DOE/EIS-0120

Final
Environmental Impact Statement

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

Volume 1

December 1987
United States Department of Energy

COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy

ACTIVITY: Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection at the Savannah River Plant, Aiken, South Carolina. TC

CONTACT: Additional information concerning this statement can be obtained from:

Mr. S. R. Wright
Director, Environmental Division
U.S. Department of Energy
Savannah River Operations Office
Post Office Box A
Aiken, South Carolina 29802
(803) 725-3957 TC

For general information on the Department of Energy's EIS process contact:

Office of the Assistant Secretary for Environment,
Safety, and Health
U.S. Department of Energy
Attn: Ms. Carol Borgstrom (EH-25)
Acting Director, Office of NEPA Project Assistance
Room 3E-080, Forrestal Building
1000 Independence Avenue SW
Washington, D.C. 20585 (202) 586-4600

ABSTRACT: The purpose of this environmental impact statement (EIS) is to assess the environmental impacts of proposed modifications and their alternatives to hazardous, low-level radioactive, and mixed waste management activities at the Savannah River Plant. The EIS, which is both a programmatic and a project-specific document, considers the following modifications:

- Implementation of remedial and closure actions at hazardous, low-level radioactive, and mixed waste sites
- Establishment of new onsite disposal facilities for hazardous, low-level, and mixed wastes
- Potential changes in the discharge of disassembly-basin purge water from C-, K-, and P-Reactors to seepage basins

This EIS assesses the impacts of the modifications to waste management activities on air and water quality,

especially on groundwater, ecological systems, health risk, archaeological resources, endangered species, and wetlands. Emphasis is given to the requirements of the Resource Conservation and Recovery Act, as amended, the Comprehensive Environmental Response, Compensation and Liability Act, as amended, and DOE Orders related to hazardous, low-level radioactive, and mixed wastes.

TC COMMENTS: In the preparation of this final environmental impact statement, DOE has considered both written comments sent to DOE and oral and written comments received during public hearings at Savannah, Georgia, on June 2, 1987, and at Aiken, South Carolina, on June 4, 1987.

FOREWORD

The purpose of this environmental impact statement (EIS) is to assess the environmental impacts of the proposed modification of waste management activities for hazardous, low-level radioactive, and mixed wastes for the protection of groundwater, human health, and the environment at the Savannah River Plant (SRP) in Aiken, South Carolina. The Savannah River Plant is a major U.S. Department of Energy (DOE) installation engaged in the production of defense nuclear materials. The production of these materials and the operation of fabrication, separation, and support facilities result in the generation of hazardous, low-level radioactive, and mixed wastes (radioactive and hazardous).

DOE has prepared this EIS, which is both programmatic and project-specific, to support broad decisions on future actions on SRP waste management activities and to provide project-related environmental input and support for project-specific decisions on proceeding with cleanup activities at existing waste sites in the F- and R-Areas at SRP, establishing new waste storage and disposal facilities, and discharging disassembly-basin purge water. The disassembly basins receive irradiated reactor fuel and targets at the reactors for disassembly prior to transfer to reprocessing facilities. The deionized water in the basins is purified continuously by filtration and demineralization, but must be purged periodically to maintain tritium oxide concentrations and consequent worker exposures at as low a level as reasonably achievable. These purges are discharged to seepage basins at each reactor site and to the containment basin in K-Area.

TE

The purpose of the proposed action and the alternative modifications considered in the EIS is to identify and select a waste management strategy for the treatment, storage, and disposal of SRP hazardous, low-level radioactive, and mixed wastes that can be implemented to comply with groundwater-protection and other requirements. These waste management activities have the greatest potential for causing effects on groundwater resources. This EIS assesses modifications for each waste management activity, which represents broadly defined strategies that DOE could select to implement specific future hazardous, low-level radioactive, and mixed waste management activities, following interaction with regulatory agencies.

TE

This dual-purpose EIS considers four waste management alternative strategies, including "No Action," as required by the Council on Environmental Quality (CEQ) regulations for implementing the procedural aspects of the National Environmental Policy Act (NEPA; 40 CFR 1502). These strategies differ in the concepts proposed for existing waste sites, new disposal facilities, and discharge of disassembly-basin purge water, and in the degree to which they require dedication of land areas, long-term monitoring, and oversight to ensure adequate protection of groundwater resources, human health, and the environment. They are based on combinations of closure and remedial actions at existing waste sites, the construction of new storage and disposal facilities, and the discharge of disassembly-basin purge water. Modification of a single waste management activity (e.g., closure and remedial actions at existing waste sites) might require the modification of another activity (e.g., the number, size, and design of new disposal facilities).

This EIS uses the terms "hazardous," "low-level radioactive," and "mixed" (i.e., hazardous and low-level radioactive) in their common sense, without regard to specific regulatory definitions, except as indicated. The EIS is not intended to be a permit application for existing SRP facilities or a vehicle to resolve the applicability of requirements of the Resource Conservation and Recovery Act (RCRA), as amended, to existing SRP facilities or waste sites. Ongoing regulatory activities and the expanded SRP groundwater monitoring and characterization program will provide the bases for the application of requirements to specific existing facilities and waste sites.

The scope of this EIS does not include high-level radioactive wastes (for which DOE prepared five previous NEPA documents), domestic and sanitary waste facilities or transuranic wastes (for which DOE is preparing a separate NEPA document).

TE Following the public comment period on the draft EIS and the publication of
the final EIS, DOE will identify its waste management activities modification
strategy and related project-level decisions in a Record of Decision. The
strategy decision will precede any project-specific decision. Research
activities to reduce waste generation, reduce waste toxicity, and increase its
TE isolation from the biosphere are continuing, as are interactions with
regulatory agencies. As a result, decisions on implementing portions of the
overall strategy or some specific actions discussed in the EIS might be
delayed. If necessary, DOE will prepare additional NEPA documents to support
the implementation of project activities that are not specifically addressed
in this EIS.

Regulatory requirements for waste management necessitated changes to SRP waste management activities. In response to these requirements and the Fiscal Year 1984 Supplemental Appropriations Act (Public Law 98-181, enacted in November 1983), DOE developed and submitted to Congress (June 13, 1984) the Groundwater Protection Plan for the Savannah River Plant. This plan and its supporting appendixes provide strategies, funding requirements, and schedules for remedial and closure actions at hazardous, low-level radioactive, and mixed waste sites to ensure the continued protection of groundwater, human health, and the environment.

TE DOE published a Notice of Intent to prepare a draft EIS in the Federal Register on April 26, 1985 (50 FR 16534), to solicit comments and suggestions for consideration in the preparation of the statement.

In response to the Notice of Intent, 16 individuals, organizations, and rep-
resentatives of Government agencies provided comments. Appendix K presents
the issues raised in the comment letters and in testimony received at two pub-
lic scoping meetings held on May 14 and May 16, 1985; this appendix also
includes DOE responses to the comments and cross-references to appropriate EIS
TE sections.

DOE published a Notice of Availability (NOA) for the draft EIS on May 4, 1987,
in the Federal Register (52 FR 16302); on May 8, 1987, the U.S. Environmental
TC Protection Agency published a corresponding NOA (52 FR 17462), which offi-
cially started the public comment period on the draft EIS. The public comment
period ended on June 30, 1987.

In response to the comments received in letters and during two public hearings (June 2 and June 4, 1987) from individuals, organizations, and Federal and state agencies, DOE has revised the draft EIS. These revisions are indicated in the final EIS by vertical change bars in the margin. Most of these change bars are marked either TC (technical change) or TE (editorial change). The remaining change bars are cross-referenced to specific public comments, which are presented in Appendix L, along with DOE's responses to the comments and cross-references to appropriate sections of the EIS. TC

DOE and its contractors (under the direction of DOE) have prepared this EIS in accordance with the CEQ's NEPA regulations (40 CFR 1500-1508) and DOE's NEPA guidelines (45 FR 20694, March 28, 1980). The EIS explicitly identifies the methodologies that were used and the scientific and other sources of information that were consulted. In addition, it incorporates available results of ongoing studies.

Extensive reference material, including Environmental Information Documents (EIDs), used to prepare this EIS is available for review in the U.S. Department of Energy's Public Reading Room, University of South Carolina, Aiken Campus, University Library, 2nd Floor, University Parkway, Aiken, South Carolina, and the Department's Freedom of Information Reading Room, Room 1E-190, Forrestal Building, 1000 Independence Avenue, S.W., Washington, DC. TE

TABLE OF CONTENTS

Chapter		Page
	Cover Sheet	iii
	Foreword	v
	Table of Contents	ix
	SUMMARY	S-1
1	NEED AND PURPOSE	1-1
	1.1 Need	1-2
	1.2 Purpose	1-3
	References	1-5
2	PROPOSED ACTION AND ALTERNATIVES	2-1
	2.1 Alternative Waste Management Strategies	2-2
	2.1.1 No-Action Strategy - Continued Protection of Offsite Environment	2-6
	2.1.2 Dedication Strategy - Compliance Through Dedication of Existing and New Disposal Areas	2-6
	2.1.3 Elimination Strategy - Compliance Through Elimination of Existing Waste Sites and Storage of Wastes	2-8
	2.1.4 Combination Strategy - Compliance Through A Combination of Dedication and Elimination of Existing Waste Sites, and Both Storage and Disposal of Wastes	2-9
	2.1.5 Other Alternative Strategies	2-10
	2.1.6 EIS Decisions and NEPA Documentation	2-10
	2.2 Existing Waste Sites	2-12
	2.2.1 Existing Waste Sites Considered	2-15
	2.2.2 Alternative Strategies for Existing Waste Sites	2-15
	2.2.2.1 No Action	2-20
	2.2.2.2 Dedication	2-21
	2.2.2.3 Elimination	2-27
	2.2.2.4 Combination	2-27
	2.3 New Disposal/Storage Facility Strategies	2-31
	2.3.1 Project-Specific Technologies	2-31
	2.3.1.1 Storage Buildings	2-36
	2.3.1.2 RCRA Landfill	2-37
	2.3.1.3 RCRA Vault	2-37
	2.3.1.4 Cement/Flyash Matrix Vault	2-37
	2.3.1.5 Engineered Low-Level Trench	2-40
	2.3.1.6 Low-Level Waste Vault	2-40
	2.3.1.7 Abovegrade Operation	2-41
	2.3.1.8 Greater Confinement Disposal	2-41
	2.3.2 Waste Volumes	2-42

Chapter Page

2 PROPOSED ACTION AND ALTERNATIVES (continued)

2.3.3 Alternative Technological Strategies 2-44
2.3.3.1 No Action 2-44
2.3.3.2 Dedication 2-47
2.3.3.3 Elimination 2-48
2.3.3.4 Combination 2-48
2.4 Discharge of Disassembly-Basin Purge Water 2-49
2.4.1 Waste Management Strategies 2-50
2.4.1.1 No Action 2-50
2.4.1.2 Dedication 2-50
2.4.1.3 Elimination 2-50
2.4.1.4 Combination 2-51
2.5 Summary and Comparison of Alternative Waste Management Strategies 2-51
2.5.1 Summary of Alternative Waste Management Strategies 2-59
2.5.1.1 No-Action Strategy 2-59
2.5.1.2 Dedication Strategy 2-65
2.5.1.3 Elimination Strategy 2-65
2.5.1.4 Combination Strategy 2-66
2.5.2 Estimated Costs 2-67
2.5.3 Site Dedication 2-68
2.5.3.1 Existing Waste Sites 2-68
2.5.3.2 New Disposal Facilities 2-69
2.5.3.3 Discharge of Disassembly-Basin Purge Water 2-69
2.5.4 Groundwater Impacts 2-69
2.5.5 Surface-Water Impacts 2-70
2.5.6 Public Health Effects 2-70
2.5.7 Aquatic Ecology 2-71
2.5.8 Terrestrial Ecology 2-71
2.5.9 Habitat/Wetlands 2-71
2.5.10 Endangered Species 2-72
2.5.11 Archaeological and Historic Sites 2-72
2.5.12 Socioeconomics 2-72
2.5.13 Noise 2-72
2.5.14 Accidents/Occupational Risks 2-72
References 2-74

3 AFFECTED ENVIRONMENT 3-1

3.1 Geography 3-1
3.1.1 Location 3-1
3.1.2 Site Description and Land Use 3-1
3.1.3 Socioeconomic and Community Characteristics . . . 3-4
3.1.3.1 Study Area 3-4
3.1.3.2 Demography 3-4
3.1.3.3 Land Use 3-5
3.1.3.4 Public Services and Facilities 3-6
3.1.3.5 Housing 3-6
3.1.3.6 Economy 3-6

Chapter Page

3 AFFECTED ENVIRONMENT (continued)

3.1.4 Historic and Archaeological Resources 3-7
3.2 Meteorology and Climatology 3-7
3.2.1 Regional Climatology 3-8
3.2.2 Local Meteorology 3-8
3.2.2.1 Average Wind Speed and Direction 3-8
3.2.2.2 Precipitation 3-8
3.2.3 Severe Weather 3-8
3.2.3.1 Extreme Winds 3-8
3.2.3.2 Thunderstorms 3-10
3.2.3.3 Tornadoes 3-10
3.2.3.4 Hurricanes and High Winds 3-11
3.2.3.5 Precipitation Extremes 3-11
3.2.4 Atmospheric Dispersion 3-12
3.2.4.1 Atmospheric Stability 3-12
3.2.4.2 Air Quality 3-12
3.3 Geology and Seismology 3-12
3.3.1 Regional Geologic Setting 3-12
3.3.1.1 Tectonic Provinces 3-12
3.3.1.2 Stratigraphy 3-14
3.3.1.3 Geomorphology 3-14
3.3.2 Seismology and Geologic Hazards 3-16
3.4 Groundwater Resources 3-16
3.4.1 Hydrostratigraphy 3-16
3.4.2 Groundwater Hydrology 3-18
3.4.2.1 Hydrologic Properties 3-18
3.4.2.2 Head Relationships 3-20
3.4.2.3 Groundwater Flow 3-23
3.4.3 Groundwater Quality 3-23
3.4.3.1 Regional Groundwater Quality 3-23
3.4.3.2 Groundwater Monitoring Results 3-23
3.4.4 Groundwater Use 3-28
3.4.4.1 Important Aquifers 3-28
3.4.4.2 Regional and Local Groundwater Use . . . 3-29
3.4.4.3 Relationship of Precipitation and Groundwater Use to Water Levels 3-30
3.5 Surface-Water Resources 3-30
3.5.1 Surface-Water Systems 3-30
3.5.2 Surface-Water Hydrology 3-32
3.5.3 Surface-Water Quality 3-32
3.5.3.1 Savannah River 3-34
3.5.3.2 Onsite Streams 3-34
3.5.4 Surface-Water Use 3-43
3.6 Ecology 3-45
3.6.1 Terrestrial Ecology 3-46
3.6.1.1 Soils 3-46
3.6.1.2 Vegetation 3-46
3.6.1.3 Wildlife 3-46
3.6.1.4 Commercially and Recreationally Valuable Biota 3-49
3.6.1.5 Endangered and Threatened Species 3-49

Chapter Page

3 AFFECTED ENVIRONMENT (continued)

3.6.2 Aquatic Ecology 3-49
3.6.2.1 Aquatic Flora 3-49
3.6.2.2 Aquatic Fauna 3-50
3.6.2.3 Commercially and Recreationally Valuable Biota 3-50
3.6.2.4 Endangered and Threatened Species 3-50
3.7 Radiation and Hazardous Chemical Environment 3-51
3.7.1 Radiation Environment 3-51
3.7.1.1 Radiation Levels from Natural and Other Offsite Sources 3-51
3.7.1.2 SRP Radiation Environment 3-52
3.7.2 Hazardous Chemical Environment 3-62
3.7.2.1 Atmospheric Environment 3-62
3.7.2.2 Groundwater Environment 3-62
3.7.2.3 Surface-Water Environment 3-64
3.7.2.4 Soils Environment 3-65
3.8 Control and Security 3-66
3.8.1 New Facilities 3-66
3.8.2 Institutional Controls 3-66
3.8.3 Postinstitutional Control 3-68
References 3-69

