) Oak Ridge Field Office (DOE-OR). DOE-OR has assigned Energy Systems the responsibility of integrating contractor (oversight) for Environmental Restoration (ER) Program activities on the Oak Ridge Reservation (ORR) and nearby off-site locations as well as at the Portsmouth (PORTS) and Paducah gaseous diffusion plants (PGDP). Energy Systems has identified more than 550 sites on the ORR where some form of environmental contamination is known or suspected.

The Energy Systems ER Program was formed in September 1989. An essential element of this program concerns handling and managing waste and environmental media resulting from cleanup activities. In January 1991, the development of a waste management plan was initiated by Energy Systems and submitted to DOE-OR in November 1992 for approval; the plan provides guidance for handling ER waste. With establishment of this plan, the necessary strategies were developed and implemented to address existing waste management issues, with the main objective being to ensure that treatment, storage, and disposal (TSD) needs were identified along with appropriate funding strategies to obtain TSD facility capabilities.

An effort was initiated in January 1991 to establish a comprehensive waste baseline to provide a consistent, documented forecast of the waste volumes expected to be generated as a result of DOE-OR ER Program activities. Initial waste generation forecast results were compiled in November 1991; the latest forecast data were compiled in November 1992.

Modeling of facility capacities immediately followed initial output of waste generation forecast data. The primary purpose of TSD capacity modeling is to assess TSD capacity and capability needs. The initial model consisted of several waste-stream–specific logic diagrams, which were used to integrate forecast data with TSD processing steps.

Currently, information management strategies are being developed and implemented to effectively address the dissemination of data, information and plans that are necessary to support the ER Program in achieving the basic requirements for planning and managing ER waste.

FUNDAMENTAL CONCEPTS

The strategy for ER has been to seek opportunities to meet the needs of waste management. A systematic approach is applied in setting a foundation of fundamental elements for waste management activities; this includes establishing strategic and tactical plans within the performing organizations which will drive improvements into the planning and implementation of waste management activities. The strategy for planning and managing ER waste is dynamic and it represents the planning process at one point in time. The strategic planning base for ER waste management involves (1) identifying necessary plans and procedures, (2) establishing and maintaining a waste generation baseline, (3) planning for TSD capacity, and (4) managing information.

Tactical planning is used to define the application and implementation of potential tools and mechanisms that can be integrated with the overall ER process and deployed to assist in managing the waste. The following tactical plans have been established: (1) develop and execute the process for capturing and compiling necessary information that would establish a baseline of waste generation forecasts; (2) develop logic that can be followed for modeling TSD processes for handling waste stream volumes from ER activities; (3) develop techniques and performance measures for waste minimization/ pollution prevention; (4) develop and execute modeling of TSD logics to determine capacity and capability needs; (5) develop information management systems that allow easy access and dissemination of information and data; and (6) develop guidance documents that provide consistency of approach to managing waste management activities. The application of these mechanisms provides a way for more specific actions to be scheduled and executed in a manner that makes progress in achieving the fundamental goals.

DEVELOPMENT AND IMPLEMENTATION OF TOOLS AND MECHANISMS

Plans and Procedures

Energy Systems manages federal facilities that require regulation and control through a myriad of DOE Orders and federal, state, and local regulations. A defined set of requirements which ensure adherence to these orders and regulations and the activities associated with implementing the requirements follows:

- Waste management planning requirements
  - develop and maintain an ER waste management plan
  - develop and maintain waste generation forecasts
  - develop and maintain the TSD capacity plan
  - develop and maintain ER waste tracking systems
  - develop waste management project plans

- Organizational roles and responsibilities
  - establish EM-30/EM-40 roles and responsibilities
  - establish integrating contractor roles and reponsibilities
  - maintain ER waste management organization roles and resonsiblities documentation

- Cost, schedule, and program controls
  - establish and maintain an ER Program life cycle baseline
  - develop and maintain a 5-year plan, a site-specific plan, an ER Program managment plan, an ER waste management plan, and other policies and procedures, as needed.

- Waste minimization programs
  - define ER waste minimizatin goals
  - develop a waste minimization program plan
  - implement the waste minimization program

- Waste management technology demonstrations
  - develop a technology demonstration plan
  - implement the technology demonstration
  - ensure technology transfer of demonstration results

- Waste management [ER waste TSD instead?] facilities design and construction

  - define ER TSD facility requirements
  - develop preliminary/conceptual designs
  - develop detailed designs
  - construct ER TSD facilities

- Waste management operations
  - verb needed ER waste generation
  - verb needed [operate?] accumulation/temporary storage area operation
  - verb needed waste transportation
  - verb needed [operate?] ER-only TSD facility operation
  - verb needed [operate?] multi-program TSD facilities operation

- Waste certification programs
  - develop waste certification policy and requirements
  - Develop an ER waste certification program plan
  - implement an ER waste certification program

- Waste managment regulatory compliance
  - develop/implement RCRA permits for ER-only TSD facilities
  - develop/implement RCRA permits for multi-program TSD facilities
  - develop National Environmental Policy Act (NEPA) documentation for ER waste management projects
  - verb needed DOE Order 5000.3A reporting for ER waste management projects
  - verb needed Federal Facility Agreement/Federal Facilities Compliance Agreement reporting for milestones related to ER waste management

