DOE/EIS-0120D

Draft
Environmental Impact Statement

Waste Management Activities for Groundwater Protection Savannah River Plant Aiken, South Carolina Volume 2

April 1987
United States Department of Energy

DOE/EIS-0120D

Draft
Environmental Impact Statement

Waste Management Activities for Groundwater Protection Savannah River Plant Aiken, South Carolina Volume 2

April 1987
United States Department of Energy

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX C

REMEDIAL, TREATMENT, AND CLOSURE TECHNIQUES

This appendix describes potential remedial, treatment, and closure action techniques and their applicability to existing waste sites on the Savannah River Plant (SRP). It also provides the basis for identification of remedial and closure actions associated with the existing waste site alternatives described in Sections 2.2.2 and 4.1 and assessed in this environmental impact statement (EIS).

The alternatives for the modification of waste management activities at existing waste sites are as follows:

- Removal of waste to the extent practicable at all waste sites, and remedial and closure actions as required
- Removal of waste to the extent practicable at selected sites, and remedial and closure actions, as required
- No removal of wastes, but remedial and closure actions, as required
- No action; that is, no removal of wastes and no remedial and closure actions

The principal remedial, treatment, and closure actions potentially associated with these alternatives are the following:

- Groundwater pumping and possible chemical or physical treatment of recovered groundwater
- Treatment of hazardous waste as a limited treatment application
- Surface sealing and capping as a closure action

Hundreds of engineering concepts and actions are available for the treatment of wastes, for the remediation of waste sites, and for closure actions, although their feasibility has not been determined. The techniques described in this appendix either have been initiated or are considered to be both technically and economically attractive to the U.S. Department of Energy (DOE) for existing waste site remediation. The descriptions of techniques for potential remedial actions are derived from two handbooks published by the U.S. Environmental Protection Agency (EPA, 1982; 1985). This EIS does not select any specific remedial, treatment, or closure technique. DOE plans to conduct studies involving groundwater monitoring and modeling, and the feasibility of approaches to establish firm remedial actions; the basis for these studies will be an alternative strategy selected by DOE.

Section C.1 describes corrective (remedial) actions, including permeable bed treatment, groundwater pumping, and impermeable barriers, and their applicability. Section C.2 describes the direct treatment of wastes and includes general information on biological, chemical, and mechanical techniques for waste treatment; it also addresses the applicability of these techniques to SRP

waste types. Section C.3 addresses closure actions, such as surface sealing and capping, water diversion and control systems, and leachate control systems. Section C.3 also describes the applicability of the closure actions to existing SRP waste sites.

C.1 CORRECTIVE ACTIONS

Corrective actions for dealing with groundwater contaminated by waste disposal sites are complex and dependent upon many variables. Many variables are site-specific, including local topography, geology, surface-water and groundwater hydrology, and existing and proposed future site development.

Corrective actions for dealing with contaminated groundwater include the following: (1) *in situ* treatment; (2) groundwater pumping; and (3) containment or diversion. *In situ* treatment is a method by which contaminated groundwater is allowed to flow through permeable treatment beds (e.g., activated carbon). The beds are installed vertically below the ground surface and are designed to filter contaminants. Groundwater pumping is used to remove contaminated groundwater for treatment, contain a groundwater plume, or lower the groundwater so it does not contact the waste disposal area and become contaminated. Containment or diversion is the installation of impermeable barriers. These barriers are positioned below the ground surface to either prevent groundwater from migrating away from the site (containment) or divert groundwater and prevent contact with waste materials (diversion). Although the following paragraphs describe the corrective actions individually, an effective design often combines two or more actions.

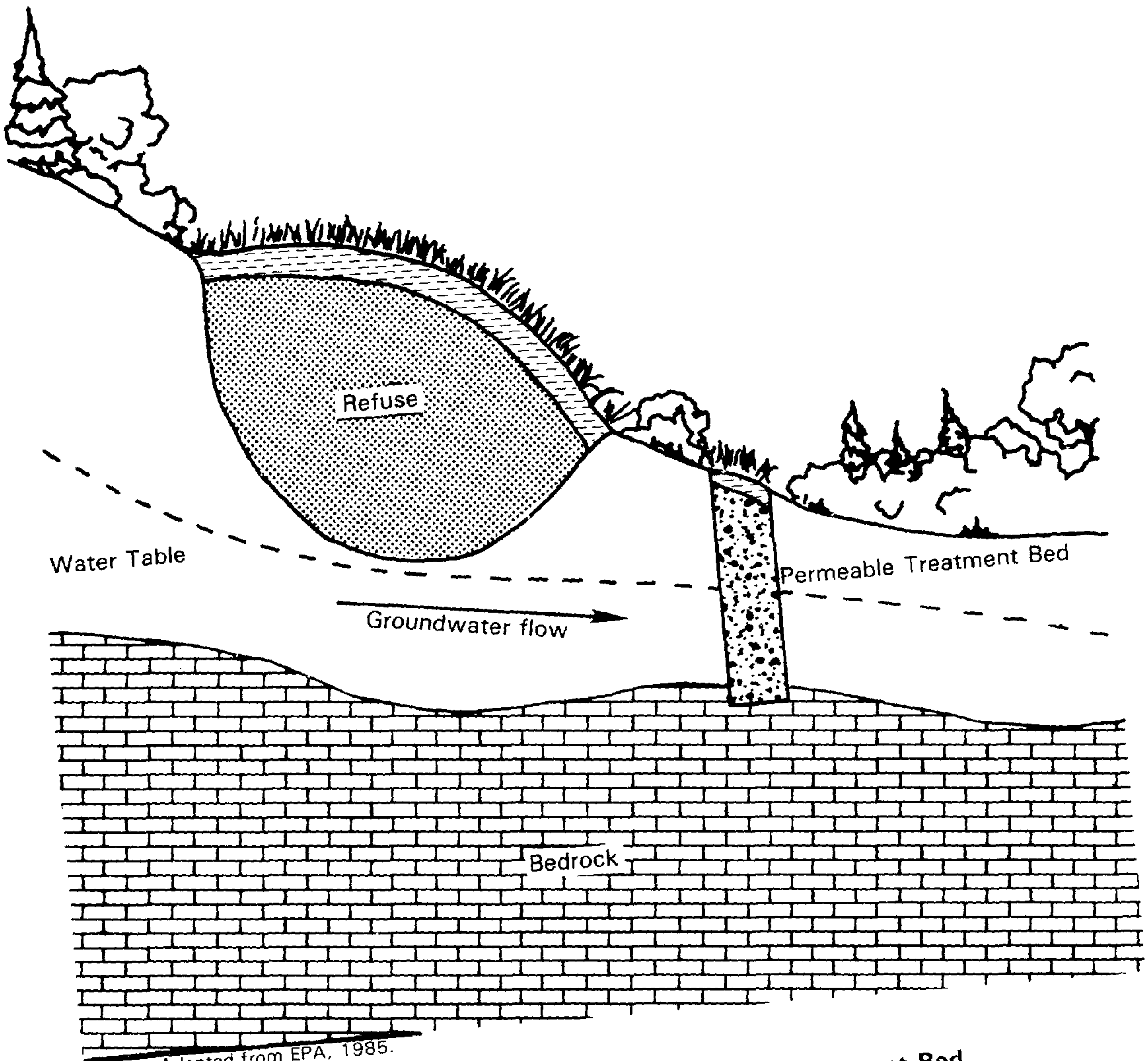
C.1.1 PERMEABLE TREATMENT BEDS

C.1.1.1 Description

Permeable treatment beds are sections of porous media through which contaminated groundwater passes and which remove the contaminants through physicochemical processes. Installed vertically below the ground surface in a manner similar to, and often with, slurry walls, permeable treatment beds are a viable means of *in situ* treatment (see Figure C-1).

Construction of a permeable treatment bed entails excavating a trench to intercept the flow of contaminated groundwater, filling the trench with the appropriate materials, and capping it. The trench extends to a confining layer at some depth below the ground surface. Permeable treatment beds are economical where the water table is close to the surface and the aquifer is shallow with bedrock or a confining layer limiting the depth to which the fill must be placed. The width of the trench is determined by the velocity of the groundwater flow, and the contact time required for effective treatment. Finally, the trench must be long enough to contain the plume and prevent it from circumventing the treatment beds.

The following materials are used in permeable beds to remove contaminants from groundwater: (1) crushed limestone or crushed shell; (2) activated carbon; (3) glauconitic greensands or zeolite; and (4) synthetic ion exchange resins. Each of these materials is effective for the removal of specific contaminants;



Source: Adapted from EPA, 1985.

Figure C-1. Installation of a Permeable Treatment Bed

however, they are limited in service life to varying degrees and must eventually be replaced or regenerated.

Crushed Limestone

Permeable treatment beds of crushed limestone contain granular materials varying from gravel- to sand-size particles. The particle size used depends on the results of the analysis of the type of soil in which groundwater flows and the level of groundwater contamination. Limestone is used to neutralize acidic flow. It also can be used to remove metallic contaminants such as cadmium, iron, and chromium from groundwater.

Activated Carbon

Activated carbon is a carbon compound that has been heated without oxygen to activate its pores. This material, which generally is derived from coal or wood, varies from pebble to sand size; it is also available in powder form. Activated carbon is used to remove organic contaminants, such as carbon tetrachloride and polychlorinated biphenyls.

Glauconitic Greensands

Glauconite is a hydrous aluminosilicate clay mineral, rich in ferric iron and potassium. Glauconite occurs as dark, light, or yellowish-green pellets 0.9 to 1 millimeter long, as casts of fossil shells, as coatings and other grains, and as a clayey matrix in coarser-grained sediments. Glauconitic greensand deposits of the Atlantic Coastal Plain have a high potential for the removal of heavy metals from contaminated water. High removal efficiencies are reported for copper, mercury, nickel, arsenic, and cadmium.

Other Materials

Other materials that are used for removing contaminants from groundwater are zeolite and synthetic ion-exchange resins. These materials are effective in the removal of heavy metal contaminants but are seldom economical for permeable beds because of problems with short life, high cost, and regeneration.

C.1.1.2 Applicability

Permeable treatment beds have limited applicability on SRP. The depth to groundwater at most of the waste sites is from 12 to 30 meters. The "green clay" is the first effective confining layer. It generally lies about 30 to 61 meters below the surface, except near Upper Three Runs Creek where it outcrops (see Sections 3.4.1 and 3.4.2).

C.1.2 GROUNDWATER PUMPING

C.1.2.1 Description

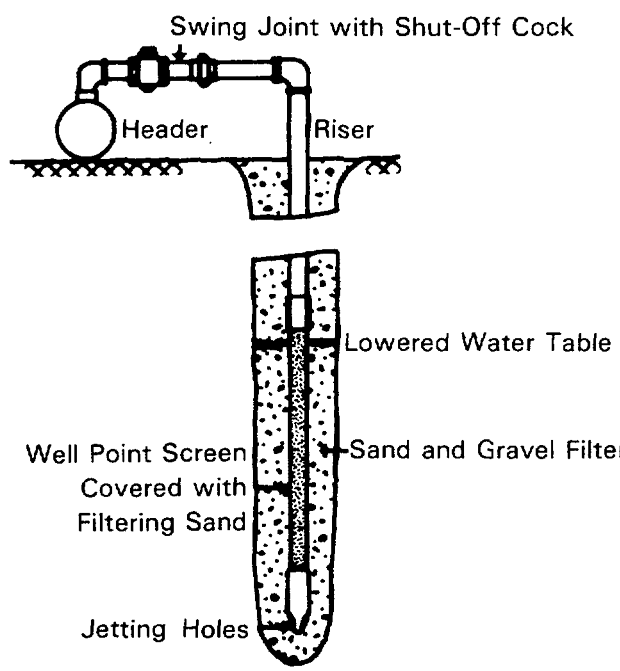
Groundwater pumping alters the elevation of the groundwater through the development of a cone of depression around the well. If wells are placed closely together, the combined cones of depression result in a depression network, which can lower the effective elevation of the groundwater over a large area. Groundwater pumping serves two purposes: it retrieves contaminated groundwater for treatment (Section C.2) and reduces further migration of the contaminants.

Groundwater pumping uses pumps to draw the groundwater to the surface through a series of wells. An adequate well system requires a careful evaluation of site conditions; a knowledge of seepage and groundwater flow to wells or wellpoints; and an understanding of wells, wellpoints, and pumping equipment. Any groundwater lowering (also referred to as dewatering) technology requires careful consideration of the possible effects of its implementation.

Wellpoints

Wellpoints are small well screens approximately 5.1 to 7.6 centimeters in diameter and 0.3 to 1.1 meters long. They are manufactured with brass or stainless-steel screens and with closed ends, drive-point tips, or self-jetting tips. Self-jetting-type wellpoints are installed in the ground with water flowing out the tip under high pressure. Closed end or plain tip wellpoints are installed into predrilled boreholes. Drive-point tips are installed directly via drop hammer and are suitable for some soils. Lines or rings of wellpoints installed on 0.9- to 3.6-meter centers and attached to a common header pipe (15 to 30 centimeters in diameter) and connected to a wellpoint pump (a combined vacuum and centrifugal pump) are called a wellpoint system (see Figure C-2).

Wellpoints are a common method of dewatering for construction purposes. They are applicable where the required depth of drawdown is no greater than 4.6 to 6.1 meters below the center of the header. Discharge capacity is generally on the order of 0.95 to 1.9 liters per second.



Source: Adapted from EPA, 1985.

Figure C-2. Well Point

Deep Wells

Deep wells differ from wellpoints by their function, which is to pump heavy flows over large vertical distances. These are typically large-diameter wells with diameters that range from 15 to 51 centimeters. Well screens typically range in length from 6 to 23 meters. Screens consist of a commercial-type water well screen or a perforated metal pipe often surrounded with a properly graded sand and gravel filter. Deep wells need 6- to 61-meter centers, depending on conditions. Pumping is performed with a submersible or vertical turbine pump installed near the bottom of the well. Well pumps are available in sizes from 0.3 to 379 liters per second, with head capabilities up to 183 meters.

Jet-Eductor Wells

Jet-eductor wells are wellpoints modified to provide lifts in excess of the typical 5- to 6-meter physical limits of standard wellpoints. Such a well is a wellpoint attached to the bottom of a jet-eductor pump, with one pressure pipe and a slightly larger return pipe.

Vacuum Wells

Vacuum wells are modified wellpoints or deep wells. The screen and riser pipe of a vacuum well are surrounded with a free-draining sand filter extending to within a few feet of the surface. The remainder of the soil is sealed with bentonite or impervious soil. The vacuum within the well effectively increases the hydraulic gradient toward the well or wellpoints.

Vertical Sand Drains with Wellpoints or Deep Wells

Vertical sand drains are used with deep wells and wellpoints to drain stratified soils where impermeable strata lay on top of more pervious strata. The drains are constructed by drilling vertical boreholes through the impermeable layers and are extended to underlying impermeable layers where wellpoints are placed. The boreholes, usually 41 to 51 centimeters in diameter, are continuously cased during advancement. The borings are filled with sand or other appropriate pervious material and the casings removed. A system of vertical sand drains is installed on 1.8- to 3.0-meter centers.

Sand drains with wellpoints or deep wells are applicable where a less permeable zone above a more pervious zone needs to be drained. The sand drains intercept the flow in the upper zone and drain it to the lower zone where the pressure is kept reduced by pumping from deep wells.

C.1.2.2 Applicability

Groundwater pumping is considered a viable method for recovering certain types of contaminated groundwater for treatment at SRP based on previous experience with groundwater contaminants. Generally, deep wells with submersible pumps would be required. The capacity of each well is limited due to the rather low transmissivity of the tertiary aquifer in areas where contaminated groundwater has been identified. In the M-Area, for example, a system of 11 recovery wells is in operation. The recovered groundwater is routed to a 25-liter-per-second air stripper that removes volatile organic compounds.

In addition to this ongoing application, all potential groundwater remedial actions identified in Appendix F would apply such pumping to recover the groundwater for treatment. Groundwater pumping would also be used to prevent further migration of contaminants.

C.1.3 IMPERMEABLE BARRIERS

Impermeable barriers are underground structures designed to restrict groundwater. The term "impermeable" is used in the context that most common types of barriers are more appropriately labeled "low permeability" barriers. The subject of impermeable barriers is readily divided into two broad categories, configurations (Section C.1.3.1), and types (Section C.1.3.2).

C.1.3.1 Barrier Configuration

The configuration of the impermeable barrier is its vertical or horizontal position relative to the waste site. Configurations are called upgradient, downgradient, circumferential, keyed (fully penetrating), or hanging (partially penetrating). Impermeable barriers in use today include slurry walls, grout curtains, and sheetpiles. Table C-1 summarizes the configurations for impermeable barriers.

Keyed or Fully Penetrating

Keyed impermeable barriers are designed to block flow from passing through the area in which they are located. They are vertical structures that are carried from the ground surface to a confining stratum or impervious layer at some depth. The barrier structure is "keyed" into the confining stratum, as shown in Figure C-3.

Hanging or Partially Penetrating

Hanging impermeable barriers are not keyed into a low permeability confining stratum. This configuration is generally used to control lighter than water contaminants such as petroleum products, which float on the top of the groundwater. The depth of the barrier depends on several variables including the thickness of the floating contaminant layer and the anticipated lowest possible water table elevation.

Circumferential Placement

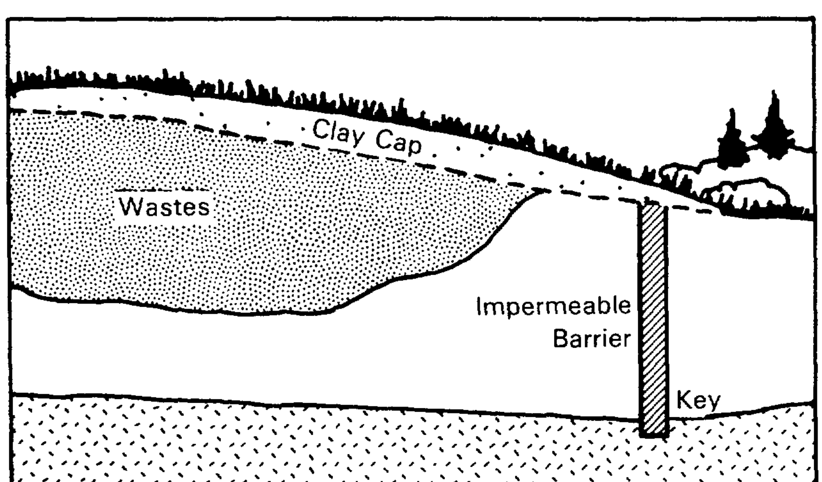
In circumferential placement, an impermeable barrier is installed completely around a waste site. With a cap and a leachate collection system, this barrier can reduce or eliminate the migration of contaminants.

Upgradient Placement

Upgradient placement is the positioning of the wall on the groundwater source side of a waste site. This type of placement is used to divert contaminated groundwater around the wastes where there is a relatively steep gradient across the site. Clean groundwater is prevented from becoming contaminated and leachate generation is reduced (see Figure C-4).

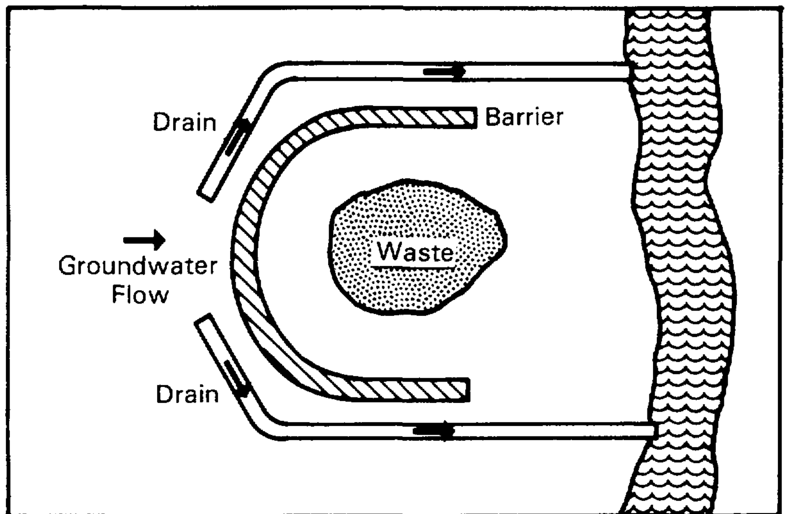
Table C-1. Summary of Configurations for Impermeable Barriers

Vertical Configuration	Horizontal Configuration: Circumferential	Upgradient	Downgradient
Keyed-in	• Most common and expensive configuration to use • Most complete containment • Vastly reduced leachate generation	• Not common • Used to divert groundwater around site in steep gradient situations • Can reduce leachate generation	• Used to capture miscible or sinking contaminants for treatment or use • Inflow not restricted, may raise water table
Hanging	• Used for floating contaminants moving in more than one direction (such as on a groundwater divide)	• Very rare • May temporarily lower water table behind it • Can stagnate leachate but not halt flow	• Use to capture floating contaminants for treatment or use • Inflow not restricted, may raise water table



Source: Adapted from EPA, 1985.

Figure C-3. Fully Penetrating Impermeable Barrier



Source: Adapted from EPA, 1985.

Figure C-4. Plan of Upgradient Placement with Drain

The design of upgradient barriers depends on site-specific variables. The actual site setting and the contaminants involved determine whether an upgradient wall can be keyed or hanging. Drainage and diversion structures might be needed to alter the flow of clean groundwater (see Figure C-5).

Downgradient Placement

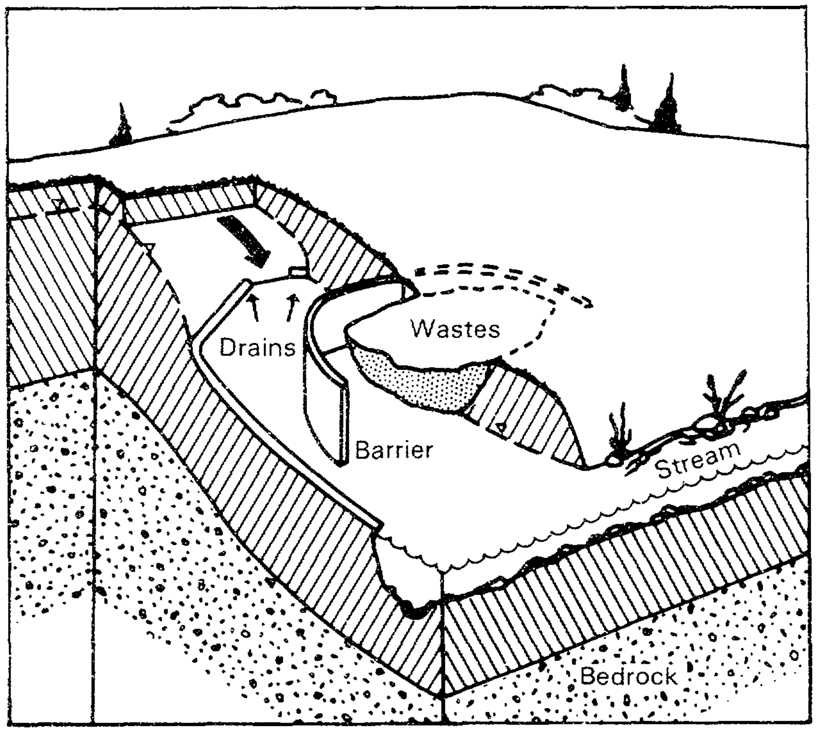
Installation of an impermeable barrier at a waste site at the side opposite the groundwater source is referred to as downgradient placement (see Figure C-6). The barrier serves as a temporary container of leachate and facilitates its easy recovery. Because it does not reduce the amount of groundwater entering the site, it is practical only in situations, such as near drainage divides, where there is a limited flow of groundwater. Without a means of recovery (i.e., deep wells or wellpoints), the volume of the barrier as a container would eventually be exceeded and contaminated groundwater would flow around the barrier and continue downgradient. Downgradient placement can use keyed- or hanging-type construction.

C.1.3.2 Barrier Types

The type of barrier chosen is a function of many variables, such as availability of materials, costs, required strength, and required permeability. Type and configuration are considered simultaneously and depend on the overall characteristics of each site.

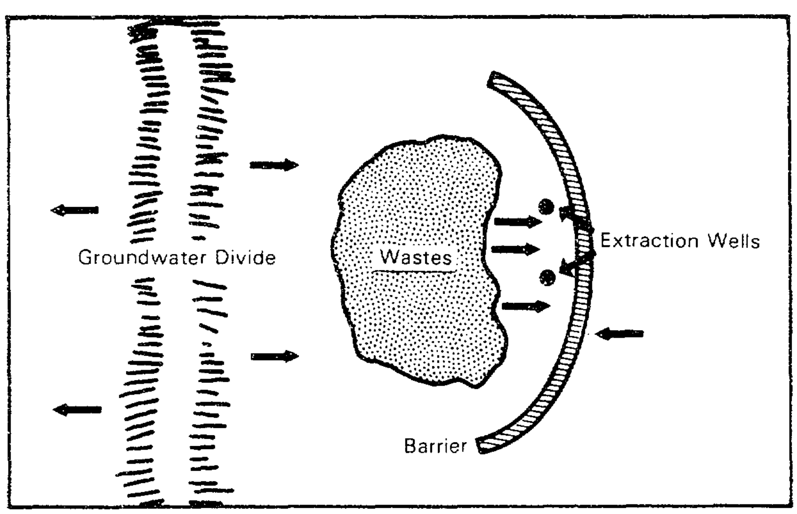
Slurry Walls

Slurry trench construction developed in the mid-1940s from the technology of clay-mud suspensions pioneered in oil well drilling operations in the early 1900s. Today, this practice covers a range of construction techniques from



Source: Adapted from Spooner *et al.*, 1985.

Figure C-5. Cut-away Cross-section of Upgradient Placement with Drain



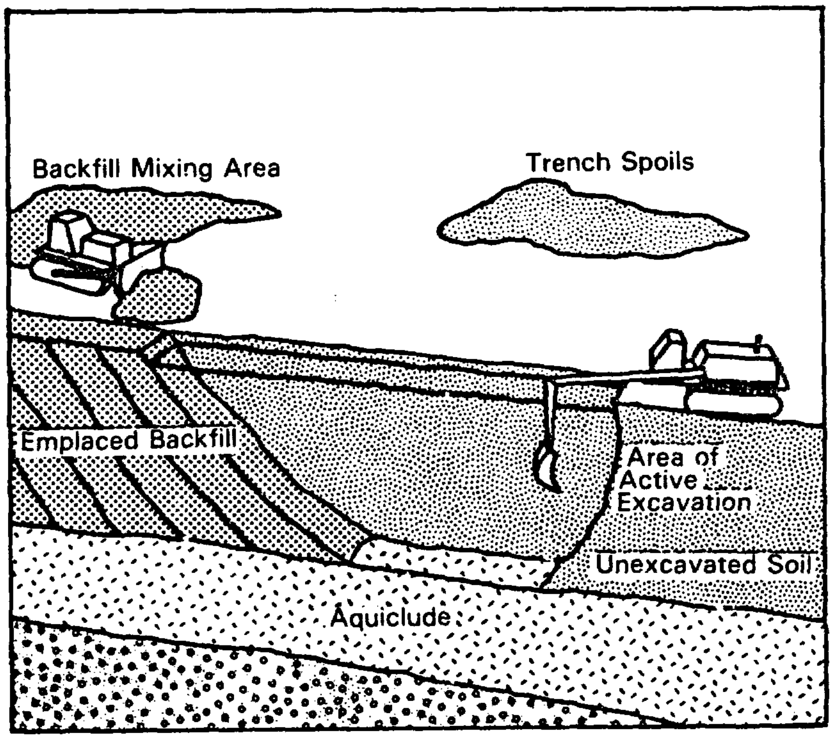
Source: Adapted from Spooner *et al.*, 1985.

Figure C-6. Plan of Downgradient Placement

simple to quite complex. In recent years, engineers and contractors have become aware of the low cost and nearly universal success of slurry wall cutoffs. This technique has largely replaced such methods as grout curtain and sheet piling cutoffs.

Two principal types of slurry walls are in common use, soil-bentonite (SB) and cement-bentonite (CB). The names are derived from the key ingredients in the slurries used to construct each respective wall. Bentonite is a clay mineral that is highly expansive when combined with water; it can swell 10 to 12 times its original volume.

Slurry walls are constructed by excavating a trench to the desired depth; mixing a slurry of soil, bentonite, and water or of cement, bentonite, and water; and backfilling layers of the slurry (see Figure C-7). As the backfilling continues, the trench becomes completely filled with a monolith of soil or cement and bentonite of extremely low permeability.



Source: Adapted from Spooner *et al.*, 1985.

Figure C-7. Construction of a Slurry Wall

Grout Curtains

Grouting is the pressure injection of one of a variety of special fluids into a rock or soil body. These fluids set or gel into the rock or soil voids, greatly reducing permeability and increasing the strength of the previously ungrouted mass. Grouting of both soil and rock is a technology that has been used successfully for decades in the field of dam design and construction. The major use of curtain grouting is to seal voids in porous or fractured rock where other methods of groundwater control are impractical or likely to be ineffective.

Grouts can be divided into two main categories, suspension and chemical grouts. Suspension grouts contain cement mixed with fine particle materials, such as sand, clay, or bentonite. Chemical grouts consist of newtonian-type fluids, either natural or synthetic, manufactured and marketed under various trade names. Examples of chemical grouts include bituminous emulsions and sodium silicate with settling agents, accelerators, or hardeners.

The grouting process involves drilling holes to a predetermined depth below the ground surface and injecting grout with special equipment. A line of holes in single, double, or triple staggered rows is advanced vertically into the subsurface area. Grout is injected into every other hole to a predetermined depth; this is done until grout has been injected into each hole and the hole is filled (see Figure C-8).

Few data are available on the ability of the grouts to resist chemical degradation when contacted by contaminants. Special consideration should be given to the reaction of chemical grouts with the leachate. Testing should be conducted to determine these reactions before this grouting is used.

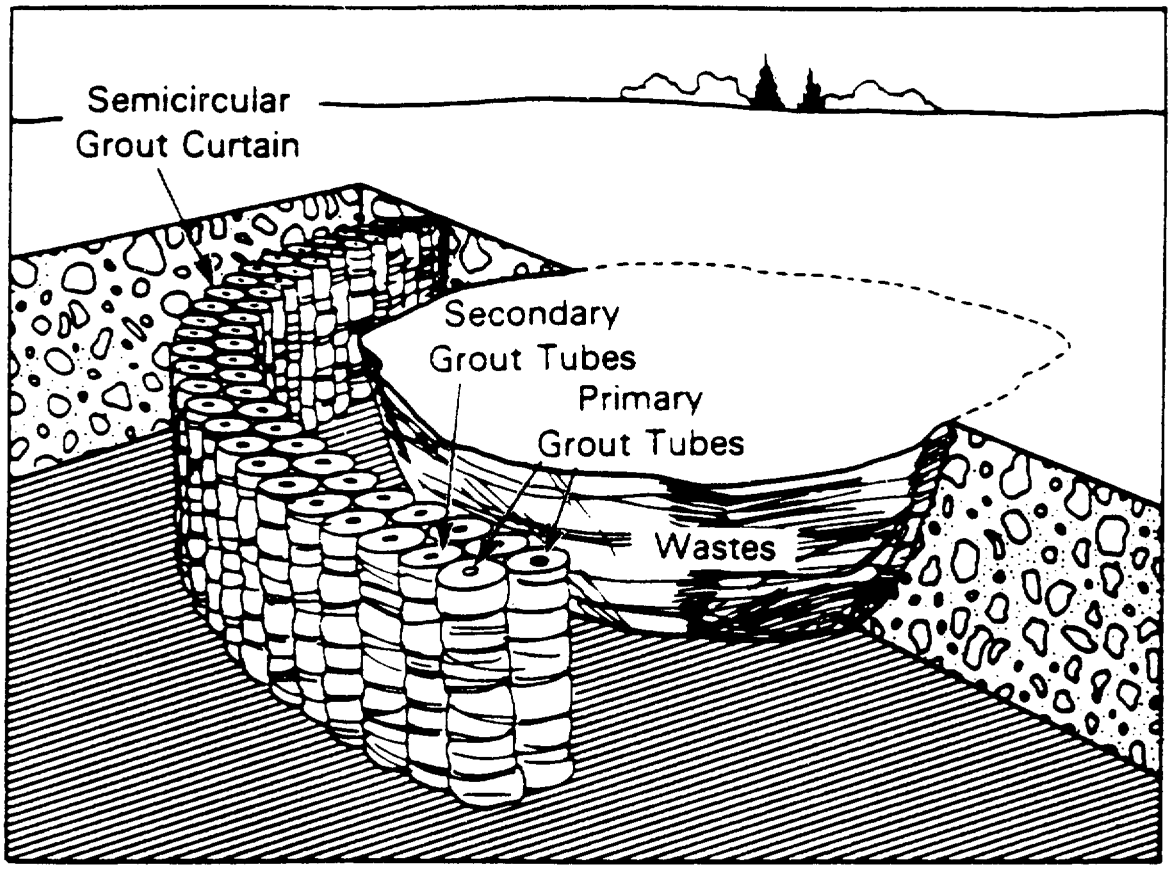
Sheetpile Walls

Sheetpile walls are narrow structural members that are driven below the ground surface mechanically to a desired depth. Sheetpiles, which are made of wood, concrete, or steel, serve a variety of functions in the construction industry. Wood is an ineffective water barrier; concrete is used primarily where great strength is required; and steel, which is an adequate sheetpile wall when used for groundwater cutoff, is the most cost-effective material available.

Steel sheetpiles are thin-walled, interlocking sections that are driven into the ground by pneumatic, steam, or vibratory piledrivers. They are manufactured in a variety of shapes and steel strengths. Lengths of the piles vary from 1.2 to 12 meters, while typical widths range from 38 to 51 centimeters. Longer lengths are available by special order.

C.1.3.3 Applicability

Barrier walls have been proposed as a possible corrective action at the Savannah River Laboratory (SRL) seepage basins, the Separations Area retention basins, the radioactive waste burial grounds, the F-Area seepage basins



Source: Adapted from EPA, 1982.

Figure C-8. Grout Curtain

and the H-Area seepage basins. Several factors limit their applicability to other SRP waste sites:

- Many SRP waste sites are located over groundwater divides. This precludes the application of upgradient barriers and generally requires the use of expensive circumferential barriers.

- Great depths would be required to reach an effective confining stratum for the application of fully penetrating barrier walls. For example, a cutoff wall approximately 46 meters deep, anchored into the Congaree Formation, was required to prevent seepage through the recently constructed L-Reactor cooling lake.

- Generally, partially penetrating barriers are applied to control lighter-than-water contaminants, especially oil. SRP sites that have received oil, such as the waste oil basins, the L-Area oil and chemical basin, and the SRL oil test site, are not likely to require any groundwater remedial action.

C.1.3.4 Summary

Groundwater pumping appears to be a more applicable corrective action at SRP than either permeable treatment beds or barrier walls for the following reasons:

- Groundwater pumping has already been demonstrated to be effective in containment and subsequent treatment of M-Area groundwater.
- Depths to confining layers (aquitards) are great over most of the SRP, thus requiring extensive excavation and disposal of potentially contaminated soil around certain existing waste sites.
- Permeable treatment beds of several different materials would be required to treat groundwater at many sites because of the mixed composition of the groundwater (i.e., sites that have demonstrated a migration of contaminants usually contain more than a single contaminant). A single bed usually is not effective in removing more than one kind of contaminant.
- The capacity of permeable treatment materials eventually becomes exhausted. In situ regeneration is not feasible. The replacement of an exhausted bed requires the subsequent disposal of the bed.

C.2 DIRECT TREATMENT OF WASTES

C.2.1 BIOLOGICAL TREATMENT

C.2.1.1 Description

An effective way to treat large quantities of contaminated water is biological treatment, which involves the use of microorganisms to digest organic materials. Principal application of this treatment is for aqueous waste streams; however, some organic liquid-phase treatment is possible. Biological treatment is accomplished by the use of one or two types of microorganisms, aerobic or anaerobic. Treatment is conducted in large lagoons or small reaction vessels or tanks. Contaminated water can be spread over land, which is known as landfarming, or treated in place (as with groundwater).

Biological treatment is a versatile treatment process, although many factors can affect its performance, such as:

- Hazardous or toxic substances that inhibit biodegradation reactions
- Retention time
- Temperature; the ideal range is 10° to 38°C
- Sensitivity to organic loading
- Bioaccumulation

Post-Extraction Technologies

The following sections describe technologies that are appropriate for the treatment of waste streams that have been extracted from the groundwater, have been pumped from a lagoon or surface impoundment, or will be received directly

as a process waste stream. Treatment can be done by many small units located throughout the site, or can be treated in a large centralized facility. The latter option is less likely to be affected adversely by a single-source shock loading.

Aerobic treatment of waste depends on the use of aerobic microorganisms supplied with sufficient air or oxygen to digest organic wastes. The reactions occur naturally in stabilization ponds, under controlled conditions in specially designed reaction vessels (digestors), or in lagoons with forced aeration.

Activated Sludge

Activated sludge treatment is a continuous-flow treatment process where microorganisms suspended in the aqueous phase metabolize the organic constituents in the presence of oxygen and nutrients. Digestion of the contaminant results in the conversion of organic molecules into carbon dioxide and water. This process is the most widely used and best understood biological treatment process.

An activated sludge process is designed according to one of three process types: high rate, conventional, or extended aeration. High-rate systems are used for low-strength waste streams, while conventional systems are used to treat higher levels of BOD and more resistant wastes. Aerated lagoons are used when low BOD levels are accompanied by difficult to treat wastes, which require a longer contact time.

Aerated Lagoon

Although primarily an aerobic treatment process, both aerobic and anaerobic processes occur simultaneously in an aerated lagoon. Similar to the activated sludge process, this system uses a continuous-flow aerated basin; however, aeration and mixing are incomplete. Thus, the microorganisms are not entirely suspended throughout the lagoon. Incoming material is treated aerobically; however, as the undigested organics and dying microorganisms settle to the bottom where dissolved oxygen levels are low, anaerobic organisms complete the decomposition.

Trickling Filter

The trickling filter is a fixed bed of rock or plastic used as a support for the growth of a biological film. The film or slime accumulates on the medium as organic wastes are metabolized. As the microorganisms grow, the thickness of the slime layer increases and the oxygen transfer to the inner layers decreases. The microorganisms near the surface enter an endogenous growth phase. The biomass near the surface of the medium begins to lose its ability to attach itself. The flow of water eventually detaches the heavier growths. Treated water and excess biomass are removed by an underdrain system and separated downstream by clarification.

Activated Biofilters

Activated biofilters (ABFs) operate as both attached and suspended growth treatment systems. The filter medium is used to support the attached biofilm,

while periodic recirculation allows for a mixing of the biomass and the waste stream. The intermittent aeration serves two purposes: to support the growth of the aerobic organisms and to remove the excess biofilm.

Biological Activated Carbon

Biodegradation on biological activated carbon is a relatively new application of two well-established technologies. This process can be used on waste streams that cannot be treated effectively by either process individually. The process begins with the addition of activated carbon to an activated sludge system.

This system is a combination of fixed film and suspended growth systems (similar to the biofilter). The biomass is suspended in the mixed liquor and also attached to the powdered carbon particles. Adsorption and degradation take place within the same basin. The underflow of settled carbon and biomass is sent to a thermal regenerator where the carbon is regenerated, and the excess sludge is destroyed. The regenerated carbon is then returned to the system for further use.

This treatment system has been effective on waste streams with even significant levels of priority pollutants. Heavy metals removal has also been enhanced.

Anaerobic Treatment Technologies

Anaerobic treatment of waste streams uses faculative and anaerobic microorganisms in an enclosed reaction vessel to achieve organic contaminant digestion. This process is applicable to wastewater treatment; however, it generally is used to treat the heavy organic loadings associated with wastewater sludges.

In-Situ Treatment

Biological treatment processes have been developed that permit the decontamination of contaminated groundwater in place. Bioreclamation is a process in which naturally occurring microorganisms are used to degrade the contaminants in the aquifer. To promote the in situ degradation, constant amounts of oxygen and nutrients must be supplied to the microorganisms. Injection wells normally are used to supply these reactants.

C.2.1.2 Applicability

The biological treatment of groundwater or hazardous waste streams has limited applicability at SRP. The major organic contaminants observed on the Plant are chlorinated aliphatic compounds, which are among the most refractory to aerobic or anaerobic degradation. The ease with which chlorinated materials are volatilized or sorbed on activated charcoal makes such processes more attractive technically.

Treatment of contaminated water by biological systems can be done under a variety of conditions and contaminant concentrations. Systems are available that will decontaminate water in place by biodegradation; in a centralized treatment facility using aerobic and/or anaerobic organisms; or in a combination of these systems.

C.2.2 CHEMICAL TREATMENT

C.2.2.1 Description

Chemical treatment, the use of chemicals to achieve a desired contaminant removal, detoxification, separation, destruction, or neutralization, is achieved by many commercially available processes. Many waste-specific processes are available; most fall into a few basic categories:

- Oxidation/reduction
- Precipitation
- Liquid/liquid extraction
- Neutralization
- Ion exchange

Oxidation/Reduction

Chemical oxidation and reduction are processes for waste detoxification and destruction. Oxidation is applicable to wastes that are oxidized by chlorine, ozone, hydrogen peroxide, potassium permanganate, and chlorine dioxide. Chemical dechlorination, a specific example of chemical oxidation, can be achieved by ozonation.

Chemical reduction is a process in which the oxidation state of a substance is lowered specifically to treat certain soluble metal ions. The reduction of hexavalent chromium to the trivalent state before precipitation with lime or caustic is an example of one application of reduction technology.

Neutralization

The discharge of extremely alkaline or acidic waste streams can pose a significant threat to the environment. Such streams can be neutralized by many available methods. The goal of such a process is to obtain an effluent that has a pH suitable for discharge within regulatory guidelines and standards, or that will not have a detrimental effect on downstream treatment processes, such as biological treatment.

Precipitation

Chemical precipitation is a well established process for the removal of inorganic compounds. There are three basic types of precipitation systems: carbonate, hydroxide, and sulfide. Of these, the hydroxide system has found the greatest use. Hydrated lime or sodium hydroxide is used to achieve an alkaline pH.

Precipitation can be used to remove both cations and anions; however, the bulk of its use has been for cation removal. The lime-soda softening process is a typical example of a cation precipitation process. This process is also a good example of the carbonate process.

Hydroxide system precipitation can be used to remove a significant number of soluble metal ions. Metals that form insoluble hydroxide precipitates include iron, aluminum, manganese, trivalent chromium, lead, zinc, copper, mercury,

silver, cadmium, and nickel. The hydroxides of these metals are normally precipitated at alkaline pH.

Sulfide precipitation has come into common use only recently in wastewater treatment. It is becoming more widely accepted due to the recent discovery that many metal sulfides are less soluble than the corresponding hydroxides. Two sources of the sulfide are sodium sulfide and ferrous sulfide.

Liquid-Liquid Extraction

Liquid-liquid extraction is a chemical separation process that is used widely to separate two immiscible liquid phases. It has, in the waste treatment field, also been used to treat contaminated soils. The basis of either process involves the use of a solvent to separate a contaminant or group of contaminants selectively from an aqueous phase or soil. In cases of gross water contamination, liquid-liquid extraction is best suited for use when distillation would be difficult because the boiling points of the mixture are too close to permit adequate separation. Following the actual separation, distillation is used (if possible) to separate the contaminate. This permits solvent reuse and the disposal of small volumes of hazardous waste.

Ion Exchange

Ion exchange is a process used to remove ionic species from an aqueous solution. In the process, the ionic species are replaced by ions on the ion-exchange resin. A hydrogen ion is exchanged for a cation, or a hydroxide group for an anion. In many applications, a toxic ion will be present in small amounts with large amounts of a relatively innocuous ion of the same or higher valence. Specific ion-exchange resins have been developed for the removal of specific ions, and the use of these resins should be considered to avoid high resin regeneration costs.

Ion exchange is considered applicable for removal of the following:

- All soluble metallic elements
- Inorganic anions such as halides, sulfates, nitrates, and cyanide
- Carboxylic and sulfonic acids, and some phenols at alkaline pH
- Radionuclides such as cobalt-60, yttrium-90, strontium-90, cesium-134 and -137, plutonium-238 and -239, and uranium-238

The ion-exchange resins, which eventually will become exhausted, can be regenerated or disposed of. The costs of onsite regeneration can be prohibitively high, especially when the site is remote. A system with replacement modules might be desirable so the resins can be regenerated offsite. In addition, the regenerant wastes will contain the removed ions at much higher concentrations than the influent, and must be treated further or disposed of properly.

C.2.2.2 Applicability

Chemical treatment methods are effective measures for the remediation of contaminated waters and soils. Table C-2 lists some chemical treatment processes and summarizes their possible applications as remedial actions.

Table C-2. Applicability of Chemical Treatment at SRP

Treatment method	Application
• Oxidation/reduction	Groundwater and surface-water decontamination - Metals - Organic contaminants
• Neutralization	Process waste streams with extreme pH values
• Precipitation	Groundwater and surface water - Metals - Radionuclides
• Liquid-liquid extraction	Grossly contaminated water and soils
• Ion Exchange	Groundwater and surface water - metals, dissolved solids, inorganic anions, carboxylic and sulfonic acids, radionuclides

C.2.3 PHYSICAL TREATMENT

C.2.3.1 Description

Most of the physical treatment processes are concentration technologies. Large wastewater streams contaminated with small concentrations of wastes are treated to produce a cleaner product and a waste stream. The product stream, or effluent, is a high-flow stream with little residual contamination, while the waste stream is a low-flow stream with high concentrations of contaminants. The effluent should be clean enough for discharge, while the waste stream must be taken to a landfill for disposal or treated and rendered nonhazardous.

Flocculation, Sedimentation

Suspended solids in waste streams inherently contain a wide distribution of particle sizes depending on the type and amount of pretreatment that has occurred. Influent streams can contain particles large enough to be visible,

or small enough to be submicroscopic. These particles generally carry an electrical charge (usually negative), which can be used advantageously in removal.

Flocculation, and a similar process coagulation, are physical processes which accomplish removal by agglomerating these similarly charged particles into large settleable particles.

Activated Carbon Adsorption

Activated carbon adsorption is a physical treatment process that has demonstrated efficient chemical removal from aqueous streams by chemical processes. The adsorption process involves the concentration of contaminants on the surface of the carbon by physical and chemical means. Attractive forces that predominate at the carbon surface are the basis for the contaminant removal. Materials that have a relatively low solubility in water or have large molecules exhibit good adsorption rates. Pesticides and PCBs are examples of contaminants that fit this description. Compounds that are adsorbed readily by activated carbon include aromatics, ethers, esters, and the larger ketones. Alcohols (except for hexanols), amines, aldehydes, and glycols are not adsorbed readily. Radionuclides such as cobalt-60 and cesium-137 can be removed successfully by this process.

Air Stripping

Volatile organic contaminants are removed readily from contaminated aqueous streams by air stripping. This simple, inexpensive process strips the volatile compounds from the water using air as the transfer medium. Contaminated water is charged into the top of a packed column and cascades over the packing while large volumes of air are forced upward through the column.

This treatment technology is well suited to the treatment of solvents and other volatile compounds that have migrated into aquifers beneath the SRP. Water extracted by wells from the water-bearing zones is treated after collection in an air-stripping tower nearby. Such remedial actions are under way in the A/M-Area.

Filtration

Both radioactive and nonradioactive solids can be separated from a liquid by one of three filtration processes: cake, depth, and surface filtration.

Cake filtration involves the separation of solids from the aqueous phase by passing the liquid through a porous filter medium, such as a cloth filter. This medium allows liquids, but not solid particles, to pass. The process yields a thick filter cake. When the operating pressure of the system increases significantly, the medium must be cleaned or replaced. The concentrated waste is then sent to disposal.

In depth filtration, a bed of porous material is used as the filtration medium. A waste stream passes through the filter, where the solid particles become trapped between the small particles of the bed. Operating pressure is also critical for this filtration type. At a certain pressure the bed must be back-washed to return the bed to its original porosity.

In surface filtration, the liquid is strained. This process is similar to the cake filtration process; however, it differs in that the matrix used for filtration becomes clogged at a much higher rate than that used for cake filtration.

Filtration can be used to remove radioactive and nonradioactive suspended solids. This technology can remove radionuclides that have lower solubilities, that tend to absorb to suspended particles, or that can be coprecipitated with other cations. Alpha emitters, such as uranium-238 and plutonium-238, are radionuclides that might be removed by filtration.

Membrane Filtration

Three filtration processes fall under this heading: microfiltration, ultrafiltration, and reverse osmosis. The applicability of each process is as follows:

- Microfiltration and ultrafiltration - High-molecular-weight inorganic and organic contaminants, uranium-238 and plutonium-238
- Reverse osmosis - Metal ions, low molecular weight organic contaminants, strontium-90, cobalt-60, and cesium-134 and -137

Evaporation

Evaporation is a process in which heat is added to a liquid (usually water) to vaporize it, resulting in the concentration of dissolved or suspended solids or the removal of volatile substances. The concentrated materials must be treated further or disposed of, and the vaporized liquid is released to the atmosphere. Three types of evaporation methods are classified by the mode of heat transfer:

- Indirect - heat source is separated from the solution by physical barrier
- Direct - heat source is applied directly to the solution
- Natural - solar energy or natural diffusion of the solution to air are used to induce evaporation

Evaporation methods are more effective for heavier radionuclides, such as cesium-134 and -137, uranium-238, and plutonium-238. Evaporation is an effective way to reduce tritium concentrations in basins.

Electrodialysis

This process is used to transfer an ionic species from one stream of liquid, through a semipermeable membrane, into another stream of liquid under the influence of an applied electrical potential. The process depends on special synthetic membranes that are permeable to a single type of ion. Cation exchange membranes permit passage only of positively charged ions, and anion exchange membranes permit the passage only of negatively charged ions, under the influence of the electrical field.

C.2.3.2 Applicability

Physical or chemico-physical treatment processes have limited applicability for the treatment of contaminated groundwater at SRP. Air stripping of volatile organic compounds, already in use in the A/M-Area, ion exchange for the removal of soluble metals and radionuclides, and carbon adsorption for the removal of volatile and semivolatile organic compounds offer the greatest feasibility. Centralized treatment facilities might be advantageous.

C.3 CLOSURE

Site closure techniques and methods are designed to reduce surface-water infiltration; to control runoff at waste disposal sites; to reduce erosion; to stabilize the surface of covered sites; and to control leachate generation. Closure techniques include capping, grading and revegetation, runoff diversion and collection, and leachate control systems.

C.3.1 SURFACE SEALERS AND CAPS

C.3.1.1 Description

Surface sealing or capping is used to cover or close a waste site. It prevents surface-water infiltration, isolates contaminated wastes and gases, controls erosion due to surface-water runoff, and provides a surface for vegetation. The process of surface sealing consists of covering the site with a layer or system of layers of natural soils, modified soils, and synthetic membranes. Other techniques use chemical sealants and stabilizers. The choice of the covering material is influenced by such site-specific variables as type of soils, availability and costs for materials, climate and hydrogeology, designed function of the cap, nature of the covered wastes, reliability of the covering material, and projected future life of the site.

<u>Clay</u>

Compacted soils are used commonly for surface sealing or capping. The capacity of a soil cap to resist fluid infiltration is primarily a function of the permeability of the soil material. Clays consist of fine particles with low permeabilities. Clays are susceptible to cracking and dessication, which can reduce their capacity to resist penetration. Therefore, they often are installed as caps in conjunction with covers comprised of other soils or materials (see the paragraph on Multimedia Cap below).

<u>Synthetic Membranes</u>

Synthetic membranes are manufactured covers, commonly made of plasticized polyvinyl chloride (PVC), polyethylene, and butyl rubber. They consist of a raw polymer and carbon black, pigments, fillers, plasticizers, chemicals, and processing aids.

<u>Admixed Materials</u>

Various admixtures can be combined with soil *in situ* to be used as covers for hazardous waste sites. Admixtures include such materials as Portland cement,

bituminous concrete, soil cement, soil asphalt, and blown asphalt. All these types of covers are relatively expensive and usually require special mixing or spreading techniques.

Chemical Sealants/Stabilizers

Chemical sealants and stabilizers can be added to soils to form strong and less permeable covers for waste sites. The most common sealant/stabilizers are cement, fly ash, lime, soluble salts, and freeze-point suppressants. Portland cement can be added to sandy soils in quantities as small as 1 percent to stabilize and reduce the permeability of the soils. Soil is treated chemically by the addition of lime. The addition of 2 to 8 percent lime will strengthen fine cohesive soils over time due to the chemical reaction of the lime with clay minerals. Lime also will increase the cementing properties of the clay and reduce shrinking and swelling.

The combination of fly ash, lime, and water forms a cementing compound that can be added to sands and gravels for strengthening and stabilizing effects. It optimizes grain size distribution and reduces shrinking and swelling. Soluble salts like sodium chloride and tetra-sodium pyrophosphate are added to fine-grained soils containing clay minerals to act as dispersing agents. They can break down the clayey aggregates into separate particles (deflocculate) and thereby increase density, facilitate compaction, and lower the permeability of the soil. A freeze-point suppressant such as calcium chloride can be very effective in solution or in dry, flaked form. A suppressant is used on poorly compacted soils during cold weather operations to reduce the potential of the pore water from freezing.

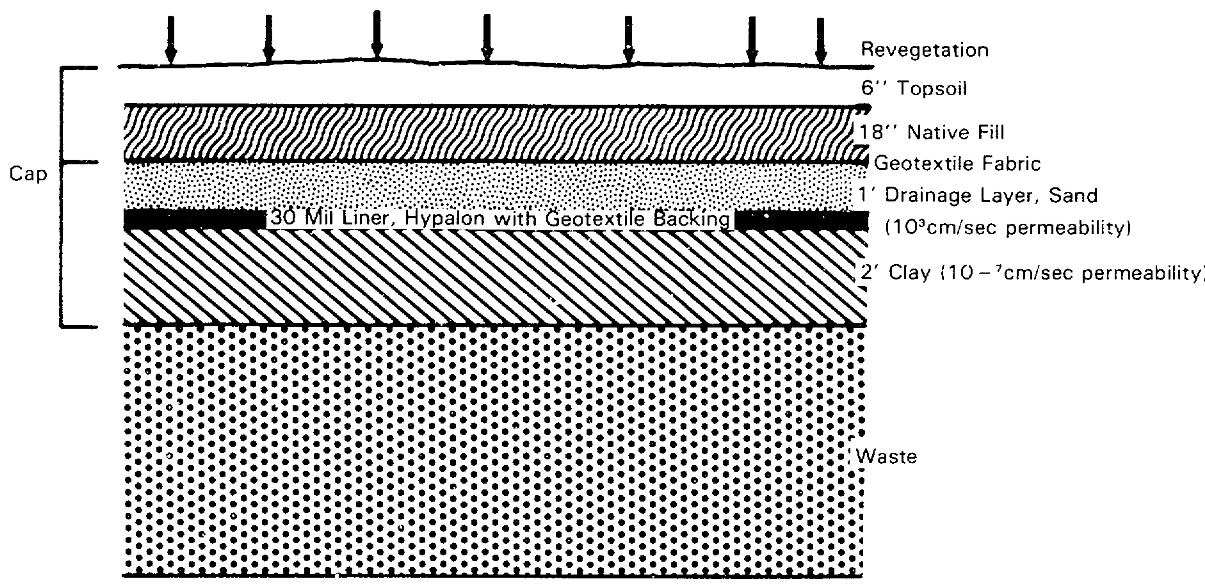
Multimedia Cap

A multimedia cap combines two or more distinct materials in multiple layers that perform specific functions. This cover is the preferred option under the Resource Conservation and Recovery Act (RCRA) and is sometimes called a RCRA-type cap.

A RCRA cap has a top soil layer to support vegetation; a water drainage channel or layer to provide an exit for water; a barrier layer or membrane to prevent infiltration and percolation of water; a buffer layer to protect the barrier by providing a smooth base; a filter layer to control the clogging of coarse layers; and a gas drainage layer. Figure C-9 shows typical layered or multimedia cover systems.

The barrier layer is the most important feature in a multimedia cap. This layer or membrane, which controls the passage of water and gases, is usually a clayey soil with low permeability or a synthetic membrane. The principal purpose of a buffer layer is to protect the barrier layer, shielding it from tears, cracks, offsets, and punctures. The water drainage channel or blanket provides a path for water to exit quickly; recommended soils for this layer are poorly graded sands and gravels; this channel is sometimes combined with a system of buried pipe drains. Filters are used to reduce the clogging of pores in the drainage layer by fine particles of another layer; the selection of a filter material depends on the nature of material being filtered. A gas drainage layer has a structure and function very similar to the water drainage layer; the gas layer is below the barrier layer so it can collect gases rising

Section View



Source: Adapted from EPA, 1985. Not to Scale

Figure C-9. Multimedia (RCRA) Cap

from the wastes, while the water layer is above the barrier layer to intercept water migrating from the surface.

C.3.1.2 Applicability

The waste sites at SRP where modeling results indicate a delay or reduction in peak contaminant concentrations could be retrofitted with one of the surface sealers or caps described above. The particular system used would be considered on a site-by-site basis. The multimedia cap might make an excellent cover for use on the SRP.

C.3.2 SURFACE-WATER DIVERSION AND COLLECTION SYSTEMS

C.3.2.1 Description

Surface-water diversion structures and collection systems provide either temporary or permanent measures to control surface flows into a hazardous or radioactive waste site. They control flooding and surface-water infiltration. The types of diversions and collectors include dikes and berms, open channels, terraces and drainage benches, chutes, and seepage basins.

Dikes and Berms

A dike or berm (these names are interchangeable) is a well-compacted earthen embankment of low-permeability, erosion-resistant, fine-grained soils. It is positioned above, below, or around the perimeter of a disposal site to intercept and divert surface water. An effective dike or berm thereby reduces erosion potential and prevents excess runoff from entering the site and infiltrating the fill.

Open Channels, Diversions, Waterways

An open channel or swale is an excavated drainageway used to intercept and divert surface water. Such a structure is usually temporary and typically stays in place until the site is sealed and stabilized. A channel upslope of the site can intercept surface water and divert flow; a channel below the site can collect and transport sediment-laden flow to holding basins.

Diversions are shallow drainageways excavated along a contour of graded slopes, with a dike along the downhill edge of the drain. In essence, a diversion is a combination of a dike and a channel that is designed to provide a more permanent control of erosion on long slopes that are exposed to heavy surface water flows. It can be at the top or at the base of long graded slopes of a site to intercept and carry flow. Diversions should be used only for slopes of 15 degrees or less.

A grassed waterway is a wide drainageway that has been stabilized with vegetation or stone riprap. It is usually positioned along the perimeter of a disposal site located within the natural slopes. A waterway is designed to collect and transfer surface water diverted from berms or diversions. A grassed waterway can be part of the final grading design for a capped and revegetated site.

Terraces or Drainage Benches

Terraces or drainage benches are located along the contours of long and steep slopes. They slow down the surface water and divert it to channels or diversions. These benches are considered to be "slope-reducing devices." They should be compacted and stabilized with vegetation.

A terrace is capable of isolating a site hydrologically, reducing erosion on covers, and containing contaminated sediments eroded from the site. An upslope terrace can slow and divert stormwater; a downslope terrace can intercept sediments and divert them to basins.

Chutes and Downpipes

Chutes and downpipes are drainage structures located downslope from dikes. They transfer concentrated runoff from an upper level to a lower level while controlling erosion.

Chutes (or flumes) are open channels lined with bituminous concrete, Portland cement, or grouted riprap. They should be on undisturbed soil or well-compacted fill.

Downpipes, also called downdrains or pipe-slope drains, are located downslope of a site. They are made of corrugated metal pipe or flexible plastic tubing. They collect discharge and transport the flow to stabilized outlets or traps. Because they have limited capacities, they can accommodate only low discharges. A downpipe can collect and transfer surface water from long, isolated outslopes or from small sites along steep slopes.

Seepage Basins and Seepage Ditches

Seepage basins and ditches intercept water from surface-water diversions or groundwater pumps and discharge it back to the groundwater by letting it seep through the ground. Such structures have a basin or ditch, a sediment trap, a bypass for excess surface water, and an emergency overflow. They are lined with gravel at the bases and have pervious material for the side walls. A seepage basin is uncovered, while a seepage ditch is backfilled with gravel or topsoil. Seepage ditches are used in parallel to increase seepage, and they can distribute water over a larger area than basins. Seepage basins use gabions for vertical side walls and dense turf for the side slopes to prevent erosion and allow infiltration.

C.3.2.2 Applicability

Any of the surface-water diversion and collection systems described above could be implemented readily at SRP. The relatively gentle slope found throughout the Plant has the effect of reducing runoff velocities and concentrations. At most sites, a properly designed and installed cover or cap should be sufficient to minimize the infiltration of water into a waste site. The need for additional protection measures such as surface-water diversion and collection systems would be reviewed during the predesign phase.

C.3.3 LEACHATE CONTROL SYSTEMS

C.3.3.1 Description

Leachate control systems prevent surface-water seepage and leachate from percolating to the groundwater. Leachate is the contaminated liquid that results when surface water migrates down through layers of a landfill and contacts the wastes. The leachate travels to the ground below or seeps from the sides of the fill. A control system intercepts the leachate before it becomes a contamination problem. A system is a series of drains that intercept and channel the leachate to a sump, a wetwell, or a collection basin.

Subsurface Drains

Subsurface drains intercept leachate and transport it away from a site. They are constructed by excavating a trench and laying underground tile or perforated piping from end to end. The pipe is surrounded with an envelope of sand, gravel, and straw, woodchips, or fiberglass. The envelope is lapped with a filter fabric to prevent fine soil from clogging the drain. The trench is closed by a backfill of topsoil or clay.

Drainage Ditches

Drainage ditches are open ditches 1.8 to 3.6 meters deep that can be trapezoidal in cross-section. They collect surface-water runoff, and are collectors leading from subsurface drains or interceptor drains.

Drainage ditches might be required for flat or gentle rolling landfills that have impermeable soils underneath, thereby making the use of subsurface drainage impractical. In some cases, these open drains are used to intercept subsurface collectors and transfer the leachate to a discharge point. Open

ditches can collect lateral surface seepage from a disposal site and prevent it from seeping into the groundwater or from flowing into protected areas.

Liners

Liners are used in new or existing sites to intercept leachate before it reaches the groundwater. They are located beneath the fill and act as impermeable barriers. Prefabricated liners, pressure-injected grouts, and bentonite slurry can all be used as bottom sealants, but prefabricated liners are used only in new sites.

C.3.3.2 Applicability

Leachate control systems and components are applicable primarily to new disposal facilities.

C.3.4 SUMMARY

All the closure techniques, both surface-water controls and leachate controls, described in the previous sections can be summarized in terms of functions. These methods primarily reduce surface-water infiltration, control runoff, reduce erosion, discharge water, and intercept leachate. Table C-3 summarizes the individual techniques with their functions.

Table C-3. Closure Techniques and Functions

Technique	Function						
	Minimize Runoff	Minimize Infiltration	Control Erosion	Isolate & Contain Wastes	Collect & Transfer Water	Discharge Water	Intercept & Transport Leachate
Surface Seals & Caps		X	X	X			
With Vegetation	X	X	X				
Dikes/Berms	X	X	X				
Ditches/Diversions/ Waterways	X	X	X				
Terraces/Benches	X		X				
Chutes/Downpipes			X		X		
Leachate Controls							X
Seepage Basins & Seepage Ditches						X	

REFERENCES

EPA (U.S. Environmental Protection Agency), 1982. Handbook: Remedial Action at Waste Disposal Sites, Municipal Environmental Research Laboratory. Cincinnati, Ohio.

EPA (U.S. Environmental Protection Agency), 1985. Handbook: Remedial Action at Waste Disposal Sites (Revised), Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio.

Spooner, P., et al., 1985. Slurry Trench Construction for Pollution Migration Control, Noyes Publications, JRB Associates, McLean, Virginia.

TABLE OF CONTENTS

LIST OF TABLES

APPENDIX D

PREDISPOSAL TREATMENT TECHNOLOGIES

The U.S. Environmental Protection Agency (EPA) broadly defines "treatment" as "any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste nonhazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume" (40 CFR 260).

For the purposes of this EIS, "predisposal treatment" is treatment provided to wastes before storage or disposal to reduce their volume or alter their chemical or physical characteristics to render them less toxic or more stable. This appendix categorizes, lists, and defines various predisposal technologies; discusses their applicability to hazardous, low-level radioactive, and mixed wastes generated at the Savannah River Plant (SRP); and describes how the applicable technologies could be employed and the results that might be expected.

D.1 APPLICABLE WASTES

The SRP generates appreciable quantities of hazardous, low-level radioactive, and mixed wastes (Appendix E). Except for nonradioactive polychlorinated biphenyls, all such wastes generated on the Plant are recycled, stored for ultimate disposal, or deposited in an onsite waste disposal facility. The Plant does not receive hazardous waste or nonbyproduct mixed waste from offsite sources.

In the context of this appendix, predisposal technologies apply only to hazardous, low-level radioactive, and mixed wastes generated by ongoing SRP operations, by existing waste site closure actions, and by offsite, defense-related generators of low-level radioactive wastes.

All hazardous wastes currently being generated either are stored in storage facilities (buildings) or are recovered and recycled. Mixed wastes, such as scintillation solutions and tritiated waste lubricating oils, are stored either at the mixed waste storage facility or at the tritium facility, depending on their levels of radioactivity.

Virtually all hazardous, low-level radioactive, and mixed wastes generated on the Plant are candidates for the application of one or more predisposal treatment technologies. These wastes include the following:

1. Hazardous and mixed waste combustible oils, solvents, and solids

2. Mixed and low-level radioactive solvents, scintillation solutions, contaminated equipment, razed-building rubble, and job control wastes

3. Mixed waste sludges generated at effluent treatment facilities (ETFs)

4. Hazardous, mixed, and low-level radioactive ash and scrubber blowdown from incinerators

5. Hazardous, mixed, and low-level radioactive waste, including contaminated soil.

D.2 AVAILABLE TECHNOLOGIES

D.2.1 VOLUME REDUCTION

During the past few years, there has been an industry-wide shift from limited waste volume reduction to maximum reduction before disposal. This shift has occurred for a number of reasons. The strongest is the realization that adequate disposal sites are a diminishing resource and, therefore, that future disposal capacity is uncertain and will be more expensive to develop (Voss and Guilbeault, 1984). The stated objectives of the Savannah River Interim Waste Management Program include the implementation of a sitewide effort to reduce the volume of waste generated and to demonstrate the technology for incinerating beta-gamma waste (DOE-SR, 1985). The technologies designed to reduce the volume of wastes for disposal fall into two general categories: (1) incineration; and (2) concentration, which includes compaction and physical treatment methods (Beamer, 1984; DOE, 1985; Enegess, 1984; Giuffre et al., 1984; NRC, 1981; Rutland, Papaiya, and Naughton, 1984; and OTA, 1985).

D.2.1.1 Incineration

As a volume reduction technique, incineration is applicable primarily to organic wastes, which combine with oxygen in the air through combustion at high temperatures to form carbon dioxide, water vapor, minor quantities of other waste gases, particulates, and residual ash. The residuals from this process consist of inorganic material (ash) and possibly scrubber blowdown from exhaust gas pollution control devices. Usually, these residuals are sent to a landfill for disposal, often after they have been solidified (see Section D.2.3.4).

D.2.1.2 Compaction

Compaction includes several processes that achieve volume reduction by compression and crushing to reduce interstitial air space within the bulk material. It is much more efficient in terms of disposal capacity, it improves the stability of landfills after closure, and it decreases leachate generation and contaminant migration by minimizing the conduits within which liquids can percolate through the waste. Solid and semisolid waste materials, particularly noncombustibles, can be compacted before disposal to achieve volume reduction if other methods are not possible or feasible.

The nuclear industry has used several compaction techniques to reduce the volume of noncombustible solid wastes before storage, shipping, and disposal (NRC, 1981):

- Compactors - compress material into final storage, shipping, or disposal containers

- Balers - compress material into bales to maintain volume reduction
- Baggers - compress material into slugs that are injected into bags, metal containers, etc.

Supercompactors substantially reduce the volume of large metal objects and other pieces of equipment.

As a predisposal treatment technology, compaction could be applied to a variety of hazardous, low-level radioactive, and mixed wastes, particularly solid noncombustible wastes. It is most applicable in the treatment of laboratory and job control wastes; under special conditions, it would be useful in the predisposal treatment of unincinerated, unsolidified wastes exhumed from existing SRP waste sites. Developmental research might show that supercompactors are applicable to materials from renovations and from decommissioning and decontamination projects. In some instances, compacting wastes as they are placed in above- or below-ground landfills might be desirable. Standard geotechnical techniques using sheepsfoot, rubber-tired, smooth, or vibratory rollers can achieve desired compaction results.

D.2.1.3 Shredding

The shredding of solid wastes containing hazardous or radioactive contaminants not only reduces the size of the particles to be placed in a container, incinerator, or landfill, but also provides a uniform particle size distribution. When applied before incineration or compaction, shredding produces a more uniform burn or a greater, more uniform density of compacted waste.

A number of types of size reduction (shredding) machines are used to handle industrial solid waste; these include the hammer mill, knife-cutters, jaw crusher, and bulky waste crusher. The actual size of the reduction depends on the waste type, feed rate, and type of shearing. Generally, small shredders (7 to 45 horsepower) are used to prepare combustible waste for incineration, while large shredders (160 horsepower) are used to reduce noncombustible wastes for compaction or disposal (Charlesworth, 1985).

Shredders might be installed on some SRP incinerators in the 1994 timeframe. Further research might identify other applications of shredding technology on the Plant.

D.2.2 CONTAINMENT

Containment technologies use fairly inert materials to reduce the leachability of a waste and to improve its stability before disposal. They have been applied successfully to hazardous and low-level radioactive wastes (NRC, 1981; EPA, 1982a; COE, 1984; DOE, 1985).

D.2.2.1 Solidification/Stabilization

Wastes can be mixed with a binding agent and cured to form a solid. This usually reduces leachability because the binding agent (1) complexes or binds the hazardous contaminants in a stable, insoluble form, or (2) entraps the waste material in a crystalline matrix.

Typical processes used to solidify low-level radioactive and mixed wastes include the following:

- Cement-based
- Pozzolanic (lime based)
- Thermoplastic (including bitumen, paraffin, and polyethylene)
- Organic polymer
- Self-cementation
- Glassification

In general, each process has features that make it particularly useful for the treatment of specific kinds of waste. Similarly, each process has limitations that restrict or even preclude its use on certain wastes. Thus, solidification processes tend to be waste-specific. Table D-1 summarizes the compatibility of these processes with various types of hazardous, mixed, and low-level radioactive wastes.

Cement-based and pozzolanic processes are used commonly to solidify hazardous and low-level radioactive wastes, although some of these processes might not be effective in the immobilization of heavy metals and fairly mobile isotopes such as cesium (COE, 1982; Kalb and Columbo, 1984; Miller et al., 1984; Clark, Perry, and Poon, 1985; Croney, 1985). However, the U.S. Army Corps of Engineers (COE, 1984) has found Sealosafe (registered trademark of the Stablex Corporation) to be effective in preventing excessive leaching of heavy metals from a solidified waste. Similarly, a lime/bentonite/cement mixture effectively fixes metals within the solidified mass (Escher and Newton, 1985). The gypsum cement, Envirostone (a registered trademark of United States Gypsum), produces solidified waste forms meeting all the criteria recommended by the U.S. Nuclear Regulatory Commission (NRC) (Phillips, 1984) for compliance with 10 CFR 61 (Rosenstiel and Lange, 1984; Rosenstiel, et al., 1984).

Solidification technology is applicable to the predisposal treatment of a variety of hazardous, low-level radioactive, and mixed wastes. These include material exhumed from SRP waste sites, incinerator wastes, low-level radioactive and mixed organic and evaporator bottom wastes from the Naval Fuel Material Facility, lead smelter and associated wastes, low-level radioactive contaminated equipment, renovation decommissioning waste, and mixed waste ETF sludges. Because this technology provides a "universally acceptable" waste product, it allows the widest choice of disposal sites (DiSalvo, 1984). In addition, the solidification of radioactive wastes reduces exposure rates associated with transportation and disposal.

Solidification processes, particularly those that are cement based, produce as much as a two-fold increase in the amount (i.e., weight and volume) of waste material to be disposed of (EPA, 1982b). Consideration of this effect is essential for an accurate determination of future disposal capacity needs.

D.2.2.2 Encapsulation

The encapsulation process involves enclosing wastes in a jacket or membrane of impermeable, chemically inert, water-resistant material to facilitate transport, storage, or disposal. It can be applied to solid hazardous wastes

Table D-1. Compatibility of Selected Waste Categories with Different Containment Technologies[a]

Waste component	Cement-based	Lime-based	Thermoplastic-solidification	Organic polymer (UF)[b]	Self-cementing techniques	Glassification and synthetic mineral formulation	Surface encapsulation
			ORGANICS				
Organic solvents and oils[c]	Many impede setting; can escape as vapor	Many impede setting; can escape as vapor	Organics can vaporize on heating	Can retard set of polymers	Fire danger on heating	Wastes decompose at high temperatures	Must first be absorbed on solid matrix
Solid organics (e.g., plastics, resins, tars)[d]	Good; often increases durability	Good; often increases durability	Possible use as binding agent	Can retard set of polymers	Fire danger on heating	Wastes decompose at high temperatures	Compatible; many encapsulation materials are plastic
			INORGANICS				
Acid wastes[c]	Cement will neutralize acids	Compatible	Can be neutralized before incorporation	Compatible	Can be neutralized to form sulfate salts	Can be neutralized and incorporated	Can be neutralized before incorporation
Oxidizers[c]	Compatible	Compatible	Can cause matrix breakdown, fire	Can cause matrix breakdown	Compatible if sulfates are present	High temperatures can cause undesirable reactions	Can cause deterioration of encapsulating materials
Sulfates[d]	Can retard setting and cause spalling unless special cement is used	Compatible	Can dehydrate and rehydrate, causing splitting	Compatible	Compatible	Compatible in many cases	Compatible

Footnotes on last page of table.

Table D-1. Compatibility of Selected Waste Categories with Different Containment Technologies[a] (continued)

Waste component	Cement-based	Lime-based	Thermoplastic-solidification	Organic polymer (UF)[b]	Self-cementing techniques	Glassification and synthetic mineral formulation	Surface encapsulation
Halides[d]	Easily leached from cement; can retard setting	Can retard set; most are easily leached	Can dehydrate	Compatible	Compatible if sulfates are present	Compatible in many cases	Compatible
Heavy metals[c]	Compatible	Compatible	Compatible	Acid pH solubilized metal hydroxides	Compatible if sulfates are present	Compatible in many cases	Compatible
Radioactive materials[c]	Compatible	Compatible	Compatible	Compatible	Compatible if sulfates are present	Compatible	Compatible

[a]Source: DOE, 1985.
[b]Urea-formaldehyde resin.
[c]Some waste streams on SRP frequently contain these components.
[d]Not usually generated on SRP; seldom observed in the groundwater.

in bulk or particulate form (e.g., contaminated demolition debris), containerized wastes, wastes in damaged or corroded drums, and wastes that have been previously stabilized by solidification.

Ideally, the jacket is bonded to the external surface of the waste. As long as the jacket is intact, the potential for leaks is low. However, this technology is in a developmental stage and few data are available on the long-term stability and integrity of covering materials or the costs of a full-scale facility (OTA, 1985; Ehrenfeld and Bass, 1983).

D.2.3 OTHER TREATMENT

D.2.3.1 Physical Treatment

Physical treatment processes concentrate semisolid or liquid wastes to render them more suitable for additional treatment or disposal. These processes include carbon adsorption, sedimentation/filtration, evaporation, air stripping, ion exchange, flotation, and reverse osmosis. They are seldom used in a single operation (DOE, 1985), but rather are combined with other technologies (often chemical or biological processes) to provide complete treatment of the waste stream. For example, many processes are employed in the M-Area ETF.

Physical treatment technologies have been proven to be effective and reliable; however, they are most likely to be used in connection with ETFs and generally are not applicable for the predisposal treatment of the types of hazardous, low-level radioactive, and mixed wastes described in this environmental impact statement. An exception is evaporation, which could be applied to ETF sludges for volume reduction and the stabilization of semisolid sludge to a dry salt form.

D.2.3.2 Chemical Treatment

Chemical treatment processes involve conditioning wastes to enhance sedimentation or filtration. These methods include precipitation, chelation, and flocculation. Other chemical technologies - for example neutralization, oxidation, reduction, solvent extraction, chlorination, and ozonation - destroy or detoxify wastes.

Chemical treatment technologies, particularly neutralization and precipitation, are applicable to the predisposal treatment of certain hazardous and mixed wastes (contaminated water, sludges, and soils from specific seepage and settling basins), but are used most commonly in ETFs.

D.2.3.3 Biological Treatment

Biological treatment technologies involve the use of oxidizing bacteria, algae, fungi, and microorganisms to destroy, stabilize, or alter organic wastes in aqueous streams. They are generally applied to process or domestic wastewaters, leachates, and other contaminated waters. Biological treatment technologies include activated sludge, stabilization ponds, trickling filters, rotating biological contactors, and land treatment.

Although these technologies are used extensively for waste treatment (including land treatment/disposal of certain oil wastes on the SRP), they generally are not applicable to the treatment of highly toxic hazardous wastes or radioactive wastes before disposal and, therefore, are of limited use for predisposal treatment on the Plant. (For additional discussion of biological treatment technologies, refer to Appendix C.)

D.2.3.4 Thermal Destruction Treatment

Thermal destruction of organic wastes, regardless of volume reduction, requires specially designed incinerator facilities that produce high temperatures and, perhaps, long residence times. This controlled incineration uses temperatures typically higher than 800°C. Many incinerators have at least two chambers. The first can be fired under either oxygen-deficient conditions (pyrolysis) or oxygen-rich conditions at temperatures of approximately 700°C; residence times in this chamber are rather long (measured in minutes). The second chamber is usually an afterburner, where combustion of the hazardous contaminants and particulates from the first chamber occurs at high efficiency in an oxygen-rich environment; residence times are usually a few seconds and temperatures are 1000°C or higher. The performance of the afterburner usually determines both the incinerator's efficiency in destroying the principal organic hazardous constituents and the identity and yield of particulates released to the emission control equipment and stack.

Hazardous waste incinerators must achieve destruction and removal efficiencies (DREs) of 99.99 percent, with the exception of dioxin incinerators, which must achieve a DRE of at least 99.9999 percent (40 CFR 264). Laboratory testing of incinerator performance under pyrolytic conditions on actual (or closely simulated) waste streams is the most effective and reliable method for predicting the emission of hazardous constituents (Dellinger et al., 1985; Mourningham and Olexsey, 1985).

Based on its assessment of incineration as a treatment method for organic hazardous wastes, the EPA (1985a) found incineration to be an environmentally sound technology that offers advantages over current disposal options under some circumstances. The EPA found little impact to health from incineration.

Thermal destruction by incineration does not destroy radionuclides. Therefore, when incineration is used to reduce the volume of wastes containing radioactivity, high-efficiency particulate air (HEPA) filters are needed to recover radioactive particulates from the exhaust gases. Both the recovered particulates and the residual ash, which contains solid radioactive particles, must be disposed of in a suitable disposal facility, usually after solidification.

Regarding its use for predisposal treatment, the Office of Technology Assessment (OTA, 1985) indicates that incineration is a proven, highly effective technology. It would, therefore, be applicable to a wide variety of hazardous, low-level radioactive, and mixed wastes, including those exhumed from existing SRP waste sites during closure actions. Table D-2 summarizes commonly used incineration technologies.

Table D-2. Commonly Used Incineration Technologies

Type	Process principle	Application	Combustion temperature (°C)	Residence Time
Rotary kilns	Waste burns in a rotating, refractory cylinder	Any combustible solid, liquid, or gas	800–1650	Seconds for gases; hours for liquids and solids
Single chamber/ liquid injection	Wastes atomize in high-pressure air or steam and burn in suspension	Liquids and slurries that can be pumped	700–1650	0.1 to 1 second
Multiple hearth	Wastes descend through several grates to burn in increasingly hotter combustion zones	Sludges and granulated solid wastes	750–1000	Up to several hours
Fluidized-bed incineration	Waste is injected into an agitated bed of heated inert particles; heat transfers efficiently to wastes during combustion	Organic liquids, gases, and granular or well-processed solids	750–900	Seconds for gases and liquids; minutes for solids

Source: EPA, 1985b.

D.3 APPROPRIATE TECHNOLOGIES

D.3.1 SUMMARY OF PREDISPOSAL TREATMENT TECHNOLOGIES

Table D-3 summarizes the advantages, disadvantages, and limitations of common predisposal treatment technologies.

D.3.2 SUMMARY OF APPROPRIATE TECHNOLOGIES

The use of predisposal waste treatment technologies can produce a substantial change on the characteristics and volume of waste to be disposed of. These changes might preclude certain disposal technologies or limit disposal alternatives to one or two specific technologies. Also, the potential difference in waste volume will have a great influence on the design capacity of required disposal facilities. Therefore, predisposal treatment must be considered as an integral part of the disposal process; it has a major impact on the sizing, design, and operation of facilities.

Tables D-4, D-5, and D-6 summarize the applicability of five predisposal technologies to various hazardous, mixed, and low-level radioactive wastes generated by, or stored at, SRP facilities.

D.3.3 EXPECTED RESULTS OF APPLICATION

Tables D-4, D-5, and D-6 indicate that, potentially, predisposal treatment technologies, specifically incineration, compaction, evaporation, solidification, and encapsulation, can be applied to a wide variety of hazardous, low-level radioactive, and mixed wastes on the SRP. At present, the use of certain technologies is being planned.

The following subsections summarize the expected results of the application of these technologies and, if possible, estimate the potential results of broader applications.

D.3.3.1 Incineration

Because of the effectiveness of incineration technology for volume reduction or thermal destruction of hazardous waste constituents, and because of its relatively low operation and maintenance costs, its development is being pursued actively on the Plant. One demonstration incineration project, the beta-gamma low-level radioactive waste incinerator, and one pilot incineration project, the transuranic (TRU) waste incinerator, are in operation on the Plant.

The beta-gamma incinerator is a two-stage, ram-feed, air-controlled, incinerator with a spray-quench tower, bag house, and high-efficiency particulate air (HEPA) filter. Waste in the first chamber is pyrolyzed at 900°C. Final combustion occurs with excess air in the second stage at 1000°C. This incinerator is achieving volume reductions of 95 to 99 percent (Weber, 1985).

The TRU waste pilot incinerator is an infrared, movable-grate type with a capacity of about 11 kilograms of solids per hour. Research conducted with this incinerator could be applied to low-level radioactive and mixed wastes

Table D-3. Advantages, Disadvantages, and Limitations of Common Predisposal Treatment Technologies[a]

Advantages	Disadvantages	Limitations	SRP applications
	VOLUME REDUCTION/DESTRUCTION/DETOXIFICATION PROCESSES		
Incineration:			
• Onsite - Destroys organic wastes (99.99+%). - Long-distance transportation of wastes not required.	Onsite feedstock preparation required. Test burn would be required. Skilled operators required. Expensive.	Mobile units have low feed rate.	SRP currently generates and stores large quantities of organic wastes.
Biological treatment:			
• Conventional - Applicable to many organic waste streams. - High total organic removal. - Inexpensive. - Well understood and widely used in other applications.	Can produce a hazardous sludge that must be managed. Might require pretreatment before discharge.	Microorganisms sensitive to oxygen levels, temperature, toxic loading, inlet flow. Some organic contaminants are difficult to treat. Flow and composition variations can reduce efficiency.	SRP currently generates and stores large quantities of organic wastes. Organically contaminated waste sites generally not amenable to in-situ biodegradation.
Chemical treatment:			
• Wet air oxidation - Good for wastes too dilute for incineration or too concentrated or toxic for biological treatment.	Oxidation not as complete as thermal oxidation or incineration. Might produce new hazardous species. Extensive testing is required. High capital investment. High-level operator skills required. Might require post-treatment.	Poor destruction of chlorinated organics. Moderate efficiencies of destruction (40-90%).	Generally not applicable to SRP organic wastes.
• Chlorination for cyanide - Essentially complete destruction. - Well understood and widely used in other applications.	Specialized for cyanide.	Interfacing waste constituents can limit applicability or effectiveness.	Generally, SRP does not produce cyanide wastes.

Footnotes on last page of table.

Table D-3. Advantages, Disadvantages, and Limitations of Common Predisposal Treatment Technologies[a] (continued)

Advantages	Disadvantages	Limitations	SRP applications
Chemical treatment (continued):			
• Ozonation - Can destroy refractory organics. - Liquids, solids, mixes can be treated.	Oxidation not as complete as thermal oxidation or incineration. Might produce new hazardous species. Extensive testing is required. High capital investment; high O&M.	Limitations not as well understood.	
• Reduction for chromium - High destruction. - Well understood and widely used in other applications.		Interfering waste constituents can limit applicability or effectiveness.	Chromium wastes currently sent to H-Area seepage basin for disposal.
Physical treatment:			
• Compaction/shredding - Low technology. - Well understood and demonstrated.	Might require air pollution control.	Limited primarily to bulky solid wastes.	
SEPARATION/TRANSFER PROCESSES			
Chemical:			
• Neutralization/precipitation - Wide range of applications. - Well understood and widely used in other applications. - Inexpensive.	Hazardous sludge produced.	Complexing agents reduce effectiveness.	Widely used technology at SRP.
• Ion exchange - Can recover metals at high efficiency.	Generates sludge for disposal. Pretreatment to remove suspended solids might be required. Expensive.	Resin fouling. Removes some constituents but not others.	Used to treat disassembly-basin purge water before discharge into reactor seepage basins.

Footnotes on last page of table.

Table D-3. Advantages, Disadvantages, and Limitations of Common Predisposal Treatment Technologies[a] (continued)

Advantages	Disadvantages	Limitations	SRP applications
Physical treatment:			
• Carbon adsorption for aqueous streams			
- Well understood and demonstrated. - Applicable to many organics that do not respond to biological treatment. - High degree of effectiveness.	Regeneration or disposal of spent carbon required. Pretreatment might be required for suspended solids, oil, grease. High O&M cost.	Some organics are poorly adsorbed.	Currently used to remove chlorinated organics from drinking water in A/M-Area on an "as-needed" basis.
• Carbon absorption for gases			
- Widely used, well understood. - High removal efficiencies.	High capital and O&M costs.	More effective for low-molecular-weight polar species. Disposal or regeneration of spent carbon required.	
• Flocculation, sedimentation and filtration			
- Low cost. - Well understood.	Generates sludge for disposal.	--	
• Stripping			
- Well understood and demonstrated.	Air controls might be required.	Applicable only to relatively volatile organic components.	A 1.5-m^3/min air stripper is removing chlorinated organics from groundwater in A/M-Area.
• Flotation			
- Well understood and demonstrated. - Inexpensive.	Generates sludge for disposal.	--	
• Reverse osmosis			
- High removal potential.	Generates sludge for disposal. Pretreatment to remove suspended solids or adjust pH might be required. Expensive.	Variability in waste flow and composition affects performance.	Research in this technology is being performed at SRP.

Footnotes on last page of table.

Table D-3. Advantages, Disadvantages, and Limitations of Common Predisposal Treatment Technologies[a] (continued)

Advantages	Disadvantages	Limitations	SRP applications
• Evaporation[b] - Well understood. - Low technology. - High degree of volume reduction.	Energy intensive.	Most effective with aqueous wastes of high solids content.	Currently being considered for drying ETF sludges to dry salt form.
	CONTAINMENT PROCESSES		
Solidification and stabilization • Improves containment performance. • High short-term effectiveness possible. • Waste material (e.g., fly ash, kiln dust) can be used as pozzolan.	Extensive testing might be required. Many processes developmental. Substantially increases volume of material to be disposed of.	Long-term integrity uncertain. Not useful for many organics.	Research on cement ashcrete and cement-fly ash saltstone is being performed at SRP.
Encapsulation: • Improve effectiveness of land disposal.	Developmental. Inefficient space utilization.	Long-term integrity uncertain. Requires solidification of bulk wastes.	Being used at greater confinement disposal demonstration in LLW burial ground.

[a]Source: OTA, 1985.
[b]Source: J. T. Baker Chemical Company, 1979.

Table D 4. Applicability of Predisposal Treatment Technologies to Hazardous Wastes[a]

Waste	Predisposal treatment technology				
	Incineration	Compaction	Evaporation	Solidification	Encapsulation
Organics, mercury and oil	3	5	5	4	5
Lathe coolant, oil	1	5	5	4	5
Oil with lead	3	5	5	4	5
Inorganic acids	3	5	5	4	5
Paint solvent	1	5	5	4	5
Other solvents	1	5	5	4	5
Toluene, xylene	1	5	5	4	5
Pesticides	1	5	5	4	5
CMP liquids	1	5	5	4	5
Sodium dichromate	1	5	5	4	5
Trichloroethane	1	5	5	4	5
Methylene chloride	1	5	5	4	5
Machine coolant	1	5	5	4	5
Naphtha-methylene chloride	1	5	5	4	5
Teargas concentrate	3	5	5	4	5
Toluene and isopropanol	1	5	5	4	5
Varnish and thinners	1	5	5	4	5
Waste paint	1	5	5	4	5
Laboratory chemicals	2, 3	5	5	3, 4	3
DWPF pilot plant sludge	5	5	1	1	3
Trichloroethylene sludge	1	5	5	4	4
Lead smelter waste	5	5	5	1	1
Beryllium-copper alloy	3	2	5	1	1
Alkalines	3	5	5	1	3
Nitrates	1	5	5	4	3
Mercury-contaminated material	1	2	5	4	1
Reactive metals	5	2	5	1	1
Contaminated soil	2	5	5	1	3

[a]Notations:
1. Broadly applicable
2. Moderately applicable
3. Limited to special conditions
4. Applicable when preceded by incineration to ash
5. Not applicable

generated on the Plant. In the first chamber, the waste is pyrolyzed at 870°C. Vaporized organic molecules and combustion products then enter an afterburner where the temperature reaches more than 1200°C for longer than 2 seconds. This type of incinerator has achieved a DRE of at least 99.9999 percent (Schreiber, 1985).

DOE plans a consolidated waste incineration facility (hazardous, mixed, and low-level) for the SRP. Current plans call for this facility to include two incinerators: one would use cyclonic, liquid injection incineration capable of destroying liquid organic wastes, including benzene from Defense Waste Processing Facility (DWPF) operations; the other would use rotary-kiln technology for the incineration of solid wastes (as much as 270 kilograms per hour) (DOE, 1985). Each unit would have spray-quench, wet-scrubber, and mist-eliminator systems. The liquid incinerator would also have a mercury absorption column. In the future, the conversion of this facility to a mixed waste facility might be desirable; if that were done, appropriate shielding and HEPA filters would be necessary.

The estimation of waste volumes in Appendix E includes assumptions for volume reduction by incineration. In general, it is assumed that liquid organics

Table D-5. Applicability of Predisposal Treatment Technologies to Mixed Wastes[a]

Waste	Predisposal treatment technology: Incineration	Compaction	Evaporation	Solidification	Encapsulation
Purex solvent	1	5	5	4	5
Scintillation fluid	1	5	5	4	5
Liquid organics	1	5	5	2, 4	5
Tritiated mercury	5	5	5	1	3
Tritiated oil	1	5	5	3, 4	5
PCB contaminated oil	1	5	5	4	5
FMF WWTF sludge	5	5	1	1	3
M-Area ETF sludge	5	5	1	1	3
F- & H-Area ETF sludge	5	5	1	1	3
FPF ETF sludge	5	5	1	1	3
Mercury-contaminated waste	1	3	5	4	3
Job control waste	1	1	5	4	3
Lead shielding	5	5	5	5	1
Mercury-contaminated equipment	5	3	5	5	1
Contaminated soil	3	5	5	1	3

[a]Notations:
1. Broadly applicable
2. Moderately applicable
3. Limited to special conditions
4. Applicable when preceded by incineration to ash
5. Not applicable

Table D-6. Applicability of Predisposal Treatment Technologies To Low-Level Radioactive Wastes[a]

Waste	Predisposal treatment technology: Incineration[b]	Compaction	Evaporation	Solidification	Encapsulation
Low-level radwaste solvents	1	5	3	1	5
Tritiated oil	1	5	5	3, 4	5
Purex solvent	1	5	5	4	5
Job control waste	1	1	5	4	1
Targets, equipment, hardware	3	3	5	4	1
Contaminated soil & radwaste	5	3	5	1	1

[a]Notations:
1. Broadly applicable
2. Moderately applicable
3. Limited to special conditions
4. Applicable when preceded by incineration to ash
5. Not applicable

[b]Incineration does not destroy or reduce radionuclides but can be used to reduce the volume, change the physical state, and chemically stabilize low-level radioactive wastes.

would be reduced by 97.5 percent, but that circumstances could reduce that to 95 or 92.5 percent. It is also assumed that combustible solids would be reduced by 92.5 percent and that the incineration of contaminated soils would result in no reduction in volume. The residuals are assumed to include both ash and exhaust gas scrubber blowdown.

D.3.3.2 Compaction

Compactor demonstration programs at the SRP and other DOE facilities (e.g., Oak Ridge and the Fuel Materials Production Facility) are reducing the volume of low-level radioactive waste. The Reactor Department and the Savannah River Laboratory (SRL) both use small (0.15-cubic-meter) box compactors. These units reduce the volume of job-control wastes by approximately 67 percent. Data from these demonstrations will provide the basis for the installation of additional compactors by the Reactor Department.

The Separations Department, which operates F- and H-Areas, has installed a large box compactor in H-Area. This unit compacts wastes into 2.6-cubic-meter, carbon-steel boxes. As waste items are received in cardboard boxes, radiation levels are verified and the waste is fed manually to the compactor. Approximately 75-percent reductions in volume have been achieved. This demonstration will permit the evaluation of (1) volume reduction achievable for low-level radioactive waste, (2) the classification of compactible material, (3) loading techniques, and (4) ventilation control requirements. Appendix E assumes a volume reduction of 75 percent through the use of this technology.

Shredding technology is a subset of Compaction. As discussed in Section D.2.1.3, shredding is particularly effective when applied before incineration or compaction. Currently, the SRP and SRL are testing two small shredders (15 and 45 horsepower) for use in preparing combustible, TRU-contaminated waste for incineration (Charlesworth, 1985).

A large (160-horsepower) shredder system that is expected to begin operation by 1990 will reduce decontaminated, noncombustible process equipment and other large items. Testing has determined that a 200-kilogram glove box can be reduced for disposal in a 208-liter drum.

The Raw Materials Department in M-Area has installed a large box compactor. That compactor presumably achieves volume reductions of 76 to 80 percent.

Collectively, these compaction programs should achieve a net reduction of about 2400 cubic meters of low-level waste annually (Mentrup, 1985). This amounts to a 9-percent reduction in the amount of low-level waste to be disposed of annually at the low-level waste burial grounds.

D.3.3.3 Evaporation

No significant research on or demonstration of evaporation technology for reducing ETF sludges to dry salt for disposal has been performed at SRP in recent years. However, assuming a bulk density of 2400 kilograms per cubic meter of dry salt, the volume reductions would range from 87.5 percent for ETF sludges with 30 percent solids content by weight to 98.3 percent for sludges with 4 percent solids by weight.

D.3.3.4 Solidification

Research on cement/fly ash solidification of ETF sludges is under way at the SRP. The material produced by this method would be formed into monoliths in lined disposal facilities, where it would cure to a concrete-like substance.

Solidification is applicable to a variety of granular solid wastes such as incinerator ash and contaminated soil; semisolid sludges such as the M-Area ETF sludge; and liquids, including contaminated water. DOE has received permits for the construction and operation of facilities to solidify decontaminated DWPF supernate and to dispose of the waste in Z-Area.

A demonstration facility for the solidification of ash from the beta-gamma incinerator is expected to undergo testing with nonradioactive materials in 1986 (Du Pont, 1985). This facility will accept ash in 208-liter (55-gallon) drums; add water, cement, and sand; and tumble the drums to produce a solidified waste form ready for disposal.

Appendix E assumes that, because of the addition of substantial quantities of material to the waste using this technology, the waste form volume would be double the original waste volume.

D.3.3.5 Encapsulation

The SRP has an active waste encapsulation program. At present, greater confinement disposal (GCD) techniques are being tested at instrumented facilities in the low-level waste burial ground. The goal of GCD is to dispose of Class B and C low-level radioactive wastes in a facility that would meet the NRC 500-year longevity guideline (10 CFR 61). Self-leveling cement grout is used to encapsulate the wastes as each "lift" is placed in a GCD demonstration borehole or trench (Cook et al., 1984). Such a use of this technology is considered to be disposal rather than pretreatment.

One predisposal alternative combines solidification and encapsulation technologies. It involves the use of a shell of concrete to contain saltstone or low-level waste grouted in place. The concrete containers can be shaped to fit tightly together in rows and columns, eliminating interstitial space and improving stability.

REFERENCES

Beamer, N. V., 1984. "Experience with Low-Level Waste Incineration at Chalk River Nuclear Laboratories," in Waste Isolation in the U.S.: Technical Programs and Pubic Education, Vol. 2, R. G. Post, ed., Tucson, Arizona, pp. 205-212.

Charlesworth, D. L., 1985. Waste Pretreatment Activities - Shredding, DPSP-85-1108, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Clark, A. I., R. Perry, and C. S. Poon, 1985. "The Rational Use of Cement-Based Stabilization Techniques for the Disposal of Hazardous Waste," in Proceedings, International Conference on New Frontiers for Hazardous Waste Management, EPA/600/9-85/025, U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio, pp. 339-347.

COE (U.S. Army Corps of Engineers), 1982. "Physical Properties and Leach Testing of Solidified/Stabilized Industrial Wastes," PB83-147983, cited in The Hazardous Waste Consultant, Vol. 1, No. 5, 1983, pp. 1-3 through 1-8.

COE (U.S. Army Corps of Engineers), 1984. Investigation of Stablex Material Emplaced at West Thurrock Facility, England, draft report prepared for the U.S. Environmental Protection Agency, cited in The Hazardous Waste Consultant, Vol. 3, No. 2, 1985, pp. 1-1 through 1-3.

Cook, J. R., et al., 1984. "Greater Confinement Disposal Activities at the Savannah River Plant," DP-MS-84-84, E. I. du Pont de Nemours & Company, Savannah River Laboratory, Aiken, South Carolina, presented at the DOE Low Level Waste Management Program, Denver, Colorado.

Croney, S. T., 1985. Leachability of Radionuclides from Cement Solidified Waste Forms Produced at Operating Nuclear Power Plants, NUREG/CR-4181, U.S. Nuclear Regulatory Commission, Washington, D.C.

Dellinger, B., et al., 1985. "Examination of Fundamental Incinerability Indices for Hazardous Waste Destruction," paper presented at EPA's 11th Research Symposium of Land Disposal, Remedial Action, Incineration and Treatment of Hazardous Wastes, cited in The Hazardous Waste Consultant, Vol. 3, No. 5, pp. 1-22 through 1-25.

DiSalvo, R., 1984. "Solidification of Chemical Decontamination Resin," in Waste Isolation in the U.S.: Technical Programs and Public Education, Vol. 2, R. G. Post, ed., Tucson, Arizona, pp. 173-176.

DOE (U.S. Department of Energy), 1985. Hazardous Chemical Defense Waste Management Program: Technology Review Report, Currently Available Technology, DOE/HWP-4, Washington, D.C.

DOE-SR (U.S. Department of Energy, Savannah River Operations Office), 1985. Savannah River Interim Waste Management Program Plan - FY-1986, DOE/SR-WM-6-1, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1985. "Solvent Burner Upgrade: Project Objective Letter (Number WM 2-60)," in Conceptual Design Package for Solvent Burner Upgrade, Work Request 851947, Engineering Department, Wilmington, Delaware.

Ehrenfeld, H., and J. Bass, 1983. Handbook for Evaluating Remedial Action Technology Plans, EPA 600/2-83-076, U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.

Enegess, D. N., 1984. "High Force Compaction: Its Capabilities and Limitations for Dry Active Waste Processing," in Waste Isolation in the U.S.: Technical Programs and Public Education, Vol. 2, R. G. Post, ed., Tucson, Arizona, pp. 79-81.

EPA (U.S. Environmental Protection Agency), 1982a. Handbook - Remedial Action at Waste Disposal Sites, EPA 625/6-82-006, Office of Research and Development, Cincinnati, Ohio.

EPA (U.S. Environmental Protection Agency), 1982b. Guide to the Disposal of Chemically Stabilized and Solidified Wastes, SW-872, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985a. Assessment of Incineration as a Treatment Method for Liquid Organic Hazardous Wastes: Summary and Conclusions, Office of Policy, Planning and Evaluation, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985b. Handbook-Remedial Action at Waste Disposal Sites (Revised), EPA/625/6-85/006, Office of Research and Development, Cincinnati, Ohio.

Escher, D. E., and J. W. Newton, 1985. "The Determination of Fixation Treatment Method Limits for Hazardous Liquids and Industrial Sludges from Disparate Sources," in Proceedings, International Conference on New Frontiers for Hazardous Waste Management, EPA/600/9-85/025, U.S. Environmental Protection Agency, Waste Engineering Research Laboratory, Cincinnati, Ohio, pp. 108-117.

Giuffre, M., D. Ensminger, J. Nalbandian, and M. Naughton, 1984. "The Economics of Radwaste Vol. Reduction Strategies," in Waste Isolation in the U.S.: Technical Programs and Public Education, Vol. 2, R. G. Post, ed., Tucson, Arizona, pp. 31-35.

J. T. Baker Chemical Company, 1979. The Management and Disposal of Hazardous Chemical Wastes, a course manual, Phillipsburg, New Jersey.

Kalb, P. H., and P. Columbo, 1984. "Full-Scale Leaching Study of Commercial Reactor Waste Forms," in Waste Isolation in the U.S.: Technical Programs and Public Education, Vol. 2, R. G. Post, ed., Tucson, Arizona, pp. 189-194.

Mentrup, S. J., 1985. Waste Pretreatment Activities - Compaction, DPSP-85-1103, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Miller et al., 1984. "Laboratory Evaluation of Steel Production Waste Stabilizers," Symposium on Iron and Steel Pollution Abatement Technology, cited in The Hazardous Waste Consultant, Vol. 3, No. 1, pp. 1-6 through 1-8.

Mourningham, R. E., and R. A. Olexsey, 1985. "Surrogate Compounds as Indicators of Hazardous Waste Incineration Performance," in Proceedings, International Conference on New Frontiers for Hazardous Waste Management, EPA/600/9-85/025, U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio, pp. 526-530.

NRC (U.S. Nuclear Regulatory Commission), 1981. Volume Reduction Techniques in Low-Level Radioactive Waste Management, NUREG/CR-22056, Washington, D.C.

OTA (Office of Technology Assessment), 1985. Superfund Strategy, OTA-IET-252, Congress of the United States, Washington, D.C.

Phillips, J. W., 1984. "Qualifications of Waste Forms To Meet the Requirements of 10 CFR 61," in Waste Isolation in the U.S.: Technical Programs and Public Education, Vol. 2, R. G. Post, ed., Tucson, Arizona, pp. 183-187.

Rosenstiel, T. L., S. P. Bodet, and R. G. Lange, 1984. Envirostone Gypsum Cement, 1984 Topical Report, United States Gypsum, Libertyville, Illinois.

Rosenstiel, T. L., and R. G. Lange, 1984. "The Solidification of Low-Level Radioactive Organic Fluids with Envirostone Gypsum Cement," in Waste Isolation in the U.S.: Technical Programs and Public Education, Vol. 2, R. G. Post, ed., Tucson, Arizona, pp. 169-172.

Rutland, L., N. C. Papaiya, and M. D. Naughton, 1984. "Current Status and Future Potential for Vol. Reduction Technologies," in Waste Isolation in the U.S.: Technical Programs and Public Education, Vol. 2, R. G. Post, ed., Tucson, Arizona, pp. 69-73.

Schreiber, R., 1985. Times Beach Dioxin Research Facility, Center for Energy and Environmental Management, paper presentation at EPA Symposium on Meeting the New RCRA Requirements on Hazardous Waste, Alexandria, Virginia.

Voss, J. W., and B. D. Guilbeault, 1984. "The Mixed Economics of Volume Reduction," in Waste Isolation in the U.S.: Technical Programs and Public Education, Vol. 2, R. G. Post. ed., Tucson, Arizona, pp. 43-48.

Weber, D. A., 1985. "Waste Treatment Activities: Incineration Write-Up for the Groundwater WM EIS," Interoffice Memorandum, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX E

NEW DISPOSAL FACILITY ALTERNATIVES

Chapter 2 of this environmental impact statement (EIS) defines four alternative waste management strategies (No Action, Dedication, Elimination, and Combination) for the modification of SRP waste management activities. In its Record of Decision, the U.S. Department of Energy (DOE) will select a strategy based on its evaluations of optional technologies that will conform to the objectives of the strategy and will achieve regulatory compliance. Section E.1 describes the various project-specific technologies being considered under each waste management strategy. Section E.2 describes the wastes that will require disposal. Section E.3 discusses the candidate sites that were identified to provide a basis for certain project-specific environmental analyses (e.g., groundwater modeling). Section E.4 identifies the project-specific technologies associated with each strategy and describes the advantages and disadvantages of implementation, the range of waste volumes currently anticipated, the range of potential costs associated with implementation, and the major analytical assumptions.

The objective of this appendix is to describe the technologies that could be used to implement each strategy, including the range of environmental impacts (see Appendix G). This range, rather than specifically defined impacts, is the result of project-specific actions that will be decided through planning and feasibility studies during the regulatory permitting process. These project-specific actions are associated with site selection, engineering design details, waste stream characteristics and volumes, closure of existing waste sites, predisposal treatment facilities, cost effectiveness, regulatory requirements, and judicial mandates. For the analysis of environmental impacts, this EIS makes conservative assumptions about project-specific actions to describe impacts that include all known reasonable waste management possibilities.

E.1 DESCRIPTION OF TECHNOLOGIES

This section describes the project-specific technologies being considered for the disposal and/or storage of hazardous, mixed, and low-level radioactive wastes. Section E.2 describes the combinations of these technologies envisioned for the implementation of each strategy. (Note: The term "disposal" refers to the permanent deposition of wastes in an engineered facility; the term "storage" presumes retrieval of the waste at some future time; the term "technology" means a project-specific technology or action; and the term "strategy" implies a combination of project-specific technologies.)

E.1.1 HAZARDOUS OR MIXED WASTE

E.1.1.1 Applicable Regulations and Criteria

The management of hazardous waste and mixed (radioactive and hazardous) waste at the Savannah River Plant (SRP) is regulated by the Resource Conservation and Recovery Act (RCRA), the Hazardous and Solid Waste Amendments (HSWA), and

DOE Orders. Chapter 6 discusses these acts and amendments and other applicable regulations.

Predisposal treatment of these wastes might be required with all of the disposal technologies. RCRA prohibits the disposal of bulk or uncontainerized liquid waste or waste containing free liquids until they are treated chemically or physically (e.g., by mixing with a sorbent solid), such that free liquids are no longer present as defined by the regulations (i.e., the paint filter test).

Under the 1984 Amendments to RCRA (i.e., HSWA), the U.S. Environmental Protection Agency (EPA) will ban the land disposal of most untreated hazardous wastes over the next 5 years. These amendments require the treatment of hazardous wastes to remove their most toxic components, allowing only the treatment residue to be disposed of on land.

EPA's first action under this requirement applies to spent solvents and wastes that contain dioxin. Other materials to be affected include liquid hazardous waste containing cyanides, metals, and polychlorinated biphenyls (PCBs); corrosive wastes; and both liquid and solid hazardous wastes containing halogenated organic compounds (HOCs). To implement these requirements, EPA is establishing predisposal treatment standards based on actual performance of the best demonstrated treatment technologies available.

Under RCRA, EPA could consider a request from DOE for an exemption to the land disposal ban. EPA's approval would have to be based on its determination that no migration of hazardous constituents would occur from the waste management unit.

Predisposal treatment of hazardous or mixed waste for volume reduction, detoxification, and chemical or physical stabilization might be desirable and cost effective, regardless of the legal requirements. Appendix D describes the application of predisposal treatment, which will be determined specifically in the context of future advanced planning designed to carry out the selected waste management strategy.

E.1.1.2 Belowground Vault Disposal (RCRA Waste)

One technology being considered for shallow-land disposal of hazardous or mixed wastes is the double-lined, reinforced-concrete vault. A typical disposal vault would be a large, water-tight, reinforced-concrete box set below the surface of the ground on an exterior liner of compacted clay. Each vault would be divided into cells for the disposal of the different types of hazardous waste. A membrane liner in each cell would ensure containment of any leakage within that cell. A leachate (or leakage) collection system would be installed in each cell above the concrete liner (floor), and a leachate monitoring and collection system would be installed between the concrete floor and the compacted clay liner.

Hazardous or mixed wastes, delivered to the vaults in containers, would be placed in the cells in layers. As each layer in a cell was completed, voids would be filled with grout and the layer would be capped with about 0.3 meter of reinforced concrete. After capping, the cells would be sealed by a sloped, reinforced-concrete roof and covered with approximately 1 meter of soil. The

closed facility would appear to be a mound at the ground surface. Space utilization efficiency would be about 66 percent.

Vaults for mixed waste would be nearly identical to those for hazardous waste, because no additional shielding would be required for radiation protection. However, intermediate-activity mixed waste (greater than 300 millirem per hour) would be handled by remote-controlled or shielded equipment and would be immediately grouted in place and covered by approximately 0.6 meter of concrete to provide the required occupational shielding.

This technology relies primarily on the design and integrity of the structure and its backup systems to ensure that hazardous or mixed waste constituents do not migrate from the facility into the surrounding soils or groundwater. The following features facilitate this objective:

- A water-tight concrete structure that prevents the entry of water into the facility and provides long-lasting stability
- Grouting of void spaces to improve stability and minimize channels through which water or liquids could percolate
- An interior synthetic-membrane (primary) liner that prevents the release of contaminated water or liquids from the facility
- A leachate collection system above the primary liner to provide a means of detecting and removing accumulated liquids
- A backup (secondary) liner consisting of at least 1.5 meters of compacted clay or the equivalent
- A secondary leachate collection system to provide a means of detecting and removing contamination outside the primary liner
- Placement below the surface of the ground to protect the structure and provide radiation shielding

E.1.1.3 Aboveground Vault Disposal (RCRA Waste)

The aboveground vault technology is similar to that of belowground vaults. This technology responds to the statement in the Notice of Intent to have the analysis of new disposal facility alternatives include an evaluation of aboveground disposal.

Section E.1.1.2 contains a description of the aboveground vault technology, except the aboveground vault is constructed at or near the natural surface of the ground with its concrete sides and roof protruding above the surface. A mixed waste facility could require allowances for additional radiation shielding or interior locational preferences for the disposal of intermediate-activity waste.

This technology relies on the design and integrity of the structure and its backup systems to ensure that hazardous and mixed waste constituents do not migrate from the facility into soils or groundwater. The features facilitating this objective are the same as those listed in Section E.1.1.2, except

the vault is above the ground. A unique feature of this technology is its construction at the surface of the ground. This eliminates the need for substantial excavation and reduces the difficulty of monitoring, inspection, and repair, which could enhance its long-term reliability.

E.1.1.4 Vault Disposal (Cement/Flyash Matrix Waste)

A technology for the disposal of selected wastes involves predisposal treatment by solidification in a cement/flyash matrix (CFM) and discharge as a slurry directly into reinforced-concrete vaults, where it cures in-place to a hard, concrete-like substance. Currently, this technology is being considered for the disposal of mixed waste sludges from the M-Area effluent treatment facility (ETF), the F- and H-Area ETF, the Fuel Production Facility ETF, and the Naval Fuel Materials Facility wastewater treatment plant, plus ash from the incineration of hazardous, mixed, and low-level radioactive wastes.

Treatment facility sludges and incinerator ash would be delivered to the treatment/disposal facility by tank truck and unloaded to a storage tank capable of holding 1 month's generated volume. Before disposal, the waste would be blended into a cement/flyash mixture that would be transported to disposal vaults for discharge and curing.

A typical disposal vault would be a large, reinforced-concrete box set either below the surface of the ground or at the surface. Each vault would be divided into cells to allow the pouring of discrete units of CFM waste and would have rain covers to help keep the chambers dry. Water that entered the facility before closure would be collected, monitored, and properly disposed of.

Closure of a filled vault would involve the placement of a concrete cover or roof, which would be either cast in place or precast in sections. A below-ground vault would be covered with soil to grade; an aboveground vault would remain exposed or would be mounded with soil to protect the facility and provide added radiation shielding.