4 ENVIRONMENTAL CONSEQUENCES 4-1

4.1 Alternative Waste Management Strategies 4-1
4.2 Alternative Waste Management Strategies at Existing Waste Sites 4-2
4.2.1 No-Action Strategy (No Removal of Waste and No Closure or Remedial Action) 4-7
4.2.1.1 Groundwater Impacts 4-7
4.2.1.2 Surface-Water Impacts 4-19
4.2.1.3 Radiological Doses 4-21
4.2.1.4 Health Effects 4-22
4.2.1.5 Ecological Impacts 4-28
4.2.1.6 Other Impacts 4-33
4.2.2 Dedication Strategy (No Removal of Waste At Existing Waste Sites, And Implementation of Cost-Effective Remedial and Closure Actions as Required) 4-34
4.2.2.1 Groundwater Impacts 4-36
4.2.2.2 Surface-Water Impacts 4-45
4.2.2.3 Radiological Doses 4-46
4.2.2.4 Health Effects 4-50
4.2.2.5 Ecological Impacts 4-55
4.2.2.6 Other Impacts 4-58

Chapter Page

4 ENVIRONMENTAL CONSEQUENCES (continued)

4.2.3 Elimination Strategy (Removal of Waste to the Extent Practicable From Existing Waste Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required) 4-58
4.2.3.1 Groundwater Impacts 4-61
4.2.3.2 Surface-Water Impacts 4-64
4.2.3.3 Radiological Doses 4-64
4.2.3.4 Health Effects 4-67
4.2.3.5 Ecological Impacts 4-71
4.2.3.6 Other Impacts 4-71
4.2.4 Combination Strategy (Removal of Waste to the Extent Practicable From Selected Existing Waste Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required) 4-75
4.2.4.1 Groundwater Impacts 4-76
4.2.4.2 Surface-Water Impacts 4-76
4.2.4.3 Radiological Doses 4-76
4.2.4.4 Health Effects 4-78
4.2.4.5 Ecological Impacts 4-79
4.2.4.6 Other Impacts 4-79
4.2.5 Comparison of Alternative Actions at Existing Waste Sites 4-80
4.2.5.1 Comparison of Strategies 4-81
4.2.5.2 Comparison of Environmental Consequences 4-82
4.3 Strategies for New Waste Management Facilities 4-87
4.3.1 No-Action Strategy 4-88
4.3.1.1 Groundwater and Surface Water 4-88
4.3.1.2 Nonradioactive Atmospheric Releases . . . 4-88
4.3.1.3 Ecology 4-89
4.3.1.4 Radiological Releases 4-90
4.3.1.5 Archaeological and Historic Resources . . 4-90
4.3.1.6 Socioeconomics 4-90
4.3.1.7 Site Dedication/Institutional Control . . 4-90
4.3.1.8 Noise 4-90
4.3.1.9 Other Impacts 4-90
4.3.2 Dedication Strategy 4-91
4.3.2.1 Groundwater and Surface Water 4-91
4.3.2.2 Nonradioactive Atmospheric Releases . . . 4-92
4.3.2.3 Ecology 4-92
4.3.2.4 Radiological Releases 4-93
4.3.2.5 Archaeological and Historic Resources . . 4-93
4.3.2.6 Socioeconomics 4-93
4.3.2.7 Site Dedication/Institutional Control . . 4-93
4.3.2.8 Noise 4-94
4.3.2.9 Other Impacts 4-94

Chapter Page

4 ENVIRONMENTAL CONSEQUENCES (continued)

4.3.3 Elimination Strategy 4-94
4.3.3.1 Ground and Surface-Water Effects 4-95
4.3.3.2 Nonradioactive Atmospheric Releases . . . 4-95
4.3.3.3 Ecology 4-95
4.3.3.4 Radiological Releases 4-95
4.3.3.5 Archaeological and Historic Resources . . 4-95
4.3.3.6 Socioeconomics 4-96
4.3.3.7 Site Dedication/Institutional Control . . 4-96
4.3.3.8 Noise 4-96
4.3.3.9 Other Impacts 4-96
4.3.4 Combination Strategy 4-96
4.3.4.1 Groundwater and Surface Water 4-97
4.3.4.2 Nonradioactive Atmospheric Releases . . . 4-97
4.3.4.3 Ecology 4-97
4.3.4.4 Radiological Releases 4-98
4.3.4.5 Archaeological and Historic Resources . . 4-98
4.3.4.6 Socioeconomics 4-98
4.3.4.7 Site Dedication/Institutional Control . . 4-98
4.3.4.8 Noise 4-98
4.3.4.9 Other Impacts 4-98
4.3.5 Summary 4-99
4.4 Strategies for Discharging Disassembly-Basin Purge Water 4-99
4.4.1 Background 4-102
4.4.2 No-Action Strategy (Continuation of Discharge to Seepage Basins) 4-104
4.4.3 Dedication Strategy 4-104
4.4.4 Elimination Strategy 4-105
4.4.5 Combination Strategy 4-108
4.4.6 Comparison of Environmental Consequences 4-109
4.5 Accidents 4-110
4.6 Decontamination and Decommissioning 4-113
4.7 Cumulative Effects 4-120
4.7.1 Existing and Planned Facilities 4-120
4.7.1.1 Facilities Near SRP 4-120
4.7.1.2 Effluent Treatment Facilities at SRP . . 4-121
4.7.1.3 Waste Treatment, Storage, or Disposal Facilities at SRP 4-122
4.7.1.4 Other Facilities at SRP 4-123
4.7.1.5 Demonstration Facilities at SRP 4-124
4.7.2 Groundwater 4-125
4.7.2.1 Groundwater Withdrawal 4-125
4.7.2.2 Groundwater Quality 4-126
4.7.3 Surface Water 4-126
4.7.3.1 Surface-Water Use 4-126
4.7.3.2 Surface-Water Quality 4-126
4.7.4 Health Effects 4-127
4.7.4.1 Exposure to Radioactive Substances . . . 4-127
4.7.4.2 Exposure to Hazardous Substances 4-129

Chapter Page

4 ENVIRONMENTAL CONSEQUENCES (continued)

4.7.5 Other Cumulative Effects 4-131
4.7.5.1 Ecological 4-131
4.7.5.2 Air Quality 4-133
4.7.5.3 Socioeconomic 4-133
4.7.5.4 Archaeological and Historic Sites 4-133
4.8 Mitigation Measures 4-133
4.8.1 Environmental Consequences 4-133
4.8.1.1 Existing Waste Sites 4-133
4.8.1.2 New Disposal Facilities 4-134
4.8.1.3 Discharge of Disassembly-Basin Purge Water 4-134
4.8.2 Mitigation Measures 4-134
4.8.2.1 Existing Waste Sites 4-134
4.8.2.2 New Disposal Facilities 4-135
4.8.2.3 Discharge of Disassembly-Basin Purge Water 4-135
4.9 Unavoidable/Irreversible Impacts 4-135
4.9.1 Strategies for Existing Waste Sites 4-135
4.9.1.1 Unavoidable Adverse Impacts 4-135
4.9.1.2 Irreversible and Irretrievable Commitments of Resources 4-137
4.9.1.3 Short-Term Uses and Long-Term Productivity 4-137
4.9.2 Strategies for New Disposal Facilities 4-137
4.9.2.1 Unavoidable Adverse Impacts 4-137
4.9.2.2 Irreversible and Irretrievable Commitments of Resources 4-138
4.9.2.3 Short-Term Uses and Long-Term Productivity 4-138
4.9.3 Strategies for Discharge of Disassembly-Basin Purge Water 4-138
4.9.3.1 Unavoidable Adverse Impacts 4-138
4.9.3.2 Irreversible and Irretrievable Commitments of Resources 4-139
4.9.3.3 Short-Term Uses and Long-Term Productivity 4-139
4.10 Preferred Alternative Waste Management Strategy 4-139
4.10.1 Rationale for Selection 4-139
4.10.1.1 Existing Waste Sites 4-139
4.10.1.2 New Disposal Facilities 4-140
4.10.1.3 Discharge of Disassembly-Basin Purge Water 4-140
4.10.2 Advantages 4-140
4.10.2.1 Existing Waste Sites 4-140
4.10.2.2 New Disposal Facilities 4-141
4.10.2.3 Discharge of Disassembly-Basin Purge Water 4-141

Chapter | Page

4 ENVIRONMENTAL CONSEQUENCES (continued)

4.10.3 Disadvantages 4-141
    4.10.3.1 Existing Waste Sites 4-141
    4.10.3.2 New Disposal Facilities 4-141
    4.10.3.3 Discharge of Disassembly-Basin Purge Water 4-141
4.10.4 Environmental Impacts 4-142
    4.10.4.1 Groundwater 4-142
    4.10.4.2 Surface Water 4-142
    4.10.4.3 Health Effects 4-143
    4.10.4.4 Ecology 4-143
    4.10.4.5 Other Impacts 4-143
4.10.5 Accidents and Occupational Risks 4-144
    4.10.5.1 Existing Waste Sites 4-144
    4.10.5.2 New Disposal Facilities 4-144
    4.10.5.3 Discharge of Disassembly-Basin Purge Water 4-144
4.10.6 Site Dedication 4-144
    4.10.6.1 Existing Waste Sites 4-144
    4.10.6.2 New Disposal Facilities 4-144
    4.10.6.3 Discharge of Disassembly-Basin Purge Water 4-145
References 4-146

5 STUDIES AND MONITORING 5-1

5.1 Monitoring Requirements and Commitments 5-2
5.2 Existing Waste Site Monitoring 5-5
    5.2.1 F- and H-Areas 5-8
    5.2.2 Radioactive Waste Burial Grounds 5-9
    5.2.3 Reactor Seepage Basins 5-9
    5.2.4 M-Area 5-10
    5.2.5 Other Monitoring Activities 5-10
        5.2.5.1 Drinking-Water Monitoring 5-10
        5.2.5.2 Surface-Water Supplies 5-10
        5.2.5.3 Groundwater Supplies 5-11
5.3 Existing Waste Sites - Future Monitoring 5-11
    5.3.1 Groundwater Quality Assessment Plan 5-11
        5.3.1.1 M-Area Settling Basin 5-11
        5.3.1.2 F-Area Seepage Basins 5-12
        5.3.1.3 H-Area Seepage Basins 5-12
    5.3.2 Monitoring Associated with Waste Management Facility Closure and Postclosure 5-12
        5.3.2.1 Metallurgical Laboratory Basin 5-12
        5.3.2.2 Mixed Waste Management Facility 5-12
        5.3.2.3 M-Area Settling Basin and Lost Lake . . . 5-13
    5.3.3 Waste Site Characterization Program 5-13
5.4 New Disposal Facilities 5-14
    5.4.1 Hazardous and Solid Waste Amendments of 1984 . . . 5-14
    5.4.2 Proposed Monitoring at New Disposal/Storage Facilities 5-14

Chapter Page

5 STUDIES AND MONITORING (continued)

- 5.5 Analytical Studies 5-15
  - 5.5.1 Groundwater-Flow Modeling 5-15
  - 5.5.2 Environmental Information Documents and PATHRAE Modeling 5-15
  - 5.5.3 Transport of Heavy Metals and Radionuclides . . . 5-16
  - 5.5.4 Environmental Radiometrics 5-16
- References 5-17

6 FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS 6-1

- 6.1 General Environmental Requirements 6-1
  - 6.1.1 National Environmental Policy Act 6-1
  - 6.1.2 Executive Order 12088: Federal Compliance with Pollution Control Standards 6-1
  - 6.1.3 Administrative Orders 6-2
- 6.2 Specific Requirements 6-3
  - 6.2.1 Atomic Energy Act 6-3
    - 6.2.1.1 Federal Statute 6-3
    - 6.2.1.2 DOE Order 5820.2 6-4
  - 6.2.2 Comprehensive Environmental Response, Compensation, and Liability Act 6-4
    - 6.2.2.1 Federal Statute 6-4
    - 6.2.2.2 Federal Regulations 6-5
    - 6.2.2.3 DOE Order 5480.14: Comprehensive Environmental Response, Compensation, and Liability Act 6-5
  - 6.2.3 Resource Conservation and Recovery Act and Hazardous and Solid Waste Amendments 6-5
    - 6.2.3.1 Federal Statutes 6-6
    - 6.2.3.2 Federal Regulations 6-6
    - 6.2.3.3 State Statute 6-8
    - 6.2.3.4 State Regulations 6-8
    - 6.2.3.5 DOE Order 5480.2: Hazardous and Radioactive Mixed Waste Management . . . 6-8
    - 6.2.3.6 Regulations Applicable to Closure and Remedial Action Activities at Existing Waste Sites 6-9
  - 6.2.4 Federal Safe Drinking Water Act 6-11
  - 6.2.5 Floodplain/Wetlands Environmental Review 6-11
  - 6.2.6 Other Requirements 6-12

TABLE OF CONTENTS (continued)

LIST OF PREPARERS

DISTRIBUTION LIST

GLOSSARY

INDEX

APPENDIX A. GEOLOGY AND SUBSURFACE HYDROLOGY

APPENDIX B. EXISTING WASTE SITES

APPENDIX C. REMEDIAL, TREATMENT, AND CLOSURE TECHNIQUES

APPENDIX D. PREDISPOSAL TREATMENT TECHNOLOGIES

APPENDIX E. NEW DISPOSAL FACILITY ALTERNATIVE

APPENDIX F. ASSESSMENT OF ACTIONS AT EXISTING WASTE SITES

APPENDIX G. ASSESSMENT OF ALTERNATIVE STRATEGIES FOR NEW DISPOSAL/STORAGE FACILITIES

APPENDIX H. TRANSPORT AND DOSE MODELS

APPENDIX I. HEALTH EFFECTS

APPENDIX J. WASTE-MANAGEMENT DEMONSTRATION PROGRAMS

APPENDIX K. SCOPING COMMENTS AND RESPONSES

APPENDIX L. COMMENTS AND DOE RESPONSES ON DRAFT ENVIRONMENTAL IMPACT STATEMENT

LIST OF TABLES

Table		Page
2-1	Alternative Waste Management Strategies	2-7
2-2	EIS Decisions and NEPA Documentation	2-11
2-3	Solid and Low-Level Radioactive Waste Sites	2-13
2-4	Existing Waste Sites by Geographic Grouping	2-17
2-5	No Action Strategy - Existing Waste Site Program Modifications for No Action	2-22
2-6	Dedication Strategy - Existing Waste Site Program Modifications for No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required	2-24
2-7	Elimination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from All Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required	2-28
2-8	Combination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from Selected Sites, and Implementation of Cost-Effective Remedial and Closure Actions Required	2-32
2-9	NOI Alternatives and Corresponding Technologies	2-36
2-10	Estimated Range of Hazardous, Mixed, and Low-Level Radioactive Waste Volumes	2-45
2-11	New Disposal/Storage Facility Alternatives	2-46
2-12	Comparison of Alternative Waste Management Strategies	2-52
2-13	Comparison of Project-Specific Actions - New Disposal Facilities	2-60
2-14	Comparison of Project-Specific Actions - Discharge of Disassembly-Basin Purge Water	2-63
3-1	1980 Population for Counties and Places of 1000 Persons or More	3-5
3-2	Average Monthly Wind Speed for Bush Field, Augusta, Georgia, 1951-1981, and WJBF-TV Tower, 1976-1977	3-9
3-3	Precipitation at Savannah River Plant, 1952-1982	3-9
3-4	Extreme Wind Speeds for SRP Area (meters per second)	3-10
3-5	Tornado Occurrence by Month	3-11
3-6	Hydraulic Conductivity of the Ellenton Formation	3-19
3-7	Average Chemical Analysis of Groundwater From Coastal Plain Formations at the Savannah River Plant	3-24
3-8	Summary of SRP Groundwater Monitoring Data	3-26
3-9	SRP Groundwater Monitoring Data - Radiological Constituents	3-28
3-10	Mean Water Chemistry of Upper Three Runs Creek and Tims Branch, 1983-1985	3-36
3-11	Mean Water Chemistry of Four Mile Creek, 1983-1985	3-37
3-12	Mean Water Chemistry of Beaver Dam Creek, 1983-1985	3-39
3-13	Mean Water Chemistry of Indian Grave Branch and Pen Branch, 1983-1985	3-40
3-14	Mean Water Chemistry of Meyers Branch and Steel Creek, 1983-1985	3-42
3-15	Mean Water Chemistry of Par Pond and Lower Three Runs Creek, 1983-1985	3-44
3-16	Land Utilization, 1983	3-45