- Waste management health and safety programs
  - develop/implement an ER health and safety program

- Waste management quality assurance programs
  - develop/implement an ER quality assurance program

Waste Generation Forecasts

Waste volumes are estimated for three phases of environmental actions: preliminary assessment (PA)/site inspection (SI), remedial investigation (RI)/feasibility study (FS), and remedial design/remedial action (RA). Volume estimates for the PA/SI stage include wastes from limited sampling activities that are necessary to identify the presence of contamination. The RI/FS stage involves a comprehensive or observational approach to determine the extent of contamination. The remediation phase has three potential scenarios: clean closure, dirty closure, and a most probable scenario. Clean closure involves excavation and removal of contaminated material. Dirty closure involves containment of contamination. The most probable scenario is the activity most likely to occur based on current information. For remediation, this could be any of several remediation techniques or some combinations of clean and dirty closure. In developing estimates for the remediation phase, the most probable scenario considered was short-term objectives to contain and control the contamination.

The waste generation forecasting activity includes both RA and decontamination and decommissioning (D&D) components of the ER Program and includes the ORR [K-25 Site, Y-12 Plant, Oak Ridge National Laboratory (ORNL), and off-site contaminated areas adjacent to these DOE plants], PGDP, and PORTS. Waste volume estimates have been developed for ~700 projects. Estimates include the primary categories and material types anticipated to be generated during the entire life of the project. Table I gives a listing of the primary categories, material types, and some indication of probable contaminant. The waste forecast identifies the total waste volume for all phases of a project, in addition to specific waste volumes that are anticipated to be removed to TSD facilities outside the AOC.

A significant tactical consideration in developing estimates for these phases of environmental actions concerns U.S. Environmental Protection Agency guidelines for managing investigation-derived wastes in the area of contamination (AOC). The term "AOC" is derived from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and refers to the areal concept of contiguous contamination. Investigation-derived waste is associated with characterization phases (e.g., PA/SI and RI/FS) of the ER process.

ER waste forecasts serve as a baseline to communicate ER's future waste management requirements to EM-30 and nuclear energy waste management organizations. To better accomplish this, ER waste forecasts have been improved to distinguish between total waste generated and waste generated that will require TSD capacity outside ER's working AOC. Distinguishing ER waste requiring TSD capacity outside the AOC is essential so that EM-30 facilities can be appropriately sized and operational in a timely manner to meet ER's needs. Figure 1 compares the ER Program total solid waste generated and the total solid waste that leaves the AOC for the years 1993–1999.

The waste forecasting information and data must be collected, compiled, and analyzed. Information is initially collected by interviewing project managers. Also, in conjunction with this approach, waste management coordinators are assigned to each plant to oversee waste management activities associated with ER waste. These coordinators compile the requested information. To ensure that a representative cross-section of information is obtained, a methodology has been developed to provide consistency in collection of information for each project. Consistency in approach must be considered, based on the nature of the contaminated site and phase of restoration activity. Table II shows an example of the methodology for estimating the quantity of soil samples to be taken on a given site during the PA/SI phase. The magnitude of expected ER waste is enormous, with over 1.1 billion ft^3 estimated over the life of the ER Program. The most significant type of waste contributing to this volume is groundwater. Both solid and liquid waste totals represent volumes greater than the volumes from existing plant operations. Figure 2 shows total mixed-waste solids and total mixed-waste liquids, forecasted per year for the ORR, between 1993 and 2005. Figure 3 shows total low-level waste solids and total low-level waste liquids for the ORR that are forecasted per year between 1993 and 2005.

Waste generation forecasts are used in developing and updating ER program life-cycle baselines. Life-cycle baselines represent the planning foundation of the overall ER Program. Waste generation forecast data are used in the life-cycle baseline as supporting justification for directing technology development, changing and supporting remedial strategies, maximizing pollution prevention/waste minimization efforts, and emphasizing areas of potential cost avoidance.

TSD Capacity and Capability Planning

Planning and development for the integration of TSD capacity and capability needs carries a multi-program and multi-site infrastructure that requires coordination of many teams. Logic diagrams and facility modeling are components in TSD facility analysis which will not remain fixed; therefore, the tools and mechanisms used are flexible so that they can be adapted to the changing requirements of the program. Identified TSD needs vary based on site-specific information such as type and quantity of waste, availability of existing facilities, provisions on the upgrade to existing facilities, and the schedule for construction of new facilities. The initial approach to defining ER TSD needs was to forecast ER waste generation rates and assess the lack of TSD capabilities, then analyze the capacity needs.

Energy Systems has enhanced the TSD capacity model, which allows the identification of overall facility and capability needs, volumes to be handled, and overall schedules. TSD facility needs include solid waste storage, treatment, and disposal; liquid waste treatment; and supporting facilities and capabilities. The waste baseline segregates the wastes by plant and waste type to allow routing of waste to the appropriate TSD facilities. The model examines facility capacity for storage, contaminant removal, volume reduction, and on-site and off-site disposal.