The vault technology for CFM disposal differs from the RCRA vaults (Sections E.1.1.2 and E.1.1.3) because it has no liners and no leachate collection systems. Rather, it relies on the solidification of the waste and the concrete structural barrier to prevent the release of waste constituents and to maintain environmental standards. The following features facilitate this waste management objective:

- Pretreatment by CFM solidification, which provides chemical and physical stability of the waste and resists leaching of constituents

- Direct discharge of the slurried mixture into the facility for curing in place, which eliminates channels into or through the waste and further resists leaching of constituents

- Concrete vault containment, which provides a structural barrier between the solidified waste and the environment

- Collection and disposal of run-on water before closure

- Limitation to specific wastes that are particularly suitable for solidification pretreatment

This technology relies extensively on the solidification pretreatment to prevent release of constituents and to render the waste potentially nonhazardous and eligible for delisting under RCRA. Without this pretreatment, RCRA technology standards would apply. Any future evaluations of this technology should include the predisposal treatment facilities as an integral component.

E.1.1.5 RCRA-Type Landfill Disposal

A RCRA-type landfill facility for hazardous or mixed waste consists of double-lined trenches with double leachate collection systems. The first liner would be of clay compacted on the bottom and sides of the trench. This would be overlain by a leachate collection system consisting of a permeable material such as sand or crushed stone. An impermeable synthetic-membrane liner would be placed above this, followed by another leachate collection system. The final layer would be a working surface of crushed stone. The waste containers would be unloaded and stacked on this surface.

Mixed waste emitting radioactivity of more than 300 millirem per hour (intermediate-activity waste) would be handled remotely or with shielded equipment. Containers of such waste would be placed at the bottom level and shielded horizontally and vertically with containers of material emitting less than 300 millirem per hour (low-activity waste).

As a trench was filled, closure would consist of filling void spaces with sand, covering the facility with a low permeability synthetic membrane, and protecting that membrane with layers of sand, a low-permeability clay cap, and soil. The cover membrane would be fused to the base membrane to provide a water-tight enclosure for the waste. Total space utilization efficiency in the trench would be about 49 percent.

After closure, the ground surface above the facility would be contoured to channel surface runoff away from the landfill, and would be seeded with grass or other shallow-rooted vegetation to stabilize the soil and mitigate erosion.

During the operation of the facilities, run-on and leachate water would be collected and monitored. If found to be contaminated, this water would be stabilized and disposed of as hazardous waste.

As with other RCRA facilities, this landfill relies largely on the design and structural integrity of the facility and its backup systems to ensure that hazardous or mixed waste constituents do not migrate from the facility into the surrounding soils or groundwater. The following features facilitate this objective:

- A water-tight sealed membrane that completely surrounds the waste to prevent the entry of water into the facility or the release of potentially contaminated water from the facility

- Sand-filled void spaces to improve stability

- A leachate collection system above the primary (synthetic-membrane) liner to provide a means of detecting and removing accumulated liquids

- A backup (secondary) liner consisting of at least 1.5 meters of compacted clay or the equivalent

- A secondary leachate collection system to provide a means of detecting and removing contamination outside the primary liner

- Placement below the surface of the ground to provide structural support, protect the liners, and provide radiation shielding of mixed waste

E.1.1.6 Retrievable-Storage Buildings

The buildings being considered for the retrievable storage of hazardous or mixed wastes would be of metal and/or concrete construction, designed and operated to prevent releases of hazardous or radioactive wastes. Wastes would be delivered to the buildings in containers (e.g., 208-liter drums or 2.5-cubic-meter steel boxes) for storage. Interior partitions would segregate noncompatible wastes. The design of mixed waste facilities would include varying degrees of radiation shielding. Access aisles would facilitate the handling and periodic inspection of the waste containers. Due to the space devoted to items other than waste storage, the estimated space utilization efficiency of such a storage building is 15 to 20 percent.

The long-term storage of hazardous and mixed wastes in a safe and secure manner depends on the design and reliability of the storage facilities and a cognitive operational program. The building design would include the following specific features:

- Separate drains and alarmed sumps for the recovery of any liquids from each partitioned area

- Smoke and fire detection, and automatic foam fire control systems

- Ventilation systems with vapor and radiation detectors to provide occupational protection and warning of potential leakage

- In mixed waste facilities, the routing of ventilated air through high-efficiency particulate filters to preclude the release of radioactive particles

Operations would include waste analysis, site security, periodic inspections of the waste containers and the facility, personnel training, emergency preparedness and procedures, recordkeeping, and reporting.

The objective of the retrievable-storage technology is to store waste temporarily in anticipation of the development of technologies for destruction, detoxification, recycling, or disposal. Pretreatment prior to storage might foreclose future options. Therefore, pretreatment generally is neither required nor desired, with the exception of some forms of volume reduction (e.g., compaction, shredding) to reduce bulk, usually by eliminating air spaces.

The retrievable-storage technology has a major disadvantage; that is, by itself it could not provide a permanent waste management solution. Future expenditures for construction of treatment or disposal facilities, retrieval of the stored waste, and operation of the future facilities would be required.

E.1.2 LOW-LEVEL RADIOACTIVE WASTE

E.1.2.1 Applicable Regulations and Criteria

DOE has published general guidelines and policies for the management of low-level radioactive waste in the form of DOE Orders; these are summarized in Chapter 6.

E.1.2.2 Engineered Low-Level Trench Disposal

The engineered low-level trench (ELLT) is a technology for the disposal of low-activity (less than 300 millirem per hour) waste. A typical ELLT disposal facility would consist of an open trench, 40 to 50 meters wide and 150 to 170 meters long, with a floor of crushed stone. Low-activity waste in steel containers would be delivered to the trench, unloaded, and stacked on the crushed stone base. The trench would be closed as it was filled. Sand would be used to fill void spaces; it would be overlain by a cap of clay, fill, and topsoil. The ground surface would be seeded, and surface water would be channeled away from the facilities to minimize infiltration of the water and erosion of the cap. Subsidence that occurred after closure would be corrected as necessary to eliminate ponding above the trench. The use of metal containers should delay subsidence for some time.

Because the ELLT technology includes no engineered barriers or leachate collection, it relies on site selection, a well-constructed low-permeability cap, and postclosure maintenance to minimize the intrusion of water into the closed trench and prevent excessive migration of waste constituents.

E.1.2.3 Vault Disposal

DOE is considering the use of vaults for the disposal of low- and intermediate-activity waste. A typical low-activity disposal vault is a large, reinforced-concrete box set either below or at the surface of the ground. The interior can be open or divided into cells, as appropriate, to accommodate facility operations and waste handling.

Typically, waste would be delivered to the facility in metal containers, which would be packed closely in the vault to minimize void spaces. When it was filled, the vault would be closed with a concrete cap or roof to seal the waste inside. A belowground vault would be covered with soil to grade and the surface would be contoured to channel runoff away from the facility. An aboveground design would remain exposed or would be mounded with soil to protect the vault from weathering or to provide additional radiation shielding.

Due to the relatively low concentration of contaminants in the low-activity waste fraction, this technology requires no additional clay or membrane liners and no leachate collection systems. The low-activity vault relies largely on the sealed concrete structural barrier, the siting, and the surface drainage

to minimize the intrusion of water, which could leach waste constituents into underlying soils and groundwater.

The vault design for intermediate-activity waste is similar structurally to that for the low-activity vault; however, due to the higher concentration of radionuclides, the design contains a complete exterior leachate collection system and a secondary barrier of compacted clay or other suitable material. Containerized or bulk intermediate-activity wastes could be grouted in place to fill void spaces and add stability, or added stability could be incorporated into the structure. Closure would be similar to that described for the low-activity vault.

The vault technology for intermediate-activity, low-level waste differs from that for the RCRA vault; it contains a single leachate collection system and exterior liner rather than the double (interior and exterior) leachate collection systems and liners required for RCRA facilities. On the other hand, the intermediate-activity vault design requires added stability by either inplace grouting or structural design to minimize the possibility of subsidence and the intrusion of water plus an exterior secondary barrier and leachate collection system to ensure that radionuclides are contained within the facility.

DOE Orders require predisposal treatment (i.e., solidification) prior to disposal of liquid low-level waste using vault technologies. Other pretreatments (i.e., volume reduction) are not required but might be desirable to enhance stability or improve the efficiency and cost effectiveness of space utilization.

E.1.2.4 Abovegrade Operations

DOE is considering an abovegrade operation (AGO) for the disposal of low-activity, low-level radioactive waste; however, this technology can be used for the disposal of both low- and intermediate-activity wastes. An AGO consists of a stable stack of waste-filled containers, surrounded by a low-permeability synthetic membrane. Typically, an AGO facility includes a subbase of compacted clay covered by the membrane. A layer of sand protects the membrane and facilitates a leachate-collection field. A geotextile layer separates the sand from the final layer of crushed stone. The subbase is sloped to aid in the collection of run-on water and leachate during operation and after closure.

Wastes would be delivered to the AGO in steel containers, which would be unloaded and stacked on the crushed stone base mat. Intermediate-activity (greater than 300 millirem per hour), low-level wastes that require added shielding would be handled by remotely controlled equipment and placed in specially prepared precast reinforced-concrete casks near the center of the pile.

The AGO would be closed with sand to fill void spaces and clay, a low-permeability synthetic membrane, and a final cover of soil. The cover membrane would be fused to the base membrane to form a water-tight sealed envelope around the stacked waste containers. This should prevent the generation of leachate from the facility; however, any water collected from beneath the facility would be tested and, if contaminated, would be solidified in concrete and disposed of as low-level waste.

An AGO unit typically measures 50 to 60 meters wide by 150 to 160 meters long at the base; following closure, it would be about 9 meters high.

AGO technology relies primarily on a stable soil base and the waste containers for structural stability, and on the synthetic membrane to minimize the intrusion of water and prevent excessive migration of waste constituents. The leachate collection system provides early warning of a leakage and a means to remove contaminated liquids. The aboveground design provides relatively easy access to the facility to conduct appraisals and effect necessary repairs.

As with other low-level waste disposal technologies, liquid wastes must be pretreated (i.e., solidified) before disposal. Other pretreatments might be desirable to enhance stability or improve space utilization.

E.1.2.5 Greater Confinement Disposal

DOE is considering greater confinement disposal (GCD) technologies for the disposal of intermediate-activity, low-level wastes that require a greater degree of isolation from the environment than low-activity wastes. GCD technology involves deeper burial, and hence more shielding, than the ELLT technology; encapsulation of the waste forms after emplacement with grout; and closure to prevent root intrusion and minimize the percolation of water to the waste.

SRP could use either of two types of GCD facilities - boreholes and trenches. In a typical GCD borehole design, waste is placed in a liner that is 2.1 meters in diameter and 6.1 meters high; the liner rests on a 0.3-meter-thick concrete pad in an augured hole with a diameter of 2.7 meters. The top of the base pad is generally 9 meters below grade and at least 3 meters above the expected high water table. The top of the waste placed in the liner is typically at least 3 meters below grade. The liner is surrounded by a 0.3-meter-thick annulus of grout. Waste in 208-liter drums would be placed in the liner in layers six drums deep and the annulus space would be filled with grout. The liner would be capped with 0.3 meter of concrete and overlain with a cap of clay, sand, and topsoil. The surface would be seeded and surface water would be channeled away from the holes to eliminate infiltration of the water and erosion of the cap.

GCD trenches have the same shielding objectives as GCD boreholes. Typically, a facility would consist of a concrete-lined trench with a low-permeability membrane liner. A typical trench might be 7 meters wide, 122 meters long, and 7.5 meters deep. Waste in steel containers or bulky, uncontainerized wastes would be placed in the trench in layers about 0.3 meter from the walls. The annular spaces would be filled with grout and the trench would be capped with 0.6 meter of reinforced concrete overlain by a cap of clay, sand, and topsoil. The surface would be seeded and surface water would be channeled away from the trench to eliminate infiltration of the water and erosion of the cap.

Total space utilization efficiency would be about 50 percent for trenches and about 40 percent for boreholes. Monitoring wells and leachate collection systems are included in the design of both types of GCD facilities to detect and recover any contaminated water.

GCD technology relies on the following design features to ensure that low-level waste constituents are not released:

- Proper siting to provide adequate depth of disposal, and at least 3 meters between the waste and the expected high water table to prevent contact of the waste with groundwater
- A concrete structure to prevent the intrusion of water into the facility or the release of potentially contaminated water from the facility
- A low-permeability clay cap to divert downward percolating water away from the facility
- Grout encapsulation of the waste after emplacement to improve stability and eliminate channels through which water could flow in contact with the waste
- Backup leachate monitoring and collection systems to provide warning of a release and a means of recovering contaminated liquids

This technology requires predisposal treatment of any liquid wastes (e.g., solidification). Other pretreatments to enhance stability or improve space utilization might be desirable and cost effective.

E.1.2.6 Engineered Storage Buildings

The retrievable-storage alternative for low-level waste involves the segregation of low-activity from intermediate-activity material. The low-activity material is stored in unshielded or lightly shielded facilities. Intermediate-activity material requires heavier radiation shielding and remote handling.

The storage facilities for low-activity wastes are concrete or metal buildings. The use of concrete block lining of the walls produces additional light shielding in some buildings.

The building design includes floor drainage sufficient to recover any liquids, heating, and ventilation, and would contain fire, smoke, vapor, and radiation detection systems and automatic fire extinguishing systems. Low-activity wastes are stored in steel containers in racks to facilitate handling and inspection.

Storage of intermediate-activity wastes is in concrete buildings or vaults, either above or below the ground, to provide adequate radiation shielding. Each facility is water-tight and has drainage collection; heat and ventilation; fire, smoke, vapor, and radiation detection, and fire extinguishing systems as required. Intermediate-activity wastes are stored in steel containers that were handled and inspected remotely.

The objectives of the retrievable-storage technology for low-level radioactive waste are to (1) store waste temporarily in anticipation of the development of more advanced technologies for suitable disposal, and (2) store waste until the radionuclides had decayed to such a point that its disposal using available technology would not violate applicable standards.

This technology requires no pretreatment of wastes other than the immobilization of liquids. Other pretreatments might be desirable (e.g., compaction, shredding) to enhance space utilization efficiency.

The major disadvantage of retrievable storage for low-level waste is the need for future expenditures for retrieval, treatment, and/or disposal facilities.

E.2 WASTES REQUIRING DISPOSAL

The planning and design of new disposal facilities rely to a great extent on the ability to forecast the volume and the important characteristics of the wastes (i.e., physical state, chemical composition, etc.) to be disposed of. SRP operations generate five basic classes of waste [hazardous, low-level radioactive, mixed, high-level radioactive (including TRU waste), and nonhazardous/nonradioactive]. Some of these wastes can be treated before disposal and some cannot. Some wastes are stored and others are disposed of. Further, the storage or disposal technology that is chosen might require or prevent certain kinds of waste treatment that, in turn, can greatly affect both the volume and the characteristics of the waste. This EIS is concerned only with hazardous, mixed, and low-level radioactive waste; it does not consider high-level radioactive and nonhazardous/nonradioactive wastes which have been covered by earlier planning efforts and documentation.

Figure E-1 shows a conceptual model of the various waste streams related to the disposal technologies. This model assumes that all wastes are at, or in transit between, any of four types of facility: waste generators, waste treatment facilities, interim-storage facilities, or waste disposal facilities (including long-term storage). It also assumes that waste generators are the only facilities that produce waste; generally, such generators can be categorized as plant operations, closure actions at existing waste sites, and offsite governmental generators. Waste treatment facilities might change the volume and character of the waste, but they do not create appreciable volumes of new waste except that resulting from the operation of the facility. Interim-storage facilities are used to store wastes until new disposal and reclamation facilities are available. Disposal facilities are engineered repositories for the permanent placement of wastes. Thus, the total volume of waste to be disposed of and the design capacity of disposal facilities are functions of the time during which the facilities are actively used, the volume of waste generated during that time, and the predisposal and disposal technologies employed.

The estimate of waste volumes was based on an operational period of 20 years and the use of existing facilities, including interim storage, between the present and the startup of new facilities. For hazardous and mixed wastes, the assumed startup date of new facilities is 1992. For low-level radioactive wastes, an assumed startup date is 1989.

At present, site-specific actions can have a substantial effect on the volume of waste to be disposed of in the future:

- A list of existing waste sites that ultimately will require removal of waste and/or contaminated soil prior to closure

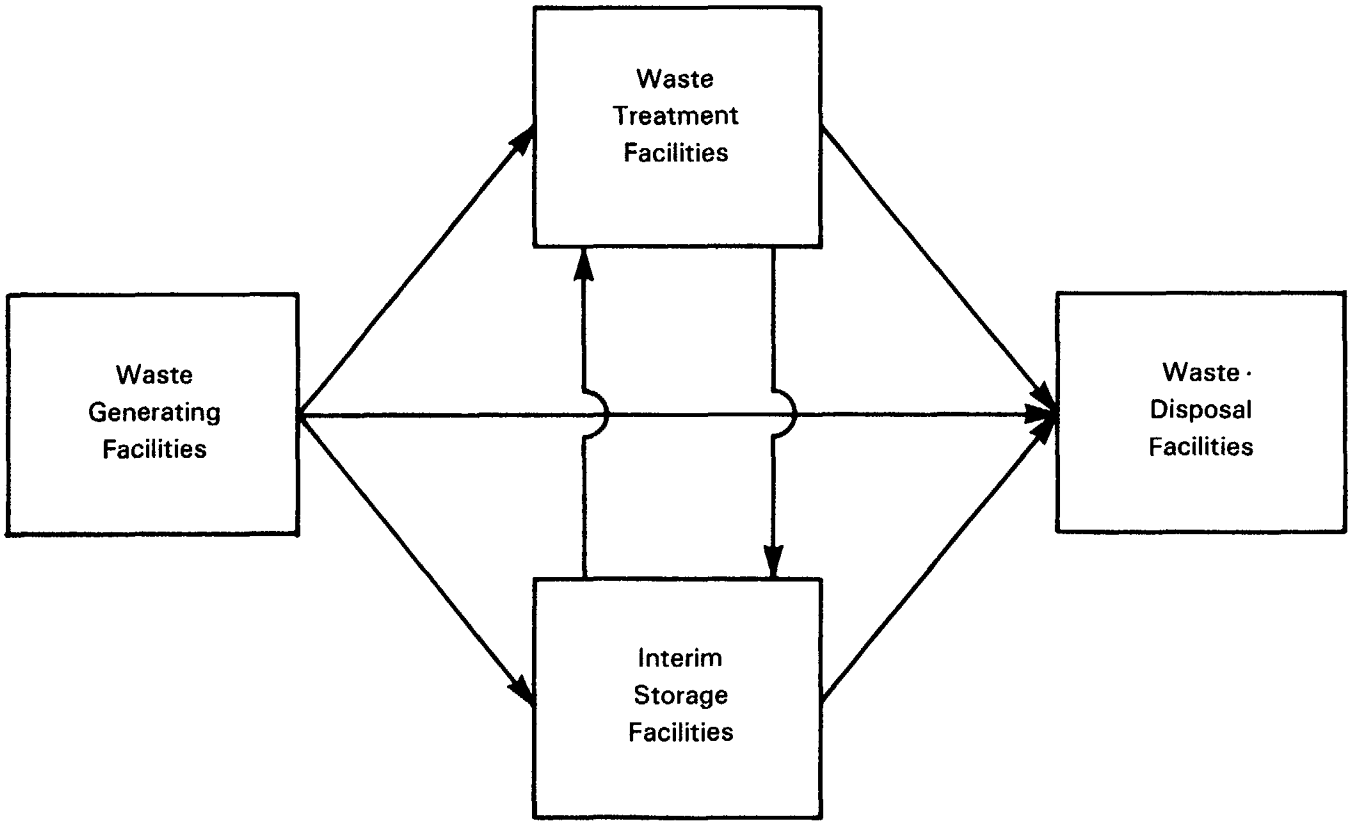


Figure E-1. Integrated Waste Disposal Model

- A determination, based on field testing and examination, of the quantity of waste or contaminated soil to be removed at existing waste sites

- The availability or integration of various predisposal treatment technologies into the management of SRP wastes (see Appendix D)

For the purposes of this EIS, waste volumes are described in terms of a range bounded by upper and lower limit volume figures that are based on current information and certain assumptions. The following assumptions define the upper limit:

- Removal will occur at all existing waste sites where it is an option.

- Due to the magnitude of waste and contaminated soil at the radioactive waste burial grounds and the mixed waste management facility, these volumes were excluded from the calculations.

- Suitable predisposal treatment technologies were assumed where they expand the untreated waste volume, except where a disposal technology requires a specific predisposal treatment (i.e., cement/flyash matrix vault disposal).

The following assumptions define the lower limit:

- No removal will occur at any existing waste sites.

- Suitable predisposal treatment technologies were assumed if they reduce the untreated waste volume, unless a disposal technology requires a specific predisposal treatment.

These sets of assumptions represent the extreme situations that probably would result in a volume range that bounds the probable 20-year volumes of hazardous, mixed, and low-level radioactive wastes.

Tables E-1 through E-3 summarize available information on SRP waste streams. The first three columns identify the sources or type of facility, the facility, and the waste. The fourth column defines the waste as solid, semisolid, or liquid. Column five lists the untreated volumes of waste estimated for the 20-year period. The sixth column presents the estimated 20-year volume of waste following predisposal treatment by incineration, compaction, or evaporation (i.e., volume reduction). The seventh column lists the estimated 20-year volume of waste following predisposal treatment by solidification or incineration and solidification. The waste volume ranges provided in Section E.3 were derived from Tables E-1 through E-3, based on the upper and lower limit assumptions previously defined.

Table E-1. Hazardous Waste Volumes (cubic meters)

Source	Facility	Waste	Physical state[a]	20-year untreated volume	Treated volume[b]	Solidified volume
Operations	Lab	Organics, Hg, oil	LD	380	9.5[c]	-
Operations	Maintenance	Lathe Coolant, oil	LD	80	2.0[c]	-
Operations	Raw materials	Li-Al dross	SD	300	22.5[d]	-
Operations	Raw materials	Oil with lead	LD	540	13.5[c]	-
Operations	Raw materials	TCE sludge	SS	120	9.0[d]	-
Operations	Monitoring	Inorganic acids	LD	20	0.5[c]	-
Operations	Construction	Paint solvent	LD	840	21.0[c]	-
Operations	Engineering	Solvents	LD	120	3.0[c]	-
Operations	Health protection	Toluene, xylene	LD	20	0.5[c]	-
Operations	Forest Service	Pesticides	LD	20	0.5[c]	-
Operations	Miscellaneous	Misc. HW	SD	120	9.0[d]	-
Storage	HWSF	CMP pit liquids	LD	33	2.5[d]	-
Storage	HWSF	Excess sodium dichromate	LD	1	0.1[d]	-
Storage	HWSF	Trichloroethane	LD	39	2.9[d]	-
Storage	HWSF	Methylene chloride	LD	1	0.1[d]	-
Storage	HWSF	Hg-contaminated mat'l.	SD	4	0.3[d]	-
Storage	HWSF	Machine coolant	LD	16	1.2[d]	-
Storage	HWSF	Misc. solvents	LD	1	0.1[d]	-
Storage	HWSF	Naphtha-methylene cl	LD	1	0.1[d]	-
Storage	HWSF	Nitrates	SD	10	0.8[d]	-
Storage	HWSF	Pesticides	LD	2	0.2[d]	-
Storage	HWSF	Paint solvents	LD	90	6.8[d]	-
Storage	HWSF	Teargas concentrate	LD	1	0.1[d]	-
Storage	HWSF	Toluene-isopropanol	LD	12	0.9[d]	-
Storage	HWSF	Varnish and thinners	LD	5	0.4[d]	-
Storage	HWSF	Waste oil with lead	LD	61	4.6[d]	-
Storage	HWSF	Waste paint	LD	5	0.4[d]	-
Storage	HWSF	Alkalies	SD	7	-	-
Storage	HWSF	Be-Cu alloy	SD	1	-	-
Storage	HWSF	Lead smelter waste	SD	10	-	-
Storage	HWSF	Lab chemicals	LD	2	-	-
Storage	HWSF	Reactive metals	SD	9	-	-
Storage	HWSF	DWPF pilot plant sludge	SS	5	-	-
Closure	716-A motor shop S.B.	Cont. soil and waste	SD	675	-	-
Closure	Metal burning pit	Cont. soil and waste	SD	21,600	-	-
Closure	Silverton Road waste site	Cont. soil and waste	SD	26,288	-	-
Closure	Met. lab. basin	Cont. soil and waste	SD	340	-	-
Closure	Misc. chem. basin	Cont. soil and waste	SD	72	-	-
Closure	Burning rubble pits (15)	Cont. soil and waste	SD	83,139	-	-
Closure	Acid/caustic basins (6)	Cont. soil and waste	SD	1,200	-	-
Closure	Hydrofluoric acid spill	Cont. soil and waste	SD	280	-	-
Closure	D-Area oil seepage basin	Cont. soil and waste	SD	5,742	-	-
Closure	CMP pits (7)	Cont. soil and waste	SD	5,500	-	-
Closure	SRL oil test site	Cont. soil and waste	SD	140	-	-
Closure	Gunsite 720 rubble pit	Cont. soil and waste	SD	35	-	-

[a]SD - Solid, LD - Liquid, SS - Semisolid (sludge)
[b]20-year volume following treatment by incineration
[c]Assumes incineration with volume reduction of 97.5 percent
[d]Assumes incineration with volume reduction of 92.5 percent

Table E-2. Mixed Waste Volumes (cubic meters)

Source	Facility	Waste	Physical state[a]	20-year untreated volume	Treated volume[b]	Solidified volume
Operations	Canyons	Purex solvent	LD	380	19[c]	-
Operations	Separations	Hg contaminated waste	SD	2,300	172.5[d]	-5
Operations	SRL, SREL	Scintillation fluid	LD	20	0.5[e]	-
Operations	FMF	WWTF sludge	SS	6,430	110[f]	12,860[g]
Operations	FMF	Organics	LD	100	-	-
Operations	FMF	Job control waste	SD	11,000	825[d]	-
Operations	SRL, H^3 facility	Lead shielding	SD	20	-	-
Operations	H^3 facility	Tritiated mercury	LD	20	-	-
Operations	H^3 facility	Job control waste	SD	15,000	1,125[d]	-
Operations	H^3 facility	Tritiated oil	LD	240	6[e]	-
Operations	DWPF	Job control waste	SD	9,000	675[d]	-
Operations	Raw materials	Job control waste	SD	35,000	2,625[d]	-
Operations	Reactor	Job control waste	SD	30,000	2,250[d]	-
Operations	Separations	Job control waste	SD	126,000	9,450[d]	-
Operations	Waste management	Job control waste	SD	56,000	4,200[d]	-
Operations	Labs	Job control waste	SD	24,000	1,800[d]	-
Operations	SRL	Job control waste	SD	20,000	1,500[d]	-
Operations	Services	Job control waste	SD	3,000	225[d]	-
Operations	Separations	Equip-Hg & wash H_2O	LD/SD	680	-	-
Operations	F- & H-Areas	ETF sludge	SS	39,743	4,970[f]	79,485[g]
Operations	M-Area	ETF sludge	SS	27,252	3,300[f]	54,504[g]
Operations	FPF	ETF sludge	SS	14,534	300[f]	29,069[g]
Storage	Storage tanks	Scintillation fluid	LD	3	0.2[d]	-
Storage	H^3 fac. stg. tanks	Tritiated oil	LD	68	5.1[d]	-
Storage		PCB contaminated oil	LD	6	0.5[d]	-
Storage	SRL, H^3 facility	Lead shielding	SD	1	-	-
Storage	H^3 facility	Tritiated mercury	LD	1	-	-
Storage	Separations	Hg-contaminated equip.	SD	28	-	-
Storage	M-Area stg. tanks	ETF sludge (first 9 mo.)	SS	1,000	120[f]	2,000[g]
Closure	SLR seepage basins (4)	Cont. soil and waste	SD	1,900	-	-
Closure	M-Area settling basin	Cont. soil and waste	SD	34,740	-	-
Closure	Lost Lake	Cont. soil and waste	SD	16,900	-	-
Closure	Rad & mixed waste B.G.	Cont. soil and waste	SD	1,476,925	-	-
Closure	F-Area seepage basins (3)	Cont. soil and waste	SD	8,000	-	-
Closure	Old F-Area S.B.	Cont. soil and waste	SD	5,230	-	-
Closure	H-Area seepage basins (4)	Cont. soil and waste	SD	20,870	-	-
Closure	Ford Bldg. seepage basin	Cont. soil and waste	SD	76	-	-
Closure	Old TNX basin	Cont. soil and waste	SD	594	-	-
Closure	New TNX basin	Cont. soil and waste	SD	359	-	-
Closure	Road A chem. basin	Cont. soil and waste	SD	1,000	-	-
Closure	L-Area oil & chem. basin	Cont. soil and waste	SD	675	-	-

[a]SD - Solid, LD - Liquid, SS - Semisolid (sludge)
[b]20-year volume following treatment by incineration or evaporation
[c]Assumes incineration with volume reduction of 95.0 percent
[d]Assumes incineration with volume reduction of 92.5 percent
[e]Assumes incineration with volume reduction of 97.5 percent
[f]Assumes pretreatment by evaporation to dry salt form
[g]Assumes solidification of untreated volume

Table E-3. Low-Level Radioactive Wastes (cubic meters)

Source	Facility	Waste	Physical state[a]	20-year untreated volume	Treated volume[b]	Solidified volume
Operations	FMF	LLW solvents	LD	160	-	320
Operations	FMF	Job control waste	SD	9,300[c]	-	
Operations	FMF	Job control waste	SD	1,000	-	2,000
Operations	FMF	Job control waste	SD	4,000	1,000[d]	-
Operations	DWPF	Job control waste	SD	10,800[c]	-	-
Operations	DWPF	Job control waste	SD	1,000	250[d]	-
Operations	DWPF	Job control waste	SD	1,000	-	2,000
Operations	H^3 facility	Job cont., targets, etc.	SD	14,700[c]	-	-
Operations	H^3 facility	Job cont., targets, etc.	SD	3,000	-	6,000
Operations	H^3 facility	Job cont., targets, etc.	SD	1,800	450[d]	-
Operations	Raw material	Job cont., equip., deb.	SD	23,300[c]	-	-
Operations	Raw material	Job cont., equip., deb.	SD	4,000	-	8,000
Operations	Raw material	Job cont., equip., deb.	SD	17,000	4,250[d]	-
Operations	Reactors	Job cont., equip., deb.	SD	28,300[c]	-	-
Operations	Reactors	Job cont., hdwr, compon.	SD	3,200	800[d]	-
Operations	Reactors	Job cont., hdwr, compon.	SD	4,000	-	8,000
Operations	Separations	Job cont., equip, deb.	SD	117,600[c]	-	-
Operations	Separations	Job cont., equip, deb.	SD	20,000	5,000[d]	-
Operations	Separations	Job cont., equip, deb.	SD	15,000	-	30,000
Operations	Waste management	Job cont., equip, deb.	SD	50,400[c]	-	-
Operations	Waste management	Job cont., equip, deb.	SD	10,000	2,500[d]	-
Operations	Waste management	Job cont., equip, deb.	SD	7,000	-	14,000
Operations	Labs	Job cont., equipment	SD	25,500[c]	-	-
Operations	Labs	Job cont., equipment	SD	3,000	750[d]	-
Operations	Labs	Job cont., equipment	SD	1,000	-	2,000
Operations	SRL	Job control waste	SD	21,000[c]	-	-
Operations	SRL	Job control waste	SD	2,000	500[d]	-
Operations	SRL	Job control waste	SD	1,000	-	2,000
Operations	Services	Job control waste	SD	2,800[c]	-	-
Operations	Services	Job control waste	SD	400	100[d]	-
Operations	H^3 facility	Tritiated oil	LD	260	-	520
Storage	Storage tanks	Purex solvent	LD	215	16[e]	32
Closure	H-Area ret. basin	Cont. soil and waste	SD	6,080	-	12,160
Closure	F-Area ret. basin	Cont. soil and waste	SD	9,154	-	18,308
Closure	Rad. waste burial ground	Cont. soil and waste	SD	1,523,075	-	3,046,150
Closure	R-Area BPOPs (3)	Cont. soil and waste	SD	7,000	-	14,000
Closure	R-Area seepage basins (6)	Cont. soil and waste	SD	7,080	-	14,160
Closure	Ford Building waste site	Cont. soil and waste	SD	345	-	690
Closure	TNX burying ground	Cont. soil and waste	SD	896	-	1,792
Closure	K-Area BPOP	Cont. soil and waste	SD	7,700	-	15,400
Closure	K-Area seepage basin	Cont. soil and waste	SD	260	-	520
Closure	L-Area BPOPs (2)	Cont. soil and waste	SD	8,300	-	16,600
Closure	P-Area BPOP	Cont. soil and waste	SD	3,800	-	7,600

[a] SD - Solid, LD - Liquid, SS - Semisolid (sludge)
[b] 20-year volume following treatment by incineration or compaction
[c] Assumes material not suitable for pretreatment
[d] Assumes compaction with volume reduction of 75.0 percent
[e] Assumes incineration with volume reduction of 92.5 percent

E.3 SITING OF FACILITIES

The selection of likely candidate sites for the evaluation of waste management strategies was restricted to the 780-square-kilometer area of the SRP. The identification of candidate sites considered the following criteria:

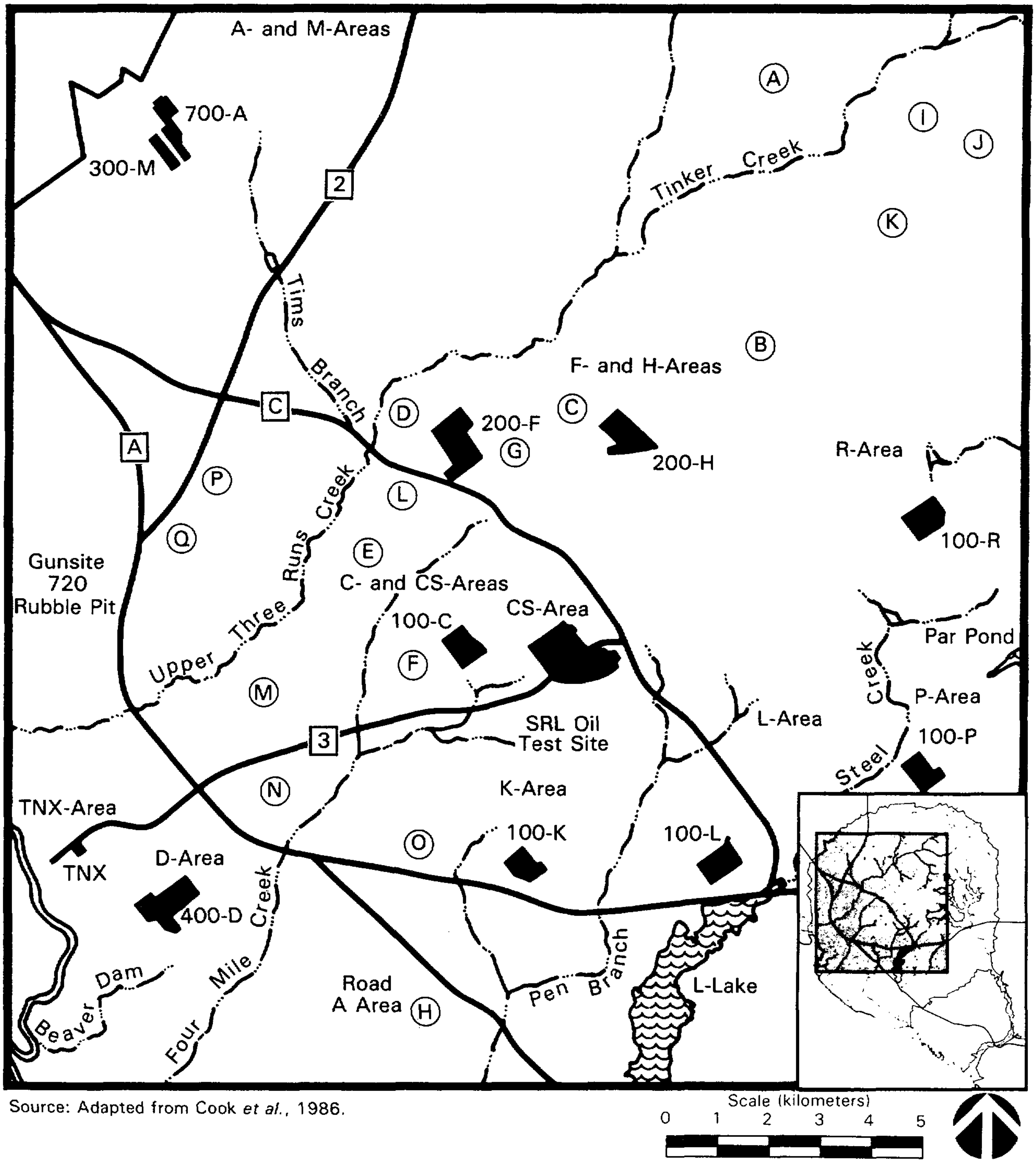
- Distance from SRP boundaries
- Relatively flat topography to minimize the potential for soil erosion
- Maximum reasonable horizontal and vertical distance to surface streams to reduce the potential for flooding (for low-level waste facility sites, this criterion was considered to increase the flow path distance and time of travel for groundwater between the waste site and the point at which surface discharge would occur)
- Maximum distance between the deposited waste and the water table to minimize the leaching of contaminants (for low-level waste facility sites, this criterion was considered to increase the vertical path of radionuclides, which also increases the time of travel between the waste site and the groundwater discharge point)
- Minimum acceptable depth of the water table (about 15 to 18 meters) to allow for construction of an inground facility with sufficient vertical buffer above the zone of groundwater fluctuation
- Sufficient acreage

Two additional criteria were applied only to low-level waste sites:

- Low hydraulic conductivity of the soils and low hydraulic gradients to maximize radionuclide travel time between the waste site and the groundwater discharge point
- Proximity to waste generators, transportation, and utility lines

Figure E-2 shows the locations of 17 sites, designated A to Q, that were identified initially from topographical maps, monitoring wells, and water-table maps. These candidate sites were screened and ranked by means of a weighted rating system. Factors applied to the evaluation of sites for hazardous and mixed waste facilities included the depth of the water table, available land area, and surface topography. The factors applied to the evaluation of sites for low-level radioactive waste disposal facilities were the same as those for hazardous and mixed waste sites, plus the distance to the SRP boundary (non-Federally controlled land) or public access areas, the distance to waste generators, and the distance to the nearest stream. (The rationale, weighting factors, and rating criteria used in the evaluation are presented in Cook and Grant, 1987; and Cook, Grant, and Towler, 1987a, 1987b).

Sites P, Q, L, and B are the most highly rated locations for hazardous or mixed waste facilities. Sites B, G, and K are the most highly rated locations for low-level radioactive waste facilities.



Source: Adapted from Cook *et al.*, 1986.

Figure E-2. Candidate Sites for New Storage/Disposal Facilities

Site B, a likely location for hazardous and mixed waste facilities, occupies an area of approximately 300 acres. It is approximately 3350 meters northeast of H-Area and 3660 meters northwest of R-Area. Site B is rectangular, with ground surface elevations ranging from about 91 to about 101 meters above mean sea level (MSL). The site is relatively flat, situated on a divide between Mill Creek to the northeast and southeast and Tinker Creek (and a tributary) to the northwest and southwest. The main channel of Tinker Creek is about 1680 meters from the site, while ephemeral tributaries to Tinker Creek are about 305 meters from the site. Judging from data on three soil borings, the depth to groundwater in this area ranged from 20 to 22 meters, and the soils consist of fine to medium sands with varying amounts of clay (Cook, Grant, and Towler, 1987a).

SRP is considering the disposal of solidified mixed waste sludges (cement/ flyash matrix) in a separate facility (Cook and Grant, 1987). Site L is a likely location for this facility because it is centrally located just south of F-Area, and it ranks high in all other criteria. This site occupies approximately 100 acres. The surface slopes are gentle throughout most of the site but increase greatly at the northwest corner and just to the west of the site. Surface elevations range from about 61 to 91 meters above MSL. Upper Three Runs Creek is approximately 400 meters west and downslope of Site L. Ephemeral tributaries to Upper Three Runs Creek flank the northern and southern boundaries of the site. Water-table elevations in the area slope toward Upper Three Runs Creek; they occur about 60 feet below grade. A well cluster near the edge of the site indicates a head reversal of about 6 meters between the upper Cretaceous Sediment aquifer and the Congaree Formation in this area.

Site G, which is the highest rated site for low-level radioactive waste facilities, covers about 200 acres immediately north of the present low-level radioactive waste burial ground, between the 200-F and 200-H Areas. The site slopes gently to the north in the direction of Upper Three Runs Creek, which is about 457 meters from the site boundary. Elevations range from 76 to 91 meters above MSL. No standing surface water has been observed in the area. The water table, as measured from more than 30 water wells in and around the site, ranges from 12 to 18 meters below the ground surface. The dominant vegetation on the site is pine trees.

In this analysis, Sites B, L, and G (see Figure E-3) provide a basis for examining the environmental impacts. DOE expects to perform future investigations during the permitting process, including detailed site feasibility studies, to select sites formally and to ensure that the chosen sites conform to all applicable regulatory, technical, and environmental requirements.

The criteria and site evaluations described above would apply primarily to belowground disposal sites. Storage and aboveground disposal sites are not subject to such stringent criteria. However, for purposes of comparison, the more stringent criteria were applied to all facilities.

E.4 WASTE DISPOSAL/STORAGE ALTERNATIVES

The waste management strategies - No-Action, Dedication, Elimination, and Combination - could be implemented in a number of ways using a number of technologies. To provide a basis for determining the magnitude of environmental

impacts, analyses herein identify the implementation technologies and explain their use. If DOE intends the concurrent use of more than one technology, the description uses the word "and" (e.g., storage buildings and RCRA landfill). If there is to be a future choice between two or more technologies, the description uses the word "or" (e.g., RCRA landfill or vaults). Table E-4 lists the technologies being considered for inclusion in each of the four waste management strategies. The following subsections provide additional detail for evaluation of waste management strategies.

E.4.1 NO-ACTION STRATEGY

The No-Action strategy provides an assessment of the consequences of not implementing a waste management strategy that would require that no new facilities be constructed to accommodate future needs. Facilities include sites, buildings, landfills, vaults, engineered trenches, boreholes, and appurtenances. For the purposes of comparative analysis, DOE assumed that SRP would continue to operate and generate wastes and that the applicable regulations and criteria would continue to remain in force.

E.4.1.1 Hazardous or Mixed Waste

The No-Action strategy for hazardous or mixed waste would continue current operating practices, using existing interim storage facilities until reaching full capacity in 1992. After 1992, the No-Action strategy assumes that hazardous or mixed waste would be stored in existing structures, on existing concrete pads, or, if these were not available, on prepared areas at existing waste sites. As much as possible, mixed waste with radioactivity greater than 300 millirem per hour would be stored in unused existing shielded structures, such as the R-Reactor building. No new (undeveloped) sites would be used to store wastes under this strategy.

Before storage, wastes would be placed in steel containers (i.e., 208-liter drums, 2.5-cubic-meter boxes). Noncompatible wastes would be segregated administratively by storing them at different locations. All stored material, except intermediate-activity wastes, would be accessible for inspection. Inspections would be conducted on a regular basis. Damaged or deteriorated containers would be replaced and any spillage or leakage would be attended to expeditiously.

The No-Action strategy assumes that hazardous and mixed wastes would receive no pretreatment prior to storage (e.g., no new facilities). Table E-5 lists the 20-year volume range for hazardous and mixed waste, as calculated from Tables E-1 and E-2.

Cost estimates associated with the management of hazardous and mixed wastes under this strategy were prepared for this EIS. The cost ranges listed in Table E-6 indicate the relative magnitude of costs associated with this category.

The primary advantages of the No-Action strategy for hazardous or mixed waste would be the delay of expenditures associated with the construction of disposal/storage facilities and, perhaps, the use of existing available structures, which otherwise would have remained unused, for storage.

Table E-4. New Disposal/Storage Facility Implementation Technologies

Waste management strategy	Disposal/storage project alternative	Disposal/storage technologies		
		Hazardous waste	Mixed waste	Low-level waste
No Action	No new facilities	Storage at existing facilities and at other available structures, pads, and areas	Storage at existing facilities and at other available structures, pads, and areas	Disposal at existing facilities and storage at other available structures, pads, and areas
Dedication	Disposal facilities	RCRA landfill or vaults[a]	RCRA landfill or shielded vaults[a], with or without CFM[b] vaults	ELLT[c], vaults[a], or AGO[d], for low-activity waste; and vaults or GCD[e] for intermediate activity waste
Elimination	Retrievable storage facilities	Storage buildings	Shielded storage buildings	Engineered storage buildings
Combination	Disposal/storage combination	Storage buildings and RCRA landfill or vaults[a]	Shielded storage buildings and RCRA landfill or shielded vaults[a], with or without CFM[b] vaults	Engineered storage buildings; and ELLT[c], vaults[a], or AGO[d], for low-activity waste; and vaults[a] or GCD[e] for intermediate-activity waste

[a]Vaults may be above or below the ground.
[b]Cement/flyash matrix.
[c]Engineered low-level trench disposal.
[d]Abovegrade operation disposal.
[e]Greater confinement disposal.

Table E-5. Estimated Range of Hazardous and Mixed Waste 20-Year Storage Volumes Under the No-Action Strategy (cubic meters)

Waste type	Lower limit[a]	Upper limit[b]
Hazardous waste	2,800	147,900
Mixed waste	421,800	512,200

[a]No removal at existing waste sites and no predisposal treatment.
[b]Removal at all existing waste sites and no predisposal treatment.

Table E-6. Estimated Cost Range for Hazardous and Mixed Waste Management Under the No-Action Strategy[a]

Item	Hazardous waste		Mixed waste	
	Lower limit	Upper limit	Lower limit	Upper limit
Site preparation	150	7,901	14,354	17,430
Operations and maintenance	1,745	92,171	99,418	120,726
Total (20 years)[b]	1,895	100,072	113,772	138,156

[a]Cost in thousands of 1986 dollars for 20-year planning period.
[b]Does not include costs of waste retrieval, any subsequent treatment, or disposal.

The No-Action strategy has many disadvantages. As described above, hazardous or mixed wastes would be placed in sealed containers, segregated, and stored in a manner that would facilitate periodic inspection. Further, inspections would be performed on a regular basis; damaged or deteriorated containers would be replaced; and any spillage or leakage would be corrected expeditiously. Under this strategy, the release of hazardous or radioactive waste and the associated health and environmental effects would be insignificant as long as no substantial leakage or spills occurred due to any cause (e.g., fire, explosion, container deterioration, containers breached by an impact). Because this type of storage is not designed and constructed specifically to include the backup systems and safety equipment required in a RCRA facility (i.e., double liners, leachate collection, special fire protection, automatic vapor detection, leakage recovery), the risk of a serious accidental release of hazardous or mixed waste and the associated effects would be much greater than with any of the "action" strategies. The magnitude of a potential performance failure of the No-Action strategy could range from zero (no releases from any cause) to release and dispersion of all waste stored in this manner. Because there are no backup systems and built-in safety equipment, the risk of a mixed waste release, including a catastrophic release, would be higher than

with any other strategies. Although this higher risk cannot be quantified, it is unacceptable under RCRA.

In addition, the No-Action strategy would result in noncompliance with RCRA, HSWA, the Safe Drinking Water Act, DOE Orders, and the Clean Water Act; would involve the use of unpermitted facilities; and could result in noncompliance with other permits or applicable laws. Finally, because no action only delays future expenditures for waste management, the life-cycle cost of the No-Action strategy could exceed that of the other strategies, particularly in the event of an accidental release of wastes.

E.4.1.2 Low-Level Radioactive Waste

The No-Action strategy for low-level radioactive waste also consists of a continuation of current operating practices using shallow-land and greater confinement disposal at the existing burial facility until its capacity is reached in 1989. After 1989, this strategy assumes that low-level waste would be stored in existing structures, on existing concrete pads, or, if these are not available, on prepared areas at the current burial facility. As much as possible, low-level waste with radioactivity greater than 300 millirem per hour would be stored in unused existing shielded structures, such as the R-Reactor building. No new (undeveloped) sites would be used for the storage of wastes.

This EIS assumes that low-level waste would be stored in sealed steel containers. The intermediate-activity wastes would be segregated and handled with shielded equipment. All stored material, except the intermediate-activity waste, would be accessible for inspection, which would be conducted on a regular basis. Damaged or deteriorated containers would be replaced, and any spillage or leakage would be collected or recovered expeditiously.

Because the No-Action strategy requires "no new facilities," low-level waste would be stored without pretreatment. The 20-year volume, therefore, would range between 403,700 and 454,400 cubic meters, depending on the volume of contaminated soil and waste derived from the removal and closure of existing waste sites.

Estimated costs for the management of low-level waste under the No-Action strategy were prepared for this EIS. These costs, listed in Table E-7, relate to the ranges of waste volumes estimated above and indicate the relative magnitude of costs associated with the implementation of this strategy.

The advantages and disadvantages of the No-Action strategy for low-level waste management are the same as those discussed for hazardous and mixed waste.

E.4.2 DEDICATION STRATEGY

The Dedication strategy involves the construction of hazardous, mixed, and low-level radioactive waste disposal facilities.

E.4.2.1 Hazardous or Mixed Waste

The technologies for implementing the Dedication strategy for hazardous waste are belowground or aboveground vaults or RCRA landfills. For mixed waste, the

Table E-7. Estimated Cost Range for Low-Level Waste Management Under No-Action Strategy[a]

Item	Lower limit	Upper limit
Site preparation	7,263	8,175
Operations and maintenance	37,794	42,536
Total (20 years)[b]	45,057	50,711

[a]Cost in thousands of 1986 dollars for 20-year planning period.
[b]Does not include costs of waste retrieval, any subsequent treatment, or disposal.

disposal technologies are belowground vaults, aboveground vaults, RCRA landfills, belowground vaults with CFM vaults, aboveground vaults with CFM vaults, or RCRA landfills with CFM vaults.

Hazardous or mixed waste disposal using above- or belowground vaults or RCRA landfills (i.e., CFM vaults not used for any portion of mixed waste) would not require the use of any specific predisposal treatment other than liquid immobilization (e.g., by sorbents); however, treatment for volume reduction and detoxification probably would be cost-effective and desirable. The three mixed waste alternatives, which include cement/flyash matrix disposal for a portion of the waste, require that this portion be solidified to a concrete-like material, which could render the waste nonhazardous under RCRA. The remainder of the mixed waste under these alternatives would be disposed of in above- or belowground vaults or RCRA landfills.

Under the Dedication strategy, the site-specific actions regarding predisposal treatment (i.e., volume reduction, detoxification, solidification) and removal/closure of existing waste sites lead to a wide range of possible hazardous and mixed waste disposal volumes. Table E-8 lists the estimated volume ranges, as calculated from the values in Tables E-1 and E-2.

Estimated costs associated with the management of hazardous and mixed wastes under the Dedication strategy were prepared for this EIS; these costs attempt to bracket site-specific actions regarding technologies, design details, and predisposal treatment effects. Table E-9 indicates the relative magnitude of the costs associated with the implementation of the Dedication strategy for hazardous and mixed waste. These costs are not complete (e.g., those for most predisposal treatment considerations have not been included), and no cost-effectiveness analysis has been performed.

The major advantages of the Dedication strategy for the future management of SRP wastes are the following:

- During the 20-year operation period, wastes would be disposed of permanently.

Table E-8. Estimated Range of Hazardous and Mixed Waste 20-Year Disposal Volumes Under the Dedication Strategy (cubic meters)

Waste type	Lower limit	Upper limit
Hazardous waste	150[a]	147,900[b]
Mixed waste	34,500[a]	512,200[b]
Mixed waste with CFM	203,600[c]	601,200[d]

[a]No removal at existing waste sites and maximum volume reduction.
[b]Removal at all existing waste sites and no volume reduction.
[c]CFM volume of 177,900 m^3 and note (a) for remaining waste.
[d]CFM volume of 177,900 m^3 and note (b) for remaining waste.

- The disposal of waste would comply with all applicable Federal and state regulations.
- Facilities would be capable of achieving compliance with environmental standards (e.g., groundwater, surface water).

The Dedication strategy has the following disadvantages:

- Facilities would be costly to construct and operate.
- Land would be dedicated to use as a waste repository in perpetuity.
- In the event of a failure that released waste constituents, retrieval of the waste packages could be difficult where certain practices were employed (e.g., grouting in place).

E.4.2.2 Low-Level Radioactive Waste

The technologies for implementing the Dedication strategy are ELLTs, AGOs, or vaults (above or below the ground) for the disposal of low-activity waste (i.e., less than 300 millirem per hour); and vaults (above or below the ground) or GCD trenches/boreholes for the disposal of intermediate-activity waste (i.e., greater than 300 millirem per hour).

Low-level waste disposal using any of the optional technologies would not require predisposal treatment other than liquid immobilization (e.g., by sorbents or solidification); however, treatments that provide volume reduction could be cost-effective and desirable.

Under the Dedication strategy, project-specific actions regarding predisposal treatment and removal/closure activities at existing waste sites can lead to a wide range of possible low-level disposal volumes. Based on the values in Table E-3, this range extends from a low of 356,700 cubic meters to an upper limit of 542,400 cubic meters. The low end of this range assumes no waste from removal/closure actions and maximum volume reduction through predisposal

Table E-9. Estimated Cost Range for Hazardous and Mixed Waste Management Under Dedication Strategy[a]

Item	Hazardous waste		Mixed waste		Mixed waste with CFM[b]	
	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
Construction	31	58,302	5,478	185,135	98,097	264,610
Operations and maintenance	90	101,004	8,552	102,752	121,543	200,065
Closure	60	90,799	5,614	113,642	61,770	149,131
20-year total	181	250,105	19,644	401,529	281,410	613,806
Postclosure	20	19,993	11,224	208,609	37,750	201,745
Total life cycle cost	201	270,098	30,868	610,138	319,160	815,551

[a]Cost in thousands of 1986 dollars.
[b]Includes estimated costs for predisposal treatment by solidification.

treatment; the upper limit assumes the maximum volume of removal/closure action wastes, no volume reduction, and solidification where applicable.

Estimated costs associated with the management of low-level wastes under the Dedication strategy were prepared for this EIS; they bracket project-specific actions regarding specific technologies, design details, and predisposal treatment effects. The cost ranges listed in Table E-10 indicate the relative magnitude of costs associated with implementing this strategy for low-level waste. However, these costs are not complete (e.g., they do not contain costs for predisposal treatment considerations); also, cost effectiveness has not been analyzed. Thus, the ranges should not be used for a direct comparative analysis or as a basis for decisionmaking.

E.4.3 ELIMINATION STRATEGY

The Elimination strategy for new waste management facilities involves the construction of hazardous, mixed, and low-level radioactive waste storage facilities. The technology for implementing this strategy uses retrievable-storage buildings, which are described in Section E.1.1.6 for hazardous and mixed wastes, and in Section E.1.2.6 for low-level radioactive waste.

Because a major objective of retrievable storage is a delay of permanent deposition of wastes in anticipation of advanced methods of treatment, recycling, or disposal, the predisposal treatment of waste could close out future waste management options. Thus, the only applicable predisposal techniques considered are liquid immobilization by sorption techniques and compaction of bulky wastes to reduce volume.

On this basis, Table E-11 lists the estimated retrievable-storage volume ranges of hazardous, mixed, and low-level waste as calculated from Tables E-1 through E-3.

The estimated costs of implementing the Elimination strategy were prepared for this EIS; they bracket project-specific actions associated with specific regulatory requirements and design details. Therefore, the costs listed in Table E-12 indicate the relative magnitude of cost associated with the strategy; they should not be used for direct comparative analysis or as a basis for decisionmaking. Unlike disposal alternatives, the Elimination strategy contains no closure or postclosure costs because the intent is to retrieve the waste at some future time.

The major advantages of the Elimination strategy with regard to future waste management facilities are the following:

- No land would be currently dedicated in perpetuity as a hazardous, mixed, or low-level waste repository.
- In the event of a failure in which wastes are spilled or leaked from their containers, facilities, equipment, and procedures would provide a rapid and efficient retrieval of the waste, such that no leakage outside the facility would occur.

Table E-10. Estimated Cost Range for Low-Level Radioactive Waste Management Under Dedication Strategy[a]

Item	Low-activity fraction		Intermediate-activity fraction		All low-level waste	
	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
Construction	18,292	130,522	23,937	29,606	42,229	196,050
Operations and maintenance	28,651	40,436	4,030	4,984	32,681	108,811
Closure	18,322	42,559	30,301	37,477	48,623	120,342
20-year total	65,265	213,517	58,268	72,067	123,533	425,203
Postclosure	96,336	98,022	23,857	29,507	120,193	220,909
Total life cycle cost	161,601	311,539	82,125	101,574	243,726	646,112

[a]Cost in thousands of 1986 dollars.

Table E-11. Estimated Range of Hazardous, Mixed and Low-Level Waste 20-Year Storage Volumes Under the Elimination Strategy (cubic meters)

Waste type	Lower limit	Upper limit
Hazardous	2,800[a]	147,900[b]
Mixed	421,800[a]	512,200[b]
Low-level radioactive	356,900[c]	454,400[d]

[a]No removal at existing waste sites and no predisposal treatment.
[b]Removal at all existing waste sites and no predisposal treatment.
[c]No removal at existing waste sites and compaction for volume reduction where applicable.
[d]Removal at all existing waste sites and no predisposal treatment.

- Storage of the wastes would comply with applicable Federal and state regulations, presuming necessary waivers to permit the long-term storage of hazardous and mixed wastes were granted by the regulatory agencies.

- Facilities would be capable of achieving compliance with all environmental standards (e.g., groundwater, surface water).

The Elimination strategy has the following disadvantages:

- Facilities would be costly to construct and operate.

- Additional future costs for retrieval of the waste and construction and operation of treatment or disposal facilities would be inevitable.

E.4.4 COMBINATION STRATEGY

The Dedication or Elimination strategy could provide adequate management of all SRP hazardous, mixed, and low-level wastes. However, the management of specific wastes could be more economical, technologically feasible, or environmentally reliable under a single strategy. Thus, the objective of the Combination strategy is to identify and implement the best mix of disposal (Dedication) and storage (Elimination) technologies based on specific hazardous, mixed, and low-level waste volumes and characteristics.

E.4.4.1 Hazardous or Mixed Waste

The Combination strategy for hazardous waste includes retrievable-storage buildings, and belowground or aboveground vaults or RCRA landfills for disposal. The Combination strategy for mixed waste consists of retrievable-storage buildings and belowground or aboveground vaults or RCRA landfills, belowground with CFM vaults, aboveground vaults with CFM vaults, or RCRA landfills with CFM vaults.

Table E-12. Estimated Cost Range for Hazardous, Mixed, and Low-Level Waste Management Under Elimination Strategy[a]

Item	Hazardous waste		Mixed waste		Low-level waste	
	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
Construction	3,777	199,482	517,135	627,967	570,951	726,926
Operations and maintenance	1,161	61,347	75,266	91,397	34,116	43,436
20-year total	4,938	260,829	592,401	719,364	605,067	770,362

[a]Cost in thousands of 1986 dollars.

Under this strategy, project-specific actions regarding predisposal treatment (i.e., volume reduction, detoxification, solidification) and removal/closure of existing waste sites lead to a wide range of possible hazardous and mixed waste disposal volumes. Table E-13 lists the estimated 20-year volume ranges, calculated from the values in Tables E-1 and E-2.

Table E-13. Estimated Range of Hazardous and Mixed Waste 20-Year Disposal/Storage Volumes Under the Combination Strategy (cubic meters)

Waste type	Lower limit	Upper limit
Hazardous waste	150[a]	147,900[b]
Mixed waste	34,500[a]	512,200[b]
Mixed waste with CFM	203,600[c]	601,200[d]

[a]No removal at existing waste sites, maximum volume reduction.
[b]Removal at all existing waste sites and no volume reduction.
[c]CFM volume at 177,900 cubic meters; no removal at existing waste sites maximum volume reduction for remaining waste.
[d]CFM volume of 177,900 cubic meters; removal at all existing waste sites and no volume reduction for remaining waste.

The estimated cost ranges in Table E-14 were prepared for this EIS; they bracket site-specific actions regarding the mix of specific technologies, design details, and volume capacity. These ranges indicate the relative magnitude of potential costs associated with the implementation of the Combination strategy for hazardous and mixed waste; they should not be used for direct comparative analysis or as a basis for decisionmaking.

In addition to the advantages and disadvantages of Dedication and Elimination described in Sections E.4.2.1 and E.4.3, the Combination strategy would allow the selection of a mix of technologies that would optimize performance and minimize cost.

E.4.4.2 Low-Level Radioactive Waste

The technologies for implementing the Combination strategy for low-level waste are engineered storage buildings, and ELLTs or vaults or AGOs for the disposal of low-activity waste (i.e., less than 300 millirem per hour); and vaults or GCD for the disposal of intermediate-activity waste (i.e., greater than 300 millirem per hour).

Site-specific actions regarding predisposal treatment (i.e., volume reduction, solidification, encapsulation) and removal/closure of existing waste sites lead to a wide range of possible low-level waste disposal volumes. Based on the values listed in Table E-3, this range extends from a lower limit of 356,700 cubic meters to an upper limit of 542,400 cubic meters. The lower limit assumes no waste removal from existing waste sites and maximum volume reduction through predisposal treatment. The upper limit assumes the maximum

Table E-14. Estimated Cost Range for Hazardous and Mixed Waste Management Under the Combination Strategy[a]

Item	Hazardous waste		Mixed waste		Mixed waste with CFM[b]	
	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
Construction	31	199,482	5,478	627,967	98,097	630,505
Operations and maintenance	90	101,004	8,552	102,752	119,756	200,065
Closure	0	90,799	0	113,642	61,770	149,131
20-year total	181	260,829	19,644	719,364	281,410	876,421
Postclosure	0	19,993	0	208,609	37,750	201,745
Total life cycle cost[c]	201	270,098	30,868	610,138	319,160	815,551

[a]Cost in thousands of 1986 dollars; columns not additive; table is read by rows, which reflect the potential range of cost associated with each item given the uncertainties associated with technological mix, predisposal treatment, and removal at existing waste sites.
[b]Includes estimated costs for predisposal treatment by cement/flyash solidification.
[c]Does not include costs for retrieval, treatment, storage, or disposal of stored waste after 20 years.

volume of removal/closure action wastes, no volume reduction, and solidification where applicable.

Table E-15 lists cost ranges associated with low-level waste management under the Combination strategy. These ranges were estimated for this EIS; they bracket the site-specific actions regarding the technological mix, design details, and volume capacity. They indicate the relative magnitude of potential costs associated with the implementation of this strategy for low-level waste; they should not be used for direct comparative analysis or as a basis for decisionmaking in this EIS.

Table E-15. Estimated Cost Range for Low-Level Radioactive Waste Management Under the Combination Strategy[a]

Item	Lower limit	Upper limit
Construction	42,229	726,926
Operations and maintenance	32,681	108,811
Closure	0	120,342
20-year total	123,533	770,362
Postclosure	0	220,909
Total life cycle cost[b]	243,726	646,112

[a]Cost in thousands of 1986 dollars; columns not additive; table is read across rows, which reflect the potential range of costs associated with each item, given the uncertainties associated with technological mix, predisposal treatment, and removal of existing waste sites.
[b]Does not include costs for retrieval, treatment, storage, or disposal of stored waste after 20 years.

The advantages and disadvantages of the Combination strategy are discussed in Section E.4.4.1.

E.5 SUMMARY

Tables E-16 through E-19 summarize the four strategies for the modification of SRP waste management practices with regard to new disposal/storage facilities.

Table E-16. No-Action Strategy

Item	Description			
Objective	Waste management with no new facilities			
Technologies	Indefinite storage of hazardous and mixed waste at existing facilities, then at other available structures, pads, or areas			
	Disposal of low-level waste at existing burial grounds, then indefinite storage at other available structures, pads, or areas			
Limitations	No new facilities, including pretreatment			
Volume range (m^3)	Hazardous	2,800	to	147,900
	Mixed	421,800	to	512,200
	Low-level	403,700	to	454,400
	Total	828,300	to	1,114,500
Volume uncertainties	Removal volume from existing waste sites			
Cost range ($1000)[a]	Hazardous	1,895	to	100,072
	Mixed	113,772	to	138,156
	Low-level	45,057	to	50,711
		160,724	to	288,939
Cost uncertainties	Total storage capacity required			
	No specific existing facilities identified			
Advantages	Would delay expenditures for waste management facilities			
	Would make use of structures that otherwise would remain unused			
Disadvantages	Unqualified higher risk of environmental releases of waste and the associated occupational, public health, and environmental impacts			
	Noncompliance with RCRA, DOE Orders, and other regulations eliciting enforcement actions			
	Probable judicial intervention			
	Inevitable future expenditures for waste treatment/disposal			

[a]Costs through the 20-year period. (Note: Site-specific actions prevent costs from being used for direct comparative analysis).

Table E-17. Dedication Strategy

Item	Description
Objective	Waste management by disposal
Technologies	Hazardous - Belowground vaults, aboveground vaults, or RCRA landfills Mixed - Belowground vaults, aboveground vaults, or RCRA landfills with or without CFM vaults Low-level - ELLTs, AGOs, or vaults for low-activity waste; vaults or GCD for intermediate-activity waste
Limitations	Mixed waste options using CFM vaults require pre-disposal treatment by cement/flyash solidification
Volume range (m^3)	Hazardous 150 to 147,900 Mixed 34,500 to 512,200 Mixed w/CFM 203,600 to 601,200 Low-level 356,700 to 542,400 Total 391,350 to 1,291,500
Volume uncertainties	Removal volume from existing waste sites Volume reduction by predisposal treatment Volume expansion by solidification
Cost range ($1000)[a]	Hazardous 181 to 250,105 Mixed 19,644 to 401,529 Mixed w/CFM 281,410 to 613,806 Low-level 123,533 to 425,203 Total 143,358 to 1,289,114
Cost uncertainties	Total disposal capacity required Optional disposal technologies Pretreatment technologies and capacities Pretreatment costs not included except with CFM portion Postclosure requirements

Table E-17. Dedication Strategy (continued)

Item	Description
Advantages	Final placement of waste
	Compliance with applicable regulations
	Compliance with environmental standards
Disadvantages	Facilities costly to construct and operate
	Land dedicated in perpetuity
	Waste retrieval difficult in a failure

[a]Costs for 20-year period through closure; does not include postclosure maintenance for 100 years. (Note: Site-specific actions prevent costs from being used for direct comparative analysis).

Table E-18. Elimination Strategy

Item	Description		
Objective	Waste management by retrievable storage		
Technologies	Storage buildings for hazardous, mixed, and low-level wastes		
Limitations	Prestorage treatments limited to liquid sorption and compaction		
Volume range (m^3)	Hazardous	2,800 to	147,900
	Mixed	421,800 to	512,200
	Low-level	356,900 to	454,400
	Total	781,500 to	1,114,500
Volume uncertainties	Removal volume from existing waste sites		
	Volume reduction by compaction		
Cost range ($1000)[a]	Hazardous	4,938 to	260,829
	Mixed	592,401 to	719,364
	Low-level	605,067 to	770,362
	Total	1,202,406 to	1,489,986
Cost uncertainties	Total storage capacity required		
	Compaction capacity and cost (not included)		
Advantages	No land dedicated in perpetuity		
	Waste retrieval relatively simple in a failure		
	Compliance with applicable regulations, presuming waivers are granted		
	Compliance with environmental standards		
Disadvantages	Facilities costly to construct and operate		
	Inevitable future expenditure for continued storage or waste retrieval, treatment, and/or disposal		

[a]Costs through the 20-year period; does not include waste retrieval, treatment, or disposal. (Note: Site-specific actions prevent costs from being used for direct comparative analysis.)

Table E-19. Combination Strategy

Item	Description			
Objective	Waste management by combination of storage and disposal			
Technologies	Storage buildings for storage of hazardous, mixed, and low-level wastes; vaults or RCRA landfills for hazardous waste; vaults or RCRA landfills with or without CFM vaults for mixed waste; ELLTs, AGOs, or vaults for low-activity low-level waste; vaults or GCD for intermediate-activity low-level waste.			
Limitations	Mixed waste options using CFM vaults require predisposal treatment by cement/flyash solidification. Prestorage treatments limited to liquid sorption and compaction.			
Volume range (m^3)	Hazardous	150	to	147,900
	Mixed	34,500	to	512,200
	Mixed w/CFM	203,600	to	601,200
	Low-level	356,700	to	542,400
	Total	391,350	to	1,291,500
Volume uncertainties	Removal volume from existing waste sites			
	Volume reduction by pretreatment			
	Volume expansion by solidification			
Cost range ($1000)[a]	Hazardous	181	to	260,829
	Mixed	19,644	to	719,364
	Mixed w/CFM	281,410	to	876,421
	Low-level	123,533	to	770,362
	Total	143,358	to	1,907,612
Cost uncertainties	Total storage and disposal capacities required			
	Optional disposal technologies			
	Pretreatment technologies and capacities			
	No pretreatment costs, except CFM solidification			
	Postclosure requirements on disposal facilities			

Table E-19. Combination Strategy (continued)

Item	Description
Advantages	Allows selection of a mix of disposal and storage technologies that would optimize performance and minimize cost Other advantages are the same as those for the Dedication and Elimination Strategies
Disadvantages	Same as those for the Dedication and Elimination Strategies

[a]Costs for 20-year period through closure do not include postclosure maintenance or retrieval, treatment, and disposal of stored wastes. (Note: Site-specific actions prevent costs from being used for direct comparative analysis.)

REFERENCES

Cook, J. R., and M. W. Grant, 1987. Environmental Information Document, Y-Area, DPST-85-856, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Cook, J. R., M. W. Grant, and O. A. Towler, 1987a. Environmental Information Document, New Hazardous and Mixed Waste Storage/Disposal Facilities at SRP, DPST-85-953, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Cook, J. R., M. W. Grant, and O. A. Towler, 1987b. Environmental Information Document, New Low-Level Radioactive Waste Storage/Disposal Facilities at SRP, DPST-85-862, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

Appendix | Page

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

Appendix | Page

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

Appendix | Page

TABLE OF CONTENTS
(Continued)

Appendix | Page

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF FIGURES

APPENDIX F

ASSESSMENT OF ACTIONS AT EXISTING WASTE SITES

This appendix describes removal, remedial, and closure actions considered feasible for the waste sites listed in Appendix B, Table B.1-1. These waste sites are characterized in detail in Appendix B. Cumulative (i.e., over all the sites) environmental consequences of the actions are presented in Section 4.2 and summarized in Section 2.2. The assessments in this appendix are presented by individual waste site and are based largely on the results of modeling.

This appendix consists of 11 major sections, each of which covers the waste sites in a particular geographic group (see Section B.1.2 in Appendix B). For example, Section F.1 assesses the actions at the waste sites in the first geographic grouping (i.e., the A- and M-Areas). Each geographic-grouping section is further divided into a section for each waste site. For example, Sections F.1.1-F.1.13 deal with the 13 waste sites in the A- and M-Areas. These sections discuss the actions, releases, and other impacts associated with the waste sites for each of the three alternatives of no action, closure with no removal of waste, and closure with removal of waste. Finally, for each alternative at each waste site, three major topics (description of action, comparison of expected releases to applicable standards, and impacts other than releases) are presented.

To accommodate this extensive scope, many essentially equivalent discussions of similar sites and groups of sites have been combined. Similarly, in order to minimize repetition, the specific waste site sections are usually followed by a section that discusses those factors related to biological impacts that apply generically to all the waste sites within a particular geographic group.

The assessments in this appendix are supported by detailed modeling of contaminant transport and health risk analyses; the models used are described in Appendixes H and I.

Also in Appendix I, criteria for the selection of chemical and radioactive constituents and sites for evaluation based on risks to human health are discussed and presented. These selection criteria, corresponding to maximum contaminant levels (or less) or proposed de minimis radioactivity values, have been applied to chemical and radioactive constituents found in the waste sites, soil, and groundwater at the Savannah River Plant (SRP). If the quantities or concentrations are below the selection criteria values, no pathway modeling calculations and, consequently, no environmental assessments are made. Such cases will be noted in those sections of this appendix addressing sites with insignificant or no measurable concentrations of constituents in groundwater or soil at and near the waste sites.

Environmental assessments of alternative actions at existing waste sites are based on data and methodologies presented in the Environmental Information Documents (EIDs) referenced herein. The methodologies employ several pathway models for assessing the effects of releases on human health and the environment (aquatic and terrestrial ecology, endangered species, and wetlands).

Water pathways include groundwater movement to water wells, groundwater movement to surface streams, erosion of waste materials and movement to a surface stream, consumption of food produced from farmland reclaimed over a waste site, consumption of crops produced through natural biointrusion of land over a waste site, and direct exposure to gamma radiation. Atmospheric pathways for human exposure are inhalation of waste particulates or gases in air and ingestion of foodstuffs containing waste materials from deposition of air particulates on the ground surface. A detailed description of the pathway analysis methodology is included in the EIDs and Appendix H of this document.

Two assumptions are made regarding the time periods of analysis for potential environmental consequences. First, it is assumed that the Department of Energy (DOE) will maintain institutional control over the SRP site for 100 years beyond 1985. This is a reasonable assumption, in light of current production planning and projected scheduling for site decommissioning. Second, the basic time period for the long-term analyses extends up to 1000 years beyond 1985. Guidelines issued by the U.S. Environmental Protection Agency (EPA) and the U.S. Nuclear Regulatory Commission (NRC) specify 1000 years as a reasonable time for calculations of projected effects of waste disposal activities.

Public exposure attributed to the surface and subsurface pathways for various waste sites are based on exposure assessment for the years in which peak concentrations occur in surface water and groundwater and for future years (100, 200, 300, 400, 500, 700, and 1000 years from 1985). Results are reported at hypothetical wells assumed to be located 1 and 100 meters downgradient from each waste site and in the Savannah River.

Groundwater concentrations of constituents that exceed health-based regulatory standards are identified in this appendix. These exceedances are reported for measured concentrations at downgradient monitoring wells and modeling predictions at the hypothetical 1- and 100-meter wells. Some constituents that were modeled are not reported because applicable standards are not available or because the standard is not based on risk to human health and the environment. These include miscellaneous organic compounds, sodium, and phosphate.

It should be emphasized that the evaluations of alternatives in this appendix are based on groundwater and surface-water concentrations at individual waste sites that are predicted by the PATHRAE code. These results are not directly comparable to monitoring results for these sites. Predicted exceedance of standards for all closure actions indicates that further action may be required. This could range from taking remedial action (e.g., groundwater cleanup) to monitoring and assuring protection of human health and the environment in close cooperation with regulatory agencies (e.g., the South Carolina Department of Health and Environmental Control). Also, any action would be designed to ensure compliance with applicable regulations. These modeling predictions represent a very preliminary indication that some action may be required. In practice, implementation of any action would be based on this work and additional site-specific modeling and actual monitoring results.

Public exposure and risk attributed to the atmospheric pathway for various waste sites include risk assessment for every year for the period 1986-1990, for every fifth year for the period 1990-2085, and for every one-hundredth year for the period 2085-2985. Risks for a maximally exposed individual are

estimated for 3 selected years: 1985 (assumed start of closure actions), 2085 (assumed start of public occupation of the SRP area), and 2985 (end of 1000-year period).

Risk assessments are presented in this appendix in their originally calculated form (King et al., 1986) as follows:

- Carcinogenic risks from radioactive and from nonradioactive waste constituents are the product of exposure (either chemical or radioactive) and the cancer risk per unit exposure. These risk estimates are expressed as the increase in probability of fatal cancer in an individual (with a value between 0 and 1). In these evaluations, risks from chemical carcinogens have been determined as lifetime risks from exposure over a period of 50 years that encompasses the year of peak exposure. Radiological risks, however, were calculated for an exposure period of the peak year only. The radiological risk values presented in this appendix are multiplied by 50 in Chapter 4 to produce a conservative estimate of lifetime-exposure risks comparable to those originally calculated for chemical carcinogenics.

- Noncarcinogenic risks from chemical constituents are presented as the ratio of the average daily lifetime dose to the acceptable daily intake (ADI) for chronic exposure. Because noncarcinogenic effects are assumed to occur only if the exposure exceeds a threshold value defined by the ADI, any value of calculated risk less than 1 means that no health effect is likely; the smaller the value, the greater the margin of safety. Individual noncarcinogenic risk values are summed to form a hazard index that also is compared conservatively to a threshold of 1.

F.1 ASSESSMENT OF ACTIONS AT A- AND M-AREA WASTE SITES

This geographic grouping of waste sites is located along the northwest edge of the SRP where Road 1 leads to the Administration Area (700-A). Figure F-1 shows the boundaries of this geographic grouping and the locations of the waste sites within it.

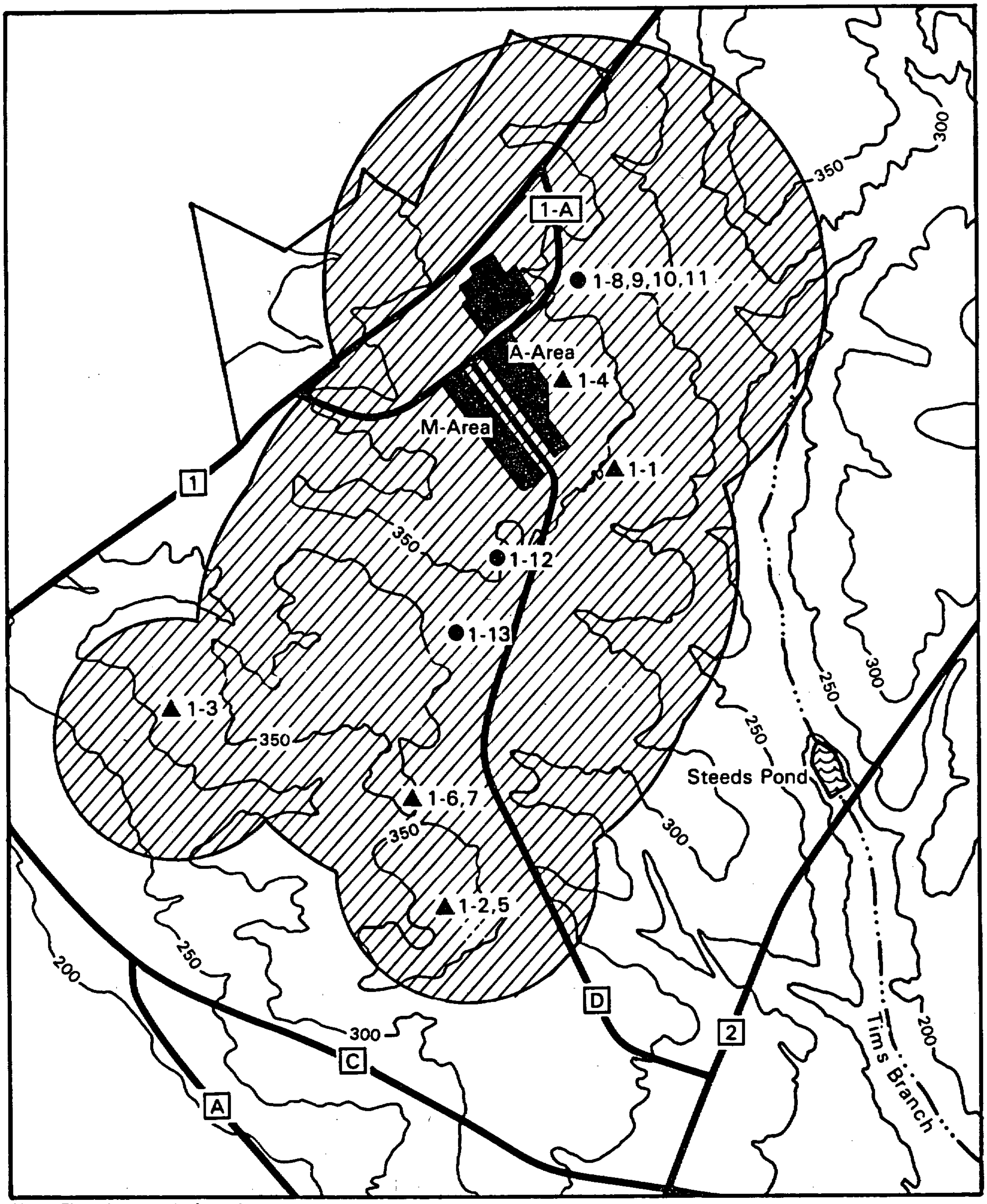
Sections F.1.1 through F.1.13 contain (or reference the section that contains) a discussion of sites 1-1 through 1-13, respectively. Section F.1.14 discusses biological impacts that are generically applicable to the A- and M-Area geographic grouping.

F.1.1 716-A MOTOR SHOP SEEPAGE BASIN, BUILDING 904-101G*

F.1.1.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Under this option, the motor shop seepage basin would remain uncovered and open to receive rainwater. Groundwater would continue to be monitored on a quarterly basis for the first year, then annually for 29 years.

*The reference source for the information in this section is Huber, Johnson, and Bledsoe, 1986.



Note: Elevations are in feet above mean sea level
1.0 foot = 0.3048 meter
Legend on following page

Scale (kilometers)
0 1 2

Figure F-1. A- and M-Area Waste Sites

Number	Potential Waste Type	Site Name	Building Number
1-1	▲	716-A Motor Shop Seepage Basin	904-101G
1-2	▲	Metals Burning Pit	731-4A
1-3	▲	Silverton Road Waste Site	731-3A
1-4	▲	Metallurgical Laboratory Basin*	904-110G
1-5	▲	Miscellaneous Chemical Basin*	731-5A
1-6	▲	A-Area Burning/Rubble Pit*	731-A
1-7	▲	A-Area Burning/Rubble Pit*	731-1A
1-8	●	SRL Seepage Basin	904-53G
1-9	●	SRL Seepage Basin	904-53G
1-10	●	SRL Seepage Basin	904-54G
1-11	●	SRL Seepage Basin	904-55G
1-12	●	M-Area Settling Basin	904-51G
1-13	●	Lost Lake	904-112G

*Indicates that waste type may be contained in the waste site
▲—Hazardous
●—Mixed

Figure F-1. A- and M-Area Waste Sites (continued)

Expected Environmental Releases

No environmental releases are expected at this site for this option.

Comparison of Expected Environmental Releases with Applicable Standards

The environmental impact and health risks associated with the motor shop seepage basin were not determined because chemical constituents at the site were below the threshold selection criteria.

Potential Impacts (Other Than Releases)

A discussion of general impacts to biological resources is presented in Section F.1.14.1. Potential aquatic impacts were considered unlikely.

The 716-A motor shop seepage basin might have an impact on the wildlife and vegetation that come into contact with its standing surface waters. Based on the available chemical analysis data on the standing surface water of the seepage basin, cadmium, lead, and mercury are higher than the EPA freshwater aquatic life criteria for these elements. Although these elements were identified based on aquatic criteria, they might have an impact on vegetation and wildlife that come into contact with the standing surface waters; however, none have been observed to date at this site.

The 716-A motor shop seepage basin is considered to be far enough from Tims Branch that impacts on the wetlands are not expected.

F.1.1.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this option, the motor shop seepage basin, in its current status, would be backfilled to grade and seeded. This option would require approximately 1350 cubic meters of soil. Groundwater would continue to be monitored on a quarterly basis for 1 year, then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

No chemical constituents at or above threshold selection criteria were identified for this waste site; thus, expected environmental releases were not determined. However, closure of the basin by backfilling would reduce the possibility that the free liquid might be transported by surface runoff or flooding.

No environmental risks due to atmospheric chemical releases from the motor shop seepage basin are expected for this option.

Potential Impacts (Other Than Releases)

A discussion of general impacts to biological resources is presented in Section F.1.14.2. Aquatic impacts are considered unlikely. Potential impacts on wildlife as a result of coming into contact with basin water would be eliminated under this option.

F.1.1.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this option, all waste would be removed from the motor shop seepage basin. The liquid would be drummed and removed to a SRP hazardous waste repository. Approximately 675 cubic meters of soil would then be excavated and removed to the SRP sanitary landfill. The basin would be backfilled to grade, requiring approximately 2025 cubic meters of soil, and seeded. Maintenance of the site would include mowing of the grounds. Groundwater would continue to be monitored on a quarterly basis for 1 year and thereafter on an annual basis for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

As stated above, no chemical constituents at or above threshold criteria were identified for this waste site; therefore, no environmental releases were determined. However, removal of the waste and backfilling of the basin should reduce the possibility of future environmental releases.

Potential Impacts (Other Than Releases)

A discussion of general impacts to biological resources is presented in Section F.1.14.3. No aquatic impacts are expected; however, the removal of wastes should minimize any such impacts. Potential impacts on wildlife as a result of coming into contact with basin water would be eliminated under this option.

F.1.2 METALS BURNING PIT, BUILDING 731-4A*

F.1.2.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The site would be left in its present condition. Groundwater monitoring for the existing wells would be continued quarterly for 1 year, then annually for 29 years. Upkeep would consist of maintaining the, groundwater monitoring wells. A U.S. Forest Service experimental study would continue, with weed and underbrush control conducted consistent with the pine tree growth study.

Comparison of Expected Environmental Releases with Applicable Standards

The waste constituents selected for assessment of the environmental impacts and health risks at the metals burning pit are tetrachloroethylene and trichloroethylene. Both of these compounds were found in the groundwater at levels higher than the selection criteria (Looney et al., 1986).

*The reference source of the information in this section is Muska, Pickett, and Marine, 1986.

Table F-1 lists the predicted maximum concentrations of tetrachloroethylene and trichloroethylene based on results of constituent transport modeling for all of the closure options, including no action. The table also lists the applicable standard for each constituent and, in parentheses, the years in which the maximum concentration is expected to be reached. For the no-action option, the table indicates maximum concentrations of tetrachloroethylene and trichloroethylene at levels in excess of the applicable standards at the 1- and 100-meter wells. Table F-1 also shows monitoring data for these two organics and for cadmium, which slightly exceeded its applicable standard but was not selected for the modeling assessment. Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

Environmental risks due to atmospheric chemical releases from the metals burning pit for this option were calculated. The risk values are conservative because they are based on emissions from two sites: the metals burning pit and the miscellaneous chemical basin. The carcinogenic risks are very low (the highest risk to the maximally exposed individual is less than 10^{-14} excess cancers) and are not considered significant.

The expected concentrations for the erosion, reclaimed farmland, and biointrusion pathways are zero for this option. That is, the erosion rate is such that no waste erodes during the first 1000 years of the simulation; waste materials are leached from the zone of excavation before a farming operation could begin, due to the 100 years of institutional control; and the 1 meter of existing soil cover equals or exceeds the root penetration assumed for the biointrusion pathway.

Potential Impacts (Other Than Releases)

The potential ecological impacts of the no-action closure plan for the metals burning pit are similar to those addressed in Section F.1.14.1. PATHRAE modeling was performed on tetrachloroethylene and trichloroethylene, which were considered to have a potential impact on the aquatic system. The results of this analysis indicate that these particular constituents should not cause a problem under any of the closure options. Provided the area is maintained by mowing, root penetration to the contaminated zone should be minimal.

F.1.2.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

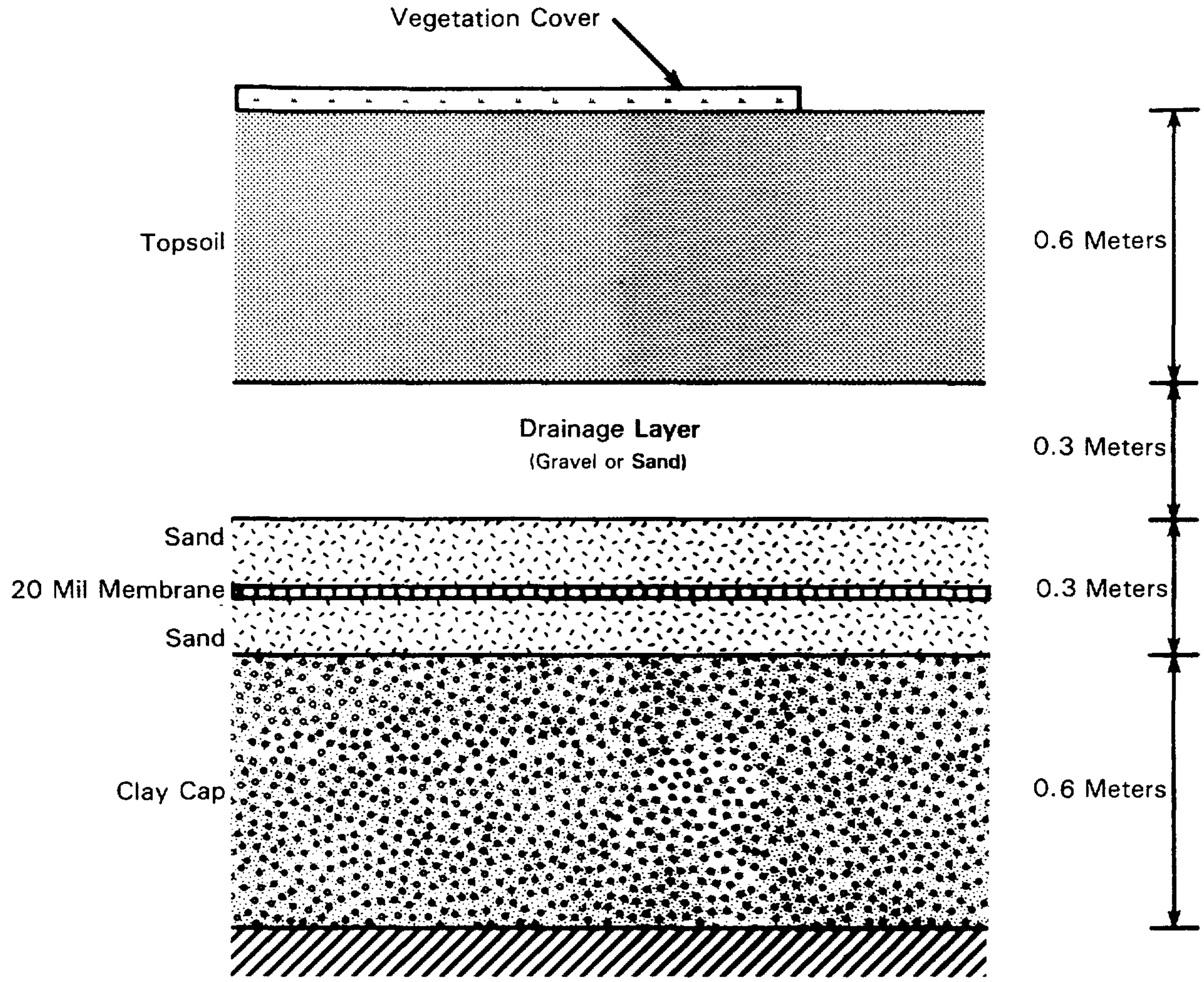
Description of Action

A low-permeability clay cap (Figure F-2) would be placed atop the existing landfill. The exact location of the area involved in the burning and disposal of the metal and debris is not known, but soil sampling to define the specific location of the metals and/or organically contaminated soil is planned prior to closure. It is expected that this could significantly reduce the amount of area requiring capping. For the purpose of this document, however, the cost analysis will be made on the assumption that the entire waste site, about 3.6 acres, would be capped. The cap would be graded and revegetated similar to

Table F-1. Predicted Maximum Concentrations (mg/L) of Various Constituents at Metals Burning Pit for Three Closure Options[a]

Constituent	Applicable standard[c]	Monitoring data maximum mean concentration	Predicted maximum concentration[b]					
			No action		No removal and closure		Removal and closure	
			1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Cadmium	1.0×10^{-2}	1.4×10^{-2} (well ABP 3)	(d)	(d)	(d)	(d)	(d)	(d)
Tetrachloroethylene	7.0×10^{-4}	1.5×10^{-3} (well ABP 2A)	2.7×10^{-3} (1985)	2.2×10^{-3} (1994)	9.5×10^{-4} (2024)	9.1×10^{-4} (2033)	(e)	(e)
Trichloroethylene	5.0×10^{-3}	4.5×10^{-2} (well ABP 3)	1.2×10^{-1} (1981)	1.0×10^{-1} (1989)	6.8×10^{-2} (1999)	6.2×10^{-2} (2007)	(e)	(e)

[a]Source: Adapted from Muska, Pickett, and Marine, 1986.
[b]Number in parentheses represents year in which concentration was reached or is expected to be reached.
[c]EPA, 1985a,b.
[d]Constituent did not meet threshold selection criteria for PATHRAE modeling.
[e]Value identical to that of no-action option.



Permeability of Drainage Layer $\geqslant 1 \times 10^{-3}$ cm/sec

Permeability of Clay Cap $\leqslant 1 \times 10^{-7}$ cm/sec

Infiltration Reduction - 99%

Figure F-2. Schematic Diagram of Low-Permeability Clay Cap

the current status of the site. Since the materials that were disposed of at the site would be left in place in this option, groundwater monitoring would be continued.

Additional corrective actions, such as groundwater extraction and treatment, might be needed to reduce the levels of trichloroethylene and tetrachloroethylene in the groundwater (see Table F-1).

Comparison of Expected Environmental Releases with Applicable Standards

The consequences of environmental releases include the relative risk to human health and the potential impact on aquatic and terrestrial ecosystems of tetrachloroethylene and trichloroethylene. The pathways that may have an impact on human health are the same as those for the first closure option (see Section F.1.2.1).

Table F-1 lists the predicted maximum concentrations of the chemical constituents based on results of groundwater modeling for this option. The table also lists the applicable standard for each constituent and, in parentheses, the years in which the maximum concentration is expected to be reached. For the no removal/closure option, the table indicates maximum concentrations of trichloroethylene and tetrachloroethylene at levels in excess of the applicable standards in the future at the 1- and 100-meter wells. Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

Additional actions might be needed to address the constituents already in the groundwater. Decisions regarding the precise actions to be taken would be based on site-specific studies and discussions with the regulatory agencies concerned.

The expected concentrations for the erosion, reclaimed farmland, and biointrusion pathways are zero for this option. Maximum concentrations were not developed for the other pathways.

Environmental risks due to atmospheric releases from the metals burning pit are conservative for this option for the reason discussed in Section F.1.2.1. Carginogenic risks would be zero for 1986 and the same as the no-action option 5 years later, due to the diffusion of the volatile contaminants through the backfill soil. The carcinogenic risk value is expected to be very low (the highest risk to the maximally exposed individual is less than 10^{-14} excess cancers) and is considered not significant.

Potential Impacts (Other Than Releases)

The potential ecological impacts of no waste removal and closure for the metals burning pit are similar to those addressed in Section F.1.14.2.

F.1.2.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Soil sampling to define the specific location of the metals and/or organics would be performed prior to closure. It is expected that this would significantly reduce the amount of soil to be excavated and/or treated. However, for the purposes of this document, the cost analysis will be made on the total volume of soil which could contain these constituents.

Photographs taken in 1974 indicate that the total pit depth was 1.0 to 1.5 meters. To remove the waste materials, it is therefore assumed that a depth of 1.5 meters over the 120 meter x 120 meter area would need to be excavated and backfilled (21,600 cubic meters). Two disposal options for the excavated materials have been considered: disposal in a hazardous waste repository, or incineration of the soil/debris mixture and reemplacement on the site. Transportation of the excavated materials to the repository would require approved metal containers. It is expected that incineration would convert the metallic materials to stable oxides and destroy any residual chlorinated hydrocarbons. The site would be regraded, vegetated, and then allowed to return to its natural state. Groundwater monitoring would be continued until the concentration of degreasing agents had decreased to background levels.

Additional corrective actions, such as groundwater extraction and treatment, might be needed to reduce the levels of tetrachloroethylene and trichloroethylene in the groundwater (see Table F-1).

Comparison of Expected Environmental Releases with Applicable Standards

The consequences of environmental releases include the relative risk to human health and the potential impact on aquatic and terrestrial ecosystems. The pathways that may have an impact on human health are the same as those for the no-action option.

This closure option was not modeled because the constituents of concern were assumed to have leached beyond the zone of excavation by the time remedial actions would occur. Therefore, this site would behave in the same manner as it would for the no-action option. Table F-1 lists the predicted maximum concentrations of the chemical constituents based on results of groundwater modeling for this option as well as for the no-action option.

Additional actions might be required to reduce the constituent levels in the groundwater to meet applicable standards. The exact measures to be initiated would be defined on the basis of site-specific studies and interaction with regulatory agencies.

Estimated occupational risks due to atmospheric chemical releases from the metals burning pit for this option are very low (the highest public and occupational risks to the maximally exposed individual are, respectively, less than 10^{-14} and 10^{-16} excess cancers) and are considered not significant.

The expected concentrations for the erosion, reclaimed farmland, and biointrusion pathways are zero for this closure option. Maximum concentrations for the other pathways were not developed.

Potential Impacts (Other Than Releases)

The potential ecological impacts of the waste removal and closure plan for the metals burning pit would be similar to those addressed in Section F.1.14.3.

F.1.3 SILVERTON ROAD WASTE SITE, BUILDING 731-3A*

F.1.3.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The site would be left in its present condition and monitored quarterly for 1 year, then annually for 29 years. Upkeep would consist of maintaining a fence and signs around the basin, cutting weeds periodically, and filling depressions at the site with topsoil and seeding.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents selected for assessment of environmental impact and health risks associated with the Silverton Road waste site are lead, tetrachloroethylene, trichloroethylene, and trichloromethane. These were selected because they were found in the groundwater at levels higher than the threshold selection criteria.

Table F-2 lists the predicted maximum concentrations of those constituents predicted to exceed applicable standards based on groundwater modeling for the no-action option. The table also lists the applicable standard for each constituent and, in parentheses, the year in which the maximum concentration is estimated to occur. A comparison of predicted maximum concentrations to applicable standards for the no-action option indicates that the peaks have already occurred at the 1- and 100-meter wells. But recent sampling data at the site indicate that trichloroethylene and tetrachloroethylene remain in excess of applicable standards.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

Estimated environmental risks due to atmospheric releases from the Silverton Road waste site are very low and are considered not significant. For example, the highest carcinogenic risk to the maximally exposed individual is less than 10^{-17} excess cancers.

*The reference source of the information in this section is Scott, Killian, Kolb, Corbo, and Bledsoe, 1986.

Table F-2. Predicted Maximum Concentrations (mg/L) of Tetrachloroethylene and Trichloroethylene at Silverton Road Waste Site for Three Closure Options[a]

		Predicted maximum concentration					
		No action[b]		No removal and closure		Removal and closure	
Constituent	Applicable standard[c]	1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Tetrachloroethylene	7.0×10^{-4}	3.5×10^{-1} (1969)	5.2×10^{-2} (1974)	(d)	(d)	(d)	(d)
Trichloroethylene	5.0×10^{-3}	3.1×10^{-1} (1966)	5.1×10^{-2} (1971)	(d)	(d)	(d)	(d)

[a]Source: Adapted from Scott, Killian, Kolb, Corbo, and Bledsoe, 1986.
[b]Number in parentheses represents year in which concentration was reached.
[c]EPA 1985a,b.
[d]Value identical to that of no-action option.

The expected concentrations for the erosion pathways are zero for this option because the length of time that it takes for the contaminants to start eroding is well over 1000 years. Maximum concentrations for the other pathways were not developed.

Potential Impacts (Other Than Releases)

The potential ecological impacts of the no-action closure plan for the Silverton Road waste site are similar to those addressed in Section F.1.14.1. Modeling was performed on lead, tetrachloroethylene, trichloroethylene, and trichloromethane, which were considered to have a potential impact on the aquatic system. The results indicate that these waste materials would not alter the present water quality of the receiving stream under any closure options. However, lead in the Savannah River is presently above the EPA criteria for aquatic life.

F.1.3.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The 3.25-acre site would be covered with 0.6 meter of borrow fill (7,890 cubic meters) and capped as described in Section F.1.2. The cap would be covered with topsoil and seeded with grass. The site would be monitored quarterly for 1 year, then annually for 29 years.

Additional corrective actions, such as groundwater extraction and treatment, might be needed to reduce the constituent levels in the groundwater.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents, the consequences of environmental releases, the exposure pathways, and the potential human health risks associated with this option would be the same as those described under Section F.1.3.1. Table F-2 presents the predicted maximum concentrations for the chemical constituents of concern at this site. It depicts predicted maximum concentrations of contaminants that peaked prior to 1985 at the 1- and 100-meter wells and appear to be receding. However, recent sampling data at the site indicate concentrations in excess of applicable standards.

Additional actions might be required to reduce the concentrations of constituents in the groundwater to meet the applicable standards. The precise actions to be taken would be decided on the basis of site-specific investigations and interactions with the regulatory agencies concerned.

Environmental risks due to atmospheric releases from the Silverton Road waste site for this action are estimated to be very low (the highest carcinogenic risk to the maximally exposed individual is less than 10^{-16} excess cancers) and are considered not significant. Noncarcinogenic risk values are zero.

Potential Impacts (Other Than Releases)

The potential ecological impacts of no waste removal and closure for the Silverton Road waste site are similar to those addressed in Section F.1.14.2.

F.1.3.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The waste would be excavated and treated in an onsite approved incinerator and the residual ash disposed of in an approved onsite waste disposal repository (Y-Area). The volume to be excavated is 26,288 cubic meters. The area would be backfilled with the same quantity of borrow fill and capped. Rainwater infiltration would be reduced at least 99 percent. The cap would be covered with topsoil and seeded with grass. The site would be monitored quarterly for 1 year, then annually for 29 years.

Additional corrective actions, such as groundwater extraction and treatment, might be needed to reduce the levels of constituents in the groundwater.

Comparison of Expected Environmental Releases with Applicable Standards

This closure option was not modeled, as the contaminants of concern were assumed to have leached beyond the zone of excavation by the time remedial actions would occur. Therefore, the concentrations are expected to be similar to those associated with the no-action option and discussed in Section F.1.3.1.

Estimated environmental and occupational risks due to atmospheric releases from the Silverton Road waste site for this action are very low and are considered not significant. For example, the highest public and occupational risks to the maximally exposed individual are estimated to be, respectively, less than 10^{-16} and 10^{-18} excess cancers. Except for 1986, the excavation year, the noncarcinogenic risk values would be zero. The public and occupational noncarcinogenic risks to the maximally exposed individual are well below 1 (with a maximum ADI value of 10^{-8}).

Potential Impacts (Other Than Releases)

The potential ecological impacts of the waste removal and closure plan for the Silverton Road waste site would be similar to those addressed in Section F.1.14.3.

F.1.4 METALLURGICAL LABORATORY BASIN, BUILDING 904-110G*

F.1.4.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

This alternative for the metallurgical laboratory basin includes the continuation of groundwater monitoring quarterly for 1 year and then annually for 29 years. Site maintenance requirements include mowing of the grass adjacent to the basin and trimming of small bushes on the banks of the basin.

*The reference source of the information in this section is Michael, Johnson, and Bledsoe, 1986.

Comparison of Expected Environmental Releases with Applicable Standards

Several chemical constituents were evaluated at this site because they were identified in groundwater sampling or were implicated as potentially significant in available records. The chemical constituents selected for evaluation of the environmental impacts and health risks associated with the metallurgical laboratory basin were chromium, lead, mercury, tetrachloromethane, 1,1,1,-trichloroethane, and trichloroethylene.

Table F-3 summarizes the predicted maximum concentrations of tetrachloromethane, 1,1,1-trichloroethane, and trichloroethylene based on groundwater modeling for all of the closure options including no action. The table also lists the applicable standard for each of these constituents and, in parentheses, the year in which the maximum concentration is expected to be reached. For the no-action option, the table indicates maximum concentrations of tetrachloromethane, 1,1,1-trichloroethane, and trichloroethylene at levels in excess of the applicable standards at the 1- and 100-meter wells. Table F-3 also lists monitoring data for gross alpha, gross beta, and radium, which exceeded applicable standards but were not modeled.

Surface-water quality is not significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

Expected atmospheric releases of chemicals from the metallurgical laboratory basin for this option are minimal. For example, lead and mercury releases are less than 1 percent of the significant emission rates under the Prevention of Significant Deterioration (PSD) regulations and are considered insignificant.

Estimated environmental risks due to atmospheric chemical releases from the metallurgical laboratory basin for this option are small and are not considered significant. The highest carcinogenic risks to the maximally exposed individual are less than 10^{-6}. The peak noncarcinogenic risks are below 1 with the maximum value less than 10^{-4}.

The concentrations for the erosion pathway are zero because the length of time for the constituents to start eroding is well over 1000 years. Maximum concentrations for other pathways were not developed.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no-action closure plan is provided in Section F.1.14.1. Chromium, lead, mercury, tetrachloromethane, 1,1,1-trichloroethane, and trichloroethylene were identified as having a potential impact on aquatic systems. The modeling results indicate that these waste materials would not alter the present water quality of the Savannah River under any closure options. However, the levels of lead and mercury from unknown sources in the Savannah River, both upriver and downriver from SRP, are presently above the aquatic biota criteria.

Because the metallurgical laboratory basin has standing surface water, there may be potential impacts on the wildlife and vegetation that come into contact with the waters. Available data on chemical analyses of the water in the

Table F-3. Predicted Maximum Concentrations of Various Constituents at Metallurgical Laboratory Basin for the Three Closure Options[a]

Constituent	Applicable standard[c]	Monitoring data maximum mean concentration	Predicted maximum concentration[b]					
			No action		No removal and closure		Removal and closure	
			1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Tetrachloromethane	5.0×10^{-3}	(d)	1.6 (1994)	1.6 (1994)	1.1 (2010)	1.0 (2008)	(e)	(e)
1,1,1-trichloroethane	2.0×10^{-1}	(d)	5.3×10^{-1} (1992)	5.2×10^{-1} (1994)	3.6×10^{-1} (2008)	3.5×10^{-1} (2009)	(e)	(e)
Trichloroethylene	5.0×10^{-3}	2.9×10^{-2} (well AMB 1A)	2.7×10^{-2} (1993)	2.6×10^{-2} (1994)	1.8×10^{-2} (2008)	1.8×10^{-2} (2009)	(e)	(e)
Gross alpha	10-20	7.4×10^{1} (well AMB 1A)	(f)	(f)	(f)	(f)	(f)	(f)
Gross beta	40-60	4.8×10^{1} (well AMB 1A)	(f)	(f)	(f)	(f)	(f)	(f)
Radium	6.0	1.0×10^{-1} (well AMB 1A)	(f)	(f)	(f)	(f)	(f)	(f)

[a]Source: Adapted from Michael, Johnson, and Bledsoe, 1986. Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[b]Number in parentheses represents year in which concentration is expected to be reached.
[c]EPA, 1985b.
[d]Below standard.
[e]Value identical to that of no removal and closure.
[f]Not modeled.

laboratory basin indicate that silver, chromium, copper, cyanide, mercury, and lead are higher than the freshwater biota criteria for these elements, an indication that they might have an impact on wildlife and vegetation that come into contact with the basin water.

The metallurgical laboratory basin is located near the wetlands of Tims Branch. Overflow of the basin during heavy rains might affect these wetlands under the no-action option.

F.1.4.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This alternative for the metallurgical laboratory basin includes batch neutralization of the 757,000 liters of basin water with either hydrated lime or limestone, release of the water to Tims Branch through NPDES Outfall A-11, backfill of the basin, and continuation of groundwater monitoring.

Following release of the water to Outfall A-11, the basin would be backfilled with approximately 567 cubic meters of soil and seeded. Groundwater monitoring would be continued quarterly for 1 year and annually for 29 years.

Additional corrective actions might be needed to reduce concentrations of constituents in groundwater.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents, the consequences of environmental releases, and the pathways associated with this option are the same as those discussed in Section F.1.4.1.

The potential risks to human health are the same for this option as for the waste removal option discussed in Section F.1.4.3. Table F-3 presents the applicable standards and the predicted maximum concentrations for the chemical constituents for the groundwater-to-river pathway and the groundwater-to-wells pathway. For the no removal/closure option, the table indicates maximum concentrations of tetrachloromethane, 1,1,1-trichloroethane, and trichloroethylene at levels in excess of the applicable standards at the 1- and 100-meter wells.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

Expected atmospheric releases of chemical constituents from the metallurgical laboratory basin for this option are very small (0 to 6.7×10^{-5} kilograms per year). They are considered insignificant for the reason discussed under Section F.1.4.1 for the no-action option. Estimated environmental risks due to atmospheric chemical releases from the metallurgical laboratory basin for this option would be about 10^{5} to 10^{10} times smaller than the risks for the no-action option. The risk values are extremely small and are considered not significant.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no waste removal and closure plan is provided in Section F.1.14.2. According to this plan, the liquid contents of the basin would be neutralized and released into Tims Branch. All such releases would comply with National Pollutant Discharge Elimination System (NPDES) permit requirements; therefore, no impact to the stream environment is anticipated.

F.1.4.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This alternative for the metallurgical laboratory basin includes batch neutralization of the basin water as described above, release of the water through Outfall A-11, removal of 0.91 meter of basin sediment, backfill of the basin, and continuation of groundwater monitoring.

Following neutralization, the basin water would be sent to Outfall A-11. Approximately 340 cubic meters of the sediment would then be removed by skip pan from the basin, placed in metal boxes, and sent to the SRP hazardous waste disposal facility. The basin would be backfilled with approximately 960 cubic meters of soil and seeded to complete closure. Groundwater monitoring would be continued quarterly for 1 year and annually for 29 years.

Additional corrective actions might be needed to reduce the levels of groundwater constituents to meet applicable standards.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents of concern are tetrachloromethane, 1,1,1-trichloroethane, and trichloroethylene. The pathways that may have an impact on human health are the same as those for the no-action option.

For the closure with removal option, Table F-3 lists the predicted maximum concentrations of the chemical constituents based on results of groundwater modeling. The table also lists the applicable standard for each contaminant and, in parentheses, the year in which the maximum concentration is expected to be reached. As in the case of no removal and closure, maximum concentrations of tetrachloromethane, 1,1,1-trichloroethane, and trichloroethylene are in excess of applicable standards at the 1- and 100-meter wells and below applicable standards at the river.

In all cases, the expected atmospheric releases of chemical contaminants from the metallurgical laboratory basin for this option would be less than for the no-action option. They are considered insignificant for the reason discussed under Section F.1.4.1 for the no-action option. Estimated environmental and occupational risks due to atmospheric chemical releases from the metallurgical laboratory basin for this option are extremely small and are considered not significant. For example, the highest public and occupational carcinogenic risks to the maximally exposed individual would be, respectively, less than 10^{-11} and 10^{-7}.

The concentrations for the erosion and biointrusion pathways are estimated as zero because the cover thickness, erosion rate, and plant-root depth would be such that erosion of the waste material would never take place within the 1000-year study period and the roots of the plants in the biointrusion pathway would never extend into the remaining waste material.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the waste removal and closure alternative is provided in Section F.1.14.3. According to this plan, the contents of the basin would be released into Tims Branch in accordance with NPDES permit requirements. Consequently, there would be no impact on the stream environment. This closure option would remove soils from the waste site and thus reduce the potential impact of plant uptake of wastes.

F.1.5 MISCELLANEOUS CHEMICAL BASIN, BUILDING 731-5A*

F.1.5.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Five monitoring wells and a site identification sign would be installed. Otherwise, the site would be left in its present condition. The site would be mowed periodically (probably every 3 to 5 years) and the groundwater monitoring wells would be maintained. The groundwater would be monitored quarterly for the first year and then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituent selected for consideration of the environmental impact and health risks for the miscellaneous chemical basin is tetrachloroethylene. This compound was detected in soil gas samples at levels higher than the selection criteria.

The consequences of environmental releases include the relative risk to human health resulting from potential exposure to waste materials transported through groundwater or atmospheric pathways and the potential impact on the aquatic and terrestrial ecosystems due to transport of waste materials into these ecosystems.

Table F-4 lists the predicted maximum concentrations of tetrachloroethylene for all closure options including no action. These data indicate concentrations above the applicable standard at the 1- and 100-meter wells, but not at the river.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

*The reference source of the information in this section is Muska, Pickett, and Marine, 1986.

Table F-4. Predicted Maximum Concentrations (mg/L) of Tetrachloroethylene at Miscellaneous Chemical Basin for Three Closure Options[a]

		Predicted maximum concentration[b]					
		No action		No removal and closure		Removal and closure	
Constituent	Applicable standard	1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Tetrachloroethylene	7.0×10^{-4} [c]	3.1×10^2 (1990)	3.0×10^2 (1999)	1.4×10^2 (2024)	1.4×10^2 (2033)	(d)	(d)

[a]Source: Adapted from Muska, Pickett, and Marine, 1986.
[b]Number in parentheses represents year in which concentration is expected to be reached.
[c]EPA, 1985a.
[d]Value identical to that of no-action option.

Estimated environmental risks due to atmospheric chemical releases from the miscellaneous chemical basin are conservatively considered the same as for the metals burning pit (Section F.1.2.1). As discussed in that section, the risks are very low and are considered not significant.

The concentrations for the erosion, reclaimed farmland, and biointrusion pathways are expected to be zero for this option.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no-action closure plan is provided in Section F.1.14.1. Potential impacts on the aquatic biota of outcropping streams were determined for tetrachloroethylene, which was considered to have a potential impact on the aquatic system. The results of the model analysis indicate that this particular compound should not be a problem for any of the closure options, based on the aquatic biota criteria.