Table Page

3-17 Common and Scientific Names for Selected Biota on the SRP . . . 3-47
3-18 Major Sources of Radiation Exposure in the Vicinity of the SRP 3-52
3-19 Atmospheric Releases and Concentrations at SRP Perimeter, 1986 3-53
3-20 Air Monitoring Station Radiation Measurements, 1986 3-55
3-21 Tritium Concentrations in Drinking Water from Onsite and Offsite Deep Wells, 1984-1986 3-57
3-22 Alpha Concentrations in Drinking Water from Onsite and Offsite Deep Wells, 1984-1986 3-58
3-23 Nonvolatile Beta Concentrations in Drinking Water from Onsite and Offsite Deep Wells, 1984-1986 3-59
3-24 Liquid Releases and Concentrations for 1986 3-60
3-25 Radioactivity in Onsite Streams 3-61
3-26 Radioactivity Deposited in Soil, 1986 3-62
3-27 Fenced/Unfenced SRP Waste Sites 3-67
4-1 Common Risks 4-6
4-2 Additional Groundwater Monitoring Wells 4-8
4-3 Peak Concentrations at 100-Meter Well for No Action, A- and M-Areas 4-9
4-4 Peak Concentrations at 100-Meter Well for No Action, F- and H-Areas 4-11
4-5 Peak Concentrations at 100-Meter Wells for No Action, R-Area 4-12
4-6 Peak Concentrations at 100-Meter Well for No Action, C-Area and Central Shops 4-14
4-7 Peak Concentrations at 100-Meter Well for No Action, TNX-Area . 4-15
4-8 Peak Concentrations at 100-Meter Well for No Action, K-Area . . 4-17
4-9 Peak Concentrations at 100-Meter Well for No Action, L-Area . . 4-18
4-10 Peak Concentrations at 100-Meter Well for No Action, P-Area . . 4-19
4-11 Waste Constituents in Surface Water for No Action 4-20
4-12 Peak Annual Doses to Maximally Exposed Individual from Radiological Releases for No Action 4-22
4-13 Radiological Health Risks to the Maximally Exposed Individual from the Peak Annual Doses for No Action 4-23
4-14 Total Noncarcinogenic Risks for No-Action, Groundwater/Surface-Water Pathway in Each Geographic Grouping 4-25
4-15 Total Nonradiological Carcinogenic Risks for No Action, Groundwater/Surface-Water Pathway in Each Geographic Grouping 4-26
4-16 Risks to the Population and the Maximally Exposed Individual Attributable to Atmospheric Nonradiological Carcinogens for No Action 4-29
4-17 Basin Liquid Disposal Methods 4-35
4-18 Waste Sites Assumed to be Capped with Low-Permeability Barriers 4-36
4-19 Peak Concentrations for Dedication Strategy, A- and M-Area . . 4-38
4-20 Peak Concentrations for Dedication Strategy, F- and H-Area . . 4-39
4-21 Peak Concentrations for Dedication Strategy, R-Area 4-42
4-22 Peak Concentrations for Dedication Strategy, C- and CS-Areas 4-43
4-23 Peak Concentrations for Dedication Strategy, TNX-Area 4-44

Table Page

4-24 Peak Concentrations for Dedication Strategy, K-Area 4-46
4-25 Peak Concentrations for Dedication Strategy, L-Area 4-47
4-26 Peak Concentrations for Dedication Strategy, P-Area 4-49
4-27 Peak Annual Doses to the Maximally Exposed Individual from Radiological Releases for the Dedication Strategy 4-50
4-28 Radiological Health Risks to Maximally Exposed Individual from the Peak Annual Doses for the Dedication Strategy 4-51
4-29 Total Nonradiological Carcinogenic Risks for Dedication Strategy, Groundwater/Surface-Water Pathway in Each Geographic Grouping 4-52
4-30 Total Noncarcinogenic Risks for Dedication Strategy, Groundwater/Surface-Water Pathway in Each Geographic Grouping 4-53
4-31 Risks to Population and Maximally Exposed Individual Attributable to Atmospheric Nonradiological Carcinogens for Dedication Strategy 4-55
4-32 Elimination Strategy Excavation and Transport Requirements . . 4-59
4-33 Excavated Waste Sites Assumed to be Capped with Low Permeability Barrier 4-61
4-34 Peak Concentrations for the Elimination Strategy, A- and M-Areas 4-62
4-35 Peak Concentrations for the Elimination Strategy, F- and H-Areas 4-63
4-36 Peak Concentrations for Elimination Strategy, R-Area 4-65
4-37 Peak Annual Dose to Maximally Exposed Individual and Years of Occurrence for Elimination Strategy 4-66
4-38 Radiological Health Risks to Maximally Exposed Individual from the Peak Annual Dose for Elimination Strategy 4-68
4-39 Total Nonradiological Carcinogenic Risks for Elimination Strategy, Groundwater/Surface-Water Pathway in Each Geographic Grouping 4-69
4-40 Total Noncarcinogenic Risks for Elimination Strategy, Groundwater/Surface-Water Pathway in Each Geographic Grouping 4-70
4-41 Risks to Population and Maximally Exposed Individual Attributable to Atmospherically Released Nonradiological Carcinogens for Elimination Strategy 4-72
4-42 Combination Strategy - Sites Selected for Waste Removal 4-77
4-43 Existing Waste Site Impacts for Each Waste Management Strategy 4-83
4-44 Basis for New Waste Management Facility Impact Evaluations . . 4-89
4-45 New Waste Management Facility Impacts for Each Waste Management Strategy 4-100
4-46 Predicted Tritium Discharge from Reactor Disassembly Basins . . 4-103
4-47 Annual and Cumulative Discharges for Non-tritium Radionuclides from Reactor Disassembly Basins (Ci) 4-103
4-48 Tritium Releases to Environment Associated with the No-Action Strategy 4-105
4-49 Highest Annual and Average Annual EWBD Associated with the No-Action Strategy 4-105
4-50 Tritium Releases to Environment Associated with the Elimination Strategy (Evaporation) 4-106

Table Page

4-51 Highest Annual and Average Annual EWBDs Associated with the Elimination Strategy (Evaporation) 4-107
4-52 Tritium Releases to Environment Associated with the Elimination Strategy (Direct Discharge) 4-108
4-53 Maximum and Average Annual EWBDs Associated with the Elimination Strategy (Direct Discharge) 4-108
4-54 Average Annual EWBD to the Maximally Exposed Individual for Each Strategy (mrem/yr) 4-110
4-55 Closure Accidents 4-114
4-56 Accident Risks for No Action 4-116
4-57 Accident Risks for No-Waste-Removal and Closure 4-117
4-58 Accident Risks for Complete Waste Removal and Closure 4-118
4-59 Accident Risks for Waste Removal and Closure at Selected Sites 4-119
4-60 RCRA and CERCLA Sites in South Carolina 4-121
4-61 Collective Cumulative Health Effects Atmospheric and Liquid Releases for Alternative Actions at Existing Waste Sites 4-128
4-62 Collective Cumulative Health Effects from Atmospheric and Liquid Releases for Alternative Actions for Disassembly-Basin Purge Water Discharge 4-129
4-63 Carcinogenic Risks for Groundwater and Surface-Water Exposure (Elimination Strategy) 4-129
4-64 Carcinogenic Risks for Groundwater and Surface-Water Exposure (No-Action Strategy) 4-130
5-1 South Carolina Hazardous Waste Management Regulations: Groundwater-Monitoring Analyses 5-3
5-2 Existing Waste Sites Availability of Groundwater Monitoring and Soil Sampling Data 5-6
6-1 Compliance of SRP Interim-Status Facilities With 1984 Hazardous and Solid Waste Amendments 6-7
6-2 Regulations Applicable to SRP Waste Management Facilities . . . 6-10

LIST OF ILLUSTRATIONS

Figure		Page
S-1	Project-Specific Components of Alternative Strategies	S-3
2-1	Project-Specific Components of Alternative Strategies	2-3
2-2	Geographic Groupings of Waste Sites	2-16
2-3	Schematic Diagram of Two Double-Liner Designs for Landfills	2-38
2-4	Schematic Diagram of Liner Systems for Below Ground Vaults (RCRA Type)	2-39
3-1	SRP Location in Relation to Surrounding Population Centers	3-2
3-2	Portion of Savannah River Plant Site	3-3
3-3	Generalized Northwest to Southeast Geologic Profile, and SRP Regional Site Locator	3-13
3-4	Tentative Correlation of Stratigraphic Terminology of Southwestern South Carolina Coastal Plain	3-15
3-5	Head Difference Between Upper Cretaceous Sediments Aquifer and Congaree Formation at Savannah River Plant (1982)	3-21
3-6	Head Difference Between Upper Cretaceous Sediments Aquifer and Congaree Formation at Savannah River Plant (1987)	3-22
3-7	Hydrographs of Tuscaloosa and Ellenton Wells	3-31
3-8	Mean Monthly Flow Rates of the Savannah River from 1964-1981 at River Mile 187.5	3-33

CHAPTER 1

NEED AND PURPOSE TC

The Savannah River Plant (SRP) near Aiken, South Carolina, is a major installation of the U.S. Department of Energy (DOE). The Plant, which began operation in the early 1950s, is the nation's primary source of reactor-produced defense materials.

Since the beginning of Plant operations, DOE and its predecessor agencies have conducted waste management activities to protect public health and the environment. An assessment of SRP waste management activities (ERDA, 1977) resulted in the adoption of a program to make improvements to the existing waste management practices in accordance with Energy Research and Development Administration (ERDA, now DOE) policies and standards. This program included regular assessments and improvements to waste management practices, studies of improved waste storage techniques, and studies to reduce the volume of waste generated.

The adoption of this program also resulted in the continuation of several waste management activities and practices at the SRP, including the use of seepage basins for the disposal of low-level radioactive liquid wastes and chemicals. Although these practices resulted in localized contamination of groundwater and land areas (Marine and Bledsoe, 1985), this contamination does not affect the offsite environment (i.e., releases to the offsite environment are within environmental and health protection standards and criteria); and the contaminated areas are dedicated to waste management activities (ERDA, 1977).

DOE's waste management practices, especially those for hazardous waste, have been subject to increasing scrutiny. On April 13, 1984, a U.S. District Court E-29
ruled (LEAF vs. Hodel) that DOE's facilities in Oak Ridge, Tennessee, were subject to the hazardous waste requirements under the Resource Conservation and Recovery Act (RCRA); DOE extended this ruling to all its Atomic Energy Act (AEA) facilities. The 1981 discovery of groundwater contamination under one settling basin at the SRP resulted in an amendment to Public Law 98-181 in TC
1983, which required DOE to discontinue use of that basin and to develop a plan for the protection of groundwater at the SRP. Subsequent enforcement actions pertaining to DOE's hazardous waste management program have been taken by Federal and State regulatory agencies, citizens' suits, and Congressional hearings.

In response to these events, DOE began a number of waste management activities on the Plant to comply with the newly emerging RCRA hazardous waste requirements at applicable AEA facilities. These activities included the preparation of a Groundwater Protection Plan for the Savannah River Plant (DOE, 1984); remedial action for contaminated groundwater discovered in M-Area in 1981 and the construction and operation of a wastewater effluent treatment plant in M-Area in lieu of the M-Area settling basin; the planning and design for the construction and operation of wastewater effluent treatment plants for F- and H-Areas (Separations Areas) and TNX-Area to discontinue the use of seepage basins in these areas; the removal of buried wastes and contaminated soil at the Chemicals, Metals, and Pesticides (CMP) pits; the construction of hazardous and mixed waste storage facilities; the preparation of RCRA permit applications for hazardous waste facilities; and an expanded monitoring program to characterize groundwater quality and geohydrology on the Plant.

Demonstration programs that will improve waste management activities are also under way; these include a "beta-gamma" incinerator; a box/drum compactor; and a greater confinement disposal (GCD) demonstration. DOE expects these programs to result in improved methods of disposal for mixed and low-level radioactive wastes or reduction in waste volumes to meet applicable regulations.

Although DOE has started these and other modified waste management activities on the Plant, additional actions are required to modify the waste management program to comply with all current applicable environmental protection requirements, including recently enacted provisions for wellhead protection under the Safe Drinking Water Act (SDWA), as amended. C-29

DOE has given initial consideration to offsite disposal alternatives. However, DOE has dismissed these alternatives from the analysis in this EIS for the following reasons:

- Increased potential for accidental public exposure to wastes transported offsite
- Cost of offsite transportation TC
- Need for siting, permitting, and development of large facilities by private developers in a timely manner
- Potential socioeconomic impacts and adverse public reaction to offsite facilities
- Potential liability for comingled wastes, when disposed of in private facilities

1.1 NEED

Operations at the SRP generate a variety of hazardous, low-level radioactive, and mixed wastes. These include hazardous wastes such as spent degreasing solvents; low-level radioactive wastes such as contaminated gloves, wipes, and liquid discharges from disassembly basins in the reactor areas; and mixed wastes such as condensate from the evaporation of high-level waste (mercury with radionuclides), process water and laboratory wastes (solvents with uranium), tritiated waste oil, and solutions used in measuring radiation (liquid scintillation solvents).

Because of past SRP waste management activities, such as the use of seepage basins and the disposal of wastes in unlined pits, groundwater (primarily water-table aquifers) in the vicinity of several waste sites has been contaminated by a variety of substances, including volatile organics, nitrates, heavy metals (lead, chromium, cadmium, and mercury), pesticides, and radionuclides.

To comply with recently enacted groundwater-protection requirements, including RCRA, the Hazardous and Solid Waste Amendments (HSWA) to RCRA, the

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Superfund Amendments and Reauthorization Act (SARA), and SDWA, DOE actions at existing waste sites and new disposal or storage facilities are required.

Several SRP locations have been used for the disposal or storage of hazardous, low-level radioactive, and mixed wastes. Many of the waste sites identified on the Plant contain or might have received hazardous, low-level radioactive, or mixed wastes. Although only a few sites currently receive low-level radioactive or permitted mixed waste, corrective actions might be required by RCRA/HSWA or CERCLA/SARA at waste sites releasing hazardous constituents, regardless of when such a site received the waste. These corrective actions would prevent the potential migration of contamination beyond the boundaries of the waste site by removing contaminants from soil, surface water, and groundwater, by removing the source of the contamination, or both. TC

Current groundwater protection and other regulations also require the establishment of new waste disposal or storage facilities. New facilities provide the needed capacity for hazardous, low-level radioactive, and mixed waste resulting from removal or exhumation actions at existing waste sites under RCRA requirements; sludges from new effluent treatment facilities that are planned or are in operation to discontinue the use of seepage basins; and wastes from interim storage facilities and ongoing SRP operations. Adequate capacity is not available in existing facilities to store or dispose of these wastes. At present, hazardous and mixed wastes are stored on an interim basis in permitted storage facilities, and the facility for the disposal of low-level radioactive waste has less than two years of capacity remaining.