Many assumptions in the logic diagrams were required to complete the TSD model. One of the most important assumptions was the use of the AOC for treatment and final placement of waste. This concept allowed the flexibility in storage, treatment, and disposal requirements as long as the contaminated media does not leave the AOC. The AOC concept is central to developing the overall strategy for ER waste management. Initial characterization, trestment, storage, and (potentially) disposal are assumed to be handled within the AOC. Contaminated media are assumed to be returned to the AOC after treatment/consolidation which meets either a health treatment standard or a risk-based consolidation-and-cap scenario. For actions being taken under CERCLA, Sect. 104(d)(4) allows treatment of related sites as one site for response purposes and, therefore, allows management of wastes transferred between select noncontiguous facilities. This provision allows transfer of waste from one site to another for more efficient response and to consider the waste transfer as if it were from a single site. Requirements for complying with the substantive, and not the procedural, aspects of the Resource Conservation and Recovery Act become effective for both waste sites, and no permit is required for on-site operations.

Generic process logics have been developed for treating, storing, and disposing of ER waste streams. Figure 4 shows the original version of a logic diagram for processing a mixed waste stream. The modeling basically applies the waste stream information to the logic diagram. After initially applying the waste stream information to the logic diagrams, the overload or shortfall to an existing or planned TSD facility can be determined. A work breakdown structure has been established and illustrated in Fig. 5 to show how cost and capacity data are collected against TSD facilities. Unit-cost tables have been developed from market research; by applying the unit cost to the shortfall, the capital and operating costs necessary for TSD support can be determined. The results can be analyzed to identify possible consolidation of common facilities and modifications to existing or planned facilities and to provide integration between the ER and waste management organizations. From these estimates, further distinctions are made as to whether existing, planned, or to-be-determined TSD facilities could be used.