F.1.5.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The 1974 photographs of this site indicated that it was a small, shallow depression - approximately 6 meters by 6 meters by 0.3 meter deep. The specific location would be confirmed by shallow soil core sampling. A low-permeability clay cap (Figure F-2) would be placed on top of the miscellaneous chemical basin. The area of the cap would be about 2000 square meters (≃45 by 45 meters) so as to completely cover the impacted area. The cap would be graded and revegetated similar to the current status of the site. Since the materials disposed of at the site would remain in place in this option, groundwater monitoring would be maintained.

In order to reduce the concentration of tetrachloroethylene in the groundwater to levels below the applicable standards in the vicinity of the basin, additional corrective actions, such as groundwater extraction and treatment, might be needed.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituent of concern at this site is tetrachloroethylene. The concentrations of tetrachloroethylene in the groundwater for this option are shown on Table F-4. This table lists the applicable standard for the contaminant, the predicted concentrations, and, in parentheses, the year in which the maximum concentration is expected to be reached. In the vicinity of the site wells at 1 and 100 meters, the concentrations exceed the applicable standard.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

Estimated environmental risks due to atmospheric chemical releases from the miscellaneous chemical basin were added to those from the nearby metals

burning pit (Section F.1.2.1). The risks are very low and are considered not significant.

The expected concentrations for the erosion, reclaimed farmland, and the biointrusion pathways are estimated as zero for this option.

Potential Impacts (Other Than Releases)

The potential ecological impacts of the waste removal and closure plan for the miscellaneous chemical basin are expected to be similar to those addressed in Section F.1.14.2.

F.1.5.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Analyses of soil samples collected during the installation of the proposed groundwater monitoring well (at the center of site) would be made to determine a depth-contamination profile. However, for purposes of estimating the disposal costs, it is assumed that the soil would be excavated to a depth of 2 meters. The total excavated volume would be 72 cubic meters. Two disposal options for the excavated materials have been considered: disposal in a hazardous waste repository, and incineration of the soil/debris mixture and reemplacement on the site. Transportation of the excavated materials to the repository or incinerator would require approved metal containers. It is expected that incineration would destroy any residual chlorinated hydrocarbons. The site would be regraded, vegetated, and then allowed to return to its natural state. Groundwater monitoring would be continued until the concentration of degreasing agents had decreased to background levels.

Additional corrective actions, such as groundwater extraction and treatment, might be needed to address the constituents already in the groundwater. The exact action to be taken would be determined by site-specific studies and by interactions with regulatory agencies.

Comparison of Expected Environmental Releases with Applicable Standards

This closure option was not modeled, as the constituent of concern was assumed to have leached beyond the zone of excavation by the time remedial actions would occur. Therefore, the site would behave in the same manner as it would for the no-action option described in Section F.1.5.1. Table F-4 lists the estimated maximum concentrations of the chemical constituents for this option based on results of groundwater modeling for the other options.

Estimated environmental and occupational risks due to atmospheric chemical releases from the miscellaneous chemical basin are conservatively considered the same as for the metals burning pit. As discussed in Section F.1.2.3, the risks are very low and are considered insignificant.

The expected concentrations for the erosion, reclaimed farmland, and biointrusion pathways are zero for this closure option.

Potential Impacts (Other Than Releases)

The potential ecological impacts of waste removal and closure for the miscellaneous chemical basin are expected to be similar to those addressed in Section F.1.14.3.

F.1.6 BURNING/RUBBLE PITS*

There are 15 burning/rubble pits on SRP, located in A-, F-, R-, CS-, C-, D-, K-, L-, and P-Areas, as follows:

Area	Building	Area	Building
A	731-A	CS	631-6G
A	731-1A	C	131-C
F	231-F	D	431-D
F	231-1F	D	431-1D
R	131-R	K	131-K
R	131-1R	L	131-L
CS	631-1G	P	131-P
CS	631-5G		

All of these pits operated over essentially the same time period and received similar waste. Consequently, the closure actions, potential releases, and associated environmental effects would be expected to be quite similar. Therefore, the options, releases, and impacts described in this section would be applicable to each of the burning/rubble pits.

The assessments of groundwater and surface-water releases presented here are based on the C-Area burning/rubble pit, which is assumed to be the worst-case representative for groundwater and surface water releases of all the burning/rubble pits at SRP. To provide a relative scale for the burning/rubble pits, the estimated disposal mass of contaminants selected for environmental assessment is listed in Table F-5.

A similar worst-case scenario was developed for atmospheric releases. The two pits in A-Area (Buildings 731-A and 731-1A) and the pit in C-Area were analyzed as a single site for purposes of assessment of the atmospheric releases from the three pits. Atmospheric releases from each of the remaining 12 pits in F-, R-, CS-, D-, K-, L-, and P-Areas were assessed on the basis of a single site containing a combination of the wastes deposited in those 12 pits.

F.1.6.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Under this closure option, the burning/rubble pits would be left in their current status. Groundwater monitoring would continue quarterly for 1 year, then annually for 29 years.

*The reference source of the information in this section is Huber, Johnson, and Marine, 1986.

Table F-5. Estimated Disposal Mass of Contaminants in the Burning/Rubble Pits

Area	Estimated Disposal Mass			
	Lead (kg)	Chromium (kg)	Chlorinated Hydrocarbons (kg)	Uranium (Ci)
A	–	–	1.23[a]	2.1×10^{-3}
F	–	–	15.08[a,b]	–
C	5530	9500	186[a]	5.2×10^{-3}
CS	–	–	<1[b]	–
D	204	–	<1[b]	–
K	–	–	4.14[a,b]	–
L			<1[b]	–
P	3330	–	67.86[a,b,c]	–

[a]Trichloroethylene.
[b]Tetrachloroethylene.
[c]1,1,1-trichloroethylene, trans-1,2-dichloroethylene, 1,1-dichloroethylene.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents and waste materials selected for consideration of the environmental impact and health risks associated with burning/rubble pits are chromium, lead, trichloroethylene, and uranium-238. These constituents were selected because they were found in the groundwater at the pit sites at levels higher than the threshold selection criteria.

The pathways associated with this site that may have an impact on human health include those cited in Subsection F.1.2.1 and, in addition, direct gamma radiation.

The groundwater contaminant transport analysis of the burning/rubble pits was performed only for the C-Area burning/rubble pit. The results of this analysis are summarized in Table F-6, which presents the expected maximum concentrations of trichloroethylene based on results of groundwater modeling as determined for the C-Area burning rubble pit for all of the closure options, including no action. The table also lists the applicable standard and the year in which the the maximum concentration is expected to occur. The table indicates that the maximum concentrations of trichloroethylene at the 1- and 100-meter wells are in excess of the applicable standard. Table F-6 also shows monitoring data for lead, gross alpha, and radium, which exceeded applicable standards but were not selected for the modeling assessment. Peak values of chromium, lead, and uranium-238 are predicted to be below their applicable standard. Peak concentrations of the four modeled constituents are predicted to be the same for all three options.

Table F-6. Predicted Maximum Concentrations of Various Constituents at the C-Area Burning/Rubble Pit for the Three Closure Options[a]

Constituent	Applicable standard[c]	Monitoring data maximum mean concentration	Predicted maximum concentration: No action[b]		No removal and closure		Removal and closure	
			1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Lead	5.0×10^{-2}	2.2×10^{-1} (well CRP 1)	(d)	(d)	(e)	(e)	(e)	(e)
Trichloroethylene	5.0×10^{-3}	2.6[f] (well CRP 3)	2.1 (1980)	1.7 (1985)	(e)	(e)	(e)	(e)
Gross alpha	10-20	2.5×10^{1} (well CRP 3)	(g)	(g)	(g)	(g)	(g)	(g)
Radium	6.0	7.5 (well CRP 3)	(g)	(g)	(g)	(g)	(g)	(g)

[a]Source: Adapted from Huber, Johnson, and Marine, 1986. Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[b]Number in parentheses represents year in which concentration was reached.
[c]EPA, 1985b.
[d]Below standard.
[e]Value identical to that of no-action option.
[f]Concentration given for TOH.
[g]Not modeled, although uranium-238 was predicted by PATHRAE to be below standards.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from these sites, as the resulting concentrations of constituents in onsite streams and the Savannah River are projected to be below drinking-water standards.

As indicated above, estimated environmental risks due to atmospheric chemical releases from the burning/rubble pits within each geographic grouping are conservative because they are based on emissions from several burning/rubble pits. Risks are still quite low for these worst-case scenarios. For example, the highest reported chemical carcinogenic risk to the maximally exposed individual is less than 10^{-7}. The noncarcinogenic hazard index is well below 1, with a peak of less than 10^{-5}. The maximum annual radiological exposure from atmospheric releases occurs in 1986 and results in a risk of 1.1×10^{-9}. These risks are considered not significant.

The predicted maximum concentration for the erosion pathway is zero because the length of time that it takes the constituents to start eroding is well over 1000 years.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts in the A- and M-Area under no action is provided in Section F.1.14.1. Results from the C-Area analysis indicate no impact on existing in-stream concentrations of chromium, lead, trichloroethylene, and uranium-238 under any of the closure options. Therefore, no impacts would be expected at the other burning/rubble pits, since the C-Area site has the largest estimated waste inventory.

F.1.6.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This option would leave all waste in its present location. Since all burning/rubble pits have been backfilled, no further backfill would be required. Groundwater monitoring would continue on a quarterly basis for 1 year, then annually for 29 years.

Additional corrective actions, such as groundwater extraction and treatment, might be needed to reduce the concentration of chlorinated hydrocarbons in the groundwater.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents, the consequences of environmental releases, and the pathways associated with this option are the same as those for the no-action option (see Section F.1.6.1), because the pit has been backfilled and is considered closed.

Potential Impacts (Other Than Releases)

The potential ecological impacts of no waste removal and closure for the A-Area burning/rubble pits are discussed in Section F.1.14.2 along with other waste sites in the A- and M-Area.

F.1.6.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this alternative, all waste deposited in the burning/rubble pits would be excavated as well as any contaminated soil to a depth of 1 meter below the base of the pits. The excavated material would be placed in metal boxes and sent to the SRP hazardous waste storage/disposal facility. The pits would be backfilled and compacted as necessary to prevent settling, and then seeded. The amount of soil required to backfill, as well as the amount of waste to be removed for each pit is as follows:

Building	Soil(m^3)	Building	Soil(m^3)
731-A	22,386	631-6G	3,298
731-1A	6,718	131-C	3,325
231-F	6,494	431-D	4,302
231-1F	10,889	431-1D	3,509
131-R	1,902	131-K	2,615
131-1R	2,948	131-L	2,529
631-1G	2,276	131-P	4,802
631-5G	5,146		

The sites would be maintained on a similar basis as the surrounding grounds. Groundwater would continue to be monitored on a quarterly basis for 1 year, then annually for 29 years.

Additional corrective actions, such as groundwater extraction and treatment, might be needed to reduce the concentration of chlorinated hydrocarbons in the groundwater.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents, the consequences of environmental releases, and the pathways associated with this option are the same as those for the no-action option. The predicted maximum concentrations of the chemical constituents for this option are the same as those for the no-action option, as the constituents are assumed to have leached beyond the zone of control (see Section F.1.6.1).

Expected environmental risks to the maximally exposed individual due to atmospheric chemical and radiological releases from these burning/rubble pits for this option are about 100 times less than those for the no-action option and are considered not significant.

Occupational risks associated with the implementation of this option were also modeled. They are very low and are considered not significant, in particular when the conservatism built into the emissions is accounted for.

The predicted maximum concentrations for the erosion pathways are zero for this closure option.

Potential Impacts (Other Than Releases)

The potential ecological impacts of the waste removal and closure plan for the A-Area burning/rubble pits are discussed in Section F.1.14.3.

F.1.7 A-AREA BURNING/RUBBLE PIT, BUILDING 731-1A

This burning/rubble pit is discussed in conjunction with the other pits in Section F.1.6. The ecological effects of this site that relate specifically to the A- and M-Area geographic grouping are discussed in Section F.1.14.

F.1.8 SRL SEEPAGE BASINS*

The Savannah River Laboratory (SRL) seepage basins [Buildings 904-53G (Basins 1 and 2), 904-54G (Basin 3), and 904-55G (Basin 4)] stopped receiving wastes in October 1982. Background information on the history of waste disposal, waste characteristics, and evidence of contamination are presented in Appendix B, Section B.2.2.

F.1.8.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The site would be left in its present condition. Groundwater monitoring with existing wells would be continued quarterly for 1 year and then annually for 29 years. Upkeep would consist of maintaining a fence and signs around the basin area and cutting the weeds periodically.

Comparison of Expected Environmental Releases with Applicable Standards

PATHRAE predicts that arsenic and tritium will exceed, or continue to exceed, groundwater standards during the 1000-year modeled period. Table F-7 lists these parameters, the corresponding regulatory standards, and the maximum concentrations predicted to be found in the groundwater near the basins. All other constituents modeled were predicted to be below applicable standards. Table F-7 also shows monitoring data for trichloroethylene, which exceeded the applicable standard but was not selected for modeling.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

Air

The nonradioactive constituents were analyzed, using the methodology discussed in the introduction to Appendix F and in Appendix I, to estimate public exposure and risk attributable to constituents released to the atmosphere from

*The reference source of the information in this section is Fowler et al., 1986.

Table F-7. Predicted Maximum Concentrations of Various Constituents at the SRL Seepage Basins for the Three Closure Options[a,b]

Constituent	Applicable standard	Monitoring data maximum mean concentration	PATHRAE-modeled maximum concentration without remedial action[c,d]: No action, 1-m well	No action, 100-m well	No waste removal and closure, 1-m well	No waste removal and closure, 100-m well	Waste removal and closure, 1-m well	Waste removal and closure, 100-m well
Arsenic	0.05	(e)	0.740 (2115)	0.21 (2135)	0.073 (2435)	0.066 (2425)	0.073 (2405)	0.066 (2425)
Trichloroethylene	0.005	0.177 (well ASB 5A)	(f)	(f)	(f)	(f)	(f)	(f)
Tritium	87,000	(g)	320,000 (1962)	200,000 (1968)	320,000 (1962)	200,000 (1968)	320,000 (1962)	200,000 (1968)

[a]Source: Fowler, Simmons, Bledsoe, and Looney, 1986.
[b]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[c]EPA, 1985b, except where otherwise indicated. ICRP Publication 30 (ICRP, 1978) methodology was used to calculate radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[d]Number in parentheses represents year in which concentration was reached or is expected to be reached.
[e]Below applicable standard.
[f]Not modeled.
[g]Not reported.

the SRL seepage basins. Releases are due to the volatization of the contaminants and wind erosion. Risks attributable to releases of carcinogens are less than 10^{-7} with the exception of year 2085, when the site boundary is presumed to be close to the source due to public habitation of the SRP site. The risk is calculated to be 1.3×10^{-7}. The risks attributable to releases of noncarcinogens are calculated to be much less than 1, with a maximum of 10^{-4} for each of the 3 years analyzed (1986, 2085, and 2985).

Environmental doses and risks to the maximally exposed individual due to radiological releases from SRL seepage basins were calculated using the methodology presented in the introduction to this appendix and in Appendix I. The calculated doses are less than 3 percent of the DOE limit of 25 millirem. The risks associated with these doses would be less than 2.0×10^{-7}.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no-action closure plan is provided in Section F.1.14.1. PATHRAE modeling was performed on arsenic, cadmium, chromium, copper, fluoride, lead, mercury, nickel, silver, sodium, tritium, cobalt-60, strontium-90, yttrium-90, cesium-137, uranium-235 and -238, and plutonium-238 and -239, which were identified as having potential impacts on the aquatic systems. The four SRL seepage basins were modeled as a single unit in order to estimate cumulative effects resulting from the closure options. The results of the PATHRAE analysis indicate that these elements would not alter the present water quality of the Savannah River under any of the closure options.

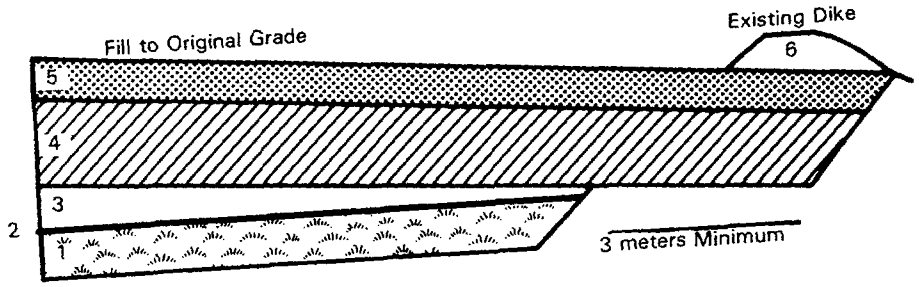
Because the SRL seepage basins have standing surface water, there may be impacts on the wildlife and vegetation that come into contact with these waters and on the wetlands, if basin overflow occurs. Based on the available chemical analysis data on the standing surface water of the seepage basins, levels of silver, copper, mercury, lead, zinc, cyanide, gross alpha, gross beta, and radium are higher than the freshwater biota criteria and the human health standards for radioactive elements. The human health standards for radioactive elements are considered to be equivalent to the freshwater biota criteria (DOI, 1968). Although these materials were identified based on aquatic criteria, they might have an impact on wildlife and vegetation that come into contact with the standing surface water of the basin.

The SRL seepage basins are located adjacent to the wetlands of Tims Branch. Impacts might occur under the no-action option if the basins overflowed into these wetlands during heavy rains.

F.1.8.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

There would be no excavation. The basin would be backfilled and capped. The fill would consist of 61 to 122 centimeters of crushed stone or washed gravel covered by a geotextile filter fabric and a minimum of 61 centimeters of common borrow fill. This would be covered by a low-permeability clay cap (see Figure F-2). Basins 1, 2, and 3 would be restored to the original ground surface (Figure F-3). Basin 4 would be filled and graded to remain above the



Legend:

1. Crushed stone or washed gravel (8 to 15 cm uniform-size stone). Approximately 0.6 m thick.
2. Geotextile filter fabric.
3. Common borrow fill. Thickness varies from 0 to 1 m.
4. Low-permeability cap. Group approximately 1.3 m thick.
5. Topsoil. Approximately 0.6 m thick.
6. Remove existing dike and use as fill where needed.

Figure F-3. Typical Basin Backfill Details of SRL Seepage Basins

original ground surface so as to ensure that the bottom sediments were covered (Figure F-4). Groundwater would be monitored quarterly for 1 year and then annually for 29 years.

Corrective action might be required for this option, since results of PATHRAE modeling predict that the concentrations in the groundwater of arsenic and tritium will remain above the maximum contaminant levels (MCLs) for this option (see Table F-7). The precise actions to be taken would be decided on the basis of site-specific studies and interactions with regulatory agencies.

Groundwater cleanup would consist of the removal of water from wells placed to contain the contaminant plume, and the physical or chemical treatment of this water to remove contaminants to concentrations that meet standards. Possible treatment technologies are discussed in Appendix C.

Comparison of Expected Environmental Releases with Applicable Standards

The implementation of this closure option, plus remedial action, would reduce all environmental releases to below MCLs (see Table F-7 for a listing of applicable standards). All other environmental releases are projected to be below regulatory standards.

The analysis described in the air release portion of Section F.1.8.1 was also performed for the no waste removal and closure option. Risks attributable to the release of carcinogens were calculated to be less than 2.9×10^{-17}. Risks attributable to the release of noncarcinogens were calculated as being less than 1, with the maximum value less than 6.5×10^{-9}. The dose is calculated to be 1.1×10^{-14} percent of the DOE limit of 25 millirem for each of the 3 years. The risk associated with this dose would be less than 8×10^{-22}.

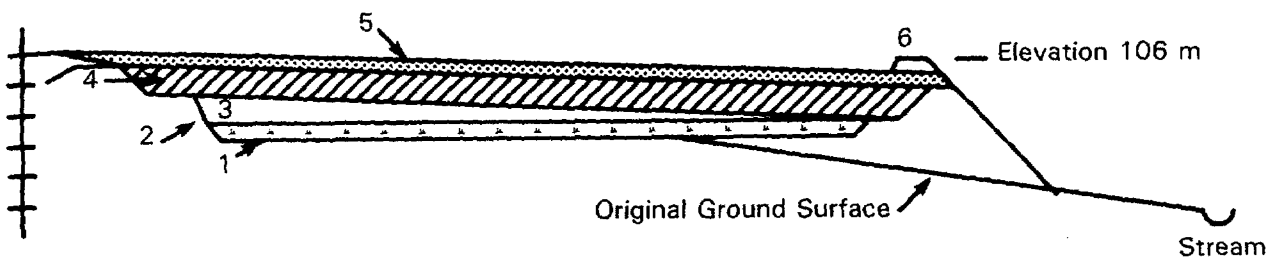
Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no waste removal and closure plan is provided in Section F.1.14.2. The contaminated water would be processed to meet NPDES standards before discharge. Therefore, no significant biological impacts on surface waters are expected.

F.1.8.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The basin would be excavated of water and waste, and the waste disposed of in a waste storage/disposal facility. Approximately 30.5 centimeters would be excavated from this basin. A total of 1900 cubic meters would be excavated from the four SRL seepage basins and disposed of in a secured area onsite. The basin would be backfilled and the site capped. The fill would consist of 61 to 122 centimeters of crushed stone or washed gravel covered by a geotextile filter fabric and at least 61 centimeters of borrow fill. This would be covered by a site low-permeability clay cap. Groundwater would be monitored quarterly for 1 year and then annually for 29 years.



Legend:
1. Crushed stone or washed gravel (8 to 15 cm uniform-size stone). Approximately 0.6 m thick.
2. Geotextile fiber fabric.
3. Common borrow fill. Thickness varies from 0 to 1 m.
4. Low-permeability cap. Group approximately 1.3 m thick.
5. Topsoil. Approximately 0.6 m thick.
6. Remove existing dike and use as fill where needed.

Figure F-4. Backfill Details for SRL Seepage Basin 4

Corrective actions might be required for this option, since the results of PATHRAE modeling indicate that the concentrations of arsenic and tritium in the groundwater would remain above the MCLs for this option (see Table F-7). The exact actions to be taken would be determined after site-specific studies and interactions with regulatory agencies.

Some of the possible treatment technologies are discussed in Appendix C.

Comparison of Expected Environmental Releases with Applicable Standards

The implementation of this closure option, plus remedial action, would reduce all environmental releases to below MCLs (see Table F-7 for a listing of applicable standards). All other environmental releases are projected to be below regulatory standards.

The analysis described in Section F.1.8.1 was also performed for the waste removal and closure option. Releases are due to the volatization of the constituents and earth-moving activities in 1986 and to volatilization in other years. Risks attributable to releases of carcinogens would be less than 2.2 x 10^{-11} and those for releases of noncarcinogens less than 5.8 x 10^{-8}.

The calculated dose to the maximum individual at the SRP boundary for each of the 3 years is less than 0.06 percent of the DOE limit of 25 millirem. The risk associated with this dose would be less than 3.8 x 10^{-9}.

An analysis of the average individual worker health risks attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk to a worker from nonradioactive carcinogens was calculated as less than 6.5 x 10^{-9}. The risk from noncarcinogens to a worker would be less than 1, with a maximum value of 10^{-4}. The total dose to the worker was calculated as 9.9 millirem, which translates to a risk of 2.8 x 10^{-6}. The total dose to the worker transporting the waste was calculated to be 18 millirem, which translates to a risk of 5.1 x 10^{-6}.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the waste removal and closure plan is provided in Section F.1.14.3. The standing water of the SRL seepage basins would be processed to meet NPDES standards before discharge; therefore, no significant biological impacts on surface waters are expected.

F.1.9 SRL SEEPAGE BASIN, BUILDING 904-53G (BASIN 2)

This seepage basin is discussed in conjunction with the other SRL seepage basins in Section F.1.8.

F.1.10 SRL SEEPAGE BASIN, BUILDING 904-54G (BASIN 3)

This seepage basin is discussed in conjunction with the other SRL seepage basins in Section F.1.8.

F.1.11 SRL SEEPAGE BASIN, BUILDING 904-55G (BASIN 4)

This seepage basin is discussed in conjunction with the other SRL seepage basins in Section F.1.8.

F.1.12 M-AREA SETTLING BASIN AND VICINITY*

The M-Area settling basin (Building 904-51G) and its associated areas have been designated as the M-Area Hazardous Waste Management Facility (HWMF). The areas included in the HWMF include the settling basin, overflow ditch, natural seepage area, a Carolina bay known as "Lost Lake" (Building 904-112G), and the inlet process sewer line. The HWMF received process effluents between 1958 and 1985. Background information on the history of waste disposal, waste characteristics, and evidence of contamination are presented in Appendix B, Section B.2.3.

F.1.12.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The liquid in the settling basin would be allowed to infiltrate or evaporate. The soils in the overflow ditch, seepage area, and Lost Lake would remain in place. General maintenance of the area around the basin, including vegetation control and maintenance of the exclusion fence, would continue. Monitoring of the groundwater would continue quarterly for 1 year, then annually for 29 years. The existing groundwater treatment facility would continue to process recovered groundwater contaminated with varying amounts of chlorocarbons. The treatment facility consists of an air stripper that is supplied with feed water from 11 groundwater withdrawal wells. The system is capable of treating a maximum flow of 1250 liters per minute. Treated effluent from the air stripper is discharged to a tributary of Tims Branch Creek at existing NPDES Outfall A-14. No additional remedial action is planned for the no-action alternative.

Comparison of Expected Environmental Releases with Applicable Standards

Current groundwater monitoring data indicate that concentrations of nitrate, gross alpha, gross beta, radium, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene exceed actual or proposed regulatory standards. PATHRAE modeling results indicate that groundwater concentrations of barium, cadmium, lead, nitrate, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene will exceed standards at various times in the future. However, the PATHRAE model does not account for removal of the chlorocarbons by the existing groundwater treatment facility.

*The reference source of the information in this section is Colven et al., 1986.

Table F-8 lists all constituents in the groundwater that currently exceed or are projected to exceed regulatory standards for the no-action alternative. The PATHRAE simulation indicates that future concentrations of modeled constituents in Tims Branch (due to outcrop of contaminated groundwater) will be below drinking-water standards.

Air

The nonradioactive constituents were analyzed, using the methodology discussed in the introduction to Appendix F and in Appendix I, to estimate public exposure and risk attributable to releases of constituents to the atmosphere from the M-Area HWMF. The analysis was performed for each of the subareas: M-Area settling basin, the overflow ditch and seepage area, and the air stripper.

Releases are due to the volatilization of the constituents and to wind erosion. Risks attributable to releases of carcinogens are less than 6.5×10^{-8} for each subarea for each of the 3 selected years (the air stripper will operate for a period of 30 years). Risks attributable to releases of noncarcinogens are calculated to be below 1, with a maximum value less than 1.3×10^{-5} for each of the 3 years.

Environmental doses and risks to the maximally exposed individual due to radiological releases from the M-Area HWMF were calculated using the methodology presented in the introduction to this appendix and in Appendix I. The calculated doses are less than 5 percent of the DOE limit of 25 millirem for each of the 3 years. The risks associated with these doses would be less than 3.3×10^{-7}.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no-action closure plan is provided in Section F.1.14.1. For the M-Area Settling Basin, PATHRAE modeling was performed on cadmium, chromium, copper, 1,1-dichloroethylene, lead, mercury, nickel, nitrate, sodium, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, and uranium-238, because each was identified as having potential impacts on the aquatic system. The results indicate that none of these materials would alter the present water quality of Upper Three Runs Creek under any closure option.

Because the M-Area settling basin has standing surface water, there may be potential impacts on the wildlife and vegetation that come into contact with the basin waters and on the wetlands, if the basin overflows. Based on the available chemical analysis data on the standing surface water of the settling basin, the levels of cadmium, copper, lead, mercury, and nickel are higher than the freshwater biota criteria for these elements. Although identification of these elements was based on aquatic criteria, they may also have a potential impact on wildlife and vegetation that come into contact with the standing water of the basin.

The M-Area settling basin is adjacent to the wetlands of Tims Branch and Upper Three Runs Creek. Potential impacts might occur under no action if the basin were to overflow into these wetlands.

Table F-8. Predicted Maximum Concentrations of Various Constituents at the M-Area Settling Basin for the Three Closure Options[a,b]

Constituent	Applicable standard[d]	Monitoring data maximum mean concentration[e]	PATHRAE-modeled maximum concentration without remedial action[c]: No action, 1-m well	No action, 100-m well	No waste removal and closure, 1-m well	No waste removal and closure, 100-m well	Waste removal and closure, 1-m well	Waste removal and closure, 100-m well
Barium	1.0	(f)	16 (2224)	2.3 (2272)	1.6 (2501)	1.3 (2535)	3.2 (2235)	(f)
Cadmium	0.01	(f)	0.16 (2252)	0.017 (2325)	0.016 (2539)	(f)	0.02 (2779)	(f)
Lead	0.05	(f)	0.068 (1990)	0.064 (1991)	(f)	(f)	0.059 (1995)	0.054 (1995)
Nitrate	10.0	132	1900 (1990)	1700 (1991)	590 (2052)	590 (2052)	1600 (1995)	1500 (1995)
Tetrachloroethylene	0.0007[g]	15.6[h]	300 (1993)	280 (1993)	82 (2073)	82 (2071)	260 (1996)	230 (1998)
Trichloroethylene	0.005	32.2[h]	57 (1990)	53 (1992)	17 (2058)	17 (2059)	49 (1996)	46 (1996)
1,1,1-trichloroethane	0.20	(f)	3.8 (1992)	3.5 (1992)	1.1 (2058)	1.1 (2058)	3.2 (1995)	3.1 (1996)
Gross alpha	10-20	21.4	(i)	(i)	(i)	(i)	(i)	(i)
Gross beta	40-60	86.2	(i)	(i)	(i)	(i)	(i)	(i)
Radium	6.0	17.5	(i)	(i)	(i)	(i)	(i)	(i)

[a]Source: Adapted from Colven et al., 1986.
[b]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[c]Number in parentheses represents year in which concentration is expected to be reached.
[d]EPA, 1985b. ICRP Publication 30 (ICRP, 1978) methodology was used to calculate radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[e]Monitoring data are for MSB water-table wells (Colven et al., 1986). Concentrations shown represent maximum single-well means reported for MSB wells.
[f]Below applicable standard.
[g]EPA, 1985a.
[h]Monitoring data for chlorocarbons reported in construction permit application (DOE, 1984).
[i]Constituent is not explicitly included in PATHRAE simulation; gross alpha and beta were included by estimating specific radionuclide inventory.

Potential aquatic impacts associated with the no-action option for Lost Lake could result from the contamination of groundwater and subsequent outcrop into Upper Three Runs Creek, and from direct contact with standing lake water by vegetation and wildlife. Since limited groundwater data are available for Lost Lake and the ditch connecting with the M-Area settling basin, impacts on aquatic resources in Upper Three Runs Creek were not determined for this pathway. Based on the available chemical analysis data on the standing surface water of Lost Lake, cadmium, lead, and mercury levels are higher than the freshwater biota criteria for these elements. As noted, although these elements were identified on the basis of aquatic criteria, they might also have an impact on wildlife and vegetation that would come into contact with the standing surface water.

Lost Lake is adjacent to the wetlands of Tims Branch. Potential impacts may occur under the no-action option if Lost Lake overflows into these wetlands.

F.1.12.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The steps involved in cleanup of the M-Area settling basin and vicinity by closure without waste removal are as follows:

- The remaining liquid in the basin would be decanted by being pumped into the overflow areas and Lost Lake, where enhanced evaporation and infiltration would occur. Pumping rates would not exceed historical overflow rates (750 to 1100 liters per minute), so as not to disturb the underlying sludge layer or overwhelm the retention capacity of the seepage and Lost Lake areas. Entrainment would be minimized by the design of pumping apparatus. Any suspended or dissolved materials carried over during this process would be retained in the shallow sediments after natural evaporation of the water.

- The gelatinous sludge layer in the basin would be stabilized to produce a solid material capable of supporting heavy equipment operation and the overburden load produced by fill and cap materials. A chemically suitable stabilization agent (Type I Portland cement) has been tested and was demonstrated to provide sufficient load-bearing capacity. The stabilization process would be performed in situ by mixing the agent directly with the sludge. The acceptable mixture ratio is 0.5 kilogram of agent per liter of sludge. The resulting product would be a layer of solid material covering the basin floor.

- A recharge network would be installed beneath the basin to flush organic contamination in the vadose zone to the groundwater, where in-place recovery systems would remove and treat the water.

  The recharge network would consist of a series of 15-centimeter-diameter perforated PVC pipe placed at 6-meter spacings lengthwise in the basin, connected by nonperforated pipe to a manhole at each end of the basin. This perforated pipe would be laid in 2.5-meter-deep trenches, which would then be backfilled with 0.3 meter of gravel and 2.2 meters of original soil. The 2.5-meter depth would put the

recharge system below the metal contamination in the soil to prevent dissolution and migration of waste material.

The purpose of the recharge network would be to replace the natural infiltration of rainwater cut off by the low-permeability cover. Clean water would be introduced to the system through a manhole at an infiltration rate of 8 liters per minute. At this rate the network would simulate natural recharge, which would serve to flush vadose zone organic contamination.

- The soil and sludge contaminated with metals would be relocated away from the overflow ditch, seepage area, and Lost Lake. Also, the process sewer line and manholes would be removed, as would 0.6 meter of soil beneath the sewer line between the basin and manhole No. 1 inside the M-Area exclusion perimeter. The total volume of soil to be excavated is shown below:

Soil/sludge from overflow ditch adjacent seepage area		5,500 m^3
Remainder of seepage area		7,500
Lost Lake		16,900
Process sewer, manholes, and soil		840
	Total	30,740 m^3

  All excavated soil would be placed in the basin and compacted to support the basin cap. Fill dirt would be added if required to level the material at the top of the berm.

- A low-permeability cap would then be emplaced. The cap would be designed and constructed to provide a maximum permeability of 1×10^{-7} centimeter per second. A layer of more permeable material would be placed on top of the clay cap, and a 0.6-meter-thick layer of topsoil added. The cap would be graded and planted to minimize erosion.

- Routine site maintenance would be carried out and a groundwater monitoring program would be maintained quarterly for 1 year and then annually for 29 years.

The current groundwater remedial action program for treatment of chlorocarbons would continue. The recharge network would flush chlorocarbons in the vadose zone to the water table, where the in-place groundwater recovery wells would remove and treat the water.

Additional remedial action may be taken to reduce concentrations of nitrate, sodium, and barium, constituents that PATHRAE simulations predict would exceed regulatory standards in the future under this option (see Table F-8).

Comparison of Expected Environmental Releases with Applicable Standards

The PATHRAE model predicts that the closure actions described above would maintain groundwater concentrations of cadmium and lead within MCLs. The current groundwater treatment facility is designed to reduce concentrations of chlorocarbons to within MCLs, and the potential additional groundwater treatment is expected to reduce concentrations of nitrate, and barium to within

MCLs or ACLs. In addition, gross alpha and gross beta constituents, which include radium and most alpha and beta radionuclides, would be reduced to levels within MCLs or ACLs by means of additional treatment. The PATHRAE simulation predicts that concentrations of inorganic constituents in the groundwater outcrop at Tims Branch would be below drinking-water standards. Treated effluent from the in-place groundwater treatment facility would be discharged to a tributary of Tims Branch and would be in compliance with NPDES permit limitations.

The analysis described in the air release section of Section F.1.12.1 was also performed for this option. Releases of carcinogens would be caused by the volatilization of contaminants through the cap on each basin. Risks attributable to these releases were calculated to be less than 1.6×10^{-8} for each of the 3 years for each subarea. Risks attributable to releases of noncarcinogens were calculated as below 1, with a maximum value less than 1.9×10^{-7} for each of the 3 selected years for each subarea. The calculated dose is less than 2.9×10^{-3} percent of the DOE limit of 25 millirem for each of the 3 years. The risk associated with this dose would be less than 2.0×10^{-10}.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no waste removal and closure plan is provided in Section F.1.14.2. Backfilling and capping the M-Area settling basin would eliminate potential impacts associated with direct exposure to standing basin water. According to this plan, the water within the M-Area settling basin would be pumped into Lost Lake.

The actions described above would reduce groundwater and surface-water contamination at the Lost Lake site. Potential impacts resulting from exposures to standing water would be eliminated. Erosion control measures would be implemented to protect aquatic resources and adjacent wetlands.

F.1.12.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The steps involved in cleanup of the M-Area settling basin and vicinity by waste removal and closure are as follows:

- The remaining liquid portion in the basin would be decanted in a manner identical to that described in Section F.1.12.2.
- The gelatinous sludge layer in the basin would be stabilized to facilitate removal and handling. The sludge would be treated with adsorbents or drying agents to produce a material which could be removed by normal excavation methods.
- Soil and sludge contaminated with metals from the basin, overflow ditch, seepage area, and Lost Lake would be removed, as would the process sewer line, manholes, and 0.6 meter of soil beneath the sewer line between the basin and manhole No. 1 inside M-Area. The extent to which soil removal for metals contamination would be required would depend on results of soil and sludge characterization studies. In general, the

depth of soil removal would range from a few centimeters in Lost Lake to several meters beneath the basin in order to remove metal contamination close to background levels. Estimates of the total volume of material required to be removed in this step are as follows:

Sludge/soil beneath basin		20,900 m^3
Overflow ditch and adjacent seepage area		5,500
Remainder of seepage area		7,500
Lost Lake		16,900
Process sewer, manholes, and soil		840
	Total	51,640 m^3

- Final disposition of the soils removed from the M-Area settling basin and vicinity would follow one of two paths:

  a. Chemical treatment - The metal contaminants in the soil would be removed from the soil by conventional chemical treatment methods. Acid and caustic washes would dissolve the metals, leaving an innocuous soil material that would be disposed of by burial. The remaining leachate would be further treated to precipitate the metals and produce a solid waste. The solidified waste would then be placed in an onsite mixed/hazardous waste repository for final disposition.

  b. Repository disposal - The soil removed from the basin and vicinity would be placed in an onsite mixed/hazardous waste repository.

- The basin and vicinity would be backfilled and regraded with onsite clean fill material. An estimated 30,000 cubic meters of fill material would be required. The area would then be revegetated with grass and trees to restore the natural state.

- Postclosure monitoring and cleanup of organic contamination in the groundwater and vadose zone would be started. In-place monitoring wells would be used to define the extent of contamination and evaluate the effectiveness of cleanup activities. These wells would also be used to determine the point at which groundwater cleanup activities could be discontinued.

- Groundwater treatment for removal of organic contamination would be accomplished by means of the in-place recovery well network and air stripping system. Vadose zone contamination would be allowed to migrate via natural recharge to the groundwater, where in-place recovery systems would remove and treat the water.

- Routine site maintenance would be carried out and a groundwater monitoring program would be maintained quarterly for 1 year and then annually for 29 years.

Potential additional remedial action, as described in Section F.1.12.2, may be required to reduce groundwater concentrations of nitrate and barium to levels within MCLs. As shown in Table F-8, PATHRAE simulations predict that these constituents will exceed regulatory standards at various times in the future for the waste removal and closure alternative.

Comparison of Expected Environmental Releases with Applicable Standards

The discussion presented in Section F.1.12.2 is also relevant to the waste removal and closure option.

The analysis described in Section F.1.12.1.1.1 was also performed for this option. Releases in the first year are due to excavation and backfilling. In future years, releases would be caused by volatilization of contaminants. Releases due to emissions from the air stripper are zero for the years 2085 and 2985 since the facility will only operate 30 years. Risks attributable to releases of carcinogens and noncarcinogens were calculated to be less than 1.5×10^{-8} and less than 1.9×10^{-7}, respectively, for each of the 3 years.

The calculated dose to the maximally exposed individual at the SRP boundary for each of the 3 years is less than the DOE limit of 25 millirem. The risk associated with this dose would be less than 1.8×10^{-20}.

An analysis of the average individual worker health risks attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk due to nonradioactive carcinogens to a worker was calculated to be less than 7.4×10^{-9}. The risk due to noncarcinogens to a worker was calculated to be below 1, with a value of 6.9×10^{-4}. The total dose to the worker was calculated as 6.6 millirem, which translates to a risk of 1.9×10^{-6}. The total dose to the worker transporting the waste would be 3.3 millirem, which translates to a risk of 9.2×10^{-7}.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the waste removal and closure plan is provided in Section F.1.14.3. Backfilling and capping the M-Area settling basin would eliminate potential impacts associated with direct exposure to standing basin water. According to the waste removal and closure plan, the water within the M-Area settling basin would be pumped into Lost Lake.

Removal of waste planned under this closure option for Lost Lake would further reduce groundwater and surface-water contamination at the site. Erosion control measures would be implemented to protect aquatic resources and adjacent wetlands.

F.1.13 LOST LAKE, BUILDING 904-112G

Lost Lake is discussed in conjunction with the M-Area settling basin and vicinity in Section F.1.12.

F.1.14 POTENTIAL IMPACTS ON BIOLOGICAL RESOURCES IN A- AND M-AREA

This section discusses those generic impacts related to aquatic and terrestrial ecology, as well as endangered species and wetlands, for each closure action. Where a discussion of site-specific data is required for a given alternative, it is presented in the appropriate section above.

There are 13 waste sites located within the A- and M-Area. The motor shop seepage basin contains surface waters, as do the metallurgical laboratory basin, the four SRL seepage basins, the M-Area settling basin, and Lost Lake. The remaining waste sites, the metals burning pit, Silverton Road waste site, miscellaneous chemical basin, and the two A-Area burning/rubble pits, are presently backfilled or covered with soil and covered with vegetation. All waste sites within this geographic grouping are either abandoned or inactive.

F.1.14.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Actions)

Aquatic Ecology

A potential aquatic impact for the waste sites of the A- and M-Area is the release to surface water of groundwater containing materials from the various waste sites of the A- and M-Area. Table F-9 lists those materials in the groundwater that were not modeled using the PATHRAE analysis but do exceed the freshwater biota criteria for each of the waste sites.

Where data are available, it can be determined that the materials listed in Table F-9 are not expected to create new or enhance existing impacts on the aquatic biota of nearby streams. This conclusion was based on the estimated dilution factors (Table F-9), which were calculated by dividing the groundwater flux by the flow rate of the receiving stream. The dilution factor indicates that these materials will be diluted so as not to affect the present water quality of the receiving stream.

Terrestrial Ecology

The potential terrestrial impacts for the waste sites of the A- and M-Area are the exposure of wildlife and vegetation to surface waters within waste sites and the toxic effects on vegetation of soils containing waste materials. The terrestrial impacts of those waste sites with standing surface waters have been addressed on an individual basis above. Plant toxicity is dependent on the plant species, root depth, chemical form of the waste materials present, soil composition and moisture, and the rate of material uptake by a plant. Because there are many variables that affect plant toxicity and because of limited information on such items, the impacts of waste materials in the soil on plants cannot be accurately assessed for these waste sites. However, any such effects would be limited to very small areas, and the likelihood of public exposure due to consumption of vegetation grown on waste sites or through the meat food chain is extremely low.

Endangered Species

No endangered species have been identified in the vicinity of the waste sites of the A- and M-Area from previous surveys at the SRP (see Table F-9). The habitats in the immediate vicinity of these waste sites are not considered to be suitable for any Federally endangered species previously reported from the SRP. Therefore, none of the actions proposed for the waste sites of A- and M-Area would have an effect on endangered species.

Table F-9. Environmental Data for A- and M-Area Waste Sites

Waste site	Areal extent of site (m)[b]	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[c]	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria[a]: Contaminant	Reported level[d]	Criterion[e]	Area of groundwater outcrop; distance (m) to nearest stream	Dilution factor[f]
716-A motor shop seepage basin (904-101G)[g]	63.1 (l) x 10.7 (w) x 2.0 (d)	800	0/2.2	No endangered species or critical habitats observed within 200 m of vicinity	Chromium Copper Lead Zinc	0.055 0.0093 0.013 0.069	0.011 0.0065 0.0013 0.047	No information	No information
Metals burning pit (731-4A)[h]	120 (l) x 120 (w) x 1-2 (d)	Over 1,000	0/0	No endangered species or critical habitats observed within 200 m of vicinity	Lead Copper Iron Zinc	0.017 0.026 0.061 0.230	0.0013 0.0065 1.0 0.047	Savannah River; 9,000	3.84×10^{-6}
Silverton Road waste site (731-3A)[i]	212 (l) x 62 (w)	Over 1,000	0/0	No endangered species or critical habitats observed within 200 m of vicinity	Zinc Copper	2.100 0.017	0.047 0.0065	Savannah River; 8,000	2.88×10^{-6}
Metallurgical laboratory basin (904-110G)[j]	31 (l) x 12 (w) x 1.5 (d)	400	0/20.9	No endangered species or critical habitats observed within 200 m of vicinity	All contaminants exceeding aquatic criteria were modeled.			Savannah River; 11,000	5.38×10^{-6}
Miscellaneous chemical basin (731-5A)[h]	6 (l) x 6 (w) x 10.3 (d)	Over 1,000	0/0	No endangered species or critical habitats observed within 200 m of vicinity	No data	No data	No data	Tims Branch; 3,000	1.42×10^{-3}

Footnotes on last page of table.

Table F-9. Environmental Data for A- and M-Area Waste Sites (continued)

Waste site	Areal extent of site (m)[b]	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[c]	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria[a]: Contaminant	Reported level[d]	Criterion[e]	Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[f]
A-Area burning/ rubble pit 731-A[k]	100 (l) x 54.6 (w) x 3.10 (d)	Over 1,000	No data	No endangered species or critical habitats observed within 200 m of vicinity	No data	No data	No data	No data	No information
A-Area burning/ rubble pit 731-1A[k]	174.3 (l) x 9.4 (w) x 3.1 (d)	Over 1,000	No data	No endangered species or critical habitats observed within 200 m of vicinity	No data	No data	No data	No data	No information
SRL seepage basin 904-53G[l]	39.3 (l) x 19.0 (w) x 2.0 (d)	0	7.1/35.2	No endangered species or critical habitats observed within 200 m of vicinity	Iron Zinc pH	9.539 0.158 4.25	1.0 0.047	Savannah River; 11,000	2.4×10^{-5}
SRL seepage basin 904-53G[l]	39.3 (l) x 39.3 (w) x 2.0 (d)	0	7.1/35.2	No endangered species or critical habitats observed within 200 m of vicinity	Iron Zinc pH	9.539 0.158 4.25	1.0 0.047	Savannah River; 11,000	2.4×10^{-5}
SRL seepage basin 904-54G[l]	53.3 (l) x 38.1 (w) x 2.7 (d)	0	7.1/35.2	No endangered species or critical habitats observed within 200 m of vicinity	Iron Zinc pH	9.539 0.158 4.25	1.0 0.047	Savannah River; 11,000	2.4×10^{-5}

Footnotes on last page of table.

Table F-9. Environmental Data for A- and M-Area Waste Sites (continued)

Waste site	Areal extent of site (m)[b]	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[c]	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria[a]			Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[f]
					Contaminant	Reported level[d]	Criterion[e]		
SRL seepage basin 904-55G[l]	94.0 (l) x 46 (w) x 3.35 (d)	0	7.1/35.2	No endangered species or critical habitats observed within 200 m of vicinity	Iron Zinc pH	9.539 0.158 2.25	1.0 0.047	Savannah River; 11,000	2.4×10^{5}
M-Area settling basin (904-51G)[m]	100.9, 85, 85, 70[n]	0	0.2/2.0	No endangered species or critical habitats observed within 200 m of vicinity	Zinc Cyanide Gross alpha Gross beta Radium	2.719 0.034 21.39 86.200 22.33	0.047 0.0052 10 40 5	Upper Three Runs Creek	3.8×10^{4}
Lost Lake (904-112G)[m]	No data	600	No data	No endangered species or critical habitats observed within 200 m of vicinity	Zinc Cyanide Gross alpha Gross beta Radium	2.719 0.034 21.39 86.20 22.33	0.047 0.0052 10 40 5	Upper Three Runs Creek	3.8×10^{4}

[a]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[b]Key: l, length; w, width; d, depth.
[c]Data from Mayer, Hoppe, and Kennamer, 1986; Du Pont, 1985.
[d]Average value for most recent year for groundwater well containing highest concentration.
[e]Based on ICRP, 1979; EPA, 1985b,c, 1986; DOI, 1968.
[f]Equivalent to groundwater flux divided by flow rate of receiving stream.
[g]Data from Huber and Bledsoe, 1986a, except as otherwise indicated.
[h]Data from Muska, Pickett, and Marine, 1986, except as otherwise indicated.
[i]Data from Scott, Killian, Kolb, Corbo, and Bledsoe, 1986, except as otherwise indicated.
[j]Data from Michael, Johnson, and Bledsoe, 1986, except as otherwise indicated.
[k]Data from Huber, Johnson, and Marine, 1986, except as otherwise indicated.
[l]Data from Fowler et al., 1986, except as otherwise indicated.
[m]Data from Colven et al., 1986, except as otherwise indicated.
[n]Side dimensions only.

Wetlands

The nearest wetlands to the waste sites of the A- and M-Area are located at Tims Branch and Upper Three Runs Creek. These wetlands consist primarily of bottomland hardwoods. Table F-9 provides the distances between the waste sites and the wetlands. Most waste sites of the A- and M-Area are considered far enough away from the wetlands so as not to be affected by any of the closure options. Those waste sites that are near the wetlands and pose a potential impact have been discussed on an individual basis above.

F.1.14.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Ecology

The potential aquatic impacts for the waste sites of the A- and M-Area include direct and indirect contamination of surface water. In some cases, this option proposes to drain the surface water of a waste site directly into a stream. The potential impacts of this action for these particular waste sites are discussed on an individual basis. Indirect contamination of surface water via groundwater from the various waste sites is not likely to create an impact on the existing stream water quality due to the dilution factor, as described in Section F.1.14.1. Also, some closure plans involve backfilling the basin with uncontaminated fill and the use of a low-permeability clay cap over the waste site. The clay cap would retard the leaching of soil contaminants into the groundwater.

Terrestrial Ecology

The potential terrestrial impacts for the waste sites of the A- and M-Area include toxic effects on vegetation caused by contaminated soil and temporary disturbance of the wildlife due to noise and habitat loss created by the closure plan. Where a clay cap is used, mowing would help prevent the establishment of deep-rooted plants and hence root penetration into the waste zone. Toxic effects on vegetation are described in Section F.1.14.1.

Endangered Species

None of the actions proposed for the waste sites of the A- and M-Area would have any effect on endangered species. See Section F.1.14.1.

Wetlands

As described in Section F.1.14.1, most of the waste sites of the A- and M-Area are considered to be sufficiently removed from the wetlands so as not to be affected by any of the closure options. However, for those waste sites that are near a wetland, corrective actions would require erosion control to prevent runoff of sedimentation into the wetlands.

F.1.14.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Ecology

The potential ecological impacts of the waste removal and closure plan for the waste sites of the A- and M-Area would be similar to those described in Section F.1.14.2, except that the removal of waste material and contaminated soils should further reduce any potential for impacts on aquatic ecosystems.

Terrestrial Ecology

The potential impact of plant toxicity as described in Section F.1.14.1 should be significantly reduced by the proposed waste removal and closure plan. The removal of wastes and contaminated soils should eliminate the potential of plant uptake of waste materials.

Endangered Species

None of the actions proposed for the waste sites of the A- and M-Area would have any effect on endangered species. See description in Section F.1.14.1.

Wetlands

Section F.1.14.1 describes the wetlands that exist within the vicinity of the A- and M-Area. Remedial actions should include soil erosion control to protect those wetlands that are near a waste site.

F.2 ASSESSMENT OF ACTIONS AT F- AND H-AREA WASTE SITES

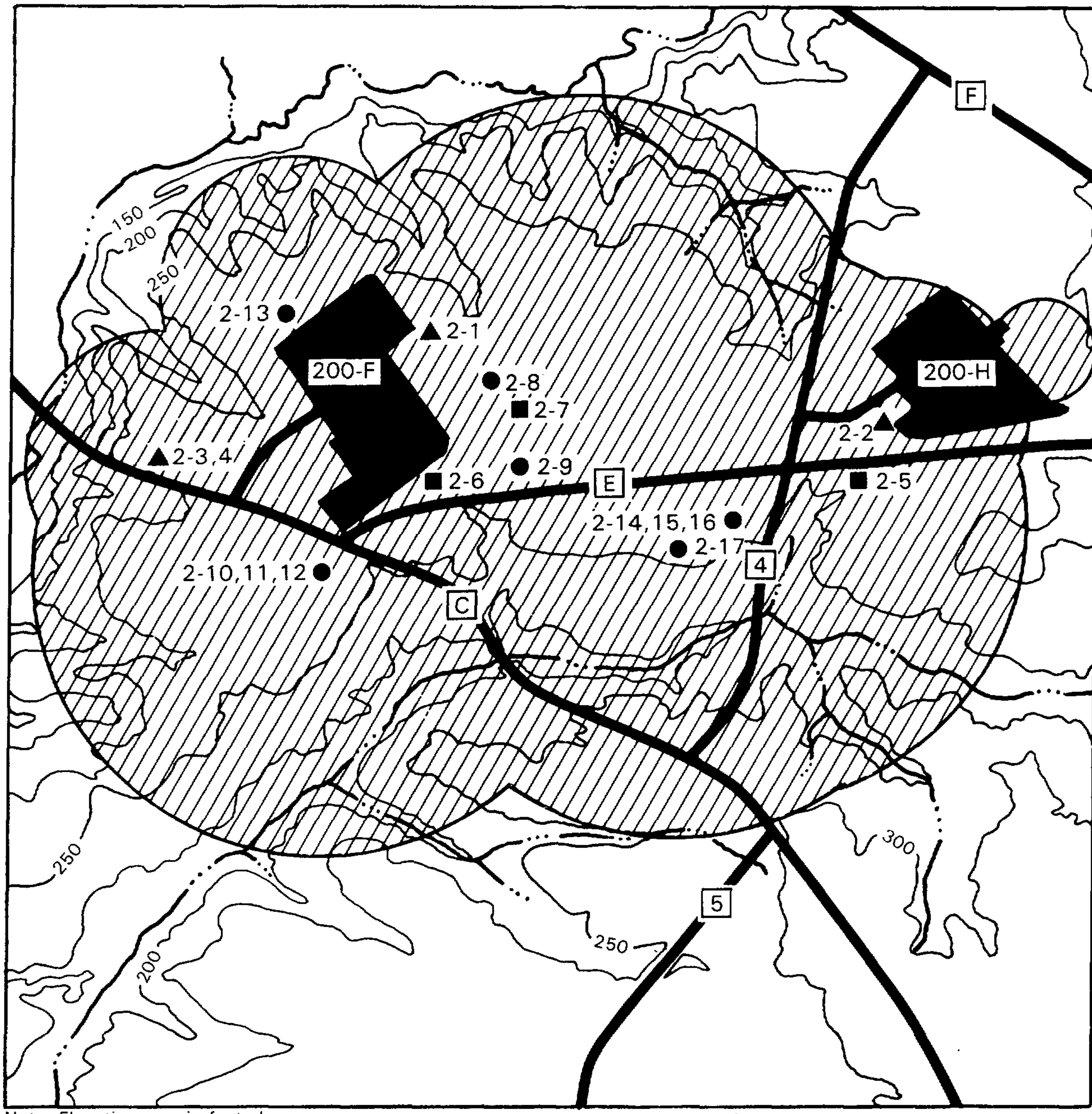
This geographic grouping of waste sites is about 10 kilometers southeast of A-Area. It is formed by waste sites associated with the Separations (200-F and -H) Areas, which are just north of Road E. Figure F-5 shows the locations of the waste sites within this grouping.

Sections F.2.1 through F.2.17 contain or reference the appropriate section for a discussion of sites 2-1 through 2-17. Section F.2.18 discusses biological impacts that are generically applicable to the F- and H-Area waste sites.

F.2.1 ACID/CAUSTIC BASINS

There are a total of six acid/caustic basins on SRP, located as follows:

Area	Building
F	904-74G
H	904-75G
R	904-77G
K	904-80G
L	904-79G
P	904-78G



Note: Elevations are in feet above mean sea level
1.0 foot = 0.3048 meter

Scale (kilometers)
0 1 2

Legend on following page

Figure F-5. F- and H-Area Waste Sites

Number	Potential Waste Type	Site Name	Building Number
2-1	▲	F-Area Acid/Caustic Basin*	904-74G
2-2	▲	H-Area Acid/Caustic Basin*	904-75G
2-3	▲	F-Area Burning/Rubble Pit*	231-F
2-4	▲	F-Area Burning/Rubble Pit*	231-1F
2-5	■	H-Area Retention Basin	281-3H
2-6	■	F-Area Retention Basin	281-3F
2-7	■	Radioactive Waste Burial Ground	643-7G
2-8	●	Mixed Waste Management Facility	643-28G
2-9	●	Radioactive Waste Burial Ground	643-G
2-10	●	F-Area Seepage Basin	904-41G
2-11	●	F-Area Seepage Basin	904-42G
2-12	●	F-Area Seepage Basin	904-43G
2-13	●	F-Area Seepage Basin (old)	904-49G
2-14	●	H-Area Seepage Basin	904-44G
2-15	●	H-Area Seepage Basin	904-45G
2-16	●	H-Area Seepage Basin	904-46G
2-17	●	H-Area Seepage Basin	904-56G

*Indicates that waste type may be contained in the waste site

▲—Hazardous

■—Low-level radioactive

●—Mixed

Figure F-5. F- and H-Area Waste Sites (continued)

The acid/caustic basins on SRP are nearly identical physically and received similar waste. Consequently, potential releases and associated environmental effects would be expected to be quite similar. Therefore, the options, releases, and impacts described in this section would be applicable to each of these six basins.

The environmental analyses for the six acid/caustic basins were performed only for the L-Area acid/caustic basin (Building 904-79G). That basin has the largest inventory of contaminants and was therefore selected as a worst-case scenario. It is conservative to assume that the other five basins would behave similarly. To provide a relative scale for the six basins, the estimated disposal mass of contaminants selected for environmental assessment is listed in Table F-10. The reference source of the information in this section is Ward, Johnson, and Marine, 1986.

Table F-10. Estimated Disposal Mass of Contaminants Selected for Environmental Assessment[a]

Constituent	Estimated Disposal Mass (kg)					
	F-Area (904-74G)	H-Area (904-75G)	R-Area (904-77G)	K-Area (904-80G)	L-Area (904-79G)	P-Area (904-78G)
Arsenic	-	-	-	-	-	0.6
Barium	-	-	-	-	16.0	-
Chromium	1.4	6.5		1.9	3.8	1.6
Copper	-	-	-	4.4	36.0	-
Lead	0.2	0.5	7.8	2.3	29.0	3.3
Mercury	0.3	-	0.1	-	0.3	-
Phosphate	8.6	-	-	4.08	6.3	-
Selenium	-	-	-	0.32	-	-
Sodium	-	-	33.0	4300.0	6206.0	-
Sulfate	-	-	-	9100.0	3300.0	-

[a]Source: Ward, Johnson, and Marine, 1986.

F.2.1.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Under this closure option, the acid/caustic basins would be left in their current condition.

The groundwater monitoring program would continue on a quarterly basis for 1 year, then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents, or waste materials, selected for assessment at the acid/caustic basins were barium, chromium, copper, lead, mercury, phosphate,

sodium, and sulfate. These constituents were selected because they were found in the groundwater or soil at levels higher than the threshold selection criteria. For the atmospheric pathway, ten constituents were analyzed: arsenic, selenium, and the eight listed above.

Table F-11 lists the predicted maximum concentration of chromium and the year in which the maximum concentration is expected to be reached, based on groundwater modeling. For the no-action option, concentrations of chromium is predicted to exceed applicable standards at the 1-meter well and to be below applicable standards at the 100-meter well.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from these sites. The resulting concentrations of constituents in Steel Creek, calculated for the worst-case scenario of the L-Area acid/caustic basin, are projected to be below drinking-water standards.

Estimated environmental risks due to atmospheric chemical releases from the acid/caustic basins for this option are based on the ten chemical constituents found in at least one but not all of the acid/caustic basins. Risks are very low. For example, the peak chemical carcinogenic risk to the maximally exposed individual is less than 10^{-8}, while the peak noncarcinogenic hazard index is less than 2×10^{-5}, far below the "no effect" threshold of 1. These risks are considered not significant.

The concentrations for the erosion and biointrusion pathways are all zero, because the length of time that it takes for the constituents to start eroding is well over 1000 years and the depth of the cover material is such that roots of plants intruding onto the waste site will never penetrate the contaminated material.

Potential Impacts (Other Than Releases)

Aquatic Ecology

PATHRAE analysis of the L-Area acid/caustic basin indicates that the influent water concentrations of copper, lead, and mercury do not exceed EPA freshwater biota criteria and do not alter in-stream concentrations of these elements for the receiving water, Steel Creek. Assuming similar influent concentrations of copper, lead, and mercury, and considering the dilution factor of the receiving water, concentrations of these elements in other onsite streams from other acid/caustic basins are not expected to be significantly altered by the use of any closure option at these basins.

In order to estimate potential impacts of other materials, water quality parameters of downgradient wells were reviewed. Those parameters for which the well concentrations were found to be greater than the water quality criteria were cadmium, chromium, iron, zinc, radium, gross alpha, and gross beta. The dilution factor of 0.0159 would produce concentrations of all waste constituents below EPA criteria in the receiving water. Consequently, there would be no impact on the biota of the streams.

Table F-11. Predicted Maximum Concentrations (mg/L) of Chromium at Acid/Caustic Basins for the Three Closure Options[a]

Constituent	Applicable standard[c]	Monitoring data maximum mean concentration	Predicted maximum concentration[b]					
			No action		No removal and closure		Removal and closure	
			1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Chromium	5.0×10^{-2}	(d)	6.7×10^{-2} (2644)	(d)	(e)	(e)	(e)	(e)

[a]Source: Adapted from Ward, Johnson, and Marine, 1986.
[b]Number in parentheses represents year in which concentration is expected to be reached.
[c]EPA, 1985b.
[d]Below applicable standard.
[e]Value identical to that of no-action option.

Terrestrial Ecology, Endangered Species, and Wetlands

The no-action alternative at the acid/caustic basins would be unlikely to have any adverse impact on terrestrial ecological resources. Although some basins are wet-weather ponds, they are too small (0.057 acre) to attract significant numbers of waterfowl. Impacts should not affect endangered species and wetlands, as discussed in Section F.2.18.1.

F.2.1.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this closure option, any liquid found in the basins would be neutralized and discharged. Approximately 500 cubic meters of soil would be required to backfill the basin to grade. The soil would be compacted to the appropriate density to prevent settling; the surface would be graded to preclude ponding of rainwater and seeded with suitable grass.

The groundwater monitoring program would be continued on a quarterly basis for 1 year, then annually for 29 years.

If required, groundwater remediation could be implemented to reduce the concentration of any contaminants to below applicable standards.

Comparison of Expected Environmental Releases with Applicable Standards

With the exception of air releases, the chemical constituents, the consequences of environmental releases, and the pathways associated with this option are the same as those for the no-action option, since contaminants have presumably leached beyond the zone of control (see Table F-11).

The estimated environmental risks due to atmospheric releases from F-Area acid/caustic basin for this option are very small. No carcinogenic risks are expected under this option. The noncarcinogenic hazard index is very low (about 10^{-15}). These risks are considered insignificant.

Potential Impacts (Other Than Releases)

Impacts on biological resources of this closure option at the acid/caustic basin are described in Section F.2.18.2.

F.2.1.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this closure option, all basin liquids would be neutralized in place and discharged, and all sediment in the basins and any chemically contaminated soil up to a depth of 0.9 meter below the original sides and bottom of the basin would be removed prior to backfilling. Any chemically contaminated soil would be removed by skip pans, placed in metal boxes, and transported to the SRP hazardous waste storage/disposal facility. Approximately 700 cubic meters

of soil would be required to backfill each basin to grade. The surface would be graded to preclude ponding of rainwater and seeded with a suitable grass.

The groundwater monitoring program already in place would be continued on a quarterly basis for 1 year; the wells would then be monitored annually for 29 years.

Additional corrective actions might be needed to address the constituents already in the groundwater. The choice of actions to be taken would be based on site-specific studies and interactions with relevant regulatory agencies.

Comparison of Expected Environmental Releases with Applicable Studies

The chemical constituents of concern, the consequences of environmental releases, and the pathways that may have an impact on human health are the same as for the no-action option. The results of the PATHRAE analyses are listed in Table F-11. The contaminant concentrations in the groundwater for this option are the same as for the no-action option.

Estimated environmental risks due to atmospheric chemical releases from the acid/caustic basins for this option are very low. Except for 1986, the year of excavation activities, no carcinogenic risks to the maximally exposed individual are anticipated. In 1986 the carcinogenic risk is less than 10^{-12} and the noncarcinogenic hazard index is less than 10^{-6}. The risks are considered not significant.

Occupational risks associated with the implementation of this option are also very low and are considered insignificant.

The expected concentrations for the erosion and biointrusion pathways are again zero. In addition, the expected concentrations for the reclaimed farm pathway are now zero because all of the contaminated material has been removed from the site.

Potential Impacts (Other Than Releases)

Impacts on biological resources of this closure option at the F-Area acid/caustic basin would be expected to be similar to those discussed in Section F.2.18.3.

F.2.2 H-AREA ACID/CAUSTIC BASIN, BUILDING 904-75G

This acid/caustic basin is discussed in conjunction with the other acid/caustic basins in Section F.2.1. The ecological effects of this site that relate specifically to the F- and H-Area geographic grouping are discussed in Section F.2.18.

F.2.3 F-AREA BURNING/RUBBLE PIT (BUILDING 231-F)

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the F- and H-Area geographic grouping are discussed in Section F.2.18.

F.2.4 F-AREA BURNING/RUBBLE PIT, BUILDING 231-1F

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the F- and H-Area geographic grouping are discussed in Section F.2.18.

F.2.5 H-AREA RETENTION BASIN, BUILDING 281-3H*

The H-Area retention basin is a low-level radioactive waste management facility that stopped receiving wastes in 1971. Background information on the history of waste disposal, waste characteristics, and evidence of contamination are presented in Appendix B, Section B.3.2.

F.2.5.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

For this option the site would remain in its present condition. Two additional wells would be installed and all wells would be monitored quarterly for 1 year, then annually for 29 years. Upkeep would consist of maintaining a fence and posting signs around the basin.

Comparison of Expected Environmental Releases with Applicable Standards

PATHRAE analyses predict that EPA drinking water standards will be exceeded within the 100-year institutional control period for both the 1-meter and 100-meter wells. All other environmental releases are projected to be below applicable standards under this option.

Groundwater

The releases are expressed in terms of radionuclide concentrations for a well 1 meter and another well 100 meters downgradient of the retention basin.

The following is a comparison of the concentrations in the 1-meter and 100-meter wells in the peak years with the EPA primary drinking-water standards:

	Concentration, pCi/L				
Well	Sr-90	Y-90	Cs-137	Pu-238	Total
MCL	4.2×10^1	5.5×10^2	1.1×10^2	1.4×10^1	
1-m well (fractional MCL)	1.4×10^4 (333)	1.4×10^4 (25)	8.8×10^1 (0.8)	7.1×10^0 (0.5)	(359)
100-m well (fractional MCL)	1.6×10^1 (0.38)	1.6×10^1 (0.03)	4.6×10^1 (0.42)	5.1×10^0 (0.36)	(1.19)

*The reference source of the information in this section is Scott, Killian, Kolb, Corbo, and Marine, 1986.

Since PATHRAE modeling predicts that the sum of the ratios for each well would exceed 1, compliance with regulatory standards is not met.

Surface Water

Surface-water quality is not significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in Four Mile Creek are projected to be below drinking-water standards.

Air

Environmental doses and risks to the maximally exposed individual due to radiological releases from the H-Area retention basin were calculated using the methodology presented in the introduction to this appendix and in Appendix I. The calculated doses were less than 1.6 percent of the DOE limit of 25 millirem per year for each of the 3 selected years. The risks associated with these doses would be less than 1.1×10^{-7}.

No nonradioactive constituents are released to the atmosphere in the H-Area retention basin.

Potential Impacts (Other Than Releases)

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways would occur 100 years from the present, at which time institutional control of the SRP is assumed lost. The doses are only 0.22 and 0.68 mrem/yr for the farm and direct gamma exposure pathways, respectively. There would be no dose from the consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments, due to the assumed limited plant-root depth.

Aquatic Resources

Potential impacts on aquatic resources as a result of the no-action closure option at the H-Area retention basin are expected to be similar to those described in Section F.2.18.1. PATHRAE analysis has been performed on strontium-90, yttrium-90, cesium-137, and plutonium-238. This analysis indicates that influent concentrations and final stream mixture for these elements would not exceed freshwater biota water quality criteria for any of the closure options.

The H-Area retention basin is a wet-weather pond. As such, aquatic or semiaquatic organisms using the basin might be adversely impacted (see Section F.2.1.1).

Terrestrial Resources

The no action alternative at the H-Area retention basin might adversely impact waterfowl or other birds or animals attracted to the pond. However, potential impacts cannot be determined due to limited data.

Endangered Species and Wetlands

As discussed in Section F.2.18.3, no adverse impacts on endangered species or wetlands are expected as a result of this closure option at the H-Area retention basin.

F.2.5.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Standing water would be removed and disposed of in the operating H-Area retention basin. The basin would be backfilled to 0.3 meter above the land surface, with about 2.4 meters of borrow fill. The amount of fill needed would be 5360 cubic meters. The fill would be covered with a low-permeability clay cap. Two additional groundwater monitoring wells would be installed and all four wells would be monitored quarterly for 1 year, then annually for 29 years.

The modeling results for this option indicate that the sum of the ratios of the peak well concentrations to their MCL values is 98 and 1.19 for the 1- and 100-meter wells, respectively. Since these values exceed 1, remedial actions might be required.

Additional actions might be needed to address the constituents already in the groundwater. The choice of action would be based on site-specific studies and interactions with regulatory agencies. Some potential treatment technologies are discussed in Appendix C.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The releases are expressed in terms of radionuclide concentrations for a well 1 meter and another well 100 meters downgradient of the retention basin.

The following is a comparison of the peak concentrations in the 1-meter and 100-meter wells with the EPA primary drinking-water standards:

	Concentration, pCi/L				
Well	Sr-90	Y-90	Cs-137	Pu-238	Total
MCL	4.2×10^1	5.5×10^2	1.1×10^2	1.4×10^1	
1-m well (fractional MCL)	3.8×10^3 (90)	3.8×10^3 (6.9)	8.8×10^1 (0.8)	7.1×10^0 (0.6)	(98)
100-m well (fractional MCL)	1.6×10^1 (0.38)	1.6×10^1 (0.03)	4.6×10^1 (0.42)	5.1×10^0 (0.36)	(1.19)

Appropriate treatment technologies would be employed to reduce the concentrations of radionuclides to below regulatory limits.

Surface Water

Releases to surface water associated with this option would not differ from those of the no-action option (Section F.2.5.1).

Air

There would be no releases to the atmosphere under this option, because the retention basin would be backfilled and then covered with sand, topsoil, and grass.

Potential Impacts (Other Than Releases)

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways would occur 100 years from the present, at which time institutional control of the SRP is assumed lost. The doses are only 3.4×10^{-5} and 2.4×10^{-11} millirem per year for the farm and direct gamma exposure pathways, respectively. There is no dose from consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments, due to the assumed limited plant-root depth.

This closure option is expected to result in no adverse impacts on biological resources at the H-Area retention basin, as is generally described in Section F.2.18.2. This option is expected to reduce further groundwater contamination, and closure would eliminate the potential for adverse impacts to organisms attracted to the wet-weather pond in the basin.

F.2.5.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The basin is located southwest of the H-Area perimeter fence and has been out of service since 1973. Standing water would be drained from the basin and removed to the operating H-Area retention basin. The depth of soil to be excavated from the basin would be 2.6 meters. A 930-square-meter area outside the basin would be excavated to a depth of 0.3 meter. The soil removed from the basin and the 930-square-meter area would be transported in metal boxes and disposed of in a waste storage/disposal facility onsite. The basin would be backfilled to 0.3 meter above the ground surface with borrow fill. The amount of backfill required would be 11,500 cubic meters. The fill would be covered with a low-permeability cap and seeded with grass over a 3160-square-meter area. Two additional groundwater monitoring wells would be installed and all wells would be monitored quarterly for 1 year, then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

PATHRAE results for waste removal and closure of this site indicate that radionuclide concentrations would be reduced at the 1-meter well. However, remedial action might be required since PATHRAE modeling indicates that the

sum of the ratios of the peak well concentrations to their MCL values exceed 1.0 for the 1- and 100-meter wells.

The following is a comparison of the concentrations in the 1-meter and 100-meter wells in the peak years:

Well	Concentration, pCi/L				
	Sr-90	Y-90	Cs-137	Pu-238	Total
MCL	4.2×10^1	5.5×10^2	1.1×10^2	1.4×10^1	
1-m well (fractional MCL)	2.2×10^3 (52)	2.2×10^3 (4)	-	-	(56)
100-m well (fractional MCL)	1.6×10^1 (0.38)	1.6×10^1 (0.03)	4.6×10^1 (0.42)	5.1×10^0 (0.36)	(1.19)

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in Four Mile Creek are projected to be below drinking-water standards.

Air

The analyses described in Section F.2.5.1 were also performed for this option. Radionuclide releases to the atmosphere would take place only during the time that waste is being removed from the retention basin. The releases are associated with the excavation activities and are assumed to occur during the first year of waste removal and closure.

The annual dose to an individual resulting from the release of radionuclides to the atmosphere would be only 1.5×10^{-3} percent of the DOE limit of 25 millirem per year.

No nonradioactive constituents would be released to the atmosphere in the H-Area retention basin, and therefore no risk assessments were performed.

An analysis of the health risks to the average individual worker that would be attributable to occupational exposure to radioactive carcinogens was performed, using the methodology presented in Appendix I. The total dose to the worker was calculated to be 600 millirem, which would produce an incremental risk of 1.7×10^{-4}. The total dose to the worker transporting the waste was 240 millirem, producing an incremental risk of 6.7×10^{-5}.

Potential Impacts (Other Than Releases)

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways occur 100 years after waste removal and closure, at which time institutional control of the SRP is assumed lost. The doses would be

only 9.8 x 10^{-6} and essentially 0 millirem per year for the farm and direct gamma exposure pathways, respectively. There would be no dose from the consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments, due to the assumed limited plant-root depth.

Aquatic Resources

The waste removal and closure option for H-Area retention basin is not expected to have adverse impacts on aquatic resources. Waste removal and closure would result in the removal of the source of contamination and the potential for adverse impacts to organisms attracted to the wet-weather pond in the basin.

Terrestrial Resources, Endangered Species, and Wetlands

For reasons discussed in Section F.2.18.2, no adverse impacts to terrestrial resources, endangered species, or wetlands are expected as a result of this closure option at the H-Area retention basin.

F.2.6 F-AREA RETENTION BASIN, BUILDING 281-3F*

The F-Area retention basin (Building 281-3F) is a low-level radioactive waste management facility that stopped receiving wastes in 1971. Background information on the history of waste disposal, waste characteristics, and evidence of contamination are described in Appendix B, Section B.3.2.

F.2.6.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

For this option the site would remain in its present condition. Four groundwater monitoring wells would be installed and monitored quarterly for 1 year, then annually for 29 years. Upkeep would consist of cutting weeds periodically and maintaining a fence and posting signs around the basin.

Comparison of Expected Environmental Releases with Applicable Standards

All environmental releases are projected to be below applicable standards for the no-action option (Scott et al., 1986).

Groundwater

The releases are expressed in terms of radionuclide concentrations for both a well 1 meter downgradient of the retention basin and a well 100 meters downgradient.

*The reference source of the information in this section is Scott, Killian, Kolb, Corbo, and Marine, 1986.

PATHRAE modeling predicts that the radionuclide concentrations resulting in the highest potential annual doses would occur between 300 and 400 years for the 1-meter and 100-meter wells. The following is a comparison of the concentrations in those wells in the peak years with the EPA primary drinking-water standard:

Well	Combination pCi/L		
	Sr-90	Y-90	Total
MCL	4.2×10^{1}	5.5×10^{2}	
1-m well (fractional MCL)	5.4 (0.13)	5.4 (0.01)	(0.14)
100-m well (fractional MCL)	9.1×10^{-3} (2.2×10^{-4})	9.1×10^{-3} (1.6×10^{-5})	(2.4×10^{-4})

Since each sum is less than 1, the radionuclide concentrations in each well are within the EPA limits.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in Four Mile Creek are projected to be below drinking-water standards.

Air

There would be no releases to the atmosphere under this option, because the retention basin has been backfilled with dirt and covered with grass.

Potential Impacts (Other Than Releases)

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways would occur 100 years from the present. The doses would be only 9.1×10^{-7} and 7.0×10^{-13} millirem per year for the farm and direct gamma exposure pathways, respectively. The dose would be zero for the pathway which involves consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments, since any such contamination is assumed to be precluded due to the limited plant root depth.

Aquatic Resources

Impacts on aquatic resources as a result of the no-action alternative at the F-Area retention basin are expected to be similar to those described in Section F.2.18.1. Although no groundwater data are available for the F-Area retention basin, it is the same size, is used for the same purpose, and received an inventory similar to the H-Area retention basin. PATHRAE analysis was performed on strontium-90, yttrium-90, and cesium-137. This analysis indicates influent concentrations and final stream mixtures would not exceed the freshwater biota water quality criteria for any closure option.

Terrestrial Resources, Endangered Species, and Wetlands

The no-action alternative at the F-Area retention basin would have no adverse impacts on terrestrial ecological, endangered species, or wetlands resources, as discussed in Section F.2.18.2.

F.2.6.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The basin would be capped with clayey sand and topsoil, and seeded. Four groundwater monitoring wells would be installed around the basin and monitored quarterly for 1 year, then annually for 29 years.

PATHRAE analyses predict that all modeled constituents would be present in the groundwater at levels below MCLs for the no waste removal and closure option. Therefore no further remedial action would be necessary.

Comparison of Expected Environmental Releases with Applicable Standards

All environmental releases are projected to be below applicable standards for the no waste removal and closure option. Releases to groundwater and surface water associated with this option would not differ from these of the no-action option (Section F.2.6.1).

There would be no releases to the atmosphere under this option, since the retention basin has already been backfilled.

Potential Impacts (Other Than Releases)

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways would occur 100 years from the present, at which time institutional control of the SRP is assumed lost. The doses are only 1.2×10^{-5} and 1.2×10^{-16} millirem per year for the farm and direct gamma exposure pathways, respectively. There would be no dose from the consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments, due to the limited plant-root depth.

This closure option is expected to result in no adverse impacts on biological resources at the F-Area retention basin, as is generally described in Section F.2.18.2. This option is expected to reduce further the potential for impacts on aquatic ecosystems in the vicinity of the outcrop.

F.2.6.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The depth of the original backfill (2.1 meters) would be excavated along with 2 meters from the basin floor, for a total of 4.1 meters. The total volume of soil to be removed would be 9154 cubic meters. The soil would be transported in metal boxes and disposed of in a waste storage/disposal facility onsite.

The basin would be backfilled to 0.3 meter above the ground surface with borrow fill. The amount of backfill required would be 9924 cubic meters. The fill would be covered with a low-permeability cap and seeded with grass over an area of 2233 square meters. Four groundwater monitoring wells would be installed around the basin and monitored quarterly for 1 year, then annually for 29 years.

PATHRAE analyses predict that all modeled constituents would be present in the groundwater at levels below MCLs for the waste removal and closure option. Therefore no further remedial action would be necessary.

Comparison of Expected Environmental Releases with Applicable Standards

All environmental releases are projected to be below applicable standards for the waste removal and closure option.

Groundwater

The peak concentrations for the 1-meter and 100-meter wells are the same as those presented in F.2.6.1. Since the sums of the fractional MCLs are less than 1, the radionuclide concentrations would be within the EPA limits.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in Four Mile Creek are projected to be below drinking-water standards.

Air

Environmental doses and risks to the maximally exposed individual due to radiological releases from the F-Area Retention Basin were calculated using the methodology presented in the introduction to Appendix F and in Appendix I.

Radionuclide releases to the atmosphere would take place only during the time that waste was being removed from the retention basin. The releases would be associated with the excavation activities and are assumed to occur during the first year of waste removal and closure.

The calculated annual dose to an individual is less than 8.4×10^{-5} percent of the per year DOE limit of 25 millirem. The risk associated with this dose would be less than 6.0×10^{-12}.

No nonradioactive constituents would be released to the atmosphere in the F-Area Retention Basin, and therefore no risk assessments were performed.

An analysis of the average individual worker health risks from occupational exposure to radioactive carcinogens was performed using the methodology presented in Appendix I. The total dose to the worker was calculated to be 1 millirem, which would produce an incremental risk of 2.8×10^{-7}. The total dose to the worker transporting the waste was calculated as 0.52 millirem, producing an incremental risk of 1.5×10^{-7}.

Potential Impacts (Other Than Releases)

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways would occur 100 years after waste removal and closure, at which time institutional control of the SRP is assumed lost. The doses would be only 1.2×10^{-7} and essentially 0 millirem per year for the farm and direct gamma exposure pathways, respectively. There would be no dose from the consumption of crops potentially contaminated as a result of biointrusion of surface sediments, due to the assumed limited plant-root depth.

As described in Section F.2.18.2, this closure option at the F-Area Retention Basin is expected to have no adverse impacts on biological resources. In addition, the source of groundwater and surface-water contamination would be eliminated.

F.2.7 RADIOACTIVE WASTE BURIAL GROUNDS*

The radioactive waste burial grounds consist of three sites: the "new" low-level radioactive waste burial ground (643-7G), the mixed waste management facility (643-28G), and the "old" radioactive waste burial ground (643-G). The latter site was used from 1952 to 1972 and is considered to be a mixed waste site; the former two sites have been operating since 1972. The sites are essentially contiguous; accordingly, for the purposes of assessment analysis, they are considered as one. More information on the history of waste disposal, waste characteristics, and evidence of contamination is presented in Appendix B.

F.2.7.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The no-action option is defined as continuing operations until SRP activities cease, followed by a period of institutional control generally considered to last for 100 years. Present operations of the filled portions of the solid waste disposal facility (burial ground) consist of:

- Maintaining present fencing and surface drainage patterns.
- Correcting trench subsidence as it occurs by backfilling with clean soil.
- Reseeding as required with a shallow-rooted grass cover.
- Frequently mowing to prevent onset of deep-rooted vegetation.
- Monitoring for chemicals and radioactivity in the existing perimeter wells and well clusters.
- Maintaining control of access to the facility (security).

*The reference source of the information in this section is Jaegge et al., 1986.

The maintenance operations described above would be applied to the entire 195 acres of the facility; however, further subsidence in the first-used section, 643-G, is expected to be infrequent.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

Monitoring and analysis indicate that groundwater beneath and around the radioactive waste burial grounds is contaminated with radionuclides, metals, and organic chemicals. Table F-12 indicates the regulatory standards and the calculated maximum concentrations for those constituents that exceed regulatory standards. Monitoring results are not presented, since data from protocol monitoring wells for the radioactive waste burial grounds are not presently available. In most cases the peaks are modeled to have occurred in the past, after the inception of waste emplacement; however, because the site is continuing to receive wastes, they are indicative of present concentrations. Those constituents whose peaks are predicted to occur in the future are indicated by including the year of peak concentration.

Tritium, nickel-63, cobalt-60, technetium-99, cesium-134, cesium-137, uranium-238, and plutonium-238 all are estimated to have exceeded their standards in the 1-meter well. PATHRAE results indicate that strontium-90 will exceed its standard in the year 2182. Even if these radionuclides were absent, the sum of the MCL ratios would at present be greater than 1, due chiefly to the contributions of strontium-90, iodine-129, and plutonium-239.

After about 100 years, the peaks would be in the vicinity of the outcrop (1000 meters from the burial grounds). For the no-action option the combination of tritium, nickel-63, and plutonium-238 would exceed the criteria for radionuclides at 100 years near the outcrop by a factor of 2.3.

Also, the nonradioactive constituents lead and xylene would exceed their concentration standards at 100 years near the outcrop (by 40 and 57 percent, respectively) for the no-action option.

After 200 years, the groundwater concentrations would be within regulatory limits except for the slow-moving strontium-90 and cadmium. Because they move so slowly, these constituents would be out of compliance only in the immediate vicinity of the burial grounds.

Surface Water

The burial grounds waste constituents leave the aquifer at the groundwater outcrop and enter the site streams. Because the waste site straddles a groundwater divide, the waste would enter both Upper Three Runs Creek and Four Mile Creek. The calculations conservatively assume that all of the wastes are transported toward the groundwater outcrop nearest the waste site. This outcrop, 1000 meters downgradient from the site, results in the waste's entering Four Mile Creek and, ultimately, being transported to the Savannah River.

As discussed in the previous section, the peak concentrations at the outcrop would occur after approximately 100 years. Incremental (from the radioactive waste burial grounds) Four Mile Creek concentrations, based on 0.170 cubic

Table F-12. Predicted Maximum Concentrations of Various Constituents at the Radioactive Waste Burial Grounds for the Three Closure Options[a]

Constituent	Applicable standard	PATHRAE-modeled maximum groundwater concentration without remedial action[b]								
		No action			No waste removal and closure			Waste removal and closure		
		1-m well	100-m well	Outcrop	1-m well	100-m well	Outcrop	1-m well	100-m well	Outcrop
RADIONUCLIDES (pCi/L)										
Tritium	8.7×10^{4}	2.9×10^{9}	6.8×10^{8}	5.7×10^{4}[c]	(d)	(d)	8.7×10^{4}[c]	(d)	(d)	8.7×10^{4}[c]
Neptunium-237	1.4×10^{-1}	2.3 (2422)	6.3×10^{-1} (2714)	(e)	(f)	(f)	(e)	(f)	(f)	(e)
Nickel-63	1.0×10^{4}	6.1×10^{5}	1.7×10^{5}	7.1×10^{3}[c]	(d)	(d)	1.1×10^{4}[c]	(d)	(d)	1.1×10^{4}[c]
Cobalt-60	2.1×10^{2}	(e)	6.2×10^{2}	(e)	(e)	(d)	(e)	(e)	(d)	(e)
Strontium-90	4.2×10^{1}	4.1×10^{2} (2182)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Technetium-99	4.2×10^{3}	1.8×10^{4}	5.2×10^{3}	(e)	(d)	(d)	(e)	(d)	(d)	(e)
Cesium-134	7.4×10^{1}	3.5×10^{2}	(e)	(e)	(d)	(e)	(e)	(d)	(e)	(e)
Cesium-137	1.1×10^{2}	1.4×10^{3}	3.7×10^{2}	(e)	(d)	(d)	(e)	(d)	(d)	(e)
Uranium-238	2.4×10^{1}	5.6×10^{1}	(e)	(e)	(d)	(e)	(e)	(d)	(e)	(e)
Plutonium-238	1.4×10^{1}	3.5×10^{2}	2.4×10^{2}	1.3×10^{1}[c]	(d)	(d)	1.8×10^{1}[c]	(d)	(d)	1.8×10^{1}[c]
CHEMICALS (mg/L)										
Cadmium	1.0×10^{-2}	3.8×10^{-2} (2235)	1.0×10^{-2} (2400)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Lead	5.0×10^{-2}	2.7	7.8×10^{-1}	7.0×10^{-2}	(d)	(d)	1.1×10^{-1}	(d)	(d)	1.1×10^{-1}
Mercury	2.0×10^{-3}	9.0×10^{-3}	2.6×10^{-3}	(e)	(d)	(d)	(e)	(d)	(d)	(e)
Xylene[g]	6.2×10^{-1}	1.4×10^{1}	3.9	6.9×10^{-1}	(d)	(d)	(e)	(d)	(d)	(e)

[a]EPA, 1985b, except where noted; ICRP Publication 30 (ICRP, 1979) methodology was used to calculate radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[b]Year of occurrence in parentheses. Figure for outcrop is approximate peak for year 2085.
[c]Below applicable standard but significant in ratio summation.
[d]Same as value for no-action option.
[e]Below standard.
[f]Not reported.
[g]EPA, 1981b.

meters per second of outcropping contaminated groundwater flow and 0.224 cubic meters per second of total flow in Four Mile Creek immediately downstream from the outcrop, would exceed the summed fractional MCL values for tritium, nickel-63, and plutonium-238 by a factor of 1.7.

Lead and xylene also exceed their concentration limits (by 6 and 18 percent, respectively). For periods of time significantly less or greater than 100 years (e.g., 0 or 200 years), the creek concentrations are within the applicable standards. Incremental concentrations in the Savannah River can be calculated by multiplying the stream concentrations by the ratio of Four Mile Creek flow rate to Savannah River flow rate (0.00078). All Savannah River concentrations would be well within the applicable standards for the no-action alternative.

Air

The nonradioactive constituents were analyzed, using the methodology discussed in the introduction to Appendix F and in Appendix I, to estimate public exposure and risk attributable to releases of constituents into the atmosphere from the radioactive waste burial grounds.

No releases of carcinogens are expected, since the basin is capped. Releases of noncarcinogens are associated with volatilization of constituents. Risks attributable to atmospheric releases are below 1, with a maximum value less than 3.5×10^{-5}.

Environmental doses and risks to the maximally exposed individual due to radiological releases from the radioactive waste burial grounds were calculated using the methodology summarized in the introduction to Appendix F and presented in Appendix I. The calculated doses were less than 1.4×10^{-3} percent of the DOE limit of 25 millirem per year for each of the 3 years. The risks associated with these doses would be less than 1.4×10^{-14}.

Potential Impacts (Other Than Releases)

Aquatic Resources

PATHRAE analysis indicates that the outcrop water concentrations of lead and mercury would exceed aquatic biota criteria. Concentrations of these elements would also exceed the aquatic criteria after mixing with Four Mile Creek. Therefore, some adverse impacts on aquatic biota might be expected as a result of this closure option. Jaegge et al. (1986) indicate that concentrations of lead remain above criteria for up to 100 years, after which all contaminants would fall below criteria levels.

In order to estimate the potential impacts of other wastes, water quality parameters of downgradient wells were reviewed in order to identify those parameters that were higher than the water quality criteria. This analysis indicated that all other wastes were present in quantities that were below the aquatic criteria.

Terrestrial Resources, Endangered Species, and Wetlands

A general discussion of impacts on terrestrial ecology, endangered species, and wetlands expected as a result of the no-action closure option at the radioactive waste burial grounds is presented in Section F.2.18.1.

F.2.7.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This option consists of leaving the waste in place and closing the site using a low-permeability cap.

Caps would be placed on areas 643-G and 643-7G, and would cover approximately 200 acres. They would consist of:

- 0.6 meter of topsoil ($K = 7 \times 10^{-4}$ cm/sec), over
- 0.3 meter of sand ($K = 1 \times 10^{-2}$ cm/sec)
- 0.15 meter of sand, over
- 20-mil membrane, over
- 0.15 meter of sand, over
- 0.6 meter of compacted clay ($K < 10^{-7}$ cm/sec)

This cap (or equivalent) would be covered with shallow-rooted vegetation. The volumes of material that would be required are: 4.8×10^5 cubic meters of topsoil, 2.4×10^5 cubic meters of drainage sand, 2.4×10^5 cubic meters of buffer sand, 8×10^5 square meters of 20-mil plastic liner, and 4.8×10^5 cubic meters of compacted clay.

The site would remain fenced and current engineered drainage continued. Reseeding and mowing would be carried out as needed. Grade would be reestablished and the cap repaired following any subsidence. Existing perimeter wells and well clusters would be used for monitoring groundwater. RCRA wells would be installed in late 1986 or early 1987. Institutional control would continue for 100 years following closure.

As shown in Table F-12, further remedial action might be required for this option, since PATHRAE modeling predicts that the concentrations of several constituents would still exceed regulatory standards. The radionuclides (other than tritium), metals, and organics which exceed regulatory standards could be removed by pumping, and the contaminated groundwater could be treated to reduce concentrations to acceptable levels. The treated water could then be discharged to a site stream or reinjected into the ground.

The removal of tritium would be more difficult because the tritium (hydrogen) is chemically part of the water. Four options to consider are detritiation, evaporation, direct discharge to onsite streams, and reinjection. Detritiation would be extremely expensive; evaporation would change the dose pathway from the groundwater to the atmosphere.

Direct discharge to onsite streams (e.g., Four Mile Creek) would rely on dilution of the tritium to acceptable concentrations. The concentration due to the groundwater in the stream would depend on the flow rate of the discharge

(essentially the flow rate of the extraction wells). Assuming discharge into Four Mile Creek (0.22 cubic meter per second) at the maximum groundwater concentration (2.9 curies per cubic meter), the maximum allowable discharge rate to meet the concentration standard of 8.7×10^{-5} curies per cubic meter would be only 6.7×10^{-6} cubic meters per second. Therefore, direct discharge to onsite streams could not meet regulatory criteria if a practical groundwater extraction rate (e.g., 0.02 cubic meter per second) were employed.

The remaining option, reinjection, would require (for all contaminants except tritium) the treated water to be reinjected into the ground. Tritium would then decay naturally in the shallow groundwater aquifers. The injection location would be chosen to maximize the efficiency of the extraction wells.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The no waste removal and closure action, of itself, would not correct the groundwater-contaminant situation at the radioactive waste burial grounds; the contaminants are already in the water in concentrations which exceed regulatory standards. The closure option would slow the rate at which contaminants enter the water table and would be effective in reducing concentrations of those slow-moving constituents which had not yet reached the water table in significant concentrations (i.e., selenium, strontium, yttrium, and neptunium). Of the latter, only strontium is predicted to exceed regulatory standards for the no-action option. This closure option would reduce strontium concentrations below the regulatory standards (see Table F-12).

Cadmium is a slow-moving constituent that is predicted to exhibit a secondary concentration peak in the future (3.8×10^{-2} milligrams per liter in the year 2235). This secondary peak would exceed the concentration standard of 0.01 milligram per liter. This closure option would reduce this secondary peak significantly below the concentration criterion.

Surface Water

As is the case with groundwater, the no waste removal and closure action, of itself, would not relieve the potential for exceeding regulatory limits in Four Mile Creek; the contaminants are already in the hydrologic system. Unlike the groundwater, however, the slower moving contaminants will not exceed the concentration standards at times greater than 100 years.

Air

The analysis described in Section F.2.7.1 was performed for this option. There would be no releases of carcinogens, since the facility would be capped. Releases of noncarcinogens would be due to volatilization of contaminants. Risks attributable to these releases are calculated to be below 1, with a maximum value less than 1.6×10^{-6} for each of the 3 years. The calculated dose due to radiological releases was less than 2.8×10^{23} percent of the DOE limit of 25 millirem for each of the 3 selected years. The risk associated with this dose would be less than 2.0×10^{-30}.

Potential Impacts (Other Than Releases)

Aquatic Resources

The impact of this closure option on aquatic resources at the radioactive waste burial grounds is expected to be similar to that described in Section F.2.7.1. However, the addition of groundwater pumping and treatment would eliminate adverse impacts, assuming that NPDES discharge requirements include aquatic life standards.

Terrestrial Ecology, Endangered Species, and Wetlands

A general discussion of impacts on terrestrial ecology, endangered species, and wetlands expected as a result of this closure option at the radioactive waste burial grounds is presented in Section F.2.18.2.

F.2.7.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The closure option for this site would include excavation of contaminated materials and capping of the area. Excavation of the waste disposal area would involve either removing the waste and soil from the waste trenches and disposing of it at another disposal area, either at SRP or elsewhere, or removing the waste from the waste trenches, processing it by sorting, size reduction, and stabilization, and redisposing of the treated waste at a mixed waste disposal facility.

Excavation would proceed as follows: machines, operated either remotely or by personnel in shielded cabs, would excavate waste along known trench lines. The excavation would be larger and deeper than the original trench in order to assure that possibly contaminated adjacent soil would also be excavated. The entire area would be covered to keep rainwater away from the excavated waste.

The estimated length of trench to be excavated is 64,000 meters, based on 50 percent utilization of the burial ground area. About 3×10^6 cubic meters of waste and contaminated soil would have to be excavated. Partial excavation would result in less waste removed, but current data and technologies are inadequate for determining how much less. Partial excavation, however, would leave residual radionuclide concentrations in excess of DOE guidelines for unrestricted sites.

After excavation, the waste-soil mixture would be sent to a process area where the mixture would be sorted, assayed, reduced, stabilized, and packaged for transport and disposal. The sorting process would take place on a number of conveyor belts and would be accomplished by remote sorting with manipulators. Small pieces and soil could be removed by a sorter such as a bouncing ball screen arrangement that is part of the conveyor system. Waste treatment would include processes such as incineration, shredding, compaction, and stabilization with grout. Waste and soil with very low levels of radioactivity could be returned to the original waste disposal area. The trigger value for the concentrations would have to be determined - a de minimis value for low-level waste does not currently exist.

Residual waste following treatment and sorting would be placed in metal disposal boxes and transported to a mixed waste disposal facility. The disposal volume to be evaluated should be 3 x 10^6 cubic meters; uncertainties regarding treatment and handling prevent estimation of any volume reduction. After excavation, the original waste disposal area would have to be closed, using a low-permeability cap as described above. The site would remain fenced and engineered drainage continued. Reseeding and mowing would be carried out as needed. Grade would be reestablished and the cap repaired following any subsidence events. Existing perimeter wells and well clusters would be used for monitoring groundwater quarterly for 1 year and then annually for 29 years. Institutional control would continue for 100 years following closure.

The possible corrective actions for this alternative would be the same as those described for the no waste removal and closure assessment.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The addition of waste removal to the closure option would further reduce the peak concentrations of those slow-moving constituents (e.g., selenium, strontium, and yttrium) that have not yet reached the water table. However, peak concentrations of selenium and yttrium are within applicable standards if no action is taken. In the case of strontium, closure alone would result in the meeting of standards.

All constituents except for tritium would be reduced below concentration standards by the remedial actions. Tritium might be reduced below standards if detritiation or evaporation were chosen.

Surface Water

As in the case of no waste removal and closure, any corrective action taken that would result in meeting concentration limits for groundwater would also meet those limits for surface water.

Air

The analysis described in Section F.2.7.1 was performed for this option. Carcinogenic risks were calculated for 1986 due to wind erosion and excavation activities. These risks were calculated to be zero in future years, since the basin would be capped. Noncarcinogenic risks due to wind erosion and excavation activities were also calculated for 1986. Risks due to volatilization and seepage were calculated for 2085 and 2985. Risks due to carcinogen releases would be less than 3.7 x 10^{-11}. Risks due to noncarcinogen releases would be below 1, with a value less than 1.6 x 10^{-7} for each of the 3 years. The calculated dose to the maximally exposed individual due to radiological releases is less than 2.8 percent of the DOE limit of 25 millirem for each of 3 years. The risk associated with this dose would be less than 2.0 x 10^{-7}.

An analysis of health risks to the the average individual worker attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarginogens was performed using the methodology presented in

Appendix I. The risk to a worker from nonradioactive carcinogens was predicted as less than 3.9×10^{-12}; the risk due to noncarcinogens was below 1, with a value of 5.9×10^{-7}. The total dose to the worker would be 4.2×10^{3} millirem, producing an incremental risk of 1.2×10^{-3}. The total dose to the worker transporting the waste would be 2.2×10^{3} millirem, producing an incremental risk of 6.2×10^{-4}.

Potential Impacts (Other Than Releases)

The waste removal and closure option at the radioactive waste burial grounds would be expected to have similar effects on ecosystems, wetlands, and endangered species as those discussed in Section F.2.7.2. Waste removal would eliminate the source of contamination.

F.2.8 MIXED WASTE MANAGEMENT FACILITY, BUILDING 643-28G

This site is discussed in conjunction with the other radioactive waste burial grounds in Section F.2.7.

F.2.9 RADIOACTIVE WASTE BURIAL GROUND, BUILDING 643-G

This site is discussed in conjunction with the other radioactive waste burial grounds in Section F.2.7.

F.2.10 F-AREA SEEPAGE BASINS*

F-Area seepage basins (Buildings 904-41G, 904-42G, and 904-43G) are mixed waste management facilities that are presently receiving waste. The three seepage basins were assumed to be a single operating unit for purposes of contaminant migration modeling and remedial action analyses. The history of waste disposal, evidence of contamination, and waste characteristics at the three basins are presented in Appendix B, Section B.3.3.

F.2.10.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The no-action option would consist of allowing the basins to drain under natural conditions (i.e., infiltration and evaporation). Once the basins' residual bottom sediments dried sufficiently, the bottom and side slopes would be covered with 15 centimeters of topsoil and hydroseeded with an appropriate grass to protect the slopes from erosion. Approximately 4000 cubic meters of topsoil would be needed to cover the basin sides and bottoms, and approximately 26,200 square meters of seeding would be needed. The area would be fenced, and entrance would be allowed only for maintenance activities. Maintenance activities would consist of inspection for unacceptable erosion and mowing. Groundwater would be monitored quarterly for 1 year, then annually for 29 years.

*The reference source of the information in this section is Killian et al., 1986a.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

Current groundwater monitoring data indicate that concentrations of lead, mercury, nitrate, tritium, radium, gross alpha, and gross beta exceed regulatory standards. PATHRAE modeling results for this option indicate that concentrations of iodine-129, strontium-90, yttrium-90, americium-241, plutonium-238, and uranium-238 would also exceed standards at various times in the future. Table F-13 lists all constituents that currently exceed or are projected to exceed regulatory standards under all closure options including no action, the corresponding standard for each constituent, and the maximum concentration found or projected to be found in the groundwater near the three F-Area seepage basins.

Surface Water

PATHRAE modeling of surface-water impacts projects that incremental tritium and nitrate concentrations in Four Mile Creek, from the addition of these constituents via the groundwater pathway, will exceed drinking-water standards. Table F-13 presents concentrations of these constituents in Four Mile Creek for no action, no waste removal, and waste removal.

Air

The nonradioactive constituents were analyzed, using the methodology discussed in the introduction to this appendix and in Appendix I, to estimate public exposure and risk attributable to atmospheric releases from the F-Area seepage basins.

Releases are associated with volatilization of contaminants and wind erosion. Risks due to carcinogenic releases were calculated to be less than 1.2×10^{-8} for each of the 3 selected years. Risks due to noncarcinogen releases would be below 1, with values less than 1.2×10^{-3} for each of the 3 years.

Environmental doses and risks to the maximally exposed individual due to radiological releases from the F-Area seepage basins were calculated using the methodology presented in the introduction to this appendix and in Appendix I. The calculated doses are less than 11.5 percent of the DOE limit of 25 millirem per year for each of the 3 selected years. The risks associated with these doses would be less than 8.1×10^{-7}.

Potential Impacts (Other Than Releases)

The maximum annual dose resulting from the reclaimed farm and direct gamma exposure pathways would occur 100 years from the present, at which time institutional control of SRP is assumed lost. The doses would be 0.19 and 1000 millirem per year for the farm and direct gamma exposure pathways, respectively.

Table F-13. Predicted Maximum Concentrations of Various Constituents at the F-Area Seepage Basins for the Three Closure Options [a,b]

Constituent	Applicable standard[c]	Monitoring data maximum mean concentration[d]	PATHRAE-modeled maximum concentrations without remedial action[c]								
			No action			No waste removal and closure			Waste removal and closure		
			1-m well	100-m well	Four Mile Creek	1-m well	100-m well	Four Mile Creek	1-m well	100-m well	Four Mile Creek
Lead	0.05	0.110 (well FSB 78)	5.1×10^{-2} (2545)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Mercury	0.002	0.0101 (well FSB 78)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Nitrate	10	254.4 (well FSB 78)	1000 (1987)	1000 (1987)	(f)	(g)	(g)	(f)	(g)	(g)	(f)
Tritium	8.7×10^4	3.8×10^7	4.5×10^7 (1957)	2.7×10^7 (1964)	(f)	(g)	(g)	(g)	(f)	(g)	(f)
Americium-241	2.5	(h)	11 (2545)	(f)	(f)	(f)	(f)	(f)	(f)	(h)	(f)
Iodine-129	20	(h)	230 (1988)	220 (1990)	(f)	88 (2036)	88 (2037)	(f)	88 (2036)	88 (2037)	(f)
Plutonium-238	14	(h)	2000 (2565)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Strontium-90	42	6500	1400 (2009)	59 (2071)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Yttrium-90	550	(h)	1400 (2009)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Uranium-238	24	(h)	2000 (2215)	52 (2985)	(f)	48 (2985)	(f)	(f)	(f)	(f)	(f)
Radium	6	37.36 (well FSB 78)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)

Footnotes on last page of table.

Table F-13. Predicted Maximum Concentrations of Various Constituents at the F-Area Seepage Basins for the Three Closure Options [a,b] (Continued)

Constituent	Applicable standard[c]	Monitoring data maximum mean concentration[d]	PATHRAE-modeled maximum concentrations without remedial action: No action, 1-m well	No action, 100-m well	No action, Four Mile Creek	No waste removal and closure, 1-m well	No waste removal and closure, 100-m well	No waste removal and closure, Four Mile Creek	Waste removal and closure, 1-m well	Waste removal and closure, 100-m well	Waste removal and closure, Four Mile Creek
Gross alpha	10-20	1272 (well FSB 78)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)
Gross beta	40-60	3975 (well FSB 78)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)

[a]Source: Adapted from Killian et al., 1986a.
[b]Concentrations in milligrams per liter for chemicals and picocuries per liter for radionuclides.
[c]EPA, 1985b. ICRP Publication 30 (ICRP, 1979) methodology was used to determine radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[d]Data are for FSB water-table monitoring wells. The concentration level provided for each constituent is the maximum single-well mean from FSB wells. Time series data are not reported for tritium or strontium-90 in Killian et al., 1986a. Tritium concentration that is provided was detected in well FSB 78 on April 9, 1985. Strontium-90 data are maximum concentration data for the groundwater.
[e]Below applicable standards.
[f]Constituent below standard.
[g]Identical to value for no-action option.
[h]Not reported.
[i]Constituent was not explicitly modeled with PATHRAE; gross alpha and beta were modeled by estimating specific radionuclide inventory.

Aquatic Resources

PATHRAE analysis indicates that the influent water concentrations of lead, mercury, and tritium exceed EPA water quality criteria for freshwater biota. Concentrations of these elements would also exceed EPA criteria after mixing with Four Mile Creek. Therefore, some adverse impacts on aquatic biota as a result of excessive concentrations of these contaminants may be expected as a result of this closure option. Lead concentrations would remain above criteria for up to 100 years, after which all contaminants are predicted to be below criteria for all closure options.

In order to estimate potential impacts of other contaminants, water quality parameters of downgradient wells (Jaegge et al., 1986) were reviewed in order to identify those parameters that were higher than the water quality criteria for aquatic life. Those parameters for which the well concentrations were greater than the criteria are beryllium, copper, iron, zinc, gross alpha, gross beta, radium, and hydrogen sulfide. The dilution factor of 0.0159 (Jaegge et al., 1986) would reduce concentrations of all waste materials except gross alpha, gross beta, and hydrogen sulfide to below EPA criteria after mixing with stream flow. Adverse impacts on aquatic biota as a result of excessive concentrations of these materials might occur.

The F-Area seepage basins are an open water area and therefore may attract and adversely impact aquatic and semiaquatic organisms, as described in Section F.2.18.1.

Terrestrial Resources

Waterfowl and other birds and animals may be attracted to the open water in the F-Area seepage basins, and are therefore subject to adverse impacts as discussed in Section F.2.18.1.

Endangered Species and Wetlands

As discussed in Section F.2.18.1, no adverse impacts on endangered species or wetlands are expected as a result of this closure option at the F-Area seepage basins.

F.2.10.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Backfilling and capping of the basin would consist of five phases:

1. Draining the basins' impounded liquids naturally, through infiltration and evaporation.

2. Stabilizing the sediment in the basins with cement.

3. Backfilling the basins with onsite soils to 0.6 meter above the surrounding ground surface, using controlled placement and compaction procedures. Approximately 114,000 cubic meters of backfill would be needed for the three basins.

4. Covering the backfill with a low-permeability cap covering an area of 6.7 acres. The cap would consist of (from top to bottom):

   - 0.15 meter of topsoil (4470 cubic meters)
   - 0.45 meter of clean fill (13,410 cubic meters)
   - A 0.3-meter drainage layer (sand or gravel or equivalent) with a minimum conductivity of 1×10^{-3} centimeter per second (8940 cubic meters)
   - A 20-mil-thick synthetic liner (29,400 square meters) with a 0.15-meter sand buffer above and below the membrane (4470 cubic meters)
   - A 0.6-meter-thick layer of compacted clay with a maximum hydraulic conductivity of 1×10^{-7} centimeter per second.

5. Hydroseeding the newly placed topsoil with an appropriate grass seed to minimize erosion. The seeding would cover an area of 6.7 acres.

The area would be fenced, and only maintenance activities would be allowed. Maintenance activities would consist of inspection for unacceptable erosion, mowing, and long-term groundwater monitoring quarterly for 1 year, then annually for 29 years.

Additional corrective actions (e.g., groundwater extraction and treatment) might be needed to address the constituents already in the groundwater. The selection of any such action would be based on site-specific studies and interactions with regulatory agencies. Some possible technologies are presented in Appendix C.

<u>Comparison of Expected Environmental Releases with Applicable Standards</u>

The closure actions described above are projected by PATHRAE to reduce levels of strontium-90 and yttrium-90 to within MCLs (see Table F-13). Levels of nitrate and tritium would not be affected by the described closure actions and would remain above standards. Treatment by one or more of the technologies described in Appendix C is expected to reduce the PATHRAE-projected environmental releases of nitrate and tritium to within MCLs or ACLs. Lead and mercury levels, although projected by PATHRAE to be within MCLs, currently exceed MCLs, as indicated by groundwater monitoring data. The levels of lead and mercury would also be reduced to within MCLs by the treatment technology. In addition, the gross alpha and gross beta constituents, including radium, would be reduced to levels within MCLs. However, the levels of iodine-129 and uranium-238 might not be substantially reduced by the remedial action, due to the slow migration of these radionuclides through the vadose zone and aquifer.

Air

The analysis described in the air release section of Section F.2.10.1 was also performed for this option. No risks due to carcinogens were calculated, since the seepage basin would be capped. Releases due to noncarcinogens in years 2085 and 2985 would result from the volatilization of mercury and phosphate

seepage. Risks are calculated to be below 1, with a value less than 3.4×10^{-6}. No release of radiological constituents is projected, since the seepage basin would be capped.

Potential Impacts (Other Than Releases)

The doses due to reclaimed farm, gamma exposure, and biointrusion pathways are negligible.

The impacts of the no waste removal and closure option on biological resources on the F-Area seepage basin are expected to be similar to those described in Section F.2.10.1. All discharges to surface streams from any corrective actions and/or treatment processes used would meet NPDES standards. This closure option would eliminate adverse impacts on aquatic life and would eliminate the potential impacts associated with attractions of organisms to the open water areas of the F-Area seepage basins.

F.2.10.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This option would consist of five phases:

1. Draining the three basins' impounded liquids naturally, through infiltration and evaporation.

2. Excavating, transporting, and disposing of basin sediments. Based on a preliminary evaluation of soil-coring data, approximately 30 centimeters of material would be removed from all basins, for a total volume of 8000 cubic meters of soil. The materials would be transported in metal boxes and disposed of in a waste storage/disposal facility.

3. Backfilling the basins with on-site soils using controlled placement and compaction procedures to 60 centimeters above the surrounding ground surface elevations. Approximately 122,000 cubic meters of backfill would be needed for all three basins.

4. Capping the backfill with a low-permeability cap as described above.

5. Hydroseeding the newly placed topsoil with an appropriate grass seed to minimize erosion (6.7 acres).

The area would be fenced, and only maintenance activities would be allowed. Maintenance activities would consist of inspection for unacceptable erosion and mowing. Groundwater would be monitored quarterly for 1 year and then annually for 29 years.

It might be necessary to take corrective actions to address those constituents already present in the groundwater at these sites. Any such actions would be based on site-specific studies and interactions with regulatory agencies.

Comparison of Expected Environmental Releases with Applicable Standards

The comparison of expected environmental releases with applicable standards that is provided in Section F.2.10.2 is also relevant to this option. However, the closure action under the waste removal and closure option, as projected by PATHRAE, would reduce the levels of uranium-238 to within regulatory standards.

The analysis described in the air release portion of Section F.2.10.1 was also performed for this option. Releases of carcinogen are assumed to occur in the first year, 1986, due to earth-moving activities. No releases are assumed to occur in subsequent years since the seepage basin would be capped. Risks to the maximally exposed individual are calculated to be less than 5.9×10^{-11}. Releases of noncarcinogens are assumed to occur in the first year due to earth-moving activities and in future years due to volatilization of contaminants. However, risks are calculated to be below 1, with a value less than 7.3×10^{-7} in each year.

Releases of radiological constituents in the first year would be due to excavation activities and would be zero in future years, since the basin would be capped. The calculated annual dose to the maximally exposed individual would be less than 0.03 percent of the DOE limit of 25 millirem. The risk associated with this dose would be less than 1.5×10^{-9}.

An analysis of the health risks to the average individual worker attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk to a worker due to nonradioactive carcinogens was calculated to be less than 2.0×10^{-10}. The risk due to noncarcinogens to a worker was calculated to be below 1, with a value of 5.5×10^{-4}. The total dose to the worker would be 940 millirem, which would produce an incremental risk of 2.6×10^{-4}. The total dose to the worker transporting the waste would be 340 millirem, producing an incremental risk of 9.5×10^{-5}.