1.2 PURPOSE

At present, DOE is proceeding with waste management activities to comply with applicable requirements on a priority and project basis; these activities include the submittal of Part B permits under RCRA for individual hazardous waste facilities and the implementation of remedial actions and closure plans pursuant to RCRA permits for individual waste facilities. DOE is committed to full compliance with applicable RCRA hazardous waste requirements on the Savannah River Plant. CERCLA/SARA requirements also apply to hazardous waste sites. TC

These priority and compliance waste management activities will continue; however, DOE recognizes that there is also a need for a comprehensive evaluation of the cumulative effects of individual actions. There is also a need for integrating and evaluating the effects of individual actions with other actions or projects. For example, RCRA might require the removal of hazardous waste from an existing waste site, but the removal is predicated on the availability of a permitted hazardous waste disposal or storage facility that has the capacity to accept the waste. Recognizing this need for a more comprehensive framework to evaluate its future waste management and groundwater-protection projects, DOE announced its intent to prepare this environmental impact statement (EIS) on April 26, 1985 (50 FR 16534).

The proposed action to which this dual-purpose EIS provides environmental input is the modification of waste management activities on the Savannah River

Plant for hazardous, low-level radioactive, and mixed wastes for the protection of groundwater, human health, and the environment. The EIS considers the following modifications to the SRP waste management program:

- Removal, remedial, and closure actions at active and inactive hazardous, low-level radioactive, and mixed waste sites

- Establishment of new waste disposal facilities for hazardous, low-level radioactive, and mixed wastes

- Alternative means for discharge of disassembly-basin purge water from C-, K-, and P-Reactors

The purpose of this proposed action is to identify and select a waste management strategy and project-specific actions for the treatment, storage, and disposal of SRP hazardous, low-level radioactive, and mixed wastes that will protect groundwater resources and comply with applicable regulatory requirements. These activities have the greatest potential for affecting groundwater resources. This EIS assesses modifications for each waste management activity that represent broadly defined strategies that DOE could select to implement future management actions regarding hazardous, low-level radioactive, and mixed waste.

This EIS, which is both programmatic and project-specific, supports the selection of a broadly defined waste management strategy and provides project-level environmental input for project-specific decisions on proceeding with future hazardous, low-level radioactive, and mixed waste management activities. TC Public and Federal and state agency comments have been incorporated in this final EIS. DOE will later identify its selected strategy in a Record of Decision. The strategy decision will precede any project-specific actions. TC Research activities to reduce waste generation and reduce waste toxicity (waste minimization) and to increase waste isolation from the biosphere are continuing, as are interactions with regulatory agencies. As a result, decisions on implementing portions of the overall strategy or some specific actions discussed in the EIS might be delayed. Additional National Environmental Policy Act documents will be prepared, if necessary, to support the implementation of project activities that are not addressed specifically in this EIS. Federal (RCRA, CERCLA, and SDWA, as amended) and State (South Carolina Hazardous Waste Management Act) regulations and DOE Orders will provide the bases for project-specific decisions.

REFERENCES

DOE (U.S. Department of Energy), 1984. Groundwater Protection Plan for the Savannah River Plant, Savannah River Operations Office, Aiken, South Carolina.

ERDA (Energy Research and Development Administration), 1977. Final Environmental Impact Statement, Waste Management Operations, Savannah River Plant, Aiken, South Carolina, ERDA-1537, Washington, D.C.

Marine, I. W., and H. W. Bledsoe, 1985. Supplemental Technical Data Summary, M-Area Groundwater Investigation, DPST-84-112, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

SUMMARY

PURPOSE

The U.S. Department of Energy (DOE) has prepared this environmental impact statement (EIS) to assess the environmental consequences of the implementation of modified waste management activities for hazardous, low-level radioactive, and mixed wastes for the protection of groundwater, human health, and the environment at its Savannah River Plant (SRP) in Aiken, South Carolina. This EIS, which is both programmatic and project-specific, has been prepared in accordance with Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended. It is intended to support broad decisions on future actions on SRP waste management activities and to provide project-related environmental input and support for project-specific decisions on proceeding with cleanup activities at existing waste sites in the R- and F-Areas, establishing new waste disposal facilities, and discharging disassembly-basin purge water. In preparing this dual-purpose EIS, the U.S. Department of Energy (DOE) has considered the comments submitted by Government agencies, private organizations, and individuals during the public scoping meetings and comment period in May 1985, and in the public comment period on the draft EIS from May 8, 1987, through June 30, 1987. Public hearings to receive comments on the draft EIS were held June 2 and June 4, 1987. TC

BACKGROUND AND NEED FOR ACTION

The Savannah River Plant is a major DOE installation that produces nuclear materials for national defense and research purposes. The SRP operations generate hazardous, radioactive [including transuranic (TRU) and high-level wastes (HLW)], and mixed (radioactive and hazardous) wastes. Previously acceptable waste disposal practices have included the use of seepage basins for liquids (i.e., acceptable under then existing regulations); disposal pits and waste piles for solids, and solid waste burial grounds for low-level radioactive wastes. TC C-22 E-41 E-43

Groundwater contamination of some aquifers has occurred because of the previously acceptable waste management practices which predated environmental regulations such as those cited below. The contaminants detected include volatile organic compounds (degreasing solvents), heavy metals (lead, chromium, mercury, and cadmium), radionuclides (tritium, uranium, fission products, and plutonium), and other miscellaneous chemicals (e.g., nitrates); concentrations of these substances have exceeded maximum contaminant levels (MCLs) and other regulatory standards or guideline concentrations. A-1 TE

This EIS uses the terms "hazardous," "low-level radioactive," and "mixed" (i.e., hazardous and low-level radioactive) in their everyday sense, without specific regard to technical or regulatory definitions, unless indicated. DOE does not intend this EIS to be a permit application for existing SRP facilities or a vehicle to resolve the applicability of the requirements of the Resource Conservation and Recovery Act (RCRA), the Hazardous and Solid Waste Amendments (HSWA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Superfund Amendments and Reauthorization Act (SARA) to existing SRP facilities or waste sites. Ongoing regulatory activities and the expanded SRP groundwater monitoring and characterization program will provide the bases for the application of specific regulations to existing facilities and waste sites following the publication of a Record of Decision by DOE.

As a result of legislative actions [Public Law 98-181, RCRA, HSWA, CERCLA,
TC SARA, and the South Carolina Hazardous Waste Management Act (SCHWMA)], their
implementing regulations, and DOE Administrative Orders, as well as DOE
concerns to protect the environment, many remedial or corrective actions have
been initiated and are under way at the SRP. These actions include the
TC removal and storage of previously buried wastes and contaminated soils; the
design, construction, and operation of liquid effluent treatment facilities;
the use of recovery wells and an air stripper to remove volatile organic
TC compounds from contaminated groundwater; the design of a two-stage, rotary-kiln
incinerator to detoxify hazardous wastes; and other waste disposal
demonstrations.

Current demonstration programs that affect waste management activities include a "beta-gamma" incinerator, a box/drum compactor, and a greater confinement disposal (GCD) demonstration. DOE expects these programs to result in improved methods of disposal for mixed and low-level radioactive wastes or reduction in waste volumes to meet applicable regulations.

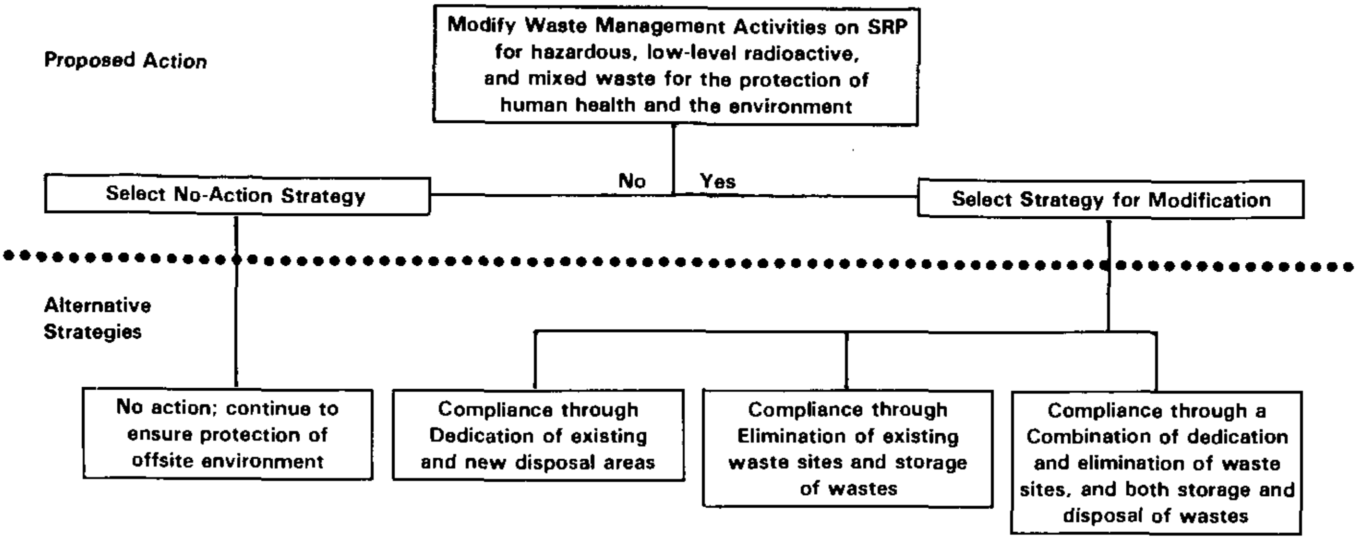
DOE plans to close existing waste sites and seepage basins; to construct new waste disposal or storage facilities to manage hazardous, low-level radioactive, and mixed wastes that might be removed from existing waste sites or that might result from ongoing and planned operations; and to consider alternative methods for the treatment of reactor-area disassembly-basin purge water.

PROPOSED ACTION AND ALTERNATIVE

The proposed action considered in this EIS is the modification of waste management activities for hazardous, low-level radioactive, and mixed wastes to protect groundwater, human health, and the environment. The alternative to the proposed action is a No-Action strategy, to be evaluated as required by the National Environmental Policy Act (NEPA) and guidelines of the Council on
Environmental Quality (CEQ). DOE does not consider no action to be a "reasonable"
TE alternative, because parts of the existing waste management program
would not comply with current groundwater protection and other requirements.

ALTERNATIVE STRATEGIES

DOE could use several alternative strategies to modify the SRP waste management program for hazardous, low-level radioactive, and mixed wastes (see Figure S-1). These strategies differ in the actions proposed for existing waste sites, new waste management facilities, and discharge of disassembly-basin purge water, and in the degree to which they require dedication of land areas, long-term monitoring, and oversight to ensure that groundwater resources, human health, and the environment are protected adequately. (The
TE disassembly basins receive irradiated reactor fuel and targets from the SRP
reactors prior to transfer to reprocessing facilities. The water in the
basins is purified continuously by filtration and demineralization but must

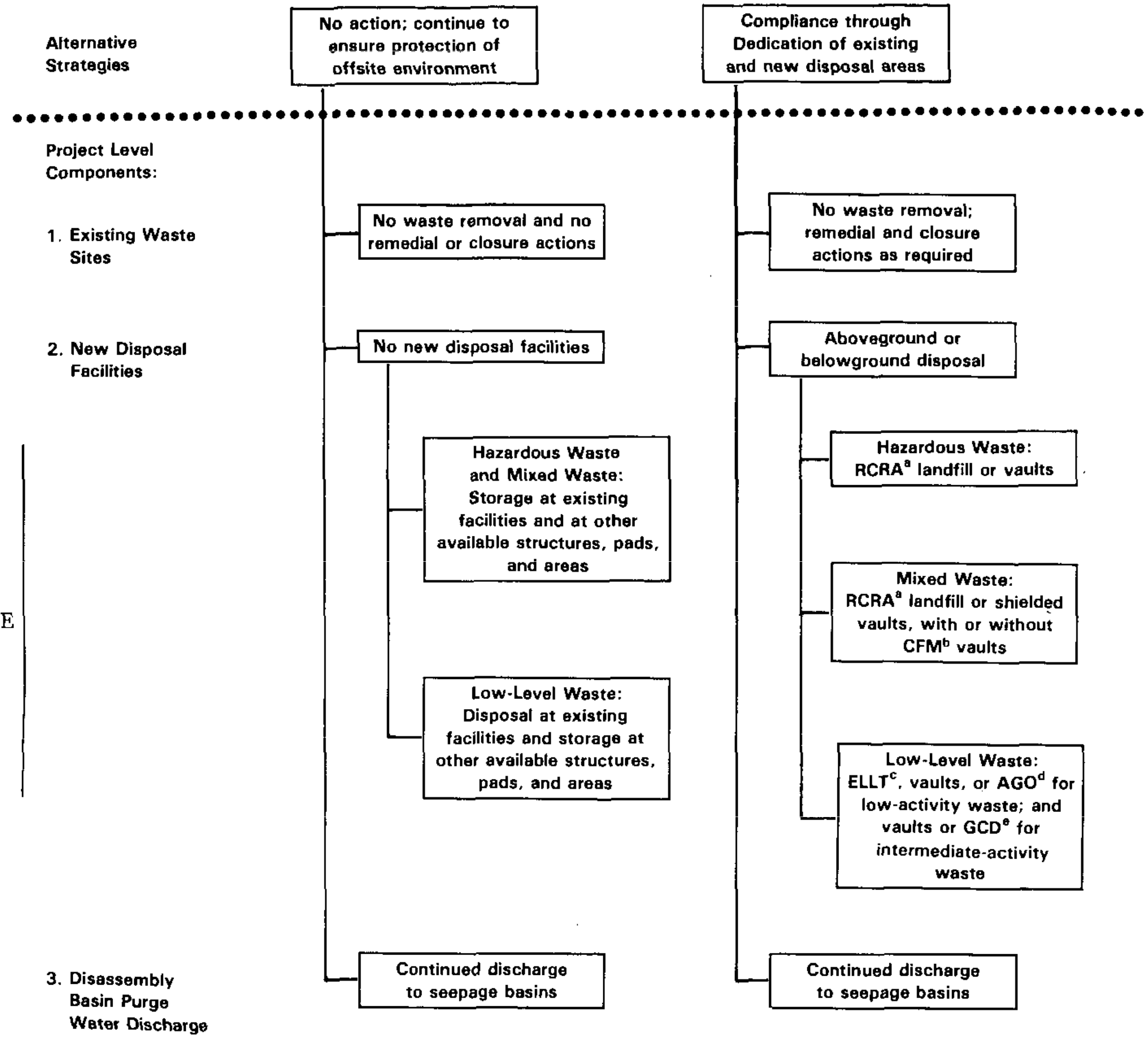


Legend:

[a] RCRA = Resource Conservation and Recovery Act
[b] CFM = Cement Flyash Matrix
[c] ELLT = Engineered Low-Level Trench
[d] AGO = Abovegrade Operation
[e] GCD = Greater Confinement Disposal
[f] Selected Sites to be identified and determined by regulatory interactions