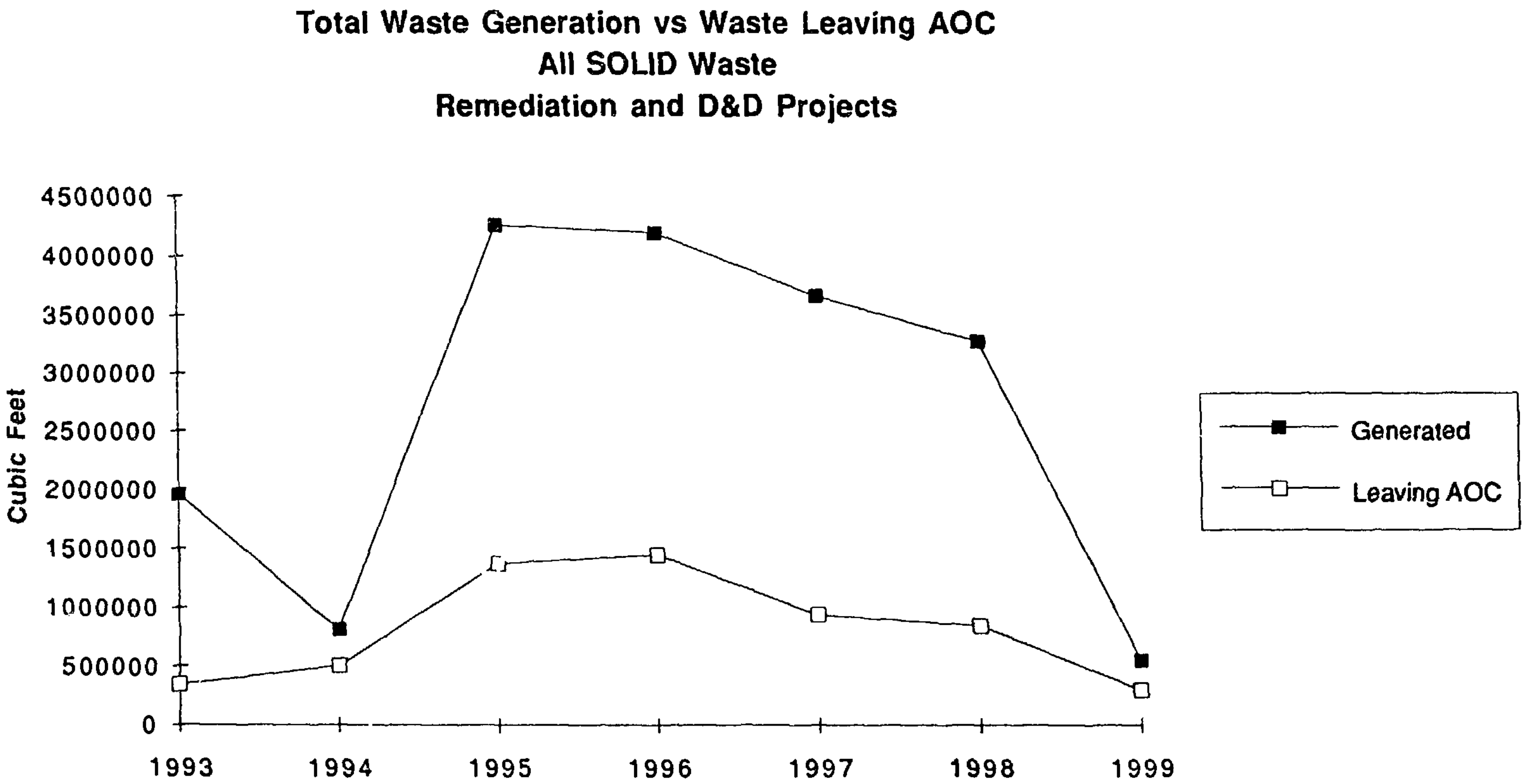
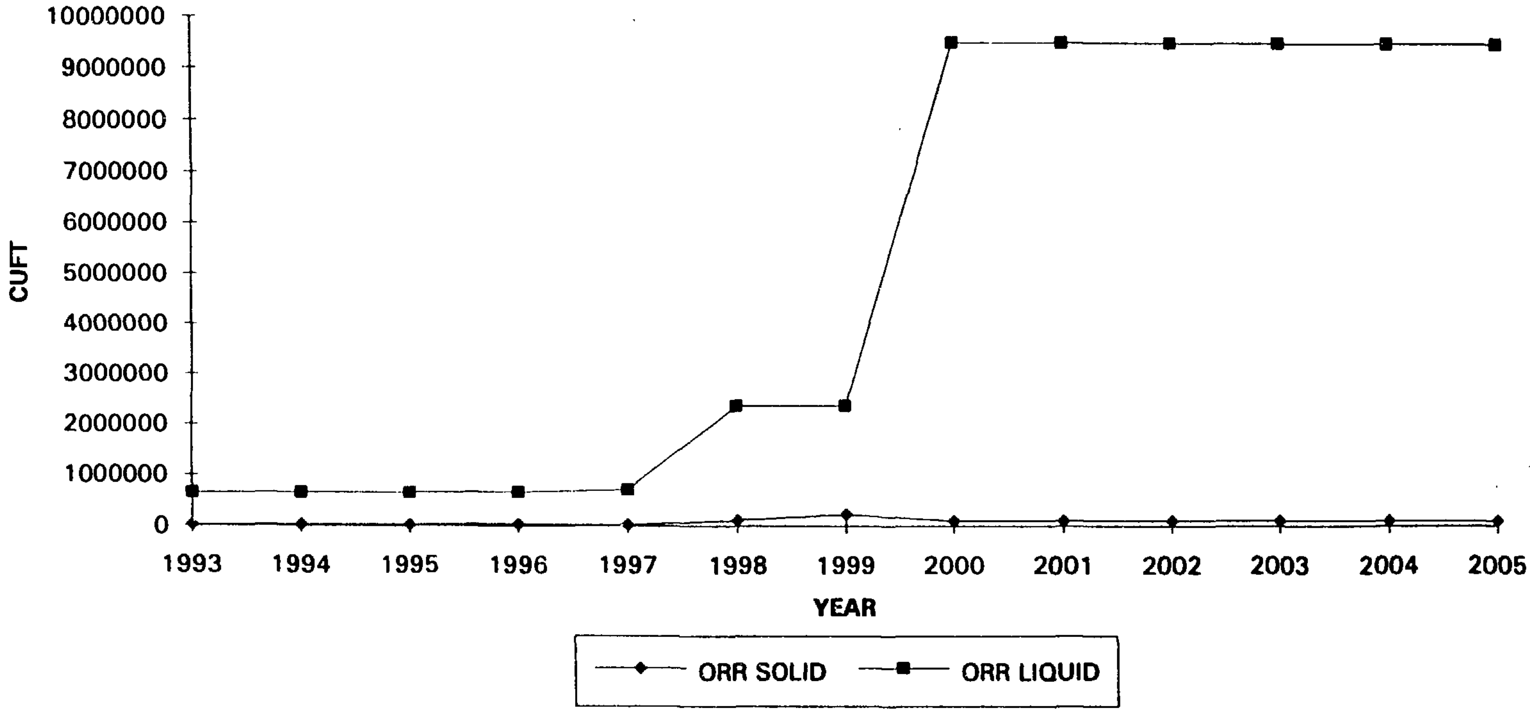