Potential Impacts (Other Than Releases)

The waste removal and closure option at the F-Area seepage basins is expected to have similar effects on biological resources as those discussed in Section F.2.10.2. Waste removal would eliminate the source of the contamination.

F.2.11 F-AREA SEEPAGE BASIN, BUILDING 904-42G

This seepage basin is discussed in conjunction with the other F-Area seepage basins in Section F.2.10.

F.2.12 F-AREA SEEPAGE BASIN, BUILDING 904-43G

This seepage basin is discussed in conjunction with the other F-Area seepage basins in Section F.2.10.

F.2.13 F-AREA SEEPAGE BASIN (OLD), BUILDING 904-49G*

The old F-Area seepage basin, the first constructed in F-Area, was used for effluent disposal from Building 221-F beginning in November 1954 and ending in May 1955. The basin received a variety of wastewater, including evaporator overheads, laundry wastewater, and an unknown amount of chemicals. The history of waste disposal, evidence of contamination, and waste characteristics at the basin are presented in Appendix B, Section B.3.3.

F.2.13.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The site would be left in its present condition. Groundwater monitoring with existing wells would be continued quarterly for 1 year, and then annually for 29 years. Upkeep would consist of maintaining a fence and signs around the basin area and controlling the vegetation.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

Table F-14 lists all constituents in the groundwater that currently exceed or are projected to exceed regulatory standards for the no-action alternative. Current groundwater monitoring data indicate that concentrations of lead, nitrate, radium, gross alpha, and gross beta exceed regulatory standards or guideline levels. Future groundwater contaminant levels predicted by the PATHRAE model indicate that concentrations of nitrate, cadmium, trichloroethylene, uranium-238, strontium-90, and yttrium-90 will exceed standards.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in the Savannah River are projected to be below drinking-water standards.

Air

The nonradioactive contaminants were analyzed, using the methodology discussed in the introduction to this appendix and in Appendix I, to estimate public exposure and risk attributable to atmospheric contaminant releases from the old F-Area seepage basin. Releases of carcinogens and noncarcinogens are associated with volatilization and wind erosion. Risks attributable to atmospheric releases of carcinogens would be less than 1.2×10^{-10} for each of the 3 selected years. Risks attributable to noncarcinogenic releases would be below 1, with a value less than 3.0×10^{-7}.

Environmental doses and risks to the maximally exposed individual due to radiological releases from the old F-Area seepage basin were calculated using

*The reference source of the information in this section is Odum et al., 1986.

Table F-14. Predicted Maximum Concentrations of Various Constituents at the Old F-Area Seepage Basin for the Three Closure Options[a,b]

Constituent	Applicable standard[d]	Monitoring data maximum mean concentration[e]	PATHRAE-modeled maximum concentration[c]: No action, 1-m well	No action, 100-m well	No waste removal and closure, 1-m well	No waste removal and closure, 100-m well	Waste removal and closure, 1-m well	Waste removal and closure, 100-m well
Cadmium	0.01	(f)	0.019 (2010)	(f)	(f)	(f)	(f)	(f)
Lead	0.05	0.12 (well FNB 2)	(f)	(f)	(f)	(f)	(f)	(f)
Nitrate	10	77.6 (well FNB 2)	1600 (1956)	69 (1964)	(g)	(g)	(g)	(g)
Trichloroethylene	0.005	0.021 (well FNB 3)	0.58 (1956)	0.023 (1965)	(g)	(g)	(g)	(g)
Uranium-238	24	(h)	3600 (2312)	(f)	310 (2370)	(f)	(f)	(f)
Strontium-90	42	(h)	900 (2027)	(f)	(f)	(f)	(f)	(f)
Yttrium-90	550	(h)	900 (2027)	(f)	(f)	(f)	(f)	(f)
Radium	6	31.7 (well FNB 2)	(i)	(i)	(i)	(i)	(i)	(i)
Gross alpha	10-20	203 (well FNB 2)	(i)	(i)	(i)	(i)	(i)	(i)
Gross beta	40-60	1234 (well FNB 2)	(i)	(i)	(i)	(i)	(i)	(i)

[a]Source: Adapted from Odum et al., 1986.
[b]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[c]Year of occurrence in parentheses.
[d]MCLs for chemicals given in EPA, 1985b; for radionuclides, ICRP Publication 30 (ICRP, 1979) methodology was used to determine concentrations that yield annual effective whole-body dose of 4 millirem.
[e]Value listed for trichloroethylene is for TOH.
[f]Below applicable standard.
[g]Identical to value for no-action option.
[h]Not reported.
[i]Not explicitly included in PATHRAE model; gross alpha and beta were modeled by estimating specific radionuclide inventory.

the methodology presented in the introduction to this appendix and in Appendix I. The calculated doses are less than 0.14 percent of the DOE limit of 25 millirem per year for each of the 3 years. The risks associated with these doses would be less than 9.2×10^{-9}.

Potential Impacts (Other Than Releases)

Aquatic Resources

PATHRAE analysis and simple dilution modeling have been performed on groundwater concentrations of cadmium, chromium, lead, and mercury, indicating that influent concentrations of these elements are below EPA criteria for freshwater biota for all closure options.

In order to estimate potential impacts of other materials, water quality parameters of downgradient wells were reviewed to identify those parameters that were higher than the water quality criteria for aquatic life. Those parameters for which well concentrations exceeded the criteria were beryllium, copper, zinc, gross alpha, gross beta, and radium. The dilution factor of 7.1×10^{-4} is expected to reduce concentrations of these wastes in Four Mile Creek to below EPA criteria.

Terrestrial Resources and Wetlands

As discussed in Section F.2.18.1, no adverse impacts on terrestrial ecological resources or wetlands are expected as a result of the no-action closure option at the old F-Area seepage basin.

Endangered Species

As discussed in Section F.2.18.1, this closure option would have no impact on endangered species. However, a species listed as under review for threatened or endangered status, the sand burrowing mayfly (Dolania americana), has been collected from a section of Upper Three Runs Creek. A small tributary to this section of Upper Three Runs Creek is within 200 meters of the old F-Area seepage basin. The no-action alternative would have no impact on this species or its habitat.

F.2.13.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The liquid in the basin would be allowed to dry by natural seepage and evaporation. The basin would then be backfilled and the site capped. There would be no excavation. The fill would consist of 0.6 meter to 1.2 meters of crushed stone or washed gravel covered by a geotextile filter fabric and a minimum of 1.2 meters of common borrow fill. The cap would be as shown in Figure F-2. Routine site maintenance would be carried out, and a groundwater monitoring program would be maintained quarterly for 1 year and then annually for 29 years.

Additional corrective actions (e.g., groundwater extraction and treatment systems) might be needed to address the constituents already in the

groundwater. The action selected would be based on site-specific studies and interactions with relevant regulatory agencies. The groundwater monitoring data in Table F-14 indicate that treatment processes would be required to reduce concentrations of lead, nitrate, radium, gross alpha, and gross beta to levels within regulatory standards. Uranium-238 and strontium-90 are assumed to be the primary sources of gross alpha and gross beta, respectively. PATHRAE simulations (see Table F-14) indicate that expected peak releases of uranium-238 and strontium-90 would exceed MCLs at various times in the future, and that peak releases of nitrate and trichloroethylene exceeded MCLs from 1956 through 1965.

Comparison of Expected Environmental Releases with Applicable Standards

The closure actions described above would be expected to maintain levels of lead, strontium-90, and yttrium-90 within MCLs or ACLs, based on the results of the PATHRAE simulation. Levels of nitrate, trichloroethylene, and uranium-238 would remain above standards following closure, but remedial action would be expected to reduce them to within MCLs or ACLs.

The analysis described in the air release portion of Section F.2.13.1 was also performed for this option. Releases are due to the volatilization of constituents. No other releases are assumed, since the seepage basin would be capped. The risks due to carcinogen releases would be less than 6.3×10^{-13} each of the 3 selected years. The risks attributable to noncarcinogens would be below 1, with a value less than 4.1×10^{-12} for each of those years.

The analysis for radiological releases described in Section F.2.13.1 was also performed for this option. There are assumed to be no releases for all constituents for this option, since the basin would be capped.

Potential Impacts (Other Than Releases)

As discussed in Section F.2.18.2, no adverse impacts on biological resources are expected as a result of this closure option at the old F-Area seepage basin, provided erosion and sedimentation are properly controlled. Consequently, the habitat of the sand-burrowing mayfly, a species under review for listing as threatened or endangered, would not be adversely affected.

F.2.13.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Before excavation of the site, the basin would be allowed to infiltrate and dry by natural seepage and evaporation. Contaminated soil would then be excavated and transported in metal boxes to a waste storage/disposal facility. Approximately 0.6 meter would be excavated from the basin. It is estimated that no more than 5230 cubic meters of soil would be excavated and placed in containers. The basin would then be backfilled and capped. The backfill would consist of 0.6 meter to 1.2 meters of crushed stone or washed gravel covered by a geotextile filter fabric and at least 0.6 meter of borrow fill. This would be covered by a low-permeability cap composed of compacted clayey sand (at least 0.6 meter thick) and 0.6 meter of topsoil as described above.

The corners of the closed basin would be marked with identification pylons. Groundwater monitoring would be conducted quarterly for 1 year and annually thereafter for 29 years. Vegetative growth above the basin would be controlled to protect the infiltration barrier.

Comparison of Expected Environmental Releases with Applicable Standards

Environmental releases to the groundwater would not be affected by waste removal, as the mobile chemicals and nuclides have been leached from the basin during the 29 years the basin has been receiving waste. Therefore, the discussion presented in Section F.2.13.2 is also applicable to the waste removal and closure option.

The analysis described in the air release portion of Section F.2.13.1 was also performed for this option. Releases are caused by volatilization of constituents and, in the first year, by wind erosion and excavation activities. Risks caused by releases of carcinogens were calculated as being less than 6.3×10^{-13} for each of the 3 years. Risks caused by releases of noncarcinogens would be below 1, with a value less than 4.1×10^{-2}.

The analyses for radiological releases described in Section F.2.13.1 were also performed for this option. Releases for 1986 are due to normal excavation activities. These releases would be zero for future years, since the basin would be capped. The dose to the maximally exposed individual at the SRP boundary would be less than 6.4×10^{-4} percent of the DOE limit of 25 millirem. The risk associated with this dose would be less than 4.5×10^{-11}.

An analysis of the health risks to the average individual worker attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk due to nonradioactive carcinogens to a worker was calculated as less than 9.1×10^{-12}. The risk due to noncarcinogens to a worker was calculated as below 1, with a value of 1.4×10^{-5}. The total dose to the worker would be 3.1 millirem, which would produce an incremental risk of 8.7×10^{-7}. The total dose to the worker transporting the waste would be 1.6 millirem, producing an incremental risk of 4.5×10^{-7}.

Potential Impacts (Other Than Releases)

As discussed in Section F.2.18.3, no adverse impacts to biological resources are expected as a result of waste removal and closure at the old F-Area seepage basin. Potential impacts to endangered species and the sand-burrowing mayfly resulting from this alternative would be similar to those described in Section F.2.13.2.

F.2.14 H-AREA SEEPAGE BASINS*

The H-Area seepage basins (Buildings 904-44G, 904-45G, and 904-56G) are mixed waste management facilities that are presently receiving wastes; basin 904-46G stopped receiving wastes in 1961. Background information on the history of waste disposal, waste characteristics, and evidence of contamination are presented in Appendix B, Section B.3.3.

F.2.14.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The no-action option would consist of allowing the basins to drain under natural conditions (i.e., infiltration and evaporation). Once the basins' residual bottom sediments dried sufficiently, the bottoms and side slopes would be covered with 15 centimeters of topsoil and hydroseeded with an appropriate grass to protect the slopes from erosion. Approximately 10,500 cubic meters of topsoil would be needed to cover basin sides and bottoms, and approximately 69,000 square meters of seeding would be needed.

The area would be fenced, and only maintenance activities would be allowed. Maintenance activities would consist of inspection for unacceptable erosion and mowing. Groundwater would be monitored quarterly for 1 year, then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

Monitoring has revealed that groundwater beneath the H-Area seepage basins is contaminated with heavy metals, inorganics, and radionuclides. In addition, PATHRAE predicts that a number of these constituents will exceed, or continue to exceed, groundwater standards. Table F-15 lists these parameters, the corresponding regulatory standards, and the maximum concentrations found, or predicted to be found, in the groundwater near the basins. Only contaminants that exceed, or are predicted to exceed, standards are listed. All other constituents are found at levels below applicable standards.

Surface Water

PATHRAE modeling of surface-water impacts projects that concentrations of tritium, nitrate, and iodine-129 in Four Mile Creek will equal or exceed drinking-water standards because of the addition of those constituents from the groundwater pathway. Table F-15 presents concentrations of those constituents in Four Mile Creek for no action, no waste removal, and waste removal.

Air

Nonradioactive constituents were analyzed to estimate public exposure and risk attributable to atmospheric releases from the H-Area seepage basins.

Releases are caused by the volatilization of constituents and by wind erosion. For this option, the risks due to releases of carcinogens would be less than 1.4×10^{-7}; the risks due to releases of noncarcinogens would be below 1, with a value less than 4.8×10^{-3} for each of the 3 selected years. Environmental doses and risks to the maximally exposed individual due to radiological releases from the H-Area seepage basins were calculated using

*The reference source of the information in this section is Killian et al., 1986b.

Table F-15. Predicted Maximum Concentrations of Various Constituents at the H-Area Seepage Basins for the Three Closure Options[a]

			PATHRAE-modeled maximum concentration without remedial action[b,c]								
			No action			No waste removal and closure			Waste removal and closure		
Constituent	Applicable standard[d]	Monitoring data maximum mean concentration[b]	1-m well	100-m well	Four Mile Creek	1-m well	100-m well	Four Mile Creek	1-m well	100-m well	Four Mile Creek
Chromium	0.05	0.136 (well HSB 68)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Lead	0.05	0.055 (well HSB 67)	0.07 (2104)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Mercury	0.002	0.0033 (well HSB 67)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Nitrate	10	65.02 (well HSB 69)	480 (1983)	480 (1985)	55 (1989)	480 (1983)	480 (1985)	55 (1989)	480 (1983)	480 (1985)	55 (1989)
Gross alpha	10-20	497 (well HSB 68)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Gross beta	40-60	10597.5 (well HSB 68)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Radium	6	33.67 (well HSB 68)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Tritium	87,000	3.7×10^7 (well H6)	2.0×10^7 (1956)	1.4×10^7 (1962)	6.8×10^5 (1974)	2.0×10^7 (1956)	1.1×10^7 (1962)	6.8×10^5 (1974)	2.0×10^7 (1956)	1.4×10^7 (1962)	6.8×10^5 (1974)
Plutonium-238	14	(g)	34 (2104)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Iodine-129	20	(g)	220 (1986)	220 (1987)	20 (2008)	120 (2008)	120 (2008)	(e)	120 (2008)	120 (2008)	(e)

Footnotes on last page of table.

Table F-15. Predicted Maximum Concentrations of Various Constituents at the H-Area Seepage Basins for the Three Closure Options (continued)[a]

Constituent	Applicable standard[d]	Monitoring data maximum mean concentration[b]	PATHRAE-modeled maximum concentration without remedial action[b,c]								
			No action			No waste removal and closure			Waste removal and closure		
			1-m well	100-m well	Four Mile Creek	1-m well	100-m well	Four Mile Creek	1-m well	100-m well	Four Mile Creek
Americium-241	2.5	(g)	23 (2104)	(g)	(g)	(e)	(g)	(g)	(e)	(g)	(g)
Uranium-234	21	(g)	48 (2032)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Uranium-238	24	(g)	41 (2032)	(e)	(e)	(e)	(e)	(e)	(e)	(e)	(e)
Neptunium-237	0.14	(g)	20 (1997)	2.4 (2147)	(e)	0.93 (2715)	0.91 (2765)	(e)	0.91 (2689)	0.89 (2733)	(e)
Strontium-90	42	1,800	1,900 (1976)	(e)	(e)	1,900 (1976)	(e)	(e)	1,900 (1976)	(e)	(e)
Yttrium-90	550	(g)	1,900 (1976)	(e)	(e)	1,900 (1976)	(e)	(e)	1,900 (1976)	(e)	(e)

[a]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[b]From Killian et al., 1986b. Tritium value is four-year mean (1982 through 1985). Strontium-90 value is maximum for groundwater.
[c]Year of occurrence in parentheses.
[d]EPA, 1985b, except where noted. ICRP Publication 30 (ICRP, 1979) methodology was used to calculate radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[e]Below applicable standard.
[f]Not explicitly modeled; gross alpha and beta were modeled by estimating specific radionuclide inventory.
[g]Not reported.

the methodology presented in the introduction to this appendix and in Appendix I. The doses are calculated to be less than 11.6 percent of the DOE limit of 25 millirem per year for each of the 3 years. The risks associated with these doses would be less than 8.2×10^{-7}.

Potential Impacts (Other Than Releases)

Aquatic Resources

Impacts of the no-action option on aquatic resources would result from wastes entering the groundwater and subsequently outcropping to Four Mile Creek. Section F.2.18.1 discusses those waste materials identified in groundwater monitoring wells at the H-Area seepage basins that were not modeled by PATHRAE and that exceed EPA water-quality criteria for aquatic life. Dilution of groundwater contaminated by the H-Area seepage basins by mixing with Four Mile Creek would not reduce these waste concentrations to below EPA criteria. PATHRAE analysis and simple dilution modeling indicate that in-stream concentrations of lead, cadmium, mercury, and chromium would exceed EPA freshwater biota criteria.

The H-Area seepage basins are an open-water area of adequate size to attract aquatic and semiaquatic organisms. Data on water quality in the basins are not available. If concentrations were to exceed EPA freshwater biota criteria, adverse impacts on organisms using the basin could occur.

Terrestrial Resources

Waterfowl and other birds and animals may be attracted to the open-water area of the H-Area seepage basins. Because this is an active operations area, wildlife may be expected to largely avoid the area due to the general level of activity; however, any organisms attracted to the basin could be adversely affected.

Endangered Species and Wetlands

For reasons discussed in Section F.2.18.1, no adverse impacts on endangered species or wetlands are expected as a result of this closure option at the H-Area seepage basins.

F.2.14.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Backfilling and capping of the basin would consist of four phases:

1. Natural drainage of the basins' impounded liquids by infiltration and evaporation.

2. Backfilling of the basins with onsite soils using controlled placement and compaction procedures to 0.6 meter above the surrounding ground surface elevation. (This 0.6-meter layer is for the establishment of vegetation.) Approximately 244,000 cubic meters of backfill would be needed for the four basins.

3. Capping of the basins with a relatively impervious cap to eliminate infiltration of precipitation.

   This cap would consist of (from top to bottom):

   - 0.15 meter of topsoil (13,155 cubic meters)
   - 0.45 meter of clean fill (39,465 cubic meters)
   - A 0.3-meter drainage layer (sand or gravel or equivalent) with a minimum conductivity of 1×10^{-3} centimeter/second (26,310 cubic meters)
   - A 20-mil-thick synthetic liner with a 0.15-meter sand buffer above and below the membrane (13,155 cubic meters)
   - A 0.6-meter-thick layer of compacted clay with a maximum hydraulic conductivity of 1×10^{-7} centimeter/second.

4. Hydroseeding of the newly placed topsoil with an appropriate legume seed to minimize erosion. The seeding would cover an area of 21.3 acres. The area would be fenced, and only maintenance activities would be allowed. Maintenance activities would consist of inspection for unacceptable erosion, and mowing. Groundwater would be monitored quarterly for 1 year, then annually for 29 years.

Remedial actions could be required for this option, since results of PATHRAE modeling predict that concentrations in the groundwater of nitrate, tritium, iodine-129, strontium-90, and yttrium-90 would remain above MCLs (see Table F-15). The precise action taken would be determined on the basis of site-specific studies and interaction with regulatory agencies. Some of the possible treatment technologies are presented in Appendix C.

Comparison of Expected Environmental Releases with Applicable Standards

The implementation of this closure/remedial option would reduce all environmental releases to below MCLs or ACLs. Inorganics and radionuclides would be removed from the groundwater to below applicable standards (see Table F-15). In addition, all other environmental releases are projected to be below regulatory concern.

The analysis described in the air release portion of Section F.2.14.1 was also performed for this option. There are no calculated risks due to carcinogenic releases since the seepage basin would be capped. The risks due to noncarcinogenic releases in each of the 3 years would be from the volatilization of mercury and phosphate seepage and were calculated as being below 1, with a maximum value less than 9.7×10^{-12}.

The analysis for radiological releases described in Section F.2.14.1 was also performed for this option. There are assumed to be no releases for any constituents, since the basin would be capped.

Potential Impacts (Other Than Releases)

Aquatic Resources

The impact of no waste removal and closure on aquatic resources at the H-Area seepage basins is expected to be similar to that described in Section F.2.14.1. Any discharge of water to streams would meet NPDES requirements. Consequently, this closure option would eliminate adverse impacts on groundwater from the H-Area seepage basin.

Terrestrial Resources

Closure, which involves drainage of the basin, would eliminate the potential for adverse impacts due to attraction of organisms to open-water areas.

Endangered Species and Wetlands

As discussed in Section F.2.18.2, no adverse impacts to wetlands or endangered species are expected as a result of implementation of this closure option at the H-Area seepage basins.

F.2.14.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This option would include remediation of all four basins in H-Area. Remediation would consist of five phases:

1. Natural drainage of the basins' impounded liquids by infiltration and evaporation.

2. Excavation, transport, and disposal of basin sediments. Based on a preliminary evaluation of soil coring data, approximately 0.3 meter of material would be removed, for a total volume of 20,870 cubic meters of soil. The excavated material would be transported to the onsite mixed/hazardous waste disposal facility.

3. Backfilling of all the basins with onsite soils to 0.6 meter above the surrounding ground surface, using controlled placement and compaction procedures. Approximately 265,000 cubic meters of backfill would be needed.

4. Capping of the basins with an impervious cap (synthetic geomembrane and low-permeability clay cap) to eliminate precipitation infiltration, covering an area of 9.3 acres. The cap would be as described in Section F.2.14.2.

5. Hydroseeding of the newly placed topsoil with an appropriate grass seed to minimize erosion. The area would be fenced, and only maintenance activities would be allowed. Maintenance activities would include inspection for unacceptable erosion and mowing. Groundwater would be monitored quarterly for 1 year, and then annually for 29 years.

Remedial actions could be required for this option, since PATHRAE modeling shows concentrations of nitrate, tritium, iodine-129, strontium-90, and yttrium-90 in the groundwater remaining above MCLs (see Table F-15).

Comparison of Expected Environmental Releases with Applicable Standards

Implementation of this closure/remedial action would reduce all environmental releases to below MCLs/ACLs. Contaminants would be removed from the groundwater to below applicable standards (see Table F-15 for a listing of standards). In addition, all other environmental releases are projected to be below regulatory concern.

The analysis for air releases described in Section F.2.14.1 was also performed for this option. Releases would be caused by excavation activities and volatilization of constituents. Risks due to releases of carcinogens were calculated as being less than 2.1×10^{-11} for each of the 3 years. Risks due to noncarcinogenic releases were below 1, with values less than 4.8×10^{-3}.

The analysis for radiological releases described in Section F.2.14.1 was also performed for this option. Releases for 1986 are due to normal excavation activities. There would be no releases for future years, since the basin would be capped. The dose to the maximum individual at the SRP boundary was calculated as being less than 0.03 percent of the DOE limit of 25 millirem. The risk associated with this dose would be 1.8×10^{-9}.

An analysis of the health risks to the average individual worker attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk due to nonradioactive carcinogens to a worker was calculated as less than 8.4×10^{-10}. The risk due to noncarcinogens to a worker was calculated as below 1, with a value of 2.5×10^{-4}. The total dose to the worker was calculated to be 1.5×10^{3} millirem, which would produce an incremental risk of 4.0×10^{-4}. The total dose to the worker transporting the waste was calculated to be 320 millirem, producing an incremental risk of 9.0×10^{-5}.

Potential Impacts (Other Than Releases)

This closure option at the H-Area seepage basins is expected to have similar effects on biological resources as those discussed in Section F.2.14.2. Waste removal would eliminate the source of contamination.

F.2.15 H-AREA SEEPAGE BASIN, BUILDING 904-45G

This seepage basin is discussed in conjunction with the other H-Area seepage basins in Section F.2.14.

F.2.16 H-AREA SEEPAGE BASIN, BUILDING 904-46G

This seepage basin is discussed in conjunction with the other H-Area seepage basins in Section F.2.14.

F.2.17 H-AREA SEEPAGE BASIN, BUILDING 904-56G

This seepage basin is discussed in conjunction with the other H-Area seepage basins in Section F.2.14.

F.2.18 POTENTIAL IMPACTS ON BIOLOGICAL RESOURCES IN F- AND H-AREA

This section discusses those generic impacts related to aquatic and terrestrial ecology as well as endangered species and wetlands for each closure and remedial action. Where a discussion of site-specific data is required for a given option, it is given in the appropriate section above.

There are 17 waste sites located within F- and H-Area. The F-Area acid/caustic basin is abandoned in place and is a wet-weather pond, as are the H-Area acid/caustic basin, the H-Area retention basin, the old F-Area seepage basin, and one of the H-Area seepage basins. Three F-Area seepage basins, three H-Area seepage basins, and the new radioactive waste burial ground (which includes the mixed waste management facility) are active waste sites. The four remaining sites, the two F-Area burning/rubble pits, the F-Area retention basin, and the old radioactive waste burial ground are backfilled or covered with soil.

F.2.18.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Action)

Aquatic Ecology

Impacts of the no-action option on aquatic ecosystems could result from wastes entering the groundwater and subsequently outcropping to Four Mile Creek. Table F-16 lists those contaminants identified in groundwater monitoring wells at the F- and H-Area waste sites not modeled using PATHRAE analyses which exceed EPA water quality criteria for aquatic life. A waste is listed in Table F-16 if the highest average measured value in any well exceeded the criterion. Since groundwater concentrations would be diluted upon entering the receiving water body, a dilution factor is also given in the table. Those cases, including PATHRAE-modeled constituents, where the criteria may be exceeded are discussed separately for each site (see previous sections).

Terrestrial Ecology

Potential terrestrial impacts for the waste sites of F- and H-Area include exposure of wildlife and vegetation to surface waters within waste sites and the toxic effects on vegetation of soils containing waste materials. The terrestrial impacts of those waste sites with standing surface waters are discussed on an individual basis in previous sections. Plant toxicity is dependent on plant species, root depth, chemical form of the waste material present, soil composition and moisture, and the rate of material uptake by a plant. Because of the many variables that affect plant toxicity, and because of the limited information on such items, the impacts of waste materials in the soil on plants cannot be accurately assessed for these sites.

Table F-16. Environmental Data for F- and H-Area Waste Sites

Waste site	Areal extent of site[b]	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[c]	Non-PATHRAE-modeled contaminants exceeding freshwater biota criteria[a]: Contaminant	Reported level[d]	Criterion[e]	Area of ground-water outcrop; distance (m) to outcrop	Dilution factor[f]
F-Area acid/caustic basin (904-74G)[g]	15.24 x 15.24	600	No data available	None in vicinity; site is near operations area and habitats are not suitable	pH	4.871,9.613	6.5-9.0	Four Mile Creek; 2000[h]	0.0159
					Cadmium	0.003	6.6E-4		
					Chromium	0.022	0.011		
					Iron	2.099	1.0		
					Zinc	0.541	0.047		
					Gross alpha	84.20	10		
					Gross beta	221.8	40		
					Radium	10	5		
H-Area acid/caustic basin (904-75G)[g]	15.24 x 15.24	500	No data available	None in vicinity; site is near operations area and habitats are not suitable	No data available			Four Mile Creek; 1000[i]	0.33[h]
F-Area burning/rubble pit 231-F[j]	18.9 x 83.8	300	No data available	None in vicinity; site is near operations area and habitats are not suitable	pH	4.2	6.5-9.0	Four Mile Creek; 2000[h]	0.0159[g]
					Cadmium	0.015	6.6E-4		
					Copper	0.009	6.5E-3		
					Mercury	2.0E-4	1.2E-5		
					Zinc	0.057	0.047		
					Gross beta	56.00	40.00		
F-Area burning/rubble pit 231-1F[j]	26.8 x 99.1	300	No data available	None in vicinity; site is near operations area and habitats are not suitable	Information the same as that for site 231-F			Four Mile Creek; 2000[h]	0.0159[g]

Footnotes on last page of table.

Table F-16. Environmental Data for F- and H-Area Waste Sites (continued)

Waste site	Areal extent of site[b]	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[c]	Non-PATHRAE-modeled contaminants exceeding freshwater biota criteria[a]			Area of groundwater outcrop; distance (m) to outcrop	Dilution factor[f]
					Contaminant	Reported level[d]	Criterion[e]		
H-Area retention basin (281-3H)[k]	36.6 x 61	200	0/78	None in vicinity; site is near operations area and habitats are not suitable	No exceedances for gross alpha, gross beta, or tritium; no chemical data available			Four Mile Creek; 1000	0.00067
F-Area retention basin (281-3F)[k]	36.6 x 61	350	0/44	None in vicinity; site is near operations area and habitats are not suitable	No data available			Four Mile Creek; 1000[l]	0.00069
Radioactive waste burial ground (643-7G)[l]	Irregular	100	4/194	None in vicinity; site is near operations area and habitats are not suitable	All contaminants exceeding aquatic criteria were modeled using PATHRAE			Four Mile Creek; 1000	0.76[m]
Mixed waste management facility (28G)[l]	Site located within boundaries of site 643-7G; information the same as for that site								
Radioactive waste burial ground (old) (643-G)[l]	Irregular, 76 acres	100	4/194	None in vicinity; site is near operations area and habitats are not suitable	Information the same as that for site 643-7G			Four Mile Creek; 1600	0.76[m]

Footnotes on last page of table.

Table F-16. Environmental Data for F- and H-Area Waste Sites (continued)

Waste site	Areal extent of site[b]	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[c]	Non-PATHRAE-modeled contaminants exceeding freshwater biota criteria[a]: Contaminant	Reported level[d]	Criterion[e]	Area of ground-water outcrop; distance (m) to outcrop	Dilution factor[f]
F-Area seepage basin 904-746[n]	27 x 84	400	0/102	None in vicinity; site is near operations area and habitats are not suitable	pH Beryllium Copper Iron Zinc Gross alpha Gross beta Radium Hydrogen sulfide	3.053 0.0075 0.101 20.23 2.603 1272 3975 37.36 1.000	6.5-9.0 0.0053 0.0065 0.047 10 40 5 0.002	Four Mile Creek; 500	0.0159
F-Area seepage basin 904-42G[n]	27 x 161	400	0/102	None in vicinity; site is near operations area and habitats are not suitable	Information the same as that for basin 904-41G			Four Mile Creek; 500	0.0159
F-Area seepage basin 904-43G[n]	94 x 219	400	0/102	None in vicinity; site is near operations area and habitats are not suitable	Information the same as that for basin 904-41G			Four Mile Creek; 500	0.0159
Old F-Area seepage basin 904-49G[n]	51 x 91	200	0/166	None in vicinity; candidate species present nearby (see text)	pH Beryllium Copper Zinc Gross alpha Gross beta Radium	3.475 0.007 0.216 0.908 202.5 1233.8 31.70	6.5-9.0 0.0053 0.0065 0.047 10 40 5	Upper Three Runs Creek; 750	0.000714
H-Area seepage basin 904-44G[p]	28 x 75	100	3.8/184	None in vicinity; site is near operations area and habitats are not suitable	pH Copper Zinc Gross alpha Gross beta Radium	3.85 0.030 3.067 497 10,597.5 33.67	6.5-9.0 0.0065 0.047 10 40 5	Four Mile Creek; 500	0.33

Footnotes on last page of table.

Table F-16. Environmental Data for F- and H-Area Waste Sites (continued)

Waste site	Areal extent of site[b]	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[c]	Non-PATHRAE-modeled contaminants exceeding freshwater biota criteria[a]			Area of ground-water outcrop; distance (m) to outcrop	Dilution factor[f]
					Contaminant	Reported level[d]	Criterion[e]		
H-Area seepage basin 904-45G[p]	34 x 141	100	3.8/184	None in vicinity; site is near operations area and habitats are not suitable	Information the same as that for basin 904-44G			Four Mile Creek; 500	0.33
H-Area seepage basin 904-46G[p]	146 x 107	100	3.8/184	None in vicinity; site is near operations area and habitats are not suitable	Information the same as that for basin 904-44G			Four Mile Creek; 500	0.33
H-Area seepage basin 904-56G[p]	Irregular, 9.3 acres	100	3.8/184	None in vicinity; site is near operations area and habitats are not suitable	Information the same as that for basin 904-44G			Four Mile Creek; 500	0.33

[a]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[b]In meters except where otherwise indicated.
[c]From Mayer, Hoppe, and Kennamer, 1986.
[d]Average value for most recent year for groundwater well containing highest concentration.
[e]Based on ICRP, 1978; EPA, 1985b,c; National Technical Advisory Committee, 1968.
[f]Equivalent to groundwater flux divided by flow rate of receiving water body.
[g]Data from Ward, Johnson, and Marine, 1986, except as otherwise indicated.
[h]Data for F-Area Seepage Basin (Killian et al., 1986a).
[i]Data for H-Area Seepage Basin (Killian et al., 1986b).
[j]Data from Huber, Johnson, and Marine, 1986, except as otherwise indicated.
[k]Data from Scott, Killian, Kolb, Corbo, and Marine, 1986, except as otherwise indicated.
[l]Data from Mayer, Hoppe, and Kennamer, 1986; Du Pont, 1985, except as otherwise indicated.
[m]Based on flux at year 100, time of maximum concentration at outcrop (Jaegge et al., 1986).
[n]Data from Killian et al., 1986a, except as otherwise indicated.
[o]Data from Odum, Christie, Fliermans, and Marine, 1986, except as otherwise indicated.
[p]Data from Killian et al., 1986b, except as otherwise indicated.

Endangered Species

As shown in Table F-16, no endangered species are known to occur in the vicinity of the F- and H-Area waste sites. The waste sites, some of which are active, are all located near active facilities and as such represent highly disturbed habitats. The area is therefore not suitable for any of the endangered species known to occur on the Savannah River Plant. The no-action closure option would have no impact on endangered species.

Wetlands

Wetlands are found within 1000 meters of each of the F- and H-Area waste sites, and as close as 100 meters from the H-Area seepage basins. Information on these wetlands is presented in Table F-16. Most wetlands are found along Four Mile Creek and its unnamed tributaries, and are more than 400 meters from the waste sites. The no-action option would cause no impacts to wetlands other than those that may be occurring now. There are no surface discharges to wetlands, and the no-action alternative would not result in any.

F.2.18.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Resources

No removal of waste and implementation of cost-effective remedial and closure actions at the F- and H-Area waste sites would have no additional adverse impacts on aquatic ecological resources. Erosion and sedimentation control measures would eliminate the potential for increased sedimentation. Some additional corrective actions (e.g., groundwater pumping and treatment) might be needed to eliminate the adverse effects of contaminant discharge to surface water. Where closure would eliminate open water at waste sites, no adverse effects to aquatic or semiaquatic organisms resulting from use of the open water areas would occur.

Terrestrial Resources

This closure option would have no adverse impact on terrestrial ecological resources at the F- and H-Area waste sites. All of the sites are highly disturbed and closely associated with active operations areas, thus providing little or no habitat for terrestrial species. Construction activities associated with this closure option would therefore not result in significant impacts. Where closure would eliminate open water, adverse effects on wildlife resulting from use of the open-water areas would not occur.

Roots of deep-rooted plants could eventually penetrate the contaminant zone for sites if a low-permeability cap was used, thereby releasing wastes to the environment. However, site maintenance by mowing during the period of institutional control would prevent this potential impact.

Endangered Species

This closure option would result in further disturbance of areas that are already highly disturbed and unsuitable as habitat for endangered species known to occur on the Savannah River Plant. No endangered species are known

to occur in the vicinity of F- and H-Area waste sites; therefore, this closure option would have no impact on endangered species.

Wetlands

As described in Section F.2.18.1, wetlands are found within 1000 meters of each of the F- and H-Area waste sites. This closure option would cause no impacts on wetlands because they would not be disturbed by the action. The potential for increased sedimentation exists but would be checked by erosion and sedimentation control measures.

F.2.18.3 Assessment of Removal of Waste to the Extent Practicable and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Ecology

In addition to wastewater removal and treatment, this closure option includes removal of contaminated waste material, sediment, and soil from the waste sites. Some additional remediation (e.g., groundwater pumping and treatment) might be required. Closure would be accomplished by backfilling and installation of a low-permeability cap, thus eliminating the sources of contamination. This option would cause no additional adverse impacts to aquatic ecological resources. Closure of the waste site would eliminate adverse effects on aquatic or semiaquatic organisms resulting from use of open-water areas at the waste site.

Terrestrial Ecology, Endangered Species, and Wetlands

For the reasons described in Section F.2.18.2, this closure option would have no adverse impacts on terrestrial resources, endangered species, or wetlands.

F.3 ASSESSMENT OF ACTIONS AT R-AREA WASTE SITES

This geographic grouping is approximately 6 kilometers east of H-Area. As shown on Figure F-6, it contains R-Reactor and waste sites that are typical of the SRP reactor areas.

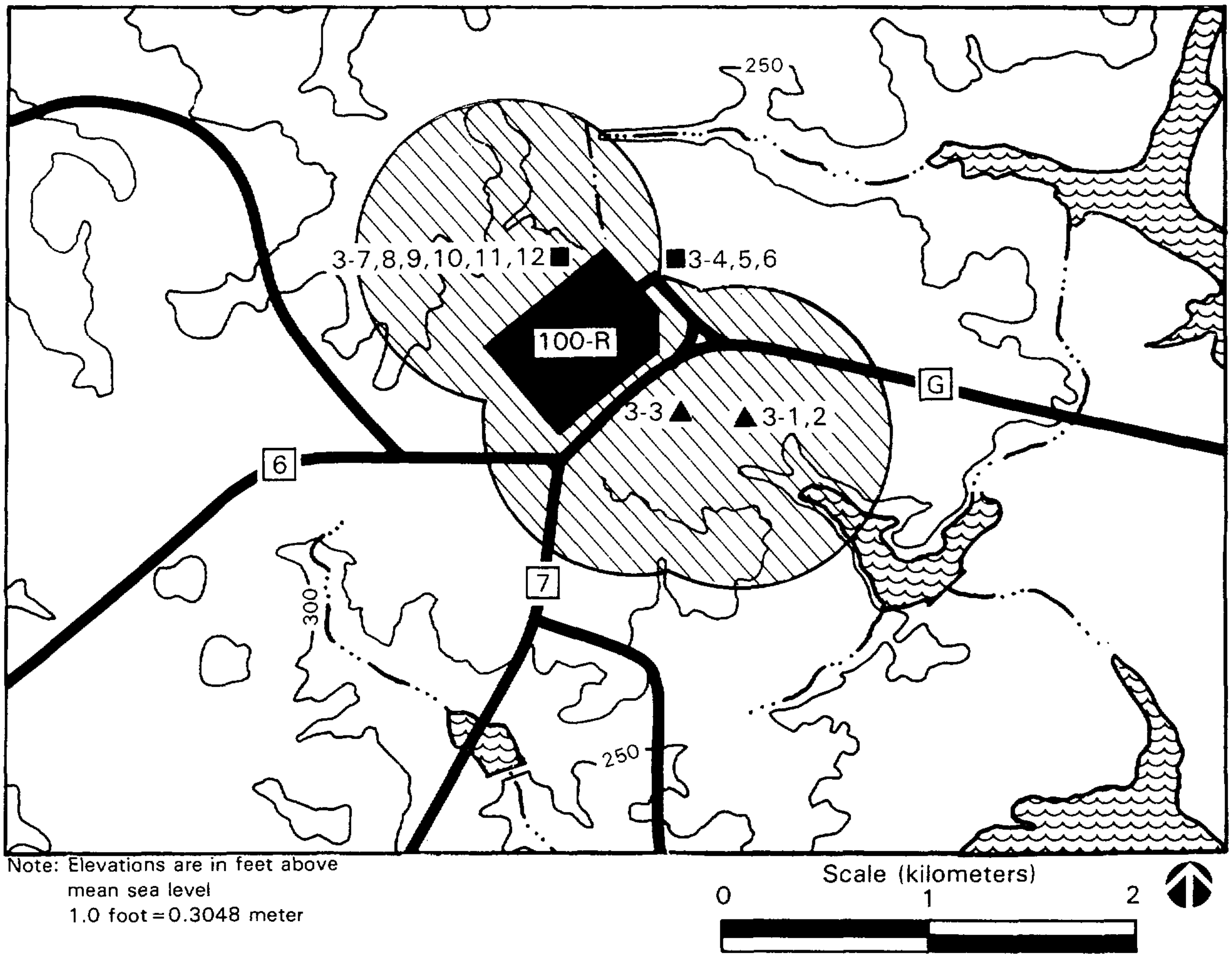
Sections F.3.1 through F.3.12 contain or reference the section that contains a discussion of sites 3-1 through 3-12. Section F.3.13 discusses biological impacts that are generically applicable to the waste sites in this geographic grouping.

F.3.1 R-AREA BURNING/RUBBLE PIT, BUILDING 131-R

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the R-Area geographic grouping are discussed in Section F.3.13.

F.3.2 R-AREA BURNING/RUBBLE PIT, BUILDING 131-1R

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the R-Area geographic grouping are discussed in Section F.3.13.



Number	Potential Waste Type	Site Name	Building Number
3-1	▲	R-Area Burning/Rubble Pit*	131-R
3-2	▲	R-Area Burning/Rubble Pit*	131-1R
3-3	▲	R-Area Acid/Caustic Basin*	904-77G
3-4	■	R-Area Bingham Pump Outage Pit*	643-8G
3-5	■	R-Area Bingham Pump Outage Pit*	643-9G
3-6	■	R-Area Bingham Pump Outage Pit*	643-10G
3-7	■	R-Area Seepage Basin	904-57G
3-8	■	R-Area Seepage Basin	904-58G
3-9	■	R-Area Seepage Basin	904-59G
3-10	■	R-Area Seepage Basin	904-60G
3-11	■	R-Area Seepage Basin	904-103G
3-12	■	R-Area Seepage Basin	904-104G

*Indicates that waste type may be contained in the waste site
▲—Hazardous
■—Low-level radioactive

Figure F-6. R-Area Waste Site

F.3.3 R-AREA ACID/CAUSTIC BASIN, BUILDING 904-77G

This acid/caustic basin is discussed in conjunction with the other acid/caustic basins in Section F.2.1. The ecological effects of this site that relate specifically to the R-Area geographic grouping are discussed in Section F.3.13.

F.3.4 R-AREA BINGHAM PUMP OUTAGE PITS*

There are a total of seven Bingham pump outage pits located in four reactor areas:

Area	Building	Area	Building
R	643-8G	L	643-2G
R	643-9G	L	643-3G
R	643-10G	P	643-4G
K	643-1G		

The options described in this section would be applicable to each of these outage pits.

Since the L-Area pits are situated closer to surface and subsurface waters, the total environmental releases and resulting impacts from the two L-Area pits would be greater than from the pits in the other areas. For this reason, the Bingham pump outage pits in the L-Area were chosen for detailed transport and pathway modeling and risk analysis. Environmental impacts associated with the L-Area outage pits are presented in this section. For purposes of this EIS, the total impacts from the pits in each reactor area are conservatively assumed to be the same as the total impacts from the two L-Area outage pits.

F.3.4.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The Bingham pump outage pits are currently receiving minimum control or upkeep. Annual inspections are made for signs of soil subsidence. Any sunken areas would be filled as required. Radiation surveys have revealed no significant concentrations of radioactivity in vegetation above the outage pits. The natural growth of trees around and onto the site has continued since 1958 and would be permitted to do so under this closure option. Under this option, as least four groundwater monitoring wells would be installed and groundwater monitoring would be conducted quarterly for 1 year and annually thereafter for 29 years.

*The reference source of the information in this section is Pekkala, Holmes, and Marine, 1986a.

Comparison of Expected Environmental Releases with Applicable Standards

The two L-Area outage pits were combined to define a single effective pit. All environmental releases are projected to be below applicable standards for the no-action option.

Groundwater

The releases are expressed in terms of radionuclide concentrations predicted by PATHRAE for wells both 1 meter and 100 meters downgradient of the outage pits. The peak concentrations in the 1-meter well are predicted to occur at 48 years (except for cobalt-60 at 61 years). The peak concentrations in the 100-meter well are predicted to occur at 124 years.

The following is a comparison of the concentrations in the peak years, defined as MCLs, with the EPA primary drinking-water standard:

Well	Concentration, pCi/L				
	Co-60	Cs-137	Sr-90	Y-90	Total
MCL	2.1×10^{2}	1.1×10^{2}	4.2×10^{1}	5.5×10^{2}	
1-m well	2.6×10^{-4}	8.6×10^{-1}	4.7×10^{0}	4.7×10^{0}	
(fractional MCL)	(1.2×10^{-6})	(0.008)	(0.11)	(0.009)	(0.13)
	2046	1960	2033	2033	
100-m well	3.4×10^{-8}	5.6×10^{-1}	3.1×10^{-1}	3.1×10^{-1}	
(fractional MCL)	$(1.6 \times 10^{-10}$	(0.005)	(0.007)	(0.0006)	(0.013)
	2086	1961	2109	2109	

Since the totals are less than 1, the radionuclide concentrations are within the EPA limits.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site. The resulting concentrations of constituents in Pen Branch, calculated for the worst-case scenario of the L-Area Bingham pump outage pits, are projected to be below drinking-water standards.

Air

No radionuclides would be released to the atmosphere under this option, since the pits have all been backfilled.

Potential Impacts (Other Than Releases)

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways occur 100 years from the present. The doses would only be 6.9×10^{-3} and 6.8×10^{-4} millirem per year for the farm and direct gamma

pathways, respectively. The dose would be zero for the pathway involving consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments, due to the assumed limited plant-root depth.

Aquatic Resources

The no-action alternative could affect aquatic resources as a result of wastes entering the groundwater with subsequent outcrop to Par Pond. No groundwater monitoring data are available for the R-Area Bingham pump outage pits. Using PATHRAE analysis and simple dilution modeling on the two L-Area Bingham pump outage pits as representative of other pump outage pits, and because of the proximity to groundwater outcrops, it has been concluded that no change in water quality of the receiving water would result from any closure option, nor would water quality criteria for the modeled radioactive elements be exceeded.

Terrestrial Resources, Wetlands, and Endangered Species

As discussed in Section F.3.13.1, no impacts on terrestrial resources, wetlands, or endangered species are expected as a result of the no-action closure option at the R-Area Bingham pump outage pit (643-8G).

F.3.4.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Because of the small amount of radioactivity buried at the Bingham pump outage pits, no remediation would be planned other than the site surveillance and groundwater monitoring included in the no-action option.

Comparison of Expected Environmental Releases with Applicable Standards

All environmental releases are projected to be below applicable standards for this closure option. Since no waste removal and closure would be the same as the no-action scenario for the Bingham pump outage pits, Section F.3.4.1 applies here.

Potential Impacts (Other Than Releases)

Since the no-action scenario is the same as no waste removal and closure for the Bingham pump outage pits, Section F.3.4.1 applies here.

As described in Section F.3.4.1, no adverse impacts to biological resources are expected as a result of this closure option at the R-Area Bingham pump outage pit (643-8G).

F.3.4.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

In this option the earthen cover would be removed from each waste site and retained for later use as backfill. The solid radioactive waste and surrounding soil would be excavated 0.3 meter below the original bottom of the outage

pit. This excavation should reduce the residual contamination in the soil beneath the outage pit to near-background levels, so that no restrictions on site use would be needed after the pit was backfilled with clean soil, compacted, graded, and seeded for erosion control. Surveys would be made of the basin floor for residual radioactive contamination; the results might require additional excavation below the 0.3-meter depth in order to achieve acceptable results.

A total of approximately 27,000 cubic meters of exhumed waste would be excavated from the pits and placed in metal boxes or bagged as necessary and trucked to a waste disposal facility at SRP designed for solid low-level radioactive waste. The bulky components of the waste (ladders, concrete, drums, pallets, piping, etc.) would require special care and equipment for exhumation, packaging, transport, and placement in the disposal facility.

The corners of each closed outage pit would be marked with identification pylons. Should soil analyses show that elevated concentrations of waste remain in the soil after excavation, four groundwater monitoring wells (one upgradient, three downgradient) would be installed around the outage pits in each of the four areas. Groundwater would be monitored quarterly for 1 year and then annually for 29 years. Site surveillance would be maintained and vegetative growth above the waste sites would be controlled.

Comparison of Expected Environmental Releases with Applicable Standards

All environmental releases are projected to be below applicable standards for this closure option.

Groundwater

Releases are expressed in terms of radionuclide concentrations for both a well 1 meter and another well 100 meters downgradient from the pits.

The concentrations resulting in the highest potential annual doses at any time in the future would occur after approximately 100 years at the 100-meter well. The concentrations at the 1-meter well after 49 years and those at the 100-meter well after 100 years would be as follows:

Well	Concentration, pCi/L				
	Co-60	Cs-137	Sr-90	Y-90	Total
MCL	2.1×10^{2}	1.1×10^{2}	4.2×10^{1}	5.5×10^{2}	
1-m well (fractional MCL)	2.5×10^{-4} (1.2×10^{-6}) 2046	8.6×10^{-1} (0.008) 1960	4.8×10^{0} (0.11) 2034	4.8×10^{0} (0.009) 2034	(0.13)
100-m well (fractional MCL)	3.1×10^{-8} (1.5×10^{-10}) 2084	5.6×10^{-1} (0.005) 1961	1.7×10^{-1} (0.004) 2088	1.7×10^{-1} (0.0003) 2088	(0.0093)

Since the sums are less than 1, the radionuclide concentrations would be within the EPA limits.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site. The resulting concentrations of constituents in Pen Branch, calculated for the worst-case scenario of the L-Area Bingham pump outage pits, are projected to be below drinking-water standards.

Air

Radionuclide releases to the atmosphere would take place only during the time that waste is being removed from the outage pits.

The annual dose to an individual resulting from the release of these radionuclides to the atmosphere would be only 1.92×10^{-5} percent of the 25 millirem/year DOE limit. The risk associated with this dose would be 1.4×10^{-12}.

An analysis of the average individual worker health risks attributable to occupational exposure to radioactive carcinogens was performed using the methodology presented in Appendix I. The total dose to the worker was calculated to be 2.4 millirem, which would produce an incremental risk of 6.7×10^{-7}. The total dose to the worker transporting the waste was calculated as 1.2 millirem, producing an incremental risk of 3.4×10^{-7}.

Potential Impacts (Other Than Releases - Radiological Only)

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways would occur 100 years after waste removal and closure, at which time institutional control of the SRP is assumed lost. The doses would only be 1.3×10^{-8} and 1.8×10^{-20} millirem per year for the farm and direct gamma pathways, respectively. The dose would be zero for the pathway which involves consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments. Such contamination is precluded due to the assumed limited plant-root depth.

The radiological impacts are assumed to be the same as those given in Section F.9.10.3.

Potential Impacts on Biological Resources

For reasons described in Section F.3.13.3, no adverse impacts on biological resources are expected as a result of this closure option at the R-Area Bingham pump outage pit (643-8G).

F.3.5 R-AREA BINGHAM PUMP OUTAGE PIT, BUILDING 643-9G

The options, releases, and other potential impacts for this outage pit are discussed in conjunction with the other Bingham pump outage pits in Section F.3.4.

F.3.6 R-AREA BINGHAM PUMP OUTAGE PIT, BUILDING 643-10G

The options, releases, and other potential impacts for this outage pit are discussed in conjunction with the other Bingham pump outage pits in Section F.3.4.

F.3.7 R-AREA SEEPAGE BASINS*

The R-Area seepage basins consist of six sites (904-103G, 904-104G, 904-57G, 904-58G, 904-59G, and 904-60G). Purge water from the disassembly basins in the reactor buildings was pumped to the seepage basins from the late 1950s until 1964. The seepage basins have been inactive since 1964 and were backfilled. R-Area basins are contiguous, and therefore they are considered as one site for evaluation and assessment analyses. The surface stream nearest to these R-Area basins is Mill Creek. No hazardous chemical constituents are believed to have been discharged to these basins.

F.3.7.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The R-Area seepage basins are currently backfilled and receive only minimal upkeep. Radiation surveys are conducted periodically, and herbicide or asphaltic covering is applied infrequently. However, groundwater is extensively monitored for radioactive contamination. In the no-action option, those activities would be continued, with quarterly monitoring for 1 year and annual monitoring for 29 years. Pylons would be installed to identify the corners of the previous basins, and vegetative growth would be controlled and surveyed periodically for radiation.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The regulatory standards and measured or estimated maximum concentrations of constituents which are of concern for regulatory requirements or health risk are presented in Table F-17. Most maximum concentrations are based on PATHRAE modeling, either because no measured concentration was available or because the calculated concentration was greater than that of the measured concentration.

The maximum estimated concentrations presented in Table F-17 correspond to the calculated peaks. In most cases these peaks occurred prior to the base year. Although the site is not receiving wastes presently, the peak concentrations, in the absence of base year (0 year) concentrations, would conservatively serve as the design basis of the remedial actions. It can be seen from Table F-17 that concentrations of cesium-137, tritium, strontium-90, and yttrium-90 are estimated to exceed the standards at the 1-meter well. Cesium-137 and tritium would exceed standards at the 100-meter well.

*The reference source of the information in this section is Pekkala, Holmes, and Marine, 1986b.

Table F-17. Predicted Maximum Concentrations of Various Constituents at R-Reactor Seepage Basins for the Three Closure Options

			PATHRAE-modeled maximum concentration without remedial action[a]					
			No action		No waste removal and closure		Waste removal and closure	
Constituent	Applicable standard[b]	Measured concentration	1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Gross beta	40-60	1.5×10^{4} (c) (well E6)	(d)	(d)	(d)	(d)	(d)	(d)
Cesium-137	1.1×10^{2}	(e)	3.3×10^{3} (1965)	1.7×10^{3} (1970)	(f)	(f)	(f)	(f)
Tritium	8.7×10^{4}	(e)	1.5×10^{8} (1963)	6.5×10^{7} (1969)	(f)	(f)	(f)	(f)
Strontium-90[g]	4.2×10^{1}	9.5×10^{3}	4.3×10^{4} (2094)	(h)	9.3×10^{3} (2111)	(h)	9.3×10^{1} (2111)	(h)
Yttrium-90[g]	5.5×10^{2}	(e)	4.3×10^{4} (2094)	(h)	9.3×10^{3} (2111)	(h)	(h)	(h)

[a]Source: Pekkala, Holmes, and Marine, 1986b (DPST-85-707). Number in parentheses represents year in which concentration was reached or is expected to be reached.
[b]EPA, 1985b. ICRP Publication 30 (ICRP, 1979) methodology was used to calculate radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[c]Gross beta value is a 3-year mean (1982 through 1984).
[d]Not modeled.
[e]Not reported.
[f]Value identical to that of no-action option.
[g]Absolute peaks for facilitated transport fraction occurred at the 1-m well in 1965 and at the 100-m well in 1970. The peak concentrations were 7.2×10^{4} and 3.7×10^{7} pCi/L, respectively. These peaks are not affected by the closure option.
[h]Below applicable standard.

Surface Water

Surface-water quality is not significantly affected by the addition of potential contaminants from this site, as the resulting concentrations of constituents in Mill Creek are projected to be below drinking-water standards.

The annual dose and associated risks to an individual resulting from the atmospheric radionuclide releases for the no-action alternative would be negligible when compared to the DOE limit of 25 millirem per year.

Potential Impacts (Other Than Releases)

The doses resulting from the erosion and biointrusion pathways were all zero. The maximum annual doses for the reclaimed farm pathway and the direct gamma exposure pathway are calculated as 19 and 2.3×10^{-6} millirem per year, respectively.

Aquatic Resources

Potential impacts to aquatic resources as a result of this closure option at the R-Area seepage basin (904-57G) are expected to be similar to those described in Section F.3.13.1. PATHRAE analysis and simple dilution modeling based on radionuclide inventories for the R-Area seepage basins indicate that stream concentrations after mixing would remain within water quality guidelines for all closure options for all years.

Terrestrial Resources, Wetlands, and Endangered Species

For reasons described in Section F.3.13.1, this closure option is expected to have no adverse impacts on terrestrial resources or endangered species at the R-Area seepage basins. Prior to complete mixing, for all closure options at year 0 (1985), tritium concentrations might be sufficiently high to impact local wetland areas adjacent to Mill Creek. By 2085, outcropping concentrations would no longer present a threat to wetlands.

F.3.7.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

In this option, no contaminated soil would be removed. However, the surface soil over the 27-acre area shown in Figure F-7 would be removed down to approximately 1 or 2 meters below the original ground surface. The area of removal would include the six basins, the contaminated section of the abandoned sewer, and major areas of groundwater contamination. A low-permeability infiltration barrier cap would then be installed over this area. The capped site would be graded and seeded for erosion control, and culverts or equivalent structures would be installed around the site to receive surface and subsurface drainage. The culverts would discharge into natural drainages to Mill Creek. Site maintenance, groundwater monitoring, placement of identification pylons, and radiation surveys would be carried out as described for the no-action option above.

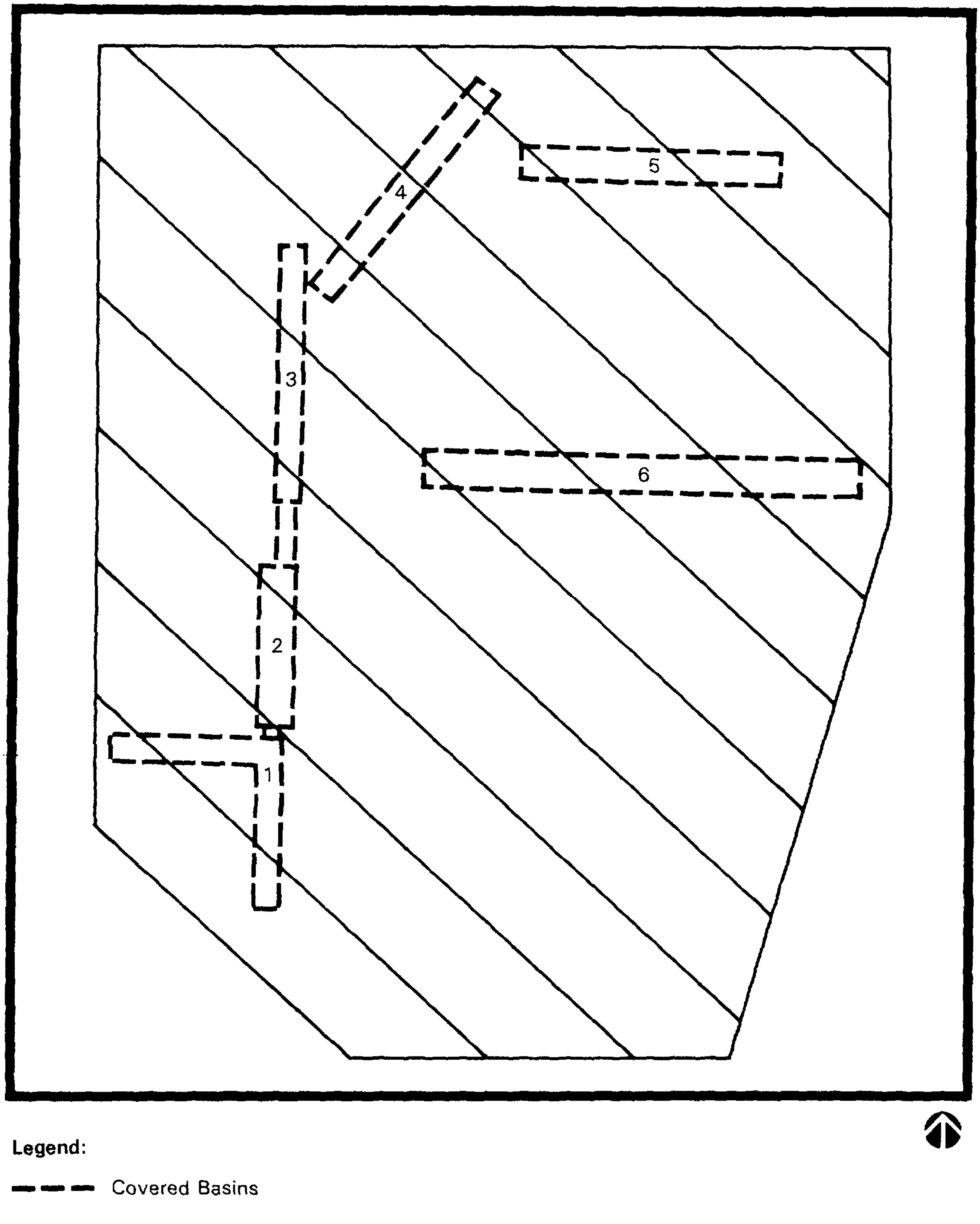


Figure F-7. Map of R-Area Seepage Basins Showing Area To Be Capped (crosshatched)

Source control and groundwater cleanup might be required for no waste removal. It can be seen from the estimated concentrations presented in Table F-17 that the concentrations in groundwater of tritium, cesium-137, strontium-90, and yttrium-90 would exceed the applicable radionuclide concentration standards. One of the possible corrective actions would be to pump the water from groundwater extraction wells and treat it further. The selection of an action plan would be based on site-specific studies and interaction with the regulatory agencies concerned. Treatment technologies are discussed in Appendix C.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The implementation of this closure action option would reduce all environmental releases to below MCLs or ACLs. Radionuclides would be removed from the groundwater to below applicable standards (see Table F-17). All other environmental releases are projected to be below regulatory concern.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in Mill Creek are projected to be below drinking-water standards.

Air

The total annual maximum individual dose would be zero; no radionuclides would be released.

Potential Impacts (Other Than Releases)

The doses due to erosion and biointrusion would all be zero. The calculated doses for the reclaimed farm pathway and direct gamma exposure would be 0.005 and 2.4×10^{-10} millirem per year, respectively.

Closure would be accomplished with a low-permeability cap covering a total of 22.7 acres. While this is a relatively large area, it is adjacent to operations areas and is not habitat for terrestrial species. Also, because erosion and sedimentation measures would be used, no adverse impacts on terrestrial ecological resources are expected as a result of this closure option at the R-Area seepage basins. Potential impacts to wetlands are discussed in Section F.3.7.1. Other ecological impacts would be similar to those discussed in Section F.3.13.2.

F.3.7.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

In this option, each of the six backfilled basins in R-Area would be excavated to remove contaminated soil indicated by the zone of elevated dose rates shown

in Figure F-8. The thickness of the radioactive zone and the amount of contaminated soil expected to be recovered are shown in Table F-18. During the waste recovery phase, contaminated sections of the abandoned construction sewer would be removed and associated contaminated soil would be recovered. After excavation, each basin would be backfilled with compacted clean soil to approximately 1 or 2 meters below the original ground surface.

Table F-18. Volume of Radioactive Soil To Be Excavated at the R-Area Seepage Basins in the Waste Removal and Closure Option

Site	Building	Thickness of Contamination (m)		Contaminated Soil (m^3)
Basin 1	904-103G	1.8		1630
2	904-104G	1.5		1080
3	904-57G	1.2		710
4	904-58G	1.2		560
5	904-59G	1.2		1090
6	904-60G	1.2		1590
Abandoned sewer		0.6		420
			Total	7080

The contaminated waste recovered during the excavation phase (7080 cubic meters) would be packaged in metal containers and trucked to a storage/disposal facility at SRP.

Following the recovery of contaminated waste, the remaining surface soil over the 27-acre area shown in Figure F-7 would be removed down to the datum plane identified above. This area includes the six basins, the contaminated section of the abandoned sewer, and major areas of groundwater contamination. An infiltration barrier would then be installed over the 27-acre area. About 7000 cubic meters of clean backfill would be required in addition to the clean soil excavated. The capped site would be graded and seeded for erosion control, and culverts or equivalent structures would be installed around the site to receive surface and subsurface drainage. The culverts would discharge into natural drainages to Mill Creek.

Groundwater monitoring wells at selected locations that would be removed during installation of the infiltration barrier would be replaced and groundwater monitoring would be continued, quarterly for 1 year and then annually for 29 years. Pylons would be installed to identify the corners of the previous basins, and vegetative growth would be surveyed periodically and controlled to protect the infiltration barrier.

Remedial action may be required for this option, since PATHRAE modeling predicts that the concentrations in groundwater of tritium, cesium-137, and strontium-90 would exceed the recommended radionuclide concentration standards

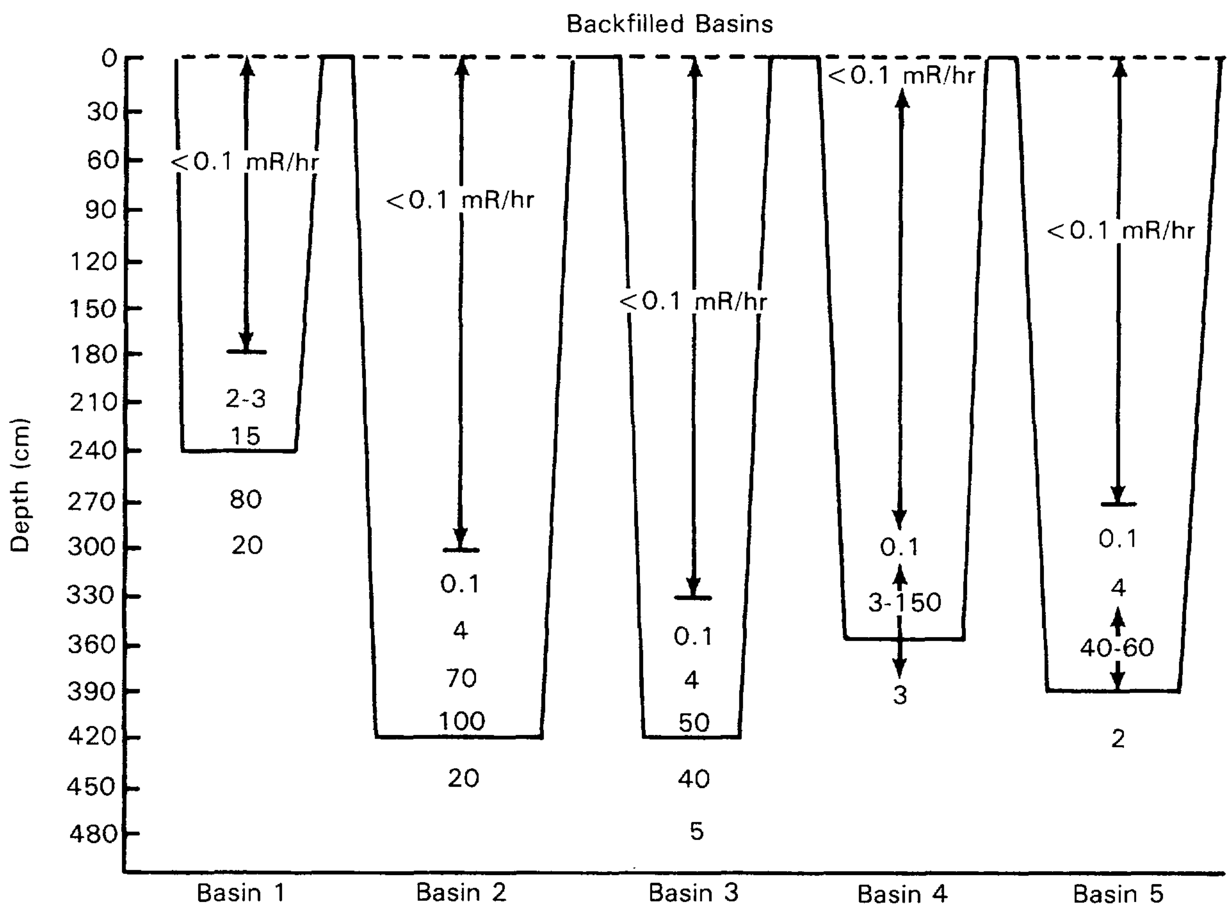


Figure F-8. Dose Rate (mR/hr) in R-Area Seepage Basins Measured in Dry Monitoring Wells

(see Table F-17). The potential remedial action for this option would be similar to that discussed in Section F.3.7.2. Final selection of an action plan would be based on site-specific studies and interactions with regulatory agencies.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The regulatory standards and measured or estimated maximum concentrations of all contaminants of concern from a regulatory and health risk viewpoint are presented in Table F-17 for waste removal and closure without further remedial action. Note, by comparison with the waste removal and closure option (see Table F-17), that the extent and concentration of groundwater contamination would be significantly reduced as a result of the waste removal. For example, the peak concentrations of strontium-90 and yttrium-90 would be reduced by a factor of 100 at the 1-meter well, with yttrium-90 reduced to below its regulatory standard. However, modeling predicts that cesium-137, tritium, and strontium-90 concentrations have exceeded or will exceed the standard; therefore, remedial action might also be required.

The implementation of this closure/remedial action option would reduce all environmental releases to below MCLs or ACLs. Radionuclides would be removed from the groundwater to below applicable standards (see Table F-17). All other environmental releases are projected to be below regulatory concern.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the site, as the resulting concentrations of constituents in Mill Creek are projected to be below drinking-water standards.

Air

Radionuclides would be released to the atmosphere during the first year only for this option.

The total annual maximum individual dose due to atmospheric releases would be less than 0.022 percent of the DOE limit of 25 millirem per year. The risk associated with this dose would be less than 1.6×10^{-9}.

An analysis of the average individual worker health risks attributable to occupational exposure to radioactive carcinogens was performed using the methodology presented in Appendix I. The total dose to the worker was calculated to be 780 millirem, which would produce an incremental risk of 2.2×10^{-4}. The total dose to the worker transporting the waste was calculated as 390 millirem, producing an incremental risk of 1.1×10^{-4}.

Potential Impacts (Other Than Releases)

The doses due to erosion and biointrusion would all be zero. The calculated doses for the reclaimed farm pathway and direct gamma exposure doses would be negligible.

For reasons described in Section F.3.13.3, no adverse impacts on aquatic or terrestrial resource or endangered species are expected as a result of this closure option at the R-Area seepage basins. Potential impacts to wetlands are discussed in Section F.3.7.1.

F.3.8 R-AREA SEEPAGE BASIN, BUILDING 904-58G (BASIN 4)

This waste site is discussed in conjunction with the other R-Area seepage basins in Section F.3.7.

F.3.9 R-AREA SEEPAGE BASIN, BUILDING 904-59G (BASIN 5)

This waste site is discussed in conjunction with the other R-Area seepage basins in Section F.3.7.

F.3.10 R-AREA SEEPAGE BASIN, BUILDING 904-60G (BASIN 6)

This waste site is discussed in conjunction with the other R-Area seepage basins in Section F.3.7.

F.3.11 R-AREA SEEPAGE BASIN, BUILDING 904-103G (BASIN 1)

This waste site is discussed in conjunction with the other R-Area seepage basins in Section F.3.7.

F.3.12 R-AREA SEEPAGE BASIN, BUILDING 904-104G (BASIN 2)

This waste site is discussed in conjunction with the other R-Area seepage basins in Section F.3.7.

F.3.13 POTENTIAL IMPACTS ON BIOLOGICAL RESOURCES IN R-AREA

This section addresses generic impacts related to aquatic and terrestrial ecology, endangered species, and wetlands for each closure option. Where a discussion of site-specific data is required for a given option, it is presented in the appropriate section above.

There are 12 waste sites located within the R-Area. Eleven sites are presently backfilled with soil and abandoned. The six R-Area seepage basins are surfaced with asphalt. The R-Area acid/caustic basin is inactive and is a wet-weather pond.

F.3.13.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Action)

Aquatic Ecology

Potential impacts of the no-action alternative on aquatic resources result from wastes entering groundwater and subsequent outcrop to Par Pond or its tributaries, or, in the case of the R-Area seepage basins, to Mill Creek, a tributary of Upper Three Runs Creek. Table F-19 lists those waste materials identified in groundwater monitoring wells within the R-Area which would exceed EPA water quality criteria for aquatic life. A waste material is

Table F-19. Environmental Data for R-Area Waste Sites

Waste site	Areal extent of site	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria: Contaminant	Reported level[a]	Criterion[b]	Area of groundwater outcrop; distance (m) to nearest stream	Dilution factor[c]
R-Area burning/ rubble pit 131-R[d]	0.11 acre	250 to Pond 4; 300 to next nearest wetland[e]	No data available	Bald eagles observed about 2.5 km NE and 2.0 km SW;[f] alligators present and nesting in Par Pond 2.5 km E[g]	pH Silver Cadmium Copper Iron Mercury	4.386 0.002 mg/L 0.0023 mg/L 0.008 mg/L 2.285 mg/L 0.0003 mg/L	6.5–9.0 1.2×10^{-4} mg/L 6.6×10^{-4} mg/L 0.0065 mg/L 1.0 mg/L 1.2×10^{-5} mg/L	Par Pond; no data available	No data available
R-Area burning/ rubble pit 131-1R[d]	0.18 acre	Information the same as that for site 131-R							
R-Area acid/ caustic basin (904-77G)[h]	0.057 acre	250 to nearest open water, 400 to next nearest wetland[e]	No data available	Bald eagles observed about 2.5 km NE and 2.0 km SW;[f] alligators present and nesting in Par Pond 2.5 km E[g].	pH Silver Cadmium Zinc Gross alpha	4.325 0.003 mg/L 0.0175 mg/L 0.068 mg/L 11.5 pCi/L	6.5–9.0 1.2×10^{-4} mg/L 6.6×10^{-4} mg/L 0.47 mg/L 10 pCi/L	Par Pond; no data available	No data available
R-Area bingham pump outage pit 643-8G[i]	6 m x 76 m	500	0/26.1 ac (26.1 ac)/ 1.9 ha (4.7 ac)	Bald eagles observed about 2.5 km NE and 2.0 km SW;[f] alligators present and nesting in Par Pond 2.5 km E[g]	No data available			Joyce Branch, (drains to Par Pond); 570	No data available

Footnotes on last page of table.

Table F-19. Environmental Data for R-Area Waste Sites (continued)

Waste site	Areal extent of site	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria			Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[c]
					Contaminant	Reported level[a]	Criterion[b]		
R-Area Bingham pump outage pit 643-9G[e]	5 m x 76 m	Information the same as that for site 643-8G							
R-Area Bingham pump outage pit 643-10G[e]	8 m x 159 m	Information the same as that for site 643-8G							
R-Area seepage basin 904-57G[d]	9 m x 90 m	250 m	0/78.6	Bald eagles observed about 2.5 km NE and 2.0 km SW;[f] alligators present and nesting on Par Pond 2.5 km E[g]	No groundwater chemistry data available			Mill Creek (tributary to Upper Three Runs Creek)	6.6×10^{5}
R-Area seepage basin 904-58G	11 m x 93 m	Information the same as that for site 904-57G.							
R-Area seepage basin 904-59G	12 m x 90 m	Information the same as that for site 904-57G.							
R-Area seepage basin 904-60G	14 m x 150 m	Information the same as that for site 904-57G.							

Footnotes on last page of table.

Table F-19. Environmental Data for R-Area Waste Sites (continued)

Waste site	Areal extent of site	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria: Contaminant	Reported level[a]	Criterion[b]	Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[c]
R-Area seepage basin 904-103G	9 m x 120 m	Information the same as that for site 904-57G							
R-Area seepage basin 904-104G	14 x 40 m	Information the same as that for site 904-57G							

[a]Average value for most recent year for groundwater well containing highest concentration.
[b]Based on ICRP 30, 1978; EPA, 1985b,c; National Technical Advisory Committee, 1968.
[c]Equivalent to groundwater flux divided by flow rate of receiving stream.
[d]Data from Huber, Johnson, and Marine, 1986, except as otherwise indicated.
[e]Data from USGS, 1963.
[f]Data from Mayer, Hoppe, and Kennamer, 1986.
[g]Data from Du Pont, 1985.
[h]Data from Ward, Johnson, and Marine, 1986, except as otherwise indicated.
[i]Data from Pekkala, Holmes, and Marine, 1986a, except as otherwise indicated.
[j]Data from Pekkala, Holmes, and Marine, 1986b, except as otherwise indicated.

listed if the highest average measured value in any well exceeded the criterion. Groundwater data are not available for the Bingham pump outage pits or the R-Area seepage basins. Since groundwater concentrations would be diluted upon entering the receiving water body, a dilution factor is given in Table F-19, where data are available. Those cases where the aquatic life criteria may be exceeded are addressed separately for each site, as is the case for those wastes modeled using PATHRAE.

All R-Area waste sites except the R-Area acid/caustic basin are backfilled and therefore would cause no adverse impacts to aquatic or semiaquatic organisms as a result of attraction to open-water areas.

Terrestrial Ecology

The no-action alternative would cause no additional adverse impacts on terrestrial resources at the R-Area waste sites. Data indicate little or no elevation of alpha or beta activity in vegetation growing on the R-Area Bingham pump outage pits over that observed at the perimeter of the Savannah River Plant. The three Bingham pump outage pits and the six R-Area seepage basins received only radioactive waste and are backfilled with soil and covered with asphalt. Adverse impacts of potential transport of radioactive contaminants to the surface by vegetation are therefore not expected as a result of the no-action alternative at the Bingham pump outage pits or the R-Area seepage basins.

The R-Area burning/rubble pits and the R-Area acid/caustic basin have received chemical wastes and are either backfilled with soil (burning/rubble pits) or remain open as a wet-weather pond (acid/caustic basin). Therefore, the potential exists for transport of chemical contaminants to the surface by vegetation growing on these sites. No data are available to determine if such impacts are occurring. The no-action alternative would not alter the present condition.

Endangered Species

Information on endangered species in the vicinity of the R-Area waste sites is shown in Table F-19. Areas apparently used by these species are sufficiently distant from the waste sites that no adverse impacts to them are expected as a result of this closure option.

Wetlands

Wetlands are found within 500 meters of each of the R-Area waste sites, and within approximately 250 meters of all sites except the Bingham pump outage pits (see Table F-19). The wetlands consist of open water and bottomland hardwood forests. The no-action closure option would cause no additional impacts on wetlands than may be occurring at the present time. No surface discharges to wetlands are currently occurring, and the no-action alternative would not result in any such discharges.

F.3.13.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Ecology

The closure and possible remedial activities are not expected to adversely impact biological resources. Erosion and sedimentation control measures would eliminate the potential for increased sedimentation. The potential for adverse impacts due to the outcropping of groundwater would be eliminated. Also, if groundwater pumping and treatment were implemented, treated groundwater would be discharged according to NPDES outfall, and impacts to the receiving water body would not be significant.

Terrestrial Ecology

The potential terrestrial impacts of no waste removal and closure for the waste sites of the R-Area would include uptake of wastes by plant roots and temporary disturbance to wildlife due to noise associated with closure activities. Continued maintenance would be required to prevent impacts from root penetration of the clay cap.

Endangered Species and Wetlands

The distance to areas known to be used by endangered species and to wetlands, plus erosion and sedimentation control measures, eliminate the potential for adverse impacts on wetlands and endangered species from the no waste removal closure option.

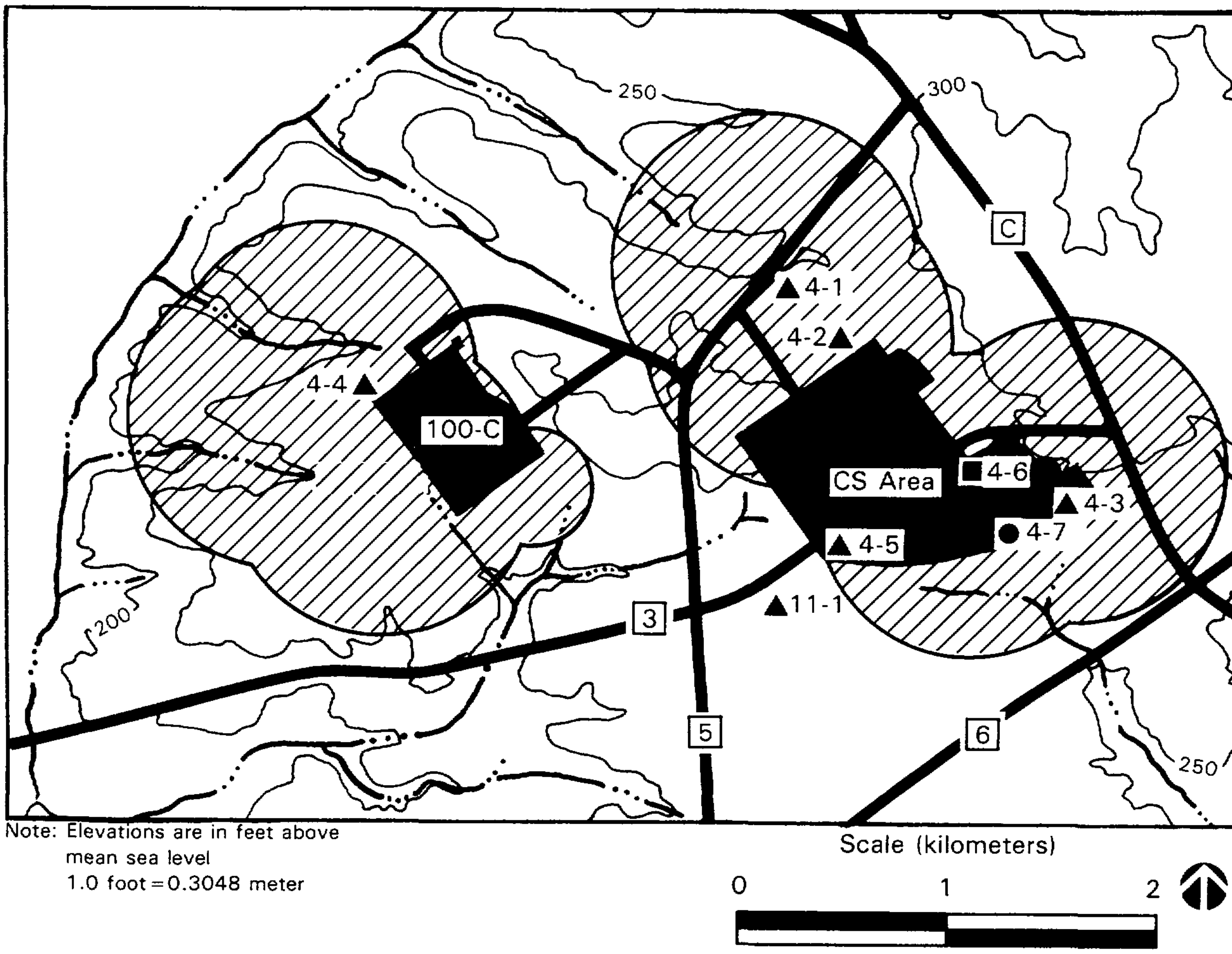
F.3.13.3 Assessment of Removal of Waste to the Extent Practicable and Implementation of Cost-Effective Remedial and Closure Actions as Required

In addition to the measures described in Section F.3.13.2, wastes located in the R-Area waste sites would be removed under this closure option. Construction activities might take longer under this option than under no waste removal and closure, but they would be similar. Therefore, no adverse impacts to biological resources are expected as a result of the waste removal and closure option at the R-Area waste sites.

F.4 ASSESSMENT OF ACTIONS AT C- AND CS-AREA WASTE SITES

This geographic grouping is near the center of the SRP, a short distance south of F- and H-Area. As shown in Figure F-9, it is actually two separate but closely spaced groupings, one formed by waste sites near C-Reactor and the other containing sites in and around the Central Shops (CS) Area.

Sections F.4.1 through F.4.7 contain or reference the section that contains a discussion of sites 4-1 through 4-7. Section F.4.8 discusses biological impacts that are generically applicable to the waste sites in the geographic grouping.



Number	Potential Waste Type	Site Name	Building Number
4-1	▲	CS Burning/Rubble Pit*	631-1G
4-2	▲	CS Burning/Rubble Pit*	631-5G
4-3	▲	CS Burning/Rubble Pit*	631-6G
4-4	▲	C-Area Burning/Rubble Pit*	131-C
4-5	▲	Hydrofluoric Acid Spill Area*	631-4G
4-6	■	Ford Building Waste Site*	643-11G
4-7	●	Ford Building Seepage Basin	904-91G
11-1	▲	SRL Oil Test Site	080-16G

*Indicates that waste type may be contained in the waste site
▲—Hazardous
■—Low-level radioactive
●—Mixed

Figure F-9. C- and CS-Area Waste Sites

F.4.1 CS BURNING/RUBBLE PIT, BUILDING 631-1G

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the C- and CS-Area geographic grouping are discussed in Section F.4.8.

F.4.2 CS BURNING/RUBBLE PIT, BUILDING 631-5G

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the C- and CS-Area geographic grouping are discussed in Section F.4.8.

F.4.3 CS BURNING/RUBBLE PIT, BUILDING 631-6G

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the C- and CS-Area geographic grouping are discussed in Section F.4.8.

F.4.4 C-AREA BURNING/RUBBLE PIT, BUILDING 131-C

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the C- and CS-Area geographic grouping are discussed in Section F.4.8.

F.4.5 HYDROFLUORIC ACID SPILL AREA, BUILDING 631-4G*

F.4.5.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Under this option the contaminated area would remain in its current status, with groundwater monitoring continuing on a quarterly basis for 1 year and then on an annual basis for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents selected for assessment of the environmental impacts and health risks associated with the hydrofluoric acid spill area were fluoride and lead. Fluoride was selected because it is suspected to be present due to the nature of the material spilled. Lead was chosen because it was found to be present in the groundwater at levels higher than the threshold selection criteria.

*The reference source for the information in this section is Huber and Bledsoe, 1986a.

The effects of groundwater contaminant transport were modeled by PATHRAE at two hypothetical monitoring wells located 1 and 100 meters downgradient from the site, and the groundwater discharge point at Castor Creek. All modeled constituents in the groundwater have peak concentrations below applicable standards. Surface-water quality would not be significantly affected by the addition of potential waste constituents from the groundwater pathway from this site, as the concentrations of constituents in Castor Creek deriving from this source are projected to be below drinking-water standards.

No carcinogenic risks from atmospheric chemical releases are expected. The noncarcinogenic risks to the maximally exposed individual would be below 1, with a value less than 10^{-6}, and would be insignificant.

Estimates of the lead and fluoride concentrations for the erosion pathway indicate that the concentrations are very small, well below levels of regulatory or health risk concern.

Potential Impacts (Other Than Releases)

General ecological impacts of the no-action closure plan for the hydrofluoric acid spill area are similar to those addressed in Section F.4.8.1.

The hydrofluoric acid spill area is located near the Carolina bays. The actions proposed for the no-action closure plan should not have any effect on the Carolina bays, because there would be no land disturbance and the waste site does not contain any standing surface water, which would facilitate soil erosion and surface runoff.

F.4.5.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this option, the site would remain in its current status. Groundwater monitoring would continue on a monthly basis for 1 year and then on an annual basis for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents, the consequences of environmental releases, and the pathways associated with this option would be the same as those for the no-action option.

The expected concentration for the erosion pathway is zero.

Potential Impacts (Other Than Releases)

The potential ecological impacts of no waste removal and closure for the hydrofluoric acid spill area would be similar to those addressed in Section F.4.8.2.

F.4.5.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This option would involve the excavation of approximately 230 cubic meters of potentially contaminated soil and its removal to an SRP mixed or hazardous waste storage/disposal facility. The excavated pit would then be backfilled to grade with clean, compacted soil, with 15 centimeters of topsoil placed over the backfill and seeded. Groundwater monitoring would continue on a quarterly basis for 1 year and then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents, the consequences of environmental releases, and the pathways associated with this option would be the same as those for the no-action option.

Environmental and occupational risks due to atmospheric chemical releases from the hydrofluoric acid spill area for this option are estimated to be about 100 times less than those for the no-action option. No carcinogenic risks are expected, and the noncarcinogenic risks are very low. The highest public and occupational risks to the maximally exposed individual would be below 1 - less than 10^{-8} and 10^{-1}, respectively - and would not be significant.

The expected concentration for the erosion pathway is zero.

Potential Impacts (Other Than Releases)

The potential ecological impacts of the waste removal and closure plan for the hydrofluoric acid spill area would be similar to those addressed in Section F.4.8.3.

F.4.6 FORD BUILDING WASTE SITE, BUILDING 643-11G*

The Ford Building waste site (Building 643-11G) is a low-level radioactive waste management facility that received insignificant amounts of waste in past years. No wastes are being discharged to the site at the present time. Background information on the history of waste disposal, waste characteristics, and evidence of contamination are presented in Appendix B, Section B.5.2.

F.4.6.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Under this option, none of the trash within the site area, e.g., the load lugger pan, shoe covers, step-off pads, coveralls, and lumber, would be removed. Groundwater monitoring wells would be installed in the vicinity of the site and would be monitored quarterly for 1 year, then annually for 29 years.

*The reference source for the information in this section is Huber, Simmons, Marine, and Holmes, 1986.

Comparison of Expected Environmental Releases with Applicable Standards

It is anticipated that insignificant amounts of radioactivity and chemicals would be released to groundwater, surface water, and air, because the amounts of radioactive and chemical constituents discharged to the site are believed to have been very small and below applicable standards.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no-action closure plan is provided in Section F.4.8.1. In the case of the Ford Building waste site, potential impacts on the aquatic biota cannot be quantified since no PATHRAE analysis or groundwater monitoring has been performed. The Ford Building waste site is located near the wetlands along the upper reaches of Four Mile Creek and Pen Branch. The no-action closure plan is not expected to have any effect on these wetlands, because there would be no land disturbance and the waste site does not contain any standing surface water.

F.4.6.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this option, all trash within the site area, e.g., the load-lugger pan, shoe covers, step-off pads, coveralls, and lumber would be monitored for potential contamination and removed to the SRP burial ground in metal containers. No sediment would be excavated from the waste site. Groundwater monitoring would be conducted as described above.

Comparison of Expected Environmental Releases with Applicable Standards

It is anticipated that insignificant amounts of radioactivity and chemicals would be released to groundwater, surface water, and air because the amounts of radioactive and chemical constituents discharged to the site are believed to have been very small and below applicable standards.

Potential Impacts (Other Than Releases)

The general ecological impacts of the no waste removal and closure plan for the Ford Building waste site would be similar to those addressed in Section F.4.8.2.

F.4.6.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this closure option, all trash within the site area, e.g., the load-lugger pan, shoe covers, step-off pads, coveralls, and lumber, would be monitored for contamination and removed to the SRP burial ground in metal containers. Approximately 345 cubic meters of soil would then be excavated from the site and removed to the SRP burial ground in metal containers. No waste pretreatment steps are deemed necessary at this time. The site would be backfilled to grade, seeded, and maintained in a manner consistent with the

surrounding grounds. Should soil analyses at closure show that above-background concentrations of waste remained in the soil after excavation, groundwater monitoring wells would be installed at the site and monitored quarterly for 1 year and then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

It is anticipated that insignificant amounts of radioactivity and chemicals would be released to groundwater, surface water, and air because the amounts of radioactive and chemical constituents discharged to the site are believed to have been very small and below applicable standards.

Potential Impacts (Other Than Releases)

The general ecological impacts of the waste removal and closure plan for the Ford Building waste site are similar to those addressed in Section F.4.8.3. However, removal of wastes and and backfilling, proposed to be included as part of the corrective action for this waste, would minimize any further impacts.

F.4.7 FORD BUILDING SEEPAGE BASIN, BUILDING 904-91G*

The Ford Building seepage basin (904-91G) is in the central shops area of the SRP. Discharges to the basin ceased in 1984. The history of disposal, evidence of contamination, and waste characteristics of the basin are presented in Appendix B, Section B.5.3.

F.4.7.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The basin would be monitored for erosion, grass would be cut, and bushes and tree seedlings would be removed. Groundwater monitoring would continue quarterly for 1 year and then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

PATHRAE modeling predicts that peak concentrations of chromium and tritium either have or will exceed groundwater standards. Table F-20 lists these parameters, the corresponding regulatory standards, the maximum mean concentration recorded in monitoring wells, and the maximum concentration found, or predicted to be found, in groundwater near the basins. Peak concentrations of all other constituents are predicted to remain below applicable standards.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from the site, as the resulting concentrations of constituents in Pen Branch are projected to be below drinking-water standards.

*The reference source for the information in this section is Pekkala, Simmons, Marine, and Holmes, 1986.

Table F-20. Predicted Maximum Concentrations of Various Constituents at the Ford Building Seepage Basin for Three Closure Options[a,b]

Constituent	Applicable standard[d]	Monitoring data maximum mean concentration	PATHRAE-modeled maximum concentration without remedial action[c]					
			No action		No waste removal and closure		Waste removal and closure	
			1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Chromium	0.05	(e)	0.18 (2334)	(e)	0.073 (2373)	(e)	(e)	(e)
Tritium	78,000	(f)	11,000,000 (1966)	7,000,000 (1973)	11,000,000 (1966)	7,000,000 (1973)	11,000,000 (1966)	7,000,000 (1973)

[a]Concentrations reported as milligrams per liter for chemical and picocuries per liter for radionuclide.
[b]Source: Pekkala et al., 1986.
[c]Year of occurrence in parentheses.
[d]EPA, 1985b, except where noted; ICRP Publication 30 (ICRP, 1979) methodology was used to calculate radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[e]Below standard.
[f]Not reported.

The nonradioactive contaminants were analyzed to estimate public exposure and risk attributable to atmospheric releases associated with closure (assumed to take place in 1986) and postclosure of the Ford Building seepage basin.

Releases are associated with suspension of contaminated dust from wind erosion; the conservative assumption is that dust generation would not be minimized by vegetative cover. Risks due to releases of carcinogens are calculated to be less than 4.6×10^{-9} for each of the 3 years. Risks due to noncarcinogen releases are calculated to be below 1, with a value less than 1.2×10^{-6}.

Environmental doses and risks to the maximally exposed individual due to atmospheric radiological releases from the Ford Building seepage basin were calculated using the methodology presented in the introduction to this appendix and in Appendix I. The doses were calculated to be less than 2.2×10^{-4} percent of the DOE limit of 25 millirem per year for each of the 3 years. The risks associated with these doses were calculated to be less than 1.6×10^{-11}.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no-action closure plan is provided in Section F.4.8.1. PATHRAE modeling was performed on tritium, cobalt-60, strontium-90, yttrium-90, cesium-137, uranium-238, chromium, lead, and mercury, which were identified as having a potential impact on the aquatic system. The results indicated that these wastes would not alter the present water quality of Pen Branch for any of the options. Outcropping concentrations of tritium might be sufficiently high to impact the local wetlands adjacent to the Pen Branch tributary receiving the contaminated groundwater. By the year 2085, outcropping concentrations of tritium were projected to decrease to insignificant levels and thus to present no threat to the aquatic biota within the wetlands.

Because this seepage basin might have standing water during times of heavy rainfall, it is possible that the water might become contaminated and pose a potential impact to wildlife, including waterfowl, or vegetation that might come into contact with the water.

F.4.7.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Implementation of the no waste removal and closure option would consist of backfilling the basin with clean soil. Under this option, the berms would be pushed into the basin, the basin would be filled with compacted backfill and topsoil and seeded, and identification pylons would be placed at each corner. A total of 567 cubic meters of backfill would be required. Groundwater monitoring would continue quarterly for 1 year and then annually for 29 years.

Among the potential remedial actions for the no waste removal and closure option is a groundwater extraction and treatment system for tritium. The

final selection of an action would be based on site-specific studies and interactions with regulatory agencies. Some of the possible treatment technologies are discussed in Appendix C.

Comparison of Expected Environmental Releases with Applicable Standards

The no waste removal and closure option is projected by PATHRAE to have no impact on tritium levels in the groundwater. Levels of chromium would be reduced by this option but would still be above drinking-water standards at the 1-meter well. Levels of tritium and chromium in the groundwater would have to be reduced to less than the MCL of 87,000 picocuries per liter and 0.05 milligram per liter, respectively. Surface water would not be adversely impacted.

The analysis described in the air release portion of Section F.4.7.1 was also performed for this option. There would be no carcinogenic releases, since the seepage basin would be capped. Noncarcinogenic releases would be the volatilization of mercury and phosphate seepage. Risks are calculated to be below 1, with a value less than 1.3×10^{-16}.

The analysis for radiological releases described in Section F.4.7.1 was also performed for this option. Releases are assumed to be zero for all constituents except tritium for this option, since the basin would be capped. Tritium has a nonzero source term in the first year due to its volatility. It would decrease to zero in 2085 and 2985 due to radioactive decay. The dose to the maximally exposed individual in 1986 is insignificant, compared to the DOE limit of 25 millirem. The risk associated with the dose is insignificant.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of no waste removal and closure is provided in Section F.4.8.2.

F.4.7.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this closure option, the influent pipeline would be blanked off at the retention tank. The retention tank discharge line to the seepage basin and contaminated soil beneath the line would be dug up, packaged in metal containers, and sent to an appropriate onsite storage/disposal facility. Vegetation around the basin would be monitored and disposed of as necessary.

The estimated depth of contaminated soil to be removed from the floor of the basin is 46 centimeters. This amount of excavation would remove any sediment eroded from the walls to the basin floor since 1984 and most of the contaminated sediment beneath the basin floor. The total volume to be excavated (an estimated 76 cubic meters) includes sediments excavated from the sides and ends of the basin. The proposed excavation would remain well above the water table, which is about 12 meters below the basin floor.

Further closure action at the waste site under this option would involve pushing the berms into the basin, filling the basin with compacted soil to

61 centimeters below the original ground level, adding topsoil or its equivalent, and grading to conform to the original surface contour. A total of 643 cubic meters of backfill would be required. After being graded, the site would be seeded with grass for erosion control and marked with identification pylons at each corner. Groundwater monitoring would continue quarterly for 1 year and then annually for up to 29 years.

Additional corrective action (e.g., pumping and treatment) might be needed to address the constituents already present in the groundwater. The precise actions taken would be selected based on site-specific studies and interactions with regulatory agencies.

Comparison of Expected Environmental Releases with Applicable Standards

The waste removal and closure option would, of course, have no impact on peak tritium levels in the groundwater, as the peak is predicted to have occurred in the past. Levels of chromium, however, are predicted to be reduced to below the drinking-water standards. Surface water would not be adversely impacted by this option.

The analysis described in the air release portion of Section F.4.7.1 was also performed for this option. Risks due to carcinogenic releases were calculated to be less than 2.4×10^{-13} in 1986 because of excavation activities, and zero in future years since the basin then would be capped. Risks due to noncarcinogenic releases were calculated for 1986 and would be caused primarily by excavation activities. For subsequent years (2085 and 2985), risks were calculated to be due to releases from the volatilization of mercury and phosphate seepage. These risks would be less than 7.0×10^{-10}.

The dose to the maximum individual at the SRP boundary in 1986 would be less than 3.9×10^{-7} percent of the DOE limit of 25 millirem for 1986 and would be due to excavation activities. The risk associated with this dose would be less than 2.8×10^{-14}.

An analysis of the average individual worker's health risks attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk to a worker from nonradioactive carcinogens was calculated to be less than 8.7×10^{-8}. The risk to a worker due to noncarcinogens would be below 1, with a value of 9.2×10^{-2}. The total dose to the worker would be 0.18 millirem, which would produce an incremental risk of 5.0×10^{-8}. The total dose to the worker transporting the waste would be 7.5×10^{-2} millirem, producing an incremental risk of 2.1×10^{-8}.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the waste removal and closure plan is provided in Section F.4.8.3.

F.4.8 POTENTIAL IMPACTS ON BIOLOGICAL RESOURCES

This section addresses those generic impacts related to aquatic and terrestrial ecology, endangered species, and wetlands for each closure and remedial

action. Where a discussion of site-specific data is required for a given option, it is presented in the appropriate section above.

This appendix discusses seven waste sites located within the C- and CS-Area. The CS burning/rubble pit is presently backfilled and covered with soil and vegetation, as are the remaining three CS burning/rubble pits and the C-Area burning/rubble pit. The Ford Building waste site consists of exposed waste. The Ford Building seepage basin at one time contained low-level radioactive waste, but now it is dry, although it occasionally impounds rainwater. All waste sites within this geographic grouping are either inactive or abandoned; however, the three C-Area seepage basins are still receiving purge water from the C-Area disassembly basin.

F.4.8.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Action)

Aquatic Ecology

A potential aquatic impact of the no-action plan for the waste sites of the C- and CS-Area is the indirect contamination of surface-water bodies via groundwater outcropping from the various waste sites found in this area. Table F-21 lists the waste materials in the groundwater that would exceed the freshwater biota criteria for each of the waste sites. Some constituents, such as silver, beryllium, cadmium, mercury, hydrogen sulfide, endrin, methoxychlor, and toxaphene, were not listed in the table because their reported values were below the detection limit of the instrumentation. The detection limits for these materials were above the freshwater biota criteria, making it impossible to determine if the concentration of the material was above or below the designated criteria.

Where data are available, it can be determined that materials not modeled by PATHRAE analysis (see Table F-21) would not be expected to create or enhance existing impacts on the aquatic biota of outcropping streams. This conclusion was based on the estimated dilution factors calculated by dividing the groundwater flux by the flow rate of the receiving stream. The dilution factor indicates that these wastes would be so diluted as not to affect the present water quality of the outcropping stream.

Terrestrial Ecology

The potential terrestrial impacts of the no-action closure plan for the waste sites of the C- and CS-Area are the exposure of wildlife and vegetation to standing surface water and the toxicity to vegetation by contaminated soils. The terrestrial impacts of those waste sites with standing surface water are addressed on an individual basis. Plant toxicity is dependent on the plant species, root depth of plants, chemical form of the waste, soil composition and moisture, and a plant's rate of waste uptake. Because there are many variables that affect plant toxicity, and because there is a lack of information on such items, the impacts of soil contamination on plants cannot be quantitatively assessed for these waste sites.

Table F-21. Environmental Data for C- and CS-Area Waste Sites

Waste site	Areal extent of site	Distance to nearest wetland	Area of wetlands within 200 m/1000 m	Endangered species data[a]	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria			Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[d]
					Contaminant	Reported level[b]	Criterion[c]		
CS-Area burning/ rubble pit 631-1G[e]	9.1 x 117.3 x 3.1	Over 1000	No information	No endangered species or habitats observed within 200 m of vicinity	Copper Zinc	0.016 mg/L 0.105 mg/L	0.0065 mg/L 0.047 mg/L	No information	No information
CS-Area burning/ rubble pit 631-5G[e]	10.7 x 117.3 x 3.1	Over 1000	No information	No endangered species or habitats observed within 200 m of vicinity	Same as 631-1G	Same as 631-1G	Same as 631-1G	No information	No information
CS-Area burning/ rubble pit 631-6G[e]	9.1 x 88.4 x 3.1	Beyond 1000	No information	No endangered species or habitats observed within 200 m of vicinity	No data	No data	No data	No information	No information
C-Area burning/ rubble pit 131-C[e]	7.6 x 106.1 x 3.1	400	0/55.6	No endangered species or habitats observed within 200 m of vicinity	Iron Gross alpha Radium	5.249 mg/L 25.25 pCi/L 7.5 pCi/L	1.0 mg/L 10 pCi/L 5 pCi/L	Four Mile Creek; 1200	8.9×10^{4}
Hydrofluoric acid spill area 631-4G[f]	9.1 x 9.1	200	1.9/34.9	No endangered species or habitats observed within 200 m of vicinity	All contaminants exceeding aquatic criteria were modeled using PATHRAE			Castor Creek; No information	3.5×10^{-7}

Footnotes on last page of table.

Table F-21. Environmental Data for C- and CS-Area Waste Sites (continued)

Waste site	Areal extent of site	Distance to nearest wetland	Area of wetlands within 200 m/1000 m	Endangered species data[a]	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria			Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[d]
					Contaminant	Reported level[b]	Criterion[c]		
Ford Bldg. waste site 643-11G[g]	6.7 x 51.5	600	0/22.0	No endangered species or habitats observed within 200 m of vicinity	No data	No data		No information	No information
Ford Bldg. seepage basin 904-91G[h]	18 x 6 (bottom) 24 x 12 (top)	600	0/20.5	No endangered species or habitats observed within 200 m of vicinity	All contaminants exceeding aquatic criteria were modeled using PATHRAE			Pen Branch; 2400	6.1×10^{-3}

[a]Data from Mayer, Hoppe, and Kennamer, 1986; Du Pont, 1985.
[b]Average value for most recent year for groundwater well containing highest concentration.
[c]Based on ICRP 30, 1978; EPA, 1985b,c; National Technical Advisory Committee, 1968.
[d]Equivalent to groundwater flux divided by flow rate of receiving stream.
[e]Data from Huber, Johnson, and Marine, 1986, except as otherwise indicated.
[f]Data from Huber and Bledsoe, 1986a, except as otherwise indicated.
[g]Data from Huber et al., 1986, except as otherwise indicated.
[h]Data from Pekkala et al., 1986, except as otherwise indicated.

Endangered Species

No endangered species have been identified in the vicinity of the waste sites of the C- and CS-Area in previous surveys at SRP (see Table F-21). The habitats in the immediate vicinity of these waste sites are not considered suitable for any Federally endangered species previously reported from the SRP. Therefore, none of the actions proposed for the waste sites of the C- and CS-Area would have any effect on threatened or endangered species.

Wetlands

Wetlands of the C- and CS-Area include two small ponds at Twin Lakes, Carolina bays, and small drainage areas of the upper reaches of Four Mile Creek and Pen Branch. Bottomland hardwood communities occur primarily along small drainages of the upper reaches of Four Mile Creek and Pen Branch and in shallow depressions of the Carolina bays. Table F-21 provides the distances between the waste sites and the wetlands. Potential impacts on these wetlands are addressed on an individual basis where warranted. For most sites, wetlands are considered sufficiently distant so as not to be affected by any closure option.

F.4.8.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Ecology

Those waste sites within the C- and CS-Area that contain standing surface waters would be left to dry via evaporation before closure operations proceeded. Thus, there would be no direct impacts on the aquatic biota of nearby surface streams, unless surface runoff occurred. Surface runoff is addressed in the wetlands section. As described in Section F.4.8.1, indirect contamination of surface waters via groundwater from the various waste sites of C-Area would not likely cause a change in the present water quality of the outcropping stream. However, for this closure option, some remedial actions would reduce any potential for aquatic impacts.

Terrestrial Ecology

The potential terrestrial impacts of no waste removal and closure for the waste sites of the C- and CS-Area include toxicity to vegetation by contaminated soils, wildlife and vegetation exposure to standing surface waters, and temporary disruption of wildlife due to noise created by closure operations. Factors relating to plant toxicity are described in Section F.4.8.1. The impacts on wildlife and vegetation exposed to standing surface waters are discussed in the applicable waste site sections.

Endangered Species

None of the actions proposed for the waste sites of the C-Area would have any effect on endangered species. See description in Section F.4.8.1.

Wetlands

Section F.4.8.1 describes the wetlands that exist within the vicinity of the C-Area. Disturbance of the land may facilitate soil erosion. Where there is standing water, there is also a potential for surface runoff during heavy rainstorms. Remedial actions would include soil erosion and surface runoff controls for those waste sites that are near wetlands to prevent sedimentation and contamination of wetlands.

F.4.8.3 Assessment of Removal of Waste to the Extent Practicable and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Resources

The potential aquatic impacts of the waste removal and closure plan are the same as described in Section F.4.8.2. However, the removal of wastes and contaminated soils from each of the sites of the C-Area should significantly reduce the amount of wastes leached into groundwater from contaminated soils, which in turn would further reduce any potential for aquatic impacts. This closure plan could also include a groundwater extraction and treatment system, additional excavation, and regrading and placement of backfill as remedial actions. These remedial actions could be considered preventive measures against impacts on the aquatic communities.

Terrestrial Ecology

The potential impact of plant toxicity as described in Section F.4.8.1 should be significantly reduced by the proposed waste removal and closure plan. The removal of wastes and contaminated soils should eliminate the potential for the uptake of wastes by vegetation.

However, for those waste sites that contain standing surface waters prior to their drying by natural seepage and evaporation, the potential exists for wildlife (including waterfowl) and vegetation to come into contact with the remaining contaminated water. There would also be a temporary disturbance of the wildlife due to noise and habitat loss created by closure activities.

Endangered Species

None of the actions proposed for the waste sites of the C-Area would have any effect on endangered species. See the description in Section F.4.8.1.

Wetlands

Section F.4.8.1 describes the wetlands that exist within the vicinity of the C- and CS-Area. As indicated in Section F.4.8.2, remedial actions should include soil erosion and surface runoff controls to protect those wetlands that are near a waste site.

F.5 TNX-AREA WASTE SITES

The TNX-Area geographic grouping is approximately 7 kilometers southwest of C-Reactor along Road 3; it is in the southwest portion of the SRP, about

15 kilometers south of A-Area. Figure F-10 shows the locations of the waste sites in this grouping, which will be assessed in the following sections.

Sections F.5.1 through F.5.5 contain, or reference the section that contains, a discussion of sites 5-1 through 5-5. Section F.5.6 discusses biological impacts that are generically applicable to the waste sites in this geographic grouping.

F.5.1 D-AREA BURNING/RUBBLE PIT, BUILDING 431-D

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the TNX-Area geographic grouping are discussed in Section F.5.6.

F.5.2 D-AREA BURNING/RUBBLE PIT, BUILDING 431-1D

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the TNX-Area geographic grouping are discussed in Section F.5.6.

F.5.3 TNX BURYING GROUND, BUILDING 643-5G*

The TNX burying ground (Building 643-5G) is a low-level radioactive waste management facility that received wastes resulting from an experimental evaporator explosion in 1953. Background information on the history of waste disposal, waste characteristics, and evidence of contamination are presented in Appendix B, Section B.6.2.

F.5.3.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

All sites would be left undisturbed. Sixteen new groundwater monitoring wells would be installed around the project area. These wells would be sampled and analyzed quarterly for the first year, then annually for the next 29 years. Site maintenance would be provided for the entire 30-year period.

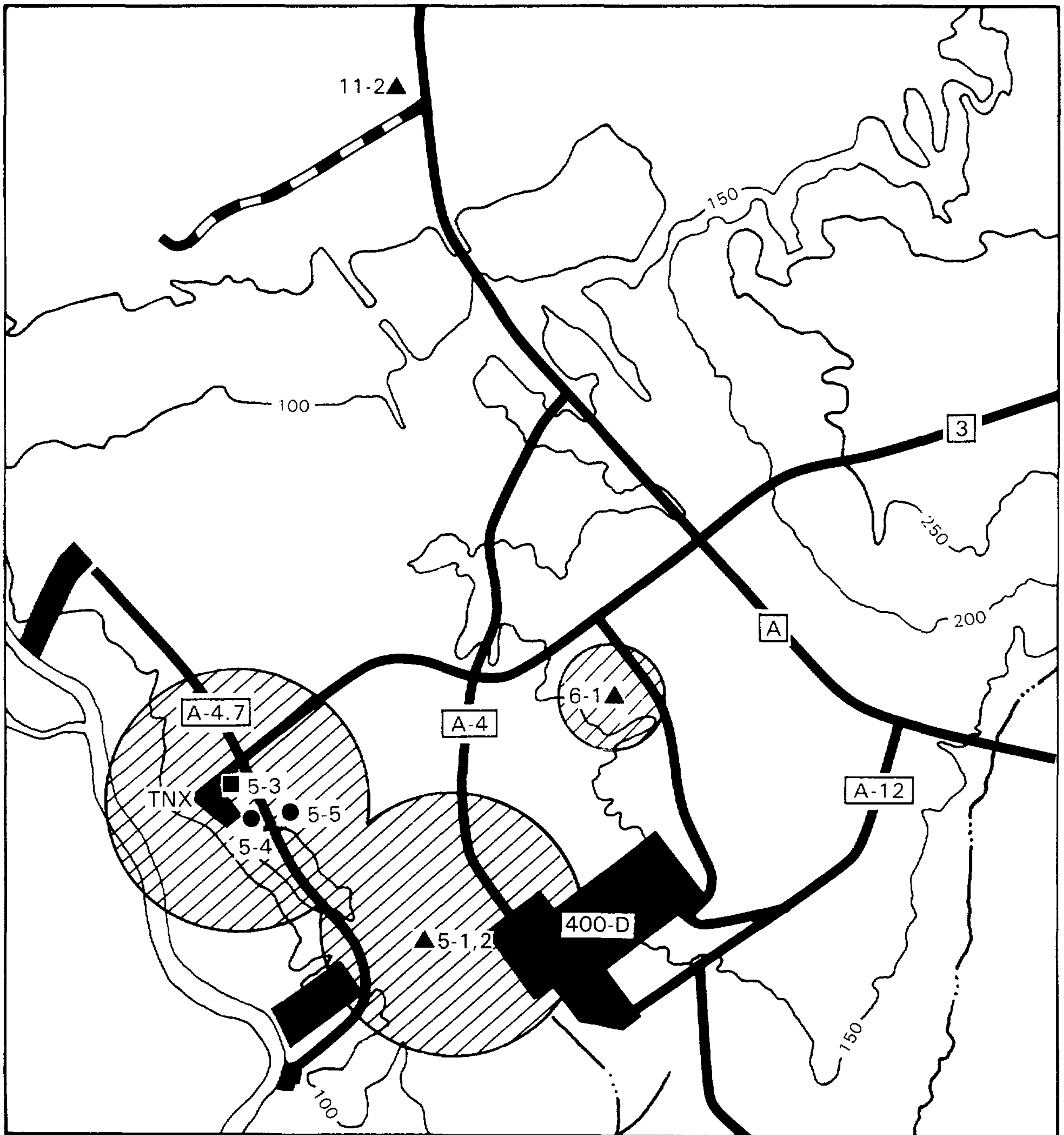
Comparison of Expected Environmental Releases with Applicable Standards

All environmental releases are projected to be below applicable standards for the no-action option.