TE

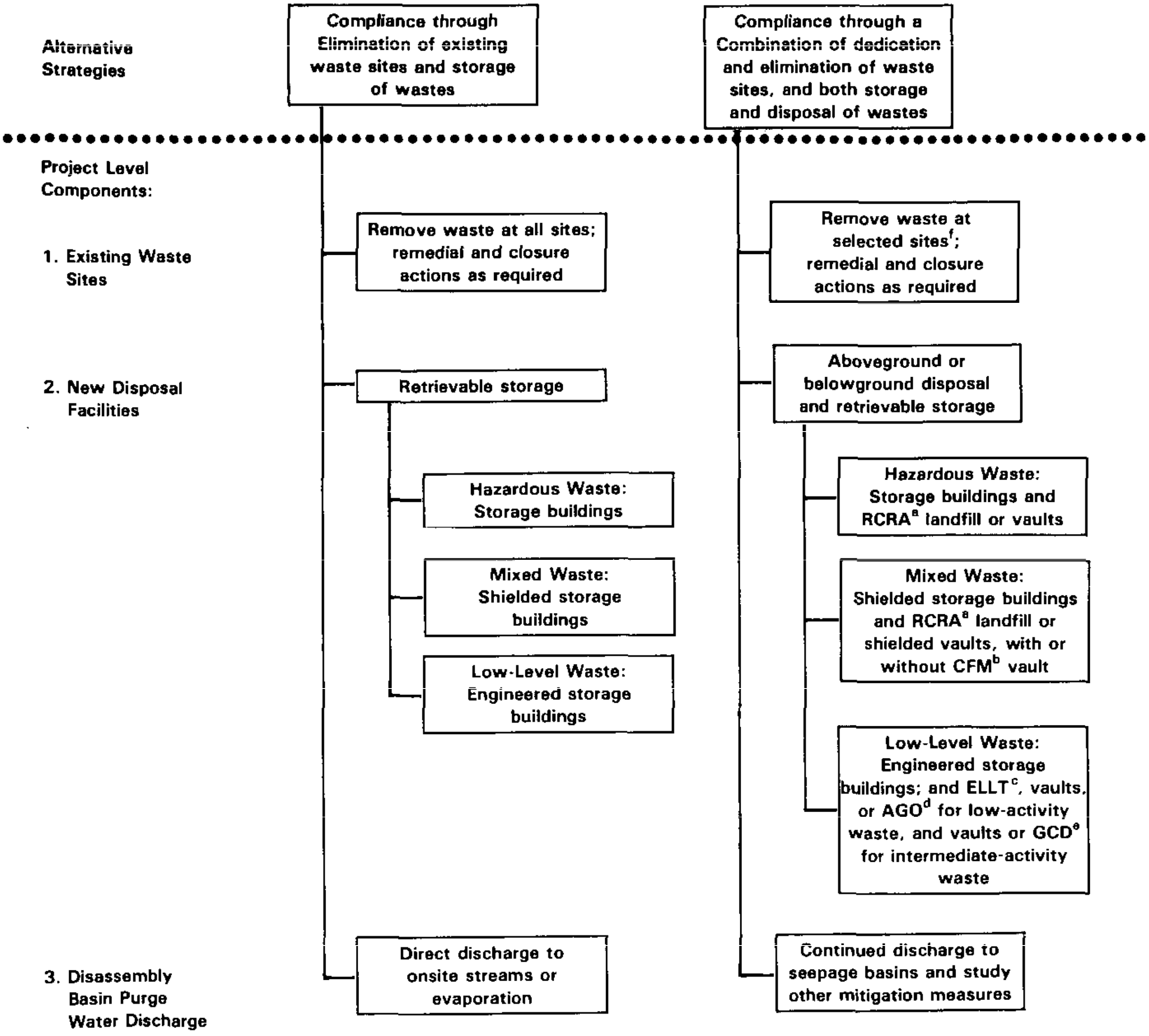
Figure S-1. Project-Specific Components of Alternative Strategies (page 1 of 3)



TE

Legend on page 1

Figure S-1. Project-Specific Components of Alternative Strategies (page 2 of 3)



Legend on page 1

Figure S-1. Project-Specific Components of Alternative Strategies (page 3 of 3)

be purged periodically to maintain required tritium oxide concentrations and resultant worker exposures, as low as reasonably achievable. These purges are discharged to seepage basins at each reactor site and to the containment basin in K-Area.)

RCRA reflects the differences in strategies by requiring the owner of a RCRA-regulated hazardous waste site that is releasing waste constituents to remove and control contaminants from the soil, surface water, and groundwater outside the site, or to remove the source of contamination from the site to achieve background levels or agreed-to alternative concentration limits. If the owner removes and controls the contaminants in environmental media outside a waste
site leaving the source in place, that site, in effect, becomes a RCRA
TE disposal facility and remains dedicated to waste management; long-term
monitoring and oversight are required to ensure environmental protection. If the owner removes the source of contamination (i.e., the waste material and contaminated soil within the site), the site no longer requires dedication to waste management purposes, nor does it require long-term monitoring and over-
F-15 sight. Long-term monitoring would be necessary at any site where waste is
left in place (i.e., closed as a landfill) or where groundwater contamination is confirmed.

The requirement for dedicating land areas for waste management purposes and committing resources to long-term monitoring and oversight is also reflected in the choice between disposing of or storing wastes. The disposal of wastes that retain their hazardous or radioactive characteristics requires permanent or long-term dedication and monitoring. Alternatively, the use of storage as an isolation technique implicitly assumes that research and development will
TE provide acceptable or improved alternatives for treatment of the stored waste
before its ultimate disposal.

The following paragraphs describe alternative strategies for modifications of SRP hazardous, low-level radioactive, and mixed waste management activities. These strategies are based on combinations of closure and remedial actions at existing waste sites, the construction of new storage and disposal facilities, and the discharge of disassembly-basin purge water. The modification of a waste management activity, such as a closure and remedial action at existing waste sites, might require the modification of another activity (e.g., the number, size, and design of new disposal facilities). The following paragraphs also present combinations of various activities and analyses to provide an overview of the environmental effects of proposed modifications of the SRP waste management program (see Figure S-1).

In this EIS, DOE presents analyses of the environmental impacts of alternative
waste management strategies. DOE, in its Record of Decision (ROD) on this
TE EIS, will select a single strategy from those described below. Site-specific
or project-specific actions will be based on ongoing investigations and interactions with appropriate regulatory agencies throughout the permitting process.

NO-ACTION STRATEGY

TE The NEPA regulations of the CEQ require an agency to evaluate the
environmental consequences of no action (40 CFR 1502.14). As a potential

implementation strategy, no action would not involve changes in current practices. It would consist of the following:

- No removal of waste at existing waste sites, and no closure or remedial actions
- No construction of new facilities for the storage or disposal of hazardous, low-level radioactive, or mixed wastes
- Continuation of periodic discharges of disassembly-basin purge water to seepage basins

Parts of the existing program would not comply with groundwater-protection requirements. DOE does not consider the continuation of a noncomplying program to be a "reasonable" alternative strategy.

DEDICATION STRATEGY

Under the Dedication strategy, DOE would modify its waste management activities to comply with all groundwater-protection requirements, including those pursuant to RCRA, by:

- Implementing closure (dewatering, stabilizing, capping) and groundwater corrective actions (installing grout curtains or barrier walls, as required) to control contamination from existing waste sites in accordance with applicable state and Federal standards C-28
- Establishing new disposal facilities (e.g., above- or belowground disposal)
- Continuing the use of seepage and containment basins for the periodic discharge of reactor disassembly-basin purge water

Under this strategy, DOE would dedicate for waste management purposes those waste sites and contaminated areas that could not be returned to public use after a 100-year institutional control period. At least 300 acres of land would be dedicated for these purposes; this is less than 0.2 percent of the total SRP land area. DOE would control releases of hazardous substances from existing waste sites that contain hazardous or mixed wastes through the closure of such sites pursuant to applicable requirements, corrective actions to control groundwater contaminant plume migration and restore groundwater quality, and other corrective actions (excluding waste removal) at the sites. TE

To accommodate hazardous, low-level radioactive, and mixed wastes generated from ongoing SRP operations, those presently in interim storage, and those from existing and planned waste management actions (e.g., sludges from new effluent treatment facilities), DOE would establish new disposal facilities at the SRP which would meet applicable requirements.

The periodic discharges of filtered and deionized disassembly-basin water from C-, K-, and P-Reactors to seepage and containment basins would continue. The use of basins for these discharges, which are not hazardous but are contaminated with small quantities of radionuclides (principally tritium), would allow time for the radionuclides to decay while migrating through shallow groundwater formations to outcrops along onsite streams. DOE would dedicate for waste management purposes those seepage and containment basins and areas contaminated with radioactivity that could not be returned to public use after a 100-year institutional control period.

ELIMINATION STRATEGY

Under the Elimination strategy, DOE would modify its waste management program to comply with all groundwater-protection requirements, including those pursuant to RCRA, by:

- C-26 Removing wastes to the extent practicable from all existing waste sites and implementing closure and groundwater corrective actions, as required by applicable state and Federal regulations
- Establishing new retrievable storage facilities
- Directly discharging disassembly-basin purge water to onsite streams, or evaporating such discharges through the use of a small commercially available boiler, vent stack, and dispersion fan

Under this strategy, DOE would not dedicate any land areas for hazardous, low-level radioactive, and mixed waste management purposes. Such wastes, including contaminated soils, would be removed from all existing waste sites to the extent practicable. After a maximum 100-year institutional control period, these sites could be used for purposes other than waste management.

DOE would store wastes removed from existing waste sites and those generated from ongoing SRP operations and existing and planned waste management actions, such as sludges from new effluent treatment facilities, in facilities from which they could be retrieved. Hazardous and mixed wastes in interim storage at the SRP would remain in the interim-storage buildings. DOE would research TC new technologies and eventually implement technologies for the permanent disposal of hazardous, low-level radioactive, and mixed wastes.

DOE would discharge the filtered and deionized disassembly-basin purge water from C-, K-, and P-Reactors to onsite streams within National Pollutant Discharge Elimination System (NPDES) permit limits, or would evaporate such discharges with a small commercially available boiler, vent stack, and dispersion fan. In either case, DOE would eliminate the seepage and containment basins now used for the discharge of disassembly-basin purge water. DOE would take closure and remedial actions at these basins, if necessary, to ensure that contaminated areas could be returned to public use after a 100-year institutional control period.

COMBINATION STRATEGY

Under the Combination strategy, DOE would modify the SRP waste management program to comply with all groundwater-protection requirements, including those pursuant to RCRA, by:

- TC Removing wastes at selected existing waste sites to the extent C-26 practicable and implementing closure and groundwater remedial actions, as required by applicable state and Federal regulations

- Establishing a combination of retrievable storage, aboveground, and belowground disposal facilities

- Continuing the use of seepage and containment basins for the periodic discharge of reactor disassembly-basin purge water

Under this alternative, DOE would remove hazardous, low-level radioactive, and mixed wastes (including contaminated soils) to the extent practicable from selected existing waste sites based on cost-effectiveness and environmental/human health risk evaluations. Based on the preliminary evaluations in this EIS, seven sites were selected as suitable for waste removal. The final decision on sites to be selected for waste removal would be made through regulatory agency interactions. After a maximum 100-year institutional control period, the areas from which waste material and contaminated soil had been removed (about 30 acres) could be used for purposes other than waste management. Sites from which waste material and contaminated soil were not removed (about 270 acres) would be dedicated for waste management purposes if they could not be returned to public use after the 100-year control period.

DOE would establish new retrievable storage and disposal facilities to accommodate wastes removed from existing waste sites and those generated from ongoing SRP operations and existing and planned waste management actions. Disposal facilities for hazardous or mixed waste would be permitted in accordance with applicable regulations. The combination of new retrievable-storage and disposal facilities would allow DOE to investigate and implement new technologies for permanent disposal of stored wastes. DOE would dedicate for waste management purposes the sites of disposal facilities established under this strategy.

Periodic discharges of filtered and deionized disassembly-basin purge water from C-, K-, and P-Reactors to seepage and containment basins would continue; DOE's assessment of the feasibility of alternative mitigation measures at the SRP would continue. If DOE determines that detritiation or another mitigation measure is appropriate in an overall waste management strategy, it could discontinue the use of these basins and evaluate actions to return the basin areas to public use after a 100-year institutional control period.

PROJECT-SPECIFIC ACTIONS

NO ACTION

In this EIS, DOE has assumed that the SRP would continue to operate and generate wastes. Under no action, current waste management activities would continue at existing waste sites, no wastes would be removed from the sites, and no remedial or closure actions would occur.

Under no action, no new facilities such as sites, buildings, landfills, vaults, engineered trenches, or boreholes would be established for waste management. Existing SRP facilities would be used until their capacities were reached, after which unpermitted structures, pads, or areas with minimal preparation for indefinite waste storage would be used.

No action would continue the present practice of periodic discharges of disassembly-basin purge water to active reactor seepage and containment basins.

EXISTING WASTE SITE REMEDIAL AND CLOSURE ACTIONS, WITH AND WITHOUT WASTE REMOVAL

A range of project-specific actions can be applied at the SRP for existing hazardous, low-level radioactive, and mixed waste sites. These actions include allowing waste to remain in sites and providing some type of closure, such as backfilling and capping. Wastes and contaminated soils would be removed at selected sites (seven sites were identified in the R- and F-Areas). Remedial actions, if required to correct groundwater contamination, could include groundwater recovery and treatment or the installation of barrier walls or grout curtains, along with suitable closure actions.

ESTABLISHMENT OF NEW STORAGE/DISPOSAL FACILITIES

TE

A number of waste storage and disposal technologies that meet standards can be applied at the SRP for hazardous, low-level radioactive, and mixed wastes. These include RCRA-type vaults (i.e., above- and belowground double-lined vaults meeting RCRA minimum technology requirements) or RCRA-type landfills with double liners and leachate collection systems for hazardous and mixed wastes. Low-level radioactive wastes would be disposed of in facilities meeting the requirements of DOE Orders, including engineered low-level trenches (ELLTs) for low-activity wastes, GCD for intermediate-activity wastes, shielded above- or below-grade vaults, or above-grade operations (AGO).

The retrievable-storage technologies for hazardous and mixed wastes, which are similar, would meet applicable standards. These facilities would be designed for essentially zero releases. For mixed waste, in addition to meeting RCRA requirements, such facilities would provide shielding of radiation sources. The technologies for low-level waste would consist of engineered storage of waste with varying degrees of isolation and shielding to accommodate different levels and types of radioactivity. These facilities would be designed to meet the as-low-as-reasonably-achievable (ALARA) requirements of DOE Orders.

DISCHARGE OF DISASSEMBLY-BASIN PURGE WATER

TC

Project-specific actions for managing the discharge of disassembly-basin purge water could include discontinuing the use of the active reactor seepage and containment basins by discharging the purge water directly to surface streams (which currently receive purge water via outcrops) or by evaporating it to the atmosphere through commercially available equipment. Releases to surface streams caused by residual seepage from prior use would continue for several years.

AFFECTED ENVIRONMENT

The Savannah River Plant is a 780-square-kilometer (192,700-acre), controlled-access area near Aiken, South Carolina. This major DOE installation was established in the early 1950s for the production of nuclear materials for national defense. More than 90 percent of the site is forested.

A very complex geohydrologic regime underlies the SRP. This regime contains a series of Coastal Plain sediments (Coastal Plain Mosaic) interspersed with clay and sandy clay layers. Two major regional aquifers, the Congaree and the Middendorf/Black Creek (Tuscaloosa), lie beneath the site, overlain by several shallower formations that produce smaller quantities of water. The deep regional aquifer (the Middendorf/Black Creek), which becomes shallower to the north and northwest of the SRP, forms the base for most municipal and industrial supplies in Aiken County. Farther south, this formation deepens and shallower aquifers such as the Congaree and McBean provide water for municipal, industrial, and agricultural uses. The Barnwell aquifer, located above the Congaree and McBean aquifers, also supplies limited quantities of domestic water in the SRP vicinity.

The water table is fairly shallow beneath most of the Plant, ranging from 10 to 30 meters below the surface. The SRP draws water from the Middendorf/Black Creek Formation, with the exception of some low-volume shallow domestic water wells.

Total groundwater use at the Plant is about 40,000 cubic meters (1 cubic meter = 264 gallons) per day. Large users of water within 32 kilometers of the center of the Plant withdraw about 135,000 cubic meters per day for municipal, industrial, and agricultural needs. Withdrawals by small users such as schools, mobile home parks, and small communities total about 2000 cubic meters daily. E-44

The flow of groundwater at the SRP is generally toward discharge zones ("outcrops") along the onsite surface streams. Water-table aquifers discharge to Upper and Lower Three Runs Creek, Pen Branch, Four Mile Creek, Tims Branch, and Steel Creek. The flow direction of these creeks is generally toward the southwest, except near the Savannah River swamp where some flow to the southeast. Groundwater from the Middendorf/Black Creek Formation discharges to the Savannah River. Wells near the river are under artesian pressure. Extensive recharge areas for the Middendorf/Black Creek Formation lie to the north and northwest of the SRP and generally to the south of the Fall Line, which separates the Coastal Plain from the Piedmont geologic province. TE

Groundwater quality in the Coastal Plain sediments is good and requires minimal treatment for industrial and municipal use. The water is soft, slightly acidic (pH range 5.5 to 6.5), and has a low total dissolved solids (TDS) content. The quality of the groundwater varies slightly from aquifer to aquifer.