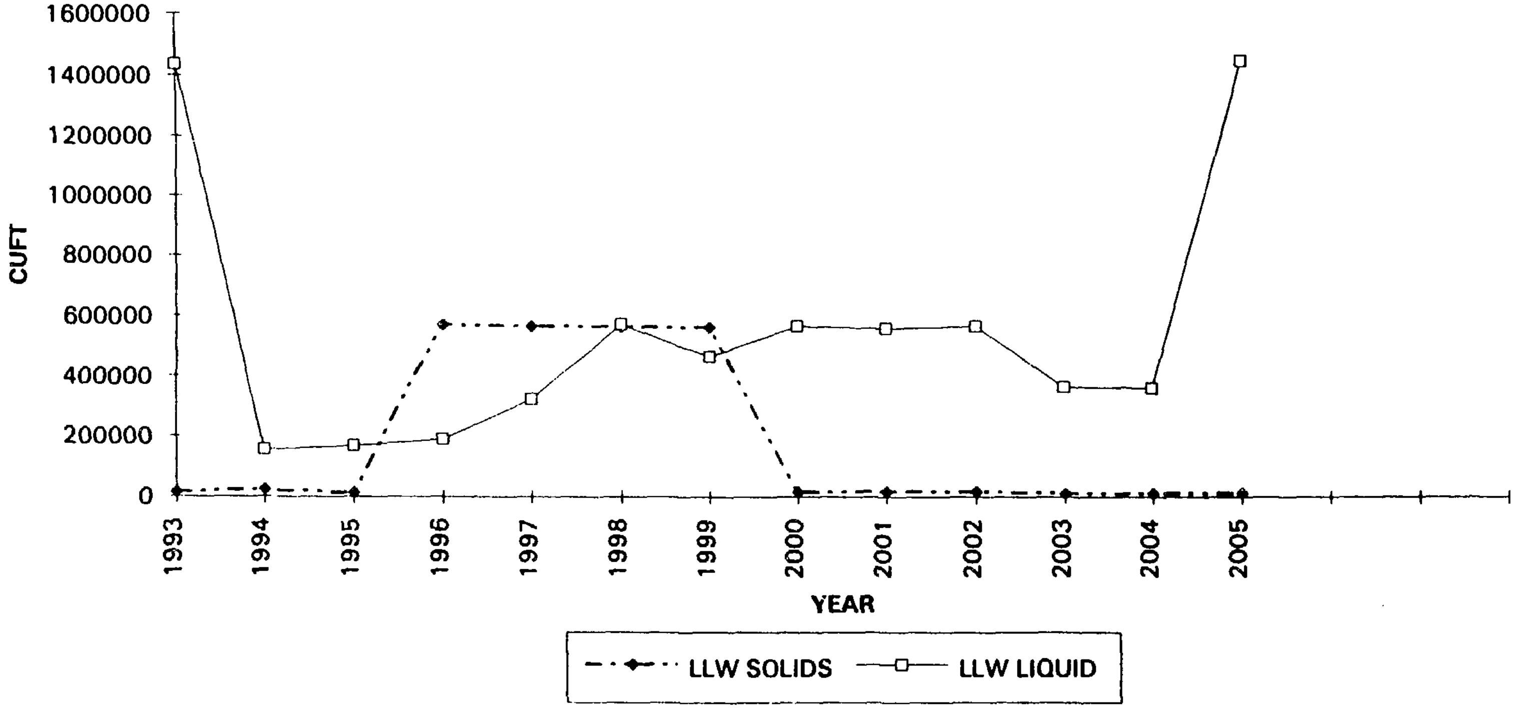