Groundwater

The releases are evaluated in terms of predicted radionuclide concentrations for hypothetical wells 1 meter and 100 meters downgradient of the burying ground. The peak concentration in the 1-meter well would occur at present

*The reference source for the information in this section is Kingley et al., 1986b.



Note: Elevations are in feet above mean sea level
1.0 foot = 0.3048 meter

Legend on following page

Scale (kilometers)
0 1 2

Figure F-10. TNX-Area Waste Sites

Number	Potential Waste Type	Site Name	Building Number
5-1	▲	D-Area Burning/Rubble Pit*	431-D
5-2	▲	D-Area Burning/Rubble Pit*	431-1D
5-3	■	TNX Burying Ground	643-5G
5-4	●	TNX Seepage Basin (old)*	904-76G
5-5	●	TNX Seepage Basin (new)*	904-102G
6-1	▲	D-Area Oil Seepage Basin	631-G
11-2	▲	Gunsite 720 Rubble Pit	N80E27.35

*Indicates that waste type may be contained in the waste site
▲—Hazardous
■—Low-level radioactive
●—Mixed

Figure F-10. TNX-Area Waste Sites (continued)

(1985), and for the 100-meter well in 31 years. The predicted peak concentrations of uranium-238 (in picocuries per liter) are 2 for the 1-meter well and 0.34 for the 100-meter well, and represent 9.1 and 1.5 percent, respectively, of the concentrations corresponding to the EPA maximum contaminant level primary drinking-water standard of 22 picocuries per liter.

No chemical contaminants are predicted to exceed groundwater MCLs in the future; however, peak nitrate concentrations were calculated to have exceeded MCLs at the 1-meter well in 1957. No groundwater monitoring data are available to evaluate current groundwater concentrations.

The maximum annual doses resulting from the reclaimed farm and direct gamma exposure pathways would occur 100 years from the present, at which time institutional control of the SRP is assumed lost. The predicted doses are only 1.8×10^{-4} and 8.8×10^{-37} millirems per year for the farm and direct gamma pathways, respectively. There would be no dose from the pathway that involves consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments, due to the assumed limited plant-root depth.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents from this source in the Savannah River are projected to be below drinking-water standards.

Air

No radionuclides would be released to the atmosphere under this option, since the waste materials lie buried beneath asphalt, buildings, and transformer pads and no excavation would take place.

The only nonradioactive constituent, nitrate, was analyzed to estimate public exposure and risk attributable to atmospheric contaminant releases from the TNX burying ground, associated with normal wind erosion and volatilization. These decrease to zero in 2085 and 2985 due to downward migration of the constituent. Risks are less than 1.5×10^{-20}.

Potential Impacts (Other Than Releases)

Aquatic Ecology

Levels of uranium-238, both before and after mixing with the Savannah River, would be below aquatic criteria. Due to limited groundwater data, it is not possible to quantify impacts of other waste materials.

Terrestrial Ecology, Endangered Species, and Wetlands

Impacts on terrestrial resources, endangered species, and wetlands would be similar to those discussed in Section F.5.6.1.

F.5.3.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Surface structures (Building 711-T, Trailer Building 676-8T, and a 13.8 kV transformer near Building 673-T) would be relocated. No waste material would be removed. The known burial sites would be covered with a low-permeability clay cap, graded, and seeded to prevent erosion. The suspected burial area would be treated in one of two ways. If soil samples from this site indicated contamination, overlying surface structures would be relocated and the area would be capped. Otherwise, the site would be left as is. Sixteen new groundwater monitoring wells would be installed in the vicinity of the sites if the suspected burial site were found to be contaminated. Only 12 groundwater monitoring wells would be required if the suspected burial site were found to be clean. Environmental monitoring and site maintenance requirements would be the same as in the previous option.

Comparison of Expected Environmental Releases with Applicable Standards

All environmental releases are projected to be below applicable standards for the no waste removal and closure option.

Groundwater, surface water, and air releases for no waste removal and closure would be the same as those presented for no action in Section F.5.3.1.

Nonradioactive air releases would also be identical to those described in Section F.5.3.1.

Potential Impacts (Other Than Releases)

Impacts on biological resources resulting from this closure option at the TNX burying ground would be similar to those described in Section F.5.6.2.

Doses from the reclaimed farm and direct gamma pathways would be essentially eliminated under this option because of the installation of a cap. There would be no impact (dose is zero) for the pathway that involves consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments. Such contamination would be precluded due to the limited plant-root depth; the roots would not contact contaminated soil.

F.5.3.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Surface structures (Building 711-T, Trailer Building 676-8T, and a 13.8 kilovolt transformer near Building 673-T) would be relocated and the three known and one suspected burial sites would be excavated (approximately 896 cubic meters). Excavated materials from the known burial sites would be packaged in metal boxes and sent to the SRP low-level radioactive waste disposal facility. Excavated material from the suspected burial site would be treated in one of two ways. If it were determined by Health Protection to be contaminated, it would be containerized in metal boxes and transported to the

low-level waste disposal facility. If this material were found to be clean, it would be used as fill when the site was backfilled. All four sites would then be backfilled and covered with a low-permeability clay cap (Figure F-2), dressed with topsoil, and seeded to prevent erosion. Sixteen new groundwater monitoring wells would be installed in the vicinity of the sites if the suspected burial site were found to be contaminated. Only 12 groundwater monitoring wells would be required if the suspected burial site were determined to be clean. These wells would be sampled and analyzed quarterly for the first year, then annually for the next 29 years. Site maintenance would be provided for the entire 30-year period.

Comparison of Expected Environmental Releases with Applicable Standards

All environmental releases are projected to be below applicable standards for the waste removal and closure option.

Groundwater and surface water releases for the waste removal and closure option would be the same as those presented for the no-action option in Section F.5.3.1.

Radionuclides released from the burying ground as a result of the excavation operation would be isotopes of uranium-234, -235, and -238, categorized as depleted uranium. The dose to an individual resulting from the release of depleted uranium to the atmosphere has been calculated to be less than 3.4×10^{-4} percent of the DOE limit of 25 millirem per year. The risks associated with this dose would be less than 2.4×10^{-11}.

Doses from the reclaimed farm and direct gamma pathways would be essentially eliminated under this option because of the removal of waste and the installation of a cap. There would be no dose for the pathway that involves consumption of crops potentially contaminated as a result of biointrusion of subsurface sediments, due to the limited plant-root depth.

The analysis described in Section F.5.3.1 for nonradioactive air releases was also performed for this option. Releases, attributable to the dust generated from excavation activities, were calculated to be less than 3.9×10^{-20} in 1986 and zero after waste removal.

An analysis of the average worker's health risks attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk to a worker due to nonradioactive carcinogens would be zero. The risk due to noncarcinogens was calculated as below 1, with a value of 3.3×10^{-15}. The total dose to the worker was calculated to be 0.30 millirem, which would produce an incremental risk of 8.4×10^{-8}. The total dose to the worker transporting the waste was calculated as 0.13 millirem, producing an incremental risk of 3.7×10^{-8}.

Potential Impacts (Other Than Releases)

Impacts to ecosystems, wetlands, and endangered species resulting from the waste removal and closure option at the TNX burying ground would be similar to those described in Section F.5.1.3.

F.5.4 OLD TNX SEEPAGE BASIN, BUILDING 904-76G*

The old TNX seepage basin operated from 1958 to 1980. The basin received a variety of chemicals from the pilot-scale tests conducted at TNX in support of the Defense Waste Processing Facility and the plant separations area. The history of waste disposal, evidence of contamination, and waste characteristics are discussed in detail in Appendix B, Section B.6.3.1.

F.5.4.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Under this option, the site would be left in its current state and groundwater monitoring would be continued on a quarterly basis for 1 year, then annually for 29 years.

Upkeep would include maintaining a fence and signs around the basin and cutting weeds periodically for the entire 30-year period. No remedial action would be conducted.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater and Surface Water

A soil and groundwater characterization program (Simmons, Bledsoe, and Bransord, 1985) was established to study the disposition of chemicals and radionuclides sent to the old TNX seepage basin. While the basin was in operation, overflow was diverted to a nearby wetland, creating an outfall delta approximately 30 meters wide within the wetland. The characterization study identified the following contaminants in the swamp sediment and soils: radium-228, thorium-228, tritium, uranium-235, uranium-238, chromium, and mercury. The radionuclide contamination detected in the swamp was concentrated within a meter of the discharge gully leading away from the basin. The mercury was concentrated in spots throughout the swamp, however, and the chromium was also well dispersed. Most of the contamination was localized within the top 0.6 meter of sediment.

In addition to sediment and soil sampling, water samples from the swamp and wells adjacent to the basin were collected. The swamp grab sample showed elevated levels of gross alpha, gross beta, radium, silver, chromium, copper, mercury, and cyanide. The swamp water contained roughly 50 times the MCL for mercury and 700 times the MCL for gross beta.

Groundwater samples collected from the water table aquifer indicated that concentrations of several inorganic and organic chemicals, and radionuclides exceed MCLs or ACLs. Table F-22 lists all constituents in the groundwater that currently exceed or are projected to exceed regulatory standards for the no-action alternative. No contamination was detected in the Tuscaloosa monitoring well located near the basin.

*The reference source for the information in this section is Kingley et al., 1986a.

Table F-22. Predicted Maximum Concentration of Various Constituents at the Old TNX Seepage Basin for Three Closure Options[a,b]

Constituent	Applicable standard[d]	Monitoring data maximum mean concentration[e]	PATHRAE-predicted maximum concentrations for all closure options[c]		
			1-m well	100-m well	Outcrop
Cadmium	0.01	0.015 (well XSB 4)	(f)	(f)	(f)
Chromium	0.05	(g)	0.071 (1983)	(g)	0.064 (2985)
Lead	0.05	0.085 (well XSB 2)	0.05 (1983)	(g)	0.072 (2985)
Mercury	0.002	0.346 (well XSB 2)	(g)	(g)	0.029 (1985)
Nitrate	10.0	225 (well XSB 2)	1800 (1983)	410 (2038)	58 (2285)
Trichloroethylene	0.005	0.470	0.042 (1983)	0.008 (2045)	(g)
Tetrachloromethane	0.005	0.026	0.75 (1983)	0.14 (2051)	0.028 (2385)
Gross alpha	10–20	202 (well XSB 4)	(f)	(f)	(f)
Gross beta	40–60	114 (well XSB 4)	(f)	(f)	(f)
Radium	6	92 (well XSB 2)	(f)	(f)	(f)

[a]Source: Adapted from Kingley et al., 1986a.
[b]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[c]Year of occurrence in parentheses.
[d]MCLs for chemicals given in EPA, 1985b; for radionuclides, ICRP Publication 30 (ICRP, 1979) methodology was used to determine concentrations that yield annual effective whole-body dose of 4 millirem.
[e]Concentrations represent maximum single-well mean reported for XSB wells (Kingley et al., 1986a; Zeigler, Lawrimore, and Heath, 1986).
[f]Not modeled.
[g]Below applicable standard.

The PATHRAE computer code was used to estimate future contaminant concentrations in the groundwater and surface water near the basin. PATHRAE results indicated that future concentrations of chromium, nitrate, trichoroethylene, and tetrachloromethane will exceed MCLs in groundwater near the basin. In addition, PATHRAE predicted that the groundwater outcrop at the wetland will contain tetrachloromethane and mercury in excess of MCLs at various times in the future. PATHRAE results indicated that the outfall delta is the primary source of contaminants entering the wetland. No contaminants were predicted to exceed regulatory standards in the Savannah River.

Air

The nonradioactive constituents were analyzed to estimate public exposure and risk attributable to atmospheric releases from the old TNX seepage basin and the outfall delta. Releases are associated with wind erosion and volatilization of constituents. Risks due to releases of carcinogens were calculated to be less than 5.4×10^{-8} in the 3 evaluated years. Risks due to noncarcinogen releases were below 1, less than 3.6×10^{-4}.

Environmental doses and risks to the maximally exposed individual due to radiological releases from the old TNX seepage basin and outfall delta were calculated using the methodology summarized in the introduction to this appendix and presented in Appendix I. The calculated doses were less than 43 percent of the DOE limit of 25 millirem per year for each of the 3 selected years. The risks associated with the peak dose is 3.0×10^{-6}.

Potential Impacts (Other Than Releases)

Aquatic Resources

The PATHRAE and simple dilution analysis indicates that influent concentrations of lead and mercury exceed EPA freshwater biota criteria (EPA, 1986) but do not alter the concentrations of these elements in the receiving water body (the Savannah River) for any closure option.

In order to estimate potential impacts of other contaminants, water quality parameters of downgradient wells were reviewed in order to identify those constituents whose parameters were higher than the water quality criteria for aquatic life. Those identified were beryllium, cadmium, iron, zinc, and copper. Due to a dilution factor of 4.8×10^{-8}, in-stream concentrations would not be expected to be significantly altered.

Terrestrial Resources, Endangered Species, and Wetlands

Impacts to terrestrial ecosystems, wetlands, and endangered species resulting from this closure option at the old TNX seepage basin would be similar to those described in Section F.5.6.1.

F.5.4.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Before the site could be closed, an office trailer and an equipment laydown area would have to be relocated, and the asphalt pavement and clay cap over the top of the basin removed and replaced with one that meets current requirements. Under this closure option, the top 1.8 meters of basin material would be excavated. The approximately 1218 cubic meters of material would be removed in metal boxes to the SRP hazardous and mixed waste storage/disposal facility. A low-permeability cap would be placed over the uncovered site, and groundwater monitoring would continue on a quarterly basis for 1 year, then annually for 29 years. There would be site maintenance for the entire 30-year period.

The PATHRAE results indicate that excavating the basin sediments and covering the site with a low-permeability cap would have no significant effect on contaminant releases to the groundwater. Therefore, the contaminant release data given in Table F-22 would also be applicable to this closure option.

Additional corrective actions (e.g., treatment of groundwater and excavation of contaminated wetland sediments) may be needed to address constituents already in the groundwater and sediments. The selection of any action would be based on site-specific studies and interactions with regulatory agencies.

Comparison of Expected Environmental Releases with Applicable Standards

The closure and remedial actions described above are expected to reduce groundwater concentrations of nitrate, chromium, mercury, trichloroethylene, tetrachloromethane, and radium to within MCLs or ACLs. Excavation of sediments from the outfall data and backfilling with clean material are expected to reduce contaminant levels in the swamp to levels found in similar undisturbed wetlands.

The analysis described in the air release portion of Section F.5.4.1 was also performed for this option. There were assumed to be no carcinogen releases to the atmosphere, since the basin would be capped. Atmospheric releases of carcinogens are due to the volatilization of the constituents. Risks were calculated to be less than 2.5×10^{-9}.

The radiological releases and resulting doses and risks for this option are the same as those presented in Section F.5.4.1 for no action.

Potential Impacts (Other Than Releases)

Impacts to biological resources resulting from this closure option at the old TNX seepage basin would be similar to those described in Section F.5.6.2.

F.5.4.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Before the site could be excavated, an office trailer and an equipment laydown area would have to be relocated. Also, the asphalt pavement and clay cap over the top of the basin would have to be removed.

The basin covered a surface area of 952 square meters. The 3.1 meters of clay and sand mix, 15 centimeters of SC-6 clay, and 46 centimeters of topsoil used to backfill and cap the basin in 1981 would have to be removed in addition to the 61 centimeters of contaminated basin bottom sediment. Therefore, approximately 4,060 cubic meters of material would have to be excavated. The backfill material excavated from the basin would be reused. Approximately 594 cubic meters of sediment which could be classified as a mixed waste would be excavated and removed to an SRP hazardous and mixed waste storage/disposal facility in metal boxes.

Approximately 594 cubic meters of additional backfill material would be needed to fill the basin. Groundwater monitoring at the site would continue on a quarterly basis for the first year and then annually for 29 years. Potential remedial action would be implemented as described in Section F.5.4.2.

Comparison of Expected Environmental Releases with Applicable Standards

The PATHRAE results indicated that contaminant releases to the groundwater would not be affected by removing waste from the basin. Therefore, the discussion of expected environmental releases presented in Section F.5.4.2.2 would also be applicable to the waste removal and closure option.

The analysis described in the air release portion of Section 5.4.1.1 was also performed for this option. Carcinogenic releases would result solely from the generation of contaminated dust as a result of excavation activities. This would occur only in the first year. Noncarcinogenic releases in the first year would be attributable to the generation of the contaminated dust as a result of excavation activities and to volatilization. In subsequent years the only source would be attributable to volatilization. Risks attributable to carcinogenic releases were calculated to be less than 1.2×10^{-11}. Risks attributable to releases of noncarcinogens were calculated to be less than 1.4×10^{-8} for each of the 3 years.

The radiological releases and resulting doses and risks for this option are the same as those presented in Section F.5.4.1 for no action.

An analysis of the health risks to the average individual worker attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk to a worker due to nonradioactive carcinogens would be less than 1.0×10^{-8}. The risk due to noncarcinogens would be below 1, with a value of 1.9×10^{-4}. The total dose to the worker would be 11 millirem, which would produce an incremental risk of 3.1×10^{-6}. The total dose to the worker transporting the waste would be 0.55 millirem, producing an incremental risk of 1.6×10^{-7}.

Potential Impacts (Other Than Releases)

Impacts to ecosystems, endangered species, and wetlands resulting from this closure option at the old TNX seepage basin would be similar to those described in Section F.5.6.3.

F.5.5 NEW TNX SEEPAGE BASIN, BUILDING 904-102G*

The new TNX seepage basin (Building 904-102G) is a mixed waste management facility that is presently receiving wastes. Background information on the history of waste disposal, waste characteristics, and evidence of contamination are presented in Appendix B, Section B.6.3.

F.5.5.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Groundwater monitoring at the site would be continued quarterly for the first year, then on an annual basis for the next 29 years, with periodic site maintenance such as lawn and vegetation cutting. Appropriate signs and fencing would be set up to keep out wild animals and unauthorized persons.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

PATHRAE predicts that concentrations of barium, chromium, nitrate, and uranium-238 will exceed groundwater standards for the no-action option. Table F-23 lists these parameters, the corresponding regulatory standards, and the maximum concentrations found, or predicted to be found, in the groundwater near the basins. Only contaminants that exceed, or are predicted to exceed, standards are listed. All other constituents are found at levels below applicable standards.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents from this source in the Savannah River are projected to be below drinking-water standards.

Air

The nonradioactive constituents were analyzed to estimate public exposure and risk attributable to atmospheric releases from the new TNX seepage basin.

Releases would be caused by wind erosion and the volatization of the constituents. Risks were calculated to be less than 10^{-7} for releases of carcinogens. Risks from noncarcinogens were calculated to be below 1, with a value less than less than 1.9×10^{-6} for each of the 3 years.

*The reference source of the information in this section is Dunway et al., 1986.

Table F-23. Predicted Maximum Concentrations of Various Constituents at the New TNX Seepage Basin for the Three Closure Options[a,b]

Constituent	Applicable standard[d]	Monitoring data maximum mean concentration[d]	PATHRAE-modeled maximum concentration without remedial action[c]					
			No action		No waste removal and closure		Waste removal and closure	
			1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Barium	1.0	(e)	5.7 (2058)	(e)	(e)	(e)	(e)	(e)
Chromium	0.05	(e)	0.15 (2563)	(e)	(e)	(e)	(e)	(e)
Nitrate	10	(e)	4500 (1987)	1900 (1990)	1000 (2005)	940 (2007)	1000 (2005)	900 (2007)
Uranium-238	24	(f)	29 (2563)	(e)	(e)	(e)	(e)	(e)

[a]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[b]Source: Dunway et al., 1986.
[c]Year of occurrence in parentheses.
[d]EPA, 1985b, except where noted; ICRP Publication 30 (ICRP, 1979) methodology was used to calculate radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[e]Below standard.
[f]Not reported; gross alpha below standard.

Environmental doses and risks to the maximally exposed individual due to radiological releases from the new TNX seepage basin were calculated using the methodology presented in the introduction to this appendix and in Appendix I. The doses were calculated to be less than 1.1×10^{-2} percent of the DOE limit of 25 millirem per year for each of the 3 years. The risk associated with these doses would be less than 7.3×10^{-10}.

Potential Impacts (Other Than Releases)

Aquatic Resources

Under this option, the basin might continue to release wastes to the environment via the surface water pathway. Aquatic life criteria for cadmium, copper, iron, mercury, and pH are exceeded by levels in the new TNX seepage basin water. These levels could have adverse impacts on aquatic and semiaquatic organisms that might use the basin or the effluent water in undiluted form. Even a relatively simple food chain in the basin would concentrate wastes to toxic levels. Extreme precipitation could cause the basin to overflow through the outfall currently in use. Thus, during times of low flow in the Savannah River or little mixing in the Savannah River swamp, some criteria might be exceeded.

PATHRAE modeling was conducted for barium, chromium, nickel, nitrate, phosphate, trichloromethane, and uranium-238. Aquatic criteria have been established for chromium, nickel, and uranium-238. Modeling showed that for all closure options, the quality of Savannah River water would not be significantly affected; however, chromium is currently slightly above the aquatic criteria.

Terrestrial Resources

Use of the new TNX seepage basin by terrestrial wildlife can be anticipated under this closure option. Birds, including waterfowl, and small animals would easily get past the planned site security fence. Under varying water-level conditions, organisms could be expected to drink basin water, burrow in sediment, and feed on vegetation growing in the basin. Impacts associated with chronic exposure to and bioaccumulation of wastes are unknown.

Endangered Species

Impacts to endangered species as a result of this closure option would be as described in Section F.5.6.1.

Wetlands

Adequate data are not available to assess quantitatively the potential impacts of the new TNX seepage basin overflow and the possible accumulation of wastes in wetland soils and vegetation resulting from this closure option.

F.5.5.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The 2170 cubic meters of basin water would be sent to the TNX effluent treatment plant for treatment after that facility starts operations. The basin would be backfilled with approximately 2160 cubic meters of backfill material and capped with a low-permeability cap. Groundwater monitoring at the site would be continued quarterly for 1 year, then on an annual basis for the next 29 years. Site maintenance would be as described in F.5.5.1.

Remedial actions might be required for this option, since results of PATHRAE modeling predict that the concentration of nitrate in the groundwater would remain above MCLs (see Table F-23).

Any pumpage from groundwater extraction wells would be subject to physical or chemical treatment to reduce contaminants to below standards. Applicable treatment technologies are discussed in Appendix C.

Comparison of Expected Environmental Releases with Applicable Standards

The implementation of this closure/remedial action option would reduce all environmental releases to below MCLs or ACLs. Nitrate would be removed from the groundwater to below applicable standards (see Table F-23). In addition, all other environmental releases are projected to be below regulatory concern.

The analysis described in the air release portion of Section F.5.5.1 was also performed for this option. There would be no releases to the atmosphere of carcinogenic and noncarcinogenic constituents, since the facility would be capped.

The analysis for radiological releases described in Section F.5.5.1 was also performed for this option. The releases are assumed to be zero for all 3 years of interest, since closure would effectively bar the atmospheric release of natural uranium.

Potential Impacts (Other Than Releases)

Impacts to ecosystems, endangered species, and wetlands resulting from this closure option at the new TNX seepage basin would be similar to those described in Section F.5.6.2. Drainage of the basin would eliminate the potential for wildlife being affected by coming into contact with basin water.

F.5.5.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The basin water would be sent to the TNX effluent treatment plant for treatment after startup of that facility. Conservative estimates indicate that 2170 cubic meters of basin water would require treatment. If waste in the new TNX seepage basin seeped to the same depth as in the old basin, then 0.6 meter

of sediment would need to be excavated; this corresponds to a volume of ≈359 cubic meters of material. Nearly all of the remaining waste source materials would be excavated. The excavated material would be transported in metal containers to a waste storage/disposal facility.

After excavation, the basin would be backfilled with ≈2529 cubic meters of backfill material. Groundwater monitoring at the site would be continued quarterly for 1 year and then annually for the next 29 years. Site maintenance would be as described above (Section F.5.5.1).

The concentration and extent of contamination would be significantly reduced by the removal of waste. Under this option, the nitrate concentration in the 1-meter well would be reduced by a factor of about 23 in the 1-meter well and to below its applicable standard in the 100-meter well. Uranium-238 would be reduced to below the applicable standards in both wells. However, remedial actions might be required for this option, since the results of PATHRAE modeling indicate that the concentrations of nitrate in the groundwater would remain above the MCL at the 1-meter well (see Table F-23). The exact actions would be determined by site-specific studies and interactions with regulatory agencies.

Water from any groundwater extraction wells would be subject to physical or chemical treatment to remove contaminants to within standards. Applicable treatment technologies are discussed in Appendix C.

Comparison of Expected Environmental Releases with Applicable Standards

The implementation of this closure/remedial action option would reduce all environmental releases to below MCLs. Nitrate could be removed from the groundwater to below applicable standards (see Table F-23). In addition, all other environmental releases are projected to be below levels of regulatory concern.

Air

The analysis described in the air release portion of Section F.5.5.1 was also performed for this option. Releases would be due to the earth-moving activities in year 1986. The addition of the cap would effectively bar the release of constituents in future years. Risks to the maximally exposed individual would be less than 1.9×10^{-13} for carcinogen releases. Risks from noncarcinogenic releases would be less than 1, with a value less than 1.9×10^{-9}.

The analysis for radiological releases described in Section 5.5.1 was also performed for this option. The releases would result from the excavation of the basin during the first year (1986) and would be zero thereafter due to the backfilling of the excavation site. The dose to the maximum individual at the SRP boundary was calculated to be less than 5.3×10^{-5} percent of the DOE limit of 25 millirem; the risk associated with this dose would be less than 3.7×10^{-12}.

An analysis of the health risks to the average individual worker that would be attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk to a worker due to nonradioactive carcinogens was

calculated as being below 1, with a value less than 1.5×10^{-10}. The risk due to noncarcinogens was 2.8×10^{-4}. The total dose to the worker was calculated to be 1.9×10^{-2} millirem, which would produce an incremental risk of 5.3×10^{-9}. The total dose to the worker transporting the waste was calculated as 5.4×10^{-3} millirem, producing an incremental risk of 1.5×10^{-9}.

Impacts to biological resources resulting from this option would be similar to those discussed in Section F.5.6.3. Drainage of the basin would eliminate the potential for wildlife's being impacted by coming into contact with basin water.

F.5.6 POTENTIAL IMPACTS TO BIOLOGICAL RESOURCES IN THE TNX-AREA

This section addresses those general impacts related to aquatic and terrestrial ecology, as well as endangered species and wetlands for each closure and remedial action. Where a discussion of site-specific data is required for a given option, it is presented in the appropriate section above.

Four of the five waste sites within the TNX-Area waste sites are inactive. The two D-Area burning/rubble pits are backfilled with soil, the old TNX seepage basin has been backfilled and covered with a clay cap, and the TNX burying ground is located under structures inside the TNX security fence. The fifth site, the new TNX seepage basin, is presently active and is filled to capacity with effluent channeled to Outfall X-13 and eventually to the Savannah River.

F.5.6.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Action)

Aquatic Ecology

Aquatic impacts for the no-action option for all waste sites located in the TNX-Area are described under each individual waste site.

Terrestrial Ecology

With the exception of the new TNX seepage basin, the waste sites in the TNX-Area are either backfilled and vegetated or are found underneath existing structures on the TNX site. The closure option would have no new impact on terrestrial ecological resources associated with sites, since no actions would be taken. However, the potential exists for plants to be adversely affected if their roots should come in contact with buried wastes.

Endangered Species

As indicated in Table F-24, no endangered species or habitat have been identified in the immediate vicinity of TNX-Area waste sites during previous surveys. However, Du Pont (1985) and Mayer, Hoppe, and Kennamer (1986) present maps and information indicating wood storks, American alligators, and bald eagles may be found within 3 kilometers of the waste sites. This information is shown in Table F-24. However, this closure option would have no impact on endangered species.

Table F-24. Environmental Data for TNX-Area Waste Sites

Waste site	Areal extent of site	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data	Non-PATHRAE-modeled contaminants exceeding freshwater biota criteria: Contaminant	Reported level[a]	Criterion[b]	Area of groundwater outcrop; distance (m) to outcrop	Dilution factor[c]
D-Area burning/ rubble pit 431-D[d]	15.2 x 82.9 m	800	No data available	Endangered species not seen in immediate vicinity of site. However, wood stork foraging area located about 2 km SW; alligator population established on Beaver Dam Creek about 3 km SW;[e] and bald eagles sighted about 3 km NW[f]	Copper Cadmium Iron Zinc pH	0.011 mg/L 0.0018 mg/L 3.99 mg/L 0.265 mg/L 3.95	0.0065 mg/L 6.6×10^{-4} 1.0 mg/L 0.047 mg/L 6.5-9.0	Savannah River; 1000	8.8×10^{-4} [g]
D-Area burning/ rubble pit 431-1D[d]	11.6 x 73.8 m	800	No data available	Endangered species not seen in immediate vicinity of site. However, wood stork foraging area located about 2 km SW; alligator population established on Beaver Dam Creek about 3 km SW;[e] and bald eagles sighted about 3 km NW[f]	Information the same as that for site 431-D			Savannah River; 1000	8.8×10^{-4} [g]
TNX burying ground (643-5G)[h]	Irregular, 0.089 acre	400	56.6	Endangered species and their habitat not identified in immediate vicinity of site. However, wood stork foraging area located about 3 km SE; alligator population established on Beaver Dam Creek about 3 km SE;[e] and bald eagles sighted about 3 km NW[f]	No data available			Savannah River; 400	2.8×10^{-5}

Footnotes on last page of table.

Table F-24. Environmental Data for TNX-Area Waste Sites (continued)

Waste site	Areal extent of site	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data	Non-PATHRAE-modeled contaminants exceeding freshwater biota criteria: Contaminant	Reported level[a]	Criterion[b]	Area of groundwater outcrop; distance (m) to outcrop	Dilution factor[c]
Old TNX seepage basin (904-76G)[i]	Irregular, 0.235 acre	50	9.8/51.6	Endangered species and their habitat not identified in immediate vicinity of site. However, wood stork foraging area located about 3 km SE; alligator population established on Beaver Dam Creek about 3 km SE;[e] and bald eagles sighted about 3 km NW[f]	ph	3.593	6.5-9.0	Savannah River; 305	4.8×10^{-8}
					Beryllium	0.019 mg/L	0.0053 mg/L		
					Cadmium	0.015 mg/L	0.00066 mg/L		
					Iron	62.51 mg/L	1.0 mg/L		
					Zinc	2.781 mg/L	0.047 mg/L		
					Copper	0.076 mg/L	0.0065 mg/L		
					Mercury	0.3464 mg/L	0.012 ug/L		
					Gross alpha	202.3 pCi/L	10 pCi/L		
					Gross beta	113.9 pCi/L	40 pCi/L		
					Radium	91.85 pCi/L	5 pCi/L		
New TNX seepage basin (904-102G)[j]	Irregular, 0.12 acre	200	3.7/89.7	Endangered species and their habitat not identified in immediate vicinity of site. However, wood stork foraging area located about 3 km SE; alligator population established on Beaver Dam Creek about 3 km SE;[e] and bald eagles sighted about 3 km NW[f]	Basin water:				
					Cadmium	0.002 mg/L	6.6×10^{-4} mg/L	Savannah River; 610	1.5×10^{-7}
					Copper	0.056 mg/L	0.0065 mg/L		
					Iron	2.16 mg/L	1.0 mg/L		
					Mercury	1.27 ug/L	0.012 ug/L		
					pH	9.6	6.5-9.0		
					Lead	0.006 mg/L	0.0013 mg/L		
					Groundwater:				
					Iron	8.32 mg/L	1.0 mg/L		
					Copper	0.01 mg/L	0.0065 mg/L		
					Cadmium	0.0016 mg/L	0.00066 mg/L		
					pH	4.663	6.5-9.0		
					Lead	0.009 mg/L	0.0013 mg/L		

[a]Average value for most recent year for groundwater well containing highest concentration.
[b]Based on ICRP 30, 1978; EPA 1985b,c; National Technical Advisory Committee, 1968.
[c]Equivalent to groundwater flux divided by flow of receiving stream.
[d]Data from Huber, Johnson, and Marine, 1986, except where otherwise indicated.
[e]Data from Du Pont, 1985.
[f]Data from Mayer, Hoppe, and Kennamer, 1986.
[g]Based on discharge to Four Mile Creek, as modeled by Huber, Johnson, and Marine, 1986. Dilution by Savannah River would be greater.
[h]Data from Kingley et al., 1986b, except as otherwise indicated.
[i]Data from Kingley et al., 1986a, except as otherwise indicated.
[j]Data from Dunway, Kingley, Johnson, and Bledsoe, 1986, except as otherwise indicated.

Wetlands

Wetland habitats are found within 1,000 meters of each of the TNX-Area waste sites, the nearest being approximately 50 meters from the old TNX seepage basin (Table F-24). Most wetland areas are over 400 meters from the waste sites. Wetland types present include emergent marsh, cypress/tupelo, bottomland hardwood, and open water (Kingley et al., 1986a). Data are not adequate to assess quantitatively the potential impacts of overflow of the new TNX seepage basin and possible accumulation of waste materials in wetland soils and vegetation resulting from the no-action option.

F.5.6.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Ecology

Impacts to aquatic resources resulting from no waste removal and closure are expected to result in decreased surface-water and groundwater contamination as compared to the no-action option. For those sites already backfilled, the addition of a clay cap is expected to reduce water infiltration and thereby reduce future groundwater contamination. Under this closure option, water from the new TNX seepage basin would be removed for treatment and the basin backfilled and covered with a low-permeability clay cap and topsoil. Filling the basin would eliminate potential aquatic impacts associated with basin use and overflow. Any discharge of water resulting from corrective actions would meet NPDES requirements and would have no impact on surface streams.

Construction activities might generate some additional sediment. However, the use of engineered sediment control structures would prevent this from having an impact.

Terrestrial Ecology

The potential terrestrial impacts of the no waste removal and closure option for the waste sites of the TNX-Area include uptake of wastes by plant roots and temporary disturbance to wildlife due to noise associated with closure activities. Continued maintenance would be required to prevent impacts from root penetration of the clay cap.

Endangered Species

No impacts to endangered species are expected as a result of this closure option. Wood storks, American alligators, and bald eagles were observed far enough from the waste sites that any increase in noise resulting from construction activities should not disturb them.

Wetlands

Under this closure option, no impacts to nearby wetlands are expected. The potential for increased sedimentation would be eliminated by erosion and sedimentation control measures. Impacts associated with overflow from the new TNX seepage basin would be eliminated.

F.5.6.3 Assessment of Removal of Waste to the Extent Practicable and Implementation of Cost-Effective and Closure Actions as Required

No impacts to aquatic ecosystems are expected from this closure option. Waste removal would reduce additional releases of waste materials to groundwater. Because of the similarity of this closure option and the no waste removal and closure option, the discussion in Section F.5.6.2 is applicable here.

F.6 ASSESSMENT OF ACTIONS AT D-AREA WASTE SITES

This geographic grouping is the area of influence assigned to the D-Area oil seepage basin. It is approximately 1000 meters west of Road A (S.C. Highway 125) and 1200 meters north of the D-Area steam plant (see Figure F-9).

F.6.1 D-AREA OIL SEEPAGE BASIN, BUILDING 631-G*

F.6.1.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Under this option, the D-Area oil seepage basin would remain in its current state. Groundwater would continue to be monitored on a quarterly basis for 1 year and then annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

PATHRAE modeling of the environmental impact and health risks associated with the D-Area oil seepage basin was not performed because chemical constituents of the groundwater and soil at the site are below the threshold selection criteria.

Potential Impacts (Other Than Releases)

Aquatic Resources

A possible pathway for aquatic resources to be affected by the no-action option is through the outcropping of contaminated groundwater to site streams. However, it is not possible to quantify such impacts since neither the location of the outcrop nor flow rates of affected groundwater are known. A comparison of waste concentrations in monitoring wells with freshwater aquatic life criteria did indicate that pH and lead concentrations were above aquatic life criteria values (Table F-25). It should be noted that there were some contaminants (Endrin, silver, mercury, methoxychlor, and toxaphene) whose reported values were below the detection limit of the instrumentation. Since the detection limits for these contaminants were above the fresh-water criteria, it is not possible to determine if they were at or below the criteria concentrations.

---

*The reference source for the information in this section is Huber, Johnson, and Bledsoe, 1986.

Table F-25. Environmental Data for D-Area Oil Seepage Basin

Waste site	Areal extent of site	Distance to nearest wetland	Area of wetlands within 200 m/1000 m	Endangered species data	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria			Area of groundwater outcrop; distance to outcrop	Dilution factor[c]
					Contaminant	Reported level[a]	Criterion[b]		
D-Area oil seepage basin[d]	1915 m^2	About 50 m	5.4 acres/ 16.8 acres	No endangered species seen in vicinity of site[e,f] and no habitat present within 200 m	pH	4.5	6.5 - 9.0	No information	No information
					Lead	0.14 mg/L	.0013 mg/L		

[a]Average value for most recent year for groundwater well containing highest concentration.
[b]Based on ICRP 30, 1978; EPA, 1985b,c; National Technical Advisory Committee, 1968.
[c]Equivalent to groundwater flux divided by flow rate of receiving stream.
[d]Data from Huber, Johnson, and Bledsoe, 1986, except as otherwise indicated.
[e]From Mayer, Hoppe, and Kennamer, 1986.
[f]Du Pont, 1985.

Terrestrial Resources

Terrestrial resources could be affected under this option if the roots of grasses and shrubs currently growing at the site penetrated the sediment layer of the old basin and thereby introduced waste materials into the ecosystem. The extent of this potential problem cannot be assessed, since an analysis of the sediment layer has not been conducted.

Endangered Species

Because no endangered species have been sighted within the vicinity of the D-Area oil seepage basin, and because suitable habitat does not exist within 200 meters of the site (Table F-25), these species would not be affected.

Wetlands

As indicated in Table F-25, the nearest wetlands to the site are about 50 meters distant. These are bottomland hardwoods which are located in shallow upland depressions. There are 5.4 acres of wetlands within 200 meters and a total of 16.8 acres within 1000 meters of the site. The latter total includes some open water and emergent marsh. Because no disturbance is planned for this closure option, no adverse effects on wetlands are expected.

F.6.1.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this option, the D-Area oil seepage basin would remain in its current state (i.e., backfilled). Groundwater would continue to be monitored quarterly for 1 year and then be continued on an annual basis for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

As described in Section F.6.1.1, expected environmental releases were not modeled for this basin. However, backfilling of the basin should reduce the possibility of the standing liquid's being transported by surface runoff.

Potential Impacts (Other Than Releases)

Because this closure option is the same as the no-action option, the material presented in Section F.6.1.1 is applicable.

F.6.1.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this option, all waste would be removed from the D-Area oil seepage basin. Approximately 5742 cubic meters of soil would be excavated and removed to the SRP sanitary landfill. The basin would then be backfilled and the site graded and seeded. Maintenance of the site would include mowing of the grounds. Groundwater would continue to be monitored on a quarterly basis for 1 year and continued on an annual basis for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

As for the no-action alternative, no chemical constituents of concern were identified for this waste site and no environmental releases were modeled. However, removal of the waste and backfilling of the basin would reduce the possibility of future environmental releases.

Potential Impacts (Other Than Releases)

Aquatic Resources

Aquatic resources should not be affected by this closure option since removal of wastes would eliminate the future influx of wastes via groundwater.

Terrestrial Resources

The removal of soil and the subsequent backfilling and grading of the waste site could lead to some disruption of terrestrial biota. Wildlife could be temporarily disturbed by noise and human presence. Once the remedial actions had been completed and the area revegetated, however, wildlife use would increase, especially if the site were allowed to succeed beyond the grassland/herbaceous stage.

Endangered Species

No impacts on endangered species are expected to occur as a result of this closure option (see Section F.6.1.1).

Wetlands

Wetlands located near the site could be affected by erosion, depending on the local drainage pattern. To avoid sedimentation impacts, erosion control measures would be implemented.

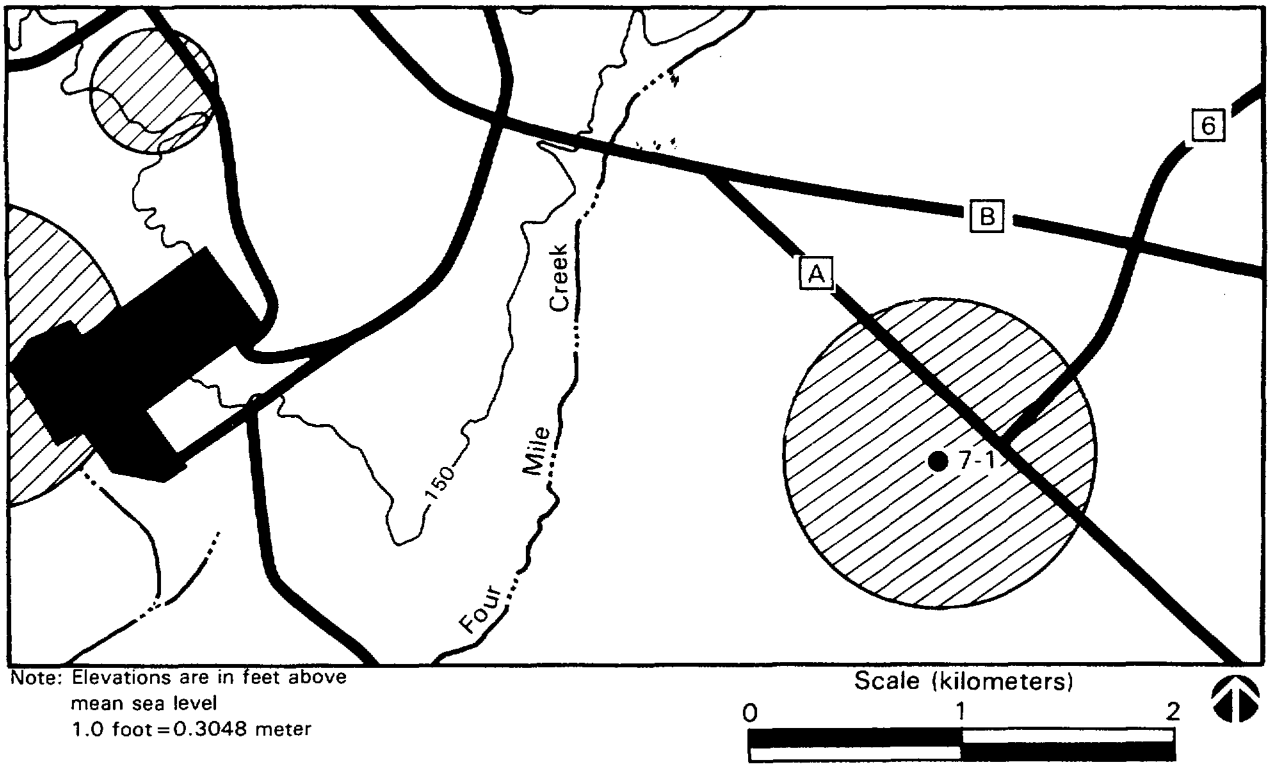
F.7 ASSESSMENT OF ACTIONS AT ROAD A AREA WASTE SITE

This geographic grouping is the area of influence assigned to the Road A chemical basin. It is located approximately 400 meters southwest of Road A near its intersection with Road 6 (Figure F-11), and about 3 kilometers east of TNX- and D-Area facilities.

F.7.1 ROAD A CHEMICAL BASIN, BUILDING 904-111G*

The Road A chemical basin (Building 904-111G) is located approximately 400 meters southwest of the intersection of SRP Road A (S.C. Highway 125) and SRP Road 6. The history of waste disposal, evidence of contamination, and waste characteristics at the basin are presented in Appendix B, Section B.8.1.1.

*The reference source of the information in this section is Muska, Pickett, and Bledsoe, 1986.



Number	Potential Waste Type	Site Name	Building Number
7-1	●	Road A Chemical Basin*	904-111G

*Indicates that waste type may be contained in the waste site
●—Mixed

Figure F-11. Road A Area Waste Sites

F.7.1.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

The site would be left in its present condition. Groundwater monitoring with the existing wells would be continued quarterly for the first year, then annually for the next 29 years. Upkeep would consist of maintenance of the groundwater monitoring wells and installation and maintenance of a site identification sign.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The history of disposal and the nature and quantities of materials disposed of in the Road A chemical basin are not known. Wastes disposed of at the site may have included miscellaneous radioactive and chemical aqueous wastes. Disposal of waste materials ceased in 1973 when the basin was closed and backfilled. Groundwater monitoring at the site began in May 1983 when three monitoring wells were installed; a fourth well was installed in July 1984.

The results of PATHRAE analysis are presented in Table F-26.

The PATHRAE simulations for the waste constituents at the Road A chemical basin were not based on actual data, because constituent inventories are not available for the site. The inventories were instead estimated from the existing concentrations of lead, tetrachloroethylene, and uranium in the groundwater. PATHRAE projections indicate that the concentrations of lead and tetrachloroethylene would remain within regulatory standards. Uranium-238, as simulated by PATHRAE, was predicted to exceed the applicable standard at the 1-meter well in the years 1975 and 2985. The source terms used in the PATHRAE model assume that uranium-238 is composed of both mobile and less mobile fractions. The mobile fraction created the 1975 simulated peak, and the less mobile fraction created the maximum 2985 peak reported in Table F-26. Monitoring for uranium-238 in the groundwater was not conducted, but its presence would have been detected by the gross alpha screening.

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site; the resulting concentrations of constituents from this source in Four Mile Creek are projected to be below drinking-water standards.

Air

The nonradioactive constituents were analyzed to estimate public exposure and risk attributable to atmospheric releases from the Road A chemical basin. Releases of the carcinogens would be due to wind erosion and volatility of the tetrachloroethylene. Risks were calculated to be less than 1.4×10^{-19}. No releases of noncarcinogens are projected to occur for the option, since the source is currently backfilled with soil.

Table F-26. Predicted Maximum Concentrations of Various Constituents at the Road A Chemical Basin for the Three Closure Options[a,b]

Constituent	Applicable standard[d]	Monitoring data maximum mean concentration[e]	PATHRAE-modeled maximum groundwater concentration without remedial action[c]					
			No action		No removal		Removal	
			1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Cadmium	0.01	0.059 (well BRD 2)	(f)	(f)	(f)	(f)	(f)	(f)
Lead	0.05	0.109 (well BRD 1)	(g)	(g)	(g)	(g)	(g)	(g)
Tetrachloroethylene	0.0007	0.009 (well BRD 2)	(f)	(f)	(f)	(f)	(f)	(f)
Gross alpha	10-20	36.75 (well BRD 2)	(f)	(f)	(f)	(f)	(f)	(f)
Radium	6	14.50 (well BRD 2)	(f)	(f)	(f)	(f)	(f)	(f)
Uranium-238	24	(h)	270 (2985)	(f)	39	(g)	0.39	(g)

[a]Source: Adapted from Muska, Pickett, and Bledsoe, 1986.
[b]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[c]Year of occurrence in parentheses.
[d]EPA, 1985a,b. ICRP Publication 30 (ICRP, 1979) methodology was used to determine radionuclide concentrations that yield annual effective whole-body dose of 4 millirem.
[e]Concentration level provided for each constituent is maximum single-well mean from BRD wells. Value for tetrachloroethylene is for TOH.
[f]Gross alpha and radium were not explicitly modeled with PATHRAE. Cadmium and tetrachloroethylene were not modeled.
[g]Below applicable standard.
[h]Not monitored, but presence would have been detected by gross alpha screening.

Atmospheric source terms were estimated for radionuclide constituents at the Road A chemical basin for the isotope of natural uranium. Since this basin is currently backfilled with soil which contains no volatile radioactive material, no atmospheric releases were projected for this option.

Potential Impacts (Other Than Releases)

Aquatic Resources

PATHRAE analysis results indicated that in-stream levels would not be significantly altered for any of the closure options; however, lead is currently above the aquatic life criteria in Four Mile Creek. In order to estimate potential impacts of other wastes, data on water quality parameters of down-gradient wells were reviewed in order to identify those constituents whose parameters were higher than the water quality criteria for aquatic life. They included pH, cadmium, and copper, (Table F-27). However, with a dilution factor of 5×10^{-5}, concentrations in Four Mile Creek would not be expected to be altered significantly.

Terrestrial Resources

After closure and backfilling in 1973, the Road A chemical basin, as well as a considerably larger area surrounding it (total area equals 3.6 acres), were graded and vegetated with bush-clover (Sericea lespedeza). Under this closure option, no further disturbance would occur to the terrestrial ecology of the waste site. Vegetation regrowth has not indicated that any adverse impacts have occurred. It should be noted that as the area succeeds to a more mature state, root penetration could reach the level of the buried waste. It is possible that some wastes could reach the ecosystem in this manner; however, data are insufficient to predict impacts.

Endangered Species

Since the site would not be disturbed under this closure option, there would be no impacts on endangered species.

Wetlands

As indicated in Table F-27, there are no wetlands within 200 meters of the waste site. Within 1000 meters of the site there are 35.7 acres of wetland, all of which is bottomland hardwood forest. No direct impact to these wetlands would occur under this closure option, since no disturbance would take place.

It should be noted that the natural discharge of the water table underneath the waste site is toward the bottomland hardwood forest to the west of the site, and that groundwater may outcrop in this area. While waste materials would not be diluted to the extent that they would if they entered Four Mile Creek, reductions could still be expected as groundwater flowed from the site to the outcrop.

Table F-27. Environmental Data for Road A Chemical Basin[a]

Waste site	Areal extent of site	Distance to nearest wetland	Area of wetlands within 200 m/1000 m (acres)	Endangered species data	Non-PATHRAE modeled contaminants exceeding freshwater biota criteria[b]			Area of groundwater outcrop; distance to outcrop	Dilution factor[e]
					Contaminant	Reported level[c]	Criterion[d]		
Road A chemical basin (904-111G)	1650 m^2; however, larger area (3.7 acres) was graded when site was closed in 1973	200 m	0/35.7	Habitats within 200 m are not suitable for endangered species[f]	pH	4.5	6.5–9.0	Four Mile Creek and swamp system; 1.7 km	5×10^{-5} (assumes outcrop to Four Mile Creek)
				Three former red-cockaded woodpecker colonies lie within 1 km[g]	Cadmium	0.059	0.00066		
				Bald eagles have been sighted about 2 km south of site[h]	Copper	0.021	0.00065		

[a]Data from Muska, Pickett, and Bledsoe, 1986, except as otherwise indicated.
[b]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[c]Average value for most recent year for groundwater well containing highest concentration.
[d]Based on ICRP, 1978; EPA, 1985b,c; National Technical Advisory Committee, 1968.
[e]Equivalent to groundwater flux divided by flow rate of receiving stream.
[f]Du Pont, 1985.
[g]Gould, Jr., Department of Energy, personal communication with Oliver, NUS Corporation, December 4, 1986.
[h]From Mayer, Hoppe, and Kennamer, 1986.

F.7.1.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

A low-permeability clay cap would be placed on top of the existing landfill. The cap would be placed only on top of the basin site itself. The area of the cap would be approximately 1700 square meters. The low-permeability cap would be graded and revegetated. The vegetation would be cut periodically to minimize intrusion of any deep-rooted species through the cap. Since the materials that were disposed of in the basin would be left in place in this option, groundwater monitoring would be continued quarterly for 1 year, and then annually for the next 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The no waste removal and closure option would result in the same PATHRAE-modeled releases as described in Section F.7.1.1 for the no-action option. As described in Section F.7.1.1, all monitored constituents are currently within MCLs, and uranium-238 is the only constituent projected by PATHRAE to exceed its MCL. However, any remedial action would not be considered until additional groundwater monitoring data were obtained and soil characterization studies were completed.

Air

No releases to the atmosphere are projected to occur for this option, since the source is currently backfilled with soil and the constituents are not volatile. Since the basin is currently backfilled with soil which contains no volatile radioactive material, no atmosphere releases were projected for this option.

Potential Impacts (Other Than Releases)

Aquatic Resources

Aquatic impacts to Four Mile Creek would be expected to be similar to those discussed in Section F.7.1.1. Placement of a clay cap would further lessen the potential future impacts to biological resources.

Terrestrial Resources

Revegetation of the site would be with herbaceous species such as vetch and deep-rooted shrubs and trees eliminated through occasional mowing. Noise and human disturbance could disturb wildlife during site operations; however, this disturbance would be temporary.

Endangered Species

As noted in Table F-27, three former colony sites for the endangered red-cockaded woodpecker have been reported within 1000 meters of the Road A chemical basin. These colony sites are no longer active and no activity has been

reported for them in recent surveys of Savannah River Plant. In addition, bald eagles have been sighted within 2 kilometers of the site (Mayer, Hoppe, and Kennamer, 1986). Because of the distance involved, remedial actions should not adversely affect the former woodpecker colony site or the bald eagle.

Other habitat in the immediate vicinity of the waste site (200 meters) are not suitable for other Federally endangered species previously reported from the SRP, including the American alligator, the wood stork, and the shortnose sturgeon (Dukes, 1984; Du Pont, 1985). Thus, actions associated with this closure option should not have any effect on these endangered species.

Wetlands

Wetlands present in the general area of the Road A chemical basin are discussed in Section F.7.1.1. Because of the distance to the nearest wetland, it is unlikely that any direct impacts resulting from this closure option would occur. Appropriate erosion and sediment control measures would be implemented.

F.7.1.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The existing backfill would be removed from the Road A chemical basin, and contaminated soil from the edges and bottom of the basin would be excavated. It is assumed that removal of 0.6 meter of soil would be sufficient to remove the contaminants. The estimated volume of backfill to be removed and reemplaced is about 4500 cubic meters. The amount of contaminated soil to be excavated and removed is estimated at 1000 cubic meters. It is assumed that the contaminated material would be transported in metal containers. Since the history of disposal indicates that radioactive materials were disposed of in this basin, it is anticipated that the excavated materials would be removed to a waste storage/disposal facility. The backfill would be reemplaced and a low-permeability clay cover laid down. Groundwater monitoring would not be continued.

Comparison of Expected Environmental Releases with Applicable Standards

The waste removal and closure option would result in the same PATHRAE-modeled releases as described in Section F.7.1.1 for the no-action option. Groundwater remedial action would not be considered for the reasons discussed in Section F.7.1.2.

Air

Releases to the atmosphere are projected to occur for this option, owing to excavation activities in 1986. No releases are expected in future years, since the source is backfilled with soil and the constituents are non-volatile. Risks due to releases of carcinogens would be less than 5.9×10^{-23}. Risks due to releases of noncarcinogens are below 1, with a value less than 1.5×10^{-9}.

Environmental doses and risks to the maximally exposed individual due to radiological releases from the Road A chemical basin were calculated using the methodology summarized in the introduction to this appendix and presented in Appendix I. The calculated doses are less than 1.0×10^{-4} percent of the DOE limit of 25 millirem per year for each of the 3 years. The risks associated with these doses would be less than 7.0×10^{-12}.

An analysis of the average individual worker's health risks attributable to occupational exposure to carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The risk to a worker due to nonradioactive carcinogens would be less than 3.3×10^{-20}. The risk due to noncarcinogens would be below 1, with a value of 6.1×10^{-5}. The total dose to the worker was calculated to be 0.6 millirem, which would produce an incremental risk of 1.7×10^{-7}. The total dose to the worker transporting the waste was calculated as 0.108 millirem, producing an incremental risk of 3.0×10^{-8}.

Potential Impacts (Other Than Releases)

Aquatic impacts would be expected to be similar to those discussed in Section 7.1.2. Removal of waste would further lessen the potential future impacts to biological resources.

F.8 ASSESSMENT OF ACTIONS AT K-AREA WASTE SITES

The approximate boundaries of the K-Area geographic grouping are Road B on the south and Road 6 on the northwest. This grouping is formed by waste sites associated with K-Reactor. Figure F-12 locates the waste sites in this grouping and shows the proximity to the Road A Area waste site.

Sections F.8.1 through F.8.4 contain or reference the section that contains a discussion of sites 8-1 through 8-4. Section F.8.5 discusses biological impacts that are generically applicable to the waste sites in this geographic grouping.

F.8.1 K-AREA BURNING/RUBBLE PIT, BUILDING 131K

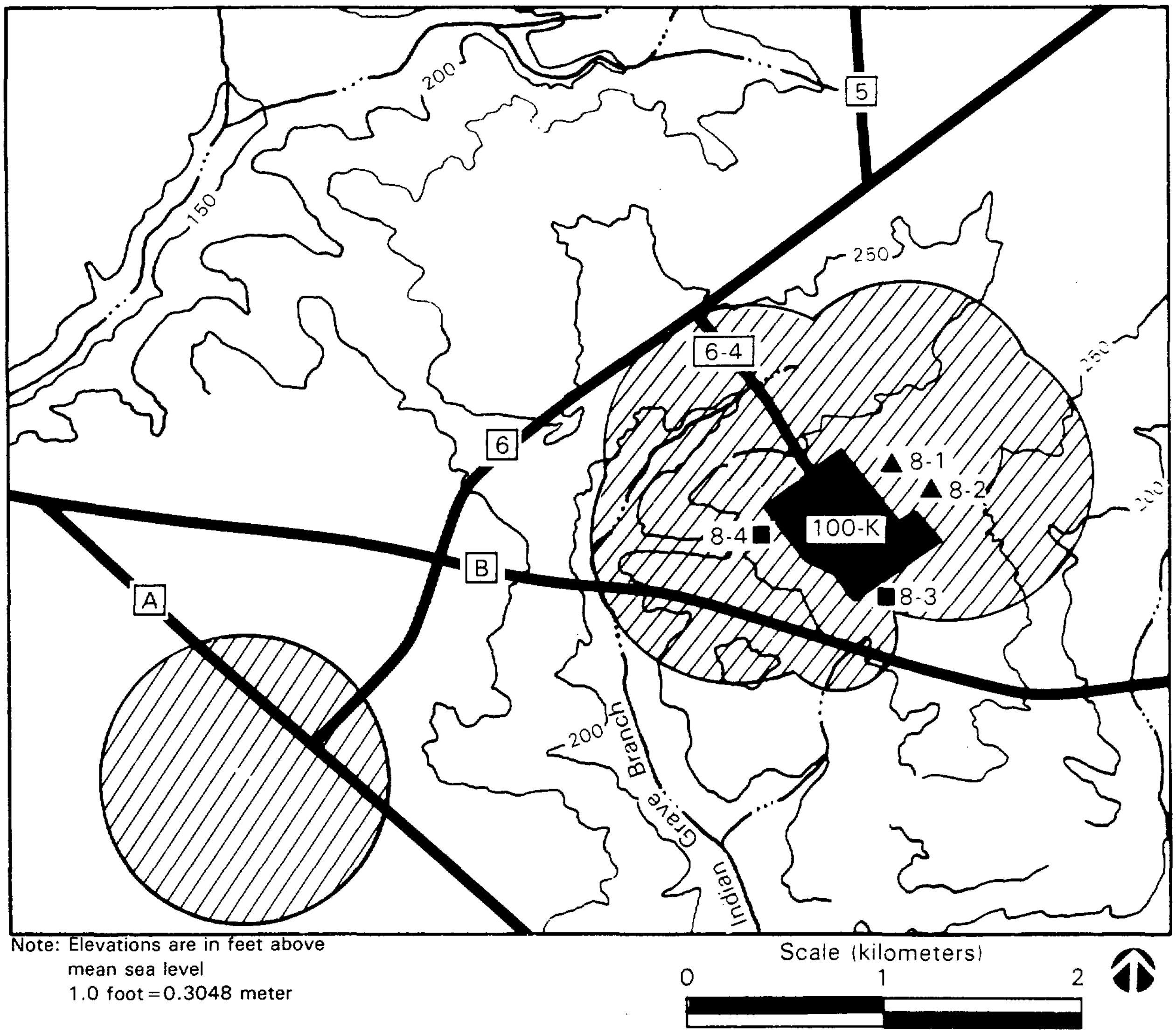
This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the K-Area geographic grouping are discussed in Section F.8.5.

F.8.2 K-AREA ACID/CAUSTIC BASIN, BUILDING 904-80G

This acid/caustic basin is discussed in conjunction with the other acid/caustic basins in Section F.2.1. The ecological effects of this site that relate specifically to the K-Area geographic grouping are discussed in Section F.8.5.

F.8.3 K-AREA BINGHAM PUMP OUTAGE PIT, BUILDING 643-1G

The options, releases, and other potential impacts for this outage pit are discussed in conjunction with the other Bingham pump outage pits in Section F.3.4.



Number	Potential Waste Type	Site Name	Building Number
8-1	▲	K-Area Burning/Rubble Pit*	131-K
8-2	▲	K-Area Acid/Caustic Basin*	904-80G
8-3	■	K-Area Bingham Pump Outage Pit*	643-1G
8-4	■	K-Area Seepage Basin	904-65G

*Indicates that waste type may be contained in the waste site
▲—Hazardous
■—Low-level radioactive

Figure F-12. K-Area Waste Sites

F.8.4 K-AREA SEEPAGE BASIN, BUILDING 904-65G*

Purge water from K-Reactor was discharged to the K-Area basin. The nearest surface stream to K-Area seepage basin is Indian Grave Branch. This basin has been inactive since 1960.

F.8.4.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

This seepage basin is no longer in service but is currently receiving minimum control and upkeep. Vegetative growth is controlled with herbicides, erosion is monitored, fences are maintained, and groundwater is monitored. Under this option, these practices would be continued for this basin. The corners of the basin would be marked with identification pylons. Groundwater monitoring would be conducted quarterly for 1 year and then annually for the next 29 years. Vegetative growth above the basin would be controlled.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The monitoring data show that this reactor seepage basin exhibits a tritium plume in the groundwater. In addition, the groundwater contains other radionuclides, including strontium-90, and yttrium-90.

The regulatory standards and measured or estimated maximum concentrations of all constituents which are of concern from regulatory or health risk are presented in Table F-28. Most maximum concentration figures are based on analysis, because either no concentration measurements were available or the calculated concentration was greater than the measured concentration.

The maximum estimated concentrations presented in Table F-28 correspond to the calculated peaks. In most cases, these peaks are predicted to have occurred prior to 1985.

To derive the radionuclide concentration standards, which result in the National Primary Drinking Water Standard of 4 millirem per year, ICRP-30 dose commitment factors were used. The dose commitment factors are based on the effective whole-body dose equivalent.

It can be seen from Table F-28 that tritium, strontium-90 and yttrium-90 concentrations exceed the standard for the 1-meter well. Tritium also exceeds standards at the 100-meter well.

Surface Water

Surface-water quality is not significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the

*The reference source for the information in this section is Pekkala, Holmes, and Marine, 1986b.

Table F-28. Predicted Maximum Concentrations of Various Groundwater and Surface-Water Constituents at K-Reactor Seepage Basin[a]

			PATHRAE-modeled maximum concentration without remedial action[b]			
			No action		No waste removal and closure, and waste removal and closure	
Constituent	Applicable standard[c]	Measured concentration	1-m well	100-m well	1-m well	100-m well
Tritium	8.7×10^{4}	1.6×10^{5}[d] (well 1)	7.2×10^{6} (1960)	4.4×10^{6} (1967)	(e)	(e)
Strontium-90	4.2×10^{1}	(f)	1.2×10^{3} (1997)	(g)	(g)	(g)
Yttrium-90	5.5×10^{2}	(f)	1.2×10^{3} (1997)	(g)	(g)	(g)

[a]Source: Pekkala et al., 1986 (DPST-85-707).
[b]Number in parentheses represents year in which concentration was reached or is expected to be reached.
[c]EPA, 1985b. ICRP Publication 30 (ICRP, 1979) methodology was used to calculate radionuclide concentrations that yield an annual effective whole body dose of 4 millirem.
[d]Tritium value is mean for 1985.
[e]Value identical to that of no-action option.
[f]Not reported.
[g]Below applicable standard.

resulting concentrations of constituents in Indian Grave Branch are projected to be below drinking-water standards.

Air

The annual dose to an individual resulting from the atmospheric radionuclide releases for the no-action alternative at various times is presented below as a percentage of the DOE limit of 25 millirem per year:

Year	Percentage of DOE limit
1	5.6×10^{-4}
100	1.2×10^{-3}
1000	2.0×10^{-13}

Risks associated with radionuclide releases are less than 8.5×10^{-11} for each of the three years considered.

Potential Impacts (Other Than Releases)

Aquatic Ecology

Potential aquatic impacts of this closure option could result from groundwater outcropping into Indian Grave Branch. Results from the analysis indicate no impact on in-stream concentrations of cesium-137, tritium, strontium-90, or yttrium-90. In order to estimate potential impacts of other wastes, data on water quality parameters of monitoring wells were reviewed in order to identify those constituents whose parameters were higher than the water quality criteria for aquatic life; they include pH and lead. The extent to which these parameters would impact Indian Grave Branch cannot be determined, since the water quality of the stream at the outfall is not known and the amount of dilution is not great.

Terrestrial Resources

As an inactive basin, its use by terrestrial and avian species would be limited to wet weather under this closure option. Potential impacts are described in Section F.8.5.1.

Endangered Species

No impacts on endangered species are expected under this closure option as discussed in Section F.8.5.1.

Wetlands

Two wetland communities (open water, 16.1 acres; and bottomland hardwood, 83.6 acres) are found within 1000 meters of the K-Area seepage basin. However, only 0.1 acre of open water is found within 200 meters. No impacts from sedimentation on the wetlands resulting from this closure option are expected, as discussed in Section F.8.5.1. However, prior to complete mixing, for all

closure options at year 0 (1985) the tritium concentrations may be sufficiently high to impact local wetland areas adjacent to Indian Grave Branch. By 2085, outcropping concentrations would no longer present a threat to wetlands.

F.8.4.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

In this option, no contaminated soil would be removed, but the basin would be allowed to dry by natural seepage and evaporation, backfilled, and fitted with an infiltration barrier to reduce the likelihood of exposure of the contamination and of its migration from the basin. The barrier is assumed to consist of an artificial membrane, compacted clay, sand, and gravel and is assumed to be 99 percent effective in preventing passage of infiltrating water. Finally, the basin would be covered with topsoil, graded, and seeded for erosion control. The corners of the basin would be marked with identification pylons. Groundwater monitoring would be conducted quarterly for 1 year and then annually for the next 29 years. Vegetation growth above the barrier would be controlled.

Comparison of Expected Environmental Releases with Applicable Standards

Groundwater

The implementation of this closure action is predicted to reduce all environmental releases except tritium to below MCLs (see Table F-28).

Surface Water

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in Indian Grave Branch are projected to be below drinking-water standards.

Air

The total annual maximum individual dose is zero; no radionuclides are released.

Potential Impacts (Other Than Releases)

Impacts on biological resources are described in Section F.8.5.2. Potential impacts to wetlands are discussed in Section F.8.4.1.

F.8.4.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

In this option, the K-Area seepage basin would be allowed to dry by natural seepage and evaporation. Contaminated soil (260 cubic meters) would then be excavated from the floor of the basin. The excavation is projected to reduce

the contamination remaining at the basin to the residual concentrations shown in Table F-29.

Table F-29. Proposed Excavation for Cleanup of K-Reactor Seepage Basin in the Waste Removal Option

Basin No.	Maximum concentration (pCi/g)			Proposed excavation depth (m)	Maximum residual contamination (pCi/g)		
	Cs-137	Sr-90	Co-60		Cs-137	Sr-90	Co-60
904-65G	510	140	30	0.30	45	95	<1

Except for cobalt-60, the maximum soil contamination level remaining after excavation is expected to be above the guidelines used for selecting radioactive contaminants for inclusion in the risk assessment of closure options. Because significant levels of contamination could remain after excavation, an infiltration barrier would be installed over the basin to reduce the likelihood of the contamination's becoming exposed and/or migrating from the waste site.

After excavation, the basin would be backfilled with about 1,600 cubic meters of clean soil and be fitted with an infiltration barrier. The barrier is assumed to consist of an artificial membrane, compacted clay, sand, and gravel and is assumed to be 99-percent effective in preventing passage of infiltrating water. Finally, the basin would be covered with topsoil, graded, and seeded for erosion control.

The corners of the closed basin would be marked with identification pylons. Groundwater monitoring would be conducted quarterly for 1 year and then annually for up to 29 years. Vegetative growth above the basin would be controlled to protect the infiltration barrier.

The excavated contaminated soil would be placed in metal containers or bagged as necessary and trucked to a waste storage/disposal facility at SRP.

Comparison of Expected Environmental Releases with Applicable Standards

Expected releases for waste removal are predicted to be the same as those described in Section F.8.4.2 for no waste removal.

Air

The annual dose resulting from atmospheric radionuclide releases for the first year would be 4.0×10^{-6} percent of the DOE limit of 25 millirem per year. The associated risk is 2.9×10^{-13}. There would be no atmospheric radionuclide releases during the other 2 years.

Potential Impacts (Other Than Releases)

Impacts on biological resources resulting from this closure option are similar to those described in Section F.8.5.3. Potential impacts to wetlands are discussed in Section F.8.4.1.

F.8.5 POTENTIAL IMPACTS ON BIOLOGICAL RESOURCES IN K-AREA

This section addresses those general impacts in this geographic grouping that are related to aquatic and terrestrial ecology, endangered species, and wetlands for each closure and remedial action. Where a discussion of site-specific data is required for a given option, it is given in the appropriate section above.

The K-Area burning/rubble pit and K-Area Bingham pump outage pit have been abandoned and are backfilled and covered with soil. The K-Area acid/caustic basin and reactor seepage basin are inactive but do act as wet-weather ponds.

F.8.5.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Action)

Aquatic Resources

Potential aquatic impacts could result from wastes entering groundwater and its subsequent outcrop into nearby streams. Data from groundwater monitoring wells for waste sites within K-Area are presented in Table F-30. No data are available for the K-Area Bingham pump outage pit. The table lists those wastes known to exceed EPA water quality criteria for freshwater aquatic life that were not modeled using PATHRAE.

Terrestrial Resources

The K-Area burning/rubble pit is inactive and has been covered with soil to grade level. Natural brush and grass have begun to grow over the site. The K-Area Bingham pump outage pit is also inactive and in similar condition. Because no action is planned under this closure option, no impacts on terrestrial ecosystems have been identified at either site. Potential impacts could occur at all sites, however, if vegetation growing at the sites accumulated contaminants through root penetration of the waste.

Endangered Species

Previous surveys for endangered species and their habitat indicate little potential for endangered species in the vicinity of K-Area (Pekkala, Holmes, and Marine, 1986b). However, American alligators and bald eagles have been sighted near Steel Creek, approximately 3 kilometers from the K-Area sites (Du Pont, 1985; Mayer, Hoppe, and Kennamer, 1986). Because no activities are planned, no adverse impacts on endangered species are expected from this closure option.

Wetlands

Data on wetlands located near the K-Area waste sites are presented in Table F-30. With the exception of 2.1 acres found within 600 meters of the K-Area

Table F-30. Environmental Data for K-Area Waste Sites

Waste site	Areal extent of site	Distance to nearest wetland	Area of wetlands within 200 m/1000 m acres	Endangered species data	Non-PATHRAE-modeled contaminants exceeding freshwater biota criteria			Area of groundwater outcrop; distance (m) to outcrop	Dilution factor[c]
					Contaminant	Reported level[a]	Criterion[b]		
K-Area burning/ rubble pit (131-K)[d]	70.1 x 9.1	550[e]	No data available	American alligator and bald eagles have been sighted at Steel Creek 3 km away[f,g]	pH	4.3	6.5	Indian Grave or Pen Branch	No data available
K-Area acid/caustic basin (904-80G)[h]	15.2 x 15.2	550[e]	No data available	Same as for site 131-K	pH Silver Gross alpha	4.6 3.9 mg/L 11 pCi/L	6.5 0.12 mg/L 10 pCi/L	Indian Grave Branch	No data available
K-Area Bingham pump outage pit (643-1G)[i]	122 x 18	600	0/1.4	Same as for site 131-K	No data available	No data available		Tributary of Pen Branch; 980	No data available
K-Area seepage basin (904-65G)[j]	41 x 21	200	0.1/99.7	Same as for site 131-K	pH Lead	4.15 0.0195	6.5 0.0013	Indian Grave Branch; 830	0.028

[a]Average value for most recent year for groundwater well containing highest concentration.
[b]Based on ICRP, 1978; EPA, 1985b,c; National Technical Advisory Committee, 1968.
[c]Equivalent to groundwater flux divided by flow rate of receiving stream.
[d]Data from Huber, Johnson, and Marine, 1986, except as otherwise indicated.
[e]Estimated from USGS, 1964.
[f]Du Pont, 1985.
[g]Mayer, Hoppe, and Kennamer, 1986.
[h]Data from Ward et al., 1986, except as otherwise indicated.
[i]Data from Pekkala, Holmes, and Marine, 1986a.
[j]Data from Pekkala, Holmes, and Marine, 1986b.

seepage basin (Pekkala, Jewell, Holmes, and Marine, 1986), no wetland areas are closer than 550 meters from any of the K-Area sites. The no-action option would cause no additional impacts on wetlands over those that may be occurring now.

F.8.5.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Resources

The types of impacts on aquatic ecosystems resulting from this closure option would be similar to those described in Section F.8.5.1 for the sites already backfilled. The potential for impacts on streams due to the contamination of groundwater would be reduced through planned groundwater remedial cleanup. Erosion control measures would be used to prevent potential aquatic impacts from sedimentation due to the remedial actions planned under this closure option.

Terrestrial Resources

Temporary impacts on terrestrial ecosystems might result from site disturbance and noise associated with the installation and operation of the groundwater extraction/treatment facilities. Erosion control measures would be used to prevent any sedimentation impacts that might result from installation and operation of the facilities. Occasional mowing would reduce the potential for waste uptake by vegetation.

Endangered Species

No impacts to endangered species are expected from this closure option. Endangered species are sufficiently distant from the sites to prevent disturbance as a result of human activities.

Wetlands

Because of their distance from the sites, wetland habitats should not be affected by backfill and remedial activities planned under this closure option. Sedimentation and erosion control procedures would prevent potential wetland disturbance.

F.8.5.3 Assessment of Removal of Waste to the Extent Practicable and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Resources

No impacts on aquatic ecosystems are expected from this closure option. Waste removal would reduce releases to groundwater. Erosion control and sedimentation measures would be used during waste excavation and during installation and operation of the groundwater extraction/treatment facilities.

Terrestrial Resources, Endangered Species, and Wetlands

Due to the similarity of this closure option and the no waste removal and closure option, the discussion presented in Section F.8.5.2 is also applicable

here. Waste removal would reduce potential impacts from biological accumulation.

F.9 ASSESSMENT OF ACTIONS AT L-AREA WASTE SITES

This geographic grouping is formed by waste sites near L-Reactor. This grouping is approximately 4 kilometers east of K-Reactor, just north of Road B. Figure F-13 shows the locations of the waste sites in the L-Area grouping.

Sections F.9.1 through F.9.12 contain, or reference the section that contains, a discussion of sites 9-1 through 9-12. Section F.9.13 discusses biological impacts that are generically applicable to the waste sites in this geographic grouping.

F.9.1 L-AREA BURNING/RUBBLE PIT, BUILDING 131-L

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the L-Area geographic grouping are discussed in Section F.9.13.

F.9.2 L-AREA ACID/CAUSTIC BASIN, BUILDING 904-79G

This acid/caustic basin is discussed in conjunction with the other acid/caustic basins in Section F.2.1. The ecological effects of this site that relate specifically to the L-Area geographic grouping are discussed in Section F.9.13.

F.9.3 CMP PITS*

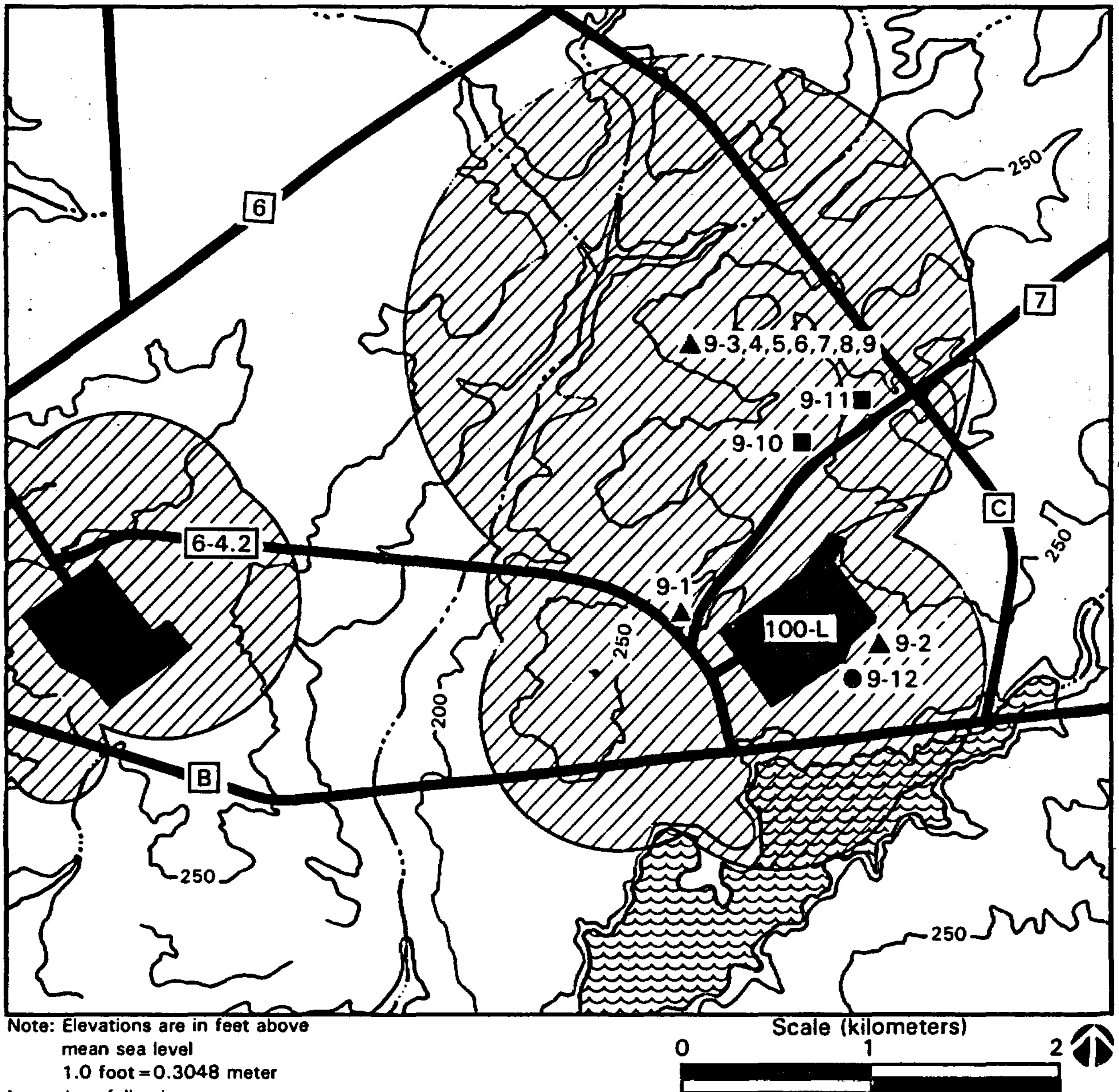
The CMP pits consist of seven adjacent waste sites (Buildings 080-17G, 080-17.1G, 080-18G, 080-18.1G, 080-18.2G, 080-18.3G, and 080-19G). The seven sites were assumed to be a single operating unit for purposes of modeling migration in groundwater and surface water. Also, the options described in this section would be applicable to each of the CMP pits. For atmospheric transport risks, each of the seven CMP pits was considered separately. However, the effects of these releases will be discussed cumulatively in this section. The history of waste disposal, evidence of contamination, and waste characteristics at these pits are presented in Appendix B, Section B.10.1.

F.9.3.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

This option would involve the quarterly monitoring of well clusters 8, 9, 10, 11, 12, and 13 for about 5 years. If at the end of 5 years there were no increase in contaminant levels, the frequency would be reduced to once per year for an additional 25 years.

*The reference source of the information in this section is Scott, Kolb, Price, and Bledsoe, 1986.



Note: Elevations are in feet above mean sea level
1.0 foot = 0.3048 meter
Legend on following page

Figure F-13. L-Area Waste Sites

Number	Potential Waste Type	Site Name	Building Number
9-1	▲	L-Area Burning/Rubble Pit*	131-L
9-2	▲	L-Area Acid/Caustic Basin*	904-79G
9-3	▲	CMP Pit	080-17G
9-4	▲	CMP Pit	080-17.1G
9-5	▲	CMP Pit	080-18G
9-6	▲	CMP Pit	080-18.1G
9-7	▲	CMP Pit	080-18.2G
9-8	▲	CMP Pit	080-18.3G
9-9	▲	CMP PIt	080-19G
9-10	■	L-Area Bingham Pump Outage Pit*	643-2G
9-11	■	L-Area Bingham Pump Outage Pit*	643-3G
9-12	●	L-Area Oil and Chemical Basin*	904-83G

*Indicates that waste type may be contained in the waste site
▲—Hazardous
■—Low-level radioactive
●—Mixed

Figure F-13. L-Area Waste Sites (continued)

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents selected for consideration of risks associated with the CMP pits are benzene, chloroethylene, 2,4-D, dichloromethane, Endrin, lead, Silvex, tetrachloroethylene, toxaphene, and trichloroethylene. Each of these compounds was selected because it was found in groundwater at levels higher than the threshold selection criteria or was expected to be found in the soil as a result of a review of an inventory of materials that were disposed of at this site (Looney et al., 1986).

Table F-31 lists the predicted maximum concentrations of the selected constituents and the year of peak occurrence after 1985, based on groundwater modeling for this site. The table also lists the regulatory limits for comparison purposes. As shown in this table, the model estimates concentrations of several constituents in excess of applicable standards at the 1- and 100-meter wells. Table F-31 indicates that the predicted peak concentration of Endrin is not anticipated in the groundwater at the 1- and 100-meter wells for more than 700 years. This is the result of Endrin's natural resistance to movement through the unsaturated soil zone between the remaining waste and the aquifer.

Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents from this source in Pen Branch are projected to be below drinking-water standards.

Cumulative environmental risks due to atmospheric chemical releases from the CMP pits are estimated to be low and not significant. Risks to the maximally exposed individual would be below 10^{-9} for carcinogenic risks. Risks to the maximally exposed individual from noncarcinogen would be below 1, with a value less than 10^{-8}.

The expected concentrations for erosion and the biointrusion pathways are zero for this option. The erosion rate is such that no waste erodes during the first 1000 years of the simulation, and the 4 meters of soil cover or exceed the root penetration assumed for the biointrusion pathway.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no-action closure plan is provided in Section F.9.13.1. PATHRAE modeling was performed on benzene, chloroethylene, 2,4-D, dichloromethane, endrin, lead, silver, tetrachloroethylene, toxaphene, and trichloroethylene, which were identified as having potential impacts on the aquatic system. The results indicate that these waste materials would not alter the present water quality of Pen Branch under any of the closure options. The CMP pits are entirely within the Pen Branch drainage system, which contains numerous areas of undrained uplands and swampy depressions. It is possible that concentrations of wastes reaching wetlands via groundwater flow will accumulate and have an impact on the aquatic and semiaquatic biota that live in these areas.

Table F-31. Predicted Maximum Concentrations of Various Chemical Constituents at CMP Pits for Three Closure Options[a]

Constituent	Applicable standard	Monitoring data maximum mean concentration	Predicted maximum concentration: No action[b] 1-m well	No action[b] 100-m well	No removal and closure 1-m well	No removal and closure 100-m well	Removal and closure 1-m well	Removal and closure 100-m well
Benzene	5.0×10^{-3}[c]	(d)	4.4×10^{-1} (1993)	1.9×10^{-1} (1997)	(e)	(e)	(e)	(e)
Chloroethylene	1.0×10^{-3}[c]	(d)	4.7×10^{-1} (1992)	2.0×10^{-1} (1995)	(e)	(e)	(e)	(e)
2,4-D	1.0×10^{-1}[c]	(f)	8.9×10^{-1} (1993)	3.8×10^{-1} (1997)	(e)	(e)	(e)	(e)
Dichloromethane	6.0×10^{-2}[g]	(d)	4.6×10^{-1} (1992)	2.0×10^{-1} (1996)	(e)	(e)	(e)	(e)
Endrin	2.0×10^{-4}[c]	(f)	1.2×10^{-3} (2705)	5.0×10^{-4} (2848)	(e)	(e)	(e)	(e)
Lead	5.0×10^{-2}[c]	5.3×10^{-2} (well CMP 12)	1.4×10^{-1} (1992)	6.1×10^{-2} (1995)	(e)	(e)	(e)	(e)
Silvex	1.0×10^{-2}[c]	(f)	2.9 (2012)	1.3 (2019)	(e)	(e)	(e)	(e)
Tetrachloroethylene	7.0×10^{-4}[g]	(d)	1.0×10^{-2} (1997)	4.4×10^{1} (2002)	(e)	(e)	(e)	(e)
Toxaphene	5.0×10^{-3}[c]	(f)	2.9×10^{-1} (2003)	1.2×10^{-1} (2009)	(e)	(e)	(e)	(e)
Trichloroethylene	5.0×10^{-3}[c]	(d)	2.6 (1994)	1.1 (1998)	(e)	(e)	(e)	(e)
Gross alpha	10-20	95 (well CMP 13)	(h)	(h)	(h)	(h)	(h)	(h)
Radium	6.0	12 (well CMP 11)	(h)	(h)	(h)	(h)	(h)	(h)

[a]Source: Scott, Kolb, Price, and Bledsoe, 1986. Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[b]Number in parentheses represents year in which concentration is expected to be reached.
[c]Source: EPA, 1985b.
[d]Statistical comparison between up and down gradient wells not performed for this parameter.
[e]Value identical to that of no-action option.
[f]Concentration is below standard.
[g]Source: EPA, 1985a.
[h]Constituent not modeled.

F.9.3.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This option would involve monitoring groundwater at the existing wells. Decreased availability of contaminants should result in the decline of observed concentrations, except perhaps at CMP-9. If trends were not downward after 1 year, a decision would be made whether or not to continue further monitoring, activate the leach field, or install a vacuum recovery system.

Additional corrective actions, such as groundwater extraction and treatment, might be used to reduce the levels of all of the contaminants in the groundwater, except Endrin and Silvex, to below applicable standards. Endrin, in particular, is an extremely slow-moving contaminant that is not anticipated to reach its peak concentration in the aquifer for several hundred years. Thus, efforts to extract it from the groundwater in the near future would be ineffective, because it remains either within the remaining bodies of waste or somewhere along the depth of the unsaturated zone.

Comparison of Expected Environmental Releases with Applicable Standards

The chemical constituents of concern are the same as for the no-action option (see Section F.9.3.1). Table F-31 lists the predicted maximum concentrations of the chemical constituents based on results of groundwater modeling.

Cumulative estimated environmental risks due to atmospheric chemical releases from the CMP pits for this option are identical to the no-action option (Section F.9.3.1).

The predicted concentrations for the erosion, reclaimed farmland, and the biointrusion pathways are again zero for this option.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no waste removal and closure plan is provided in Section F.9.13.2. Proposed remedial action for the CMP pits, consisting of activated leach fields and/or installation of a vacuum recovery system, should help reduce the potential for contamination of the groundwater, which would ultimately reduce the potential impacts on the aquatic biota.

F.9.3.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Currently, 99.5 percent of all hazardous material has been removed from the seven CMP areas. Further action could be taken to lower residual concentrations to background levels. Among the possible actions are:

1. Grouting and abandoning four wells totaling approximately 170 meters (CMP-9B, 9C, 16B, 16C).

2. Excavating nearly 4000 cubic meters of compacted fill and crushed stone together with the HDPE liner previously placed in the pit areas.

3. Excavating 1500 cubic meters of earth at depths of up to 27 meters below grade. The average concentration of organics in this material would be about 15 ppm.

4. Incinerating the earth moved.

5. Refilling the excavation to grade with clean fill (the incinerated material could be used) and seeding for erosion control.

Additional corrective actions, such as groundwater extraction and treatment, could be used in conjunction with this closure option to reduce the present level of contaminants in the groundwater. The selection of actions would be based on site-specific studies and interactions with cognizant regulatory agencies. Removal of the remaining waste, as defined by the original waste boundaries, would not be sufficient to ensure removal of all remaining constituents, particularly Endrin. Further investigation would be required to locate the extent of the Endrin plume, which is (and will be, for the entire 100-year institutional control period) resident in the unsaturated zone between the waste and the water table. Once the plume location is specified, further strategies could be devised (e.g., a combination of waste removal and remedial actions such as forcing the Endrin into the water table, from which it could be pumped and removed) to ameliorate future instances in which Endrin exceeds standards.

Comparison of Expected Environmental Releases with Applicable Standards

Table F-31 lists the predicted maximum concentrations of the chemical constituents based on results of groundwater modeling for this option as well as the other options. These data indicate significant contamination of the groundwater in the vicinity of the pits. When the groundwater is discharged to the river, however, the concentrations are below applicable standards.

Estimated environmental and occupational risks due to atmospheric chemical releases from the CMP pits for this option are very low and are considered not significant. They are lower than those for the first two options (Sections F.9.3.1 and F.9.3.2).

The expected concentrations for the erosion, reclaimed farmland, and biointrusion pathways are again zero.

An analysis of the health risks to the average individual worker that would be attributable to occupational exposure to radioactive carcinogens (both nonradioactive and radioactive) and noncarcinogens was performed using the methodology presented in Appendix I. The total dose to the worker was calculated to be 2.4 millirem, which would produce an incremental risk of 6.7×10^{-7}. The total dose to the worker transporting the waste was calculated as 1.2 millirem, producing an incremental risk of 3.4×10^{-7}.

The groundwater remediation system could be designed so that the contaminant levels in the groundwater would fulfill applicable standards. In addition, any release from the treatment system would meet applicable standards.

Potential Impacts (Other Than Releases)

The potential ecological impacts of the waste removal and closure plan for the CMP pits are similar to those described in Section F.9.13.3.

F.9.4 CMP PIT, BUILDING 080-17.1G

This pit is discussed in conjunction with the other CMP pits in Section F.9.3.

F.9.5 CMP PIT, BUILDING 080-18G

This pit is discussed in conjunction with the other CMP pits in Section F.9.3.

F.9.6 CMP PIT, BUILDING 080-18.1G

This pit is discussed in conjunction with the other CMP pits in Section F.9.3.

F.9.7 CMP PIT, BUILDING 080-18.2G

This pit is discussed in conjunction with the other CMP pits in Section F.9.3.

F.9.8 CMP PIT, BUILDING 080-18.3G

This pit is discussed in conjunction with the other CMP pits in Section F.9.3.

F.9.9 CMP PIT, BUILDING 080-19G

This pit is discussed in conjunction with the other CMP pits in Section F.9.3.

F.9.10 L-AREA BINGHAM PUMP OUTAGE PIT, BUILDING 643-2G

The options, releases, and other potential impacts for this outage pit are discussed in conjunction with the other Bingham pump outage pits in Section F.3.4.

F.9.11 L-AREA BINGHAM PUMP OUTAGE PIT, BUILDING 643-3G

The options, releases, and other potential impacts for this outage pit are discussed in conjunction with the other Bingham pump outage pits in Section F.3.4.

F.9.12 L-AREA OIL AND CHEMICAL BASIN, BUILDING 904-83G*

F.9.12.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Actions)

Description of Action

The site would be left in its present condition. Groundwater monitoring of existing wells would be continued on a quarterly basis for 1 year and then

*The reference source for the information in this section is Pekkala, Price, and Bledsoe, 1986.

annually for 29 years. Upkeep would consist of maintaining a fence and signs around the basin area and cutting the weeds periodically.

Comparison of Expected Environmental Releases with Applicable Standards

The current groundwater monitoring data indicate that no constituents included in the analysis exceed regulatory standards based on the maximum single-well mean for each constituent. However, PATHRAE simulation indicates that future concentrations of cadmium, chromium, lead, mercury, tetrachloroethylene, americium-241, strontium-90, tritium, uranium-238, yttrium-90, cobalt-60, and plutonium-238 either have recently exceeded or are expected to exceed MCLs in groundwater near the basin in the future (Table F-32).

Surface-water quality is not significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents from this source in Steel Creek are projected to be below drinking-water standards.

Environmental doses and risks to the maximally exposed individual due to radiological releases to the atmosphere from the L-Area oil and chemical basin were calculated using the methodology presented in the introduction to this appendix and in Appendix I. The calculated doses are less than 0.47 percent of the DOE limit of 25 millirem per year for each of the 3 years. The risks associated with these doses would be less than 3.3×10^{-8}. Estimates of public exposure and risks attributable to atmospheric releases of carcinogens and noncarcinogens for this option were not performed, owing to the limited amount of information.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no-action closure option is provided in Section F.9.13.1. PATHRAE modeling was performed on cadmium, chromium, lead, mercury, nickel, tetrachloroethylene, tritium, cobalt-60, strontium-90, cesium-137, uranium-235 and -238, plutonium-238, and 239 and americium-241, which were identified as having potential impacts on the aquatic system. The results indicate that these materials would not alter the present water quality of Steel Creek under any of the closure options. It should be noted that lead and mercury in Steel Creek are presently above the aquatic biota criteria. Since the groundwater flow from the oil and chemical basin becomes part of the undrained uplands and swampy surface depressions of Steel Creek, full dilution of wastes is not likely to occur and some accumulation could occur in these wetland areas.

Because the basin sometimes contains standing water during periods of rainfall, this water could contain wastes from contaminated soils and pose a potential problem to wildlife, including waterfowl, and vegetation that come into contact with it. There is also the potential impact of surface runoff into nearby streams and wetlands during heavy rainstorms, if not controlled. Wetlands in the vicinity of the oil and chemical basin consist of the bottomland hardwood communities along Steel Creek and the open-water wetland of L-Lake.

Table F-32. Predicted Maximum Concentrations of Various Constituents at the L-Area Oil and Chemical Basin for the Three Closure Options[a,b]

Constituent	Applicable standard[d]	PATHRAE-modeled maximum concentration without remedial action[c]					
		No action		No waste removal and closure		Waste removal and closure	
		1-m well	100-m well	1-m well	100-m well	1-m well	100-m well
Cadmium	0.01	0.03 (1986)	(e)	(e)	(e)	(e)	(e)
Chromium	0.05	3.3 (2027)	0.098 (2535)	(e)	(e)	(e)	(e)
Mercury	0.002	0.035 (1979)	(e)	(e)	(e)	(e)	(e)
Lead	0.05	0.22 (2098)	(e)	(e)	(e)	(e)	(e)
Tetrachloro-ethylene	.0007[f]	0.016 (1979)	0.016 (1979)	(g)	(g)	(g)	(g)
Americium-241	2.5	180 (2098)	(e)	5.3 (2210)	(e)	(e)	(e)
Cobalt-60	210	7300 (1976)	(e)	(g)	(e)	(g)	(e)
Plutonium-238	14	18 (2098)	(e)	(e)	(e)	(e)	(e)
Strontium-90	42	2100 (1980)	(e)	(g)	(e)	(g)	(e)
Tritium	8.7×10^4	4.6×10^8 (1962)	3.2×10^8 (1967)	(g)	(g)	(g)	(g)
Uranium-238	24	130 (2027)	(e)	(e)	(e)	(g)	(e)
Yttrium-90	550	2100 (1980)	(e)	(g)	(e)	(g)	(e)

[a]Source: Adapted from Pekkala, Price, and Bledsoe, 1986.
[b]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[c]Year of maximum concentration in parentheses.
[d]MCLs for chemicals are given in EPA, 1985b; for radionuclides, ICRP Publication 30 (ICRP, 1979) methodology was used to determine concentrations that yield annual effective whole-body dose of 4 millirem.
[e]Below applicable standard.
[f]EPA, 1985a.
[g]Identical to value for no-action option.

F.9.12.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

No waste material would be removed. The bottom of the basin would be stabilized with cement to support backfill loads. The concrete decontamination pad and associated piping would be bulldozed into the basin. The basin would then be backfilled with approximately 3000 cubic meters of borrow fill, provided with a low-permeability clay cap (an additional 900 cubic meters), and compacted and seeded to prevent settling and erosion. The existing four groundwater monitoring wells would be sampled and analyzed quarterly for 1 year, then annually for the next 29 years. Site maintenance would be provided for the entire 30-year period.

As shown in Table F-32, concentrations of tetrachloroethylene, americium-241, strontium-90, tritium, yttrium-90, and cobalt-60 in groundwater near the basin are predicted by PATHRAE to exceed MCLs. Potential remedial action (e.g., groundwater pumping and treatment) could be required to address these constituents. Any actions taken would be based on site-specific studies and interactions with regulatory agencies. For example, the number, size, location, pumping rate, and pumping duration of groundwater-withdrawal wells would be determined after the contaminant plume was defined and a quantitative flow analysis was performed. Appropriate treatment technologies would be employed to reduce the concentrations of the constituents to below regulatory limits. Before a groundwater remedial action program was initiated, additional monitoring would be needed to define the actual extent and concentration of the contaminant plume.

Comparison of Expected Environmental Releases with Applicable Standards

Regulations promulgated under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) apply to closure and remedial actions. The regulations require that groundwater affected by the chemical basin be processed to achieve contaminant levels within MCLs established under the Safe Drinking Water Act.

The closure and potential groundwater remedial actions that may be used are expected to reduce the concentrations of tetrachloroethylene, americium-241, strontium-90, tritium, yttrium-90, and cobalt-60 to within MCLs. Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in Steel Creek are projected to be below drinking-water standards. An analysis for radiological releases to the atmosphere described in Section F.9.12.1 was also performed for this option. No releases are assumed to occur for this option, since the basin would be capped. No analysis of carcinogen and noncarcinogen releases was performed for this option, due to limited information.

Potential Impacts (Other Than Releases)

A general description of the ecological impacts of the no waste removal and closure plan is provided in Section F.9.1.2. The proposed closure plan of the

L-Area oil and chemical basin includes drainage of any existing standing water in the basin. However, as the contents of the basin would be released according to the NPDES permit requirements, impacts to the aquatic biota would not be significant. Solidifying the soils and capping the waste site with a low permeable clay would retard the leaching of wastes into the groundwater and thereby reduce the potential impacts on the aquatic biota. The area should be revegetated with shallow-rooted plants and mowed to prevent root penetration into the clay cap.

F.9.12.3 Assessment of Removal of Waste to the Extent Practicable and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

This alternative for the oil and chemical basin includes removal of any basin water, removal of basin sediments, backfilling and capping with a low-permeability cover, and continuation of groundwater monitoring.

Any residual rainwater in the basin would be removed to Waste Management Operations for disposal. Basin sediments contaminated to a depth of 0.9 meter below the basin would be stabilized and excavated. The 675 cubic meters of friable mixture would be loaded into metal containers for transport to a waste storage/disposal facility.

The concrete pad next to the basin and its pipeline to the basin would be removed and sent to the SRP low-level radioactive solid waste disposal facility. The basin would then be backfilled with 3500 cubic meters of borrow fill. The waste site would be provided with a low-permeability clay cap (900 cubic meters) and compacted and seeded to prevent settling and erosion. The existing four groundwater monitoring wells would be sampled and analyzed quarterly for the first year, then annually for the next 29 years. Site maintenance would be provided for the entire 30-year period.

As shown in Table F-32, concentrations of tetrachloroethylene, strontium-90, tritium, yttrium-90, and cobalt-60 in groundwater near the basin are predicted by PATHRAE to exceed applicable MCLs. Potential remedial action needed to reduce these constituents to below regulatory standards is discussed in Section F.9.12.2.

Comparison of Expected Environmental Releases with Applicable Standards

Regulations promulgated through RCRA and CERCLA apply to closure and remedial actions. The regulations require that groundwater affected by the chemical basin be processed to achieve contaminant levels within MCLs established under the Safe Drinking Water Act.

The potential groundwater remedial actions described in Section F.9.12.2 are expected to reduce the concentrations of tetrachloroethylene, strontium-90, tritium, yttrium-90 and cobalt-60 to within applicable MCLs. Surface-water quality would not be significantly affected by the addition of potential contaminants from the groundwater pathway from this site, as the resulting concentrations of constituents in Steel Creek are projected to be below drinking-water standards. The analysis of radiological releases to the atmosphere described in Section F.9.12.1 was also performed for this option.

Releases would be due to excavation activities in 1986 but would be zero thereafter, since the basin would be capped. The dose to the maximally exposed individual was calculated as being less than 3.1×10^{-4} percent of the DOE limit of 25 millirem per year. The risk associated with this dose would be less than 2.2×10^{-11}. No analysis of carcinogen and noncarcinogen releases was performed for this option due to limited information.

An analysis of the health risks to the average individual worker attributable to occupational exposure to carcinogens and noncarcinogens for unprotected and protected workers was performed using the methodology presented in Appendix H. The risks due to carcinogen releases to the unprotected and protected worker were calculated as being less than 9.4×10^{-7} and 9.0×10^{-20}, respectively. The risks due to noncarcinogen releases to an unprotected and protected worker were below 1 and less than 1.3×10^{-3} and 2.5×10^{-5}, respectively. The total dose to the worker was calculated to be 24 millirem, which would produce an incremental risk of 6.7×10^{-6}. The total dose to the worker transporting the waste was calculated as 12 millirem, producing an incremental risk of 3.4×10^{-6}.

Potential Impacts (Other Than Releases)

In addition to the ecological impacts of the waste removal and closure plan provided in Section F.9.1.3, this option could include the drainage of standing water. However, as contents of the basin would be released according to the NPDES permit requirements, impacts on the aquatic biota probably would not be significant.

F.9.13 POTENTIAL IMPACTS ON BIOLOGICAL RESOURCES IN L-AREA

This section addresses those general impacts related to aquatic and terrestrial ecology, endangered species, and wetlands for each closure and remedial action. Where a discussion of site-specific data is required for a given option, it is presented in the appropriate section above.

There are 12 waste sites in L-Area. The L-Area burning/rubble pit is presently covered with soil and vegetation. Other waste sites within this geographic grouping include the seven CMP pits, which have been excavated and capped; the two L-Area Bingham pump outage pits, which contained low-level radioactive waste and are presently backfilled and covered with vegetation; the L-Area acid/caustic basin, which is dry except for an occasional impoundment of rainwater; and the L-Area oil and chemical basin, which contained low-level radioactive waste but is presently dry except for an occasional impoundment of rainwater. All waste sites within this geographic grouping are either abandoned or inactive.

F.9.13.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Actions)

Aquatic Ecology

The no-action closure plan for the waste sites of L-Area could indirectly contaminate surface-water bodies via the outcropping of groundwater from the various waste sites of L-Area. Table F-33 lists those groundwater wastes not modeled by PATHRAE that exceed the freshwater EPA aquatic life criteria for

Table F-33. Environmental Data for L-Area Waste Sites

Waste site	Areal extent of site (m)	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[b]	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria[a]			Area of groundwater outcrop; distance (m) to nearest stream	Dilution factor[e]
					Contaminant	Reported level[c]	Criterion[d]		
L-Area burning/ rubble pit 131-L[f]	8.8 x 70.1 x 3.1	700	No information	No endangered species or habitats observed within 200 m of vicinity; bald eagles sighted 600 m away; American alligator observed in former L-Reactor cooling water discharge canal	Copper Iron Zinc Gross alpha	0.012 5.105 0.052 24.5	0.0065 1.0 0.047 10	No data	No data available
L-Area acid/ caustic basin 904-79G[g]	15.24 x 15.24 x 2.13	400	0/234.2	See comments under L-Area burning/rubble pit 131-L	Iron Zinc	7.516 0.424	1.0 0.047	Steel Creek; no data	3.8×10^{-4}
CMP pit 080-17G[h]	3-5 x 15-23 x 3-5	0	24.4/86.1	See comments under L-Area burning/rubble pit 131-L	Copper Iron Zinc Gross alpha Radium	0.011 3.56 5.94 95 11.75	0.0065 1.0 0.047 10 5	Pen Branch; no data	6.0×10^{-4}
CMP pit 080-18.2G[h]	3-5 x 15-23 x 3-5	0	24.4/86.1	See comments under L-Area burning/rubble pit 131-L	Copper Iron Zinc Gross alpha Radium	0.011 3.56 5.94 95 11.75	0.0065 1.0 0.047 10 5	Pen Branch; no data	6.0×10^{-4}
CMP pit 080-18.3G[h]	3-5 x 15-23 x 3-5	0	24.4/86.1	See comments under L-Area burning/rubble pit 131-L	Copper Iron Zinc Gross alpha Radium	0.011 3.56 5.94 95 11.75	0.0065 1.0 0.047 10 5	Pen Branch; no data	6.0×10^{-4}

Footnotes on last page of table.

Table F-33. Environmental Data for L-Area Waste Sites (continued)

Waste site	Areal extent of site (m)	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[b]	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria[a]			Area of groundwater outcrop; distance (m) to nearest stream	Dilution factor[e]
					Contaminant	Reported level[c]	Criterion[d]		
CMP pit 080-19G[h]	3-5 x 15-23 x 3-5	0	24.4/86.1	See comments under L-Area burning/rubble pit 131-L	Copper Iron Zinc Gross alpha Radium	0.011 3.56 5.94 95 11.75	0.0065 1.0 0.047 10 5	Pen Branch; no data	6.0×10^{-4}
CMP pit 080-17.1G[h]	3-5 x 15-23 x 3-5	0	24.4/86.1	See comments under L-Area burning/rubble pit 131-L	Copper Iron Zinc Gross alpha Radium	0.011 3.56 5.94 95 11.75	0.0065 1.0 0.047 10 5	Pen Branch; no data	6.0×10^{-4}
CMP pit 080-18G[h]	3-5 x 15-23 x 3-5	0	24.4/86.1	See comments under L-Area burning/rubble pit 131-L	Copper Iron Zinc Chlorine Gross alpha Radium	0.011 3.56 5.94 5.775 95 11.75	0.0065 1.0 0.047 0.011 10 5	Pen Branch; no data	6.0×10^{-4}
CMP pit 080-18.1G[h]	3-5 x 15-23 x 3-5	0	24.4/86.1	See comments under L-Area burning/rubble pit 131-L	Copper Iron Zinc Gross alpha Radium	0.011 3.56 5.94 95 11.75	0.0065 1.0 0.047 10 5	Pen Branch; no data	6.0×10^{-4}
L-Area Bingham pump outage pit 643-2G[i]	130 x 9 x 4	400	0/14	See comments under L-Area burning/rubble pit 131-L	No information	No information	No information	Pen Branch; no data	3.3×10^{-3}
L-Area Bingham pump outage pit 643-3G[i]	144 x 8 x 4	400	0/14	See comments under L-Area burning/rubble pit 131-L	No information	No information	No information	Pen Branch; no data	3.3×10^{-3}

Footnotes on last page of table.

Table F-33. Environmental Data for L-Area Waste Sites (continued)

Waste site	Areal extent of site (m)	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data[b]	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria[a]			Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[e]
					Contaminant	Reported level[c]	Criterion[d]		
L-Area oil and chemical basin 904-83G[j]	36.6 x 24.4 x 3.4	400	0/248	See comments under L-Area burning/rubble pit 131-L	Gross beta	120.0	40	Steel Creek; no data	1.5×10^{3}

[a]Concentrations reported as milligrams per liter for chemicals and picocuries per liter for radionuclides.
[b]Data from Mayer, Hoppe, and Kennamer, 1986; Du Pont, 1985.
[c]Average value for most recent year for groundwater well containing the highest concentration.
[d]Based on ICRP 30, 1979; EPA, 1985b,c; National Technical Advisory Committee, 1968.
[e]Equivalent to groundwater flux divided by flow rate of receiving stream.
[f]Data from Huber, Johnson, and Marine, 1986, except as otherwise indicated.
[g]Data from Ward, Johnson, and Marine, 1986, except as otherwise indicated.
[h]Data from Scott, Kolb, Price, and Bledsoe, 1986, except as otherwise indicated.
[i]Data from Pekkala, Holmes, and Marine, 1986a, except as otherwise indicated.
[j]Data from Pekkala, Price, and Bledsoe, 1986, except as otherwise indicated.

each of the waste sites. Some wastes, such as silver, beryllium, cadmium, mercury, hydrogen sulfide, Endrin, methoxychlor, and toxaphene, were not listed in Table F-33 because their reported values were usually below the detection limit of the instrumentation. The detection limits for these materials were above the freshwater biota criteria, making it impossible to determine if wastes were present at levels above or below the designated biota criteria.

Where data are available, it can be determined that most materials not modeled using PATHRAE analysis (see Table F-33) would not be expected to create or enhance impacts on the aquatic biota of nearby streams. (Those waste sites within the L-Area that might still pose a problem are addressed separately.) This conclusion was based on the estimated dilution factor, which was calculated by dividing the groundwater flux by the flow rate of the receiving stream. This factor indicates that levels of waste materials would be diluted so as not to affect the water quality of the receiving stream.

Terrestrial Ecology

Potential terrestrial impacts of the no-action closure plan for the waste sites of L-Area include the exposure of wildlife and/or vegetation to standing contaminated surface waters and contaminated soils. The terrestrial impacts of those waste sites with standing surface waters are addressed individually. Plant toxicity is dependent on the plant species, the root depth of the plants, the chemical form of the contaminant, the soil composition and moisture, and the rate of waste material uptake by a plant. Because there are many variables that affect plant toxicity and because there is a lack of information on such items, the impacts of soil contamination on plants cannot be accurately assessed.

Endangered Species

No endangered species have been identified in the immediate vicinity of the waste sites of L-Area from previous surveys at SRP (see Table F-33). The habitats in the immediate vicinity of these waste sites are not considered to be suitable for any Federally endangered species previously reported from the SRP. There have been sightings of the bald eagle within the vicinity of L-Lake just south of the L-Area waste sites (Mayer, Hoppe, and Kennamer, 1986), but no nests have been seen in this area. Also, the American alligator has been observed in the former L-Reactor cooling water discharge canal. The no-action option for the waste sites of L-Area is not expected to have any effect on endangered species.

Wetlands

Wetlands of the L-Area include bottomland hardwood and scrub/shrub communities that occur along Steel Creek and the upper reaches of Pen Branch, and the open water wetland of L-Lake. Table F-33 provides the distances between the waste sites and the wetlands of L-Area. Potential impacts on these wetlands are addressed individually where appropriate. Impacts would be unlikely where wetlands are located some distance from a waste site.

F.9.13.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Ecology

The no waste removal and closure plan for the waste sites of the L-Area would probably contribute directly and indirectly to the contamination of surface-water bodies. Direct contamination of surface-water bodies would occur if standing water were discharged directly into streams without being treated. Those waste sites that contain standing water are addressed individually. Indirect contamination of surface-water body via groundwater is described in Section F.9.13.1. According to the possible closure and remedial actions for the various L-Area waste sites, the level of impacts on the aquatic biota should be significantly lower than that of the no-action plan.

Terrestrial Ecology

The potential terrestrial impacts of the no waste removal and closure plan for the waste sites of L-Area include toxicity to vegetation via contaminated soils and temporary disturbance of the wildlife due to noise and habitat loss during closure operations. A general discussion relating to plant toxicity is provided in Section F.9.13.1.

Endangered Species

Potential impacts on endangered species would be similar to those addressed in Section F.9.13.1. Noise generated by this closure option could have a temporary impact on the bald eagle.

Wetlands

Section F.9.13.1 describes the wetlands that exist within the vicinity of L-Area. Because closure operations might induce soil erosion, remedial action should include erosion and surface runoff control to protect the wetlands.

F.9.13.3 Assessment of Removal of Waste to the Extent Practicable and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Ecology

Aquatic impacts of the waste removal and closure plan for the waste sites of L-Area could include direct and indirect contamination of surface-water bodies. However, the proposed closure plan for this option also involves removal of wastes and contaminated soils from the various waste sites of L-Area. This closure action would further reduce the potential for wastes entering groundwater, which should ultimately reduce potential impacts on the aquatic biota.

Terrestrial Ecology

The potential terrestrial impacts of the waste removal and closure plan for the waste sites of L-Area would include toxicity to vegetation via contaminated soils and temporary disturbance of the wildlife due to noise and habitat loss during closure operations. The removal of wastes and contaminated soils should prevent the uptake of wastes by vegetation.

Threatened or Endangered Species

Potential impacts on endangered species would be similar to those addressed in Section F.9.13.1. Noise generated by this closure option may have a temporary impact on the bald eagle.