Groundwater quality has been evaluated by DOE on the basis of geographic and functional groupings for most of the sites considered in this EIS that received or might have received hazardous constituents, low-level radioactive wastes, or mixed wastes. TE

Surface water at the SRP consists of the Savannah River, surface streams that transect the Plant and drain to the Savannah River, and two cooling lakes, Par Pond and L-Lake. (One small onsite stream flows to the east and joins tributaries of the Salkehatchie River.) A swamp borders the Savannah River along most of the southwestern Plant boundary. Surface-water quality is characterized by low mineral content, low TDS, and a pH range of 5.6 to 8.4. TE

ENVIRONMENTAL CONSEQUENCES

The determination of the environmental consequences associated with the alternative waste management strategies is based on a combination of data and analyses derived from:

TC
- Groundwater monitoring and soils/sediment analyses
- Groundwater flow and transport modeling
- Estimation of waste site inventories
- Estimation of onsite and offsite doses, health effects, and risks for radionuclides and hazardous chemicals through surface and groundwater, atmospheric, and occupational pathways
- Estimation of ecological impacts
- Estimation of risks to onsite occupants following a 100-year period of institutional control

These assessment methodologies required the use of flow and solute transport models for groundwater; atmospheric dispersion models for radiological and nonradiological constituents; and estimation of health risks through radiological and/or chemical health risk models.

C-12 S-15 Groundwater monitoring has been performed at the SRP routinely, and data from these efforts have been made available in many reports, most recently in the Environmental Information Documents (EIDs) prepared for this EIS. Several groundwater flow and transport models were used, in particular the PATHRAE model, to provide a basis for comparing the relative effects of the alternative strategies, particularly in respect to the existing waste sites. Other codes were used in health effects assessments. One-meter and 100-meter downgradient wells were used as hypothetical receptors for groundwater modeling at existing waste sites. Boundary wells were assumed at proposed new disposal facilities for the same purpose. Onsite surface streams and the Savannah River were assumed as receptor locations for assessing ecological impacts and offsite drinking-water radiological dose and chemical substance exposures. These doses and exposures are primarily intended to evaluate the alternatives with respect to each other; site-specific groundwater modeling would be required for more precise, absolute exposure assessments.

Modeling calculations to determine atmospheric exposures to radioactive and hazardous waste materials were made for the EIS using a number of computer codes for soil and airborne contaminant loadings, transport of radioactive and hazardous materials, population exposures (including evaluation data), and food uptake. Another code was used to calculate airborne risks for the population and the maximally exposed individual. Onsite worker exposure was also estimated.

C-12 Existing waste site inventories for transport modeling efforts were established using physical records or calculations involving either groundwater monitoring results or soil core sampling results. These data resulted in estimates of potential waste inventories (waste disposal mass) for comparisons of alternative removal, remedial, or closure actions. Historic information on operations and waste disposal and storage activities was used to estimate the mass or volume of waste that would be contained in proposed new disposal facilities. A computer code modeled these sites for boundary wells, surface streams, and future site-occupant scenarios, as in existing waste site modeling. C-12

COMPARISON OF ALTERNATIVE WASTE MANAGEMENT STRATEGIES

This EIS compares the alternative waste management strategies, as well as the project-specific actions. It evaluates health effects, doses, and exposures to the general population or workers, the level of environmental impact, volumes and kinds of wastes, and retrievability of wastes for future treatment.

NO-ACTION STRATEGY

No major onsite environmental benefits are expected from the No-Action strategy; however, the offsite environment would be protected as a result of continuing waste management practices such as groundwater cleanup in the A/M-Areas. This strategy would result in the following: TE

- Onsite groundwater (water-table) impacts
- Elevated concentrations of tritium, strontium-90, and nitrate in Four Mile Creek E-45
- Potential terrestrial impacts from open pits and basins
- Accidental releases from stored wastes with possible impacts on aquatic and terrestrial ecology and socioeconomics TE
- Continued minor habitat and wetlands impacts
- Occupational exposures and risks of fires, spills, and leaks due to waste transportation and accidents

This strategy would not produce any impacts to archaeological or historic resources or endangered species. In addition, noise impacts associated with this strategy would not be produced. TE This strategy probably would require the dedication of about 300 acres at existing waste sites plus a significant amount of land in areas receiving adverse impacts, primarily from shallow-aquifer groundwater contamination. In the future, occupants of the SRP site would be exposed to the largest areas of unmitigated contamination.

The estimated total capital cost to continue current practices is about $17 million. Total 20-year operating costs for the No-Action strategy are estimated at about $86 million. Estimated lifetime maintenance and monitoring costs are about $51 million. TC

DEDICATION STRATEGY

The major environmental benefits predicted to occur from the implementation of the Dedication strategy include improvement of onsite groundwater quality from remedial and closure actions at existing waste sites; improvement of onsite surface-water quality; reduction of potential public health effects; and reduction in atmospheric releases. A disadvantage would be the removal of some sites from public use through their dedication for waste management purposes; as much as 700 acres would be affected. Environmental impacts under this strategy could include the following:

- Local and transitory onsite groundwater drawdown effects
- Minor short-term terrestrial impacts due to the use of borrow pits for backfill
- Impacts to wildlife habitat due to land clearing and development
- The dedication of about 400 acres of land to new above- and belowground disposal facilities
- The dedication of about 300 acres at existing waste sites

There would be no impacts to archaeological or historic resources, socioeconomic resources, or endangered species; there would be no impacts from
TC noise. Accidents and occupational risks could occur due to waste material transportation and handling resulting from spills, leaks, or fires.

TC The total capital cost for implementation of this strategy ranges from about $281 million to $788 million. Total 20-year operating costs range from about $51 to $258 million. Estimated costs for closure range from about $19 to $31 million. Estimated post-closure maintenance and monitoring costs range from about $65 million to $119 million. The cost ranges are based on the types of facilities that would be selected.

ELIMINATION STRATEGY

The environmental benefits expected from the implementation of the Elimination strategy include improvement to onsite groundwater and surface-water quality from the removal and closure of all existing waste sites and remedial actions, as required; reduction of potential public health effects and atmospheric releases (except increased tritium air releases under the evaporation option); and no requirement for dedication of sites at the SRP. Disadvantages include higher occupational risks than with other strategies and the absence of assurance of the future availability of disposal sites in other areas. Environmental impacts that could occur under this strategy include:

- Onsite groundwater drawdown effects (local and transitory)
- Added tritium releases to surface streams from direct discharge or increased atmospheric (evaporation) releases
- The highest occupational risks of all the strategies during waste removal, closure, and remedial actions
- Terrestrial impacts at borrow pits that were greater than those for other strategies

- Some loss of habitat (up to 400 acres) due to land clearing and development during the construction of the retrievable-storage facilities TC

- The greatest risk of spills, leaks, and fires, and the greatest worker exposures due to waste removal and transportation

There would be no impacts to archaeological or historic resources, socioeconomic resources, or endangered species; there would be no impacts from noise. This strategy would result in the lowest future risks to future occupants at the waste sites and contaminated areas following the extensive removal, remedial, and closure actions, but there are unknown, unquantifiable impacts associated with the eventual retrieval, treatment, and disposal of these stored wastes. TE

The total capital cost for implementation of this strategy during the 20-year operational period would range between $2.0 billion and $4.8 billion. Total 20-year operating costs would range from about $370 million to $2.4 billion. Estimated post-closure maintenance and monitoring costs are about $37 million. TC

COMBINATION STRATEGY

Major environmental benefits to be derived from implementation of the Combination strategy include secure, retrievable storage and disposal of wastes; improvement to onsite surface water and groundwater from removal of wastes at selected sites, closure of selected waste sites, and remedial actions, as required; reduction of potential public health effects; and reduction of atmospheric releases. The dedication of some sites for waste management purposes would be required. This strategy could cause the following impacts: TE

- Local and transitory groundwater drawdown effects

- Some habitat disruption on up to 400 acres of land required by the new disposal facilities TC

There would be no impacts to archaeological or historic resources, socioeconomic resources, or endangered species; there would be no impacts from noise. Waste removal and handling would pose fewer occupational risks from accidents, fires, spills, and leaks because fewer waste sites would be involved. Potential impacts to future occupants would be between the extremes of the No-Action and Elimination strategies.

The estimated total capital cost of implementation of the Combination strategy ranges from about $334 to $957 million. Total 20-year operating costs range from about $73 to $397 million. Closure costs range from about $37 to $48 million. Estimated post-closure maintenance and monitoring costs range from $90 to $105 million. TC

SUMMARY

Considering all environmental factors and costs, a Combination strategy (i.e., compliance through a combination of site dedication, elimination of some existing waste sites, and disposal/storage of wastes) would be DOE's preferred alternative. The Combination strategy includes project-specific actions of waste removal at selected existing waste sites and remedial and closure actions as required; above- and belowground disposal and retrievable storage for new disposal and storage facilities; and continuation of the discharge of disassembly-basin purge water to seepage basins, with continued studies on detritiation or other mitigation measures.

CHAPTER 2

PROPOSED ACTION AND ALTERNATIVES

Waste management activities have been under way at the Savannah River Plant (SRP) since operations began in the early 1950s. Periodic reviews and the results of research and development programs were used to update and refine these activities. In 1977, the SRP reviewed its waste management activities and chose to continue those that were consistent with the requirements at the time (ERDA, 1977). Because of changing environmental concerns and regulations [including the Resource Conservation and Recovery Act (RCRA), the Hazardous and Solid Waste Amendments (HSWA) to RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Superfund Amendments and Reauthorization Act (SARA), and the Safe Drinking Water Act (SDWA)], some of these activities are no longer acceptable. Accordingly, the U.S. Department of Energy (DOE) is proposing to modify its waste management activities.

This dual-purpose environmental impact statement (EIS) is both a programmatic and a project-specific document. It considers broad waste management strategies and associated project-specific actions. The EIS does not preempt the regulatory decisionmaking process, but is a prerequisite to the DOE Record of Decision. It provides an analysis based on available data and information that describes the range of environmental impacts - beneficial and adverse - that accompany each strategy and project-specific action.

The action proposed in this EIS is the modification of waste management activities on the Savannah River Plant for hazardous, low-level radioactive, and mixed wastes for the protection of human health and the environment. The alternative to the proposed action is "no action," or not modifying existing waste management activities, and continuing current activities for managing low-level radioactive and chemical wastes. Because these activities would not comply with current applicable requirements and might affect activities that already protect groundwater resources, DOE does not consider the continuation of ongoing activities, or "no action," to be a "reasonable" alternative as defined in Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA) of 1969.

DOE could implement several alternative waste management strategies for SRP hazardous, low-level radioactive, and mixed waste to comply with applicable requirements. Section 2.1 describes the alternative strategies from which DOE will select a preferred alternative strategy in its Record of Decision (ROD) on this EIS. Sections 2.2, 2.3, and 2.4 describe the strategies for closing existing waste sites on the SRP, for new disposal facilities, and for managing the discharge of disassembly-basin purge water, respectively. Section 2.5 summarizes the environmental consequences of the alternative strategies. TE

The alternative strategies are based on combinations of project-specific actions. Such actions represent those evaluated in this EIS; they are represented by such decisions as the disposal of low-level radioactive waste in a facility for which conceptual designs are presented, or the disposal of TE

TE disassembly-basin purge water by direct discharge to surface streams or by discharge to seepage basins. Figure 2-1 shows the project-specific components of the alternative strategies.

2.1 ALTERNATIVE WASTE MANAGEMENT STRATEGIES

In considering modifications to SRP waste management activities for hazardous, low-level radioactive, and mixed wastes, DOE could select one of several alternative strategies. These strategies differ in the waste management concepts proposed for existing waste sites, new disposal facilities, and discharge of disassembly-basin purge water. They also differ in the degree to which they require dedication of land areas, long-term monitoring, and control to ensure that releases from SRP facilities are within applicable standards.

TE RCRA, as amended, reflects these differences by requiring the owner of a hazardous waste site having continuing releases either to remove and control contaminants from the soil, surface water, and groundwater outside the site while allowing the waste to remain in place, or to remove the waste from the site to within background levels or agreed-to alternative concentration limits. If the contaminants in environmental media outside a waste site were removed and controlled, the waste site land area would remain dedicated to waste management; long-term monitoring and oversight would be essential to ensure environmental protection. If the source of contamination (i.e., the waste material and contaminated soil within the site) were removed, the site would no longer need to be dedicated to waste management purposes, nor would it require long-term monitoring and oversight. Long-term monitoring would be necessary at any site where waste is left in place (i.e., closed as a landfill) or where groundwater contamination is confined. The requirements of CERCLA/SARA also apply to certain SRP existing waste sites. F-15

This difference in the need to dedicate land areas for waste management purposes and to commit resources to long-term monitoring and oversight is also reflected in the choice of disposing of or storing hazardous, low-level radioactive, or mixed waste. Disposal requires the permanent or long-term dedication of land areas. Storage, on the other hand, requires neither permanent nor long-term dedication; storage implicitly assumes that research and development will provide better methods for disposal than those currently available.

The management of hazardous and mixed waste on the SRP is regulated by RCRA, HSWA, CERCLA/SARA, and DOE Orders. RCRA and HSWA provide a national program to minimize the present and future threat to human health and the environment from the transportation, treatment, storage, and disposal of hazardous waste. RCRA is administered by the South Carolina Department of Health and Environmental Control (SCDHEC), under the authority of the U.S. Environmental Protection Agency (EPA). CERCLA/SARA are administered by EPA. DOE Orders set forth policy, guidelines, and criteria for the management of hazardous, mixed, and low-level radioactive wastes generated by DOE facilities.

The following sections discuss alternative strategies for the modification of hazardous, low-level radioactive, and mixed waste management activities for existing waste sites, new storage and disposal facilities, and disassembly basin purge-water discharge, which would be consistent with the requirements of RCRA, HSWA, and DOE Orders. Additionally, in accordance with NEPA implementing regulations, this chapter also discusses a No-Action strategy. TC

E-57 Table 2-1 summarizes the alternative strategies for SRP hazardous, low-level radioactive, and mixed waste management activities; this table presents a central consideration of this EIS: the modification of a single waste management activity might require modification of another. Each alternative strategy, therefore, must be comprised of mutually compatible project-specific components.

The development of the waste management strategies described in this EIS is a logical outgrowth of needed SRP waste management activities and recently enacted regulations. These individual activities are analyzed and evaluated as mutually exclusive and independent. The following discussions combine modifications that are consistent with the alternative strategies for the overall management of SRP hazardous, low-level radioactive, and mixed waste.

2.1.1 NO-ACTION STRATEGY - CONTINUED PROTECTION OF OFFSITE ENVIRONMENT

CEQ guidelines (40 CFR 1502.14) require a Federal agency to evaluate the environmental consequences of "no action." As a potential strategy for this EIS, "no action" would consist of:

- No removal of waste at existing waste sites, and no closure or remedial actions
- No construction of new facilities for the storage or disposal of hazardous, low-level radioactive, or mixed wastes
- Continuation of periodic discharges of disassembly-basin purge water to active seepage and containment basins.

The No-Action strategy would include the continuation of current activities for management of low-level radioactive and chemical wastes. Because the existing program would not comply with current groundwater and other environmental protection requirements, DOE does not consider it to be a "reasonable" alternative strategy.