Fig. A.6. Total solid waste generated vs solid waste leaving the AOC from remediation and D&D projects.

MIXED WASTE FORECAST FOR THE OAK RIDGE RESERVATION



LOW LEVEL WASTE FORECAST FOR THE OAK RIDGE RESERVATION



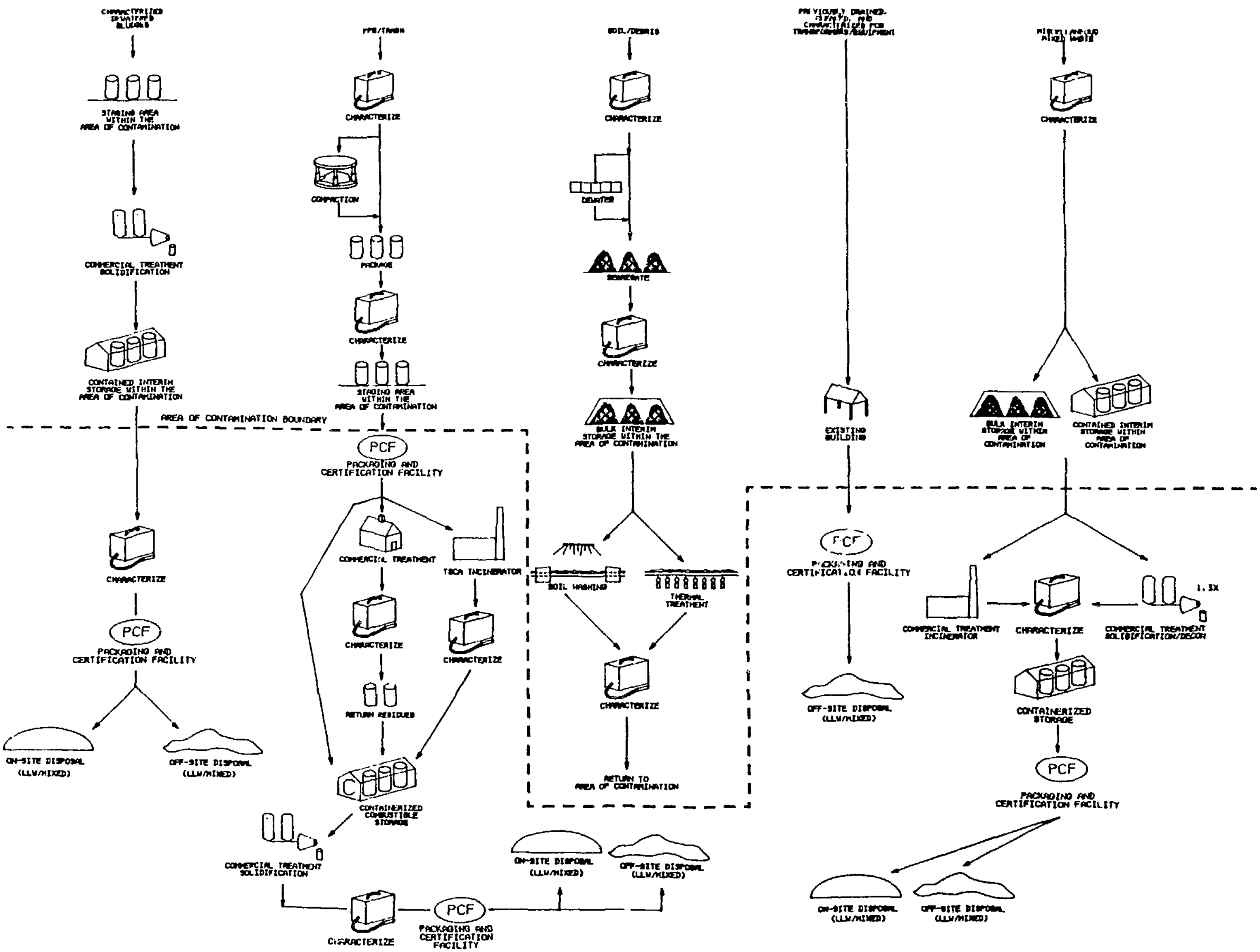


Fig. B.4. RCRA mixed waste management strategy

Because the TSD modeling process is very tedious and complex, use of an automated system with a simulation software application is necessary so that the time spent assessing TSD capability needs is reduced. The application also allows the flexibility of varying waste stream and facility parameters for facility optimization studies. The flexibility allows for TSD facility optimization studies. The results from the simulations can be used in forecasting TSD facility bottlenecks and facility throughput capacities. Assessments can be made as to the potential impacts to environmental and regulatory compliance, financial planning, and facility planning. Assessments can be made so that potential treatment delays and land disposal restrictions can be understood. Overall, the simulation establishes the basis for existing facility modifications and the justification for new facility development.

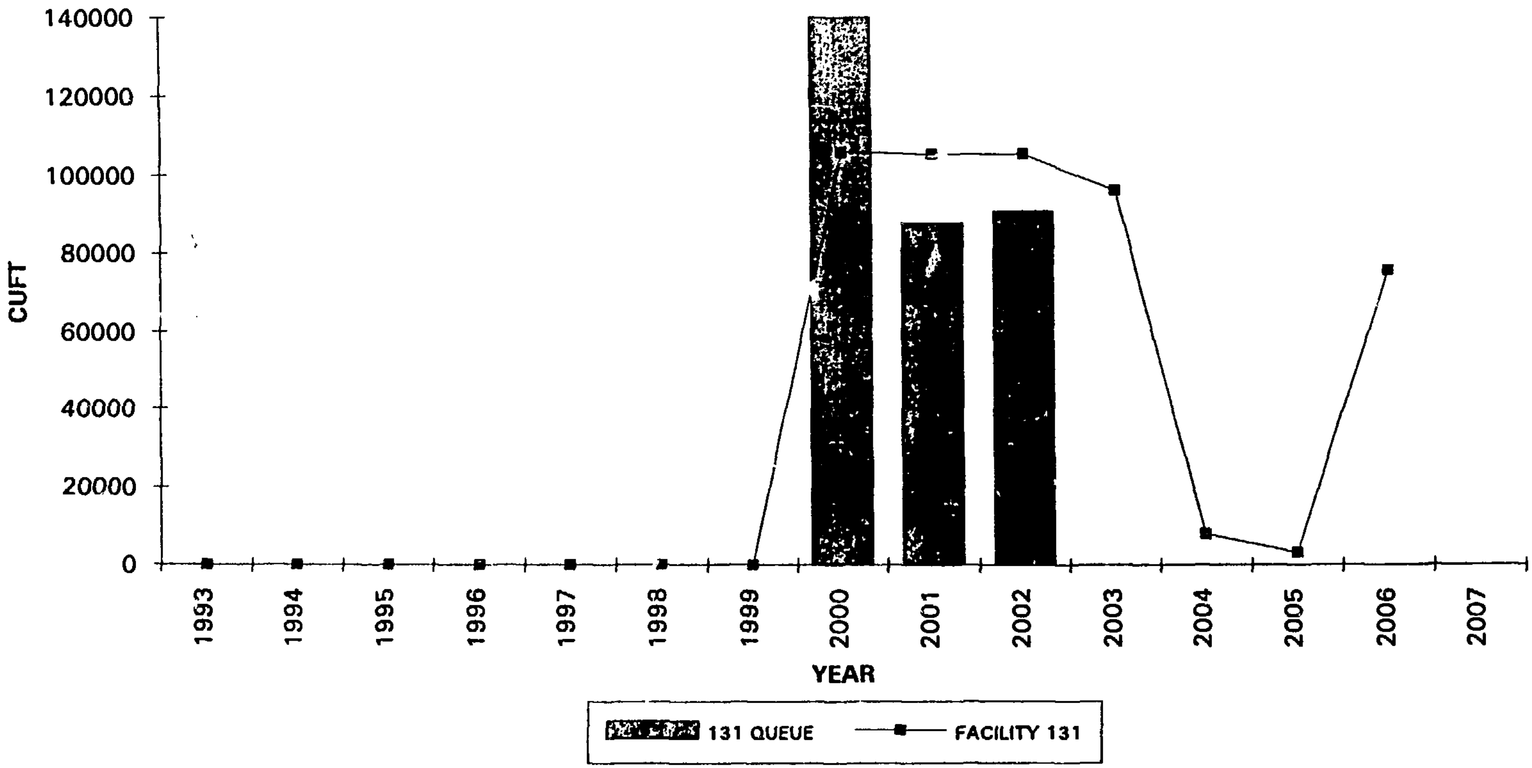
The computerized application of the model will automatically simulate each predefined facility process logic diagram. Initial model simulations were made on treatment facilities based on waste projections from ORNL, the Y-12 Plant, and the K-25 Site. Treatment facility scenarios were simulated using unlimited, 100%, and 50% capacity allocations for ER waste. Simulations for analysis of storage and disposal facilities are still being processed.