Wetlands

Section F.9.13.1 describes the wetlands that exist within the vicinity of L-Area. Because closure operations could induce soil erosion, remedial actions should include erosion and surface runoff control to protect the wetlands.

F.10 ASSESSMENT OF ACTIONS AT P-AREA WASTE SITES

This geographic grouping is formed by waste sites associated with P-Reactor, which is approximately 4 kilometers northeast of L-Reactor. Figure F-14 shows the boundaries of this geographic grouping and the locations of the waste sites within it.

Sections F.10.1 through F.10.3 contain or reference the section that contains a discussion of sites 10-1 through 10-3. Section F.10.4 discusses biological impacts that are generically applicable to the waste sites in this geographic grouping.

F.10.1 P-AREA BURNING/RUBBLE PIT, BUILDING 131-P

This burning/rubble pit is discussed in conjunction with the other burning/rubble pits in Section F.1.6. The ecological effects of this site that relate specifically to the P-Area geographic grouping are discussed in Section F.10.4.

F.10.2 P-AREA ACID/CAUSTIC BASIN, BUILDING 904-78G

This acid/caustic basin is discussed in conjunction with the other acid/caustic basins in Section F.2.1. The ecological effects of this site that relate specifically to the P-Area geographic grouping are discussed in Section F.10.4.

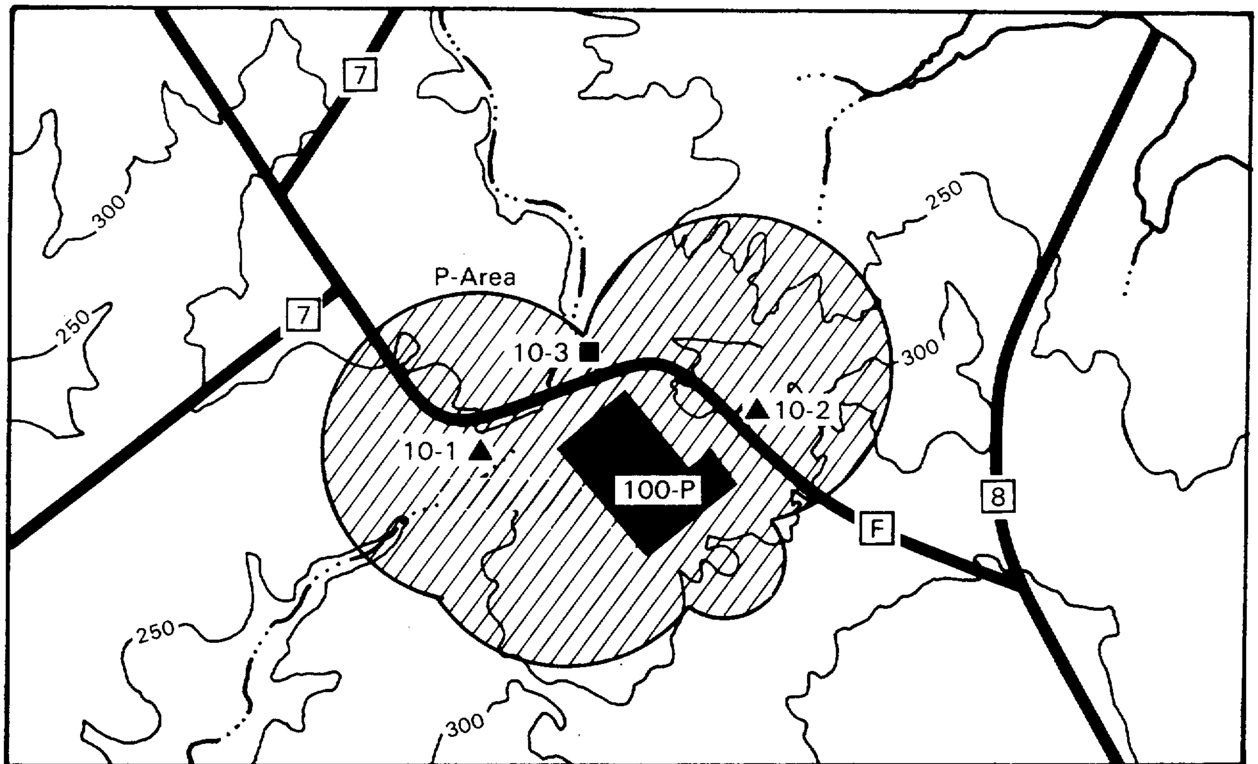
F.10.3 P-AREA BINGHAM PUMP OUTAGE PIT, BUILDING 643-4G

The options, releases, and potential impacts for this outage pit are discussed in Section F.3.4.

F.10.4 POTENTIAL IMPACTS TO BIOLOGICAL RESOURCES IN P-AREA

This section addresses those general impacts related to aquatic and terrestrial ecology, as well as endangered species and wetlands, for each closure and remedial action. Where a discussion of site-specific data is required for a given option, it is presented in the appropriate section above.

The P-Area Burning/Rubble Pit and the P-Area Bingham pump outage pit have been abandoned and are backfilled and covered with soil. The P-Area acid/caustic basin is inactive and is a wet-weather pond.



Note: Elevations are in feet above mean sea level
1.0 foot = 0.3048 meter

Scale (kilometers)
0 1 2

Number	Potential Waste Type	Site Name	Building Number
10-1	▲	P-Area Burning/Rubble Pit*	131-P
10-2	▲	P-Area Acid/Caustic Basin*	904-78G
10-3	■	P-Area Bingham Pump Outage Pit*	643-4G

*Indicates that waste type may be contained in the waste site
▲—Hazardous
■—Low-level radioactive

Figure F-14. P-Area Waste Site

F.10.4.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Action)

Aquatic Resources

Aquatic impacts could result from the contamination of groundwater and its subsequent outcrop into nearby streams. Data from groundwater monitoring wells for five waste sites within P-Area are presented in Table F-34. No data are available for the P-Area Bingham pump outage pit. The table lists those waste materials not modeled by PATHRAE analysis known to exceed EPA water quality criteria for freshwater aquatic life. Owing to the detection limits of groundwater monitoring procedures, accurate concentration levels of some contaminants [silver (except at the P-Area acid/caustic basin), beryllium, cadmium, mercury, hydrogen sulfide, endrin, methoxychlor, and toxaphene] cannot be determined. Because the detection limits are above the EPA criteria, potential aquatic impacts from these contaminants are unknown.

A simple dilution equation was used to estimate concentrations in nearby streams of wastes not modeled by PATHRAE analysis. Data were not available to determine dilution concentrations in the unnamed tributaries to Par Pond for the P-Area acid/caustic basin and Bingham pump outage pit waste sites. Results of this analysis for the P-Area burning/rubble pit indicate that in-stream pH levels should not be significantly altered.

Terrestrial Resources

The P-Area burning/rubble pit is inactive and has been covered with soil to grade level. Natural brush and grass have begun to grow over the site. The P-Area Bingham pump outage pit is also inactive and in similar condition. Because no action is planned under this closure option, no impacts on terrestrial ecosystems have been identified at either site. Impacts could occur at all sites, however, if vegetation growing at the sites accumulated contaminants through root penetration of the waste. Continued maintenance (occasional mowing) might be necessary to prevent the growth of deep-rooted plant species and subsequent bioaccumulation in plants and animals.

Endangered Species

Previous endangered species and habitat surveys indicate little potential for endangered species in the vicinity of P-Area (Pekkala et al., 1986b). However, American alligators and bald eagles have been sighted at Par Pond approximately 2.5 kilometers from the P-Area sites (Du Pont, 1985; Mayer et al., 1986). Because no activities are planned, no adverse impacts on endangered species are expected from this closure option.

Wetlands

An area of wetland vegetation was identified on the USGS Girard NE, South Carolina quadrangle, approximately 400 meters from the P-Area burning/rubble pit (USGS, 1964). Total wetland acreages and the specific wetland vegetation types present are unknown for this site and for the P-Area acid/caustic basin. Data for the other sites are presented in Table F-34. Because no disturbance is planned under this closure option, no adverse effects to wetlands are expected.

Table F-34. Environmental Data for P-Area Waste Sites

Waste site	Areal extent of site (m)	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria			Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[c]
					Contaminant	Reported level[a]	Criterion[b]		
P-Area burning/ rubble pit 131-P[d]	64 x 18.3	400[e]	No data available	American alligator population established at Par Pond and Steel Creek 2.5 km away,[f] and Bald eagles sighted at Par Pond 2.5 km away[g]	pH	4.0	6.5-9.0	Steel Creek; 400	8.2×10^{-4}
P-Area acid/caustic basin 904-78G[h]	15.2 x 15.2	600[e]	No data available	Same as for site 131-P	pH Silver	4.4 17 mg/L	6.5-9.0 0.12 mg/L	Tributary to Par Pond; no data available	No data available
P-Area Bingham pump outage pit 643-4G[i]	144 x 8	600	0/8.5	Same as for site 131-P	No data available	No data available		Tributary to Par Pond; 760	No data available

[a]Average value for most recent year for groundwater well containing highest concentration.
[b]Based on ICRP 30, 1978; EPA, 1985b,c; National Technical Advisory Committee, 1968.
[c]Equivalent to groundwater flux divided by flow rate of receiving stream.
[d]Data from Huber, Johnson, and Marine, 1986, except as otherwise indicated.
[e]Estimated from USGS, 1964.
[f]Du Pont, 1985.
[g]Data from Mayer, Hoppe, and Kennamer, 1986.
[h]Data from Ward, Johnson, and Marine, 1986, except as otherwise indicated.
[i]Data from Pekkala, Holmes, and Marine, 1986a, except as otherwise indicated.

F.10.4.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Resources

The impacts to aquatic ecosystems resulting from this closure option would be the same as those of the no-action closure option for the sites already backfilled. If groundwater remedial cleanup were undertaken, it should reduce groundwater and surface-water contamination and potential adverse aquatic impacts. Sedimentation and erosion control measures would be required to prevent aquatic impacts of remedial actions proposed under this closure option.

Terrestrial Resources

Impacts to terrestrial ecosystems could result from site disturbance and noise associated with any corrective action measures undertaken. These impacts would be minimized by proper engineering design and careful operation. For example, engineered sediment control measures would be used to prevent erosion impacts.

Endangered Species

No impacts to endangered species are expected from this closure option. Endangered species are sufficiently distant from the sites to prevent their being disturbed by human activities.

Wetlands

Because of the distances from the sites, wetland habitats should not be affected by backfill and the remedial activities planned under this closure option. Sedimentation and erosion control procedures would prevent potential disturbance to wetlands.

F.10.4.3 Assessment of Removal of Waste to the Extent Practicable and Implementation of Cost-Effective Remedial and Closure Actions as Required

Aquatic Resources

No impacts to aquatic ecosystems are expected from this closure option. Waste removal would reduce additional contaminant releases to the groundwater. Erosion control and sedimentation measures would be required during waste excavation and during installation and operation of the remedial actions planned under this option.

Terrestrial Resources

Because of the similarity of this closure option and the no waste removal and closure option, the discussion presented in Section F.10.4.2 is applicable here. Waste removal would reduce any impacts of biological accumulation.

Endangered Species

No impacts to endangered species are expected from this closure option. Endangered species are sufficiently distant from the sites to prevent their being disturbed by human activities.

Wetlands

Because of the distances from the sites, wetland habitats should not be affected by backfill and remedial activities planned under this closure option. Sedimentation and erosion control procedures would prevent potential disturbance to wetlands.

F.11 ASSESSMENT OF ACTIONS AT MISCELLANEOUS AREA WASTE SITES

This section assesses two waste sites, the SRL oil test site and the gunsite 720 rubble pit, which are not within the boundaries of the 10 geographic groupings described in the previous sections. The SRL oil test site is south of Road 3, a short distance from CS-Area (see Figure F-8). The gunsite 720 rubble pit is west of Road A, about 10 kilometers south of A-Area and 5 kilometers north of D-Area.

F.11.1 SRL OIL TEST SITE, BUILDING 080-16G*

F.11.1.1 Assessment of No Action (No Removal of Waste and No Remedial or Closure Actions)

Description of Action

The site would be left as is, but four groundwater monitoring wells would be installed (one upgradient and three downgradient). The wells would be monitored quarterly for 1 year, and then yearly for an additional 29 years if no contamination were detected in the initial monitoring period. Well identification and site identification signs would be installed and maintained. Otherwise, the site would be allowed to return to its natural state.

Comparison of Expected Environmental Releases with Applicable Standards

Estimates of the environmental impact and health risks associated with SRL oil test site were not determined because chemical constituents at the site did not exceed the selection criteria.

Potential Impacts (Other Than Releases)

Aquatic Resources

Although groundwater monitoring has not been conducted (Table F-35), impacts of the no-action alternative on the aquatic ecosystem are not likely to occur as a result of groundwater outcropping to a stream, since vertical migration

*The reference source for the information in this section is Johnson, Pickett, and Bledsoe, 1986.

of oil through the soil was found to be minimal. Since vegetative growth on the site is sparse, it is possible that small quantities of oil could reach a nearby branch of Four Mile Creek due to erosion; however, it is unlikely that any significant impacts to the stream would occur. PATHRAE modeling was not conducted for the Savannah River oil test site.

Terrestrial Resources

Currently the site is sparsely covered with grasses and weeds. It is likely that vegetative cover would remain sparse under the no-action alternative. Consequently, the potential for accumulation by these plants of waste constituents is minimal. Routine mowing might be required to prevent the establishment of deep-rooted vegetation.

Endangered Species

As noted in Table F-35, no endangered species have been sighted in the vicinity of the oil test site, and habitat within 200 meters are not suitable for such species. Impacts to endangered species are unlikely, considering that the site would not be disturbed under this option.

Wetlands

Depending upon local topography, erosion could carry waste materials to wetlands during storms; however, considering the distances involved (see Table F-35), impacts would not likely be significant.

F.11.1.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

In this option, the contaminated soils would not be removed; however, a low-permeability clay cap would be installed. It is assumed that the area of the cap would cover only the SRL oil test plots, about 6400 square meters. Four groundwater monitoring wells would be installed (one upgradient and three downgradient). The wells would be sampled and analyzed quarterly for 1 year, and then yearly for an additional 29 years if no contamination were found in the initial monitoring period. Site and well identification signs would be maintained. Vegetation on top of the cap would be cut periodically to keep out any deep-rooted species.

Comparison of Expected Environmental Releases with Applicable Standards

As stated before, chemical constituents were not identified for this waste site, and expected environmental releases could not be estimated. However, the installation of a low-permeability cap would reduce the possibility of environmental releases.

Table F-35. Environmental Data for Miscellaneous Area Waste Sites

Waste site	Areal extent extent of site (m^2)	Distance to nearest wetland (m)	Area of wetlands within 200 m/1000 m (acres)	Endangered species data	Non-PATHRAE-modeled groundwater contaminants exceeding freshwater biota criteria: Contaminant	Reported level	Criterion	Area of ground-water outcrop; distance (m) to nearest stream	Dilution factor[a]
SRP oil test site 080-16G[b]	1040 (total disturbed area)	About 125	7.7/12.6	No endangered species identified in vicinity,[b] and no habitat present within 200 m[c]	Groundwater monitoring has not been conducted			Data not available	Data not available
Gunsite 720 rubble pit N80K, E27, 45K[d]	6.6	About 200	2.7/105.5	No habitat for endangered species within 200 m and no such species seen in vicinity except as noted below American alligators seen in Upper Three Runs Creek about 600 m from site[b] Bald eagles sighted about 3 km west of site[c]	Data not available on contaminants present at site			Data not available	Data not available

[a]Equivalent to groundwater flux divided by flow of receiving stream.
[b]Data from Pickett and Bledsoe, 1968; Du Pont, 1985.
[c]Data from Mayer, Hoppe, and Kennamer, 1986.
[d]Data from Huber and Bledsoe, 1986b, except as otherwise indicated.

Potential Impacts (Other Than Releases)

Aquatic Resources

Impacts on aquatic ecosystems should not occur, since hydrocarbon vertical migration is minimal and a clay cap and revegetation would prevent transport of wastes to nearby surface waters by erosion. During placement of the clay cap, appropriate erosion control measures should be used to minimize possible sedimentation of surface waters.

Terrestrial Resources

Impacts on terrestrial ecosystems would be beneficial, since the placement of a clay cap and mowing of vegetation would prevent the uptake of wastes by plants. This option could result in certain short-term adverse impacts such as displacement of wildlife due to noise and other human disturbances.

Endangered Species

Endangered species should not be affected by no waste removal and closure (see Section F.11.1.1).

Wetlands

Wetlands should not be affected. The wastes would be buried under a clay cap, the revegetation of which would reduce the transport of wastes due to erosion. During placement of the cap, appropriate erosion control measures would have to be implemented to prevent sedimentation.

F.11.1.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

The contaminated soil would be excavated and removed to the sanitary landfill. The soil volume to be excavated would be approximately 140 cubic meters (3.7 meters x 10.7 meters x 0.30 meter deep x 12 plots). The depth of soil excavation was chosen to be 0.3 meter because no hydrocarbon contamination was detected below that depth.

The site would be backfilled, graded, seeded to prevent erosion, and then allowed to return to its natural state. A low-permeability clay cap would not be installed. No signs or upkeep would be required. No groundwater monitoring wells would be installed.

Comparison of Expected Environmental Releases with Applicable Standards

As for the other alternatives, no chemical constituents of concern were identified for this waste site and no environmental releases were estimated. However, removal of the wastes and contaminated soils could reduce the possibility of future environmental releases.

Potential Impacts (Other Than Releases)

Aquatic Resources

Since wastes would be removed, long-term impacts on aquatic ecosystems would not occur. Temporary construction-related impacts and mitigation measures would be similar to those discussed in Section F.11.1.2.

Terrestrial Resources

Since wastes would be removed and a clay cap would not be installed, vegetation could be allowed to return to its natural state. This would permit a wider variety of wildlife to inhabit the site than under the no waste removal and closure option and prevent the possible contamination that would occur under the no-action option. Temporary disturbances from waste removal, backfilling, and grading activities would be similar to those discussed in Section F.11.1.2.

Endangered Species and Wetlands

Endangered species and wetlands should not be affected by this option.

F.11.2 GUNSITE 720 RUBBLE PIT, BUILDING N80K, E27.35K*

F.11.2.1 Assessment of No Action (No Removal of Waste, and No Remedial or Closure Actions)

Description of Action

Under this option the drums would remain in their present location. Four groundwater monitoring wells would be installed and would be monitored quarterly for 1 year. Groundwater monitoring would then continue annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

Estimates of the environmental releases associated with the gunsite 720 rubble pit were not determined because chemical constituents at the site did not exceed the selection criteria.

Potential Impacts (Other Than Releases)

Aquatic Resources

Aquatic impacts, if they were to occur, would involve Upper Three Runs Creek, since this stream receives both groundwater and surface-water flow from the site. There is no indication of aquatic impacts, based on data at the site.

*The reference source of the information in this section is Huber and Bledsoe, 1986b.

Terrestrial Resources

There is no indication of any terrestrial impacts, based on data at the site.

Endangered Species

As noted in Table F-35, no endangered species or their habitat have been identified within 200 meters of the waste site. While American alligators have been reported from Upper Three Runs Creek, approximately 600 meters south of the site, the habitat in which they are found is considered marginal. Bald eagles have been sighted at the lower end of Upper Three Mile Creek, about 3 kilometers from the site. Because of the distances involved, it is unlikely that alligators or eagles would be adversely affected by the no-action alternative.

Wetlands

Wetland communities found within 200 and 1000 meters of the gunsite 720 rubble pit are given in Table F-35. The only wetland type present within this radius is bottomland hardwood forest. No adverse impacts are expected, based on available information.

F.11.2.2 Assessment of No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this closure option any liquids in the drums would be stabilized with cement, bentonite, or another appropriate substance and the drums buried. The excavated area would then be backfilled to grade and seeded. Four groundwater monitoring wells would be installed and would be monitored quarterly for 1 year. Groundwater monitoring would then be continued annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

As stated, chemical constituents have not been identified for this waste site, and environmental releases have not been established. Additional studies are needed to determine whether stabilization of the drummed waste would eliminate possible future environmental releases.

Potential Impacts (Other Than Releases)

Aquatic Resources

As noted in Section F.11.2.1, no aquatic impacts are expected, based on data at the site. Stabilization of the contents of the drums and their subsequent burial would eliminate the surface transport of wastes to Upper Three Runs Creek and lessen groundwater transport.

Terrestrial Resources

This option should eliminate the potential for direct contact of wildlife with the wastes at the site. During burial, refilling, and grading of the

stabilized waste drums, noise and construction activities could cause temporary displacement of wildlife.

Endangered Species and Wetlands

The discussion presented in Section F.11.2.1 is generally applicable to this section as well.

F.11.2.3 Assessment of Removal of Waste to the Extent Practicable, and Implementation of Cost-Effective Remedial and Closure Actions as Required

Description of Action

Under this closure option, any drums found during excavation would be removed and transported to the SRP mixed/hazardous waste storage/disposal facility. Approximately 35 cubic meters of soil located around the buried drums would also be excavated and taken to the same facility. The site would then be backfilled to grade and seeded. Four groundwater monitoring wells would be installed and would be monitored quarterly for the first year. Groundwater monitoring would then be continued annually for 29 years.

Comparison of Expected Environmental Releases with Applicable Standards

As in the other two options, no chemical constituents of concern were identified for this waste site, and therefore no environmental releases were estimated. However, removal of the waste and backfilling the basin could reduce the possibility of environmental releases.

Potential Impacts (Other Than Releases)

Aquatic Resources

This option would offer the best protection for Upper Three Runs Creek.

Terrestrial Resources

Removal of waste drums and soil followed by regrading and revegetation of the site would reduce the potential for exposure of terrestrial species. Noise and construction activities would cause temporary disturbance to wildlife.

Endangered Species

The discussion presented in Section F.11.2.1 is applicable to this section as well.

Wetlands

Removal of drums and contaminated soil would prevent any possible contamination to wetlands. Operations associated with cleanup of the site would be conducted in such a way as to minimize erosion and sedimentation.

REFERENCES

Colven, W. P., C. F. Muska, J. B. Pickett, and H. W. Bledsoe, 1986. Environmental Information Document, M-Area Settling Basin and Vicinity, DPST-85-703, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1984. Wastewater Construction Permit Application, Project S-2583, Groundwater Remedial Action. Savannah River Operations Office, Aiken, South Carolina

DOI (see U.S. Department of the Interior).

Dukes, E. K., 1984. The Savannah River Plant Environment, DP-1642, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Dunway, J. W., L. E. Kingley, W. F. Johnson, and H. W. Bledsoe, 1986. Environmental Information Document, New TNX Seepage Basin, DPST-85-698, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1985. Comprehensive Cooling Water Study - Annual Report, DP-1697, Volumes 1-11, J. B. Gladden, M. W. Lower, H. E. Mackey, W. L. Specht, and E. W. Wilde (editors), Savannah River Plant, Aiken, South Carolina.

EPA (U.S. Environmental Protection Agency), 1981a. Radioactivity in Drinking Water, Criteria and Standards Division, EPA 570/9-81-002, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1981b. Advisory Opinion for Xylenes, Office of Drinking Water, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985a. "Hazardous Waste Management System; Identification and Listing of Hazardous Waste" (40 CFR 261), Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985b. "National Primary Drinking Waste Regulations" (40 CFR 141), Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985c. "National Secondary Drinking Water Regulations" (40 CFR 143), Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1986. Quality Criteria for Water 1986, EPA 440/5-86-001, Washington, D.C.

Fowler, B. F., R. V. Simmons, H. W. Bledsoe, and B. B. Looney, 1986. Environmental Information Document, Savannah River Laboratory Seepage Basins, DPST-85-688, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Holmes, W. G., J. W. Fenimore, D. E. Gordon, and J. T. Prendergast, 1983. Technical Summary, Groundwater Quality Protection at the Savannah River Plant, Volume II, DPST-83-829, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Huber, L. A., and H. W. Bledsoe, 1986a. Environmental Information Document, Hydrofluoric Acid Spill Area, DPST-85-696, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Huber, L. A., and H. W. Bledsoe, 1986b. Environmental Information Document, Gun Site 720 Rubble Pit, DPST-85-713, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Huber, L. A., W. F. Johnson, and H. W. Bledsoe, 1986. Environmental Information Document, Waste Oil Basins, DPST-85-701, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Huber, L. A., W. F. Johnson, and I. W. Marine, 1986. Environmental Information Document, Burning/Rubble Pits, DPST-85-690, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Huber, L. A., R. V. Simmons, I. W. Marine, and W. G. Holmes, 1986. Environmental Information Document, Ford Building Waste Site, DPST-85-708, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

ICRP (International Commission on Radiological Protection), 1978. "Limits for Intakes of Radionuclides by Workers," Annals of the ICRP, Publication 30, Vol. 3, New York, New York.

ICRP (International Commission on Radiological Protection), 1979. "Limits for Intakes of Radionuclides by Workers," Annals of the ICRP, ICRP Publication 30, Vol. 2 (3/4), Oxford, England.

Jaegge, W. J., N. L. Kolb, B. B. Looney, I. W. Marine, O. A. Towler, and J. R. Cook, 1986. Environmental Information Document, Radioactive Waste Burial Grounds, DPST-85-694, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Killian, T. H., N. L. Kolb, P. Corbo, and I. W. Marine, 1986a. Environmental Information Document, F-Area Seepage Basins, DPST-85-704, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Killian, T. H., N. L. Kolb, P. Corbo, and I. W. Marine, 1986b. Environmental Information Document, H-Area Seepage Basins, DPST-85-706, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

King, C. M., W. L. Marter, B. B. Looney, J. B. Pickett, 1986. Environmental Information Document, Methodology and Parameters for Assessing Human Health Effects for Waste Sites at the Savannah River Plant, DPST-86-298, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Kingley, L. E., R. V. Simmons, H. W. Bledsoe, J. A. Smith, and W. F. Johnson, 1986a. Environmental Information Document, Old TNX Seepage Basin, DPST-85-710, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Kingley, L. E., R. V. Simmons, H. W. Bledsoe, J. A. Smith, and W. F. Johnson, 1986b. Environmental Information Document, TNX Burying Ground, DPST-85-711, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Looney, B. B., J. B. Pickett, C. M. King, W. G. Holmes, J. A. Smith, and W. F. Johnson, 1986. Environmental Information Document, Selection of Chemical Constituents and Estimation of Inventories for Environmental Analysis of Savannah River Plant Waste Sites, DPST-86-291, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Mayer, J. J., R. T. Hoppe, and R. A. Kennamer, 1986. Bald and Golden Eagles of the SRP, SREL-21, Savannah River Ecology Laboratory, Division of Stress and Wildlife Ecology, Aiken, South Carolina.

Michael, L. M., W. F. Johnson, and H. W. Bledsoe, 1986. Environmental Information Document, Metallurgical Laboratory Basin, DPST-85-689, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Muska, C. F., J. B. Pickett, and H. W. Bledsoe, 1986. Environmental Information Document, Road A Chemical Basin, DPST-85-699, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Muska, C. F., J. B. Pickett, and I. W. Marine, 1986. Environmental Information Document, Metals Burning Pit Miscellaneous Chemical Basin, DPST-85-691, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

National Technical Advisory Committee, 1968, Water Quality Criteria, Federal Water Pollution Control Administration, U.S. Department of the Interior, Washington, D.C.

Odum, J. V., B. S. Christie, C. B. Fliermans, and I. W. Marine, 1986. Environmental Information Document, Old F-Area Seepage Basin, DPST-85-692, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Pekkala, R. O., W. G. Holmes, and I. W. Marine, 1986a. Environmental Information Document, Bingham Pump Outage Pits, DPST-85-695, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Pekkala, R. O., W. G. Holmes, and I. W. Marine, 1986b. Environmental Information Document, Reactor Seepage Basins, DPST-85-707, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Pekkala, R. O., V. Price, and H. W. Bledsoe, 1986. Environmental Information Document, L-Area Oil and Chemical Basin, DPST-85-700, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Pekkala, R. O., R. V. Simmons, I. W. Marine, and W. G. Holmes, 1986. Environmental Information Document, Ford Building Seepage Basin, DPST-85-709, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Pickett, J. B., and H. W. Bledsoe, 1986. Environmental Information Document, Savannah River Laboratory Oil Test Site, DPST-85-697, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Scott, S. C., T. H. Killian, N. L. Kolb, P. Corbo, and H. W. Bledsoe, 1986. Environmental Information Document, Silverton Road Waste Site, DPST-85-702, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Scott, S. C., T. H. Killian, N. L. Kolb, P. Corbo, and I. W. Marine, 1986. Environmental Information Document, Separations Area Retention Basins, DPST-85-693, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Scott, S. C., N. L. Kolb, V. Price, and H. W. Bledsoe, 1986. Environmental Information Document, CMP Pits, DPST-85-712, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Simmons, R. V., H. W. Bledsoe, and J. L. Bransord, 1985. Technical Data Summary: Chemical and Radionuclide Characterization Study of the Old TNX Seepage Basin, DPST-85-115, E. I. du Pont de Nemours and Co., Savannah River Laboratory, Aiken, South Carolina.

U.S. Department of the Interior, 1968. Water Quality Criteria, report of the National Technical Advisory Committee to the Secretary of the Interior. Federal Water Pollution Control Administration, Washington, D.C.

USGS (U.S. Geological Survey), 1963. Ellenton SE, 7.5-minute Quadrangle Map, USGS, Washington, D.C.

USGS (U.S. Geological Survey), 1964. Girard NE, South Carolina Quadrangle Map, 1964, Rev. 1981, Scale 1:24000, U.S. Department of the Interior, Reston, Virginia.

Ward, J. W., W. F. Johnson, and I. W. Marine, 1986. Environmental Information Document, Acid/Caustic Basins, DPST-85-705, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Zeigler, C. C., I. B. Lawrimore, and E. M. Heath, 1986. Savannah River Plant Environmental Report for 1985, Volume 2, DPSPU-86-30-1, E. I. du Pont de Nemours and Co., Savannah River Plant, Aiken, South Carolina.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

APPENDIX G

ASSESSMENT OF ALTERNATIVE DISPOSAL FACILITIES

This environmental impact statement (EIS) furnishes an environmental basis for selecting a strategy to modify waste management activities at the Savannah River Plant (SRP). Appendix G provides the range of potential environmental impacts of the four strategies described in Chapter 2 (i.e., No Action, Dedication, Elimination, and Combination). Table G-1 lists the technologies the U.S. Department of Energy (DOE) could employ under each strategy. The implementation of each waste management strategy has been defined in terms of these technologies and facilities, which assume design and operation in compliance with all applicable regulations and requirements (see Appendix E).

This appendix discusses the range of the technologies, including the capacities and waste characteristics employed in a strategy, and the possible range of environmental impacts of each. The environmental evaluation is conservative; it analyzes impacts on groundwater, surface water, air, ecology, archaeological and historic resources human health, socioeconomics, land dedication, institutions (DOE), and noise. Some analyses (i.e., groundwater modeling) were conducted at specific sites because of the need for site-related parameters.

Appendix E describes site selection. Site B was selected for hazardous waste facilities and mixed waste RCRA facilities; Site L for mixed waste cement/fly ash matrix disposal; and Site G for low-level radioactive waste facilities (see Figure E-3). Some analyses (e.g., archaeological and historic resources) occurred at the three or four highest ranked candidate sites. Other analyses (i.e., noise) were based on the nature of the potential impact on conditions at any candidate site. Table G-2 shows the basis of impact evaluations in each environmental category.

The accuracy of numerical modeling results (i.e., groundwater concentrations and radiological doses) and qualitative results are affected by assumptions, potential ranges of significant parameters, and site-specific details. These results lie within an average factor of 5 order-of-magnitude level of accuracy, and determine the relative performance of a strategy. They are used in this EIS for comparative evaluations and strategy selection.

G.1 NO-ACTION STRATEGY

G.1.1 SUMMARY AND OBJECTIVES

The No-Action strategy would continue the current management of hazardous, mixed, and low-level radioactive wastes with no new facilities. The existing interim storage buildings for hazardous and mixed waste would be used for storage until their capacity is reached in 1992. The existing low-level radioactive waste burial ground would be used for disposal of low-level waste until its capacity is reached in early 1989. Thereafter, containerized wastes would be stored indefinitely in other existing structures, on available concrete pads, or in other waste storage or disposal areas.

Table G-1. New Disposal/Storage Facility Technologies

Waste management strategy	Disposal/ storage objective	Disposal/storage technologies		
		Hazardous waste	Mixed waste	Low-level waste
No Action	No new facilities	Storage at existing facilities and at other available structures, pads, and areas	Storage at existing facilities and at other available structures, pads, and areas	Disposal at existing facilities and storage at other available structures, pads, and areas
Dedication	Disposal facilities	RCRA landfill or vaults[a]	RCRA landfill or shielded vaults[a], with or without CFM[e] vaults	ELLT[b], vaults[a], or AGO[c] for low-activity waste; and vaults or GCD[d] for intermediate activity waste
Elimination	Retrievable storage facilities	Storage buildings	Shielded storage buildings	Engineered storage buildings
Combination	Disposal/storage combination	Storage buildings and RCRA landfill or vaults[a]	Shielded storage buildings and RCRA landfill or shielded vaults[a], with or without CFM[e] vaults	Engineered storage buildings; and ELLT[b], vaults[a], or AGO[c] for low-activity wastes; and vaults[a] or GCD[d] for intermediate-activity waste

[a]Vaults may be aboveground or belowground.
[b]Engineered low-level trench disposal.
[c]Above grade operation disposal.
[d]Greater confinement disposal.
[e]Cement/flyash matrix.

Table G-2. Basis for New Waste Management Facility Impact Evaluations

Environmental Category	Basis of Impact Evaluation
Groundwater	Environmental impacts analyzed using computer model or presumption of facility compliance with regulations; assumptions include (1) Candidate Site B (RCRA facilities for hazardous or mixed waste), Site L (DOE facilities for delisted mixed waste), or Site G (DOE facilities for low-level radioactive waste); (2) Waste stream consists of operations and interim storage wastes; and (3) Some pretreatment.
Surface Water	Same as Groundwater.
Nonradiological Air	Impacts based on the presumption that wastes are containerized at the treatment or generating facility prior to delivery for disposal or storage.
Ecology	Impacts based on a conservative estimate of the land area required for technologies assuming maximum waste volumes, and various ecological features as determined at the candidate sites.
Radiological Releases	Same as Groundwater.
Archaeological and Historic	Impacts based on results of an archaeological and historic field survey of candidate sites.
Socioeconomics	Impacts assume a peak construction force for new waste management facilities not exceeding 200 persons.
Noise	Impacts based on attenuation features at all possible siting locations.
Site Dedication	Impacts based on an estimate of the land area required for disposal assuming the most land intensive technologies and maximum waste volumes.
Institutional	Impacts assessed relative to applicable regulations.

Under No Action, noncompatible hazardous and mixed wastes would be segregated and stored to simplify periodic inspection. Inspections would be performed regularly, damaged or deteriorated containers would be replaced, and any spillage or leakage would receive immediate attention. Low-level radioactive and mixed wastes having radioactivity greater than 300 millirem per hour

(i.e., intermediate-activity waste) would be placed in existing unused shielded structures such as the R-Reactor building.

The release of waste constituents and the associated health and environmental effects would be insignificant if no substantial leaks or spills occurred as a result of fire, explosion, container deterioration, or breach of containers by impact. Storage facilities of this type would not be designed and constructed to include the backup systems and safety equipment required of a regulated facility (e.g., liners and barriers, leachate collection, built-in fire protection, vapor detection, leakage recovery); thus, the risk of a serious accidental release of waste and the associated effects would be greater than any of the other strategies. A potential failure in performance of No Action could result in releases ranging from zero (no releases under optimum circumstances) to the release and dispersion of all waste stored (under severe accidental or natural disaster circumstances). Because there would be no barriers, backup systems, and safety equipment, the risk of any waste constituent release, including a catastrophic release, would be higher than with other strategies. Although this higher risk cannot be quantified, it would be unacceptable under applicable regulations.

Details not considered in the environmental evaluation of No Action include identification of specific unused structures, pads, or areas for storage; container design; specific handling and operational procedures; and specific characteristic of the waste generated. No Action would not achieve regulatory compliance, and poses higher environmental and health risks. The assessment of specific environmental categories assumes that the No-Action strategy would result in a high risk of sudden or long term accidental release of waste, adversely affecting the environment and potentially affecting human health.

G.1.2 GROUNDWATER AND SURFACE WATER EFFECTS

Waste management under No Action could involve a greater risk of accidental release of waste constituents to surface and subsurface waters than other strategies. Potential impacts to the environment cannot be predicted accurately but over a 20-year period are assumed to exceed those of currently documented SRP existing waste sites.

G.1.3 NONRADIOACTIVE ATMOSPHERIC RELEASES

The preparation of existing structures, pads, and other areas for the storage of wastes under No Action would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts and truck traffic, and suspended particulates and dust from ground-surface disturbances. All applicable emission standards would be met during this activity.

The EIS assumes that all wastes would be packaged in high-integrity containers and that, except for accidents, natural disasters, or neglect, there would be no releases. Because of the lack of backup containment systems, leak sensors, and protection systems (e.g., fire, freezing), and because of its vulnerability to natural forces and human error, the No-Action strategy would have an unquantified risk of release and atmospheric dispersion of the stored material ranging between zero and 100 percent, which could cause environmental and health effects both on- and offsite.

G.1.4 ECOLOGICAL EFFECTS

Under the No-Action strategy, releases could range between zero and 100 percent of the waste stored. The ecological impact would depend on the amount and type of material released, the proximity to sensitive areas, and on the effectiveness of cleanup actions. Wetlands and aquatic resources would be especially sensitive to uncontrolled releases. The exact nature and extent of impacts cannot be determined, but the risk of such damage is higher than with other strategies.

G.1.5 RADIOLOGICAL RELEASES

Structures, pads, and areas that could be used to store mixed and radioactive wastes after the existing facilities reached capacity would not be equipped with protective and backup systems to contain releases. Although storage operations would strive to prevent releases of radiological contaminants to the environment, the risk of such an occurrence would be much higher for No Action than for any other strategy. The on- and off-site effects of such releases cannot be accurately determined but could involve impact on human health and the environment.

G.1.6 ARCHAEOLOGICAL AND HISTORIC RESOURCES

No new construction would be required because existing facilities would be used. Additional pads for storage of wastes would be located at an existing facility where, because of past soil disturbances, there are no significant archaeological resources.

G.1.7 SOCIOECONOMICS

A small construction workforce would be needed to prepare existing structures and areas for the storage of wastes. No socioeconomic impacts on the local communities would occur because existing SRP workforce would be used.

G.1.8 DEDICATION OF SITE

The No-Action strategy would not involve permanent placement of wastes at existing facilities, but rather a temporary storage arrangement in which the ability to retrieve the waste was preserved. Assuming an uneventful period of storage, the long term dedication of these storage facilities would not be required. However, site dedication could be required as a result of previous waste management practices or a serious accidental release of wastes during storage.

G.1.9 INSTITUTIONAL IMPACTS

Because No Action would involve the use of existing structures and waste disposal facilities for an indefinite period, DOE would have to maintain full title and control of the land as long as the wastes were stored.

G.1.10 NOISE

The preparation of storage areas under No Action could require heavy equipment. Noise from this equipment would not be detectable at the SRP boundary

because of attenuation provided by distance, topography, and natural vegetation.

G.2 DEDICATION STRATEGY

G.2.1 SUMMARY AND OBJECTIVES

With the Dedication strategy for waste management, DOE would establish new disposal facilities to accommodate hazardous, low-level radioactive, and mixed wastes generated from ongoing SRP operations in interim storage, and from the closure of existing waste sites. Waste disposal sites would be dedicated for waste management in perpetuity. About 400 acres would be required. For the service life of the facilities plus an institutional control period following cessation of active service, DOE would monitor and maintain the sites to ensure long term environmental and public health protection.

Table G-1 lists the technologies included in the Dedication strategy; they are described in Appendix E.

Under the hazardous waste category, both RCRA landfill and vault technologies are considered to be equivalent in their groundwater protection capabilities, therefore, both were evaluated. The RCRA landfill and vault technologies under mixed waste are equivalent as well; however, when either of these is combined with cement/flyash matrix (CFM) vaults, they represent a potential worst-case environmental impact. Therefore, RCRA landfill or vault, with CFM vault, was selected to describe mixed waste impacts.

Under low-level waste, the vault and greater confinement disposal technologies for intermediate-activity waste are considered equivalent in groundwater protection capabilities and no distinction is made in the evaluation. Among the technologies for low-activity waste disposal, the engineered low-level trench (ELLT) technology was selected to evaluate the impacts.

The assessment of environmental impacts for the Dedication strategy presumes that facilities would be constructed and operated in accordance with applicable regulations and would achieve regulatory and environmental compliance.

Modeling has identified potential mitigation and associated costs. Model results show that exceedances of environmental or health standards such as structural failure of the facility will occur at a specified future time and that postclosure maintenance and monitoring will cease at the end of the 100-year institutional control period. In these instances, the EIS assumes that appropriate actions will be taken to avoid such a failure, including waste retrieval, remedial action, and/or indefinite postclosure care. Thus, this EIS limits the comparison of impacts to the conclusion of the 100-year institutional control period.

G.2.2 GROUNDWATER AND SURFACE WATER EFFECTS

The base floodplain of the SRP region is confined to riparian wetlands and low terraces along the Savannah River and its primary tributaries. Siting criteria for new disposal facilities avoid such flood-prone areas; thus, no impacts due to potential flooding of the facilities are expected.

G.2.2.1 Hazardous Waste

Facilities for hazardous waste management would be designed to meet or exceed RCRA minimum technology requirements (i.e., a goal of zero release) and prevent contact of waste constituents with groundwater. The facilities would include interior and exterior leachate collection systems to recover and retain any waste releases that could occur. Accordingly, releases of contaminants to the subsurface environment are not expected to occur and groundwater quality should not be significantly affected during the period of institutional control.

Modeling of hazardous and mixed waste streams combined predicts that, beyond the institutional control period, both RCRA landfill and vault technology will eventually fail to varying degrees given certain conditions and sufficient time. The RCRA landfill without a low-permeability cap and no predisposal treatment resulted in exceedances at the boundary well of the acceptable daily intake (ADI) of several hazardous substances soon after the end of the institutional control period. Exceedances of surface water criteria were determined in wetlands and Upper Three Runs Creek. No exceedances were identified for the Savannah River because of its dilution capacity.

Vault technology, a low-permeability cap, and predisposal treatment (i.e., incineration) all resulted in improvements which were somewhat additive. Modeling showed no exceedances of the ADI or surface water criteria for vault technology with a low-permeability cap and predisposal treatment. Table G-3 summarizes all exceedances of the ADI and surface water criteria identified by the modeling effort. For potential impacts which are projected to occur beyond the 100-year institutional control period, future planning would determine the most cost-effective, cost-beneficial technological option.

G.2.2.2 Mixed Waste

Mixed waste management with RCRA landfills or vaults would meet or exceed RCRA minimum technology requirements. Releases of contaminants to the subsurface environment are not expected to occur. Groundwater quality should not be significantly affected during the period of institutional control (see G.2.2.1).

Modeling indicates that no hazardous substances are released in concentrations which exceed applicable groundwater or surface water standards during a period up to 10,000 years following closure.

Of the radiological constituents only uranium-238 was shown to exceed the derived standard [i.e., ICRP Publication 30 (ICRP, 1979) methodology was used to determine the radionuclide concentration that individually yields an annual effective whole-body dose or organ dose of 4 millirem/yr, the dose limit required by EPA Primary Drinking Water Standards (40 CFR 141)]. Table G-4 shows that the estimated peak concentration at the boundary well was 8.3 times the standard concentration and was predicted to occur at 10,000 years. All remaining boundary well nuclides, as well as all surface water nuclides including uranium, did not exceed their respective derived standard concentrations.

Modeling was conservatively conducted with no solubility limit inputs for uranium. Uranium chemistry in the natural environment is very complex and is a function of many factors including soil pH, groundwater reduction-oxidation

Table G-3. Ratio of Modeled Peak Concentration to ADI[a]/Surface Water Criteria[b]

Substance	RCRA landfill No Cap	RCRA landfill With Cap	Vault No Cap	Vault With Cap
	BOUNDARY WELL (No Pretreatment)			
2,4-D	3.1 (100)[c]	2.2 (140)	< 1	< 1
Lead	140 (7700)	14 (74000)	77 (8100)	< 1
Methylethyl Ketone	550 (110)	52 (260)	3.3 (330)	3.3 (760)
Nitrate	4.6 (110)	3.6 (130)	< 1	< 1
Phenol	50 (110)	40 (130)	< 1	< 1
Toluene	8.8 (210)	< 1	< 1	< 1
TBP[d]	1200 (160)	130 (810)	8.2 (1000)	8.3 (9600)
Xylene	3300 (100)	1800 (170)	17 (330)	17 (1100)
	BOUNDARY WELL (Treated Waste)			
Lead	170 (7500)	19 (74000)	75 (8500)	< 1
Nitrate	1.1 (170)	1.1 (200)	< 1	< 1
	WETLAND (No Pretreatment)			
Benzene	2000	190	520	16
2,4-D	9400	8100	80	79
Lead	1.3	1.1	1.3	< 1
Lindane	37000	3600	800	300
Phenol	210	190	1.8	1.8
Toluene	590	54	35	4.6
TBP[d]	5.9	4.9	< 1	< 1
111-TCE[e]	5900	4900	49	49
	WETLAND (Treated Waste)			
Lead	1.3	1.1	1.2	< 1
	UPPER THREE RUNS CREEK (No Pretreatment)			
Benzene	2.0	< 1	< 1	< 1
2,4-D	9.4	8.1	< 1	< 1
Lindane	37	3.6	< 1	< 1
111-TCE[e]	5.9	4.9	< 1	< 1

(No Exceedances at the Savannah River With or Without Pretreatment)

[a]Acceptable Daily Intake.
[b]Source: Cook, Grant, and Towler, 1987.
[c]Numbers in parentheses represent the number of years after closure when peak will occur.
[d]Tributyl phosphate.
[e]1,1,1-Trichloroethane.

Table G-4. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Dedication Strategy, Mixed Waste[a]

Radionuclide	Derived standard[b]	Estimated concentration[c]: Boundary well – Estimate	Boundary well – Ratio	Wetlands – Estimate	Wetlands – Ratio	Upper Three Runs Creek – Estimate	Upper Three Runs Creek – Ratio	Savannah River – Estimate	Savannah River – Ratio
Tritium	8.7×10^{4}	1.1×10^{0} (114)	1.3×10^{-5}	2.2×10^{-2} (140)	2.5×10^{-7}	2.2×10^{-5} (140)	2.5×10^{-10}	4.1×10^{-7} (140)	4.7×10^{-12}
Strontium-90	4.2×10^{1}	2.5×10^{-4} (361)	6.0×10^{-6}	1.9×10^{-14} (914)	4.5×10^{-16}	1.9×10^{-17} (914)	4.5×10^{-19}	3.6×10^{-19} (914)	8.6×10^{-21}
Yttrium-90	5.5×10^{2}	2.5×10^{-4} (361)	4.5×10^{-7}	1.9×10^{-14} (914)	3.5×10^{-17}	1.9×10^{-17} (914)	3.5×10^{-20}	3.6×10^{-19} (914)	6.5×10^{-22}
Uranium-235	2.2×10^{1}	1.6×10^{-1} (10,000)	7.3×10^{-3}	7.7×10^{-3} (10,000)	3.5×10^{-4}	7.7×10^{-6} (10,000)	3.5×10^{-7}	1.4×10^{-7} (10,000)	6.4×10^{-9}
Uranium-238	2.4×10^{1}	2.0×10^{2} (10,000)	8.3×10^{0}	9.5×10^{0} (10,000)	4.0×10^{-1}	9.5×10^{-3} (10,000)	4.0×10^{-4}	1.8×10^{-4} (10,000)	7.5×10^{-6}
Ratio Total			8.3×10^{0}		4.0×10^{-1}		4.0×10^{-4}		7.5×10^{-6}

[a]Source: Cook and Grant, 1986.
[b]ICRP Publication 30 (ICRP, 1979) methodology was used to determine radionuclide concentrations that individually yield an annual effective whole-body or organ dose of 4 millirem. Four millirem dose limit required by 40 CFR 141.
[c]Figures in parentheses represent number of years after closure.

(redox) potential (Eh), cation exchange capacity, and the presence of chelating or complexing species. In a field situation, low uranium solubility limits compared to the release rate will act as a limit to the migration of uranium from the facility. Uranium, and other radionuclides, are not expected to exceed derived groundwater or surface water standards due to the presence of solubility limits.

G.2.2.3 Low-Level Radioactive Waste

Low-level radioactive waste management activities, which were selected to evaluate impacts to groundwater and surface water, included ELLTs for disposal of low-activity waste (less than 300 millirem per hour) and vaults or GCD for disposal of intermediate-activity waste. These facilities would be constructed in accordance with DOE Orders and would achieve releases which are as low as reasonably achievable (ALARA). Groundwater and surface water modeling predict the peak concentrations of radionuclides and the times at which they occur. Table G-5 compares the modeling results to the derived groundwater standard for each nuclide.

Table G-5 shows that peak concentrations of low-activity waste constituents occur at the boundary well as soon as 24 years following closure during the institutional control period and at 5400 years in the future. The ratio of each peak concentration to its respective standard is less than one, indicating that no exceedances are projected to occur. Peak concentrations occur at widely varying times, and the sum of the ratios is less than one, indicating that even if the peak concentrations occurred at the same time, the total annual radiological dose received by an individual using boundary well water or surface water for his sole drinking water supply would be less than 0.2 percent of the drinking water standard.

The peak concentrations of intermediate-activity waste occur as soon as 38 years and as long as 7500 years after closure. With the exception of tritium and uranium-234, all ratios of concentrations to standards are below less than 1. Modeling estimates that uranium-234 exceeds its derived standard, peaking at 7480 years. Since modeling contains no solubility limits for uranium, this value is considered high, and the uranium-234 concentration is not expected to exceed its derived groundwater standard (see Section G.2.2.2).

Tritium in surface waters is not expected to exceed its derived standard. Peak tritium concentration of approximately 70 times the derived standard occurs 38 years following closure at the boundary well. This exceedance is based on a conservative assumption that the facilities would contain no liners or leachate collection. The tritium peak occurs at 38 years, during the institutional control period. Therefore, an exceedance of the derived standard for tritium is not expected to occur because: (1) the vault technology or the optional GCD technology used for intermediate-activity waste disposal contain liners and leachate collection systems that would intercept and recover any tritium released from the waste, (2) the boundary well peak occurs within the 100-year institutional control period, an indication that the peak leachate concentration would be sooner providing for substantial decay of tritium by the end of institutional control, (3) if leachate continued to exceed standards at the conclusion of the 100-year institutional control period, an extended control period would be implemented by DOE until groundwater standards would be achieved without leachate collection, and (4) as a mitigation

Table G-5. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Dedication Strategy, Low-Level Waste[a]

Radionuclide	Derived standard[b]	Estimated concentration[c]: Boundary well — Estimate	Boundary well — Ratio	Wetlands — Estimate	Wetlands — Ratio	Upper Three Runs Creek — Estimate	Upper Three Runs Creek — Ratio	Savannah River — Estimate	Savannah River — Ratio
LOW-ACTIVITY WASTE									
Carbon-14	2.6×10^{3}	1.25×10^{-1} (30.1)	4.81×10^{-5}	1.62×10^{-2} (53.1)	6.23×10^{-6}	1.62×10^{-5} (53.1)	6.23×10^{-9}	3.03×10^{-7} (53.1)	1.17×10^{-10}
Tritium	8.7×10^{4}	4.20×10^{0} (24.4)	4.83×10^{-5}	1.92×10^{-1} (40.1)	2.21×10^{-6}	1.92×10^{-4} (40.1)	2.21×10^{-9}	3.58×10^{-6} (40.1)	4.11×10^{-11}
Iodine-129	2.0×10^{1}	3.36×10^{-3} (132)	1.68×10^{-4}	4.44×10^{-4} (179)	2.22×10^{-5}	4.44×10^{-7} (179)	2.22×10^{-8}	8.29×10^{-9} (179)	4.15×10^{-10}
Rubidium-87	1.1×10^{3}	2.35×10^{-7} (2730)	2.14×10^{-10}	3.24×10^{-8} (3350)	2.95×10^{-11}	3.24×10^{-11} (3350)	2.95×10^{-14}	6.06×10^{-13} (3350)	5.51×10^{-16}
Selenium-79	6.6×10^{2}	7.42×10^{-3} (1380)	1.12×10^{-5}	1.02×10^{-3} (1700)	1.55×10^{-6}	1.02×10^{-6} (1700)	1.55×10^{-9}	1.90×10^{-8} (1700)	2.88×10^{-11}
Technetium-99	4.2×10^{3}	4.13×10^{0} (24.4)	9.83×10^{-4}	5.62×10^{-1} (47.7)	1.34×10^{-4}	5.62×10^{-4} (47.7)	1.34×10^{-7}	1.05×10^{-5} (47.7)	2.50×10^{-9}
Neptunium-237	1.4×10^{-1}	1.15×10^{-4} (5430)	8.21×10^{-4}	1.59×10^{-5} (6640)	1.14×10^{-4}	1.59×10^{-8} (6640)	1.14×10^{-7}	2.97×10^{-10} (6640)	2.12×10^{-9}
Subtotal			2.08×10^{-3}		2.80×10^{-4}		2.80×10^{-7}		5.22×10^{-9}
INTERMEDIATE-ACTIVITY WASTE									
Carbon-14	2.6×10^{3}	3.63×10^{-1} (57.1)	1.40×10^{-4}	1.41×10^{-2} (91.8)	5.42×10^{-6}	1.41×10^{-5} (91.8)	5.42×10^{-9}	2.64×10^{-7} (91.8)	1.02×10^{-10}
Tritium	8.7×10^{4}	6.13×10^{6} (37.7)	7.05×10^{1}	6.58×10^{4} (55.4)	7.56×10^{-1}	6.58×10^{1} (55.4)	7.56×10^{-4}	1.23×10^{0} (55.4)	1.41×10^{-5}
Iodine-129	2.0×10^{1}	2.00×10^{-2} (171)	1.00×10^{-3}	7.82×10^{-4} (295)	3.91×10^{-5}	7.82×10^{-7} (295)	3.91×10^{-8}	1.46×10^{-8} (295)	7.30×10^{-10}

Footnotes on last page of table.

Table G-5. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Dedication Strategy, Low-Level Waste[a] (continued)

Radionuclide	Derived standard[b]	Estimated concentration[c]							
		Boundary well		Wetlands		Upper Three Runs Creek		Savannah River	
		Estimate	Ratio	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio
Rubidium-87	1.1×10^{3}	2.17×10^{-5} (3020)	1.97×10^{-8}	8.51×10^{-7} (3490)	7.74×10^{-10}	8.51×10^{-10} (3490)	7.74×10^{-13}	1.59×10^{-11} (3490)	1.45×10^{-14}
Selenium-79	6.6×10^{2}	3.40×10^{-1} (709)	5.15×10^{-4}	1.32×10^{-2} (1410)	2.00×10^{-5}	1.32×10^{-5} (1410)	2.00×10^{-8}	2.46×10^{-7} (1410)	3.73×10^{-10}
Technetium-99	4.2×10^{3}	1.20×10^{1} (646)	2.86×10^{-3}	4.69×10^{-1} (102)	1.12×10^{-4}	4.69×10^{-4} (102)	1.12×10^{-7}	8.77×10^{-6} (102)	2.09×10^{-9}
Strontium-90	4.2×10^{1}	1.16×10^{-7} (1060)	2.76×10^{-9}	(d)	-	(d)	-	(d)	-
Yttrium-90	5.5×10^{2}	1.16×10^{-7} (1060)	2.11×10^{-10}	(d)	-	(d)	-	(d)	-
Uranium-234	2.1×10^{1}	2.47×10^{1} (7480)	1.18×10^{0}	(d)	-	(d)	-	(d)	-
Uranium-235	2.2×10^{1}	2.80×10^{-1} (7480)	1.27×10^{-2}	(d)	-	(d)	-	(d)	-
Uranium-236	2.2×10^{1}	2.02×10^{0} (7480)	9.18×10^{-2}	(d)	-	(d)	-	(d)	-
Uranium-238	2.4×10^{1}	1.23×10^{0} (7480)	5.13×10^{-2}	(d)	-	(d)	-	(d)	-
Neptunium-237	1.4×10^{-1}	2.05×10^{-2} (3270)	1.46×10^{-1}	7.87×10^{-4} (4750)	5.62×10^{-3}	7.87×10^{-7} (4750)	5.62×10^{-6}	1.47×10^{-8} (4750)	1.05×10^{-7}
Subtotal			7.20×10^{1}		7.62×10^{-1}		7.62×10^{-4}		1.42×10^{-5}
Ratio Totals			7.20×10^{1}		7.62×10^{-1}		7.62×10^{-4}		1.42×10^{-5}

[a]Source: Cook, Grant, and Towler, 1986.
[b]ICRP Publication 30 (ICRP, 1979) methodology was used to determine radionuclide concentrations that individually yield an annual effective whole-body or organ dose of 4 millirem as required by 40 CFR 141.
[c]Figures in parentheses represent number of years after closure.
[d]No significant radionuclide concentration at this receptor location within 10,000 years after closure.

measure, tritium waste could be segregated from the intermediate-activity waste stream and stored for decay in place.

Low-level radioactive waste constituent concentrations are not expected to exceed derived standards at the boundary well, wetlands, Upper Three Runs Creek, or the Savannah River with any combination of the low-level waste technologies in Table G-1.

G.2.3 NONRADIOACTIVE ATMOSPHERIC RELEASES

The construction of waste disposal facilities would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts and truck traffic, and suspended particulates and dust from ground surface disturbances. All applicable emission standards would be met during construction.

Because hazardous wastes would be delivered in sealed containers, releases would be unlikely. Thus, no significant impact on air quality is projected.

G.2.4 ECOLOGICAL EFFECTS

The candidate sites range as close as 300 meters to primary SRP streams (i.e., Upper Three Runs Creek, Tinker Creek) and even closer to associated wetlands and ephemeral feeder streams. The operation and dedication of facilities is not expected to involve releases which would exceed groundwater quality standards or surface water standards/criteria; therefore, no adverse impacts on aquatic or terrestrial ecology are expected.

Construction of waste disposal facilities may involve clearing as much as 400 acres for the waste facilities and roads. This clearing would destroy existing or potential wildlife habitat and foreclose any other future benefits that may be provided by a natural landscape in the SRP region (e.g., timber production). The available habitat on the SRP amounts to 184,200 acres; thus, the maximum loss of about 0.2 percent (i.e., 400 acres) would have an insignificant effect on the ecology of the Plant and the region.

Five endangered species (bald eagle, red-cockaded woodpecker, wood stork, American alligator, and shortnose sturgeon) occur on or near the SRP site; however, none are present on or in the immediate vicinity of any candidate sites. Therefore, construction of the disposal facilities under the Dedication strategy would not cause adverse impacts to any endangered species.

In addition to the habitat destruction, traffic, facility lighting, and human presence in the area would disturb wildlife in otherwise unaffected areas surrounding the facility and associated roadways. Traffic would also increase the risk of vehicle-wildlife collisions; however, because of slow vehicle speed such occurrences would be rare and would not have a significant impact on wildlife populations.

Construction of the facilities could result in soil erosion and subsequent sedimentation of nearby streams, distant wetlands, or creeks. Adequate erosion and sedimentation control measures should eliminate impacts on wetlands and water bodies.

With the belowground disposal options, the uptake of wastes by vegetation could occur if the roots of plants penetrated the clay cap and/or other barriers between the surface and the waste forms. Therefore, shallow-rooted species will be used to stabilize soils during closure and will be mowed during the postclosure, institutional control period to prevent deeply rooted plants (e.g., shrubs and trees).

G.2.5 RADIOLOGICAL RELEASES

G.2.5.1 Hazardous Waste

Since by definition hazardous wastes do not contain radioactive constituents, no radiological releases are expected from hazardous waste disposal facilities.

G.2.5.2 Mixed Waste

Mixed waste management with RCRA landfills or vaults would meet or exceed RCRA minimum technology requirements. Radiological releases from the facilities, as well as releases of other waste constituents, are not expected to occur during the institutional control period (see Section G.2.2.1). RCRA landfills with CFM vaults or RCRA vaults with CFM vaults and potential waste constituent releases are described in Section G.2.2.2.

Computer modeling was used to estimate the peak individual radiological doses from boundary well water, Savannah River water, and food grown onsite. Unlike ADIs for hazardous waste constituents, radiological doses expressed in millirem per year are additive and can be evaluated individually or collectively against a dose standard.

Table G-6 shows the peak radiological doses estimated by the model and the estimated times of occurrence for the three pathways. Conservative assumptions in the model were that the facility would not include a low-permeability cap, and that there were no solubility controls for uranium. As expected, only uranium-238 at the boundary is shown to be responsible for the exceedance of the 4 millirem/year drinking water dose standard. Doses from all other nuclides at the boundary well and all nuclides including uranium-238 from other pathways are below the standard.

The model assumes that no solubility control for uranium is impossible in the environment of SRP and conservative (see Section G.2.2.2). Radiological dose from uranium-234 and all nuclides collectively at the hypothetical boundary well and through other pathways are expected to be significantly below the 4-millirem-per-year standard.

G.2.5.3 Low-Level Radioactive Waste

Computer modeling was used to predict peak individual radiological doses from ELLT disposal of low-activity waste and vault or GCD disposal for intermediate-activity waste. The two pathways analyzed were the boundary well and the Savannah River. Doses were calculated on the basis of an individual's diet of plant, meat, and dairy foodstuffs grown using well or river water plus the direct annual ingestion of 370 liters of the same water.

Table G-6. Peak Radiological Dose and Times of Occurrence for Dedication Strategy, Mixed Waste[a]

Radionuclide	Boundary well Dose	Boundary well Time	Savannah River Dose	Savannah River Time	Food Grown on Site Dose	Food Grown on Site Time
Tritium	6.1×10^{-5}	114	2.2×10^{-11}	140	(b)	-
Strontium-90	1.6×10^{-5}	361	3.3×10^{-20}	914	4.4×10^{-5}	100
Yttrium-90	(b)	-	2.5×10^{-21}	914	(b)	-
Uranium-235	1.9×10^{-2}	10,000	1.8×10^{-8}	10,000	(b)	-
Uranium-238	2.2×10^{1}	10,000	2.0×10^{-5}	10,000	2.6×10^{-4}	100
Cesium-137	(b)	-	(b)	-	2.8×10^{-5}	100
Total Dose	2.2×10^{1}		2.0×10^{-5}		3.3×10^{-4}	

[a]Source: Cook and Grant, 1986. Doses calculated using PATHRAE model incorporating a human diet of plant, meat, and dairy foodstuffs, and 370 liters of contaminated water ingested per year. Doses expressed in millirem per year; time in number of years after closure.
[b]Dose contributed from this radionuclide is insignificant.

Table G-7 shows the peak radiological doses estimated by the model and the estimated times of occurrence for the two pathways. Modeling has identified tritium from the intermediate-activity fraction as the dominant radionuclide relative to individual dose. However, when considering the inclusion of leachate collection and radiological decay during the period of institutional control plus the ability to extend institutional control as necessary or segregate and store tritium for decay in-place, the total radiological doses from either pathway are within the applicable 4 millirem/year standard.

Doses from uranium-234, as well as the other uranium isotopes, would be substantially less than shown because of solubility effects in the environment not included in the modeling effort (see G.2.2.2).

G.2.6 ARCHAEOLOGICAL AND HISTORIC RESOURCES

Brooks, Hanson, and Brooks (1986) describe an intensive archaeological survey of the SRP candidate sites in compliance with Federal regulations. Within the six highest-rated candidate sites for waste disposal facilities under the Dedication strategy, five archaeological sites were located in Site G and two in Site L. Candidate Site K was not evaluated. Because of their limited extent, content, disturbed surface context, or the presence of similar preserved sites nearby, none of these sites is considered eligible for listing in the National Register. No further archaeological testing within these areas is warranted. Should a site for construction, other than those which have been evaluated, be considered for implementation during future planning, a similar field evaluation will be conducted out to minimize potential impacts to archaeological resources.

G.2.7 SOCIOECONOMICS

The projected peak construction workforce is not expected to exceed 200 persons and would be from the existing SRP workforce. Workers are assigned to SRP projects based on availability. The construction workers required for this project reside in the SRP area and represent a maximum of only 2.6 percent of the Fiscal Year 1988 construction workforce projected by DOE. No impacts on the local communities and services because of inmigrating workers are expected.

G.2.8 DEDICATION OF SITE

The original land acquisition efforts for SRP were authorized by the Atomic Energy Act of 1946 (P.L. 77-585). This Act created the Atomic Energy Commission (AEC) and gave broad authority for land acquisition. These actions were not subject to discretionary Congressional review on such line items as specific parcel purchases.

The purchase of SRP properties was through fee-simple titles, which provide absolute ownership without limitations or conditions on their disposition. Land titles currently owned by DOE show no evidence of a remainder or reversion clause suggesting limited-ownership status (i.e., interest in an estate that passes on at a specified time or on the occurrence of a specific event). Moreover, a review of the AEC's official files and minutes yielded no evidence that a discussion of such actions took place during the land acquisition process at SRP.

Table G-7. Peak Radiological Dose and Times of Occurrence for Dedication Strategy, Low-Level Waste[a]

Radionuclide	Boundary well Dose	Boundary well Time	Savannah River Dose	Savannah River Time
	LOW-ACTIVITY WASTE			
Carbon-14	1.58×10^{-4}	30.1	2.06×10^{-8}	53.1
Tritium	2.24×10^{-4}	24.4	1.93×10^{-10}	40.1
Iodine-129	6.67×10^{-4}	132	1.89×10^{-9}	179
Rubidium-87	8.93×10^{-10}	2730	4.24×10^{-14}	3350
Selenium-79	4.37×10^{-5}	1380	2.97×10^{-10}	1700
Technetium-99	3.93×10^{-3}	24.4	1.14×10^{-8}	47.7
Neptunium-237	2.09×10^{-5}	5430	6.19×10^{-11}	6640
Subtotal	5.04×10^{-3}		3.44×10^{-8}	
	INTERMEDIATE-ACTIVITY WASTE			
Carbon-14	4.59×10^{-4}	57.1	1.79×10^{-8}	91.8
Tritium	3.28×10^{2}	37.7	6.62×10^{-5}	55.4
Iodine-129	3.97×10^{-3}	171	3.32×10^{-9}	295
Rubidium-87	8.24×10^{-8}	3020	1.11×10^{-12}	3490
Selenium-79	2.00×10^{-3}	709	3.84×10^{-9}	1410
Technetium-99	1.14×10^{-2}	64.6	9.52×10^{-9}	102
Strontium-90	7.43×10^{-9}	1060	b	–
Yttrium-90	5.72×10^{-10}	1060	b	–
Uranium-234	3.06×10^{0}	7480	b	–
Uranium-235	3.34×10^{-2}	7480	b	–
Uranium-236	2.41×10^{-1}	7480	b	–

Footnotes on last page of table.

Table G-7. Peak Radiological Dose and Times of Occurrence for Dedication Strategy, Low-Level Waste[a] (continued)

Radionuclide	Boundary well		Savannah River	
	Dose	Time	Dose	Time
Uranium-238	1.35×10^{-1}	7480	b	-
Neptunium-237	3.72×10^{-3}	3270	3.06×10^{-9}	4750
Subtotal	3.31×10^{2}		6.62×10^{-5}	
Total Dose (all wastes)	3.31×10^{2}		6.62×10^{-5}	

[a]Source: Cook, Grant, and Towler, 1986. Doses calculated using PATHRAE model scenarios incorporating a human diet of plant, meat, and dairy foodstuffs, and 370 liters of contaminated water ingested per year. Doses expressed in millirem per year; time in number of years after closure.
[b]No significant dose at this receptor location within 10,000 years after closure.

As a result of this ownership in perpetuity, DOE is responsible for ensuring long term dedication of the area to solid, hazardous, and nuclear waste disposal. Each disposal option identified in this EIS would require permanent dedication, defined as the retention of full title coupled with the implementation of security measures to prevent intentional or inadvertent human intrusion. Security measures include the enclosure of the actual site, the establishment of a land-use buffer zone around the waste facility within which only limited activities could occur (e.g., ecological research and forest management), the compliance with contingency plans and spill prevention and control measures, the erection of permanent markers to warn against future intrusion, and an extended period of institutional control as required.

New disposal facilities would require site dedication of up to an estimated 400 acres plus a buffer zone to ensure full compliance with the RCRA and South Carolina Hazardous Waste Management Regulations, and/or consistency with DOE Orders on environmental and public health protection.

G.2.9 INSTITUTIONAL IMPACTS

For DOE to ensure institutional control for the estimated 20-year service life of the waste disposal facilities and the monitoring period to follow, it must maintain full title to the land on which the disposal facilities are located. DOE must maintain organizational authority over the security and management of the site. Site dedication and security control require long term control by a consistently cognizant organization.

In addition to the 30 years specified by RCRA for hazardous waste facilities, DOE intends to provide a minimum additional 70 years of institutional control for 100 years. However, if necessary, these sites will be maintained in perpetuity to ensure long term environmental and public health protection.

Institutional control requirements were imposed on DOE pursuant to RCRA and DOE Orders (see Table G-8).

G.2.10 NOISE

Construction and operation of disposal facilities under the Dedication strategy would require heavy equipment. Noise from the equipment would not be detectable at the SRP boundary from any site, and most other locations not less than 1 kilometer from the Plant boundary because of attenuation provided by distance, topography, and natural vegetation.

G.3 ELIMINATION STRATEGY

G.3.1 SUMMARY AND OBJECTIVES

Waste management under the Elimination strategy would use retrievable storage facilities to manage the hazardous, mixed, and low-level radioactive wastes generated for 20 years. A major objective of this strategy is to delay permanent deposition of wastes in anticipation of future, advanced methods of treatment, recycling, or disposal. Land is used on a temporary basis for waste management rather than being dedicated in perpetuity. When wastes are retrieved, the land may be used for other purposes or restored to a natural condition.

The technology included in the Elimination strategy is retrievable storage buildings as listed in Table G-1 and described in Appendix E.

The assessment of environmental impacts for the Elimination strategy presumes that retrievable storage facilities would be permitted, constructed, and operated for 20 years in accordance with applicable regulations including periodic inspections and maintenance. Retrievable storage would achieve the goal of zero releases at hazardous and mixed waste facilities and ALARA releases, assumed to be zero, at low-level waste facilities. By the end of the operational period, it is presumed that advanced technologies for treatment, recycling, or disposal would be available so that the stored waste could be retrieved from the facilities.

The evaluation of the Elimination strategy is more limited than the Dedication strategy because it involves only the 20-year operational period (i.e., no post-operational impacts are considered) and it focuses only on the storage facilities (i.e., no consideration of impacts associated with construction or operation of the facilities during the 20-year operational period).

G.3.2 GROUNDWATER AND SURFACE WATER EFFECTS

The retrievable storage facilities of the Elimination strategy would achieve zero releases of waste constituents. Therefore, groundwater and surface water would not be contaminated with waste constituents.

Table G-8. Institutional Control Requirements

Requirement	Citation	Implementing agency	Summary
Financial requirements	R.61-79. 264, Subpart H[a]	South Carolina Department of Health and Environmental Control	Requires financial assurance of fiscal viability in the form of a trust fund, surety bond, or closure letter of credit. Although the Federal Government is exempt from this requirement, it recognizes the necessity for long term viability to ensure adequate closure and postclosure care.
Closure and postclosure performance standards	R.61-79. 264, Subpart G[a]	South Carolina Department of Health and Environmental Control	Requires the need for maintenance be minimized and the potential for runoff and leaching be curtailed. Requires a postclosure monitoring period of 30 years.
Radioactive waste management	DOE 5820.2, Chapter III[b]	DOE	Requires security systems and permanent markers to prevent intrusion.

[a]South Carolina Hazardous Waste Management Regulations.
[b]DOE Administrative Order.

The base floodplain of the region is confined primarily to wetlands and low terraces along the Savannah River and its primary tributaries. Siting criteria avoid such flood prone areas; thus, no impacts due to potential flooding of storage facilities are expected.

G.3.3 NONRADIOACTIVE ATMOSPHERIC RELEASES

The construction of the waste retrievable-storage facilities would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts and truck traffic, and suspended particulates and dust from ground surface disturbances. All applicable emission standards would be met during construction.

Because hazardous, mixed, and low-level radioactive wastes would be delivered in high-integrity sealed containers, releases would be unlikely. No significant impact on air quality is projected.

G.3.4 ECOLOGICAL EFFECTS

No releases of waste constituents would result from operation of storage facilities. No contaminant-related impacts on aquatic or terrestrial resources are expected.

Construction of waste storage facilities may involve clearing up to 400 acres of land for facilities and roads. Clearing would destroy existing or potential wildlife habitat and foreclose other benefits (e.g., timber production) for the 20-year period of operations. Thereafter, the area could be restored to a natural condition or put to other nonrestricted uses.

The available habitat on SRP amounts to 184,200 acres. The maximum loss of habitat, amounting to about 0.2 percent (i.e., 400 acres), would have an insignificant effect on the ecology of the plant and the region.

Five endangered species (bald eagle, red-cockaded woodpecker, wood stork, American alligator, and shortnose sturgeon) are on or near the SRP site; however, none are present on or in the immediate vicinity of candidate sites. Therefore, construction of the retrievable storage facilities would not cause adverse impacts to endangered species.

In addition to destroying habitat; traffic, facility lighting, and human presence in the area would disturb wildlife in otherwise unaffected areas surrounding the facility and associated roadways. Traffic would increase the risk of vehicle-wildlife collisions; however, because of slow vehicle speed, such occurrences would be rare and would not have a significant impact on wildlife populations.

Construction of the facilities could result in soil erosion and subsequent sedimentation of the nearby streams, the more distant wetlands, or the creeks. Adequate erosion and sedimentation control measures should eliminate impacts on wetlands and water bodies.

G.3.5 RADIOLOGICAL RELEASES

The retrievable storage facilities would be designed to achieve a goal of zero releases of waste constituents. The release of radiological contaminants to the environment is not anticipated.

G.3.6 ARCHAEOLOGICAL AND HISTORIC RESOURCES

No effect on any significant archaeological resources through the development of selected candidate sites for waste storage facilities is anticipated. A request will be made to the South Carolina State Historic Preservation Officer for concurrence with this conclusion. (See Section G.2.6.)

G.3.7 SOCIOECONOMICS

No socioeconomic impacts are expected from the construction of retrievable storage facilities (see Section G.2.7).

G.3.8 DEDICATION OF SITE

The Elimination strategy (i.e., retrievable-storage facilities) would require a site for a finite period of time. During this period, methods of waste recycling or disposal presumably would be developed and used at SRP, such that at some future date the stored wastes could be retrieved and removed. Facilities could then be decommissioned and removed making these areas available for restoration or redevelopment. The Elimination strategy would not require the dedication of land for waste management purposes in perpetuity.

G.3.9 INSTITUTIONAL IMPACTS

Because the Elimination strategy would involve only temporary use (i.e., 20 years) of a site, after which use would not be restricted, DOE would not have to maintain full title and control of the land in perpetuity to ensure long term protection of public health and the environment. However, since the basis of this strategy presumes that technologies for treatment, recycling, or disposal will be available before the end of the 20-year operational period, DOE could undertake the research and development, planning, engineering, and construction to ensure that facilities are available.

G.3.10 NOISE

Noise associated with the construction and operation of storage facilities under the Elimination strategy would not be detectable at the SRP boundary from any candidate site because of attenuation provided by distance, topography, and natural vegetation.

G.4 COMBINATION STRATEGY

G.4.1 SUMMARY AND OBJECTIVES

The Dedication and Elimination strategies would provide adequate waste management of all SRP wastes as described in Appendix E (see Sections G.2 and G.3). The management of specific wastes would be more economical, more

technologically feasible, or more environmentally reliable under one or the other strategy. A prime objective of the Combination strategy is to provide the optimum mix of disposal (i.e., Dedication) and storage (i.e., Elimination) technologies for hazardous, mixed, and low-level radioactive waste characteristics and volumes.

Technologies included in the Combination strategy for hazardous, mixed, and low-level radioactive waste are listed in Table G-1 are described in Appendix E.

The technologies under each waste category are storage buildings and RCRA landfills or vaults for hazardous waste; storage buildings and RCRA landfills or vaults with CFM vaults for mixed waste; and for low-level radioactive waste, storage buildings and ELLTs for the low-activity fraction, and vaults or GCD for intermediate-activity fraction (see Section G.2.1).

The assessment of environmental impacts for the Combination strategy presumes that facilities would be permitted, constructed, and operated in accordance with applicable regulations. Storage facilities would operate 20 years, then most wastes would be retrieved for application of waste management technologies. Disposal facilities would be operated for 20 years ending with closure of the final unit. Thereafter, postclosure monitoring and maintenance would be carried out for a minimum of 100 years.

The storage actions of the strategy are assumed to result in no releases of waste constituents to the environment during their 20-year operational period. No post-operational impacts are considered. No consideration has been given to impacts associated with the construction or operation of future waste management facilities to treat or dispose of stored wastes.

Currently, the range in the technological mix between storage and disposal extends from virtually all storage and little disposal to virtually all disposal and minimal storage. Impact discussions are included in this range.

G.4.2 GROUNDWATER AND SURFACE WATER EFFECTS

The base floodplain of the SRP region is confined to riparian wetlands and low terraces along the Savannah River and its primary tributaries. Siting criteria for new waste management facilities avoid such flood prone areas; thus, no impacts of potential flooding of the facilities are expected.

G.4.2.1 Hazardous Waste

There are no releases expected from storage facilities during the 20-year operational period and releases of contaminants to the subsurface from disposal facilities are not expected to occur as long as monitoring and leachate collection continues (see Sections G.2.2.1 and G.3.2). Groundwater quality would not be significantly affected through the 100-year institutional control period. Potential impacts beyond the institutional control period are described in Section G.2.2.1.

G.4.2.2 Mixed Waste

No releases of waste constituents will occur for storage facilities during the 20-year operational period and releases of contaminants from the RCRA disposal facilities are not expected to occur during the period of institutional control.

Modeling indicates that hazardous constituents would not be released from the CFM vaults in concentrations which exceed applicable standards for up to 10,000 years. Likewise, radiological constituents including uranium are not expected to exceed their respective derived standards.

G.4.2.3 Low-Level Radioactive Waste

Low-level radioactive waste management facilities, selected to evaluate impacts on groundwater and surface water, were storage buildings, ELLTs for disposal of low-activity waste, and vaults or GCD for intermediate-activity waste. It was expressly assumed that retrievable storage would be employed for the majority of intermediate-activity tritium wastes, carbon-14, and iodine-129. No releases of these stored wastes are expected and no impact on groundwater or surface water is anticipated.

Modeling was used to predict the times of occurrence and the peak concentrations of radionuclides in ground and surface water. Table G-9 compares the modeling results to the derived groundwater standard for each nuclide. Peak concentrations of radionuclides are below their respective derived standard with the exception of uranium-234 which is just slightly above standard, 7500 years in the future. The uranium-234 concentration is not expected to exceed the derived groundwater standard as shown by the modeling (see Section G.2.2.2).Therefore, low-level radioactive waste constituent concentrations are not expected to exceed derived standards at the boundary well, wetlands, Upper Three Runs Creek, or the Savannah River with any mix of low-level waste technologies for the Combination strategy.

G.4.3 NONRADIOACTIVE ATMOSPHERIC RELEASES

The construction of waste disposal and retrievable storage facilities would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts and truck traffic, and suspended particulates and dust from ground surface disturbances. All applicable emission standards would be met during construction.

Because hazardous wastes would be delivered in sealed containers, releases would be unlikely. No significant impact on air quality from the Combination strategy is projected.

G.4.4 ECOLOGICAL EFFECTS

The candidate sites are as close as 300 meters to primary SRP streams (i.e., Upper Three Runs Creek, Tinker Creek) and closer to wetlands and ephemeral feeder streams. Since the operation and dedication of facilities is not expected to involve releases which would exceed groundwater quality standards or surface water standards/criteria, no adverse impacts on aquatic or terrestrial ecology are expected.

Table G-9. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Combination Strategy, Low-Level Waste[a]

		Estimated concentration							
		Boundary well		Wetlands		Upper Three Runs Creek		Savannah River	
Radionuclide	Derived standard[b]	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio
LOW-ACTIVITY WASTE									
Carbon-14	2.6×10^{3}	1.25×10^{-1} (30.1)	4.81×10^{-5}	1.62×10^{-2} (53.1)	6.23×10^{-6}	1.62×10^{-5} (53.1)	6.23×10^{-9}	3.03×10^{-7} (53.1)	1.17×10^{-10}
Tritium	8.7×10^{4}	4.20×10^{0} (24.4)	4.83×10^{-5}	1.92×10^{-1} (40.1)	2.21×10^{-6}	1.92×10^{-4} (40.1)	2.21×10^{-9}	3.58×10^{-6} (40.1)	4.11×10^{-11}
Iodine-129	2.0×10^{1}	3.36×10^{-3} (132)	1.68×10^{-4}	4.44×10^{-4} (179)	2.22×10^{-5}	4.44×10^{-7} (179)	2.22×10^{-8}	8.29×10^{-9} (179)	4.15×10^{-10}
Rubidium-87	1.1×10^{3}	2.35×10^{-7} (2730)	2.14×10^{-10}	3.24×10^{-8} (3350)	2.95×10^{-11}	3.24×10^{-11} (3350)	2.95×10^{-14}	6.06×10^{-11} (3350)	5.51×10^{-14}
Selenium-79	6.6×10^{2}	7.42×10^{-3} (1380)	1.12×10^{-5}	1.02×10^{-3} (1700)	1.55×10^{-6}	1.02×10^{-6} (1700)	1.55×10^{-9}	1.90×10^{-8} (1700)	2.88×10^{-11}
Technetium-99	4.2×10^{3}	4.13×10^{0} (24.4)	9.83×10^{-4}	5.62×10^{-1} (47.7)	1.34×10^{-4}	5.62×10^{-4} (47.7)	1.34×10^{-7}	1.05×10^{-5} (47.7)	2.50×10^{-9}
Neptunium-237	1.4×10^{-1}	1.15×10^{-4} (5430)	8.21×10^{-4}	1.59×10^{-5} (6640)	1.14×10^{-4}	1.59×10^{-8} (6640)	1.14×10^{-7}	2.97×10^{-10} (6640)	2.12×10^{-9}
Subtotal			2.08×10^{-3}		2.80×10^{-4}		2.80×10^{-7}		5.22×10^{-9}
INTERMEDIATE-ACTIVITY WASTE									
Carbon-14	2.6×10^{3}	7.56×10^{-2} (304)	2.91×10^{-5}	1.86×10^{-3} (333)	7.15×10^{-7}	1.86×10^{-6} (333)	7.15×10^{-10}	3.48×10^{-8} (333)	1.34×10^{-11}
Tritium	8.7×10^{4}	2.67×10^{-5} (223)	3.07×10^{-10}	1.99×10^{-7} (241)	2.29×10^{-12}	1.99×10^{-10} (241)	2.29×10^{-15}	3.71×10^{-12} (241)	4.26×10^{-17}
Iodine-129	2.0×10^{1}	4.30×10^{-3} (975)	2.15×10^{-4}	1.06×10^{-4} (1040)	5.30×10^{-6}	1.06×10^{-7} (1040)	5.30×10^{-9}	1.98×10^{-9} (1040)	9.90×10^{-11}

*Footnotes on last page of table.

Table G-9. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Combination Strategy, Low-Level Waste[a] (continued)

Radionuclide	Derived standard[b]	Boundary well Estimate	Boundary well Ratio	Wetlands Estimate	Wetlands Ratio	Upper Three Runs Creek Estimate	Upper Three Runs Creek Ratio	Savannah River Estimate	Savannah River Ratio
		Estimated concentration							
Rubidium-87	1.1×10^{3}	2.17×10^{-5} (3020)	1.97×10^{-8}	8.51×10^{-7} (3490)	7.74×10^{-10}	8.51×10^{-10} (3490)	7.74×10^{-13}	1.59×10^{-11} (3490)	1.45×10^{-14}
Selenium-79	6.6×10^{2}	3.40×10^{-1} (709)	5.15×10^{-4}	1.32×10^{-2} (1410)	2.00×10^{-5}	1.32×10^{-5} (1410)	2.00×10^{-8}	2.46×10^{-7} (1410)	3.73×10^{-10}
Technetium-99	4.2×10^{3}	1.20×10^{1} (646)	2.86×10^{-3}	4.69×10^{-1} (102)	1.12×10^{-4}	4.69×10^{-4} (102)	1.12×10^{-7}	8.77×10^{-6} (102)	2.09×10^{-9}
Strontium-90	4.2×10^{1}	1.16×10^{-7} (1060)	2.76×10^{-9}	(d)	-	(d)	-	(d)	-
Yttrium-90	5.5×10^{2}	1.16×10^{-7} (1060)	2.11×10^{-10}	(d)	-	(d)	-	(d)	-
Uranium-234	2.1×10^{1}	2.47×10^{1} (7480)	1.18×10^{0}	(d)	-	(d)	-	(d)	-
Uranium-235	2.2×10^{1}	2.80×10^{-1} (7480)	1.27×10^{-2}	(d)	-	(d)	-	(d)	-
Uranium-236	2.2×10^{1}	2.02×10^{0} (7480)	9.18×10^{-2}	(d)	-	(d)	-	(d)	-
Uranium-238	2.4×10^{1}	1.23×10^{0} (7480)	5.13×10^{-2}	(d)	-	(d)	-	(d)	-
Neptunium-237	1.4×10^{-1}	2.05×10^{-2} (3270)	1.46×10^{-1}	7.87×10^{-4} (4750)	5.62×10^{-3}	7.87×10^{-7} (4750)	5.62×10^{-6}	1.47×10^{-8} (4750)	1.05×10^{-7}
Subtotal			1.49×10^{0}		5.76×10^{-3}		5.76×10^{-6}		1.08×10^{-7}
Ratio Totals			1.49×10^{0}		6.04×10^{-3}		6.04×10^{-6}		1.13×10^{-7}

[a]Source: Cook, Grant, and Towler, 1986.
[b]ICRP Publication 30 (ICRP, 1979) methodology was used to determine radionuclide concentrations that individually yield an annual effective whole-body or organ dose of 4 millirem. Four millirem dose limit required by 40 CFR 141.
[c]Figures in parentheses represent number of years after closure.
[d]No significant radionuclide concentration at this receptor location within 10,000 years after closure.

Construction of waste disposal facilities may involve clearing up to 400 acres for the waste facilities, roads, and appurtenances. Clearing would destroy existing or potential wildlife habitat and foreclose any other future benefits that may be provided by a natural landscape in the SRP region (e.g., timber production). The available habitat on the SRP amounts to 184,200 acres; thus, the maximum loss of about 0.2 percent (i.e., 400 acres) would have an insignificant effect on the ecology of the Plant and the region.

Five endangered species (i.e., bald eagle, red-cockaded woodpecker, wood stork, American alligator, and shortnose sturgeon) occur on or near the SRP site; however, none are present on or in the immediate vicinity of any candidate sites. Therefore, construction of the disposal facilities under the Combination strategy would not cause adverse impacts to any endangered species.

In addition to the habitat destruction; traffic, facility lighting, and human presence in the area would disturb wildlife in otherwise unaffected areas surrounding the facility and associated roadways. Traffic would also increase the risk of vehicle-wildlife collisions; however, because of the slow vehicle speed, such occurrences would be rare and would not have a significant impact on wildlife populations.

Construction of the facilities could result in soil erosion and subsequent sedimentation of nearby steams, the more distant wetlands, or the creeks. Adequate erosion and sedimentation control measures should eliminate impacts on wetlands and water bodies from this source.

With the belowground disposal options, the uptake of wastes by vegetation could occur if the roots of plants penetrated the clay cap and/or other barriers between the surface and the waste forms. Therefore, shallow rooted species will be used to stabilize soils during closure and will be maintained by mowing during the postclosure, institutional control period to prevent more deeply rooted plants (e.g., shrubs and trees).

G.4.5 RADIOLOGICAL RELEASES

G.4.5.1 Hazardous Waste

Because hazardous wastes do not contain radioactive constituents by definition, no radiological releases are expected from hazardous waste disposal/storage facilities.

G.4.5.2 Mixed Waste

The major radiological releases of the Combination strategy are associated with the CFM vault technology (see Section G.2.5.2). It is concluded that individual doses during the peak year, for all radionuclides including uranium-234, would not exceed the 4 millirem/year drinking water standard through all modeled pathways.

G.4.5.3 Low-Level Radioactive Waste

Under the Combination strategy, retrievable storage would be expressly designated for the intermediate-activity carbon-14, tritium, and iodine-129. Currently, storage of other wastes remains optional. Table G-10 shows the peak

Table G-10. Peak Radiological Dose and Times of Occurrence for Combination Strategy, Low-Level Waste[a b]

Radionuclide	Boundary well Dose	Boundary well Time	Savannah River Dose	Savannah River Time
		LOW-ACTIVITY WASTE		
Carbon-14	1.58×10^{-4}	30.1	2.06×10^{-8}	53.1
Tritium	2.24×10^{-4}	24.4	1.93×10^{-10}	40.1
Iodine-129	6.67×10^{-4}	132	1.89×10^{-9}	179
Rubidium-87	8.93×10^{-10}	2730	4.24×10^{-14}	3350
Selenium-79	4.37×10^{-5}	1380	2.97×10^{-10}	1700
Technetium-99	3.93×10^{-3}	24.4	1.14×10^{-8}	47.7
Neptunium-237	2.09×10^{-5}	5430	6.19×10^{-11}	6640
Subtotal	5.04×10^{-3}		3.44×10^{-8}	
		INTERMEDIATE-ACTIVITY WASTE		
Carbon-14	9.57×10^{-5}	304	2.36×10^{-9}	333
Tritium	1.43×10^{-9}	223	2.00×10^{-16}	241
Iodine-129	8.54×10^{-4}	975	4.51×10^{-10}	1040
Rubidium-87	8.24×10^{-8}	3020	1.11×10^{-12}	3490
Selenium-79	2.00×10^{-3}	709	3.84×10^{-9}	1410
Technetium-99	1.14×10^{-2}	64.6	9.52×10^{-9}	102
Strontium-90	7.43×10^{-9}	1060	b	–
Yttrium-90	5.72×10^{-10}	1060	b	–
Uranium-234	3.06×10^{0}	7480	b	–
Uranium-235	3.34×10^{-2}	7480	b	–
Uranium-236	2.41×10^{-1}	7480	b	–

Footnote on last page of table.

Table G-10. Peak Radiological Dose and Times of Occurrence for Combination Strategy, Low-Level Waste[a,b] (continued)

Radionuclide	Boundary well		Savannah River	
	Dose	Time	Dose	Time
Uranium-238	1.35×10^{-1}	7480	b	-
Neptunium-237	3.72×10^{-3}	3270	3.06×10^{-9}	4750
Subtotal	3.49×10^{0}		1.92×10^{-8}	
Total Dose	3.50×10^{0}		5.36×10^{-8}	

[a]Source: Cook, Grant, and Towler, 1986.
[b]Doses calculated using PATHRAE model incorporating a human diet of plant, meat, and dairy foodstuffs, and 370 liters of contaminated water ingested per year. Doses expressed in millirem per year; time in number of years after closure.

radiological doses estimated by the model and their estimated times of occurrence for the boundary well and Savannah River pathways. The sum of doses from all radionuclides is below the 4 millirem/year drinking water standard for both the boundary well and Savannah River pathways. The modeling result of a 3.5 millirem/year peak is a conservative sum. It assumes that all nuclide doses peak at the same time, that no solubility limits exist for uranium, and that there is no leachate collection during the 100-year institutional control period. The nuclide doses would peak at various times from 24 to 7500 years beyond closure, environmental factors would limit the solubility of uranium and leachate collection would occur as required during the institutional control period. Consequently, radiological doses from low-level radioactive waste facilities would be below the 4 millirem/year standard (see Section G.2.5.3).

G.4.6 ARCHAEOLOGICAL AND HISTORIC RESOURCES

No effect on any significant archaeological resources through the development of selected candidate sites for waste storage and disposal facilities is anticipated. A request will be made to the South Carolina State Historic Preservation Officer for concurrence with this conclusion. (See Section G.2.6.)

G.4.7 SOCIOECONOMICS

No socioeconomic impacts are expected from the construction of storage and disposal facilities under the Combination strategy (see Section G.2.7).

G.4.8 DEDICATION OF SITE

The disposal portion of the Combination strategy, involving up to 400 acres plus a buffer zone, would require site dedication in perpetuity to ensure full compliance with RCRA and South Carolina Hazardous Waste Management Regulations, and consistency with DOE Orders regarding environmental and public health protection.

The storage portion of the strategy, however, would require the use of a site for a finite period of time. Then the facilities could be removed and the site restored to a natural condition or redeveloped for other land uses with no restrictions (see Sections G.2.8 and G.3.8).

G.4.9 INSTITUTIONAL IMPACTS

Institutional impacts associated with the disposal portion of the Combination strategy would be the same as those in Section G.2.9.

Because the retrievable-storage portion of the Combination strategy would involve temporary use of a site (i.e., 20 years), DOE would not have to maintain full title and control of that portion of the site in perpetuity to ensure long term protection of public health and the environment. Thus, institutional impacts associated with the storage facilities would be insignificant.

G.4.10 NOISE

Noise associated with the construction and operation of storage and disposal facilities under the Combination strategy would not be detectable at the SRP boundary from any candidate site because of attenuation provided by distance, topography, and natural vegetation.

G.5 SUMMARY

Table G-11 provides a summary of the four alternative waste management strategies.

Table G-11. Summary of New Waste Management Facility Impacts for Each Waste Management Strategy

Environmental Category	No action	Dedication	Elimination	Combination
Groundwater/surface water	Potentially more damaging than all current existing waste sites	No significant impact through period of institutional control. Potential hazardous and radioactive releases, thereafter	No significant impact through 20-year period of operation	No significant impact through period of institutional control. Potential hazardous and radioactive releases, thereafter
Nonradioactive atmospheric	Potential dispersion of large quantities of waste due to disaster (e.g., fire)	No significant impact	No significant impact	No significant impact
Ecology	Potential substantial impacts both onsite and offsite and downstream	No significant waste related impacts. No significant loss of habitat. No impact to rare/endangered species	Same	Same
Radiological releases	Potentially very damaging to the environment and public health	No significant impact through the period of institutional control. Potential impacts thereafter from tritium unless mitigated	No significant impact through 20-year period of operation	No significant impact through the period of institutional control. No significant impact from tritium thereafter
Archaeological/historic	No impact	No impact	No impact	No impact
Socioeconomics	No impact	No impact	No impact	No impact
Noise	No impact	No impact	No impact	No impact
Site dedication	Potential site dedication of land contaminated by accidental releases	Dedication of up to 400 acres of land for waste management in-perpetuity	No dedication of land in-perpetuity	Dedication of up to 400 acres of land for waste management in-perpetuity
Institutional	Would result in DOE's non-compliance with environmental laws and regulations	Possible site maintenance and monitoring indefinitely beyond institutional control period	Commitment to carry out research and development, planning, engineering, and construction of advanced waste management technologies.	Possible site maintenance and monitoring indefinitely beyond institutional control period. Commitment to carry out research and development, planning, engineering, and construction of advanced waste management technologies

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX H

TRANSPORT AND DOSE MODELS

This appendix describes the analytical models used to determine the transport through the environment and potential exposure of individuals to waste constituents resulting from the alternative actions evaluated in this environmental impact statement. The primary transport is via the groundwater pathway; Section H.1 describes the hydrogeologic models used to evaluate that pathway. Atmospheric pathways provide more routes for exposure via deposition and uptake in foods and by inhalation; Section H.2 describes models used for these evaluations.

H.1 HYDROGEOLOGIC MODELS

This section describes the hydrogeologic models used to support this environmental impact statement (EIS). The assessments in the EIS are based on data and study results presented in Environmental Information Documents (EIDs). The computer models are identified in several documents (Colven et al., 1985; Stephenson et al., 1986; Merrell, Rogers, and Bollenbacher, 1986; Rogers, Merrell, and Bollenbacher, 1986; Merrell and Rogers, 1986). The hydrogeologic models discussed in this appendix are PATHRAE, MOD3D, and SWIFT II.

H.1.1 PATHRAE

PATHRAE is an analytical model used to provide a basis for quantitative estimates of the human health risks associated with land disposal of wastes. This code was developed originally for the U.S. Environmental Protection Agency (EPA) for low-level radioactive waste disposal. It was modified to estimate health risks and environmental effects of removal and closure options for low-level radioactive, mixed, and hazardous waste disposal sites on the Savannah River Plant. PATHRAE has also been used in performance assessments of new disposal facilities for hazardous wastes, mixed wastes, and low-level radioactive wastes. The value of the PATHRAE model is its simplicity of operation and its presentation of analysis results for a set of waste constituents and pathways.

PATHRAE was the primary model used to provide a basis for the relative environmental consequences of the various approaches considered for existing waste sites and new disposal facilities. The following paragraphs evaluate the ability of PATHRAE to perform this task. This evaluation was performed by the following methods:

- Comparison with other analytical models
- Comparison with measured concentrations
- Comparison with three-dimensional numerical solutions
- Evaluation of the selection of model input values and their effect (i.e., sensitivity on model results

A comparison with other analytical results indicates good agreement between PATHRAE and a slightly more complex analytical model. This indicates that two simplifying assumptions in PATHRAE (i.e., plug flow in the unsaturated zone and uncoupled longitudinal and transverse dispersion in the saturated zone) do not have a significant effect on transport predictions. PATHRAE predicts higher concentrations than a three-dimensional dispersion model. This indicates that neglecting the vertical dispersion causes PATHRAE to be more conservative than the more sophisticated three-dimensional model. PATHRAE also predicts concentrations that are higher than those predicted by the EPA VHS model, which was developed specifically to develop conservative models of land disposal scenarios. In the concentrations presented in Chapter 4 and Appendix F for the 1- and 100-meter wells, this conservatism was increased by neglecting the transverse dispersion component of the PATHRAE model.

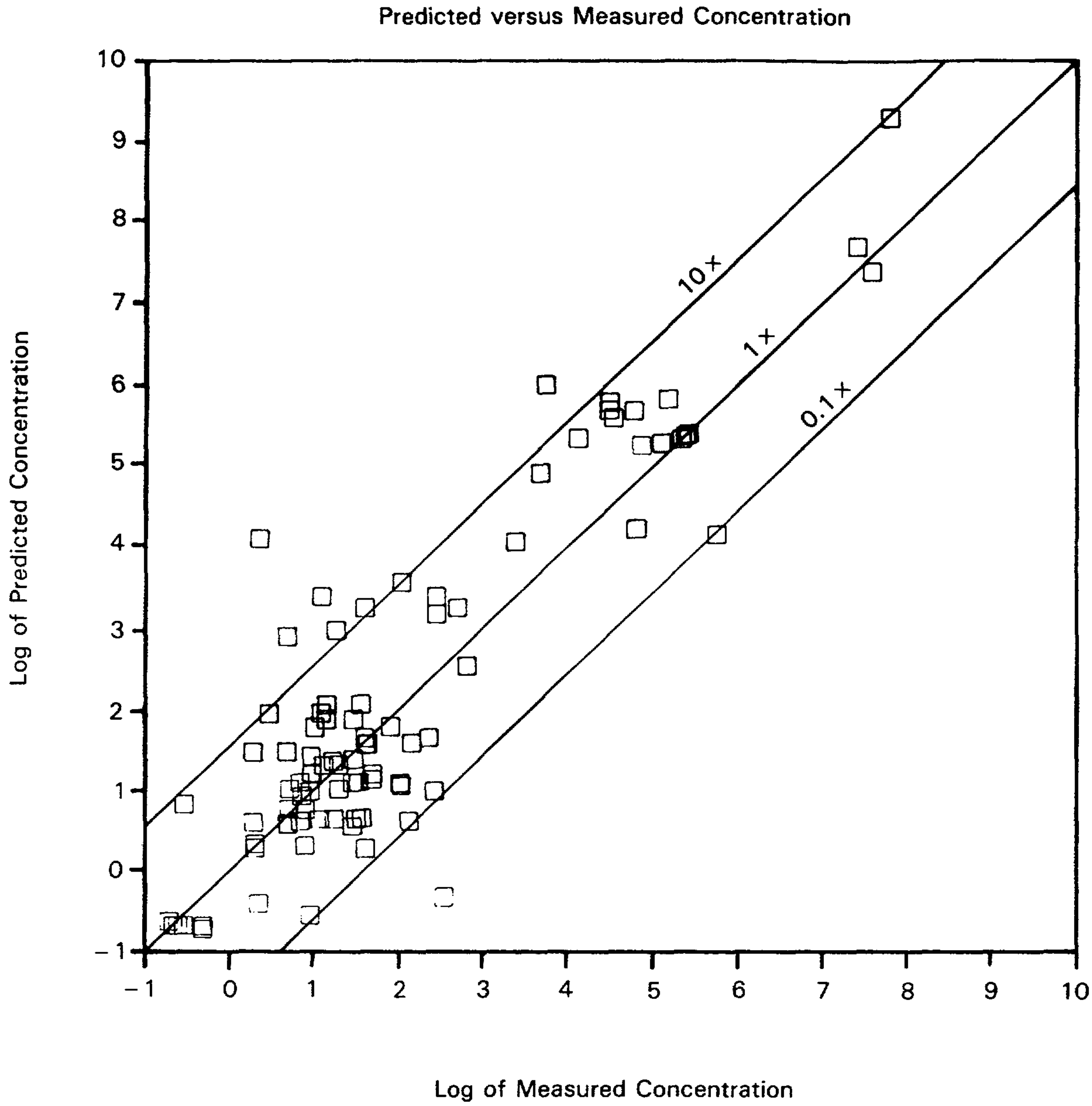
Figure H-1 shows the comparison of PATHRAE to measured concentrations. The data suggest that the methods used to predict groundwater concentrations generated reasonable results. Figure H-1 shows considerable uncertainty associated with the prediction of chemical and radionuclide concentrations. Approximately 73 percent of the predictions are within one log cycle (i.e., a factor of 10) of the measured concentrations. Therefore, predicted concentrations that differ by a factor of 10 or greater are considered to be significant. Concentrations predicted to be marginally above or below applicable standards (e.g., factors of 2 or less) are smaller than the uncertainty inherent in the model.

Researchers also compared PATHRAE results to those generated by "more sophisticated" three-dimensional flow and transport models. The three-dimensional models were used in the A- and M-Areas and the F- and H-Areas, where detailed geohydrologic data were available. Generally, the peak concentrations predicted by PATHRAE are higher by factors of 10 or greater than those predicted by the three-dimensional models. The model comparisons suggest that PATHRAE is conservative but sufficiently accurate to compare relative differences in various waste management approaches.

Researchers applied sensitivity analyses to bound the range of predicted concentrations that would result from the uncertainty in estimating the input parameters. The input parameters that have the most significant effects on results are assumed inventory, groundwater flow rate, and leach rate. These studies indicate that the variations due to uncertainties in input parameters are less than the inherent uncertainties of the model. The worst-case deviation for a single parameter was less than a factor of 10.

In summary, these four studies indicate that the PATHRAE model is sufficiently accurate to make relative comparisons between generic waste management approaches. However, specific conceptual design-level decisions would require more detailed site-specific modeling.

Researchers can investigate site performance for radioactive/hazardous waste disposal with relatively few parameters to define the site condition. This characteristic makes the model useful for the evaluation of a wide range of radioactive and hazardous waste disposal problems. The modified version of PATHRAE can evaluate the environmental and health risk due to nonradioactive contaminants by the input of equivalent model parameters.



Source: Looney et al. 1986

Figure H-1. Verification of Model Results

General inputs to the model include the following:

- Dimension and size of the source
- Flow rate of the receiving surface stream
- Distance to the receiving surface stream
- Depth to the aquifer
- Aquifer distance to accessible location
- Bulk density of aquifer materials
- Groundwater flow velocities
- Longitudinal and lateral dispersivities
- Total waste volume
- Density of waste
- Parameters associated with vegetation and air deposition
- Atmospheric parameters such as atmospheric stability, wind speed, diffusion coefficient, precipitation, etc.
- Soil retardation characteristics
- Porosity of aquifer
- Cover thickness and impermeability
- Mixing thickness of aquifer
- Surface erosion rate

The contaminant transport through the aquifer is determined by the solution of either the one-dimensional advection equation or the one-dimensional advection-dispersion equation with decoupled longitudinal and transverse dispersion. In association with this methodology, the model includes the following assumptions:

1. The aquifer is one-dimensional consisting of an infinitely long homogeneous, isotropic porous medium.

2. The releases of contaminants from the source are constant or are an exponentially decaying function of time.

3. Only adsorption-desorption equilibrium of contaminant between water and aquifer materials is considered in calculating the effect of retardation. Effects of pH, redox potential, and thermodynamically competing species are neglected.

4. The movement of contaminants in the unsaturated zone is described in terms of plug flows.

The code contains algorithms for analyzing 10 different pathways. The pathways that were modeled include groundwater movement to hypothetical water wells nearby, groundwater movement to the Savannah River, waste erosion and movement to the Savannah River, food consumption on reclaimed farm, and consumption of crops grown through natural biointrusion.

For groundwater movement to nearby water wells, the pathway consists of downward migration of the modeled waste components through advection and diffusion or as a result of dissolution in percolating precipitation. The waste components move downward through the unsaturated zone to the aquifer and move horizontally to nearby wells downstream (in the sense of aquifer flow). Two hypothetical well scenarios were analyzed: one immediately adjacent to the waste disposal facility (i.e., the 1-meter well) and one 1000 meters downstream from the edge of the facility. The models for both vertical and horizontal movement of waste materials account for chemical retardation by the soils. Once withdrawn from the well, the water is assumed to be consumed directly by individuals and used to irrigate crops that are then consumed by these same individuals.

For groundwater movement to surface streams, the pathway is similar to that described above, but the modeled waste components are assumed to continue to move through the aquifer until released to surface waters. For the purpose of analyzing the potential impacts of releases through this pathway, the release was assumed to be into the Savannah River, with its downstream consumer populations. The waste components are assumed to be mixed completely with water in the Savannah River.

The following subsections present equations describing the transport and dose via groundwater to surface waters and to wells.

H.1.1.1 Groundwater Pathway to a Surface Stream

The dose from groundwater migration to a river is calculated from:

$$D = \frac{Q \lambda_L f_0 U_1}{q_w} (DF) \qquad \text{(H-1)}$$

where:

Q = inventory of the radionuclides (picocuries) or toxic chemicals (kilograms)

q_w = flow rate of the river (cubic meters per year)

f_o = fraction of the inventory arriving at the river from transport through the aquifer

λ_L = fraction of each nuclide/chemical leached from the inventory in a year

U_1 = annual equivalent surface water uptake by an individual (cubic meters per year)

DF = dose conversion factor for radionuclides (millirem per picocurie) = 1 for chemicals

D = (units) dose in mrem for one year or kg/yr for chemicals

In Equation H-1, the product of Q and λ_L represents the release rate of radionuclide/chemical from the source. Parameter f_o determines the fraction of radionuclide/chemical released from the source that can reach the river. U_i is the amount of river water consumed by an individual. DF defines the dose to an individual for each unit of radionuclide or chemical uptake.

Transport of contaminants through the aquifer can be described by the advection-dispersion equation:

$$\frac{\partial C}{\partial_t} = -\frac{V}{R} \bullet \frac{\partial C}{\partial X} + \frac{D_L}{R}\frac{\partial^2 C}{\partial X^2} - \lambda C \qquad \text{(H-2)}$$

where:

- C = concentration of contaminant (picocuries per liter or milligrams per liter)
- V = seepage velocity of the groundwater flow (meters per year)
- X = distance along the mean groundwater flow direction (meters)
- D_L = longitudinal dispersion coefficient along the direction of flow (square meters per year)
- R = retardation factor $= 1 + \frac{\rho}{p} k_d$
- λ = first-order decay constant
- ρ = aquifer density
- P = aquifer porosity
- k_d = sorption coefficient in the aquifer (cubic meters per kilogram)

If the dispersion term is neglected, Equation H-1 reduces to the one-dimensional advection equation with radioactive decay

$$\frac{\partial C}{\partial t} = -\frac{V}{R} \bullet \frac{\partial C}{\partial x} - \lambda C \qquad \text{(H-3)}$$

Parameter f_o of Equation H-1 can be calculated for either dispersive or nondispersive groundwater transport. For the nondispersive case, the line source is assumed to decrease in inventory with time at a constant fraction due to both the release of contaminant and radioactive decay. The solution of the one-dimensional advection equation (Equation H-3), for this boundary condition, parameter f_o, is as follows:

$$f_0 = 0 \quad \text{for} \quad t \leqslant t_1 - t_0 \qquad \text{(H-4)}$$

$$f_0 = \frac{V_a}{LR\lambda_L} \bullet [1\text{-exp}\ [-\lambda_L\ (t-(t_1-t_0))]\ ] \quad \text{for} \quad t_1 - t_0 < t < t_1$$

$$f_0 = \frac{V_a}{LR\lambda_L} \bullet \exp\ [-\lambda_L(t-t_1)]\ [1-\exp(-\lambda_L t_0)] \quad \text{for} \quad t_1 \leqslant t$$

where:

- t = time (years)
- t_0 = RL/V_a
- t_1 = $R(L+X_w)/V_a$
- R = retardation factor
- k_d = sorption coefficient in the aquifer (cubic meters per kilogram)
- ρ = aquifer density (kilograms per cubic meter)
- L = length of waste site in direction parallel to aquifer flow (meters)
- V_a = interstitial horizontal aquifer velocity (meters per year)
- X_w = distance of groundwater flow from nearest edge of burial pits to the river (meters)
- p = aquifer porosity

For dispersive groundwater transport, the source is considered to be a line of point sources that release contaminants, with the exception of radioactive decay, at a constant rate. The solution of the one-dimensional advection-dispersion equation (Equation H-2), for this boundary condition, the parameter f_o, can be expressed as:

$$f_0 = \frac{1}{N} \sum_{j=1}^{N} [Fj(t) - Fj(t-1/\lambda_L)] \qquad \text{(H-5)}$$

where:

- $Fj(t)$ = $0.5\ U(t)\ [\mathrm{erfc}\ (z-) + \exp(d_j)\ \mathrm{erfc}\ (z+)]$
- $U(t)$ = unit step function
- $z\pm$ = $\dfrac{d_j^{1/2}[1 \pm t/Rt_{wj})]}{2[t/Rt_{wj})]^{1/2}}$
- d_j = distance from sector center to access location divided by the longitudinal dispersivity
- t_{wj} = water travel time for distance d_j (years)
- N = number of mesh points in numerical integration

The disposal area of length L is divided into N sectors of equal length. A point source of the appropriate magnitude is placed at the center of each sector. The distance d_j is measured from the center of sector j to the access location. The summation shown in Equation H-5 represents the integration of the point source analytical solutions to approximate an area source.

H.1.1.2 Groundwater Pathway to a Well

The dose from groundwater migration with discharge to a well is calculated from:

$$D = \frac{Q\lambda_L f_0 U_2 (DF)}{q_w} \quad \text{(H-6)}$$

The aquifer flow rate $\bar{q}_w$ is given, in this case, by:

$$q_w = \begin{cases} WLP & \text{for } H_w > L_p \\ WL_p v_a p & \text{for } H_w < L_p \end{cases}$$

where

W	= width of waste pit perpendicular to aquifer flow (meters)
P	= water percolation rate (meters per year)
L_p	= length of well casing in aquifer (meters)
H_w	= vertical dimension of contaminated zone in aquifer (meters)
v_a	= horizontal velocity of aquifer (meters per year)
U_2	= annual equivalent total uptake of well water by an individual (cubic meters per year)

Continuity of mass for the contaminated water in the unsaturated and saturated zone requires that

$$H_w = \frac{P \bullet L}{p \bullet v_a} \quad \text{(H-7)}$$

In addition to modeling the effects of longitudinal dispersion in the aquifer, the well pathway can account for any transverse dispersion that might occur. This reduces the conservatism when calculating contaminant doses for the well pathway. In modeling of transverse dispersion, the term f_o in Equations H-5 and H-6 is modified by an additional multiplicative term, f_t, given by:

$$f_t = \frac{1}{2} \operatorname{erf} \left[\frac{(y_w + W/2)R}{2(D_y t)^{1/2}} \right] - \frac{1}{2} \operatorname{erf} \left[\frac{(y_w - W/2)R}{2(D_y t)^{1/2}} \right] \quad \text{(H-8)}$$

where:

y_w = distance to well from center of waste area in the direction perpendicular to the aquifer flow (meters)
D_y = transverse dispersion coefficient (square meters per year)

For the limiting case in which D_y goes to zero, f_t becomes equal to 1. Therefore, the effects of transverse dispersion can be ignored by choosing D_y equal to zero.

Although a portion of the model's algorithms associated with subsurface transport have been verified analytically by comparison with the simplified analytical solutions and other independent calculations using different programs, the overall model has not been verified with field measurements. A report prepared by Clemson University discusses PATHRAE code sensitivity and verification (Fjeld et al., 1986).