2.1.2 DEDICATION STRATEGY - COMPLIANCE THROUGH DEDICATION OF EXISTING AND NEW DISPOSAL AREAS

For this strategy, the SRP hazardous, low-level radioactive, and mixed waste management activities could be modified to comply with applicable requirements by:

- Implementing closure (dewatering, stabilization, capping) and groundwater corrective actions, as required (installing grout curtains or barrier walls), to control contamination from existing waste sites in accordance with applicable standards
- Establishing new disposal facilities (e.g., vaults or trenches) above or below the ground
- Continuing the use of seepage and containment basins for the periodic discharge of reactor disassembly-basin purge water.

Releases of hazardous substances from existing waste sites that contain hazardous or mixed wastes would be controlled through the closure of such sites (if not already closed) under RCRA requirements, remedial actions to control groundwater contaminant plume migration and to restore groundwater quality, and other corrective actions (excluding removal) at the sites to prevent further releases of hazardous substances. Under this strategy, DOE would dedicate for waste management purposes those waste sites and contaminated (hazardous and radioactive) areas that could not be returned to public use after a 100-year institutional control period.

To accommodate hazardous, low-level radioactive, and mixed wastes generated from ongoing SRP operations, those presently in interim storage, and those from existing and planned waste management activities to comply with groundwater protection requirements (e.g., sludge from new effluent treatment facilities), new disposal facilities meeting applicable requirements would be established on the SRP.

The periodic discharges of filtered and deionized disassembly-basin water from C-, K-, and P-Reactors to active seepage and containment basins would continue. The use of basins for these discharges, which are not hazardous but are contaminated with tritium, would allow time for radioactive decay to occur while migrating to groundwater outcrops along onsite streams. If the seepage and containment basins and contaminated areas could not be returned to public use after a 100-year institutional control period, DOE would dedicate such areas permanently for waste management purposes.

2.1.3 ELIMINATION STRATEGY - COMPLIANCE THROUGH ELIMINATION OF EXISTING WASTE SITES AND STORAGE OF WASTES

The SRP hazardous, low-level radioactive, and mixed waste management activities could be modified to comply with all groundwater protection requirements by:

- Removing wastes to the extent practicable from all existing waste sites and implementing closure and groundwater remedial actions, as required
- Establishing new retrievable storage facilities
- Directly discharging disassembly-basin purge water to onsite streams, or evaporating such discharges through the use of a small commercially-available boiler, vent stack, and dispersion fan.

Under this strategy, no land areas would be dedicated for hazardous, low-level radioactive, and mixed waste management purposes. Such wastes, including contaminated soils, would be removed from all existing waste sites to the extent practicable. After an assumed 100-year institutional control period, most of these sites could be used for purposes other than waste management.

Wastes removed from existing waste sites and those generated from ongoing SRP operations and existing and planned waste management activities to comply with groundwater-protection requirements would be stored in facilities from which they could be retrieved. Hazardous and mixed wastes currently in interim storage at SRP would remain in the interim storage buildings. A research program would be initiated to investigate or develop new technologies for the permanent disposal of hazardous, low-level radioactive, and mixed wastes. Once these new technologies were proved to be cost-effective, stored wastes would be permanently disposed of.

The filtered and deionized disassembly-basin water from C-, K-, and P-Reactors would be discharged to onsite streams in accordance with a National Pollutant Discharge Elimination System (NPDES) permit or evaporated in a small commercially available boiler, vent stack, and dispersion fan. Seepage and containment basins used for the discharge of disassembly-basin purge water would be eliminated. Closure and remedial actions would be taken at these basins, if necessary, to ensure that contaminated areas could be returned to public use after a 100-year institutional control period.

2.1.4 COMBINATION STRATEGY - COMPLIANCE THROUGH A COMBINATION OF DEDICATION AND ELIMINATION OF EXISTING WASTE SITES, AND BOTH STORAGE AND DISPOSAL OF WASTES

For this strategy, the SRP's hazardous, low-level radioactive, and mixed waste management activities could be modified to comply with all groundwater protection and other environmental requirements by:

- Removing wastes at selected existing waste sites to the extent practicable and implementing closure and groundwater remedial actions, as required by applicable regulations
- Establishing a combination of retrievable storage and aboveground or belowground disposal
- Continuing the use of seepage and containment basins for the periodic discharge of reactor disassembly-basin purge water, while continuing investigations of source mitigation measures.

Under this strategy, hazardous, low-level radioactive, and mixed wastes (including contaminated soils) would be removed to the extent practicable from selected existing waste sites, based on cost-effectiveness and on environmental and human health risks. Preliminary analyses for this EIS have identified sites in R- and F-Areas for waste removal; additional sites may be selected in the future, based on further site-specific investigations and regulatory interactions. After a maximum 100-year institutional control period, the areas from which waste material and contaminated soil had been removed could be used for purposes other than waste management. Sites from which waste material and contaminated soil had not been removed would be dedicated for waste management purposes if they could not be returned to public use after the 100-year control period.

TC

New retrievable storage and disposal facilities would be established to accommodate waste removed from existing waste sites and waste generated from ongoing SRP operations and existing and planned waste management activities to comply with groundwater protection requirements. Disposal facilities for hazardous or mixed waste would be permitted in accordance with applicable requirements. The combination of new storage and disposal facilities [e.g., greater confinement disposal (GCD), vaults, and engineered low-level trenches] would minimize the amount of hazardous, low-level radioactive, and mixed waste placed in disposal facilities and would allow DOE to initiate a research program to develop new technologies for permanent disposal. DOE would dedicate disposal facilities established for these wastes for waste management purposes.

Under this strategy, periodic discharges of filtered and deionized disassembly-basin water from C-, K-, and P-Reactors to the active seepage and containment basins would continue. DOE would continue to assess the general applicability of other mitigation measures at the SRP. If DOE were to determine that detritiation or another approach is applicable, it would discontinue the use of these basins and evaluate actions to return the basin areas to public use after a 100-year institutional control period.

2.1.5 OTHER ALTERNATIVE STRATEGIES

In addition to the No-Action strategy and the three alternative strategies described above, other strategies considered included discontinuing SRP operations or shipping and disposing of hazardous, low-level radioactive, and mixed wastes at another (offsite) facility.

TE DOE determined that discontinuing SRP operations, which would affect only the volume of future hazardous, low-level radioactive, and mixed waste to be stored or disposed of, would be unacceptable, because such a strategy would not allow DOE to meet established requirements for the production of defense nuclear materials.

Strategies for the shipment and management of hazardous, low-level radioactive, and mixed wastes at an offsite facility were also eliminated because of increased environmental and human health risks due to the transportation of wastes (ERDA, 1977) as well as the uncertainties associated with SRP operational dependence on the continued availability and capacity of offsite waste disposal sites (see Chapter 1).

2.1.6 EIS DECISIONS AND NEPA DOCUMENTATION

Table 2-2 presents the decisions that will be based on this EIS, regulatory interactions related to this EIS, and other SRP waste management NEPA documentation. Only those activities in the first column will be included in the Record of Decision (ROD) for this EIS. Other activities and NEPA documents will be tiered or referenced to this EIS as part of ongoing NEPA documentation activities. These documentation activities are not part of the ROD for this EIS, but will be based on regulatory agency interactions.

J-1 The environmental effects of high-level radioactive waste (HLW) management were not assessed in this EIS, but are discussed in Waste Management Operations, Savannah River Plant FEIS (ERDA 1537); a supplement to ERDA 1537, Double-Shell Tanks for Defense High-Level Radioactive Waste Storage (DOE/EIS-0062); Long Term Management of Defense High-Level Radioactive Wastes (Research and Development Program for Immobilization (DOE/EIS-0023); and the Defense Waste Processing Facility FEIS (DOE/EIS-0082). Records of Decision have been published for all of the EISs cited above, except ERDA 1537.

J-1 DOE has prepared an environmental assessment (DOE/EA-0315) on the continued disposal and retrievable storage of transuranic (TRU) wastes. The alternatives were not analyzed in this EIS; however, source terms of TRU waste disposed of in the burial ground (643G) were factored into the analysis.

2.2 EXISTING WASTE SITES

Table 2-3 exhibits the current status of existing waste sites (i.e., solid and radioactive waste sites) that fall within the scope of this EIS and how they relate to current waste regulations. Several interim status sites are included in the table (as they are in Table 6-1), even though they are not within this scope of the EIS.

Potential CERCLA sites are those that are known to be inactive after November 19, 1980. They include both potentially hazardous sites and potentially mixed waste sites as defined in this EIS. One site, the D-Area Oil Seepage Basin, is potentially hazardous under SCHWMR but not under Federal (RCRA) regulations. TC

Known releases are those concentrations of hazardous constituents that exceed the higher of background or Table I values (40 CFR 264, 94(a)) at the point of compliance. Release does not include radionuclides, hazardous constituents detected in soil or groundwater within a site boundary (fenceline), or any substance migrating directly to surface water or air.

Additional information related to these sites is given in Appendixes B and F on a site-by-site basis and in the following sections as related to waste management strategies.

Under the alternative strategies discussed in Section 2.1, DOE could take four of the following possible actions at existing waste sites that contain or might contain hazardous, low-level radioactive, and mixed waste:

- No removal of waste at existing waste sites, and no closure or remedial actions (no action)
- No removal of waste at existing waste sites, and implementation of cost-effective closure and remedial actions as required (dedication)
- Removal of waste to the extent practicable from all existing waste sites, and implementation of cost-effective closure and remedial actions as required (elimination)
- Removal of waste to the extent practicable at selected existing waste sites, and implementation of cost-effective closure and remedial actions as required (combination)

The following sections describe existing SRP waste sites that contain or might contain hazardous, low-level radioactive, and mixed wastes, and the project-specific actions that DOE could take under each strategy.

2.2.1 EXISTING WASTE SITES CONSIDERED

Operations on the SRP result in the generation of hazardous wastes; low-level radioactive wastes; mixed wastes, which contain both hazardous and radioactive materials; and other solid wastes such as sanitary and domestic wastes and rubble.

At the SRP, 168 waste sites have been or are being used for the disposal or storage of wastes. This section considers 77 of these 168 sites in detail as existing waste sites. Six active reactor seepage basins and the K-Area containment basin receive periodic low-level radioactive discharges from the disassembly basins at C-, K-, and P-Reactor. These basins are considered in Section 2.4, which examines the alternatives for managing disassembly-basin purge water. The L-Reactor seepage basin was analyzed in the Final EIS for L-Reactor operation. The remainder of the 168 waste sites contain sanitary waste, solid waste, and/or rubble, or are otherwise not appropriate for consideration in this EIS (see Appendix B). No decision is made in this EIS on waste management activities for the remaining existing waste sites.

The 77 waste sites that are considered in detail consist of 37 sites that have or might have received hazardous waste, 19 sites that have or might have received low-level radioactive waste, and 21 sites that have or might have received mixed waste. In general, these 77 sites are near the facilities from which they receive wastes. This results in several clusters, or groupings, of waste sites rather than individual sites distinctly separated from each other.

Because actions taken at a waste site, including groundwater withdrawal, might affect the groundwater transport of waste in other sites, a conservative boundary of influence was calculated for each waste site based on the planned actions, extent of data availability, and type of waste (Du Pont, 1984a). The intersection and overlapping of the individual waste site boundaries led to the identification of ten geographic groupings of waste sites and two miscellaneous areas - each containing a single waste site - where actions taken for waste sites in one geographic grouping would not be expected to interact with actions taken in another grouping. Figure 2-2 shows the ten geographic groupings and two miscellaneous areas.

Table 2-4 lists the waste sites within each of the ten geographic groupings and the miscellaneous areas. This table also indicates, for each of the 77 waste sites, the potential category of waste that is or might be contained in the site and if the site is currently receiving waste material. The 77 waste sites listed in Table 2-4 are characterized in Appendix B, together with a brief description of other waste sites not considered in this EIS. TE

2.2.2 ALTERNATIVE STRATEGIES FOR EXISTING WASTE SITES

This section summarizes the four project-specific actions that DOE could take for the waste sites listed in Table 2-4. Each action is included in one of the alternative strategies discussed in Section 2.1. TE

The details for each project-specific action are preliminary, presented for the purpose of approximating its costs and environmental consequences. Specific actions such as the selection of sites for waste removal (see Section 2.2.2.4), the volume of waste removed, site capping, or groundwater remedial

TE

Table 2-4. Existing Waste Sites by Geographic Grouping

	Waste sites	Building	Receiving waste	Potential category[a]
		A- AND M-AREAS		
1-1[b]	716-A motor shop seepage basin	904-101G	No	Hazardous
1-2	Metals burning pit	731-4A	No	Hazardous
1-3	Silverton Road waste site	731-3A	No	Hazardous
1-4	Metallurgical laboratory basin	904-110G	No	Hazardous
1-5	Miscellaneous chemical basin	731-5A	No	Hazardous
1-6	A-Area burning/rubble pit	731-A	No	Hazardous
1-7	A-Area burning/rubble pit	731-1A	No	Hazardous
1-8	SRL seepage basin	904-53G	No	Mixed
1-9	SRL seepage basin	904-53G	No	Mixed
1-10	SRL seepage basin	904-54G	No	Mixed
1-11	SRL seepage basin	904-55G	No	Mixed
1-12	M-Area settling basin	904-51G	No	Mixed
1-13	Lost Lake	904-112G	No	Mixed
		F- AND H-AREAS		
2-1	F-Area acid/caustic basin	904-74G	No	Hazardous
2-2	H-Area acid/caustic basin	904-75G	No	Hazardous
2-3	F-Area burning/rubble pit	231-F	No	Hazardous
2-4	F-Area burning/rubble pit	231-1F	No	Hazardous
2-5	H-Area retention basin	281-3H	No	Low-level radioactive
2-6	F-Area retention basin	281-3F	No	Low-level radioactive
2-7	Radioactive waste burial ground	643-7G	Yes	Low-level radioactive
2-8	Mixed-waste management facility	643-28G	No	Mixed
2-9	Radioactive waste burial ground	643-G	No	Mixed
2-10	F-Area seepage basin	904-41G	Yes	Mixed
2-11	F-Area seepage basin	904-42G	Yes	Mixed

Footnotes on last page of table.

TE

Table 2-4. Existing Waste Sites by Geographic Grouping (continued)

	Waste sites	Building	Receiving waste	Potential category[a]
2-12	F-Area seepage basin	904-43G	Yes	Mixed ✓
2-13	F-Area seepage basin (old)	904-49G	No	Mixed ✓
2-14	H-Area seepage basin	904-44G	Yes	Mixed ✓
2-15	H-Area seepage basin	904-45G	Yes	Mixed ✓
2-16	H-Area seepage basin	904-46G	No	Mixed ✓
2-17	H-Area seepage basin	904-56G	Yes	Mixed ✓
		R-AREA		
3-1	R-Area burning/rubble pit	131-R	No	Hazardous
3-2	R-Area burning/rubble pit	131-1R	No	Hazardous
3-3	R-Area acid/caustic basin	904-77G	No	Hazardous
3-4	R-Area Bingham pump outage pit	643-8G	No	Low-level radioactive
3-5	R-Area Bingham pump outage pit	643-9G	No	Low-level radioactive
3-6	R-Area Bingham pump outage pit	643-10G	No	Low-level radioactive
3-7	R-Area seepage basin	904-57G	No	Low-level radioactive
3-8	R-Area seepage basin	904-58G	No	Low-level radioactive
3-9	R-Area seepage basin	904-59G	No	Low-level radioactive
3-10	R-Area seepage basin	904-60G	No	Low-level radioactive
3-11	R-Area seepage basin	904-103G	No	Low-level radioactive
3-12	R-Area seepage basin	904-104G	No	Low-level radioactive
		C- AND CS-AREAS		
4-1	CS burning/rubble pit	631-1G	No	Hazardous
4-2	CS burning/rubble pit	631-5G	No	Hazardous
4-3	CS burning/rubble pit	631-6G	No	Hazardous
4-4	C-Area burning/rubble pit	131-C	No	Hazardous
4-5	Hydrofluoric acid spill area	631-4G	No	Hazardous
4-6	Ford Building waste site	643-11G	No	Low-level radioactive
4-7	Ford Building seepage basin	904-91G	No	Mixed

Footnotes on last page of table.