Figure 5 illustrates a simulation identified as Facility 131 with 100% capacity allocation for ER waste. Facility 131 represents a group of facilities that provide thermal desorption/recovery technologies. Facility 131 is defined to provide a total capacity of 210,800 ft^3/year by the year 2000. The primary inputs to the facility are waste streams comprised of sludges (organic/inorganic) and soil/debris (organic/inorganic) from mixed waste and hazardous waste generation. It was determined that ~600,000 ft^3 of the mixed waste soil/debris (inorganic) generated during the period of 1998 to 2001 is attributable to ER waste at the Y-12 Plant. These amounts contribute to the facility queue problems. Less capacity would increase the backlog over a longer period of time. After the year 2001, waste volumes decrease, allowing Facility 131 to process the waste that is backlogged. All of the waste backlog would be processed by the end of the following year. This scenario requires the assessment of available storage space during the period of the backlog. Among other alternatives to be considered is delaying generation of the sludges, but further evaluation of the related projects and regulatory drivers must be addressed prior to making a recommendation.

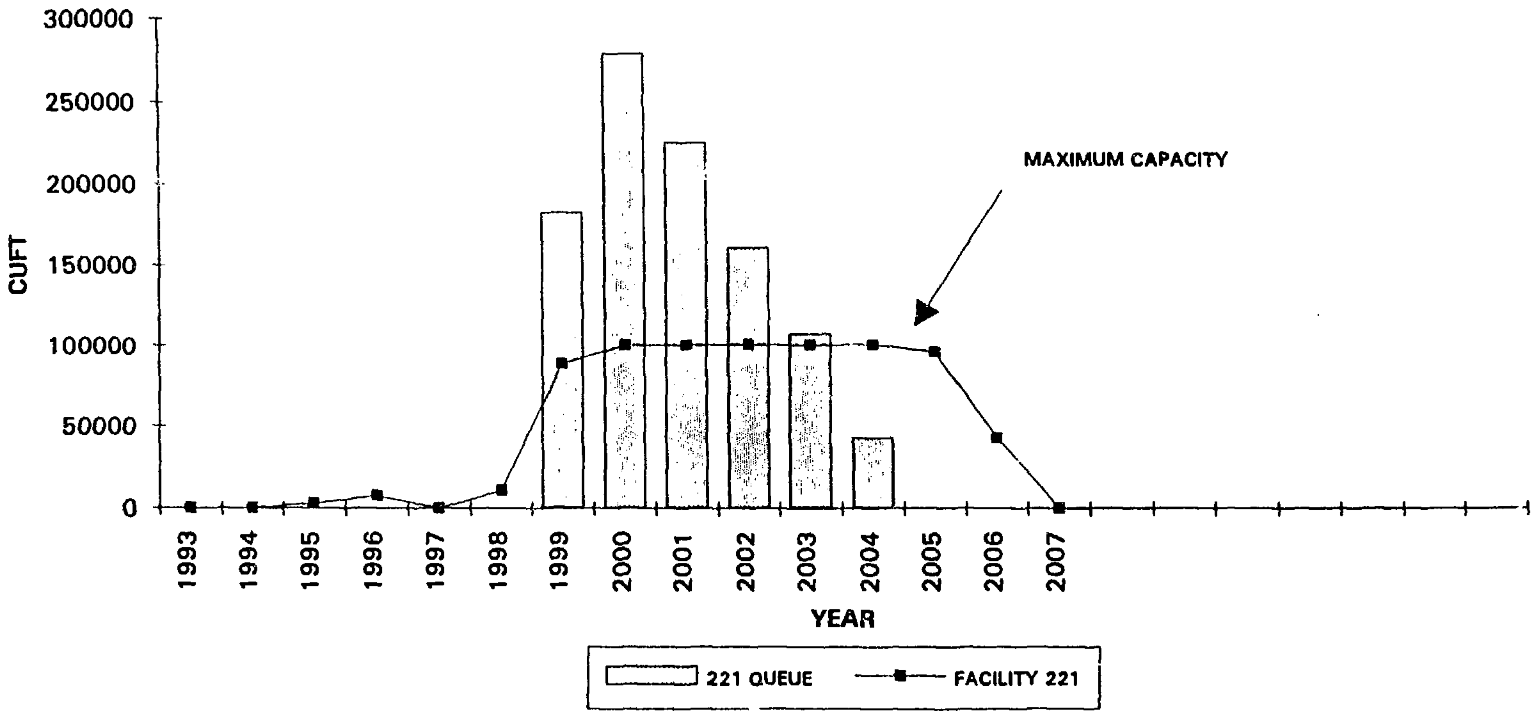
Figure 6 illustrates a simulation identified as Facility 221 with 50% capacity allocation for ER waste. Facility 221 is designated as an off-site commercial smelting capability. The treatment capacity for this facility is defined at 100,010 ft^3/year. As predefined in the process logic diagrams, this facility receives by-product waste from other facility processes during the execution of the model simulations. Logics in the simulation which send by-product waste to Facility 221 include sanitary/industrial solids, low-level waste solids, mixed solids, and hazardous solids.