H.1.2 MOD3D

The MOD3D model, which was developed by the U.S. Geological Survey, simulates three-dimensional groundwater flow in a porous, heterogeneous, and anisotropic medium with irregular boundaries. The uppermost hydrologic unit can have a free water-table surface. Stress can be applied to the system in the form of well discharge/recharge, and as recharge from precipitation. A modified version of this model extends its application to simulations involving head-dependent sources and sinks such as river, springs, or drains, and evapotranspiration. These modifications also enhance the effectiveness of the iterative solution process used by the original version.

This model can simulate groundwater flow in both a fully three-dimensional and a quasi-three-dimensional manner, depending on the availability of data and the requirements of computer memory. It can simulate each hydrologic unit with one or more layers and permits the use of variable grid spacing. If the analysis can neglect the storage in a confining bed and the associated horizontal component of flow, the model can incorporate the effects of vertical leakage through a confining bed into the vertical component of the anisotropic hydraulic conductivity of adjacent aquifers.

The iterative numerical technique used to solve the set of simultaneous block-centered, finite-difference, approximated, algebraic equations is the strongly implicit procedure. This method converges faster and has fewer rounds of errors than the iterative alternating direction implicit method.

Groundwater flow in a three-dimensional, heterogeneous, and anisotropic porous medium can be expressed as

$$\nabla \bullet \left(K_{ij} \frac{\partial h}{\partial x_j}\right) = S_s \frac{\partial h}{\partial t} + W(x,y,z,t) \qquad \text{(H-9)}$$

where:

∇	=	vector differential operator
h	=	hydraulic head (L)
S_s	=	specific storage (L^{-1})
K_{ij}	=	tensor of hydraulic conductivity (LT^{-1})
X_j	=	distance in the space direction j (L)
W(x,y,z,t)	=	volumetric flux per unit volume of aquifer (T^{-1}) representing source/sink of the porous medium

Assuming that the coordinate axes x, y, and z are aligned with the principal directions of the hydraulic conductivity tensor, the crossproduct terms drop from Equation H-9. It reduces into the following form:

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial y}\right) = S_s\frac{\partial h}{\partial t} + W(x,y,z,t) \qquad \text{(H-10)}$$

in which K_{xx}, K_{yy}, and K_{zz} are the components of the hydraulic conductivity in the three principal directions x, y, and z. In the finite-difference approach, it is often convenient to represent a hydrologic unit by one layer of nodes. Thus, if Equation H-9 is multiplied by the thickness (b) of the hydraulic unit, Equation H-10 can be written as:

$$\frac{\partial}{\partial x}\left(T_{xx}\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(T_{yy}\frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(b\,K_{zz}\frac{\partial h}{\partial z}\right) = S^{1}\frac{\partial h}{\partial t} + bW(x,y,z,t) \qquad \text{(H-11)}$$

in which T_{xx} and T_{yy} are the principal components of the transmissivity tensor, and S^1 is the storage coefficient. Although the model is designed to solve Equation H-10, it will solve Equation H-9 by substituting hydraulic conductivity, specific storage, and W(x,y,z,t) for transmissivity, storage coefficient, and bW(x,y,z,t), respectively. If the upper hydrologic unit is under water-table conditions, the specific yield is used to replace the storage coefficient in Equation H-10. The transmissivity in Equation H-10 is defined as a function of the head obtained from the previous iteration. That is,

$$T_{xx}{}^{n}{}_{(i,j,k)} = K_{xx\ (i,j,k)} \bullet b^{n-1}_{i,j,k} \qquad \text{(H-12)}$$

where:

$b^{n-1}_{i,j,k}$	=	the saturated thickness of the upper hydrologic unit at iteration n-1
n	=	iteration index

The required input data to simulate an aquifer under a stress of pumping are the transmissivity or hydraulic conductivity, storage coefficient or specific storage, initial head distribution, geometry of the hydrologic unit, dimension and layout of the finite-difference grid, length of pumping periods, number of pumping wells, pumping rates, and other simulation control parameters.

This model incorporates the following assumptions and limitations:

1. Aquifer properties can be heterogeneous and anisotropic.

2. Aquifer properties and hydrologic characters are uniform within each block of the model grid.

3. The perimeter of the aquifer should be described by a no-flow boundary.

4. Grid axes are parallel to the principal directions of the transmissivity tensor if the aquifer is anisotropic.

5. Head-dependent sources/sinks can also be simulated.

6. Darcy's Law can be applied in the porous media of the aquifers.

7. A simulated aquifer can be represented by such boundary conditions as constant head, constant flux, and head-dependent flux.

8. Only one horizontal anisotropy factor is allowed for each layer.

9. Overpumping can create an irreversible dry cell.

10. If the same aquifer is simulated by several layers and the water table is expected to traverse more than one layer, the cells can be converted incorrectly to no-flow cells.

11. Because the conversion to no-flow is irreversible, only declines in the water table can be simulated.

12. A confining layer with a given vertical hydraulic conductance is assumed to be below the water-table layer because vertical hydraulic conductance is left as a non-zero constant until the cell is converted to a no-flow cell.

McDonald and Harbaugh (1984) developed this modular, three-dimensional, finite-difference model to simulate groundwater flow in the porous medium. Their main objectives were to produce a program that can be modified readily, is simple to use and maintain, can be executed on a variety of computers with minimum changes, and is relatively efficient with respect to computer memory and execution time.

This model has been applied to a number of studies, including various aquifer and flow conditions in the A/M-Area and the Separations (F and H) Areas. In addition to the field application, this model also has been compared successfully with simplified analytical solutions. This model has better convergence than the quasi-three-dimensional model. In general, it has been appropriately

validated, modified, and documented. Reliable results can be obtained, especially for aquifers in which the properties are ideally stratified and the groundwater flow in the porous medium can be modeled for the condition of confining beds.

MOD3D has been used in conjunction with SWIFT II for a number of groundwater flow and transport investigations. MOD3D provided the flow results; SWIFT II provided the contaminant transport results. The waste sites or locations studied were the A/M-Area, the old TNX seepage basin, the F- and H-Area seepage basins, and the low-level radioactive waste burial ground. Published results of these field problems are not available at present. In addition, the published results of code verification of MOD3D are not available, even though the code has gone through the USGS review process. However, the model includes detailed mass balance algorithms to provide confidence in convergence and apportioning of sources and sinks.

H.1.3 SWIFTII

SWIFTII (Sandia Waste Isolation Flow and Transport for Fractured Media) is a general nuclide transport code to describe migration from the repository through the groundwater system. It is based on the finite-difference method, and solves not only for flow and solute transport but also for heat and brine transport.

The code simulates the flow and transport of energy, solute, and radionuclides in a geologic medium. SWIFTII is a 3-D finite-difference groundwater flow and nuclide transport code. The model takes into account saturated flow in an isothermal or heated porous medium as well as sorption and desportion mechanisms. In addition the code takes into explicit account nuclide decay and the creation of daughter products. For the nuclide decays, the code considers conservation of dissolved contaminants, energy, and total liquid mass. The fluid density can be a function of pressure, temperature, and concentration. Viscosity can also be a function of temperature and concentration. Aquifer properties can vary spatially. Hydrodynamic dispersion is described as a function of velocity. Boundary conditions allow natural water movement in the aquifer, heat losses to the adjacent formation, and location of injection, production, and observation points anywhere in the system.

SWIFTII solves four differential equations, together with a number of submodels describing the nonlinearities, in a sequential manner. Options include:

- Steady-state or transient flow
- Steady-state or transient density-dependent brine transport
- Solute transport
- Heat transport
- Dual porosity or discrete fracture-matrix
- Salt dissolutioning
- Well bore
- Radioactive waste-leach source
- Heterogeneous and/or anisotropic media
- Confined and/or water table conditions and recharge
- Recharge and/or wells

The code is fairly general and can be used to examine most far-field problems. It contains many options in terms of geometry, processes, and boundary conditions. Because it contains heat flow, it may also be used to examine some near-field problems.

SWIFTII is a general-purpose code and is applicable to most geologic media, including fractured rock. The main limitation would be due to the availability of data. It may be valid in many cases to perform a horizontal or vertical averaging. SWIFTII may still be used to perform a one- or two-dimensional simulation for this purpose.

Sensitivity analysis has been performed on both physical and numerical parameters.

Verification of numerical decay processes appear in the SWIFTII documentation. Verification of flow, heat, and solute transport appear in which eight problems are documented.

Three field comparison problems for flow, heat, and solute transport have been performed (Colven et al., 1985).

H.2 ATMOSPHERIC TRANSPORT PATHWAY

Modeling calculations to determine potential risk to human populations due to atmospheric transport of waste materials have been made using a variety of computer codes. The pathway scenarios were inhalation of polluted air and ingestion of contaminated food by individuals and the offsite population. The occupational risk to personnel from airborne contaminants generated during actual waste site closure operations was included.

H.2.1 SOURCE TERMS

Atmospheric source terms for the site were estimated from soil inventories. Contaminants selected for atmospheric transport modeling were the same as those analyzed for the subsurface transport exposure scenario (Looney et al., 1986). Atmospheric source terms account for volatilization of select contaminants (i.e., organics), dust generated by suspension of contaminated soil due to wind erosion, and dust generated as a consequence of excavation of contaminated soil from the site. The time-dependent nature of atmospheric source terms was estimated to account for the time period of interest in this analysis (1000 years). SESOIL (Bonazountas and Wagner, 1984), an EPA soil layer model, was used to estimate the soil contaminant concentration profiles as a function of time. SESOIL accounts for potential upward transport (volatilization) and downward movement (infiltration) of each contaminant for each remedial action. Airborne contaminant loadings are estimated using SESOIL and MARIAH (a National Oceanographic and Atmosphere Administration box model) (Holton et al., 1986). SESOIL estimates the amount of contamination entering the atmosphere over time from the site via volatilization. MARIAH estimates suspended dust loading to the atmosphere and excavation-generated dust loading due to digging, vehicular movement, and dumping. The source term for potential atmospheric transport away from the site - the contaminant loading due to dust - is the product of the dust loading and the contaminant concentration in the top soil layer.

H.2.2 TRANSPORT AND DOSE MODELS

The transport of waste constituents from a waste disposal facility to potential receptor sites through atmospheric dispersion was modeled using the XOQDOQ computer code (Sagendorf, Goll, and Sandusky, 1982). The XOQDOQ code is an NRC model that is used for routine release of atmospheric dispersion calculations to SRP. The code was modified to handle area source terms. The XOQDOQ transport code uses a modified Gaussian plume model to estimate constituent concentration as a function of distance and direction from a waste site. Time-dependent source strength and meteorological conditions were input parameters.

The calculation of the transport of materials from SRP by the atmosphere is based on meteorological conditions that are measured continuously at seven onsite meteorological towers and at a 365-meter television transmitting tower 30 kilometers northwest of the geometric center of the Plant. These meteorological measurements were to calculate the dispersive characteristics of the atmosphere by methods used in the nuclear industry (NRC, 1977a).

H.2.2.1 Nonradiological Exposures

After waste contaminant concentrations at potential receptor locations were determined, the results were translated into individual and population exposures. The maximally exposed individual at the site boundary and general population exposures to airborne substances via inhalation and ingestion pathways were determined. The CONEX computer code (Holton et al., 1986) uses XOQDOQ transport results and local population demographics to estimate time-dependent population exposures to nonradioactive airborne substances. The TERREX computer code (Holton et al., 1986) also uses XOQDOQ transport results along with local crop production data and local population demographics to estimate population data and local foodstuff uptake. The population demographics used in the CONEX and TERREX codes are estimated using a population growth model. Using census data from 1980 as the initial basis, the population growth model estimates the surrounding population from 1980 to 2050. After 2050, the population is assumed to be constant. After the end of the assumed 100-year period of institutional control (2085), the SRP reservation is assumed to be inhabited by the public. Hence, the air receptor is closer to the waste site at the end of the institutional control period.

Risk posed to the public population was calculated using a computer code called MILENIUM (Holton et al., 1986). For each potential airborne contaminant, the MILENIUM code translates time-dependent exposure results into a population dose and into a maximally exposed individual dose. The code uses the dose results and appropriate unit cancer risk (UCR) values and acceptable daily intake (ADI) factors (explained in Appendix I) to estimate excess risks for the population and a maximally exposed individual at the SRP boundary.

Risk posed to the worker involved in waste excavation activities was estimated using the MARIAH and MILENIUM computer codes. MILENIUM uses the source term results generated by MARIAH and appropriate UCRs and ADIs to estimate excess worker risk. A conservative assumption built into these models is that the occupational workforce would not use special protective clothing during waste excavation operations.

H.2.2.2 Radiological Exposures

To calculate the doses and corresponding human health risks associated with the atmospheric transport of radioactive waste materials, DOE used transport and dosimetry models developed for the nuclear industry. These models were developed by the U.S. Nuclear Regulatory Commission (NRC) and others for assessing the effects of operations of licensed commercial nuclear facilities (NRC, 1977b; ICRP, 1978). The radioactive transport and dose models have been implemented in the following computer programs:

- MAXIGASP: Calculates maximum and average doses to offsite individuals from atmospheric releases

- POPGASP: Calculates population doses from atmospheric releases

MAXIGASP and POPGASP are Savannah River Laboratory (SRL) modified versions of the NRC program GASPAR (Eckerman et al., 1980). The modifications enable the input of specific SRP physical and biological data. SRL did not modify the basic calculational methods used in the GASPAR program (Marter, 1984).

The pathway scenarios considered for the calculation of doses received by individuals and the offsite population are inhalation, ingestion, and exposure to direct radiation from material deposited on the ground.

DOE used the annual average concentration and deposition factors calculated with the XOQDOQ program in the MAXIGASP and POPGASP programs, along with data on population distribution, vegetable crop production, milk production, and meat production, to calculate offsite radiation exposure.

The direct gamma exposure pathway calculates the external radiation dose to an individual standing directly over a waste site. This scenario allows the cover material over the waste to erode at a specified rate so the degree of shielding provided by the cover can decrease in time. This pathway also assumes that no loss of contaminants occurs by leaching to the groundwater pathways. The time dependence of the source term is defined solely by radioactive decay.

H.2.2.3 Cumulative Radiological Effects

In evaluating the radiological impacts for the no-action alternative, and during the first year after the implementation of the other three options, the cumulative effects of the operation of all nuclear facilities in the affected region also were considered. This region includes the Savannah River Plant and the area within 80 kilometers of the Plant.

The impacts from the following nuclear facilities, which represent existing and planned operations, were considered in calculating cumulative effects:

- The SRP, which includes four production reactors (L, P, K, and C) with associated support facilities, in addition to the low-level radioactive waste and mixed waste sites

- The Defense Waste Processing Facility, under construction at S-Area on the Plant

- The Fuel Materials Facility, under construction at F-Area on the Plant
- The Fuel Production Facility, to be constructed at H-Area on the Plant
- The Vogtle Electric Generating Station, under construction across the Savannah River from the southwestern boundary of the Plant
- The Barnwell Nuclear Fuel Plant (BNFP; not operating) adjacent to and east of the Plant
- The Chem-Nuclear Services, Inc., low-level radioactive disposal site adjacent to BNFP (no releases expected)

Table H-1 lists the maximum individual and population doses associated with each of these facilities as base-case doses derived from documentation that summarizes doses for releases from each facility (DOE, 1986).

To obtain the cumulative impact of the operation of all nuclear facilities in the region including each of the four alternatives, DOE combined the base-case doses in turn with the doses from the no-action alternative, the no-waste-removal alternative, the waste-removal-at-selected-sites alternative, and the waste-removal alternative.

H.3 ENVIRONMENTAL DOSE COMMITMENT

Man can receive doses externally from radioactive materials outside the body or internally from the intake of radioactive material by inhalation or ingestion. Radionuclides that enter the body are distributed to various organs and are removed by normal biological processes and radioactive decay. The rate at which each radionuclide is removed from the body depends on its chemical, physical, and radiological properties. Historically, dose calculations have included an accounting of doses resulting from the fraction of radionuclides retained in the body for 50 years following the year of intake. The dose commitment factors used in these dose calculations include this 50-year integrating period.

Similarly, radioactive materials released in a given year remain in the environment for varying lengths of time, depending on many environmental factors and on the decay rate of each radionuclide. The environmental dose commitment (EDC) concept has been used to account for this activity.

EPA developed the EDC concept, defining the environmental dose commitment as "...the sum of all doses to individuals over the entire time period the material persists in the environment in a state available for interaction with humans." The EPA report presenting this concept (EPA, 1974) describes its implementation and presents some sample calculations. These calculations integrate doses for 100 years following radionuclide release rather than "the entire time period." This 100-year integrating period is distinct from the 50-year integrating period discussed above because it deals with the accumulation of doses from residual radioactivity in the environment rather than in the body.

Table H-1. Annual Cumulative Maximum Individual and Collective Doses from Atmospheric and Liquid Releases from Indicated Facilities

Dose	Release	Facilities: SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total
Annual maximum individual (millirem per year)	Atmospheric	1.5×10^{1}	7.0×10^{-4}	5.6×10^{-3}	4.0×10^{-5}	5.4×10^{-1}	1.6×10^{1}
	Liquid	1.1	3.7×10^{-3}	6.5×10^{-4}	-	9.9×10^{-1}	2.1
	Combined	1.6×10^{1}	4.4×10^{-3}	6.3×10^{-3}	4.0×10^{-5}	1.5	1.8×10^{1}
Annual collective (person-rem per year)	Atmospheric	8.1×10^{1}	9.4×10^{-2}	7.4×10^{-1}	4.1×10^{-3}	4.8×10^{-1}	8.2×10^{1}
	Liquid	3.2×10^{1}	5.4×10^{-1}	9.2×10^{-2}	-	-	3.3×10^{1}
	Combined	1.1×10^{2}	6.3×10^{-1}	8.3×10^{-1}	4.1×10^{-3}	4.8×10^{-1}	1.1×10^{2}

[a]There will be no radioactive liquid releases during normal FPF operations.
[b]Georgia Power Company, 1985; liquid dose is "negligible."

This analysis uses the 100-year integrating period; in other words, all collective (population) dose calculations include an accounting of collective doses caused by environmental radioactivity levels for 100 years following each year's release. The 100-year period provides meaningful results by accounting for impacts over a period of time that is about equal to the maximum lifetime of an individual; thus, it provides a measure of risk to an individual. Longer integrating periods or an infinite time integral would require extremely speculative predictions about the human environment for thousands of years into the future.

For the EDC calculations, changes in environmental characteristics were not predicted. Population size and distribution were based on the latest estimates. The analysis assumed that the historic meteorology would continue into the future and that food production and consumption patterns would be static.

REFERENCES

Bonazountas, M., and J. Wagner, 1984. SESOIL: A Seasonal Soil Component Model, Arthur D. Little, Inc., Cambridge, Massachusetts.

Colven, W. D., T. H. Killian, M. W. Grant, C. M. King, B. B. Looney, I. W. Marine, D. W. Pepper, and D. E. Stephenson, 1985. Groundwater Numerical Modeling Studies at the Savannah River Plant, DPST-85-887, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

DOE, 1986. Draft Environmental Impact Statement, Alternative Cooling Water Systems, Savannah River Plant, Aiken, South Carolina, DOE/EIS-0121D, Savannah River Operations Office, Aiken, South Carolina.

Eckerman, K. F. et al., 1980. Users Guide to GASPAR Code, NUREG-0597, U.S. Nuclear Regulatory Commission, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1974. Environmental Radiation Dose Commitment: An Application to the Nuclear Power Industry, EPA-520/4-73-002, Washington, D.C.

Fjeld, R. A. , A. W. Elzerman, T. J. Overcamp, N. Giannopoulos, S. Crider, and B. L. Sill, 1986. Verification and Sensitivity of the Calculational Methods Used in the PATHRAE Code To Predict Subsurface Contaminant Transport for Risk Assessments of SRP Waste Sites, Department of Environmental Systems Engineering and Department of Civil Engineering, Clemson University, Clemson, South Carolina.

Georgia Power Company, 1985. Vogtle Electric Generating Plant, Unit 1 and Unit 2, Applicant's Environmental Report - Operating License Stage, Amendment 6.

Holton, G. A., D. F. Montague, M. P. Johnson, M. D. Muhlheim, and S. B. Farmer, 1986. Atmospheric Contaminant Transport Analysis and Human Health Risk Assessment at Savannah River Plant, draft final report, J. B. Associates, Inc., Knoxville, Tennessee.

ICRP (International Commission on Radiological Protection), 1978. Limits for Intakes of Radionuclides by Workers, Publication 30, Pergamon Press, New York.

Looney, B. B., J. B. Pickett, C. M. King, W. G. Holmes, J. A. Smith, and W. F. Johnson, 1986. Selection of Chemical Constituents for an Estimation of Inventories for Environmental Analysis of Savannah River Plant Waste Sites, DPST-86-291, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Marter, W. L., 1984. Environmental Dosimetry for Normal Operation at SRP, DPST-83-270, Revision 1, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

McDonald, M. G., and A. W. Harbaugh, 1984. A Modular Three-Dimensional Finite Difference Groundwater Flow Model, U.S. Geological Survey, Open File Report 83-875.

Merrell, G. B., and V. C. Rogers, 1986. Modeling of Waste Sites at the Savannah River Plant Using the PATHRAE Computer Code, Rogers and Associates Engineering Company, Salt Lake City, Utah.

Merrell, G. B., V. C. Rogers, and M. K. Bollenbacher, 1986. PATHRAE-RAD Performance Assessment Code for Land Disposal of Radioactive Waste, Rogers and Associates Engineering Company, Salt Lake City, Utah.

NRC (U.S. Nuclear Regulatory Commission), 1977a. Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Regulatory Guide 1.111, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), 1977b. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, Regulatory Guide 1.109, Revision 1, Washington, D.C.

Rogers, V. C., G. B. Merrell, and M. K. Bollenbacher, 1986. The PATHRAE-HAZ Performance Assessment Code for Land Disposal of Hazardous Chemical Wastes, Rogers and Associates Engineering Company, Salt Lake City, Utah.

Sagendorf, J. F., J. T. Goll, and W. F. Sandusky, 1982. XOQDOQ: Computer Program for Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations, NUREG/CR-2919, Pacific Northwest Laboratory, Richland, Washington.

Stephenson, D. E., C. M. King, M. W. Grant, and D. B. Looney, 1986. Methodology for Productive Modeling of Environmental Transport and Health Effects for Waste Sites at the Savannah River Plant (draft), DPST-86-710, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

TABLE OF CONTENTS

LIST OF TABLES

APPENDIX I

HEALTH EFFECTS

This appendix describes the models used to estimate health risks to the public from exposures to chemical and radioactive waste materials following the implementation of each remedial alternative. The appendix divides the modeling methodology into its component parts and describes each to provide sufficient information for an understanding of the application of risk assessment to the remedial alternative selection process.

Risk assessment has three major components: (1) hazard assessment, consisting of hazard identification and dose-response assessment; (2) exposure assessment; and (3) risk characterization (King et al., 1986). These components are common to all assessments of the risk of exposure to hazardous substances, regardless of the substance under investigation, the species, the population or environmental systems at risk, the medium in which exposure occurs, the route of exposure, or the adverse effects under consideration.

Hazard assessment involves the identification of substances of concern (i.e., as subjects of the risk assessment) and an initial determination of the intrinsic toxicity of these materials (dose-response assessment). Exposure assessment is the process of measuring or estimating the intensity, duration, and frequency of exposure to these pollutants, including the identification of routes of exposure and the determination of human receptors at risk; Appendix H describes this element of risk assessment. Risk characterization is the process of estimating the incidence of an adverse effect under the various conditions of exposure described in the exposure assessment; it involves combining the results of the exposure and hazard (dose-response) assessments.

I.1 <u>HAZARD ASSESSMENT</u>

I.1.1 HAZARD IDENTIFICATION

Hazard identification is the process of determining whether exposure to an agent can cause an increase in the incidence of a health condition (cancer, birth defects, etc.). According to the National Research Council hazard identification involves characterizing the nature and strength of the evidence of causation (National Research Council, 1983). The Savannah River Plant (SRP) health risk analysis identified certain chemical and radioactive waste materials as hazardous on a site-by-site basis. An indepth evaluation of these materials, using transport modeling and risk calculations, forms the basis of the risk assessment.

The hazard evaluation process was divided into two parts. First, the available data - including soil characterization studies, groundwater analyses, influent records, and process chemical usage - were analyzed to determine what chemicals might have been disposed at each site. Second, the concentration of each chemical was compared to a "selection criterion" listing. If the groundwater or soil concentration exceeded the selection criterion, the material was selected as a part of the transport modeling and risk calculation

studies. In addition, if large amounts of specific chemicals were believed to have been released to the site (based on inventory or process usage), those materials were included for assessment, even if the soil or groundwater characterization data did not indicate their presence (Looney et al., 1986).

Soil and groundwater concentration criteria for selection of radioactive and chemical wastes and sites for evaluation were based on toxicological and modeling information published by the U.S. Environmental Protection Agency (EPA). Additionally, the South Carolina Department of Health and Environmental Control (SCDHEC) regulations governing groundwaters of the State were considered in setting selection criteria (Looney et al., 1986).

The selection of a radionuclide from an SRP site for environmental assessment and dose-risk calculations was based on detection of that radionuclide in soils or groundwater at levels that exceed the guideline activity concentrations listed in Table I-1 (Looney et al., 1986). These concentrations correspond to those that would be "below regulatory concern" (Guimond and Galpin, 1984) or "de minimis" (NRC, 1984); that is, they would produce a negligible increase in societal risk of adverse health effects (10^{-5} to 10^{-7} lifetime risk increment). The groundwater concentrations correspond to 1-half the EPA Interim Primary Drinking Water Standard of 4 millirem per year (EPA, 1976). The soil concentrations are derived by considering all dose pathways, both external and internal, that would result in a dose to the maximally exposed individual that does not exceed 30 millirem per year. This value provides a margin below the DOE standard of 100 millirem per year when combined with the annual exposures from the drinking-water and airborne pathways of 4 and 25 millirem, respectively.

Groundwater and soil criteria for selection of chemical waste constituents and sites for evaluation were also established. In determining whether a given nonradioactive compound present in groundwater at SRP waste sites was the subject of a risk or environmental assessment, measured levels in groundwater were compared with maximum contaminant limits (MCLs) or other health-based standards. If the observed levels exceeded 0.5 times the MCL (or, in the absence of the MCL, 1 times other relevant health criteria or guidelines), the compound was included in the assessment. This approach resulted in the assessment of a larger number of chemicals present in groundwater, and, therefore, was more conservative than a comparison made solely on the basis of EPA delisting guidelines (Looney et al., 1986).

The approach for the selection of compounds for risk assessment based on soil contaminant concentrations was similar to that developed by EPA in the final rule on identification and listing of hazardous waste (EPA, 1985a). Using a 20-fold dilution factor based on EP toxicity testing procedures (EPA, 1984) and assuming a dilution factor of 10 to account for hydrodynamic dispersion in a saturated groundwater system, Looney et al. (1986) developed the following soil constituent concentration criterion:

$$\text{Soil criterion } (\mu g/g) = \text{MCL } (\mu g/L) \times 10 \times 20 \times \frac{1L}{1000g/L}$$

Table I-1. Selection Criteria for Radioactive Constituents[a]

Constituent	Groundwater concentration guideline (pCi/L)	Soil concentration guideline (pCi/g)
Americium-241	8	2.6×10^{1}
Americium-243	8	7.9
Antimony-125	150	NA
Carbon-14	NA	4.9
Cesium-134	10,000	4.2
Cesium-135	NA	4.7×10^{1}
Cesium-137	450	1.1×10^{1}
Cobalt-60	50	2.9
Curium-243	8	1.9×10^{1}
Curium-244	8	6.0×10^{1}
Curium-246	8	7.6
Hydrogen (tritium)	10,000	2.7×10^{4}
Iodine-129	0.5	2.9
Iron-55	NA	4.1×10^{2}
Neptunium-237	NA	4.3×10^{-1}
Nickel-59	NA	2.6×10^{2}
Nickel-63	NA	1.1×10^{4}
Niobium-94	NA	2.7
Plutonium-238	8	3.3×10^{1}
Plutonium-239	8	3.3×10^{1}
Plutonium-240	8	3.3×10^{1}
Plutonium-241	NA	1.9×10^{3}
Plutonium-242	8	3.2×10^{1}
Sodium-22	200	NA
Strontium-90	4	3.4×10^{1}
Technetium-99	450	2.0×10^{2}
Uranium-233	NA	6.5×10^{1}
Uranium-235	NA	1.5×10^{1}
Uranium-238	NA	2.2×10^{1}

[a]Source: Looney et al., 1986.

where:

MCL = the maximum constituent limit (or other health-based criteria of relevance in the absence of the MCL)

10 = dilution factor due to mixing in groundwater

20 = dilution factor due to leaching in the unsaturated zone

This criterion represents the level of a given constituent in soil that would result in a concentration equivalent to the MCL in water at a receptor well 152 meters downgradient, based on the VHS model used by EPA for screening purposes.

Table I-2 lists the groundwater and soil criteria developed for each nonradioactive waste constituent identified by sampling and analysis at the various sites. The hazard assessment component of the health risk assessment model was accomplished by the selection of nonradioactive constituents based on (1) exceeding concentration criteria, (2) exceeding the soil criteria, or (3) indicating that a particularly hazardous constituent was present in the site waste. In some cases, background concentration information and analytical protocol information were factored into the selection process.

I.1.2 DOSE-RESPONSE ASSESSMENT

Health impacts associated with exposure to radionuclides usually are treated separately from impacts associated with nonradioactive materials (King et al., 1986). Similarly, risk characterization for carcinogens and noncarcinogens usually is considered separately. This is due to a fundamental difference in the way organisms typically respond to these classes of compounds. For noncarcinogens, toxicologists recognize the existence of a threshold of exposure below which there is only a small likelihood of adverse health effects in an exposed population. Exposure to carcinogenic compounds, however, is not characterized by the existence of a threshold. Rather, all levels of exposure are considered to carry a risk of adverse effect (risk per unit dose). Carcinogenic risks are associated with radionuclides and some nonradioactive materials.

I.1.2.1 Radiological Risks

Health impacts from radiation exposure, whether from sources external or internal to the body, generally are considered to be "somatic" (affecting the individual exposed) or "hereditary" (affecting descendants of the exposed individual). At low doses, the induction of fatal cancers, which is the somatic risk of most importance, is responsible for the major portion of health effects estimates provided.

The dose-response relationship used in this analysis assumes a linear non-threshold model; that is, the health effects probabilities observed in studying populations exposed to high doses at high dose rates are assumed to apply in proportion to the dose, at the low dose levels estimated to result from these proposed actions. Although the probability of health effects resulting from radiation exposure depends on age, sex, type of radiation, and other factors, a review of reports by the Committee on the Biological Effects of Ionizing Radiation (BEIR, 1980), the International Commission on Radiological Protection (ICRP, 1977), and the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR, 1982) indicates that, for average populations, a reasonable range is $1.65 - 2.80 \times 10^{-4}$ adverse (fatal) effects per man-rem of collective dose. The upper limit of this range is used in this analysis to estimate radiological risks and includes all fatal stochastic (probabilistic) somatic and genetic effects.

Table I-2. Selection Criteria for Nonradioactive Constituents[a]

Constituent	Groundwater concentration guideline (μg/l)	Soil concentration guideline (pCi/g)
Aluminum	NS[b]	NS
Arsenic	25	10
Barium	500	200
Beryllium	NS	NS
Cadmium	5	2
Chloride	NS	NS
Chromium	25	25
Copper	1,000	200
Cyanide	100	40
Fluoride	2,000	800
Iron	NS	NS
Lead	25	10
Mercury	1	0.4
Manganese	NS	NS
Nickel	175	70
Nitrate (as N)	5,000	2,000
Phosphate (as P)	10	150
Selenium	5	2
Silver	25	10
Sodium	10,000	4,000
Sulfate	400,000	80,000
Zinc	5,000	1,000
Endrin	0.1	0.04
Lindane	2	0.8
Methoxychlor	50	20
Silvex	5	2
Toxaphene	2.5	1
2-4,D	50	20
Trichloroethylene	2.5	1
Carbon tetrachloride	2.5	1
Vinyl chloride	0.5	0.2
1,2-dichloroethane	2.5	1
Benzene	2.5	1
1,1-dichloroethylene	3.5	1.4
1,1,1-trichloroethane	100	40
p-dichlorobenzene	375	150
Formaldehyde	15	3
Dichloromethane	60	12
Chlorobenzene	1,000	200
Chloroform	0.5	0.1
Ethyl benzene	2,500	700

Footnote on last page of table.

Table I-2. Selection Criteria for Nonradioactive Constituents[a] (continued)

Constituent	Groundwater concentration guideline (μg/l)	Soil concentration guideline (pCi/g)
Tetrachloroethylene	0.7	0.14
Toluene	10,000	2,000
1,1,2-trichloroethane	0.6	0.12
Di-n-butyl-phthalate	44,000	8,800
Bis(2-ethylhexyl)phthalate	20,000	4,000
Diethyl-phthalate	500,000	100,000
Methyl ethyl ketone	2,000	400
Trichlorofluoromethane	10,000	2,000
1,1,2-Trichloro-1,2,2-trifluoroethane	455,000	175,000
1,2-dichloroethylene	350	70
Phenol	3500	700
Dichlorobenzenes	3000	600
Trifluorotrichloroethane	955	191
Fluoroanthene	5	1
Naphthalene	5	1
Xylene	NS	7
Tetrachlorobiphenyl	NS	1
Pentachlorobiphenyl	NS	1
Hexachlorobiphenyl	NS	1

[a]Source: Looney et al., 1986.
[b]NS = No standard.

I.1.2.2 Nonradioactive Carcinogenic Risks

The procedure for calculating risk of exposure to carcinogenic compounds used in the SRP risk assessment is well documented (National Research Council, 1983; EPA, 1983; Roderick, 1984; King et al., 1986). A nonthreshold dose-response model was used to calculate a unit risk value (risk per unit dose) for each chemical; Table I-3 lists unit cancer risks (UCRs) for a select list of SRP waste constituents. The risk per unit dose (UCR) was multiplied by the estimated average daily lifetime dose experienced by the exposed population, to derive an estimate of risk as follows:

$$R = D \times UCR$$

where:

D = average daily lifetime dose (milligrams per kilogram of body weight per day)

UCR = unit cancer risk estimate [(milligrams per kilogram of body weight per day)$^{-1}$]

Table I-3. Toxicity Data for Potential Carcinogenic Effects[a]

Chemical	Ingestion $(mg/kg/day)^{-1}$	Inhalation $(mg/kg/day)^{-1}$
Arsenic and compounds	1.50×10^{1}	5.00×10^{1}
Beryllium and compounds	-	2.60
Cadmium and compounds	-	7.8
Chromium VI and compounds	-	4.1×10^{1}
Nickel and compounds	-	1.20
Aldrin	1.10×10^{1}	
Benzene	4.45×10^{-2}	2.60×10^{-2}
Carbon tetrachloride	1.3×10^{-1}	
Chloroform	7.00×10^{-2}	
1,2-dichloroethane	6.90×10^{-2}	
1,1-dichloroethylene		1.50×10^{-1}
Dichloromethane (methylene chloride)		6.30×10^{-4}
Lindane	1.33	
Polychlorinated biphenyls	4.34	
Polynuclear aromatic hydrocarbons	1.15×10^{1}	6.10
2,3,7,8 TCDD (dioxin)	1.56×10^{5}	
1,1,2,2-tetrachloro-ethane	2.00×10^{-1}	
Tetrachloroethylene	5.10×10^{-2}	1.70×10^{-3}
Toxaphene	1.10	

Footnote on last page of table.

Table I-3. Toxicity Data for Potential Carcinogenic Effects[a] (continued)

Chemical	Ingestion $(mg/kg/day)^{-1}$	Inhalation $(mg/kg/day)^{-1}$
1,1,1-trichloroethane	1.6×10^{-3}	
1,1,2-trichloroethane	5.73×10^{-2}	
Trichloroethylene	1.10×10^{-2}	4.60×10^{-3}
Vinyl chloride	2.30	2.50×10^{-2}

[a]Source: King et al., 1986.

R is an explicit estimate of risk and will have a value between 0 and 1. In evaluating the risk of exposure to more than one carcinogen, the risk values (R) for each compound were summed to give an overall estimate of total carcinogenic risk (EPA, 1983; Roderick, 1984). This was done for each source of environmental release, for each associated pathway, and for each receptor group at risk of exposure.

I.1.2.3 Nonradioactive Noncarcinogenic Risks

The traditionally accepted practice of evaluating exposure to noncarcinogenic compounds has been to determine experimentally a no-observable-effect level (NOEL) and to divide this by a "safety factor" to establish an acceptable human dose [e.g., acceptable daily intake or ADI (National Research Council, 1983)]. Table I-4 lists values of ADIs used in this analysis. The ADI was compared to the average daily dose experienced by the exposed population to obtain a measure of risks as follows:

$$R = D/ADI$$

where:

D = average daily lifetime dose (milligrams per kilogram of body weight per day)

ADI = acceptable daily intake for chronic exposure (milligrams per kilogram of body weight per day)

The method of developing acceptable limits of exposure implies that the application of safety factors of various magnitudes to an experimentally derived NOEL will ensure minimal risk. The acceptable exposure levels (e.g., ADIs) typically are derived by making assumptions about the nature of dose-response relationships at low doses, and by drawing inferences based on the available data (National Research Council, 1983).

The risk values derived for noncarcinogens will vary from less than 1 to more than 1. The smaller the value of R, the larger the margin of safety (MOS). The smaller the MOS, the larger the risk.

Table I-4. Toxicity Data for Noncarcinogenic Effects[a]

Chemical	Ingestion (mg/kg/day)	Inhalation (mg/kg/day)
	INORGANIC	
Arsenic and compounds	0.00	2.80×10^{-3}
Barium and compounds	5.10×10^{-2}	1.40×10^{-4}
Cadmium and compounds	2.90×10^{-4}	
Chromium III and compounds	1.50	5.10×10^{-3}
Chromium VI and compounds	5.00×10^{-3}	
Copper and compounds	3.70×10^{-2}	1.00×10^{-2}
Iron and compounds		8.60×10^{-3}
Lead and compounds	1.40×10^{-3}	4.30×10^{-4}
Manganese and compounds	2.20×10^{-1}	3.00×10^{-4}
Mercury and compounds (alkyl)	2.80×10^{-4}	1.00×10^{-4}
Mercury and compounds (inorganic)	2.00×10^{-3}	5.10×10^{-5}
Nickel and compounds	1.00×10^{-1}	1.20
Phosphoric Acid (H_3PO_4)	5.10×10^{-3}	5.10×10^{-3}
Selenium and compounds	3.00×10^{-3}	1.00×10^{-3}
Silver	3.00×10^{-3}	
Sodium	5.70×10^{-1}	
Sulfuric Acid (H_2SO_4)	5.10×10^{-3}	5.10×10^{-3}
Zinc and compounds	2.10×10^{-1}	1.00×10^{-2}
Chloride	3.00×10^{-1}	

Footnote on last page of table.

Table I-4. Toxicity Data for Noncarcinogenic Effects[a] (continued)

Chemical	Ingestion (mg/kg/day)	Inhalation (mg/kg/day)
	INORGANIC (continued)	
Cyanides	2.00×10^{-2}	
Fluorides	5.00×10^{-2}	
Nitrate	2.86×10^{-1}	
Phosphate	3.0×10^{-1}	
Sulfate	3.5×10^{-1}	
	ORGANIC	
Bis-2ethylhexyl phthalate	6.00×10^{-1}	
Carbon tetrachloride	7.00×10^{-4}	
Chlorobenzene	2.70×10^{-2}	5.70×10^{-3}
Dibutyl phosphate	2.55×10^{-2}	2.55×10^{-2}
1,2 Dichlorobenzene	9.00×10^{-2}	
1,1 Dichloroethane	1.20×10^{-1}	1.40×10^{-1}
trans-1,2 Dichloroethylene	4.03	4.03
Dichloromethane (methylene chloride)	5.00×10^{-2}	
2,4 Dichlorophenoxy-acetic acid (2,4D)	1.26×10^{-1}	
n-Dodecane	7.40	7.40
Endrin	1.00×10^{-3}	
Ethylbenzene	9.70×10^{-2}	
Freon	2.86×10^{1}	2.86×10^{1}

Footnote on last page of table.

Table I-4. Toxicity Data for Noncarcinogenic Effects[a] (continued)

Chemical	Ingestion (mg/kg/day)	Inhalation (mg/kg/day)
	ORGANIC (continued)	
Lindane	3.00×10^{-4}	
Methoxychlor	5.00×10^{-2}	
Methyl ethyl ketone	4.60×10^{-2}	
Naphthalene	2.60×10^{-1}	
Phenol	1.00×10^{-1}	2.00×10^{-2}
Silvex	9.00×10^{-3}	
Sym-Trimethylbenzene	6.38×10^{-1}	6.38×10^{-1}
Tetrachloroethylene	2.00×10^{-2}	
Toluene	2.90×10^{-1}	
Tributyl Phosphate	1.28×10^{-2}	1.28×10^{-2}
1,1,1 Trichloroethane	5.40×10^{-1}	6.30 HEA
Tylene (mixed)	1.00×10^{-2}	4.00×10^{-1}

[a]Source: King et al., 1986.

The data base (King et al., 1986) for UCRs and ADIs for inhalation and ingestion pathways was derived from the EPA Superfund Public Health Evaluation Manual (EPA, 1983), which was designed to conform to EPA's proposed risk assessment guidelines (49 FR 46294-46331; 50 FR 1170-1176) and to serve as a framework for analyzing public health risks and for developing design goals for remedial alternatives.

I.1.2.4 Occupational Risks

Occupational risks due to workers' exposures to radioactive constituents were estimated with the use of the methodology outlined in Section I.1.2.1 for assessing public risk. The occupational risks are based on the assumption that the average worker is exposed for 40 hours per week, for the period of cleanup. If a worker were exposed to the DOE annual occupational dose limit of 5 rem to the whole body, the increased risk to that worker would be 1.4×10^{-3} health effects. Occupational risks due to worker exposures to nonradioactive carcinogenic and noncarcinogenic constituents were estimated

with the use of the methodologies outlined in Sections I.1.2.2 and I.1.2.3, respectively, for assessing public risk, with the following exceptions. The occupational risks are based only on worker exposure via the inhalation pathway and assuming the average individual works at the site for 8 hours each day, for the period of cleanup.

I.2. RISK CHARACTERIZATION

I.2.1 GENERAL APPROACH

Risk characterization is the process of estimating the incidence of a health effect under the various conditions of human exposure described in the exposure assessment (National Research Council, 1983). It essentially combines the exposure and dose-response assessments.

Risks associated with exposure to radionuclides and nonradioactive carcinogenic waste materials are characterized as the probability of a health effect occurring in an exposed individual or the number of health effects in a population group.

The individual risks take on values ranging from 0 to 1. For example, a 10^{-6} cancer risk indicates that an individual incurs a one-in-a-million additional chance (i.e., above the normal likelihood) of cancer due to exposure to the waste material. In this analysis, cancer risk estimates have been added when concurrent exposure to more than one carcinogen occurs. For example, con- current exposure to two waste constituents, each posing a 10^{-6} cancer risk, is assumed to yield an overall 2×10^{-6} additional cancer risk (i.e., two chances in a million, or one in 500,000) beyond the normal likelihood of cancer.

Risk characterization for exposure to noncarcinogens is estimated from the fraction of the ADI represented by the estimated dose. A fractional ADI less than 1.0 indicates that the estimated exposure dose is less than that recognized as constituting a health hazard. Consequently, some MOS exists at the estimated dosage if the fraction of ADI is less than 1. Under this system, the smaller the MOS, the larger the risk. For example, if the fraction of ADI is 0.1 for one contaminant, and 0.01 for another, the latter (0.01) has a larger associated MOS than the former (0.1) and, hence, a lower attendant risk of the associated health effect.

ADI fractions can be added when concurrent exposure to more than one noncarcinogen occurs to provide a means of evaluating the MOS resulting from exposure to a mixture of contaminants. In such cases, the hazard index (HI) (EPA, 1985b) of the mixture based on the assumption of dose additivity is defined as

$$HI = E_1/AL_1 + E_2/AL_2 + \ldots + E_i AL_i$$

where:

E_i = exposure level to the i^{th} toxicant

AL_i = maximum acceptable level for the i^{th} toxicant

Because the inverse of the acceptable level can be used as an estimate of toxic potency, the equation can be interpreted as a normalized weighted-average dose, with each component dose scaled by its potency. As this index approaches unity, concern for the potential hazard of the mixture increases. If HI is greater than 1, the concern for the potential hazard is the same as if an acceptable level were exceeded for an individual compound (i.e., if E_i/AL_i exceeded 1). If the variabilities of the acceptable levels are known, or if the acceptable levels are given as ranges (e.g., associated with different margins of safety), then HI should be presented with estimates of variation or as a range (EPA, 1985b).

The hazard index is not a mathematical prediction of incidence of effects or severity. Statistical properties of this index and its dependence on the shape of the dose-response curves for the components are not known. Much additional research is required to determine the accuracy of the hazard index as a numerical prediction of toxic severity. The hazard index is only a numerical indicator of the transition between acceptable and unacceptable exposure levels and should not be overinterpreted (EPA, 1985b).

I.2.2 WASTE SITE RISK CHARACTERIZATION

To characterize the risks associated with potential exposure to hazardous materials at any SRP waste site, the dosages, as determined in the exposure assessment step, were evaluated in terms of their attendant carcinogenic and noncarcinogenic risks. Radioactive and nonradioactive carcinogenic risks were evaluated separately for the mixed waste sites.

Carcinogenic and noncarcinogenic risks were calculated for all exposure scenarios (subsurface and atmospheric) over the 1000-year time period for each remediation option. Risks were displayed in tabular or graphic format over appropriate time intervals, usually 100 years. Maximum risks and time of occurrence were also calculated and displayed. Additionally, summary estimates of risks for all exposure routes were computed by summing the carcinogenic risk estimates and ADI fractions. These risks are presented in Chapter 4 of this statement for each of the sites and remediation alternatives evaluated.

The methods for evaluating and characterizing carcinogenic and noncarcinogenic risks have been used only to assess the relative risk of adverse effects from alternative remediation options at a given site or from one site to the next on the SRP. These methods are not to be assumed to be a quantitative evaluation and prediction of the incidence of adverse effects in exposed populations, but are rather a tool for the assessment of relative risk (i.e., comparison across sites or across the different remediation options).

REFERENCES

BEIR (Committee on Biological Effects of Ionizing Radiation, National Academy of Sciences), 1980. The Effects on Population of Exposure to Low Levels of Ionizing Radiation, Division of Medical Sciences, Assembly of Life Sciences, National Research Council, National Academy of Sciences, Washington, D.C.

EPA (U.S Environmental Protection Agency), 1976. "National Interim Primary Drinking Water Standards," 40 CFR 141.

EPA (U.S. Environmental Protection Agency), 1983. Superfund Risk Evaluation Manual, Part I, Draft, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., and updates.

EPA (U.S. Environmental Protection Agency), 1984. "Identification and Listing of Hazardous Waste," 40 CFR 261, Appendix II, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985a. "Hazardous Waste Management System: Identification and Listing of Hazardous Waste," 50 Federal Register 48886-48967, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985b. "Proposed Guidelines for the Health Risk Assessment of Chemical Mixtures and Request for Comments," 50 Federal Register 1170-1176, Washington, D.C.

Guimond, R. J., and F. L. Galpin, 1984b. "EPA's View on de minimis Limit for Nuclear Radiation Practice," U.S. Environmental Protection Agency, paper presented to the Health Physics Society, New Orleans, Louisiana.

ICRP (International Commission on Radiological Protection), 1977. Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Permagon Press, New York.

King, C. M., W. L. Marter, B. B. Looney, J. B. Pickett, 1986. Environmental Information Document, Methodology and Parameters for Assessing Human Health Effects for Waste Sites at the Savannah River Plant, DPST-86-298, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Looney, B. B., J. B. Pickett, C. M. King, W. G. Holmes, J. A. Smith, and W. F. Johnson, 1986. Selection of Chemical Constituents for an Estimation of Inventories for Environmental Analysis of Savannah River Plant Waste Sites, DPST-86-291, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

NRC (U.S. Nuclear Regulatory Commission), 1984. Proposed Revision to 10 CFR 19, 20, 30, 31, 32, 34, 40, 50, 51, and 70.

National Research Council, 1983. Risk Assessment in the Federal Government; Managing the Process, National Academy Press, Washington, D.C.

Roderick, J. V., 1984. "Risk Assessment at Hazardous Waste Disposal Sites," Hazardous Waste, Vol. 1, No. 3, pp. 333-362.

UNSCEAR (United Nations Scientific Committee on Effects of Atomic Radiation), 1982. Ionizing Radiation: Sources and Biological Effects, 1982 Report to the General Assembly, United Nations, N.Y.

TABLE OF CONTENTS

APPENDIX J

WASTE MANAGEMENT DEMONSTRATION PROGRAMS

This appendix describes hazardous, low-level radioactive, and mixed waste demonstration programs that have been implemented at SRP. These programs were established to demonstrate the feasibility of treatment or disposal technologies for these categories of wastes. One demonstration program has led to the establishment of a full-scale operating system for groundwater recovery and remedial action.

J.1 HAZARDOUS WASTE DEMONSTRATION PROGRAMS

Research is under way on cement/fly-ash solidification of the DWPF supernate to form saltstone monoliths suitable for disposal. This process is also being considered for stabilizing the following wastes: (1) incinerator ash and scrubber blowdown, (2) effluent treatment facility (ETF) sludges, and (3) still-bottom sludge from the Naval Reactor Fuel Materials Facility (FMF) process-water treatment.

J.2 MIXED WASTE DEMONSTRATION PROGRAMS

At present, the Savannah River Plant (SRP) has no demonstration programs for mixed wastes. However, research on a method for the stabilization of some wastes of this type is under way (see Section J.3.2).

J.3 LOW-LEVEL RADIOACTIVE WASTE DEMONSTRATION PROGRAMS

J.3.1 INCINERATION

DOE is developing a full-scale incineration process for nonhazardous, slightly radioactive solvent and beta-gamma contaminated solid wastes and is demonstrating this process at SRP. The incinerator is a two-stage, controlled air unit capable of incinerating 181 kilograms of solids per hour or 1500 liters of liquid wastes per hour. Waste in the first chamber is pyrolyzed at 900°C. Final combustion is achieved with excess air in the second stage at 1000°C (Lewandowski, Long, and Mersman, 1984).

From October 1981 through September 1982, the Savannah River Laboratory (SRL) demonstrated the incineration equipment by burning nonradioactive solid and solvent wastes. The equipment was moved from the laboratory for further demonstration and low-level waste incineration. In January 1984, DOE began a 2-year SRP demonstration program to develop further the process for incinerating nonhazardous solvents, to demonstrate solids burning capabilities, to incinerate the existing inventory of radioactive solvents, and to burn a fraction of the newly generated, suspect-low-level, radioactive solid wastes. This incinerator has received all applicable permits.

This program demonstrated the following key elements of equipment operation, optimization, and maintenance (Lewandowski, Long, and Mersman, 1984):

- Successful relocation and operational testing of the process equipment.
- Selection and testing of a suitable spray nozzle for burning solvent slurry; optimization of the feed rates for the solvent and atomizing medium.
- Testing of several spray nozzle locations and orientations.
- Conformation of parameters for operating the dry off-gas system.
- Chemical fixing of the phosphorus released by burning tributyl phosphate using tetrabutyl titanate as a fixative; this minimizes the formation of phosphoric acids and reduces long-term corrosion rates and filter blinding.
- Removal of ash from the incinerator on a semicontinuous basis, using two automatically sequenced ash rams that are electrically interlocked and designed to remove ash after it has cooled in a removal duct.
- Replacement of the castable refractory in both chambers of the incinerator with 80 percent brick and 20 percent castable refractories.
- Enhancement of combustion safeguards by placing strongbacks on the incinerator cleanout doors.
- Improvements in the application of the hydraulic cylinders.
- Development of a method for incinerating small amounts of water in the solvent slurry.

In addition, a pilot incinerator for transuranic (TRU) wastes is operating on the Plant. This is an infrared movable-grate incinerator with a capacity of about 11 kilograms of solids per hour. Results of research conducted with this incinerator could be applied to low-level radioactive mixed wastes on the Plant.

J.3.2 SOLIDIFICATION/STABILIZATION

SRP has an active waste-stabilization program. Greater confinement disposal (GCD) techniques are being tested at the Burial Ground (643-7G). The goal of GCD is to dispose of the higher activity fraction of low-level radioactive wastes in a near-zero-release facility that would meet U.S. Nuclear Regulatory Commission (NRC) guidelines (10 CFR 61). Self-leveling cement grout is used to solidify the wastes before placement in a GCD demonstration borehole or trench (Cook et al., 1984).

GCD boreholes on the Plant have been in operation for about 2 years. It is too early to assess long-term performance. However, the boreholes have been free of liquids, indicating that no water is infiltrating to the waste. The grout liner is expected to last for hundreds of years. While the lifetime of the inner fiberglass liner is not known, the fiberglass is made with a resin

that is specifically unaffected by most chemicals; it is expected to be stable in the grout matrix for more than 100 years (Du Pont, 1986).

Another solidification program currently under way involves the ashcrete demonstration facility. This process solidifies low-level radioactive ash generated by the Beta-Gamma Incinerator. The demonstration facility will accept ash in 0.2-cubic-meter drums; add water, cement, and sand; and tumble the drums to produce a containerized solidified waste ready for disposal.

Research also is under way on cement/fly-ash solidification of various low-level radioactive wastes (J.1).

J.3.3 COMPACTION

Compactor demonstration programs on the Plant are evaluating volume reduction technologies for low-level radioactive waste. The Du Pont Reactor Department and the Savannah River Laboratory each use a small (0.15-cubic-meter) box compactor. Annually, these units will reduce approximately 425 cubic meters of job-control wastes to approximately 140 cubic meters. Data from these demonstrations will determine the number of additional compactors to be installed.

A large box compactor in H-Area compacts wastes into 2.5-cubic-meter, carbon steel boxes. As waste items are received in cardboard boxes, radiation levels are verified and the waste is fed manually to the compactor. Approximately 2265 cubic meters of waste can be compacted to a volume of about 565 cubic meters. This demonstration will permit the determination of achievable volume reduction for low-level radioactive waste and a classification of compactible material, loading techniques and ventilation-control requirements.

Another large box compactor has been installed in M-Area. This unit will compact about 700 cubic meters to a volume of about 170 cubic meters or less.

These compactor programs are expected to achieve a 9-percent reduction (approximately 2400 cubic meters annually; Mentrup, 1985) in the amount of low-level waste disposed of at the Burial Grounds.

J.3.4 SHREDDING

SRP generates as much as 1415 cubic meters of TRU combustible and noncombustible wastes each year. Since 1965, such waste has been stored at the Burial Ground (643-G and 643-7G) for retrieval. Shredders will be used in the TRU processes developed to prepare these wastes for final disposal; these processes will handle both newly generated wastes and waste now being stored for retrieval.

Demonstration programs are in progress at both SRP and SRL. Two small (45- and 15-horsepower) shredders will prepare combustible TRU-contaminated waste for incineration. These units, which have been installed in a pilot-plant facility for thorough nonradioactive testing, will demonstrate a remote operation and maintenance capability.

A large (160-horsepower) shredder will size-reduce decontaminated noncombustible items, such as decommissioned glove boxes and process equipment. This unit is being installed in an integrated test facility for demonstration of

remote operation and maintenance technique. Simulated glove boxes made of both 0.3- and 0.6-centimeter steel and stainless steel have been size-reduced successfully (Charlesworth, 1985).

J.4 REMEDIAL AND CLOSURE ACTION DEMONSTRATION PROGRAMS

At present, DOE has no major demonstration projects on the SRP to define specific remedial and closure actions for existing waste sites. An earlier major demonstration project has led to a specific remedial action project; that is, the pilot air stripper in the M-Area was used to demonstrate the removal of volatile organics from the groundwater. The air stripper and a groundwater recovery well system are in full scale operation.

REFERENCES

Charlesworth, D. L., 1985. Waste Pretreatment Activities - Shredding, DPSP-85-1108, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Cook, J. R., O. A. Towler, D. L. Peterson, C. A. Langton, and J. A. Reddick, 1984. Greater Confinement Disposal Activities at the Savannah River Plant, DP-MS-84-84, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1986. Environmental Information Document, New Low-Level Radioactive Waste Storage/Disposal Facilities at SRP, DPST-85-862, Savannah River Laboratory, Aiken, South Carolina.

Lewandowski, K. E., B. E. Long, and K. E. Mersman, 1984. Solvent Incineration at Savannah River, DP-MS-84-8124x, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Mentrup, S. J., 1985. Waste Pretreatment Activities - Compaction, DPSP-85-1103, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

TABLE OF CONTENTS

LIST OF TABLES

APPENDIX K

SCOPING COMMENTS AND RESPONSES

The U.S. Department of Energy (DOE) announced its intent to prepare an environmental impact statement (EIS) on waste management activities for groundwater protection at the Savannah River Plant in the Federal Register on April 26, 1985. Interested parties were invited to submit written comments or suggestions for consideration in preparing the EIS during a 30-day public comment period that ended on May 28, 1985, or at two public scoping meetings.

During the public comment period, 16 individuals, agencies, and organizations presented written or oral comments; one individual provided written comments at one of the public scoping meetings and more detailed written comments after the meetings. Table K-1 lists the individuals, agencies, and organizations who provided comments.

Table K-2 presents the comments received at the scoping meetings or in writing during the public comment period. This table also provides DOE's responses to these comments.

Table K-3 summarizes the topics contained in the comments and references the appropriate chapters and sections of this EIS.

At the public scoping meetings, DOE presentations inadvertently referred to the alternative of aboveground disposal as "greater confinement disposal facilities." Greater confinement disposal is an in-ground disposal concept, and the summary of this EIS contains a brief correction of this inadvertent statement.

Table K-1. Agencies, Organizations, and Individuals Submitting Scoping Comments

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	STATEMENT OF FRANCES HART Energy Research Foundation 2530 Devine St. Columbia, SC 29205 Waste Management Activities for Groundwater Protection at the Savannah River Plant, Aiken, South Carolina Scoping Comments on the Preparation of an Environmental Impact Statement Aiken, South Carolina May 14, 1985 Energy Research Foundation 2530 Devine Street Columbia, South Carolina 29205 Natural Resources Defense Council 1350 New York Avenue, NW Washington, D.C. 20005	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	I am Frances Hart and I represent the Energy Research Foundation. We appreciate the opportunity to present suggestions for the scope of an Environmental Impact Statement on hazardous waste managament at the Savannah River Plant and we commend the Department of Energy for voluntarily undertaking this assessment.	
A-1	Before making specific comments, however, we would like to stress the need to view this process within the context of national and state laws regulating hazardous wastes. DOE must make it clear that any selection of alternatives is limited by existing regulatory requirements under the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation and Liability Act (Superfund), and other federal laws; by South Carolina's Hazardous Waste Management regulations and the South Carolina Pollution Control Act; and by SRP's own commitments.	All alternatives considered in the EIS are assessed in relation to applicable regulations and standards. Chapter 6 discusses the applicable regulatory requirements associated with the alternatives, including DOE Orders and the Resource Conservation and Recovery Act, as amended.
A-2	The NEPA process cannot and must not be used to circumvent these requirements, nor may required actions be delayed pending completion of the EIS.	If NEPA requirements conflict with other applicable statutes, Chapters 1 and 6 of the EIS will discuss the conflicts.
A-3	Thus, there are no alternatives for closure and remedial action at RCRA sites other than those specified in the statute and applicable regulations. CERCLA sites will be subject to the same cleanup standards as commercial sites. For other sites, such as low-level radioactive waste sites with no hazardous waste contamination, SRP would be guided by the ALARA principle and its own requirements and commitments towards alternatives to shallow land burial, such as engineered above-ground storage and other state-of-the-art technology. Many of our specific comments are, therefore, stated in terms of compliance with these pertinent regulations.	See the response to comment A-1.
	We would expect that any Environmental Impact Statement would include, first of all, a background description consisting of at least the following elements:	
A-4	1. A section describing all applicable laws, regulations and orders, and potential future requirements; including RCRA, as amended, Superfund Reauthorization bills, Clean Air and Water Acts, Safe Drinking Water Act, OSHA, Atomic Energy Act, EPA radiation standards, and DOE Order 5820.	See the response to comment A-1. The EIS discusses the status, intent, and potential applicability of regulations that are required under the 1984 RCRA amendments, even though they might not be finalized or issued.

Table K-2. Scoping Comments and DOE Responses

Comment number		Comment	Response
A-5	2.	A characterization of the existing environment including a detailed discussion of SRP geology, hydrology, seismicity, local climate and meteorology, and so on. This description should include a detailed discussion of SRP groundwater characteristics, including interconnection of aquifers and connection of contaminated aquifers with surface streams flowing offsite. All environmental studies by outside contractors, universities, and researchers should be referenced.	Chapter 3 and Appendixes A and B of the EIS discuss and characterize the existing environment. Chapter 5 discusses environmental studies and monitoring programs within the scope of the EIS. Appendix A describes the geology and subsurface hydrology of the SRP, including the relationship of groundwater to surface water. Documents used to prepare Appendixes A and B are referenced.
	3.	A characterization of existing waste generation and treatment should include:	
A-6		a) a brief history including types and amounts of hazardous, low-level, and mixed wastes previously generated;	Appendix B of the EIS discusses previously generated wastes contained in existing hazardous, low-level radioactive, and mixed waste sites.
A-7		b) a detailed description of types and amounts of hazardous, low-level, and mixed wastes currently generated at SRP, including wastes discharged to air, surface waters, land, groundwater, TSD facilities, and shipped offsite;	Chapters 2 and 4 of the EIS discuss the quantities and characteristics of hazardous, low-level radioactive, and mixed wastes from ongoing and planned SRP operations, wastes in storage, and wastes from remedial and closure actions requiring disposal. A description of all releases and effluents that are currently generated and not related to the protection of groundwater resources is outside the scope of this EIS; however, these releases are discussed in U.S. Department of Energy Savannah River Plant Environmental Report for 1984 (DPSPU 85-30-1).
A-8		c) anticipated changes in types or amounts of hazardous, low-level, and mixed wastes to be generated in the future;	Chapters 2 and 4 discuss major assumptions on changes in the types or amounts of waste requiring disposal.
A-9		d) programs underway to reduce or eliminate the generation of wastes as expeditiously as possible, as required by RCRA;	Chapters 2 and 4 and Appendix D discuss predisposal technologies to reduce volume, solidify/stabilize, treat, and control hazardous, low-level radioactive, and mixed wastes. Waste minimization permitting requirements of RCRA are discussed in Chapter 6; however, as required by RCRA, waste minimization programs are continuing efforts at SRP and are not specific alternatives for remedial actions or for other actions that are within the scope of this EIS.

Table K-2. Scoping Comments and DOE Responses

Comment number			Comment	Response
A-10		e)	steps taken by SRP to encourage process substitution, materials recovery, properly conducted recycling, reuse and treatment, as required by RCRA;	See the response to comment A-9.
A-11		f)	results of previous studies and steps taken to reduce the volume of wastes generated at SRP, including incineration and compaction;	See the response to comment A-9.
A-12		g)	results of any studies undertaken or programs underway to separate mixed wastes into hazardous and radioactive components;	There are no current programs or studies for separating mixed wastes into separate hazardous and low-level radioactive components.
A-13		h)	compliance with RCRA hazardous waste generator requirements and applicable DOE regulations;	Chapter 6 summarizes applicable RCRA requirements for waste generators and associated DOE Orders and regulations.
A-14		i)	provide to the greatest extent possible the information required by the Hazardous Substances Inventory section of the Superfund Improvement Act of 1985.	Appendix B characterizes existing hazardous, low-level radioactive, and mixed waste sites. Appendix B also discusses the history of waste disposal, evidence of past and existing contamination, and waste characteristics. Also see the response to comment A-1.
A-15	4.		Describe the types, amounts, and source or destination of hazardous, low-level, or mixed wastes, if any, that are transported onsite and offsite. Discuss compliance with RCRA and DOE transportation requirements. Discuss any past accidental releases during transportation.	The final EIS for waste management operations at SRP (ERDA-1537) discusses the transport of waste materials. Chapter 6 of this EIS discusses applicable regulatory requirements for the transport of waste material that might be associated with proposed actions and alternatives. Also see Chapter 4.
	5.		A characterization of current waste storage should include:	
A-16		a)	a description of the location and contents of all SRP storage facilities for hazardous, low-level, or mixed wastes, including idle production facilities and underground storage tanks;	The EIS describes the characteristics and amounts of wastes in storage requiring disposal in Chapters 2 and 4. Existing storage facilities and idle production facilities are outside the scope of this EIS.
A-17		b)	anticipated changes in types and amounts of hazardous, low-level, and mixed wastes to be stored at SRP, or in the number or location of storage facilities, in the future;	Anticipated changes in the amounts of hazardous, low-level radioactive, and mixed wastes requiring disposal are considered in Chapters 2 and 4. These sections also describe new retrievable-storage facilities for disposal of hazardous, low-level radioactive, and mixed wastes that have not been approved and permitted.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
A-18	c) discuss DOE's alternative storage plans if storage of these wastes is prohibited under section 201(j) of the 1984 RCRA amendments;	The EIS considers only those new retrievable-storage facilities that comply with applicable Federal and State requirements, as currently defined. See Chapter 6.
A-19	d) discuss implications and plans for compliance with 1984 RCRA amendments concerning underground storage tanks.	Compliance of new retrievable-storage facilities with applicable Federal and State regulatory requirements is discussed in Chapters 4 and 6.
	6. A characterization of current waste disposal at SRP should include:	
A-20	a) a complete description of all SRP past and present disposal facilities for hazardous, low-level, and mixed wastes, including size, location, and type of facility, type and amount of waste disposed of, source of each type of waste disposed, date on which each type of waste was placed in facility, and date - if any - on which waste disposal ceased;	Appendix B and its referenced documents present the pertinent characteristics of existing hazardous, low-level radioactive, and mixed waste sites, including location, history of waste disposal, past and existing contamination, and characterization of disposed wastes.
A-21	b) discuss whether and to what extent SRP facilities have been used to dispose of waste generated offsite.	Chapters 2 and 4 discuss waste material for disposal on the SRP that is generated offsite.
	The Environmental Impact Statement should include detailed descriptions of environmental effects of past and current waste management activities at SRP including the following:	
A-22	1. Complete information and monitoring data regarding past waste releases from all waste generating, transporting, treatment, storage, and disposal facilities, including dates of releases, amount and toxicity of waste released, extent and nature of environmental contamination, extent to which release is continuing, and all other information required by Section 244 of the 1984 RCRA amendments.	See the responses to comments A-7 and A-20. The EIS considers existing hazardous, low-level radioactive, and mixed wastes site regardless of whether they are defined as "continuing release" sites.

Table K-2. Scoping Comments and DOE Responses

Comment number		Comment	Response
A-23	2.	Detailed discussion of effects of each release on groundwater, surface streams, air, vegetation, wildlife, health and safety of workers, and public health and safety. Include the extent to which release has traveled or has the potential to travel offsite. Several of the streams at SRP dissect aquifers known to be contaminated; these aquifers are discharging to streams and the material is being carried offsite.	Chapters 2 and 4 and Appendixes F through I discuss the environmental consequences and the methods for assessing the environmental consequences of the proposed action and alternatives. Also see the responses to comments A-7 and A-20.
A-24	3.	Detailed discussion of maximum cumulative environmental effects which could be caused by such releases; assessment must include the following: a) a detailed description of background (i.e., not affected by any SRP operations) concentrations in all media for all actual and suspected pollutants, and current distributions from chronic releases from point sources and nonpoint sources in all media for all pollutants. b) impacts to vegetation including but not limited to pollutant concentrations in specific tissues from root uptake and absorption from the atmosphere; changes in vegetation distribution resulting from pollutants; changes in physiologic processes (e.g., growth, carbon fixation, reproductive effort and success) resulting from pollutants; physical effects (e.g., chlorosis, growth reduction) resulting from pollutants; c) impacts to animals including but not limited to pollutant concentrations in specific tissues from bio-accumulation and inhalation; changes in physiologic processes (e.g., growth, reproductive effort and success) resulting from pollutants; physical effects (e.g., hair loss, teratogenic effects) from pollutants;	Cumulative environmental effects of the proposed action and alternatives are discussed in Section 4.7. Chapter 3 and Appendixes A and B describe the existing SRP environment, including current impacts from prior hazardous, low-level radioactive, and mixed waste management practices.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	d) impacts to ecosystems including but not limited to changes in habitat structure that limit or change floral/faunal distributions; changes in energy flow that might effect floral/faunal distributions, both immediate and delayed; changes that might affect the species composition of communities;	
	e) maximum health effects that could be caused by such releases, including the uncertainties involved in each calculation;	
	f) compare the releases, doses and levels of contamination discussed above with standards found in DOE orders, the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act, EPA standards, and other applicable standards.	
A-25	4. Detailed discussion of any studies or programs underway or planned to obtain more data on past releases, including groundwater monitoring programs, placement of new wells, and so on.	Chapter 5 discusses ongoing and planned monitoring programs and studies related to the proposed action and alternatives.
A-26	5. Provide for all pollutants literature, data, or experimental toxicological data to support predicted impacts to terrestrial and aquatic flora and fauna, including estimates of accuracy and precision for predicted impacts.	Chapter 4 and its referenced documents describes the methods and assumptions related to the assessment of health effects from radiological and nonradiological releases.
A-27	6. Any facility which must obtain any types of hazardous waste permit must include in the permit application provisions for corrective action for all prior releases of hazardous waste from any waste management facilities, as required by Sections 206 and 207 of the 1984 RCRA amendments. This means that SRP must provide plans for corrective action for all of the CERCLA sites, requiring the installation of groundwater monitoring systems, development of cleanup plans, and so on. At SRP, with a total of 153 identified waste sites, this will be a major undertaking. Discuss SRP's plans for compliance.	Chapters 2 and 4 of the EIS assess alternative remedial and closure actions at existing hazardous, low-level radioactive, and mixed waste sites. Based on the Record of Decision to be prepared on this EIS, the alternatives selected for implementation will be defined in detail when the required permit applications are made before implementation of the proposed action. Not all of the 153 waste sites identified on the SRP contain hazardous, low-level radioactive, and mixed wastes.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
A-28	7. The atmospheric distribution (micro and macroscale) of volatile organic compounds such as solvents must be addressed. EPA is currently undertaking the development of air standards for VOC including the compounds historically and currently used at SRP. Regulations will cover emissions from point as well as nonpoint sources (e.g., lagoons, rivers, and sewage and waste treatment facilities, and irrigation systems). Portable gas chromotographs employed with a sound sampling plan can adequately describe existing atmospheric distributions of VOC's. Meteorological models validated internally and calibrated to the SRP region, must be employed for macroscale distributions.	Ambient air quality and meteorological parameters are discussed in Chapter 3. Atmospheric releases of nonradioactive substance due to alternative remedial and closure actions for waste sites considered in the EIS are discussed throughout Chapter 4.
A-29	8. Discuss any response, corrective, or closure activities undertaken at any of these facilities.	Chapter 1 discusses programs and projects for corrective action and closure that have been approved or permitted on the SRP.
	The Environmental Impact Statement discussion of current waste management and disposal activities at SRP should include the following as well:	
A-30	1. Discuss compliance with RCRA at all SRP hazardous and mixed waste facilities, including: a) M-, F-, and H-Areas seepage basins; b) CMP pits; c) the old TNX basin, which must be closed as a RCRA 265 unit; d) the new TNX basin, whose contents appear to include mercury, methylene chloride and other listed solvents and so must be included in SRP's Part B application and RCRA groundwater monitoring requirements; e) the Savannah River Lab seepage basins, which received waste after July 26, 1982, and so must be included in the Part B application and RCRA groundwater monitoring requirements;	Chapter 6 discusses the applicable Federal and State requirements, including permits for the proposed action and alternatives considered in the EIS.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	f) the L-Area Oil and Chemical Basin which has been inactive but not closed, and so must be included in the Part B application and RCRA groundater monitoring requirements;	
	g) the Metallurgical Lab basin and overflow seepage depressions;	
	h) the underground storage tanks, waste oil trenches and other hazardous waste landfill trenches at the low-level waste burial ground;	
	i) the Ford Building seepage basin and waste site;	
	j) the 716-A Motor Shop seepage basin;	
	k) the Experimental Sewage Sludge application sites;	
	l) acid/caustic basins;	
	m) burning and rubble pits;	
	n) coal pile runoff containment basins.	
A-31	2. Discuss compliance with groundwater assessment requirements of RCRA at all applicable facilities, including M, F, and H Areas. The discussion of compliance must demonstrate in detail that SRP's groundwater monitoring system meets the following RCRA requirements:	Chapter 5 discusses the SRP groundwater quality assessment plan.
	a) minimum of one upgradient and three downgradient monitoring wells;	
	b) wells must monitor the uppermost aquifer;	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	c) downgradient wells must be placed in a position to immediately detect migration of statistically signficant amounts of hazardous waste or hazardous waste constituents to the uppermost aquifer; wells placed more than a few feet from the impoundment cannot meet this requirement of immediate detection; d) wells must be analyzed for parameters specified in 265.92(6) and according to a specified schedule; e) If groundwater contamination is detected, a formal and detailed groundwater quality assessment plan to identify the rate and extent of contamination must be implemented. Regulations require that within 15 days of the detection of a statistically significant difference, a specific plan be submitted which includes: 1) number, location, and depth of any new wells; 2) sampling and analytical methods to be used; 3) criteria to be used in evaluating the data; 4) schedule for implementation 5) certification by a qualified geologist or geotechnical engineer. The discussion of compliance should also take into account the following:	
A-32	a) There are many monitoring wells at SRP, but there is little available information about construction techniques and materials. Details regarding construction and also precise sampling locations, methods of selecting locations, sampling procedures and preservation techniques need to be specified to	See the response to comment A-31.

Table K-2. Scoping Comments and DOE Responses

Comment number		Comment	Response
		demonstrate conformity with RCRA. Site geology is complex but it appears that almost all basins are underlain by several interconnected aquifers, making the use of cluster wells necessary.	
A-33	b)	SRP must do Appendix VIII analyses yearly at all areas which display groundwater contamination. There is some indication at several of the basins, according to the Technical Summary of Groundwater Protection Plan, that contamination from substances which were supposedly never placed in the basins is occurring. This, and the fact that there seems to have been a lack of control and recordkeeping regarding disposal practices in the past, make Appendix VIII analyses at all regulated areas crucial. SRP Types A, B, C, D, and E analyses collectively do not contain all the Appendix VIII compounds.	See the responses to comments A-30 and A-31.
A-34	c)	Seepage basins at F and H Areas receive or have received wastewater hazardous because of low pH and contamination by mercury or chrome. Two of the basins are inactive and should be listed as CERCLA sites. The active basins must receive a hazardous waste storage permit. Because groundwater contamination from the active pits has been detected, the issuance of a storage permit to these surface impoundments does not seem justified, and a groundwater assessment program as specified under RCRA should already have been implemented.	Chapters 2 and 4 discuss alternative remedial and closure actions for existing waste sites, including the F- and H-Area seepage basins. Also see the response to comment A-30.
A-35	d)	At a RCRA facility the closure performance standard and the spill cleanup and groundwater cleanup standards require the removal of all waste. Thus any inorganic or organic constituent in total concentration above background should be removed. The level of existing contamination at SRP is not relevant to this demand, nor is there any kind of special status or exemption afforded any facility in meeting this demand.	Both Federal and State hazardous waste regulations call for either the removal of waste or closure without removal. Each of these alternatives will be assessed for existing hazardous, low-level radioactive, and mixed waste sites.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
A-36	e) A discussion of M-Area compliance with closure standards must include the following: 1) There are essentially seven hazardous waste units to consider: - the M-Area settling basin - the pipeline from process buildings to the basin - the natural seepage area - the overflow from M-basin to the seepage area - Lost Lake - the overflow from the seepage area to Lost Lake - the sewer lines from the process buildings to Tim's Branch 2) The solvent storage tanks behind Buildings 313M and 321M have leaked organic solvents into the ground and should be considered a RCRA facility. 3) The M-basin has received effluents which are hazardous because of low pH and contamination by mercury, cadmium, chrome, and lead. The effluent also contains large quantities of listed solvents. Thus the waste would require more than control of pH alone to be classified as non-hazardous. 4) The treatment of contaminated groundwater by an airstripping unit should only be done in accordance with a hazardous waste treatment permit, and upon proper certification that this alternative is the preferred one. Remedial actions such as air-stripping of organic compounds from contaminated groundwater must address micro and macro-scale	Chapter 1 discusses those approved or permitted actions being taken at M-Area for which separate NEPA documentation has been prepared. Also see the response to comment A-30.

Table K-2. Scoping Comments and DOE Responses

Comment number		Comment	Response
		atmospheric distributions as well as runoff to nearby streams and recontamination of soils by VOCs returned to earth in precipitation and settling.	
		5) The basin must receive a permit and cannot be closed until a permit is issued.	
		6) Placing waste generated from cleanup of Lost Lake, seepage areas, etc., into the basin is totally unacceptable. If any other material has to be excavated, it should be placed in a secure RCRA facility. If the other waste is left in place, these areas should also be considered regulated units requiring post-closure care.	
A-37	f)	There is a specific ban on construction of new hazardous waste facilities without prior issuance of a permit. Since the average time to issue a hazardous waste permit is two years, and no construction activity can begin until a permit is issued, discuss how this requirement will affect SRP's plans and implementation schedules for additional facilities.	See the response to comment A-30.
A-38	g)	Discuss SRP compliance with relevant commitments made during the L-Reactor NEPA process.	Chapter 1 discusses the commitments made in the L-Reactor EIS.
A-39	h)	Discuss SRP compliance with EPA requests made in connection with its review of the L-Reactor EIS, including its request that DOE expedite the decommissioning of the low-level waste burial ground; that it halt the discharge of disassembly basin purge water to seepage basins; and that state-of-the-art disposal techniques be substituted in both instances.	EPA comments submitted on the draft EIS for the restart of L-Reactor were addressed in Volume 3 of the final EIS (DOE/EIS-0108).
A-40	i)	Discuss plans for alternative storage and disposal techniques if certain types of waste are banned from land disposal under Section 201 of the 1984 RCRA amendments.	See the response to comment A-18.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
A-41	j) Discuss plans to retrofit existing surface impoundments within the next four years to meet the minimum technological requirements of the 1984 RCRA amendments, including double liners and leachate collection systems.	DOE will comply with applicable portions of the Resource Conservation and Recovery Act, as amended, including the minimum technological requirements for and closure of land disposal facilities. Also see the response to comment A-1.
A-42	k) Discuss plans to comply with the requirement, effective September 1, that all facility owners or operators must certify that a program is in place to reduce volume and/or toxicity of waste to the degree economically feasible; for example, how SRP will conform to the same standards in this regard as other aluminum extrusion facilities do.	See the response to comment A-9.
A-43	l) Discuss plans to comply with the requirement, also effective September 1, that a generator must certify that the treatment or disposal method used is the best and most practical currently available method which will minimize current and future threats to human health and the environment.	See the response to comment A-9.
A-44	m) Discuss plans to comply with the requirement that the Part B application contain a certification that the facility is in compliance with all applicable groundwater monitoring and financial responsibility requirements.	See the response to comment A-30. DOE will meet specific and applicable requirements of Part B applications as part of the permitting process for facilities. Federal facilities are exempt from the financial responsibility requirements of RCRA.
A-45	Possible environmental impacts and cumulative impacts of all proposed actions must be described in detail, including estimated changes in concentrations and distributions of pollutants in all media for all proposed actions.	Chapter 4 discusses the environmental consequences of the proposed action and alternatives and cumulative environmental effects.
A-46	The Environmental Impact Statement should describe all energy and resource commitments as follows: 1. present for all alternatives in comparable units budgets of energy and resources committed to construction, operation and maintenance; 2. provide detailed documentation to support unit value assignments and conversion factors to comparable units;	Section 4.9 discusses environmental impacts that cannot be avoided or that are irreversible for each of the categories of alternatives considered in the EIS, including energy and resource commitments.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	3. provide estimates of accuracy and precision by which total commitments for each alternative can be evaluated and compared.	
A-47	I will close with two final comments. First, although "source, special nuclear, and byproduct materials" which are regulated by the Atomic Energy Act are exempt from RCRA, the AEA definition of these materials is very narrow, and does not include the hazardous wastes with which these AEA materials may be associated. The AEA contains no provisions for managing hazardous wastes, nor does it authorize DOE to regulate these mixed wastes. Mixed wastes should be regulated according to the requirements of both RCRA and the AEA. Where RCRA regulations overlap with the AEA, the more stringent standard should prevail. In the rare case where compliance with both sets of requirements is physically impossible, the burden should be on DOE to demonstrate the inapplicability of RCRA.	See the response to comment A-30. Chapter 6 discusses the status and applicability of mixed waste rulemaking.
A-48	Finally, the Federal Water Pollution Control Act explicitly requires DOE to comply with all state laws "respecting the control and abatement of water pollution in the same manner and to the same extent as any non-governmental entity." This requires compliance with all state water pollution requirements, including groundwater pollution. Formal authority over monitoring and control of all sources is necessary if South Carolina's responsible agency, the Department of Health and Environmental Control, is to address the SRP waste management and groundwater contamination problem in the comprehensive manner demanded by the South Carolina Pollution Control Act. Thank you.	On April 8, 1985, DOE and the South Carolina Department of Health and Environmental Control entered into a Memorandum of Agreement to cooperate mutually in ensuring the environmental quality on the SRP. As stated in this memorandum, DOE will comply with specific environmental acts of the State of South Carolina. Also see the response to comment A-30.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	STATEMENT OF W. F. LAWLESS Assistant Professor of Mathematics Paine College SCOPING COMMENTS CONCERNING SAVANNAH RIVER PLANT WASTE MANAGEMENT ACTIVITIES ENVIRONMENTAL IMPACT STATEMENT by W. F. Lawless Assistant Professor of Mathematics Paine College May 28, 1985	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	INTRODUCTION	
	The Department of Energy (DOE) has initiated comments and suggestions to assist in identifying environmental issues and the scope of an environmental impact statement (EIS) on waste management activities for groundwater protection at the Savannah River Plant (SRP). Public comments are to be considered in the preparation of an EIS. An April 29, 1985 DOE news release identified the DOE intent to prepare such an EIS and included background information on the SRP; the DOE news release also included alternatives for treating waste sites, for building new waste disposal facilities, and for discharging reactor basin purge water, plus the non-inclusive listing of SRP environmental issues (1).	
	The comments herein were delivered in draft at the first DOE scoping meeting, held at the H. Odell Weeks Activity Center in Aiken, SC, May 14, 1985.	
	General Comments	
B-1	1. Savannah River Plant Seepage Basins In August 1983, a hotline complaint was filed with the DOE Inspector General charging the DOE with willfully avoiding its public responsibility to prepare an EIS for the new DOE Order 5820.2, Radioactive Waste Management (2,3). Such an EIS has not been written, but one is now planned for SRP groundwater protection waste management activities (1). The Department of Energy is to be congratulated on this very important and forthright action. It is hoped that similar actions will take place at all DOE sites throughout the nation. The new EIS planned for the Savannah River Plant will speak volumes on the inadequacies of DOE Order 5820.2, a regulation that is a mockery of American technology and epitomizes the mishandling of radioactive and hazardous wastes by the DOE bureaucracy. The new EIS will begin to correct the groundwater damage done by the DOE's use of seepage basins at SRP, basins still allowed by DOE Order 5820.2.	Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modification of waste management activities at the SRP, including the requirements of the Resource Conservation and Recovery Act, as amended, and DOE Orders. A NEPA assessment of DOE Order 5820.2 is outside the scope of this EIS.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
B-2	The SRP is cleaning up one of its 68 liquid waste seepage basins, the M-Area seepage basin (4). The General Accounting Office (GAO) has estimated that the M-Area seepage basin clean-up will cost up to $64 million or more (4), yet the Savannah River Plant will be using a seepage basin when the L-Reactor comes on line in 1985 (5). The new EIS should carefully detail what seepage basins will continue to be used at the Savannah River Plant and for how long, the contaminants to be disposed of and where, the estimated contaminant build-up at each basin, the basins that are clogged to further seepage and are overflowing, the current estimated clean-up cost for each basin, and the rationale for each basin's continued use.	Chapters 2 and 4 and Appendix F discuss remedial and closure actions at hazardous, low-level radioactive, and mixed waste sites. Appendix B characterizes each of the waste sites considered. Chapters 2 and 4 and Appendix G discuss new disposal facility alternatives for hazardous, low-level radioactive, and mixed waste, including waste material from remedial and closure actions at existing waste sites. Chapters 2 and 4 discuss alternatives to the continued use of seepage basins for the discharge of disassembly-basin purge water from C-, K-, and P-Reactors.
B-3	Seepage basins are one of the sources of hazardous and radioactive waste contamination of migratory fowl and animals at the SRP (6). Contaminated animals have been known to leave the Savannah River Plant site (6). The new EIS should quantify this phenomenon by detailing how each basin has possibly contributed to this means of spreading contamination, and to where with what extent. The new EIS should review the steps SRP has taken to prevent the spread of hazardous and radioactive contamination via water fowl and animals from each one of the 68 known seepage basins.	The Operating Contractor has developed a Program for Management of Contaminated Wildlife at the Savannah River Plant, which identifies and monitors potential human exposure pathways to wildlife contaminated by hazardous and radioactive substances. The locations, contaminants, and descriptions of those areas of potential contamination are contained in various reports (DPSP-83-1008, DPSP-84-1054, DSPS-84-1051, and DPSPU-84-302). Procedures followed in the wildlife monitoring program are contained in DPSOP 271.1. Chapter 4 of the EIS assesses the environmental consequences of the proposed modifications to waste management activities at the SRP, including impacts to aquatic and terrestrial biota and potential health effects from radiological releases that take into account known major pathways of exposure.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
B-4	2. Waste Management Practices. The DOE Intent to Prepare an Environmental Impact Statement (1) states that a 1977 EIS on the SRP "...resulted in the implementation of a waste management practices improvement program in accordance with DOE policies and standards." This 1977 EIS (ERDA 1537) included many important predictions that have not been publicly assessed by the DOE and should be assessed in the new EIS (8). Many of these predictions have proven wrong, e.g., on the levels of contamination entering the groundwaters underlying the SRP radioactive waste burial grounds and the radioactive and hazardous waste seepage basins, and on how well protected the Tuscaloosa aquifer was from contaminated groundwaters above the Tuscaloosa aquifer (5, 6, 7, 8).	Chapter 3, Appendix A, Appendixes F through I, and references in the EIS document all major assumptions and predictions related to the assessment of environmental consequences of the proposed modifications to waste management activities.
B-5	The SRP publishes annual monitoring reports on radioactive and hazardous contamination at and off the SRP (e.g., reference 6). The new EIS should not only assess the correctness of ERDA 1537, but should as well analyze the monitoring reports from 1977 to the present. Special attention should be directed to DOE excess releases on and off the SRP. For instance,	The EIS uses the results of SRP monitoring programs in characterizing and assessing the environmental consequences of the proposed modifications of waste management activities. Also see the response to comment B-4.
B-6	a) strontium-90 released from the F-Area seepage basins has been found to be at a groundwater concentration over eight (8) times the DOE Concentration Guides, or over 40,000 times the EPA drinking water standard, yet no reprimand has been given to Du Pont, the prime SRP contractor, because of this excess. The new EIS should detail every instance where the DOE Concentration Guides have been exceeded, what corrective actions have been taken and with what long-term effects.	Chapters 2 and 4 and Appendix F discuss remedial and closure actions at existing waste sites, including the F-Area seepage basins.
B-7	b) The annual off plant SRP monitoring reports indicate that strontium-90 in milk samples collected from around the SRP are within ranges found by the Environmental Protection Agency (EPA) (9). In a 1984 report, the EPA collected its own milk sample near the SRP and confirmed by their analysis that strontium-90 in milk samples drawn from near the SRP are not significantly different from other milk	Chapter 4 presents the radiological impacts from proposed remedial and closure actions at existing waste sites, including the potential radiological doses due to atmospheric releases.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	samples from the southeastern U.S (10). However, the EPA apparently did not review the SRP annual monitoring data on strontium-90 in milk. That data, collected by the Savannah River Plant, indicates that the mean strontium-90 milk concentrations, along certain wind paths, are significantly greater than the mean concentrations in southeastern U.S. milk data as published by the EPA (11). One source of the strontium-90 in milk from around the SRP may be the airborne resuspension from seepage basin releases.	
B-8	3. Waste Management Assessments The SRP waste management practices improvement program that started with the 1977 EIS (ERDA 1537), as announced in the DOE intent to prepare the new EIS, was stated to also include regular assessments and improvements to SRP waste management programs (1). A listing of all waste management assessments, including appraisals with findings and recommendations, since 1977 should be a part of the new EIS. For instance, the 1982 Savannah River Plant radioactive low level waste burial ground management appraisal report, not published by DOE, should be included (13). This appraisal report was highly critical of DuPont's management of the SRP radioactive waste burial grounds, but not having been finalized nor transmitted to DuPont, the appraisal report became the subject of a separate hot line complaint to the DOE Inspector General (12, 13). The result of that hot line complaint and a subsequent re-appraisal as directed by the DOE Inspector General, has been to dramatically transform operations at the SRP burial grounds (22).	Chapters 2 and 4 and Appendix G identify remedial and closure actions for the low-level radioactive burial ground. Appendix B also characterizes the burial ground.
B-9	The burial ground management appraisal report did not assess SRP seepage basins, but a 1982 radioactive high-level waste tank farm appraisal report attempted to do so and attempted to assess the long-term impacts seepage basins would have on the SRP groundwater environment (14, 15). However, that part of the high-level waste tank farm appraisal report was stopped by DOE management (12), but in effect, part of that long-term appraisal will be assessed in the new Waste Management Activities EIS. The scope of the original long-term appraisal of the high-level waste tank farms appears to have been more far reaching than the	The purpose of this EIS is to assess the proposed modifications of waste management activities at the SRP for hazardous, low-level radioactive, and mixed wastes. A discussion of high-level waste management activities is outside the scope of the EIS. The impacts of high-level waste management activities at SRP were discussed in DOE/EIS-0062.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	scope of the new EIS (15); the latter's scope should be expanded to cover all sources of SRP groundwater contamination, including the SRP high level radioactive waste tank farm and the Defense Waste Production facility (DWPF).	
B-10	4. DOE Concentration Guides As stated in the recent DOE news release (1), the DOE wants "...to ensure continued protection of groundwater, human health and the environment." However, numerous instances have occurred at SRP where concentrations of radionuclides have exceeded the DOE Concentration Guides (16, p. 25, Table D; 17). Yet, the DOE apparently does not take steps to bring releases into the environment below levels established by these DOE Concentration Guides, nor has the DOE cited the SRP contractor when the Concentration Guides have been exceeded (18). This appears to be incongruent with DOE policy. For example, the 1984 L-Reactor EIS reported that strontium-90 groundwater concentrations from F-Area seepage basins reached 340,000 pCi/L (5). This level of strontium-90 is 42,500 times greater than the EPA drinking water standard and over 8 times higher than the DOE Concentration Guides (16, 17). When this was discussed with DOE, the DOE responded that the contractor was under no obligation to meet the DOE Concentration Guide for strontium-90 in groundwater (19). Putting aside, for the moment, the question of whether the DOE Concentration Guides themselves provide satisfactory protection to human health and the environment, exceeding those DOE Concentration Guides assuredly cannot protect anything. Since the DOE still self-regulates nuclear wastes, it would appear that these DOE Concentration Guides afford both the DOE and the prime contractor a cozy relationship. The new EIS should question the efficacy of these DOE Concentration Guides and whether, in the best interests of the public, these guidelines should be replaced with regulations that bite.	See the response to comment B-6. Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modifications of waste management activities, including DOE Orders.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	In 1984, the federal court removed the DOE's right to self regulate hazardous chemical wastes (4) after the largest industrial spill of mercury occurred at the DOE Oak Ridge facility (20, 21). The new EIS is a good, first step forward for the DOE to recoup lost credibility, but it must be strongly reinforced with a cost-efficient, professional operation that cleans up the SRP environment and keeps it clean. The DOE can ill afford another cover-up.	
B-11	5. <u>Remedial Action Programs</u> The M-Area remedial action program to manage and control existing groundwater contamination was included in the L-Reactor EIS (5), but it has not been central to the subject of an EIS until now, yet corrective action alternatives to the M-Area basin clean up apparently do not exist because remediation has already begun (4, 5). The new EIS is a fine idea, but it comes after the fact for deciding the appropriate course of action for the M-Area seepage basin clean-up, and for allowing public input into that decision, unless, with the new EIS, the DOE is now offering the public this opportunity. The M-Area seepage basin clean-up will jettison an estimated 30 tons per year of chlorinated hydrocarbons into the atmosphere at one of the most populated work areas on the SRP plant site (4, 5). It is appropriate that the public have the right to question the Savannah River Plant scientists and engineers on the decision to allow airborne releases of these potentially hazardous chemicals within the SRP manufacturing and administration areas.	As stated at the public scoping meetings, approved and permitted remedial actions are currently underway in M-Area (i.e., operation of an air stripper and the construction and operation of an effluent treatment facility to discontinue use of the M-Area seepage basin). These actions, taken pursuant to Public Law 98-181, are discussed in Chapter 1 of the EIS. Because these actions have been approved previously and a separate NEPA review has been performed, these actions are not considered in detail in the EIS. The EIS considers the disposal of the sludge from the M-Area effluent treatment facility. Operation of the air stripper meets all applicable air-quality standards and its operation has been permitted by the South Carolina Department of Health and Environmental Control.
B-12	The SRP Groundwater Quality Protection Program discussed the removal of highly contaminated soil and chemical and pesticide hazardous waste from the CMP seepage basins for transport, storage and disposal elsewhere (7). This remedial action should similarly be a apart of the new EIS, especially if highly contaminated wastes will be transported and disposed offsite the SRP plant site.	Chapter 1 discusses the removal of waste material from the CMP pits. Disposal of the waste material, currently in a permitted hazardous waste storage building, is considered as part of the material requiring disposal at new onsite disposal facilities, to be assessed in Chapter 4 of the EIS.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	Specific Comments	
B-13	1. The 1983 technical summary document, <u>The Technical Summary of Groundwater Quality Protection Program</u> at Savannah River Plant, Volumes I and II, should be up-dated and corrected where necessary. For instance, the M-Area seepage basin is listed as non-radioactive instead of as a mixed waste basin.	The EIS will use the most current data available.
	References	
	1. U.S. DOE news release, <u>Department of Energy Announces Scoping Meetings Concerning Waste Management Activities EIS</u>, April 29, 1985. The news release included as an attachment, the Department of Energy Waste Management Activities for Groundwater Protection at the Savannah River Plant, Aiken, SC: <u>Intent to Prepare an Environmental Impact Statement</u>.	
	2. Letter to C. Benge, Inspector, DOE Inspector General's Office, from W. F. Lawless, "DOE Order 5820.1 (Management of Transuranic Contaminated Material) and draft DOE Order 5820, Radioactive Waste Management," August 27, 1983.	
	3. U.S. Department of Energy Order 5820.2, <u>Radioactive Waste Management</u> (1984).	
	4. <u>Department of Energy Acting to Control Hazardous Waste at its Savannah River Nuclear Facilities</u>, U.S. General Accounting Office report to the Honorable Ernest F. Hollings, United States Senate, Rep. GAO/RCED-85-23 (1984).	
	5. <u>Final Environmental Impact Statement, L-Reactor Operation, Savannah River Plant, Aiken, SC</u>, U.S. Department of Energy 3-Volume Rep. DOE/EIS-0108 (1984).	
	6. <u>Environment Monitoring at the Savannah River Plant, Annual Report for 1982</u>, Savannah River Plant Rep. DPSPU 83-302 (1984).	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
7.	Technical Summary of Groundwater Quality Protection Program at Savannah River Plant, Volume I, Site Geohydrology and Solid Hazardous Wastes, a Savannah River Plant Rep. DPST-83-928 (1983).	
8.	Final Environmental Impact Statement, Waste Management Operations, Savannah River Plant, Aiken, SC, U.S. Energy Research and Development Administration Rep. ERDA-1537 (1977).	
9.	Environmental Monitoring in the Vicinity of the Savannah River Plant, Annual Report for 1982, Savannah River Plant Rep. DPSPU 83-30-1 (ca. 1983).	
10.	An Airborne Radioactive Effluent Study at the Savannah River Plant, a U.S. Environmental Protection Agency Rep. 520/5-84-012 (1984).	
11.	W. F. Lawless, "General and Specific Comments," p. 91-95, Final Environmental Statement Related to the Operation of Vogtle Electric Generating Plant, Units 1 and 2, a U.S. Nuclear Regulatory Commission Rep. NUREG-1087 (1985).	
12.	Letter to C. Benge, Inspector, Department of Energy, Inspector General's Office, from W. F. Lawless, SRP Burial Ground Appraisal Report (BGAR)	
13.	W. F. Lawless, Savannah River Plant (SRP) Burial Ground, Building 643-G, Management Appraisal Report, Appraised June 2-13, 1980, a U.S. Department of Energy Savannah River Operations Office draft report (1982).	
14.	W. F. Lawless, K. G. Brown, Management Appraisal Report, Savannah River Plant (SRP) Tank Farm,, a U.S. Department of Energy Savannah River Operations Office report (1981).	
15.	W. F. Lawless, K. G. Brown, B. M. Dodge, Performance Audit Questions, Savannah River Plant (SRP) Tank Farm, a U.S. Department of Energy Savannah River Operations Office draft report (1982).	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
16.	W. F. Lawless, The Savannah River Plant: Hazardous and Radioactive, Comments on a Panel's Review and Findings of Ongoing Health Effects and Epidemiological Studies of Operations at the Savannah River Plant (1985).	
17.	Environmental Monitoring at the Savannah River Plant, Annual Report for 1982, SRP Rep. DPSPU 82-302 (1984).	
18.	Letter to R. L. Morgan, Manager, DOE-Savannah River Operations Office, from W. F. Lawless, transmitting reference 16, February 8, 1985.	
19.	C. Nandrasy, DOE-Savannah River Public Relations Office, personal communication, February 8, 1985.	
20.	"The Lost Mercury at Oak Ridge," News and Comment, Science, 221, 130-132 (1983).	
21.	B. A. Fenimore, "Atomic Bombs, Chemical Wastes," Environment, 26, 2-3 (1984).	
22.	The 1984 Department of Energy response to Congressman Dingell.	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	STATEMENT OF SHEPPARD N. MOORE Chief, NEPA Review Staff Environmental Protection Agency Region IV Atlanta, Georgia	
	My name is Sheppard N. Moore and I'm Chief of the NEPA Review Staff for Region IV, U.S. Environmental Protection Agency, Atlanta, Georgia. I'm presenting this statement on behalf of Jack E. Ravan, Regional Administrator. I also would like to state that Larry Neville of our General Counsel's Office is with me today. We're pleased at EPA to see the Department of Energy preparing an Environmental Impact Statement as part of the decision-making process concerning waste management activities at the Savannah River Plant. The Environmental Protection Agency has a long history of involvement with working with DOE in the State of South Carolina and we look forward to working with them during the preparation of this EIS. As many of you will recall, the issue of hazardous waste and groundwater management was raised on numerous occasions during the EIS process on the L-Reactor Restart, but was resolved through mitigation efforts with EPA, you, and the State. The EIS will provide a mechanism for thorough analysis of reasonable alternatives to manage the hazardous waste at SRP. The RCRA permitting procedures do apply to DOE and will be used to establish a Remedial Action Plan for waste management. I appreciate the opportunity to be here and my primary purpose in being here is to hear what the public has to say. Thank you.	Comments noted. No response on scoping required.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	STATEMENT OF ARTHUR H. DEXTER 3033 Powderhouse Rd. Aiken, SC 29801 May 14, 1985 Comments at DOE Hearing - Aiken, SC The handouts that you recently sent me indicate a desire on the part of DOE to protect groundwater resources, human health, and the environment from any adverse effects of waste management activities. I too share these concerns and after reading the proposed scope of he EIS, I wondered if it shouldn't be expanded to include other concerns that - so far as I am aware - have not yet been addressed in an EIS. I would like to cite three such concerns for your consideration:	
D-1	1) Within the tank farm where 32-million gallons of high-level radioactive waste is stored, there are wells which draw water from the Tuscaloosa aquifer to cool these waste tanks. Several years ago, a new waste storage tank was inadvertently scheduled to be installed directly on top of an existing well. When the error was discovered, the tank was relocated 40 ft. from the well and the well was plugged with concrete. Knowledgeable people contend that this course of action was inappropriate, in that the shrinkage of the concrete plug during solidification will produce annualar voids, in spite of the best of precautions. Should the adjacent waste tank leak or overflow there is a real possibility for the flow of radioactive liquid directly into the Tuscaloosa aquifer. I would like to see this matter addressed in the EIS.	The purpose of the EIS, as announced in the Federal Register, is to assess the potential environmental effects of the modification of waste management activities for hazardous, low-level radioactive, and mixed wastes for the protection of groundwater, human health, and environment. High-level radioactive waste management activities have been described extensively in four previous environmental impact statements (ERDA-1537, DOE/EIS-0023, DOE/EIS-0062, and DOE/EIS-082), and are outside the scope of this EIS.
D-2	2) Within the waste-management facilities, there is an important waste-transfer line for high-level radioactive waste that is enclosed within another pipe, or shroud, so that, in the event of the rupture of the transfer line, the liquid would be contained within the shroud. It appeared that the shroud was breached several years ago when	See the response to comment D-1.

Table K-2. Scoping Comments and DOE Responses

Comment number		Comment	Response
		monitors revealed the in-leakage of water into the shroud subsequent to heavy rains. I should like to ask if this shroud has since been repaired or replaced and I should like to request that the EIS establish standards for the shut down of process equipment when the integrity of important protective devices is lost.	
D-3	3)	It is said that radioactive materials have escaped through the expansion joints of the concrete floors of the canyon buildings. It is further said that this material is moving through the soil beneath the buildings. Does this problem come under waste management and should it be addressed in the EIS?	See the response to comment D-1.
	Thank you for the opportunity to voice these concerns.		
	Arthur H. Dexter 3033 Powderhouse Rd. Aiken, SC 29801		

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	STATEMENT OF BEATRICE JONES SCOPING MEETING SAVANNAH RIVER PLANT May 14, 1985	
E-1	Although I welcome the opportunity for comments at this scoping meeting in preparation of the DOE's EIS on waste management activities at the Savannah River Plant, I nevertheless find it regrettable that the NUS Corporation will be preparing the Environmental Impact Statement. Previous public criticism of their preparation of the DOE's EIS indicated their inefficiency with their lack of objectivity. It often appears that the NUS Corporation discovers what the Agency wants and then chooses what supports it. The signing by the NUS Corporation of a three year, $10.7 million contract with the Department of Energy indicates there has been no attempt to dispel public criticism.	A response to previous comments on the role of NUS Corporation in assisting DOE in the preparation of environmental impact statements was contained in Volume 3 of the Final Environmental Impact Statement, L-Reactor Operation, Savannah River Plant, Aiken, S.C. (DOE/EIS-0108) on pages M-35 and M-37. DOE is solely responsible for the preparation and contents of its environmental impact statements.
E-2	The opening remarks of the SRP Groundwater Protection Implementation Plan stated that SRP's monitoring and other activities "are the foundation of a broadly based environmental program which has consistently demonstrated the negligible environmental impact of the site's operations on the general public." Statements like this appear to be in conflict with the National Environmental Policy Act, which, according to the Calvert Cliff's Decision, has as one of its purposes, "...to advise other interested agencies and the public of the environmental consequences of planned federal action."	The statement in the SRP Groundwater Protection Implementation Plan was based on the monitoring and analysis of samples during operation of the SRP. The statement was not intended to be a conclusion on actions or activities to be considered in the EIS.
E-3	Anything that affects the environment affects the general public. There is little that is negligible at the Savannah River Plant. Over the years, the Savannah River Plant has built up tremendous amounts of contamination, some of which is being addressed. Nevertheless, the re-start of the L-Reactor, and new facilities yet to come on line, will add to the existing problems. The D.O.E. has stated that there is no immediate threat of any kind to the on- or off-site population. They have also stated in their April 1984 report that 82 monitoring wells have been drilled in the A/M area for management of the groundwater contaminated with volatile chlorocarbons. However,	Monitoring programs and studies related to the actions considered in the EIS are discussed in Chapter 5.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	according to S.C.D.H.E.C., there are presently at least 160 monitoring wells in the area indicating the difficulty in following the plume of migration, and an increase of 78 or more wells in a year.	
E-4	In a report of June 22, 1970 by the U.S. Department of the Interior Geological Survey, it was stated, "Although monitoring wells are of value at the site of nuclear facilities, it must be remembered that the data obtained from the monitoring will not necessarily prove that radionuclides are not migrating from the site. (This, of course, would apply to volatile chlorocarbons or other contaminants, as well.) In other words, the absence of radionuclides (in this case, chlorocarbons) obtained from a monitoring system does not prove containment of radionuclides (or chlorocarbons) on-site. Because of the complexity in the flow patterns of groundwater, radionuclides (or other contaminants) contained in it could by-pass the monitoring wells, and not be detected until they have moved some distance from the site."	The bases for the prediction of groundwater transport of contaminants will be discussed in Appendixes A and H of the EIS.
E-5	It is for these reasons that the highly prioritized, highly contaminated A/M area is of particular concern to me, although I have not forgotten other areas. According to the Revised: April 4, 1984 SRP Groundwater Protection Implementation Plan, process water was discharged to Tims Branch and the M area settling basin from 1953-1982, a period of twenty-nine years. Tims Branch contained volatile chlorocarbons from seepage of the settling basin, spills and leaking underground process effluent piping which resulted in groundwater contamination. The chlorocarbons traveled down Tims Branch to Steeds Pond and may have migrated into the ground along the effluent route.	Programs underway for the remediation of chlorocarbon contamination of groundwater in the A/M-Area are discussed in Chapter 1, and the relationship of groundwater to surface hydrology will be discussed in Chapter 3 and Appendix A. Actions and activities in the A/M-Area that are not underway and that might be implemented are assessed in Chapter 4.
E-6	A possible explanation contrary to the DOE's "plant security" reason for their occupancy and control of the Forest Service Lands, comprising tracts 1 and 2--the Talatha Units which adjoin the SRP near the Administration Area--is that migration of the contaminated groundwater from the A/M area may be more extensive than previously known, and either off-site, or closer to the plant boundary than the DOE would care to admit. Dr. Joseph	As contained in the environmental assessment on the transfer of control of occupancy and use of lands adjacent to SRP, the tracts of land were originally part of the Savannah River Plant and the sole consideration in transferring the control of the land was to improve the security posture of SRP. Chapter 4 and Appendix F discuss the potential migration of groundwater contamination both on and off of the

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	Spencer who was the plant's technical supervisor in 1983, stated in April of that year that the Tuscaloosa aquifer flows toward Jackson, as well as New Ellenton and Talatha. Occupancy of the Talatha Units of USFS land may make it possible for the DOE to truthfully say that there has been no off-site migration of contamination. I believe there is considerable evidence that is supportive of my view. There may be a similar explanation for Tract 3, the Swamp Unit, which adjoins the western boundary of the SRP near the "D" area, heavy water area, and Equipment Test Facility.	SRP, including those tracts formerly controlled by the U.S. Forest Service.
E-7	With regard to the DOE's Environmental Impact Statement, most of all I would like to see in the EIS decision-making process how you have figured the cost of SRP waste management in terms of health effects, and/or the shortening of people's lives. I would like to know what monetary figure you have selected to represent the value of a person's life.	The potential health effects of alternatives and the methods used to evaluate health effects are presented in Sections 4.2, 4.3, 4.4, and 4.7 and Appendix I. The methodology of assessing health effects does not assign a "cost" to health effects or shortening of people's lives; rather, it assesses the potential risk of increased incidences of cancer.
E-8	The public has the right to expect that this time you comply completely with RCRA, since it took a legal battle on the part of citizens' organizations to force the DOE to do what they should have been doing all along. Beatrice D. Jones	Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modification of waste management activities at the SRP, including the requirements of the Resource Conservation and Recovery Act, as amended.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	STATEMENT OF IRA DAVIS Richmond County Property Owners Association	
	Ladies and gentlemen, we are here today for two reasons. The first is to give these gentlemen the benefit of our thinking in connection with the up-coming EIS. The second is to hear and explanation from them of the measures which are planned and which will be put in motion when and if the EIS is approved by DOE Headquarters in Washington, D.C. I think sometimes we are too slow to realize and appreciate the fact that ours is a government of, for and by the people of the country. In some other countries the thing would be done and we would be told about it after it was all over. In some other countries it would be done and, regardless of the risk we would not be told at all. Here, and only here, we are told up front what is contemplated and asked to contribute our thinking to the united effort to determine the danger to the environment and determine how to keep the risks to a minimum. Almighty God, in his infinite wisdom placed all species on this earth to remain for a time and then, in the eternal plan and scheme of things to pass away and give room for other species to take their place. Man may be a part of this scheme - we do not know. We do know that we and we alone have the power to destroy the greater part of what we call our world. The question is if we have the wits to preserve it. The best professionals in our country's service have contributed their special talents to determining the present and future dangers to the environment today, tomorrow, and as far in the future as man can see with any pretense of accuracy. The purpose of the EIS, as I understand it, is to balance the risk against the gain, to determine what if any, other precautions need to be taken and, if so, how it should best be done. Fine! But when the first atomic bomb laid waste Hiroshima man was made a junior partner by God and given knowledge to enable him, if he is foolish, to destroy himself.	*Comments noted. No response on scoping required.*

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	No man, whether sitting in the Pentagon or here in this room, can say with certainty what the environmental results will be. But some of us know this, others can hazard a guess. Our way of life is threatened as never before by the forces of a Godless world that would utterly destroy us to ensure its own supremacy. The Russians looking down through the bomb sights on their Bears and Backfires care not what damage they do to the environment where their bombs fall. Their only care is can they destroy the war making potential of SRP quick enough and completely enough to prevent it furnishing our own Armed Forces with the means to take dreadful revenge for their fast strike. If they can, they will win and win the world with it. If they cannot, the cost will be 100,000,000 plus Russian casualties, most of them inside European Russia. Such losses would undoubtedly mean the end of the Communist system, regardless of the final outcome of the war. For make no mistake, ladies and gentlemen, the old saying is true - nobody ever started a fight he didn't think he could win. But, our starry eyed liberals say - and what makes them so awfully dangerous is the fact that most of them sincerely believe what they say - we already have enough warheads to blow up the world x number of times over. True, maybe. But some of those same warheads were made during the '50s and are beginning to lose their efficiency with age. They must be modified, rejuvenated or even replaced if we are to continue to be able to say to Moscow "Yes, you can kill us but the price of doing it is your own life." That is what is keeping an uneasy truce and has since 1950 - the certainty that our destruction would mean theirs as well. So let me close by saying this - nothing from George Washington risking the little band of ragged patriots in the middle of the Deleware of Christmas Eve to the outcome of the tests at Los Alamos which ended the bloodiest conflict in world history - nothing worth doing was ever done without RISK.	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	Our task is to determine the degree of that risk, how to minimize it or avoid it and to go back to our own communities and squelch rumors that our great grandchildren will be born with horns in the middle of their foreheads from drinking radio active water caused by the discharge from SRP into our own Savannah River. The men who work daily with this dreadful power have as much to lose as we do - in some cases maybe more. None of them back away. We must know if we will have clean water and fresh clean air. We cannot survive without them. But if some sub-species has reached the end of its allotted time in God's great scheme of things it dies so that free men can live in progress, sleep at night in their beds in peace and pass a better world on to their children - then men themselves have died, gladly, for the same reasons. Nuclear power for peace could be the greatest boon to mankind since the invention of fire. Nuclear power for war could destroy us. If we are to join other bygone nations on the scrapheap of history let no man be able to say, truthfully, that they met their fate because of an unwillingness to fight and die for what they believed in. Nor let them be able to say that our fate overtook us because, like ostriches we stuck our heads in the sand and waited for the danger to pass. I quote the Father of our Country, who saw us through our birth and childhood. George Washington said "The best way to insure peace is to remain ever prepared to defend it. Let us prove, to ourselves, to our grand children who, terrified by false rumors and blinded by meaningless platitudes, wail "better Red than Dead," that we mean to be neither. If there are risks let us use our science to minimize them - then take them. And ending to the time of testing, quibbling and indecision is upon us. The time for action is upon us. Let us build and strengthen ourselves so that we can say - and make it stick - "come the three other corners of the world in arms against us we shall shock them. AND NAUGHT SHALL MAKE US RUE, IF THIS LAND TO ITSELF DOES REMAIN BUT TRUE."	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	Thank you. Ira Davis Jr. Pres. R.C.P.O.A P. O. Box 5631 Augusta, GA 30906	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	STATEMENT OF GENE WEEKS Speaking for Judith E. Gordon, Ph.D. Nuclear Issues Coordinator South Carolina Chapter Sierra Club SIERRA CLUB SOUTH CAROLINA CHAPTER TO: DOE Officials, Scoping Meeting for EIS on Waste Management at SRP. FROM: Judith E. Gordon, PhD, Nuclear Issues Coordinator, South Carolina Chapter, Sierra Club Re: Comments on proposed EIS. The South Carolina Chapter wishes to express its appreciation for the opportunity to present comments on waste management activities and procedures at the Savannah River Plant (SRP). I'm sure we can agree that the Department of Energy's willingness to write an environmental impact statement (EIS), without "outside" coercion, is going to save all of us time and energy, so to speak.	
G-1	Attached to this statement is a more detailed fact sheet that outlines the Sierra Club's position on the treatment of low-level nuclear waste. In the interest of brevity, this will not be read now but instead entered as part of the record of this hearing. Our main concerns are outlined as follows. The Environmental Protection Agency (EPA) has stated that groundwater contamination is a growing problem in the U.S. It has led to the closing of private and public wells in at least 25 states. One of the major sources of contamination is surface impoundments. While EPA is, of course, speaking of commercial facilities, we have seen similar contamination occur at SRP with the movement of trichloro- and perchloroethylenes into the Tuscaloosa Aquifer from seepage basins at the SRP. Had DOE officials been asked about the possibility of such leakage ten years ago, they would have assured the public that it was such	Comments in fact sheet noted. The EIS discusses alternatives for the disposal of hazardous, low-level radioactive, and mixed waste including above-ground disposal facilities in Chapters 2 and 4.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	a remote possibility that it wasn't worth a second thought.	
G-2	Today there are plenty of second thoughts - how well do we really understand the hydrology of this region? Are seepage basins AND shallow-trench burial, for that matter, really the best way to handle either hazardous or low-level radioactive waste? It is becoming obvious that the answers and possible solutions are far more complex than technocrats ever envisioned. Worldwatch Institute's paper on water management (Water: Rethinking Management in an Age of Scarcity, #61, Dec. 84) emphasizes the seriousness of the contamination problem, be it commercial or defense in origin. "As much as a fourth of the world's water supply could be rendered unsafe for use by the year 2000." We in the Sierra Club feel that government operations have a unique opportunity, if not a responsibility, to demonstrate to all concerned that the proper handling of waste can prevent future catastrophes. Indeed SRP now has such an opportunity to correct many of its past errors. Along these lines, we assume that DOE officials will want to	Chapter 3 and Appendixes A and H discuss the geology and subsurface hydrology at the SRP as well as geohydrological modeling used to assess the alternatives in the EIS. Also see the response to comment G-1.
G-3	1. Conform to all state and national regulations that currently apply to disposal of commercial hazardous and low-level radioactive wastes. This includes compliance with the Resource Conservation and Recovery Act (RCRA) as directed by the court decision (LEAF v. Hodel, No. 3-83-562, E.D. Tenn. 1984) stating that federal defense facility "mixed" wastes are also subject to RCRA regulations.	Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modification of waste management activities at the SRP, including the requirements of the Resource Conservation and Recovery Act, as amended, and the status and applicability of "mixed waste" regulations.
G-4	2. Consider greatly increase use of above-ground storage of hazardous and low-level radioactive waste, especially in view of the dismal record of such sites as Maxey Flats, KY, and Sheffield, IL where so-called safe trenches leaked prematurely and had to be permanently closed. The climate and hydrology of the Eastern U.S. do not lend themselves well to trench disposal of waste. EPA has stated that half of all commercial sites are located over thin or permeable unsaturated zones; that over 70% lack proper lining; that nearly one third of all sites are within a mile of a water well that could be affected by contamination. How much of this applies to defense waste disposal sites at SRP?	See the response to comment G-1.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
G-5	3. Support new regulations that redefine low-level waste so that, for example, radionuclides that require more than 100 years of monitoring are treated as high-level waste and handled separately.	The development and support of new regulations are not within the scope of this EIS.
G-6	4. Consider all state-of-the-art disposal methods and make choices on criteria that first emphasize sufficient isolation and safety and then consider costs. We have seen what short-term savings have produced - ineffective trench burial and leaking seepage basins!	See the response to comment G-1.
G-7	5. Permit effective outside monitoring so that the public can have some faith that things are really working as they should.	Chapter 5 discusses groundwater monitoring activities at SRP, including the relationship of monitoring activities to State and EPA requirements.
G-8	6. Admit that in view of past problems, the SRP site is not well suited to waste burial, and perhaps another production reactor is not in the best interests of anyone save those whose jobs are tied to SRP. This is by no means a statement that jobs are not an important consideration, but that the health and welfare of the people of this area are more important. DOE should seriously consider job retraining and location for those who may need it if and when the SRP facilities are no longer needed.	See the responses to comments G-1, G-2, and G-3. The subject of a new production reactor is outside the scope of this EIS.
	We are sure you will want to meet these challenges in creative ways and in the best interests of all concerned. Thank you.	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	ATTACHMENT SIERRA CLUB Radioactive Waste Campaign Fact Sheet "Low-Level" Nuclear Waste: Options for Storage Legislators, policy makers and citizens are rushing to meet a deadline of January 1986 set by the U.S. Congress (Low-Level Radioactive Waste Policy Act) when regional solutions to the "low-level" nuclear waste problem must be in place. The imminence of this unrealistic deadline has forced decision makers to opt for the quick fix, disposing of all "low-level" waste in burial grounds. Burial grounds differ little from garbage-type landfills. Waste generators believe landfills can somehow be made to work. But they are not a viable option. In moist areas, water runoff and underground migration inevitably bring water into a landfill and carry out poisonous chemical and radioactive substances. Waste generators and the Nuclear Regulatory Commission (NRC) consider all "low-level" waste the same. But it is not. Some is extremely radioactive and long-lived, requiring monitoring and maintenance for thousand of years; other waste is slightly contaminated and short-lived. These "low-level" waste streams should not be "disposed of" in the same place, using the same basic technology - shallow landfills. A sound "low-level" waste management policy calls for segregating radioactive waste at the point of generation and storing it above-ground. While the waste is stored above-ground, we can be assured of no leakage into our ground water. The waste can be easily monitored and protected. Short-lived waste will decay to non-toxic levels.	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response

THE WASTE STREAM MUST BE SEGREGATED AT THE POINT OF GENERATION

Each of the different types of "low-level" waste have specific characteristics and require specific storage techniques.