Significant waste backlogs appeared in the simulation during processing years 1991 and 2003. Further analysis determined that ORNL ER waste streams were the major contributor. Simulation at the 50% capacity allocation level for Facility 221 will not accommodate the waste loads that were presented for processing. This scenario requires the consideration for increasing the capacity allocation for ER waste. Delaying waste generation becomes a complex issue because of the potential to backlog other facilities.

FACILITY 131 PROCESSED WASTE AND BUILDUP, ORR @ 50 % CAPACITY



FACILITY 221 PROCESSED WASTE AND BUILDUP, ORR @100% CAPACITY



Information Management

Management of information for ER waste management is essential for implementing waste management tools and mechanisms. The integration and automation of waste management activities, support systems, and mechanisms is most effective and expedient with multiple site and project interfaces.

The mechanism currently automated implements waste generation forecasting, TSD modeling, and waste minimization/pollution prevention; the waste generation forecast uses data base applications. A data base management system has been designed and implemented, giving consideration to the magnitude and various combinations of information that may be needed. The system uses commercially available data base applications for a personal computer. Add-ons have been included in the management system to provide user-friendly screens for ease of data entry. TSD modeling uses software simulation applications while receiving input from the waste generation forecast data base; a numerical scoring system is a data base application used for waste minimization performance assessments. Various parameters are used from the waste generation forecast data base (e.g., waste category, waste type, and waste volume).

The tactical plan currently in progress is a feasibility study to develop an on-line, computerized ER waste management information system that will allow the access of these applications and potential integration with other systems, mechanisms, or tools.

SUMMARY

The integration of these strategies and capabilities have been developed and applied to improve the quality of planning for ER waste and to increase the efficiency and productivity in ER waste management activities. The systems and mechanisms conceived for the management of ER waste have evolved into a reality and have proven to be applicable as a means to implement the recently approved memorandum of understanding between the DOE Headquarters Office of Waste Management and the DOE Headquarters Office of Environmental Restoration.

The fundamental need in forecasting ER waste by way of a systematic approach establishes a foundation on which to build all other waste management systems. Other mechanisms and tools built upon this foundation are TSD process logic diagrams and TSD facility simulations. The process logic diagrams define the steps that may be taken to treat, store, and dispose of waste and environmental media based on the specific make-up of a waste stream. The TSD facility simulations provide a layer of automation to schedule waste processing in existing and planned facilities with built-in facility capacities and operational delays.

The strategic principles have culminated in the implementation of an infrastructure that can be consistently applied for ER waste management activities. The results will ultimately provide a use in preparing the alternatives and approaches for environmental cleanup.

Table I. Forecast waste description

Waste category[a]	Characterization	Waste types
Mixed[b]	Organic	Well development/ purge waters
Low-level waste	Inorganic	Solvents/oils
Resource Conservation and Recovery Act (RCRA)/Toxic Substances Control Act (TSCA)[c]	Combustible	Decontamination solutions
Transuranic (TRU)[d]	Noncombustible	Groundwater
Sanitary	RCRA listed	Miscellaneous liquids
	RCRA characteristic	Personal protective equipment/trash
	TRU remote-handled	Soil
	TRU contact-handled	Debris
		Sludges
		Asbestos
		Equipment
		PCB equipment
		Metal
		Miscellaneous solids

[a]Includes both liquid and solid forms.
[b]Includes RCRA/TSCA/LLW; RCRA/LLW; and TSCA/LLW.
[c]Includes RCRA/TSCA; RCRA; and TSCA.
[d]Includes TRU/RCRA/TSCA/LLW; TRU/RCRA; TRU/TSCA; TRU/LLW; and TRU.

Table II. RI/FS Phase I and Phase II soil-sampling criteria

Site type	Sample depth[a]	Samples per area
Burial grounds	Refusal	*b*
Pipelines—above ground 0–25 lin ft 25–50 lin ft 50–100 lin ft	Refusal	 3 4 5
Pipelines—underground 0–25 lin ft 25–50 lin ft 50–100 lin ft	Refusal	 3 4 5
Tanks—aboveground	Refusal	4 per tank
Tanks—underground	Refusal	4 per tank
Pits—lined (e.g., concrete)	Refusal	4 per pit
Pits—unlined	Refusal	6 per pit
Ponds/impoundments (man-made)	Refusal	*b*
Streams	Refusal[c]	*b*
Rivers/lakes (naturally occurring)	3 ft or refusal, whichever is less	*b*
Storage areas/yards/drums/ waste piles/scrap	Refusal	*b*
Landfarms	Refusal	*b*
Floodplains/wetlands	Refusal	*b*

[a]Due to the significant depth to bedrock/refusal at Paducah, 30 ft will be considered the maximum soil depth to be sampled (groundwater wells will be sampled to 65 ft).

[b]If study area to be sampled is
> 0 but ≤ 2725 ft^2, then take 4 samples
> 2725 but ≤ 5450 ft^2, then take 6 samples
> 5450 but ≤ 10,900 ft^2, then take 8 samples
> 10,900 but ≤ 21,800 ft^2, then take 10 samples
> 21,800 but ≤ 43,560 ft^2, then take 12 samples

[c]Site-specific conditions may not allow sampling to refusal. In such cases, the estimated depth is 3 ft.