REACTOR WASTE, which accounts for 24% of the radioactivity of "low-level" waste sent to burial grounds[1], falls into two radically different categories. Wet waste which consists of ion exchange resins and sludges, and dry waste which consists of clothing, rags and tools. By volume, power reactors account for about 54% of the waste stream.

WET WASTE Resins and irradiated components, such as control rods, make up over 95% of the radioactivity in reactor "low-level" waste.[1] The nuclear industry tends to talk only in terms of volume when discussing "low-level" waste. This is misleading. The radioactivity, longevity and chemical composition of the material must be an integral part of a sound waste management policy.

Resins are a media with the consistency of caviar. They are used to purify the water that circulates around the fuel in the reactor. Of particular concern is cesium-137, which is water soluble, and therefore, readily migrates out of the nuclear fuel into the surrounding cooling water. Because of this solubility, the substance will also readily migrate out of a burial ground. An average reactor produces 500 curies* of cesium-137 per year.[12] with 80 operating nuclear power plants in the U.S., about 40,000 curies of cesium-137 are shipped to burial grounds each year.

Besides cesium-137, another dominant component of reactor wet waste is cobalt-60. These two isotopes have half-lives,* respectively, of 30 and 5 years and must be sequestered from the environment for at least 300 and 50 years, respectively. These wet wastes, because of their toxicity, longevity and mobility in the case of the cesium-137, should not be dumped in landfills. They should be temporarily stored in bunkers, preferably above-ground, carefully monitored and subsequently, isolated in a high-level waste repository, when one is available.

*see glossary.

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	DRY WASTES These are generally only slightly contaminated materials that can be compacted: Some of these materials conceivably could be incinerated because the radioactivity could be trapped on filters as in done in Canada (see page 4). The difficulty with incinerating the dry wastes of the nuclear reactor "low-level" waste stream is that, if an incinerator were operating, nuclear utilities would press to also have the resins and sludges incinerated. This would pose an unacceptable health hazard to surrounding communities because of the large amounts of cesium and other isotopes going up the stack, material which could not be entirely trapped on stack filters. If not incinerated, the dry wastes of a reactor should be compacted and stored in bunkers. IS IT FEASIBLE? Can the wet waste stream be separated from the dry waste steam at the reactor? Yes, it is already being divided prior to transport. Because of high radiation levels of resins, these materials are currently transported in shipping containers separate from the steel drums and wooden crates used for dry wastes. Current practice is that, in these separate shipping containers the wet and dry wastes are sent to the same burial grounds, and buried together. This segregation, initiated at the reactor for transport purposes should be used for storage purposes as well, as is done in Canada[3] (see page 4). INDUSTRIAL WASTE These account for 73% of the radioactivity of the "low-level" waste going to burial sites.[1] In this category fall two large producers of isotopes for medical and research purposes: New England Nuclear (MA) and Union Carbide (NY) which, respectively, account for 24% and 15% of the total radioactivity of the nation's "low-level" waste. New England Nuclear's waste is primarily tritium, producing 120,000 curies per year. Since tritium behaves exactly like water, it cannot be isolated in a landfill. This waste should be stored in above-ground bunkers for at least 100 years. Union Carbide's waste consists of all the radionuclides represented in irradiated fuel. By no stretch of the imagination can this waste, which is dominated by the long-lived	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	isotopes such as strontium-90 and cesium-137, be classified as "low-level." This is waste, which along with the resins and sludges from reactors, should be isolated in above-ground storage bunkers, temporarily (20-50 years) and then moved to a high-level waste repository. By volume, industrial waste accounts for about 11% of the total stream. INSTITUTIONAL WASTE, which accounts for about one-third of the volume of waste presently going to commercial burial grounds, consists of materials both from hospitals and research institutions. These two waste streams are significantly different from one another with medical waste dominated by short-lived materials such as technetium-99m with a half-life of six hours and the research waste stream consisting of long-lived materials such as carbon-14 and tritium with half-lives, respectively, of 5,000 and 12 years. Other shorter-lived materials are also included in institutional waste. The medical waste, with less than one percent of the radioactivity in "low-level" waste, lends itself to being stored in above-ground facilities for about three years until it has decayed to levels low enough to be disposed of as regular trash. Dartmouth College has a program (described in detail on page 4) which offers considerable promise for similar institutions. Hospitals in cities should follow Dartmouth's example by using a centralized storage location for isotopes for the necessary decay period. LANDFILLS LEAK An erroneous assumption dominating current "low-level" waste planning is that landfills can be prevented from leaking. The history of both radioactive and chemical landfills in humid climates does not substantiate this claim. The unlined dump, and even the double liner approach, using a leachate* collection system, have failed in areas of average rainfall (30-40 inches per year). Experts, such as Dr. Peter Montague at Princeton University, Center for Energy and Environmental Studies have stated.	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	"We found that four state-of-the-art landfills in New Jersey developed leaks within one year. I think the whole idea of secure landfills is really a figment of optimistic imaginations."	
	The track record of radioactive landfills in humid areas, has similarly been poor (see box 1). Of six commercial sites which have operated in the United States, three are now closed because of problems: Maxey Flats, Kentucky; West Valley, New York; and Sheffield, Illinois. All three have had water infiltration into trenches, slumpage of trench covers and erosion. At each site, radioactivity has migrated and expensive remedial actions are continuing. The major operating radioactive landfill for the country, Barnwell, South Carolina, is located in a high rainfall area. It has not had buildup of radioactive leachate because of the porous, sandy trench bottom which allows radioactive water to drain out into the environment. Tritium has been detected 45 feet from the burial trenches at Barnwell. The other operating sites, in Beatty, Nevada and Richland, Washington, both located in semi-arid regions, have apparently not had the same problems as at other sites.	
	Leaking radioactive landfills are not acceptable to the general public. The definition of a "safe" level of radiation has changed drastically over time as we have learned more about radiation and human health. Most physicians agree now that it is the accumulation of low-level radiation doses which is hazardous. We still do not know the exact dose which causes cancer, though we do know that there is a direct correlation between the amount of radiation received by humans and the incidence of cancer.[4]	
	ABOVE-GROUND STORAGE IS PREFERABLE	
	Above-ground storage avoids the health hazard of leaky burial grounds and avoids the high cost associated with remedial action that, inevitably, will be required at failed burial grounds. Above-ground structures permit storage in a facility that can be easily repaired. While, over time, concrete may deteriorate, cracks may develop, or operational error may cause leakage, problems can be quickly detected and remedied. Above-ground	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	structures can be designed in such a way as to provide a double barrier which can be used to isolate leakage and prevent it from moving into ground water. The nuclear industry and its boosters have fabricated a number of disadvantages to above-ground storage: cost, nonpermanence, reliance on institutional controls, sabotage, even plan crashes. Many of these arguments, discussed in box 2, are simply red herrings. The industry, in advocating radioactive landfills, is promoting an "out-of-sight, out-of-mind" solution. But as the operating record at three closed sites has made one point abundantly clear: RESIDENTS AND TAXPAYERS ALWAYS PAY IN THE END FOR LEAKY LANDFILLS. ABOVE-GROUND STORAGE IS PRACTICAL AND FEASIBLE Above-ground structures are being used by utilities operating power reactors in the United States and Canada,[3] and by medical and research institutions. The Tennessee Valley Authority (TVA) has built above-ground storage modules at the Sequoyah Nuclear Plant near Chattanooga, Tennessee.[2] Several utilities in the Northeast are designing and building on-site, above-ground storage facilities. Vermont Yankee in Vermont, Pilgrim I in Massachusetts and Susquehanna in Pennsylvania are all moving in this direction. TVA ABOVE-GROUND STORAGE Presently, the TVA ships "low-level" radioactive waste to the Barnwell, South Carolina landfill. Because of the near-term uncertainty of space at Barnwell, the NRC approved and TVA has partially constructed an above-ground storage facility at the two Sequoyah nuclear reactors located on the Tennessee River, 18 miles northeast of Chattanooga. The TVA above-ground storage facilities are not much more complicated than a large concrete box, called a module, with special features to collect radioactive leakage and to shield workers.	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	The storage modules are constructed, as needed, of reinforced concrete with an inner decontaminable coating. The modules are large, rectangular boxes, 34' wide, 195' long and 19-1/2' high. The thickness of the concrete floor slab is 39-1/2", while that of the caps and walls is 24". Modules for the storage of resins are almost twice as thick - 42". According to TVA plans, eight resin storage modules and five trash modules will be located on a 20-acre area. There are four compartments in each module. Each compartment contains a liquid drainage system and sampling valves. Any radioactive liquids can be collected and repackaged, or taken to the nuclear plant for processing. Filters and booties that are less radioactive are stored in 18-gauge, steel drums or boxes. The more radioactive exchange resins are stored in more rugged carbon steel cylinders coated with epoxy. A giant mobile crane straddles the entire concrete module, running along curbed concrete sidewalks on each side of the module. Module loading/unloading steps, through use of the rubber-tired, diesel-powered gantry crane, are shown in box 2. The highest radiation doses are received by crane operators, though the concrete shielding reduces the levels. Since the storage facility is located about 200' from the site boundary, the doses to the public were expected to exceed the NRC hourly radiation limits while the cover is off the storage module. Above-ground storage units can be located so that public exposure is not necessary. The above-ground storage facility is of substantial construction and is expected to remain functional for several decades. The NRC will, however, only license above-ground storage facilities for a five-year period. This limit will need to be extended for the above-ground storage to be implemented. The NRC has no technical justifications for this limit. ONTARIO HYDRO EXPERIENCE Ontario Hydro operates eight nuclear reactors with a total capacity of 5,100 MW(e), with an additional eight reactors under construction.[3] The Canadian reactors, called CANDU reactors,	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	are different than U.S. reactors which must be shut down for refueling every 12 to 18 months. The CANDU reactors are fueled while the reactor is operating. Defective fuel leaks radioactivity into the cooling water. In the CANDU reactors, this fuel can be promptly replaced. This means the CANDU generates about one-half of the "low-level" waste that U.S. reactors produce for the same electrical output. In the Ontario Hydro system, there are four reactors at each site. A central storage area, the Waste Operations Site, located at the Bruce pant near Tiverton, Ontario, will service all 16 Ontario Hydro reactors. At each reactor site, the resins are slurried into large (three cubic feet) carbon steel cylinders. These sit upright in shipping containers and are sent to Bruce for storage. These resins, along with water purification filters, are stored either in tile holes or Quadricells. The tile holes are located underground; they are cylindrical, concrete storage containers, each of which holds two ion exchange resins. After loading, the containers are backfilled with concrete. A leachate collection system and monitoring system are utilized at the bottom of the tile holes. As part of Ontario Hydro's waste management plan, when the resins and filters have cooled to the point where radiation levels are less than one rem per hour, the cylindrical container and concrete backfill will be lifted in one piece and transported to an above-ground storage building (see photo page 5). Resins are also stored in Quadricells, heavy concrete vessels which are placed in an above-ground concrete room 8' by 8' at its base, and 18' high , similar to a cemetery mausoleum. The roof is sloped to aid water runoff. The walls and floors are 2' thick, and, with the inner concrete cylinders, sufficient to shield workers and to withstand impacts from airplane crash, or tornado-borne utility poles. Fifteen Quadricells are placed in an area about 20' wide by 272' in length. The minimum design life is 50 years.	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	The Ontario Hydro system for storing resins is clearly far superior to the U.S. system in which these radioactive, water soluble materials are dumped in leaky landfills. Also in use by Ontario Hydro are inground concrete trenches. These are for dry waste which is compacted and non-combustible and for radioactive ash that is generated by incineration of slightly contaminated materials such as clothing and papers. These concrete trenches are 10' wide, 10' deep and 125' long. The concrete lid is one foot thick; the trench walls are somewhat thicker. The trench slopes to a sump and standpipe which allows for water detection and removal. The above-ground storage building in the Ontario Hydro system is for wastes with radiation levels of less than one rem per hour. Both resins and lower-level wastes in the concrete trenches will eventually be stored here. This building is a prefabricated concrete warehouse with walls 1-1/4' thick and a concrete roof 1/2' thick. The building dimensions are 164' long by 98' wide by 26' high. The building has smoke detection equipment, carbon dioxide fire extinguishers and an internal drainage system. DARTMOUTH COLLEGE Dartmouth College in Hanover, New Hampshire produces "low-level" radioactive waste in medical and scientific research and at the College hospital.[5] In the past, this waste was shipped to commercial radioactive landfills in Richland, Wash. and Barnwell, S.C. While the volume produced between 1977 and 1982 remained stable (120 to 150 55-gallon drums per year), the cost of disposal increased by a factor of seven in this five year period. Like most medical and research institutions, the radioactive waste can be placed into five categories: liquid, solid, liquid scintillations vials (LSV), animal carcasses and other. For liquids containing less than 100 microcuries per liter of radioactivity, this waste, containing tritium and iodine-125, is disposed of into the sewer. Liquids containing more than 100 microcuries per liter are stored in one-gallon containers within a lined 30-gallon drum. This waste is primarily iodine-125	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	(half-life: 60 days) and phosphorus-32 (half-life: 14.3 days), and is stored for ten half-lives. Solid waste, consisting of disposable plastic and glass items, and contaminated paper, is placed in a lined 55-gallon steel drum and compacted to reduce the volume. A drum typically contains a few millicuries of tritium, sulfur-35, chromium-51 and iodine-125, and is stored for at least ten half-lives, or approximately 2.4 years. After this storage period, 55-gallon drums containing less than a millicurie of tritium, will be disposed of as regular trash. Glass and plastic liquid scintillation vials are put into a lined 55-gallon drum for temporary storage. A shredder-crusher is used to separate the liquid, containing tritium, carbon-14, phosphorus-32, sulfur-35 and iodine-125, from the plastic and glass. Vials containing shorter-lived radionuclides are separated from those with tritium and carbon-14, and are stored for ten half-lives. The vials containing tritium and carbon-14 below minimum NRC levels and are disposed of as regular trash. Carcasses, mainly rats, are first stored in a cooler. If the carcasses contain iodine-125, they are placed in a freezer for sufficient decay (5 to 10 half-lives). Carcasses containing minute amounts of tritium and carbon-14 are incinerated. Other waste from special experiments may contain up to one to three curies of tritium. This waste, managed on a case-by-case basis, is packed separately and shipped to a commercial burial site. Based on the production rate of radioactive waste and the management methods mentioned above, Dartmouth College built a storage building capable of holding 240 drums, with expansion space for future needs. The storage building is a reinforced concrete structure 24' wide, 98' long and about 11' high. the walls are one-foot thick, insulated and faced with a brick veneer. To collect leakage, the floor slopes toward the center where a collection pit is located. With the doors set four inches above floor level, the room will hold about 800 gallons	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response
	of fire water. A telephone and fire alarm pull station provide added safety and the building is equipped with heat detectors. The cost of the whole building, 2/5 of which is used for waste storage, was $125,000. Dartmouth estimates that the yearly cost of the storage facility, including operating and equipment costs, are less than the disposal costs at a radioactive landfill. As a result of this waste storage program and the short-lived nature of medical and research wastes, almost no radioactive waste is shipped to a radioactive landfill. CONCLUSIONS These examples of above-ground storage show that the technology is available. Above-ground storage will be resisted by utilities because of higher initial costs and because it will require the utility to maintain long-term responsibility for the wastes, rather than thrusting the long-term responsibility off on an unsuspecting state and its taxpayers. Some of the questions that need to be resolved are how many above-ground storage sites should be developed? Should these be at the reactor sites? What should be the design life of these facilities? Should above-ground storage operate in tandem with an incineration facility strictly limited to reactor dry wastes? It is clear that further research needs to be done on these questions. It is also clear that utilities and state governments must break off their love affair with out-of-sight, out-of-mind shallow landfill "solutions." It is time to re-think the "low-level" waste problem.	

Table K-2. Scoping Comments and DOE Responses

Comment number	Comment	Response

FOOTNOTES

[1]Department of Energy, *Spent Fuel and Radioactive Waste Inventories, Projections and Characteristics*, DOE/NE-0017/2, Washington, D.C., September, 1983.

[2]Nuclear Regulatory Commission, Environmental Impact Appraisal and Safety Evaluation Report of Low-Level Radioactive Waste Storage at Tennessee Valley Authority, Sequoyah Nuclear Plant, Docket No. 30-19101, Washington, D.C., September, 1982.

[3]Carter, T.J., "Radioactive Waste Management Practices at a Large Canadian Electric Utility," In Seminar in Management of Radioactive Waste from Nuclear Power Plants, Karsruhe, West Germany, 5-9 October, 1981, International Atomic Energy Agency, Vienna, Austria 1982.

[4]National Academy of Sciences, BEIR Report, Washington, D.C.

[5]Schori, E., "Disposal of Low-Level Radioactive Waste," Presented at League of Women Voters Conference on Low-Level Radioactive Waste, Boston, Mass., November 1983.

GLOSSARY

Leachate - The soluble components from waste which leak from a landfill when rain percolates through the trenches. *This polluted liquid is called* leachate.

Curies - A unit which measures radioactivity equivalent to 37 billion disintegrations per second.

Half-life - A period of time required for the disintegration of half of the atoms in a radioactive material.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	STATEMENT OF MS. DORCAS J. ELLEDGE	
	I live in Columbia, South Carolina. I am a native South Carolinian and have been concerned for some time about the environmental quality that we are presently living in and what we are leaving...living...leaving future generations. I'm real glad that the Federal Government finally decided that the SRP was not the fifty-first state, but is a part of the State of South Carolina, which is a part of the United States of America. I wondered for sometime when they would come to that decision. I attended the hearings on the L-Reactor, and I was disappointed the DOE decided not to come up with the best solution to the problem concerning Steel Creek and the cooling towers. They had a choice, but due to time, so they said, and money, not the best solution did they do. This was a disappointment. I hope and pray that DOE, with the encouragement and insistence of EPA, will get the best solution to the problems of groundwater... possible groundwater contamination, and that already contaminated, for the Savannah River Plant. I think it's time that the health and safety of South Carolinians and, in this case, Georgians, too, take priority over time and costs. There comes a time of reckoning. Potable water is essential to life. You can't live without it. No living thing can. So, I hope this will be a consideration, and the first consideration of DOE and EPA, who will be working with them. We are South Carolinians who have been, really, put upon, maybe by our own will, ignorance, whatever you want to call it, but I would find it reprehensible if DOE compromised the health and safety of the people of South Carolina on this issue of groundwater contamination. I am not a scientist. I have, for thirty years, been a nurse, and dealt with health and sickness and death. Please do what is best in the interest of health and safety for the citizens of South Carolina, and I appreciate this opportunity to speak with you.	Comments noted. No response on scoping required.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	STATEMENT OF MR. T. M. KING	
	My name's T. M. King. I live in Bath, South Carolina. Concerned citizens, gentlemen; I won't go into the warmongering thing here, and I personally do not believe that these weapons are necessary, but we'll skip all that, you've heard it before.	
I-1	An honest EIS is needed for the SRP because of the leaking, hazardous waste, and non-hazardous, or so-called non-hazardous waste, from both above-ground storage tanks and seepage basins entering into the CSRA water supply and aquifer, and numerous radioactive gas releases, which most of them have not been reported to the public and Aiken.	The EIS will present a characterization of existing hazardous, low-level radioactive, and mixed waste sites at SRP (Appendix B), including an assessment of groundwater contamination and health effects of alternatives for remedial and closure actions at these waste sites (Chapter 4). The storage and immobilization of high-level radioactive waste in waste tanks is not within the scope of this EIS. These subjects have been discussed extensively in the following documents: • <u>Final Environmental Impact Statement, Waste Management Operations, Savannah River Plant, Aiken, South Carolina</u>, ERDA-1537, September 1977. • <u>Final Environmental Impact Statement, Long-Term Management of Defense High-Level Radioactive Wastes, Savannah River Plant, Aiken, South Carolina</u>, DOE/EIS-0023, November 1979. • <u>Final Environmental Impact Statement (Supplement to ERDA-1537, September 1977), Waste Management Operations, Savannah River Plant, Aiken, South Carolina</u>, DOE/EIS-0062, April 1980. • <u>Final Environmental Impact Statement, Defense Waste Processing Facility, Savannah River Plant, Aiken, South Carolina</u>, DOE/EIS-082, February 1982.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
		Releases of radioactive material and their impacts on the population within a 50-mile radius from the Savannah River Plant and downstream consumers of Savannah River water are published in an annual series of reports available to the public, entitled Environmental Monitoring in the Vicinity of the Savannah River Plant. The most recent of these reports is for 1984.
I-2	This environmental impact should be taken a step further by including a study on the health effects of citizens living in the areas around the SRP. In a '76 study, conducted by DuPont, revealed a sixty percent excess incidence of lung cancer, and I repeat that; a sixty percent excess incidence of lung cancer. And a hundred and fourteen percent higher than average leukemia rate at the SRP site.	The EIS will discuss the potential health effects of alternatives for existing waste sites in Section 4.2, alternatives for new disposal facilities in Section 4.3, and alternatives for disassembly-basin purge water in Section 4.4.
I-3	I strongly recommend this area health study be taken independently, hopefully with funds provided by the Government, if possible,	A review of the feasibility and usefulness of conducting further epidemiologic studies of delayed health effects around the SRP was undertaken by a panel organized by the Centers for Disease Control of the U.S. Department of Health and Human Services. The review and recommendations of the panel are documented in a report entitled, Epidemiologic Projects Considered Possible to Undertake in Populations Around the Savannah River Plant. Public comments and responses and DOE's final position regarding the panel's recommendations are documented in Public Comment and Meeting Report, A Centers for Disease Control Review Panel's Recommendations on Health Effects and Epidemiological Studies of Operations at the Savannah River Plant, Aiken, South Carolina, DOE/ER-0225, May 1985.
I-4	and, also, that something be done about the transportation of this nuclear waste traveling the city streets of Aiken, South Carolina, congested small streets, not to mention the highways, and even parking across the street at the Burger King. I think it's gone a little too far. This is spaceship Earth. Let's don't foul our own nests. Thank you.	See the response to comment A-15.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	STATEMENT OF MARY LOU SEYMOUR	
	My name is Mary Lou Seymour. I'm a resident of Aiken County, I live in Bath. I am today representing the CSRA Health Project, which is a group of citizens from the CSRA, and our main interest is getting an independent health study done.	
J-1	We have come and testified several times at epidemiological meetings, and all this kind of stuff, and we haven't seen anybody want to do a health study of the residents of the area.	See the response to comment I-3.
	Many of our members have been affected by working at the plant, physically, and many have died, and we talk to people every day that have cancers and leukemia, and we think this should be documented. Now, I don't know if this is in the scope of an environmental impact study, but I think that people's health, that's part of the environment, too. It's the environment that's causing that.	
	And we would like, once again, to urge that a study be done of the residents of the area, and maybe y'all won't find anything. Well, that would be wonderful. We could all sleep quietly at night. But I don't...I don't know, from the way they never want to do it, it makes us think that there is something wrong, and we would sincerely like to urge you to put all possible efforts to doing a health study of this area.	
	Thank you.	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	STATEMENT OF HANS NEUHAUSER Coastal Director Georgia Conservancy	
	Thank you. I am Hans Neuhauser. I am Coastal Director of the Georgia Conservancy with offices in Savannah. The Georgia Conservancy is a statewide membership organization that is concerned about the quality of the environment in the State of Georgia and in adjacent areas. Our concern relates in large measure to our membership which includes individuals who live along the Savannah River, both in the Augusta area and in the Savannah area. First of all, I would like to thank the Department of Energy for complying with the National Environmental Policy Act and holding this and other scoping meetings on this proposal. I believe that the Department of Energy has learned its lesson from the L-Reactor and from the litigation and the Congressional action that went along with that issue. And I think the opportunity for citizens to participate in providing suggestions on this proposal will in the long run be beneficial for the Department of Energy and the operation of the Savannah River Plant. The concerns that our organization have, I believe, mirror the concerns that have been expressed by others relating to groundwater and surface water contamination.	
K-1	In Georgia, we are dependent on a number of aquifers and on the Savannah River for drinking water and industrial process water, and we need to make sure that these water supplies remain clean and useful for the people of Georgia, not only now but in the future, and so we urge the Department of Energy to take all necessary steps to prevent groundwater and surface water contamination, and in those areas where there has already been contamination to take all necessary actions to remove that contamination.	The EIS discusses the impacts to surface-water and groundwater quality from remedial and closure actions at existing waste sites in Section 4.2, from new disposal facilities in Section 4.3, and the discharge of disassembly-basin purge water in Section 4.4. Cumulative surface-water and groundwater quality impacts are presented in Section 4.7.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
K-2	We are also concerned about such things as endangered species, like the woodstork. Many of these have been identified in other scoping process documents.	Potential impacts to endangered species are discussed in Sections 4.2, 4.3, 4.4, and 4.7. Chapter 6 discusses the status of any required consultations in accordance with the Endangered Species Act.
K-3	We would like to urge the Department of Energy to comply with the Resource Conservation and Recovery Act in developing this environmental impact statement. It has been indicated by others that on occasion the Department of Energy has attempted to circumvent compliance with the Resource Conservation and Recovery Act by hiding under the provisions of the Atomic Energy Act, and we feel that both the States of South Carolina and Georgia would benefit from the Department of Energy's voluntary compliance with all the requirements of that act.	Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modifications of waste management activities at the SRP, including the requirements of the Resource Conservation and Recovery Act, as amended.
K-4	Finally, we would like to see incorporated into the Environmental Impact Statement analysis an evaluation of the opportunities for independent oversight of this activity. In our view, many of the organizations at the Savannah River Plant have been carried out in the past without adequate independent oversight, particularly by agencies that have the technical expertise to determine exactly what is being done. So we would like to see an analysis of an independent oversight role for such agencies as the Environmental Protection Agency, the South Carolina Department of Health and Environmental Control, the Georgia Environmental Protection Division and citizens' interests. This concern for citizen and independent agency oversight is not a minor issue with us, and it does not confine itself simply to the waste management issue. It is something that we believe is necessary for not only the Savannah River Plant operation but the entire nuclear developments in the Savannah River basin, and this position is endorsed by a broad range of citizens, including groups like the	Chapter 5 discusses groundwater monitoring activities at SRP, including the relationship of these activities to State and EPA requirements. Also see the response to comment K-3.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	Savannah Area Chamber of Commerce, so it is no small concern to us and the residents of this area. In conclusion, again I would like to thank you for holding these meetings. I apologize that there are so few people who have come to express interest or concern about this, but again I think it is a tribute to the opening of the process that some of this lack of interest is due to. Thank you.	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	STATEMENT OF DR. ZOE TSAGOS League of Women Voters Northern Beaufort County	
	PRESENTED BY THE LEAGUE OF WOMEN VOTERS OF NORTHERN BEAUFORT COUNTY AT A PUBLIC SCOPING HEARING FOR AN EIS ON WASTE MANAGEMENT AT SRP	
	May 16, 1985	
	I have appeared before you several times. However, for the record, I identify myself as Dr. Zoe Tsagos and I represent the League of Women Voters of Northern Beaufort County.	
	The problem of ground water contamination and waste management practices at the SRP has come up at every public meeting which has been held by DOE which I have attended, originally on the start-up of the L-Reactor and then at the scoping meeting for the EIS. Today we are considering with you on what should be included in an EIS on Waste Management which is required by several recent legislative acts.	
L-1	According to a statement by DOE in May 1984, and according to the contents of the EIS on the L-Reactor the following, in brief, were proposals applied to ground water protection: to "construct a $30 million waste water facility" by April 1985 in order to terminate the use of seepage basins; to pump out the already seeped chemical solvents from the Tuscaloosa Aquifer; to study and act to correct ground water problems on site; and to approach the problem of hazardous wastes in ground water. Now with an EIS in preparation, specifically on Waste Management, a greater analysis will be made on how DOE can bring about the above aims.	The referenced effluent treatment facility and groundwater withdrawal program are actions being taken at the SRP Fuel and Fabrication Area (M-Area) in accordance with the Supplemental Appropriations Act of 1984, Public Law 98-181. These actions, which have been approved and permitted, are discussed in Chapter 1.
L-2	Problems have arisen this past year in relation to waste management and ground water pollution. Perhaps the most significant has been the question as to whether mixed wastes, radioactive and non-radioactive, would be covered by law, specifically by the Resource Conservation and Recovery Act (RCRA) for on site storage and disposal in all nuclear weapons facilities.	Chapter 6 discusses applicable Federal and State regulatory requirements for the proposed modifications of waste management activities at the SRP, including the requirements of the Resource Conservation and Recovery Act, as amended, and the status and applicability of "mixed waste" regulations.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	The case brought by the Natural Resources Defense Council (NRDC) and the Legal Environmental Assistance Foundation (LEAF) in the suit LEAF vs. Hodel on the Oak Ridge, Tennessee Plant challenging the position that mixed wastes must be exempted from RCRA supervision on the grounds of national security. On April 13, 1984, this position was held invalid by a ruling in a U.S. District Court in Tennessee. In a letter of June 14, 1984 by NRDC to William Ruckelshaus, the then Director of the Environmental Protection Agency (EPA), he was urged to accept the Tennessee court decision as precedent setting and that it be applied to all nuclear weapons facilities. On August 1, 1984, DOE conceded that RCRA requirements for treatment and storage of wastes apply to mixed wastes and that this interpretation has over-all application. We are in favor of this decision since it is a logical acceptance of the fact that mixed wastes cannot and should not be divided into their component parts for each of the regulatory agencies' jurisdiction. A quotation from the NRDC letter to Ruckelshaus puts it clearly: There is no provision in RCRA permitting deregulating of hazardous wastes by mixing them with exempted materials, such as AEA (Atomic Energy Act) materials. Nor should there be, since such wastes become no less "hazardous" by virtue of their radioactive components. A further recommendation has been made by NRDC to EPA, namely that the contracting company, if any, be held responsible for complying with RCRA since they, the contractors/managers "are the ones actually generating, treating, storing and disposing of the wastes." We find this position logical and likely to expedite corrective measures on ground water waste management, as well as for other waste disposal such as solid, liquid etc. at SRP.	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	A significant statement on agency jurisdiction is the following from the NRDC letter: "In the rare case where compliance with both sets of requirements is physically impossible, the burden is on DOE to demonstrate the inapplicability of RCRA." The LWVUS in Convention in 1984 formed a Water Resources Task Force which will concern itself with the improvement of water quality in general in the nation and with lobbying for and supporting legislation which will best bring this improvement about. Special stress will be placed on the quality of ground water management. We come now to the DOE notice for today's scoping meeting for the citizen input to an EIS on an SRP Waste Management Program "for the protection of ground water, human health and the environment." In the DOE material sent to us on the Intent to Prepare an EIS, the background on Waste Management activities is touched upon, indicating how it started in 1952 and about the 1977 EIS on improved waste management operations. Now new regulatory requirements, one should add with many new regulating agencies and legislative acts, make certain changes necessary in the SRP Ground Water Management Program, especially because of the provisions of the RCRA and of the CERCLA (Comprehensive Environmental Response Compensation and Liability Act). In an article in the Beaufort Gazette of May 14, 1985 under Fran Smith's by-line, she reports the present scoping meetings and she notes the following: The Department of energy has identified 153 basins, pits, or piles of hazardous wastes on the 300-square mile tract that either do affect groundwater or could affect it. Some of them have been disposal sites for 30 years. The variety of materials includes mercury, volatile organic chemicals and acids.	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
L-3	The source of this data is not given. However, since the statement following, as well as the description of ground water pollution sites at SRP are ascribed to Jim Ferguson, director of S.C. DHEC, Bureau of Water Controls Compliance and Enforcement Division, he seems to be the source of the statement quoted above. We feel that although the time is fairly short when the 1977 Waste Management Program was established to the present, the 153 areas of real or potential ground water pollution is excessive if an ongoing inspection and correction program had been really in operation.	The identification of 153 waste sites at the SRP is contained in a document prepared by E. I. du Pont de Nemours and Company entitled, <u>Technical Summary of Groundwater Quality Protection Program at Savannah River Plant</u>, DPST-83-829, December 1983. Of the 153 sites, approximately 80 active and inactive sites contain hazardous, low-level radioactive, or mixed wastes. The EIS describes the required remedial and closure actions to be taken at these waste sites - at several sites remedial and closure actions will not be required and assesses the environmental consequences of alternative actions at these sites in Chapter 4. Chapter 5 discusses the ongoing groundwater monitoring program at the SRP for the detection of contaminants.
L-4	Again quoting from the article by Fran Smith cited above, "The S.C. Water Resources Commission especially would like to have some cluster wells drilled outside the 300-square mile plant site to be used for groundwater testing, according to a spokesman." We recommend that this testing be carried out in view of the degreasing chemicals and possibly other pollutants which have reached into the Tuscaloosa Aquifer and for the protection of the health of the residents of the town of Jackson, in particular, which is only two and a half miles away from SRP.	Extensive groundwater sampling and modeling efforts are under-way at SRP. These programs, including groundwater monitoring outside the SRP, are discussed in Chapter 5.
L-5	In the DOE statement of April 19, 1985 on the Intent to Prepare an EIS for Waste Management at SRP, there is the following statement: "Projects are currently underway at SRP to comply with recently enacted RCRA and CERCLA (Comprehensive Environmental Response Compensation and Liability Act) regulatory requirements for groundwater protection and to protect public health and the environment." SCDHEC and EPA permits are also needed to work on this ground water program. We feel that with the acquiring of the required permits and authorizations, DOE, supported by the regulatory agencies both state and federal which are concerned in ground water usage, should be able to reach a more effective control of this very serious problem of ground water pollution which seems to have become dangerously widespread.	See the response to comment L-2.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
L-6	Two announcements in the press, both of them familiar to DOE, should be mentioned here. They were both Associated Press releases from Washington picked up by the Beaufort Gazette. The first, June 5, 1984, said that the SRP was chosen as "a preferred option" for the burial of radioactive nuclear engine rooms from retired navy submarines over a period of years as obsolescence set in. The second press release of February 21, 1985, is concerned with the plan to build a new reactor which would have state-of-the-art technology and the possible closing down of one of the older operating reactors at SRP when the new one is on stream. With programs such as these two possible in the not distant future, setting aside any consideration, at the present time of possible opposition to either or both of these two projected events on the part of individuals and organizations, ground water pollution becomes more menacing. Finally, we do not think that indicating our preference in "Alternatives" to be followed under different conditions for the solution of the ground water pollution problem would be of great value here, since we assume that the safest and most corrective methods will be chosen by DOE, DuPont, and the various agencies,	The referenced programs either have been (decommissioned naval submarine reactor compartments) or will be (new production reactor) the subject of a separate NEPA review, and and are outside the scope of this EIS.
L-7	state and federal, that have oversight at SRP. In this scoping material sent to us by DOE, obviously, the last alternative, in each case, of doing nothing is not acceptable. Thank you, Mr. Chairman.	The no-action alternative, which is required pursuant to the regulations of the Council on Environmental Quality [40 CFR 1502.14(d)], is discussed in the EIS for each set of alternatives considered (i.e., existing waste sites in Sections 2.2 and 4.2, new disposal facilities in Sections 2.3 and 4.3, and disassembly-basin purge water discharge in Sections 2.4 and 4.4). DOE identifies its preferred alternative for each set of alternatives in Sections 2.1 in accordance with 40 CFR 1502.14(e).

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	STATEMENT OF THE HONORABLE HARRIET H. KEYSERLING State Representative District, South Carolina	
	The last time I appeared at a Department of Energy hearing, I supported an environmental impact statement before the restart of the L-Reactor.	
	My reasoning was that nuclear hazards are nuclear hazards, whether it be government produced or commercial, and if there is any danger in one kind of waste, there is the same in the other.	
	Therefore, the same rules and regulation should hold for both. When I first became involved in the problems of nuclear waste, I was told by those who produced it I should be less concerned about nuclear wastes than chemical wastes, because there was more potential hazard and therefore more control over nuclear waste.	
	I don't know about the first statement, that I need not be concerned about nuclear waste, but they were right about the problems which would and have surfaced about other chemical wastes and other hazardous wastes, so I come here today with the some statement as I made concerning the L-Reactor, to say that hazardous wastes are hazardous wastes, whether they be from government or commercial facilities.	
M-1	So the same rules and regulations which the federal government finds necessary for commercial waste should also apply to government as well radioactive and mixed wastes. I urge all the alternatives that you will consider be within existing regulatory requirements under the Resource Conservation and Recovery Act, the compensation and liability act, other federal laws, as well as South Carolina's laws and regulations.	The EIS assesses the potential environmental effects of modifying waste management activities at SRP for low-level radioactive, hazardous, and mixed wastes in compliance with applicable regulatory requirements, including the Resource Conservation and Recovery Act, as amended. Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modification.
	I also want to express my thanks for going through this EIS process and for giving the public an opportunity to give their views at this and other meetings. Thank you.	

Table K-2. Scoping comments and DOE responses

STATEMENT OF R. LEWIS SHAW

SOUTH CAROLINA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL CONTROL

2600 Bull Street
Columbia, SC 29201

Commissioner
Robert S. Jackson, M.D.

May 28, 1985

Mr. Charles G. Halstead
Assistant Manager for Health,
Safety and Environment
US Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, S.C. 29802

Re: Comments on Scope of the Environmental Impact Statement on the Waste Management Activities for Groundwater Protection at the Savannah River Plant

Dear Mr. Halstead:

The Department appreciates the opportunity to provide comments on the above referenced subject. For your preparation of the EIS the Department presents the following items for consideration:

Comment number	Comments	Responses
N-1	1. Preparation of the EIS should not interfere with permitting and compliance activities, ongoing or future, required by the Department.	The purpose of the EIS is to assess the environmental consequences of modifying waste management activities at the SRP for hazardous, low-level radioactive, and mixed wastes in accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969, as amended. If NEPA requirements conflict with the requirements of other applicable statutes, Sections 1.1 and 1.2 and Chapter 6 will discuss these conflicts.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
N-2	2. The EIS should encompass all wastes sites which are required by the 1984 RCRA amendments to be investigated as "continuing release" sites.	The EIS considers existing hazardous, low-level radioactive, and mixed waste sites regardless of their definition as "continuing release" sites.
N-3	3. The EIS should provide a description of all applicable laws, regulations and agreements for each existing and proposed hazardous, low-level radioactive, and mixed waste site.	Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modifications of waste management activities at the SRP.
N-4	4. The EIS should discuss existing and future laws and regulations which govern remedial and closure actions and their relationship to the NEPA and Federal budget processes.	See the response to comment N-3. A discussion of future laws is outside the scope of the EIS.
N-5	5. The Department recommends that recycling, reuse, incineration or further treatment (to render waste less hazardous) receive a higher ranking than land based treatment, storage or disposal facilities as preferred alternatives for future management of hazardous waste.	Appendix D discusses predisposal techniques such as source control, incineration, compaction, and biological/chemical treatment.
N-6	6. The Department recommends that the EIS evaluate the feasibility of using off-site treatment, storage, or disposal facilities which may be better suited than new sites on the SRP.	The subject and alternatives of using offsite facilities for waste - particularly radioactive waste - was discussed in the <u>Final Environmental Impact Statement, Waste Management Operations, Savannah River Plant, Aiken, South Carolina</u> (ERDA-1537), and was dismissed due to cost and potential exposures due to transport.
N-7	In conclusion, the Department wishes to clarify that the preparation, or the EIS itself should not be construed to satisfy any existing State regulation or requirement. Sincerely, R. Lewis Shaw, P.E. Deputy Commissioner Environmental Quality Control	Although this EIS is not a permit application, the DOE Record of Decision on the EIS will identify those actions to protect groundwater, human health, and the environment for which DOE will request the necessary approvals and permits for implementation.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	RLS/lnj cc: Kim Hill Jim Joy Jim Ferguson Hartsill Truesdale Virgil Autrey Bill Culler	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	STATEMENT OF MARY T. KELLY, PRESIDENT	
	LEAGUE OF WOMEN VOTERS of South Carolina May 24, 1985 2838 Devine Street Columbia, S.C. 29205 Telephone: 771-0063	
	Mr. Charles G. Halstead Assistant Manager for Health, Safety and Environment U.S. Department of Energy SRP Operations Office P.O. Box A Aiken, SC 29802	
	Dear Mr. Halstead:	
	The League of Women Voters of South Carolina appreciates this opportunity to help identify some of the issues which we think should be addressed in the proposed Environmental Impact Statement for waste management activities at the Savannah River Plant.	
O-1	Our organization believes that the operation at Savannah River in all aspects should have to comply with state and federal environmental laws and regulations for water quality, air quality, groundwater quality and protection, and hazardous waste management; and that representatives of state and federal regulatory agencies must be accorded full access for inspection and monitoring as well as complete cooperation. The implications for the health and safety of the citizens of this and neighboring states are too serious if such access and compliance are not guaranteed.	Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modifications of waste management activities at the SRP. Chapter 5 discusses groundwater monitoring activities at SRP, including the relationship of these activities to State and EPA requirements.
O-2	We realize that changing practices of the chemical industry are now mandating practices which are more health and environmentally protective than those followed in the 50's, 60's, and 70's. But we also realize that in the past certain practices which were widely followed were even then suspect. However, in the interests	Chapter 1 describes the approved actions being taken to eliminate the use of seepage basins, and Section 4.2 evaluates the environmental consequences of remedial and closure actions at existing hazardous, low-level radioactive, and mixed waste sites, including seepage basins.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	of getting the job done, they were followed. The use of unlined seepage basins is a case in point, as well as the manner in which degreasing solvents and metallic pollutants were handled and allowed to enter the atmosphere, the sediment, and the groundwater.	
0-3	Consequently, we ask that any cost-benefit analysis that will lead to less than the best and most protective technology, be disallowed. The continued use of a seepage basin for the L-Reactor is a case in point.	The EIS identifies DOE's preferred alternatives in Chapter 2. The L-Reactor seepage basin was evaluated in the Final Environmental Impact Statement, L-Reactor Operations, Savannah River Plant, Aiken, South Carolina (DOE/EIS-0108), and SCDHEC subsequently concurred in its use. This seepage basin is outside the scope of this EIS.
0-4	Careful, professionally prepared specific comments have been submitted by Energy Research Foundation and the Natural Resources Defense Council. We ask that their suggestions receive the utmost consideration, as well as the contributions of others who have commented or testified. We request that this communication be included in the scoping record. Sincerely yours, Mary T. Kelly, President MTK:fb	See the responses to the comments A-1 through A-48 "A."

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	STATEMENT OF GOVERNOR RILEY STATE OF SOUTH CAROLINA Office of the Governor Richard W. Riley, Governor Post Office Box 11450 Columbia 29211 May 20, 1985 Mr. C. G. Halstead, Jr. Assistant Manager for Health, Safety and Environment United States Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 Dear Mr. Halstead: I am writing in response to your announcement of "scoping" activities in support of the preparation of an Environmental Impact Statement (EIS) on waste management at the Savannah River Plant. The Memorandum of Agreement recently signed by the South Carolina Department of Health and Environmental Control and the United States Department of Energy seems to have improved communication between the two agencies, and you are to be commended for your current efforts to address waste management issues in a comprehensive manner.	
P-1	South Carolinians are understandably sensitive about waste storage and disposal within the state, particularly when waste has not been generated by in-state firms. Therefore, it is very important for the EIS to specify that the waste management activities undertaken at the Savannah River Plant will be solely for wastes generated at the site.	Sections 2.3 and 4.2.1 discuss waste material requiring disposal, including that presently in storage, waste resulting from remedial and closure actions (at SRP), and waste from ongoing operations.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
P-2	South Carolinians are also concerned about what many perceive as a lack of quality control in waste management activities. I would like the EIS to include a full discussion of the quality assurance program designed to ensure the safety of the new waste management facilities. Such a program should not only include protection for "whistle blowers" but, more importantly, should incorporate positive incentives to encourage employees to call potential safety issues to the attention of top management personnel. Knowledge that potential hazards to human health or the environment will be promptly identified and eliminated is necessary to reassure those of us who have been alarmed by recent reports of improper waste management. I look forward to your keeping me informed as the EIS is developed. Yours sincerely, Richard W. Riley RWR:bd	Chapter 6 discusses those DOE Orders applicable to the identification and resolution of potential hazards to human health or the environment.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses

SCOPING COMMENTS CONCERNING SAVANNAH RIVER PLANT
WASTE MANAGEMENT ACTIVITIES
ENVIRONMENTAL IMPACT STATEMENT

by

W. F. Lawless

Assistant Professor of Mathematics

Paine College

May 28, 1985

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses

STATEMENT OF W. F. LAWLESS
Assistant Professor of Mathematics
Paine College

PAINE COLLEGE
1235 Fifteenth Street (10)
Augusta, Georgia 30910
404-722-4471

May 31, 1985

C. G. Halstead, Jr., Assistant Manager
for Health, Safety, and Environment
U.S. DOE - Savannah River Plant
P.O. Box A
Aiken, SC 29801

Dear Mr. Halstead:

As stated in my handwritten letter to you May 28th, hand delivered to your office the same day with my final scoping comments, per requirements stated in the Federal Register notice (50(81), April 26, 1985, p. 16534), this letter transmits a cleanly typed version of my final scoping comments on the proposed SRP Waste Management Activities EIS. Minor editorial changes differ from the copy provided May 28th, and a new conclusion statement, the 8th, has been added, however, no new information nor references have been added per our agreement.

It has been a pleasure providing the enclosed comments, and it is hoped they will be of some value to the DOE. Thank you for the opportunity to comment, and for your assistance.

Sincerely,

W. F. Lawless, Assistant
Professor of Mathematics

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	INTRODUCTION	
	The Department of Energy (DOE) has initiated comments and suggestions to assist in identifying environmental issues and the scope of an environmental impact statement (EIS) on waste management activities for groundwater protection at the Savannah River Plant (SRP). Public comments are to be considered in the preparation of an EIS. An April 26, 1985 Federal Register identified the DOE intent to prepare such an EIS and included background information on the SRP; the notice also included alternatives for treating waste sites, for building new waste disposal facilities, and for discharging reactor basin purge water, plus the non-inclusive listing of SRP environmental issues (1).	
	The comments herein were delivered in draft at the first DOE scoping meeting, held at the H. Odell Weeks Activity Center in Aiken, SC, May 14, 1985.	
	CONCLUSIONS	
Q-1	1. The proposed EIS should justify why an EIS is not being written for the national DOE Order 5820.2, Radioactive Waste Management, an Order that has and will have a much greater environmental impact on the nation and at SRP than the proposed action.	The subject of preparing an EIS for DOE Order 5820.2 is beyond the scope of this EIS.
Q-2	2. The new EIS should justify the continued use of seepage basins at SRP, natural soil columns that are extraordinarily expensive to clean up. Their continued use does not appear to be in the best interest of the public, nor does their use make good business and engineering sense.	The EIS assesses remedial and closure actions at hazardous, low-level radioactive, and mixed waste sites, including seepage basins, in Sections 2.2 and 4.2. The continued use of the C-, K-, and P-Reactor area seepage basins for disassembly-basin purge water are assessed in Sections 2.4 and 4.4. Also see the response to comment O-3.
Q-3	3. Environmental Impact Statements (EIS) rely on complex predictions that are difficult to disprove. Independent peer review panels and the assessment of past predictions should in part correct this problem. EIS statements should no longer be treated as passive documents to be filed and never officially assessed.	As required by the regulations of the Council on Environmental Quality (40 CFR 1502.19), copies of the draft EIS will be provided to Federal and State agencies having special expertise on any environmental impact that might be involved.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
Q-4	4. Release of contaminants on and off the SRP exceed DOE Concentration Guides, however no citations against excessive releases have been filed against the SRP prime contractor, DuPont. The groundwater clean up at SRP may well exceed $250 million, paid for by the taxpayers. Yet, it appears that the prime contractor has been relieved of any financial obligations and penalities in the clean up. In fact, the prime contractor's contract was renewed in 1984.	Sections 2.2 and 4.3 and Appendix F discuss remedial and closure actions at hazardous, low-level radioactive, and mixed waste sites in relation to applicable Federal and State regulations, including DOE Orders.
Q-5	5. Public reviews of EIS statements are inadequate. The public is unqualified to review these complex, recondite documents, but a combination of independent peer review panels followed and coupled with public reviews may correct this problem, and may enhance the rigor and the quality of the final document.	See the response to comment Q-3.
Q-6	6. The DOE philosophy appears to be that cost is no object to cleaning up publicly identified environmental problems. This is inappropriate, bureaucratic in approach, and unprofessional at best. Although it is appropriate to correct an original lack of engineering and scientific insight it is time that the DOE bureaucracy become responsible in spending the millions of taxpayer dollars to manage radioactive and hazardous wastes. The contamination build-up problems in the M-Area seepage basin and other SRP seepage basins have been known for many years, yet other seepages are planned. This disregard by the DOE may be typical of a bureaucracy, but is no longer tolerable in this or any other society.	See the response to comment Q-2.
Q-7	7. The DOE should not be allowed to both self-regulate and manage radioactive wastes. The DOE lost the right to self-regulate hazardous chemical wastes in 1984 in a federal court suit filed in response to one of the largest industrial spills of mercury in the U.S. The $64 million clean-up of the single M-Area radioactive and hazardous waste seepage basin at SRP implies that the DOE is not capable of safely managing and regulating either hazardous or radioactive wastes.	Chapter 6 discusses the applicable Federal and State regulatory requirements for the proposed modifications of waste management activities at the SRP, including the requirements of the Resource Conservation and Recovery Act, as amended, and DOE Orders. Also see the response to comment Q-4.

Table K-2. Scoping comments and DOE responses

Comment number		Comments	Responses
Q-8	8.	The DOE tendency to publish vast amounts of apparently meaningless statistical information should be rigorously upgraded. Selected data from selected monitoring wells often do not adequately describe the data set, nor correlate to standards, nor fit with other selected data.	The preparation of the EIS complies with the provisions of the Council on Environmental Quality as contained in 40 CFR 1502.2, which require an EIS to focus on significant environmental issues and alternatives, while reducing the accumulation of extraneous background data and not being encyclopedic.
		GENERAL COMMENTS	
	1.	Savannah River Plant Seepage Basins In August 1983, a hotline complaint was filed with the DOE Inspector General charging the DOE with willfully avoiding its public responsibility to prepare an EIS for the new DOE Order 5820.2, Radioactive Waste Management (2,3). Although the environmental impact of DOE Order 5820.2 is national in scope and is much greater than the proposed groundwater protection action for SRP waste management activities, the latter a local action versus a national action for the former, such an EIS has not been written (1). Nonetheless, the Department of Energy is to be congratulated on this very important and forthright action to prepare an EIS for Savannah River Plant waste management activities. It is hoped that similar actions will take place at all DOE sites throughout the nation, and that one day, an EIS will be written to cover DOE Order 5820.2. The new EIS planned for the Savannah River Plant will document many of the inadequacies of DOE Order 5820.2, a regulation that mocks American technology and one that epitomizes the mishandling of radioactive and hazardous wastes by the DOE bureaucracy. The new EIS will continue to focus on the corrective actions necessary to remediate the groundwater damage done by the DOE's use of seepage basins at SRP, basins still allowed by DOE Order 5820.2.	
Q-9		The new EIS should justify why it is being written and why no EIS has been written for DOE Order 5820.2, a regulation that has and will have a quantifiably greater impact on the national environment than the proposed action.	The purpose of the EIS is stated in Section 1.2. Also see the response to comment Q-1.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
Q-10	The SRP is cleaning up one of its 68 liquid waste seepage basins, the M-Area seepage basin (4). The General Accounting Office (GAO) has estimated that the M-Area seepage basin clean-up will cost up to $64 million or more (4), yet the Savannah River Plant will be using a seepage basin when the L-Reactor comes on line in 1985 (5). The new EIS should carefully detail what seepage basins will continue to be used at the Savannah River Plant and for how long, the contaminants to be disposed of and where, the estimated contaminant build-up at each basin, the releases to each basin since start-up, the basins that are clogged to further liquid waste seepage and are overflowing, the current estimated clean-up cost for each basin, and the rationale for each basin's continued use.	See the responses to comments B-2 and Q-2.
Q-11	Seepage basins are one of the sources of hazardous and radioactive waste contamination of migratory fowl and animals at the SRP (6). Contaminated turtles have been known to leave and have been collected from off the Savannah River Plant site (6). The new EIS should quantify this phenomenon by detailing how each basin has possibly contributed to this means of spreading radioactive and hazardous contamination, and to where with what extent by what means (turtles, fish, fowl, plants, resuspension, etc.). The new EIS should review the steps SRP has taken to prevent the spread on and off plant of hazardous and radioactive contamination through all of the various possible pathways from each one of the 68 known seepage basins (7).	See the response to comment B-3.
Q-12	2. Waste Management Practices. The DOE "Intent to Prepare an Environmental Impact Statement" (1) states that a 1977 EIS on the SRP "...resulted in the implementation of a waste management practices improvement program in accordance with DOE policies and standards." This 1977 EIS (ERDA 1537) included many important predictions that have not been publicly assessed by the DOE and should be assessed in the new EIS (8). Many of these predictions have proven wrong, e.g., on the levels of contamination entering the groundwaters underlying the SRP radioactive waste burial grounds and the radioactive and hazardous waste seepage basins, and on how well protected the Tuscaloosa aquifer was from contaminated groundwaters above the Tuscaloosa aquifer (5, 6, 7, 8).	See the response to comment B-4.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
Q-13	The recondite interactions between DOE operations and the environment creates the need for an EIS to include many predictions of the impacts of these interactions, predictions based on both assumptions and complex equations not easily verified, especially during the short public review period of an EIS. Nor is the public qualified to review an EIS. These documents are replete with abstruse, technical processes and environmental systems that usually confound experts. The establishment of a competent, independent peer review for all environmental impact statements (EIS) with adequate review time and appropriate peer-review authority should become a part of the EIS process. First, an EIS should verify or not, to the extent knowledge has been gained, each prediction made in previous EIS statements (in this case, ERDA 1537, DOE/EIS-0062, DOE/EIS-082, DOE/EIS-0108); second, an independent peer review panel should study the draft(s) and final EIS documents (other cognizant organizations and authorities should be included on the panel); third, a public review of the EIS documents and peer review comments should be conducted after the draft and final documents have been reviewed.	See the responses to comments B-5, Q-3, and Q-8.
Q-14	The SRP publishes annual monitoring reports on radioactive and hazardous contamination at and off the SRP (e.g., reference 6). The new EIS should not only assess the correctness of ERDA 1537, but should as well analyze the monitoring reports from 1977 to the present. Special attention should be directed to DOE releases that exceed DOE Concentration Guides and EPA drinking water standards on and off the SRP. For instance,	See the response to comment B-5.
Q-15	a) strontium-90 released from the F-Area seepage basins has been found to be at a groundwater concentration over eight (5) times the DOE Concentration Guides, or over 40,000 times the EPA drinking water standard, yet no reprimand has been given to Du Pont, the prime SRP contractor, because of this excess. The new EIS should detail every instance where the DOE Concentration Guides have been exceeded since plant start-up, what corrective actions have been taken and with what long-term consequences.	See the response to comment B-6.

Table K-2. Scoping comments and DOE responses

Comment number		Comments	Responses
Q-16		Environmental Protection Agency (EPA) drinking water standards are important performance measures, regardless of whether groundwater is available or accessible as public drinking water sources, for the following reasons. The SRP has apparently not been designated a reservation to be kept from public hands for perpetuity, but is planned to be eventually returned to the public domain, yet the SRP is contaminated and cannot be released until levels of contamination do not jeopardize public safety. Thus, EPA drinking water standards provide a measure of DOE environmental performance and concomitantly the degree of remediation before the return of DOE property to the public. The new EIS should recognize the importance of EPA drinking water standards and should compare all data to applicable DOE Concentration Guides and EPA drinking water standards.	The need to dedicate existing hazardous, low-level radioactive, and mixed waste sites to ensure the protection of public health and safety is addressed in Section 2.1 of the EIS. Also, see the response to comment Q-4.
Q-17	b)	The annual off plant SRP monitoring reports indicate that radioactive strontium-90 contamination in milk samples collected from around the SRP are within ranges found by the Environmental Protection Agency (EPA) (9). The SRP annual monitoring reports attribute the strontium-90 in milk from around the plant to world-wide nuclear test fall-out (9), but statistical tests comparing SRP data with regional data discredit this hypothesis. Support for this hypothesis is found in a 1984 report of a one-week study of the SRP conducted by the EPA in 1982. The EPA collected one milk sample from a dairy about 32 km northwest of SRP plant center and purportedly confirmed by their analysis that the concentration of radioactive strontium-90 in milk samples drawn from near the SRP are not significantly different from other milk samples from the southeastern U.S. (10). However, the EPA apparently did not review or overlooked the SRP annual monitoring data (9) for radioactive strontium-90 concentrations in milk (see Table 1 below). That data, collected by the Savannah River Plant in 1982, indicates that the mean strontium-90 milk concentrations, along certain wind paths, are significantly greater than the mean concentrations in southeastern U.S. milk data as published by the EPA in 1982 (11, p. 91-95). One source of the strontium-90 in milk from around the SRP may possibly be the airborne re-suspension from SRP seepage basin releases.	See the response to comment B-7.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses

Table 1

1982 Radioactive Strontium-90 Contamination in Milk (9)

	Mean Strontium-90 Milk Concentration, pCi/L
1. EPA Southeastern U.S. Data	1.8
2. EPA Single Milk Sample around SRP (Langley, SC)*	1.8
3. SRP Milk Data	4.1
4. SRP Milk Data Northeast/ Southwest of SRP	6.0
5. SRP Milk Data Maximum Average (Waynesboro, GA)	7.5
6. SRP Milk Data Maximum Reading (Waynesboro, GA)	14
7. EPA Drinking Water Standard	8

*NOTE: The SRP milk data for 1982 for milk from Langley, SC, had an average Strontium-90 concentration of 1.6 pCi/L.

Comment number	Comments	Responses
Q-18	3. Waste Management Assessments The SRP waste management practices improvement program that started with the 1977 EIS (ERDA 1537), as announced in the DOE intent to prepare the new EIS, was stated to also include regular assessments and improvements to SRP waste management programs (1). A listing of all waste management assessments, including appraisals with findings and recommendations, since 1977 should be a part of the new EIS. For instance, the 1982 Savannah River Plant radioactive low level waste burial ground management	See the response to comment B-8.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	appraisal report, not published by DOE, should be included (12). This appraisal report was highly critical of DuPont's management of the SRP radioactive waste burial grounds, but not having been finalized nor transmitted to DuPont, the appraisal report became the subject of a separate hot line complaint to the DOE Inspector General (12, 13). The result of that hot line complaint and a subsequent re-appraisal as directed by the DOE Inspector General, has been to dramatically transform operations at the SRP burial grounds (14). At the same time, because there were so few Savannah River Laboratory (SRL) research recommendations for improvements to operations of the SRP burial grounds before the 1980 appraisal of the SRP radioactive waste burial grounds, also because there have been significant changes since the 1980 appraisal, including the implementation of almost all the recommendations made in the 1982 appraisal draft report (14), the SRL Laboratory's significance to radioactive waste management is questioned. The new EIS should discuss the importance of the SRL Laboratory to SRP operations, and what changes since the 1980 appraisal have occurred to make the SRL Laboratory more relevant to SRP operations.	
Q-19	The burial ground management appraisal report did not assess SRP seepage basins, but a 1982 radioactive high-level waste tank farm appraisal report attempted to do so and attempted to assess the long-term impacts seepage basins would have on the SRP groundwater environment (15, 16). However, that part of the high-level waste tank farm appraisal, i.e., the long term performance appraisal of the high-level waste tank farm, was stopped by DOE management (13), but in effect, part of that long-term appraisal will be assessed in the new Waste Management Activities EIS. The scope of the original long-term appraisal of the high-level waste tank farms appears to have been in some aspects more far reaching than the scope of the new EIS (16; copy attached)); the latter's scope should be expanded to cover all sources of SRP groundwater and soil contamination, including the SRP high level radioactive waste tank farm, Defense Waste Production Facility (DWPF) and DWPF waste and by-products disposal, such as saltcrete disposal.	See the response to comment B-9.

Table K-2. Scoping comments and DOE responses

Comment number		Comments	Responses
Q-20	4.	DOE Concentration Guides As stated in the recent DOE news release and Federal Register (1), the DOE wants "...to ensure continued protection of groundwater, human health and the environment." However, numerous instances have occurred at SRP where concentrations of radionuclides have exceeded the DOE Concentration Guides (17, p. 25, Table D; 18). Yet, the DOE apparently does not take steps to bring releases into the environment below levels established by these DOE Concentration Guides, nor has the DOE cited nor fined the SRP contractor when the Concentration Guides have been exceeded (19). A case in point is the $64 million clean up cost of the M-Area basin, a cost to be paid for with tax dollars, not DuPont corporate funds. This appears to be incongruent with DOE policy. For example, the 1984 L-Reactor EIS reported that strontium-90 groundwater concentrations from F-Area seepage basins reached 340,000 pCi/L (5). This level of strontium-is 42,500 times greater than the EPA drinking water standard and over 8 times higher than the DOE Concentration Guides (17, 18). When this was discussed with DOE, the responded that the contractor was under no obligation to meet the DOE Concentration Guide for strontium-90 in groundwater (20). Putting aside, for the moment, the question of whether the DOE Concentration Guides themselves provide satisfactory protection to human health and the environment, exceeding those DOE Concentration Guides assuredly cannot protect anything. Since DOE still self-regulates nuclear wastes, it would appear that these DOE Concentration Guides apparently afford both the DOE and the prime contractor a cozy relationship. The new EIS should question the efficacy of these DOE Concentration Guides and whether, in the best interests of the public, these guidelines should be replaced with regulations that bite. In 1984, the federal court removed the DOE's right to self regulate hazardous chemical wastes (4) after the largest industrial spill of mercury occurred at the DOE Oak Ridge facility (20, 21). The new EIS is a good, first step	See the response to comment B-10.

Table K-2. Scoping comments and DOE responses

Comment number		Comments	Responses
		forward for the DOE to recoup lost credibility, but it must be strongly reinforced with a cost-efficient, professional operation that cleans up the SRP environment and keeps it clean. To do so is in the best interests of the public, and it makes good business and engineering sense as well. The DOE can ill afford another cover-up.	
Q-21	5.	<u>Remedial Action Programs</u> The M-Area remedial action program to manage and control existing groundwater contamination was included in the L-Reactor EIS (5), but it has not been central to the subject of an EIS until now, yet corrective action alternatives to the M-Area basin clean up apparently do not exist because remediation has already begun (4, 5). The new EIS is a fine idea, but it comes after the fact for deciding the appropriate course of action for the M-Area seepage basin clean-up, and for allowing public input into that decision, unless, with the new EIS, the DOE is now offering the public this opportunity. The M-Area seepage basin clean-up will jettison an estimated 30 tons per year of chlorinated hydrocarbons into the atmosphere at one of the most populated work areas on the SRP plant site (4, 5). It is appropriate that the public have the right to question the Savannah River Plant scientists and engineers on the decision to allow airborne releases of these potentially hazardous chemicals within the SRP manufacturing and administration areas.	See the response to comment B-11.
Q-22		The SRP Groundwater Quality Protection Program discussed the removal of highly contaminated soil and chemical and pesticide hazardous waste from the CMP seepage basins for transport, storage and disposal elsewhere (7). This remedial action should similarly be a apart of the new EIS, especially if highly contaminated wastes will be or have been transported and disposed offsite the SRP plant site.	See the response to comment B-12.
		SPECIFIC COMMENTS	
Q-23	1.	As part of the new EIS, the 1983 technical summary document, <u>The Technical Summary of Groundwater Quality Protection Program at Savannah River Plant</u>, Volumes I and II, should be up-dated and corrected where necessary (7). For instance,	See the response to comment B-13.

Table K-2. Scoping comments and DOE responses

Comment number		Comments	Responses
		the M-Area seepage basin is listed as non-radioactive instead of as a mixed waste basin, and basin 904-49G has been omitted from Figure 5-4, p. 5-11. It would be helpful to include the numbers of each type of basin or pit on page 5-7.	
Q-24	2.	As part of the new EIS each new project, each remedial action program, and each current SRP program that impacts the human health and the SRP environment should be assessed for total costs, including the decontamination and decommissioning (D&D) costs for the SRP.	Impacts to human health and the environment for remedial and closure actions, new disposal facilities, and the discharge of disassembly-basin purge water are identified in Chapter 4. To the extent practicable, estimated costs associated with the alternatives are presented. A detailed discussion of decontamination and decommissioning of SRP facilities is outside the scope of this EIS.
Q-25	3.	The past estimate made in 1982 for the D&D of the SRP was set between $2-20 billion. This estimate should be up-dated and explained in detail in the new EIS.	A detailed discussion of decontamination and decommissioning of SRP facilities is outside the scope of this EIS.
Q-26	4.	The estimated date that the SRP will be returned to the public domain should be provided with detailed explanations in the new EIS.	The estimated date for return of the SRP to public use is outside the scope of the EIS. Also see the response to comment Q-16.
Q-27	5.	The Nuclear Regulatory Commission has inferred in its Plant Vogtle Environmental Statement that Vogtle environmental impacts can be assessed independently of SRP releases (11, p. 9-27), and the consequences of combined environmental effects are in essence not a part of their review process. To the credit of DOE, the L-Reactor EIS made such an assessment (5). However, who ultimately is responsible to study the combined effects of all releases into the environment from all sources?	Section 4.7 discusses the cumulative effects of the alternatives considered in combination with the effects of other existing and planned facilities at and near the SRP.
Q-28	6.	A 6000 curie cesium-137 source and cobalt-60 sources were left unattended in the SRP environment for a number of years before being disposed in the SRP burial ground. This should be discussed including environmental impacts.	Remedial and closure actions for the burial ground are discussed and assessed in Sections 2.2 and 4.2 and Appendixes B and F.
Q-29	7.	Allied General Nuclear Services (AGNS) has had transuranic waste sent to SRP for disposal. The significance of this action should be discussed.	The purpose of the EIS, as announced in the Federal Register, is to assess the potential environmental effects of the modifications of waste management activities for hazardous, low-radioactive, and mixed wastes. A discussion of high-level and transuranic wastes is outside the scope of this EIS.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
Q-30	8. Reported SRP airborne data for the release of tritium appears to be confounded by the lack of timely and relevant meteorological data, e.g., concomitant humidity readings (17 p. 10-12). This should be discussed.	Data in SRP monitoring reports has been used in the preparation of the EIS. Revisions to the monitoring reports to provide absolute humidity during periods of data collection - which can be derived by a division of data provided - is not within the scope of this EIS.
Q-31	9. The SRP data published in annual monitoring reports (also, cf. 5, 7) is not unified nor understandable nor conclusive but selective; nor does the data display ranges nor significant statistics of the data base. Data published in the future by SRP, especially in this EIS, should provide a means of the data base available for a particular observation (for instance, strontium-90 groundwater concentrations under F-Area seepage basins), a range of the data, number of data sources in the data base, and pertinent data statistics (e.g., standard deviations), and comparisons of the data to EPA drinking water standards, DOE Concentrations Guides, and other applicable standards. This problem is endemic in all SRP reports, but two examples will be given in addition to Specific Comment No. 8: First, the maximum level of gross beta contamination in wells sampling ground water underlying the F-Area seepage basin was reported to be 8,000 pCi/L in the May 1984 L-Reactor EIS (5, pp.F-88 and M-112) but in the 1981 Annual At-The SRP Monitoring Report (18) published in April 1984, the maximum level was reported to be 330,000 pCi/L, a level over forty times greater than the first level; this is significant because SRP took particular exception to an earlier comment about water contaminated at the 8,000 pCi/L level being used for drinking water (5, p. M-112), all the while having knowledge that the actual level of contamination was much higher, knowledge the commentor did not have; but this is significant for the more compelling reason that SRP has not published a range so that even the 330,000 pCi/L level may not be the maximum (viz., strontium-90 has been reported in this same area, 1-3 miles downstream, to reach a level of 340,000 pCi/L at outcrop (5, p. F-84; 19)).	See the responses to comments B-4, Q-8, and Q-30. The format and content of the annual monitoring report has been changed for 1984.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	Second, data is often published in a meaningless, but authoritative fashion, such as the inventory in pounds of lead or mercury in a core sample but without supporting data to determine concentrations and/or significance (7, p. 6-30); or such as collected rainwater concentrations of radioactive contamination per square area, but without supporting data that would allow the calculation of volume concentrations effectively preventing the determination of whether or not standards have been violated (18, p. 93-94). On the one hand, this gives the appearance of DOE's honesty in publishing so much information, but on the other hand, information presented in gibberish is of little value.	
Q-32	10. SRP data do not include the releases of all hazardous chemical and radioactive nuclides at the SRP. Nor is the data displayed in an understandable and accessible form. This should be corrected.	See the responses to comments B-4, Q-8, Q-30, and Q-31.
Q-33	11. Data averages should not be reported without providing the significance to those averages, i.e., ranges, standard deviations, etc.	See the responses to comments B-4, Q-8, Q-30, and Q-31.
Q-34	12. The high-level waste (HLW) tank corrosion pitting problem at SRP has not been adequately addressed in an EIS and should be in this EIS in light of the continuing problem observed in the Type IV tanks; and second, because HLW tanks 25-28 are new type III tanks that went into operation after the corrosion pitting was found in the remaining Type III tanks, tanks 25-28 should be assessed for potential corrosion pitting problems in this EIS. Tanks 25-28 were not cleaned nor treated for the corrosion pitting as the other new Type III HLW tanks were. The performance of the SRP HLW tanks since the corrosion pitting incidences should be reviewed as well (5).	See the response to comment Q-29.

Table K-2. Scoping comments and DOE responses

Comment number		Comments	Responses
Q-35	13.	In December, 1982 in private discussions within DOE management, doubt was expressed by DOE management for the need of the DWPF facility. However, apparently to induce Congress to fund the DWPF, the estimated cost was reduced from around $3 billion to $1 billion, and the proposed cost for new HLW tanks (FY-1984 request) were more than doubled from past HLW tank costs (23), both as extraordinary but apparently effective inducements. Will the cost for the DWPF remain at $1 billion? Could the DWPF have been built within the existing HLW tank farm system without the expenditure of $1 billion?	See the response to comment Q-29.
Q-36	14.	The National Academy of Sciences (NAS) was highly critical of the DWPF in their analysis of the DWPF, although based on data provided to the Academy by SRP (24). This new EIS should formally address the NAS criticism and justify the tax expenditures for solidifying the SRP high level waste before a geologic repository will be available, especially comparing the cost of storing the solidified HLW until such a repository is available against having waited until the repository would have been concurrently available before constructing the DWPF. This analysis should use actual HLW tank costs and not the inflated costs in the proposed congressional line item No. 84-SR-037 (23).	See the response to comment Q-29.
Q-37	15.	The L-Reactor EIS (5; and other documents: e.g., cf., 6, 7) reviewed the groundwater concentrations of chlorinated hydrocarbons in the M-Area, but made only passing reference to unspecified hydrocarbons in other areas of the plant (cf. 5, p. M-270). This should be detailed by specific type wherever they exist. As well, all hazardous chemicals and potentially hazardous chemicals should be assessed and listed in the published data tables in the new EIS. The data tables for a particular monitoring well should include all chemicals and radionuclides in one table per well, in an easily accessed manner. (Compare the difficulty of determining the significance of the data listed in the L-Reactor EIS, Tables F-14 and F-15 with pages F-85 ad F-99, reference 5.)	The EIS characterizes the radiological and chemical composition of waste sites in Appendix B, including those sites having significant concentrations of chlorinated hydrocarbons. Also see the responses to comments B-4 and Q-8.

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
Q-38	16. In a 1981 internal DOE memorandum (25), DOE stated "...present SRP burial ground operations do not comply nor are they compatible with RCRA hazardous waste regulations if applied to mixed hazardous wastes." Part of the reason for noncompliance is that SRP used underground tanks to store hazardous chemical wastes (5, 7, 8). What is being done to correct this problem?	See the responses to comments A-16 through A-19 and Q-29.
Q-39	17. The low level waste (beta-gamma) incinerator has not been publicly reviewed in an EIS and should be assessed in this EIS. Costs (construction and operational), airborne and solid releases, and a comparison to applicable standards should be provided. The types of materials incinerated along with appropriate experimental statistics of the incineration process should be provided and discussed.	Chapter 1 discusses the low-level (beta-gamma) waste incinerator and other approved projects that are being implemented. Appendix D also discusses the use of incinerators as a predisposal technique. Section 4.3 assesses alternative new disposal facilities for wastes, including ash from incinerators.
Q-40	18. In the past, despite legal requirements to do so, the DOE has apparently tended not to publish fully, e.g., discrepancies between public SRP monitoring reports versus internal SRP monitoring reports (13, 14); SRP slider-turtle radioactive strontium-90 contamination (6, 13); and, SRP plutonium-238 contaminated combustible waste generation of dangerous levels of hydrogen gas (14). The new EIS should review what safeguards DOE has implemented to assure the public that the public's interests and right-to-know will be protected.	See the responses to comments Q-3 and Q-7.
Q-41	19. The environmental impact at SRP of DOE 5820.2 as a change from AEC 0511, Radioactive Waste Management (26), should be assessed within the new EIS.	See the response to comment Q-1.
Q-42	20. The new EIS should assess the cost and impact of having the SRP regulated by the NRC and the EPA for SRP radioactive waste management. Differences between commercial regulations and DOE regulations should be highlighted. The DOE should justify its right to self-regulate radioactive wastes.	The cost and impact of having SRP regulated by the NRC is outside the scope of the EIS. Compliance of new low-level radioactive disposal facilities wth applicable regulations is discussed in Section 4.3.

Table K-2. Scoping comments and DOE responses

Comment number		Comments	Responses
Q-43	21.	The new EIS should explain what is happening to congressional underrun funds from SRP construction projects, whether or not underrun funds are turned back to the U.S. Treasury, and if so how much, whether or not underrun funds discourage cost efficiencies, whether or not construction cost indexes on waste management construction projects should be published, and whether or not funding abuses have occurred in the past at SRP (23).	These comments are not within the scope of the EIS.
Q-44	22.	The effectiveness of the various environmental release and dose consequence models used by SRP should be discussed in the new EIS, especially calibration and validation of the models (e.g., NOAA models, DOSETOMAN, etc.).	The 1984 annual monitoring report discusses the use of environmental release and dose consequence models, in addition to quality assurance and validation. The EIS discusses assumptions and methods used to calculate radiological doses presented in Appendix H.
Q-45	23.	The SRP decided (27) in 1977 to continue the use of seepage basins at SRP, despite the 1973 AEC regulation requiring seepage basins and other natural soil columns, not allowed in the commercial sector, to be phased out (26). Considering the $64 million clean up costs of the single M-Area seepage basin (4), that the DOE no longer prohibits the use of seepage basins and natural soil columns (3), and that the L-Reactor will enter into service another seepage basin this year (5), discuss in the new EIS why the DOE feels it is acting in the best interest of the public in the protection of the SRP environment, especially the groundwater underlying SRP (cf. the DOE policy, reference 5, p. F-111).	See the response to comment Q-2.
Q-46	24.	The planned EIS should justify the disposal of saltcrete in the SRP environment and should discuss predicted groundwater levels of contamination directly under the saltcrete.	The disposal of saltcrete from the DWPF was assessed in the final EIS for the Defense Waste Processing Facility (DOE/EIS-0082) and is not within the scope of this EIS. Immobilization of other low-level radioactive waste in saltstone or concrete monoliths is discussed in Appendix D.
Q-47	25.	The SRP proposed FY 1985 budget proposed reducing the number of groundwater monitoring wells observing the migration of radionuclides migrating from the SRP low level radioactive waste burial grounds (13). Discuss whether or not this cut back was effected and justify the cut back in light of the indicated increasing levels of radionuclide migration in the SRP burial grounds between 1977 and 1981 (8, 13, 18).	Chapter 5 discusses ongoing and planned monitoring programs.

Table K-2. Scoping comments and DOE responses

Comment number		Comments	Responses
Q-48	26.	Discuss the status of the transuranic (TRU) combustible waste generation of hydrogen gas problem and the concerns of the transportation over public highways of this TRU combustible waste to the WIPP facility in New Mexico.	See the response to comment Q-29.
Q-49	27.	Discuss the operational usage of all 51 HLW tanks at SRP. Discuss the concerns of using cooling well water in the HLW tank farm with water drawn from the important Tuscaloosa aquifer, especially discussing the potential pathway for contaminants into the aquifer via these cooling water wells.	See the response to comment Q-29.
Q-50	28.	What is the disposition of the SRP inventory of 32,536,000 pounds of depleted UO_3? What are the environmental consequences at SRP of having retained this material at SRP?	Inventories of SRP material that are not wastes are not within the scope of the EIS.

REFERENCES

1. Department of Energy,, Waste Management Activities for Groundwater Protection at the Savannah River Plant, Aiken, SC; Intent to Prepare an Environmental Impact Statement, Federal Register, 50 (81), 16534-16535 (1985).

2. Letter to C. Benge, Inspector, DOE Inspector General's Office, from W. F. Lawless, "DOE Order 5820.1 (Management of Transuranic Contaminated Material) and draft DOE Order 5820, Radioactive Waste Management," August 27, 1983.

3. U.S. Department of Energy Order 5820.2, Radioactive Waste Management (1984).

4. Department of Energy Acting to Control Hazardous Waste at its Savannah River Nuclear Facilities, U.S. General Accounting Office report to the Honorable Ernest F. Hollings, United States Senate, Rep. GAO/RCED-85-23 (1984).

5. Final Environmental Impact Statement, L-Reactor Operation, Savannah Rier Plant, Aiken, SC, U.S. Department of Energy 3-Volume Rep. DOE/EIS-0108 (1984).

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	6. Environment Monitoring at the Savannah River Plant, Annual Report for 1982, Savannah River Plant Rep. DPSPU 83-302 (1984).	
	7. Technical Summary of Groundwater Quality Protection Program at Savannah River Plant, Volume I, Site Geohydrology and Solid Hazardous Wastes, a Savannah River Plant Rep. DPST-83-928 (1983).	
	8. Final Environmental Impact Statement, Waste Management Operations, Savannah River Plant, Aiken, SC, U.S. Energy Research and Development Administration Rep. ERDA-1537 (1977).	
	9. Environmental Monitoring in the Vicinity of the Savannah River Plant, Annual Report for 1982, Savannah River Plant Rep. DPSPU 83-30-1 (ca. 1983).	
	10. An Airborne Radioactive Effluent Study at the Savannah River Plant, a U.S. Environmental Protection Agency Rep. 520/5-84-012 (1984).	
	11. Final Environmental Statement Related to the Operation of Vogtle Electric Generating Plant, Units 1 and 2, a U.S. Nuclear Regulatory Commission Rep. NUREG-1087 (1985).	
	12. W.F. Lawless, Savannah River Plant (SRP) Burial Ground, Building 643-G, Management Appraisal Report, Appraised June 2-13, 1980, a U.S. Department of Energy Savannah River Operations Office draft report (1982).	
	13. Letter to C. Benge, Inspector, Department of Energy, Inspector General's Office, from W. F. Lawless, SRP Burial Ground Appraisal Report (BGAR), August 4, 1983.	
	14. The Department of Energy, Savannah River Operations Office response to the August 13, 1984 letter from Congressman John Dingell to Secretary Donald R. Hodel. The update of the 1980 Burial Ground Appraisal report is Attachment 4.B.	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	15. W. F. Lawless, K. G. Brown, Management Appraisal Report, Savannah River Plant (SRP) Tank Farm., a U.S. Department of Energy Savannah River Operations Office report (1981).	
	16. W. F. Lawless, K. G. Brown, B. M. Dodge, Performance Audit Questions, Savannah River Plant (SRP) Tank Farm, a U.S. Department of Energy Savannah River Operations Office draft report (1982).	
	17. W. F. Lawless, The Savannah River Plant: Hazardous and Radioactive, Comments on a Panel's Review and Findings of Ongoing Health Effects and Epidemiological Studies of Operations at the Savannah River Plant (1985).	
	18. Environmental Monitoring at the Savannah River Plant, Annual Report for 1981, SRP Rep. DPSPU 82-302 (1984).	
	19. Letter to R. L. Morgan, Manager, DOE-Savannah River Operations Office, from W. F. Lawless, transmitting reference 16, February 8, 1985.	
	20. C. Nandrasy, DOE-Savannah River Public Relations Office, personal communication, February 8, 1985.	
	21. "The Lost Mercury at Oak Ridge," News and Comment, Science, 221, 130-132 (1983).	
	22. B. A. Fenimore, "Atomic Bombs, Chemical Wastes," Environment, 26, 2-3 (1984).	
	23. Letter to A. Walters, Inspector, Department of Energy Inspector General's Office, from W.F. Lawless, Change Room Facility, Building 241-58H, S-3932, July 26, 1983. Attachment 6, FY84 Budget Validation, SRP Project No. 84-SR-037, Congressional line item for 4 high level waste tanks.	
	24. Radioactive Waste Management at the Savannah River Plant: A Technical Review, National Academy of Sciences Press (1981).	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
25.	Internal DOE-Savannah River Memo Route Slip with Attachment I, comments on th possible implementation of RCRA at SRP, from T. B. Hindman, Jr., Director Waste Management Project Office, DOE-Savannah River, to W.A. Reese, Director Safety and Health Division, May 19, 1981.	
26.	U.S. Atomic Energy Commission Manual Chapter 0511, Radioactive Waste Management (1973).	
27.	W.L. Marter, New Criteria for Seepage Basin Use, a Savannah River Plant Rep. DPST-77-444 (1977).	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	ATTACHMENT	

Performance Audit Questions

Savannah River Plant (SRP) Tank Farm

Report Date

8-12-82

W. F. Lawless
K. G. Brown
B. M. Dodge

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	<u>Personnel</u>	
	1. What is the exposure history for personnel in the tank farm and burial ground?	
	2. Incidents 241-FH-81-6, WMI-82-5-8, and WMI-81-10-21 discuss skin contamination of waste management supervisors. What training on procedures and radiation protection is required for supervisors? How can management track the level of training and correlate the number of incidents that occur to deficiencies in training? What procedures can be incorporated to reduce the "personnel error" reason offer for incidents?	
	3. Please provide us with organizational charts and responsibilities for waste operations and waste technology, as well as personnel time in the job.	
	<u>Tank Farm</u>	
	1. What are the estimated curies, hazardous or potentially hazardous, and mixed substances released (initial or contained loss of control; e.g., spill) to the environment (by species, curies, volume and weight) from the tank farm, excluding the seepage basins?	
	2. DPSPU-79-302 gives the amount of radioactivity per tank farm monitoring well. What impact on groundwaters have these nuclides had? What tank farm monitoring wells are not covered in DPSPU-79-302 and what data has been obtained from these wells?	
	3. What are the yearly release guides and actual annual and cumulative releases for each operational unit in the tank farm (i.e., tanks, diversion boxes, etc. excluding seepage basins) since they were placed into radioactive service? Have the releases from the tank farm migrated and, if so, describe the limit of migration? Update pages 348-349 of ERDA 1537.	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
4.	DPSTSY-200-8, pages 5-6 state that "No incidents since 1959 that resulted in or would result in ground water or surface contamination are noted in the data base." Is this saying that no incidents have happened to this effect since 1959? Please update this statement.	
5.	What is the current status (movement rate and distance) of the migrating nuclides and their long-term impact (by migrating species) around Tanks 8 and 16?	
6.	DPSPU-79-302 gives nuclide migration for the area around Tank 8. What other nuclide migration is there in and around the tank farm? Please provide any trend analyses that have been made on these areas.	
7.	What are the yearly release guides and actual releases for each evaporator? Characterize the releases (i.e., liquid and airborne amounts by radioactive species and curies). Describe the monitoring methods for evaporators. Are evaporators inspected routinely for leaks, cracks, etc.?	
8.	What is the status of the waste tank farm transfer system? What is the condition of the operational units and their expected remaining life time, i.e., diversion boxes, evaporators, etc.? Are all systems presently operational? What are the retirement and D&D plans? (Include the interarea transfer line.)	
9.	Please provide us with the latest list of waste management DPSOPs and DPSOLs.	
10.	Is chloride induced tape employed anywhere in the tank farm? Is it used on stainless steel? If so, where?	
11.	Are air flow monitors installed in transfer lines to assure proper connections are made? If not, how are proper connections determined?	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
12.	For each of the Liquid Waste Surveillance Methods listed in Figure 10, p. 22, of the SRP Presentation to NAS panel on SRP wastes (10-17-78), what is the respective probabilistic statistical effectiveness (i.e., % known and probability assurances)? What is the probability of waste (by volumes and curies) lost into the environment or unaccounted for as a result of the balance checks? (c.f. p.6, Chromate Water Piping Leak, DPSP-81-21-6). How is the loss to the environment determined?	
13.	Please provide us with a copy of tank farm incident experience since the beginning of operations. Tabelize and classify the incidents similar to those in DPSTSY-200-6, p.6-3.	
14.	What is the calculated criticality in the different tank types? How does the actual content of fissile materials in the tanks compare to this? When was the last criticality audit performed in the tank farm? What were the results of the audit?	
15.	What are your requirements and procedures for reporting spills or leaks as they relate to the Superfund Act of 1980?	
16.	What are your procedures for reporting tank farm operating incidents? When do you notify DOE? What is your follow up procedure once the problem has been resolved?	
17.	What is your preventive maintenance program for each tank farm facility and piece of equipment (specifically pumps, generators, cranes, etc)? Are failure histories maintained for performance of trend analyses? How are results of trend analyses factored back into the preventative maintenance program?	
18.	When a leak occurs in a transfer line (CTS, interarea, etc.), how is it detected then pinpointed? How long does this process take (average time, historical maximum time)? What impact does it have on operations, programs, and the environment? Can cost effective improvements be made in this area?	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	19. If a monitor alarm sounds during a transfer (from the canyon to a pump pit, pump pit to tank, tank to evaporator, etc), is the transfer stopped? Discuss how much waste (or liquid) will continue down the line, and how long it will take to reach a final destination. Is the transfer stopped as soon as the alarm sounds?	
	20. In August and September 1981, a series of alarms occurred in H-Area Leak Detection Box-2 (LDB-2). Initially, no radiation was found in the box and the alarms were attributed to moisture. However, when the drain downstream from the box was purged with dry air, activity from 350 to 2000 mrad was subsequently found in the box. What are your procedures for investigating a monitor alarm? Explain why the procedure failed to detect the leak in LBD-2. (DP-81-125-3).	
	21. What are the currently projected waste transfer costs and time schedule for sludge removal, salt removal, sludge processing, salt processing, and chemical cleaning? Show capital and operating costs (or design, construction), start up and completion dates by task, year, and tank.	
	22. What is the technical basis for the tank chemistry control sampling schedule? Please provide us with a copy of the schedule.	
	23. What risks are assumed by the following modifications to the operating criteria of the tank farm: a. Use of evaporator feed tanks as low heat waste receivers; b. Use of the additional 300,000 gallons of tank space in salt tanks; c. Continued use of a Type I tanks in F-area as an emergency spare; and	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	d. Use of one Type III tank as an emergency spare to cover both F and H areas?	
	Will an additional Type III tank be used when one is eventually emptied?	
	24. Why is the interarea line inadequate for transferring processed sludge from F to H area, but is adequate when using only one Type III tank as an emergency spare for both areas?	
	25. What is the impact of the out-of-specifications thicknesses on the longevity of Tanks 35 and 36? What is the impact of the out-of-specifications flatnesses on the longevity of Tanks 43 and 50?	
	26. Are Type III encasements (cement-asbestos jackets) used for transfer line designs today? Are there any Type III encasement lines in use today? If so, are the rubber seals checked routinely for degrading? (DPSTSA-200-3, p.3.171).	
	27. In the April 1982 Waste Management Programs Report (DPSP 82-21-4), Tables 4 and 14 give the following data:	

	Table 4 (gal)		Table 14 (gal)	
	F-Area	H-Area	F-Area	H-Area
Evaporator Feed	541,585	389,378	525,000	338,000
Concentrate	360,301	297,782	403,000	245,000
RBOF fed to CRC	215,970	0	224,000	114,000
Seepage Basin	238,670	141,650	230,000	114,000

Why are the figures in these tables different? What are the correct figures? What method is used in previewing draft copies of the monthly report to preclude these types of discrepancies?

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
28.	In construction, what are your criteria and procedures for accepting design variances to construction specifications? Are design variances separated into critical and non-critical acceptance procedures? If so, how is this categorization determined and put into practice? Specifically discuss the criteria and procedures for accepting variances in Tanks 43 and 50. Be sure to include a discussion as to why a variance was chosen rather than complying with specifications.	
29.	What are your management controls that assure DOE that a subcontractor is meeting requirements? Explain how these controls were exercised in the following cases: a. Failure to meet flatness specifications in Tanks 43 & 50? b. Discovery of a rolling defect in Tank 45; c. Insufficient gritblasting in most tanks, an overblasting in Tanks 38 and 41; and, d. Stress relieving Tank 50 twice. Answer specifically: 1. Why did these problems occur? 2. Who corrected these problems (if corrected)? 3. Was the subcontractor held responsible financially? 4. Were the best interests of the government taken care of in this cost conscious period?	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
30.	The QA audit of Tank 45, DPSP 80-72-2 (3-5-80), checklist 2, states that "Plates shall be inspected for cold laps, surface imperfections, stringer separation at edges." It further states that the primary plates were inspected, defects identified and repaired. However, on 5-1-81, a defect was found on the tank bottom after gritblasting for pit inspection. Subsequent repair and inspection concluded that the defect was "a rolling defect in the original plate." (Metallurgical Report, 12-15-81, "Linear Defect Repair - Waste Tank 45). According to the audit, this defect should have been catalogued and repaired. Who performs your quality assurance inspections? Are they chosen by qualifications, i.e., an electrical engineer inspects electrical systems, a metallurgist inspects for material defects, etc.?	
31.	In Tank 38, a source of communication between the primary and annulus tanks resulted when a design change made in the field was not coordinated with construction procedure changes. What are your procedures for coordinating design changes with the other organizations involved in the project?	
32.	Every new tank built at SR is redesigned. Is this cost effective and efficient? The planned FY 1984 waste tank design costs are estimated at $9,400,000 compared to a design costs of $3,715,000 (based on 8.84% on $42M) for Tanks 41 and 51. Since the FY 84 tanks are duplicates of the last tanks built, why isn't there a decrease in cost due to economies of scale? Why are the tank costs escalated at the last tanks' authorized cost instead of the actual costs? In addition, since inflation is abating and is expected to be lower than a double digit rate, why have the FY 1984 tanks' projected costs been escalated at _____ %? (figures are based on conceptual design reports)	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
	33. Since January 1982, water or water marks have been observed in the annuli of 21 of the 43 double wall waste tanks (8 tanks are single wall). What is the cause of this inleakage? How is the cause determined? How is the problem corrected? How can you assure secondary containment if inleakage has occurred? Why weren't these errors (in Tanks 38-51) detected and corrected during tank fabrication and prior to tank service?	
	34. During construction of Tanks 38-51, chemically treated plywood place on tank floors for protection resulted in ferrous orthophosphate pitting of the floors.	
	Also, modifications to mechanical agitation pump motor stands resulted in broken shafts. Additionally, decontamination efforts of a failed feed pump in 299-H severely damaged the motor (draft WM operations and surveillance monthly report, July 1982, p.10). What are your procedures for evaluating safety methods for potential detrimental effects?	
	Seepage Basins	
	1. How long does it take tritium and groundwater to move from the seepage basins to Four Mile Creek? Specifically, show how these migration rates are determined.	
	2. What are the yearly release guides and releases, annual and cumulative, to the seepage basins (F, H, and combined)? What are the yearly release guides (migrated) and releases, annual and cumulative, from the seepage basins to Four Mile Creek (F, H, and combined)? How many times have the absolute limits been exceeded in the history of the seepage basins? What measures are taken if the releases exceed the release guides in any year? What is the justification for the action?	
	3. One of the basins in H-area has been "abandoned in place". What provisions have been made to stop airborne contamination? Similarly, what is done to stop airborne releases from the exposed, dried out portions of the basins?	

Table K-2. Scoping comments and DOE responses

Comment number	Comments	Responses
4.	What are your closure plans for the seepage basins (as requested by SCDHEC)? When will these plans be completed?	
5.	What is the status of the migration of nuclides and hazardous elements in retention and seepage basins? The following elements are known to be in the basins: Ru-103, 106; Cs-137; H_3; Ce-144, 141; Sr-89, 90; Zr-95; Nb-95; I-131; Pu-238, 239; and U-238. What other elements and compounds are in the basin and in the environment (classify as to radioactive, hazardous, mixed, and unknown impact with estimated volumes, weights, and curies)? Also, what has migrated to Four Mile Creek by monitoring results?	
6.	How are overflow constraints for seepage basins enforced to maintain the level within 8 inches of the top? Is there a correlation with discharge amount? What are the backup systems for overflow and basin leakage? Please provide a list of overflow incidents and their impact on the environment (include migration, settlement of elements, resuspension, curies and biological parameters).	
7.	Are non-radioactive or mixed materials sent to the seepage basins monitored routinely? What are the results of chemical analyses on fluid sent to seepage basins? Are all chemicals identified? What are the release guides for these chemicals sent to the seepage basins? What non-radioactive or mixed contaminants have been found in the SRP monitoring program? (DPST-77-444, p.12).	
8.	The chemicals that would be released if fluid was sent directly to Four Mile Creek instead of seepage basins would exceed NPDES requirements. When fluid is sent directly to Four Mile Creek, what analyses is made to verify that the non-radioactive chemicals are in compliance with NPDES requirements? What type of fluid is sent directly to Four Mile Creek? What are the Four Mile Creek monitoring results? (Meyer to Stetson, 9-26-77).	

Table K-3. Scoping Topics and Appropriate EIS Sections

Comment number	Scoping topic	EIS section
A-1	Regulatory requirements	Ch. 6
A-2	Regulatory requirements	Ch. 1, 6
A-3	Regulatory requirements	Ch. 6
A-4	Regulatory requirements Future laws/regulations	Ch. 6 Outside the scope of this EIS
A-5	Affected environment Environmental studies	Ch. 3, Appendixes A and B Ch. 5
A-6	Waste site characterization	Appendix B
A-7	Waste site characteristics	Ch. 2, 4
A-8	Changes in waste generation	2.3.2, 4.3.1
A-9	Predisposal technologies	2.3.2, 4.3.1, Appendix D
A-10	Predisposal technologies	2.3.2, 4.3.1, Appendix D
A-11	Predisposal technologies	2.3.2, 4.3.1, Appendix D
A-12	Research studies	Outside the scope of this EIS
A-13	Regulatory requirements	Ch. 6
A-14	Affected environment Regulatory requirements	Appendix B, Chapter 3 Ch. 6
A-15	Transportation of waste Regulatory requirement	4.5 Ch. 6
A-16	Waste storage	2.3, 4.3
A-17	Changes in waste storage	2.3, 4.3
A-18	Regulatory requirements	Ch. 6
A-19	Regulatory requirements	Ch. 6
A-20	Waste site characterization	Appendix B
A-21	SRP disposal of waste generated offsite	2.3, 4.3

Table K-3. Scoping Topics and Appropriate EIS Sections (continued)

Comment number	Scoping topic	EIS section
A-22	Affected environment	Ch. 3, Appendix A, B
	Environmental monitoring	Ch. 5
	Waste site characterization	Appendix B
	Assessment of impacts	Ch. 4, Appendixes F and G
A-23	Environmental impacts	Ch. 2, 4, Appendixes F through I
	Health effects	4.7, Appendix I
	Accident analysis	4.5
A-24	Environmental impacts	4.7
	Health effects	4.7, Appendix I
	Affected environment	Ch. 3, Appendixes A and B
A-25	Environmental monitoring	Ch. 5
A-26	Ecological impacts	Ch. 4
A-27	Regulatory compliance	2.1, Ch. 6
A-28	Atmospheric effects	Ch. 3, 4.2, 4.3
A-29	Current compliance status	Ch. 1
A-30	Regulatory requirements	Ch. 6
A-31	Regulatory requirements	Ch. 6
A-32	Environmental monitoring	Ch. 5
A-33	Regulatory requirements	Ch. 6
	Environmental monitoring	Ch. 5
A-34	Regulatory requirements	Ch. 6
	Remedial and closure alternatives	2.1, 4.2, Appendixes B and F
A-35	Regulatory requirements	Ch. 6
	Remedial and closure alternatives	2.1, 4.2, Appendixes B and F
A-36	Permitted facilities	Ch. 1
	Regulatory requirements	Ch. 6
A-37	Regulatory requirements	Ch. 6
	Implementation schedules	

Table K-3. Scoping Topics and Appropriate EIS Sections (continued)

Comment number	Scoping topic	EIS section
A-38	L-Reactor EIS	Ch. 1
A-39	L-Reactor EIS	Vol. 3 of the L-Reactor EIS
A-40	Regulatory requirements	Ch. 6
A-41	Regulatory requirements	Ch. 6
A-42	Predisposal technologies	2.3.2, 4.3.1, Appendix D
A-43	Predisposal technologies	2.3.2, 4.3.1, Appendix D
A-44	Regulatory requirements	Ch. 6
A-45	Environmental impacts	Ch. 4
A-46	Unavoidable and irreversible impacts	4.9
A-47	Regulatory requirements	Ch. 6
A-48	State authority for regulating waste	Ch. 6, Memorandum of Understanding
B-1	Regulatory requirements	Ch. 6
B-2	Remedial and closure alternatives New disposal facility alternatives Disassembly-basin purge water alternatives	2.1, 2.2, 4.2, Appendixes B and F Appendix G 2.4, 4.4
B-3	Health effects	Ch. 4, Appendix I
B-4	Affected environment	Ch. 3, Appendix A, Appendixes F through H
B-5	Environmental monitoring	Ch. 5
B-6	Remedial and closure alternatives	2.1, 2.2, 4.2, Appendix F
B-7	Atmospheric effects	4.2, 4.3, 4.7
B-8	Remedial and closure alternatives	2.1, 2.2, 4.2, Appendixes B and C
B-9	High-level radioactive waste	Outside the scope of this EIS

Table K-3. Scoping Topics and Appropriate EIS Sections (continued)

Comment number	Scoping topic	EIS section
B-10	Emission limitations	Ch. 6
B-11	Ongoing remedial actions	Ch. 1
B-12	Ongoing remedial actions	Ch. 1
B-13	Use of current data	EIS will use most current data available
D-1	High-level radioactive waste	Outside the scope of this EIS
D-2	High-level radioactive waste	Outside the scope of this EIS
D-3	High-level radioactive waste	Outside the scope of this EIS
E-1	Role of contractor in preparing EIS	Vol. 3 of the L-Reactor EIS
E-2	Environmental monitoring	Ch. 5
E-3	Environmental monitoring	Ch. 5
E-4	Groundwater contamination	Appendixes A and H
E-5	Ongoing remedial actions Ground-water/surface-water relationships Remedial and closure actions	Ch. 1 3.4, 3.5, Appendix A 2.1, 2.2, 4.2
E-6	Groundwater contamination	4.2, Appendix F, H
E-7	Health effects	Ch. 4, Appendix I
E-8	Regulatory requirements	Ch. 6
G-1	New disposal facility alternatives	2.3, 4.3
G-2	Affected environment New disposal facility alternatives	Ch. 3, Appendixes A and B 2.3, 4.3
G-3	Regulatory requirements	Ch. 6
G-4	New disposal facility alternatives	2.3, 4.3
G-5	Future laws/regulations	Outside the scope of this EIS
G-6	New disposal facility alternatives	2.3, 4.3

Table K-3. Scoping Topics and Appropriate EIS Sections (continued)

Comment number	Scoping topic	EIS section
G-7	Environmental monitoring	Ch. 5
G-8	New production reactor	Outside the scope of this EIS
	New disposal facility alternatives	2.3, 4.3
	Affected environment	Ch. 3, Appendixes A, F through H
I-1	Waste site characterization	Appendix B
	High-level radioactive waste	Outside the scope of this EIS
	Health effects	4.1, 4.2, 4.3, annual monitoring
I-2	Health effects	4.2, 4.3 4.4, Appendix I
I-3	Independent health effects study	Study needs evaluated by Centers for Disease Control, U.S. Department of Health and Human Services
I-4	Transportation of waste	4.5
J-1	Independent health effects study	Study needs evaluated by Centers for Disease Control, U.S. Department of Health and Human Services
K-1	Surface/groundwater impacts	4.2, 4.3, 4.4
	Cumulative hydrologic impacts	4.7
K-2	Endangered species	4.2, 4.3, 4.7
	Endangered species	Ch. 6
K-3	Regulatory requirements	Ch. 6
K-4	Environmental monitoring requirements	Ch. 5
	Regulatory requirements	Ch. 6
L-1	Current waste management projects	Ch. 1
	Regulatory requirements	Ch. 6
L-2	Regulatory requirements	Ch. 6
L-3	Remedial and closure alternatives	2.1, 2.2
	Environmental impacts	4.2
	Environmental monitoring	Ch. 5
L-4	Groundwater monitoring	Ch. 5

Table K-3. Scoping Topics and Appropriate EIS Sections (continued)

Comment number	Scoping topic	EIS section
L-5	Regulatory requirements	Ch. 6
L-6	Burial of decommissioned naval reactors	Outside the scope of this EIS
	New production reactor	Outside the scope of this EIS
L-7	Alternatives	Ch. 2, 4
M-1	Regulatory requirements	Ch. 6
N-1	Regulatory conflicts	1.1, 1.2, Ch. 6
N-2	Regulatory requirements	Ch. 6
N-3	Regulatory requirements	Ch. 6
N-4	Future laws/regulations	Outside the scope of this EIS
N-5	Predisposal technologies	Appendix D
N-6	Offsite treatment, storage, and disposal facilities	Evaluated in another EIS
N-7	Regulatory conflicts	1.1, 1.2, Ch. 6
O-1	Regulatory requirements	Ch. 6
	Environmental monitoring	Ch. 5
O-2	Current waste management projects	Ch. 1
	Regulatory requirements	Ch. 6
	Environmental impacts	4.2
O-3	Analysis of alternatives	Ch. 2
	L-Reactor seepage basin	Evaluated in another EIS
O-4	Response to comments	Appendix K
P-1	Waste material generated, stored, and disposed of onsite	2.3.2, 4.3.1
P-2	Regulatory requirements	Ch. 6

Table K-3. Scoping Topics and Appropriate EIS Sections (continued)

Comment number	Scoping topic	EIS section
Q-1	EIS for DOE Order 5820.2	Outside the scope of this EIS
Q-2	Remedial and closure alternatives Disassembly-basin purge water alternatives Analysis of alternatives	2.1, 2.2, 4.2 2.4, 4.4 Ch. 2, 4.2, 4.3, 4.4
Q-3	Professional review of EIS	Copies of draft EIS provided to Federal and State agencies having special areas of expertise
Q-4	Regulatory requirements Remedial and closure alternatives	Ch. 6 2.1, 2.2, 4.2, and Appendix F
Q-5	Professional review of EIS	See Q-3
Q-6	Environmental impacts	2.2, 2.3, 2.4, 4.2, 4.3, 4.4, 4.7
Q-7	Regulatory requirements	Ch. 6
Q-8	Content and quality of data in EIS	EIS will comply with requirements and intent of 40 CFR 1502.2
Q-9	EIS for DOE Order 5820.2	Outside the scope of this EIS
Q-10	Analysis of alternatives	Ch. 2, 4.2, 4.3, 4.4 Appendixes F, G
Q-11	Health effects	Ch. 4
Q-12	Ground-water contamination	Ch. 3, Appendixes A, F through I
Q-13	Modification of the NEPA process	Outside the scope of the EIS
Q-14	Environmental monitoring	Ch. 5
Q-15	Remedial and closure alternatives	2.1, 2.2, 4.2, Appendix F
Q-16	Regulatory requirements Remedial and closure alternatives Site dedication	Ch. 6 2.1, 2.2, 4.2, Appendix F 2.1, 4.2
Q-17	Atmospheric effects	4.2, 4.3

Table K-3. Scoping Topics and Appropriate EIS Sections (continued)

Comment number	Scoping topic	EIS section
Q-18	Remedial and closure alternatives	2.1, 2.2, 4.2, Appendix F
Q-19	High-level radioactive waste	Outside the scope of this EIS
Q-20	Emission limitations	Ch. 6
Q-21	Ongoing remedial actions	Ch. 1
Q-22	Ongoing remedial actions	Ch. 1
Q-23	Use of current data	EIS uses the most current data available
Q-24	Health effects	Ch. 4, Appendix I
	Decontamination and decommissioning costs	Outside the scope of this EIS
Q-25	Decontamination and decommissioning costs	Outside the scope of this EIS
Q-26	Site dedication	2.1, 4.2
Q-27	Cumulative impacts	4.7
Q-28	Burial ground	2.2, 4.2, Appendixes B and F
Q-29	Transuranic wastes	Outside the scope of this EIS
Q-30	Detailed reporting of meteorological monitoring data	Outside the scope of this EIS
Q-31	Groundwater contamination	Ch. 3, Appendixes A, F through I
	Content and quality of data in EIS	Complies with requirements and intent of 40 CFR 1502.2
	Detailed reporting of environmental monitoring data	Outside the scope of this EIS
Q-32	Monitoring data content and format	Outside the scope of this EIS
Q-33	Monitoring data format	Outside the scope of this EIS
Q-34	High-level radioactive waste	Outside the scope of this EIS

Table K-3. Scoping Topics and Appropriate EIS Sections (continued)

Comment number	Scoping topic	EIS section
Q-35	Defense Waste Processing Facility	Outside the scope of this EIS
Q-36	Defense Waste Processing Facility	Outside the scope of this EIS
Q-37	Waste site characterization	Ch. 3, Appendixes A, B, F through I
Q-38	Affected environment-waste storage	2.3, 4.3
	Environmental impacts of retrievable waste storage	2.3, 4.3
	Regulatory requirements	Ch. 6
Q-39	Compliance status of incinerators	Ch. 1
	Incinerators as predisposal technique for reducing waste volume	Appendix D
	New disposal facility alternatives	4.3
Q-40	NEPA requirements	Complies with requirements and intent of 40 CFR 1502.2
	Health effects	Ch. 4, Appendix I
	Atmospheric effects	4.2, 4.3
Q-41	EIS for DOE Order 5820.2	Outside the scope of this EIS
Q-42	Regulation of the SRP by the NRC	Outside the scope of this EIS
Q-43	Status of construction project funds	Outside the scope of this EIS
Q-44	Radiological dose assessment - models and assumptions	Appendix H
Q-45	Remedial and closure alternatives	2.1, 2.2, 4.2
	Disassembly-basin purge water alternatives	2.4, 4.4
	Analysis of alternatives	Ch. 2, 4.2, 4.3
Q-46	Defense Waste Processing Facility	Outside the scope of this EIS
Q-47	Environmental monitoring	Ch. 5
Q-48	Transuranic waste	Outside the scope of this EIS
Q-49	High-level radioactive waste	Outside the scope of this EIS
Q-50	Disposition of nonwaste products	Outside the scope of this EIS