Table 2-4. Existing Waste Sites by Geographic Grouping (continued) TE

	Waste sites	Building	Receiving waste	Potential category[a]
	TNX-AREA			
5-1	D-Area burning/rubble pit	431-D	No	Hazardous
5-2	D-Area burning/rubble pit	431-1D	No	Hazardous
5-3	TNX burying ground	643-5G	No	Low-level radioactive
5-4	TNX seepage basin (old)	904-76G	No	Mixed
5-5	TNX seepage basin (new)	904-102G	Yes	Mixed
	D-AREA			
6-1	D-Area oil seepage basin	431-D	No	Hazardous
	ROAD A AREA			
7-1	Road A chemical basin	904-111G	No	Mixed
	K-AREA			
8-1	K-Area burning/rubble pit	131-K	No	Hazardous
8-2	K-Area acid/caustic basin	904-80G	No	Hazardous
8-3	K-Area Bingham pump outage pit	643-1G	No	Low-level radioactive
8-4	K-Area seepage basin	904-65G	No	Low-level radioactive
	L-AREA			
9-1	L-Area burning/rubble pit	131-L	No	Hazardous
9-2	L-Area acid/caustic basin	904-79G	No	Hazardous
9-3	CMP pit	080-17G	No	Hazardous
9-4	CMP pit	080-17.1G	No	Hazardous
9-5	CMP pit	080-18G	No	Hazardous
9-6	CMP pit	080-18.1G	No	Hazardous
9-7	CMP pit	080-18.2G	No	Hazardous
9-8	CMP pit	080-18.3G	No	Hazardous
9-9	CMP pit	080-19G	No	Hazardous

Footnotes on last page of table.

TE

Table 2-4. Existing Waste Sites by Geographic Grouping (continued)

Waste sites		Building	Receiving waste	Potential category[a]
9-10	L-Area Bingham pump outage pit	643-2G	No	Low-level radioactive
9-11	L-Area Bingham pump outage pit	643-3G	No	Low-level radioactive
9-12	L-Area oil and chemical basin	904-83G	No	Mixed
		P-AREA		
10-1	P-Area burning/rubble pit	131-P	No	Hazardous
10-2	P-Area acid/caustic basin	904-78G	No	Hazardous
10-3	P-Area Bingham pump outage pit	643-4G	No	Low-level radioactive
		MISCELLANEOUS AREAS		
11-1	SRL oil test site	080-16G	No	Hazardous
11-2	Gunsite 720 rubble pit	N80,000; E27,350[c]	No	Hazardous

---

[a] This EIS uses the terms "hazardous," "low-level radioactive," and "mixed" (i.e., hazardous and low-level radioactive) in their most common sense, without specific regard to technical or regulatory definitions, unless indicated.

[b] The numbering system arbitrarily identifies the geographic group and each site within that group. For example, site 1-1 represents the first site in the first geographic group.

[c] No building number; located by SRP map coordinate system.

actions, if any, would be based on detailed site-specific modeling, actual monitoring results, and decisions resulting from regulatory interactions.

Section 4.2 describes the potential environmental consequences associated with these actions at existing waste sites; Appendix F describes them in more detail on a site-by-site basis.

2.2.2.1 No Action

Under the No-Action strategy, waste removal, closure, and remedial actions would not take place on the SRP, but measures considered necessary to protect the offsite environment would continue. More specifically, waste sites would be maintained for erosion protection, weed control, and grass mowing; additional groundwater monitoring wells would be installed; existing and new wells would be monitored; and fences would be installed where necessary to exclude animals and unauthorized personnel. The ongoing program to remove volatile organics from the groundwater in the Tertiary (shallow) sediments in M-Area through a system of recovery wells routed to an air stripper would continue. The monitoring and protective activities described for No Action would also be included in the closure and remedial actions described in Sections 2.2.2.2 through 2.2.2.4.

Under No Action, some hazardous and radioactive constituents would exceed applicable standards in the groundwater in the Tertiary sediments, and would not comply with current groundwater-protection requirements. Small supply wells could be screened into these aquifers after the period of institutional control, when most constituents in the groundwater would have decayed or dispersed to concentrations that would be below regulatory, human health, and environmental concern. Dedication of the existing waste sites and areas where groundwater constituents were still above these levels of concern would be necessary to ensure the protection of human health and the environment.

While No Action would have cost advantages and reduced occupational risks, it would not comply with current groundwater protection requirements and could render parts of the SRP unsuitable for public use after the 100-year institutional control period. Table 2-5 lists details assumed for the purpose of assessing the No-Action strategy. TE

2.2.2.2 Dedication

Using the Dedication strategy, releases of hazardous substances from existing waste sites would be controlled through the closure of such sites (if not already closed). Groundwater corrective actions (such as recovery, treatment, and installation of barrier walls or grout curtains) could be implemented to control groundwater contaminant plume migration. Dedication of those sites and contaminated areas that could not be returned to public use after a 100-year institutional control period would be required for waste management purposes; about 300 acres of SRP land would be involved. TC

Under the Dedication strategy, existing basins that have not previously been filled would be backfilled after dewatering. Wastes and sludges would be stabilized and impermeable barriers (caps) would be installed as required. Berms or other structures to prevent runon or runoff would be installed as required. Preliminary cost estimates and modeling of contaminant transport are based on the assumptions identified in Table 2-6. TE

Preliminary modeling indicates that the number of remedial actions that could be required under the Dedication strategy would be greater than those required under a strategy that included waste removal. Chapter 4 presents predicted concentrations of contaminants.

The primary disadvantages of this strategy are the extent of groundwater remediation potentially required and the need to dedicate the waste sites for waste management purposes. This strategy, however, would have significant advantages over the Elimination strategy (Section 2.2.2.3) with respect to cost, terrestrial ecology impacts, and occupational risks.

2.2.2.3 Elimination

The Elimination strategy includes removal of hazardous, low-level radioactive, and mixed waste (including contaminated soil) from all existing waste sites to the extent practicable and the closure of each site (see Section 2.2.2.2). After a maximum 100-year institutional control period, these areas could be returned to public use. Further remedial actions to control the migration of hazardous and radioactive substances from some sites would be required.

Table 2-7 lists preliminary estimates of the volumes of contaminated soil and waste and the costs of removal and closure. When the mixed and low-level burial grounds are included, approximately 3.2 million cubic meters of waste and potentially contaminated soil are contained in the existing waste sites. Without the burial grounds, the volume totals approximately 214,000 cubic meters. After waste removal, all sites would be backfilled, and the waste, contaminated soil, and some additional potentially contaminated soil would be transported to an acceptable onsite storage or disposal facility (see Section 2.3).

TE
TC

This strategy would require the fewest groundwater corrective actions, if any. Predicted concentrations of contaminants are presented in Chapter 4.

The primary advantages of this strategy are that the removal of waste and subsequent closure and remedial actions would eliminate the waste sites, the need to dedicate these areas for waste management purposes, and their monitoring after closure. Significant disadvantages include the extremely high cost of removing, transporting, and disposing of or storing the waste in a new disposal or storage facility; the potential adverse effects on the terrestrial ecology during these activities; and significant occupational risks primarily due to transportation accidents and worker exposure to radioactive substances during waste removal activities.

TE
TE

2.2.2.4 Combination

Under the Combination strategy, wastes (including contaminated soil) would be removed from existing waste sites selected on a basis of environmental and human health benefits and cost-effectiveness, and all sites would be closed. The areas from which waste had been removed could be returned to public use after the institutional control period. Sites from which waste was not removed would be dedicated for waste management purposes if they were not suitable for public use after the institutional control period. Releases from existing waste sites would be controlled through closure (as described in Section 2.2.2.2), with or without waste removal, and applicable requirements would be met. Groundwater corrective actions could be required in addition to closure to control groundwater contaminant plume migration.

Sites where preliminary modeling indicates that significant reductions in groundwater contaminants would occur as a result of waste removal include the old F-Area seepage basin and the six R-Area seepage basins. Transport modeling predicts that the concentrations of contaminants in the groundwater at those sites would be reduced extensively (e.g., by factors of 15 and greater) due to waste removal. This strategy assumes, for cost and assessment purposes, waste removal at these sites. The other 70 sites are assumed to receive the same closure actions as the Dedication strategy described in

TE

Section 2.2.2.2. Required groundwater corrective action under this option could be less than that required for the no-waste-removal action because of the removal of waste at the selected sites.

Table 2-8 lists parameters for sites under the Combination strategy. Approximately 12,500 cubic meters of waste and potentially contaminated soil are contained in the selected sites; this equals approximately 6 percent of the total volume of waste and contaminated soil contained in existing waste sites, excluding the mixed and low-level burial grounds. The excavated waste, contaminated soil, and some additional potentially contaminated soil would be transported to an acceptable onsite storage or disposal facility (see Section 2.3).

TE

TC

The magnitude of remedial actions potentially required probably would not be significantly greater than that of the Elimination strategy (removal at all sites), and less than that of no removal. Modeling predicts that the concentration of uranium-238 would be reduced by a factor of 15 by removal of waste from the old F-Area seepage basin. Concentrations of strontium-90 and yttrium-90 would be reduced by a factor of 100 by removal of waste at the R-Area seepage basins.

In comparison with the Elimination strategy, the Combination strategy significantly reduces the cost, ecological impacts, occupational hazards, and new storage/disposal capacity requirements of waste removal. Its primary disadvantage is that DOE would have to dedicate for waste management purposes those sites where waste had not been removed and that were not suitable for public use after the 100-year institutional control period.

2.3 NEW DISPOSAL/STORAGE FACILITY STRATEGIES

Section 2.1 describes the alternative waste management strategies for SRP waste management activities. Each of the alternative strategies includes a disposal and storage alternative that, in turn, includes one or more project-specific actions. This section describes these actions and the manner in which they can be combined as part of the selected strategy.

2.3.1 PROJECT-SPECIFIC TECHNOLOGIES

The Notice of Intent (NOI) to prepare this EIS (DOE, 1985) listed five alternatives for hazardous, mixed, and low-level radioactive waste facilities. Project-specific technologies derived from these five alternatives provide the basis for the waste management strategies. Table 2-9 lists the alternatives and their corresponding technologies.

TE

Requirements under RCRA, HSWA, and DOE Orders cover all aspects of waste management, including the siting of facilities, facility design, facility permits and operations, limits on the release of waste constituents from facilities, design requirements for waste containers, leak detection systems, leachate recovery systems, runoff and runon control systems, liners, waste segregation, and waste acceptance. These site-specific, project-specific actions will be addressed in future planning and in response to the regulatory permitting and decisionmaking processes that will ensure that new facilities meet all

TE Table 2-9. NOI Alternatives and Corresponding Technologies

NOI Alternative[a]	Technology	Waste Applications
Retrievable storage	Storage buildings	Hazardous, mixed, or low level
Shallow land disposal	RCRA landfill	Hazardous or mixed
	Belowground vault (RCRA)	Hazardous or mixed
	CFM[b] vault	Mixed
	Engineered low-level trench	Low level
	Belowground vault (DOE)	Low level
	GCD trench	Low level
	GCD borehole	Low level
Aboveground disposal	Aboveground vault (RCRA)	Hazardous or mixed
	Aboveground vault (DOE)	Low level
	Abovegrade operation	Low level
Combination	All of the above	As applicable
No action	No new facilities	Hazardous, mixed, or low level

TC

[a] NOI-Notice of Intent to prepare this EIS (50 FR 16534)
[b] Cement/flyash matrix (solidification)

applicable requirements. To provide DOE an environmental basis for selecting a waste management strategy, this EIS describes the technologies for new facilities and presumes that they are designed to comply with all applicable requirements.

TC The following sections describe each technology in terms of its function and features. These descriptions do not include such design details as construction materials, dimensions, and siting, because site-specific details to achieve regulatory compliance will be developed during the permitting process. The descriptions focus on the basic capabilities, long-term reliability, and effectiveness of each technology for waste management as it applies to each alternative strategy.

2.3.1.1 Storage Buildings

Storage buildings are being considered for retrievable storage of hazardous, mixed, and low-level radioactive wastes. They would be used to hold containerized wastes safely and securely for as long as 20 years. The design would include segregation of noncompatible hazardous wastes; radiation shielding as necessary; liquid recovery drains and alarmed sumps; smoke, fire, vapor, and radiation detection systems; ventilation systems; and automatic fire extinguishing systems. Operational controls would include site security, periodic inspections of the waste containers and the facility, personnel training, emergency preparedness and procedures, and recordkeeping.

2.3.1.2 RCRA Landfill

The RCRA landfill is being considered for hazardous and mixed waste disposal. It would employ a double-lined (primary and secondary liners) trench with double leachate-collection systems (above the primary liner and between the primary and secondary liners). Figure 2-3 shows two liner systems. Waste in containers would be stacked in the trench. As it is filled, the trench would be covered by a membrane sealed to the primary liner to form a watertight envelope. A low-permeability cap over the facility would divert percolating water laterally away from the closed trench.

The landfill would not contain an engineered structure; it would rely on the sides of the trench, on the waste containers, and on fill soil for stability. Placement below the surface of the ground would provide all necessary radiation shielding (for mixed waste) following closure.

When sited, designed, and operated in accordance with RCRA regulations, this type of hazardous and mixed waste disposal should provide many decades of reliable service. The primary leachate-collection system would provide warning and a means of recovering the waste if the containers failed. The secondary leachate-collection system would provide warning and the means to recover the wastes if the primary liner failed. If a secondary liner of clay were employed, its design would delay leachate penetration for at least 30 years (EPA, 1985). Although the hazardous and mixed wastes being disposed of could outlast the disposal facilities described in this EIS, the integrated systems would provide the early warning necessary to take mitigative action so that releases to the environment would not occur (i.e., zero release).

2.3.1.3 RCRA Vault

DOE is considering the use of RCRA-type vaults (vaults that comply with RCRA) for the disposal of hazardous and mixed waste at SRP. A typical hazardous or mixed waste disposal vault is a building-size, watertight, reinforced-concrete box set on or below the ground surface. An exterior leachate-collection system and secondary liner envelop the bottom of the facility. An interior liner and leachate-collection system are within the concrete structure. Figure 2-4 shows an arrangement of barriers used in this technology. TE

Containerized wastes would be segregated and stacked in the chambers of the facility. Empty spaces could be filled with sand or grout, and the facility would be sealed by a sloped, reinforced-concrete roof. If the facility were constructed belowground, it would then be covered with soil to grade. If aboveground, it could remain exposed or be mounded with soil to provide additional radiation shielding.

Vaults rely on the waste containers, the interior and exterior leachate-collection systems, and the concrete structure to ensure long-term isolation of wastes and no releases to the environment.

2.3.1.4 Cement/Flyash Matrix Vault

The cement/flyash matrix (CFM) vault is a technology for the disposal of selected mixed wastes. This technology involves segregating the mixed waste sludge from such facilities as the M-Area effluent treatment facility (ETF), the F- and H-Area ETF, the Fuel Production Facility (FPF), and the Naval Fuel Materials Facility wastewater treatment plant, plus ash from incinerators in which hazardous, mixed, and low-level radioactive waste might have been burned. These wastes would be blended into a cement/flyash matrix and discharged as a slurry directly into reinforced-concrete vaults, where it would cure to a hard, concrete-like substance. This solidification process TC should render the waste nonhazardous and eligible for possible delisting under TE RCRA regulations. DOE is also considering blast furnace slag as a component in the stabilization of wastes.

The CFM vault technology differs from the RCRA-type vault in that it would contain no liners and no leachate-collection system. Instead, this technology would rely on the solidification of the waste in conjunction with the concrete structural barrier to preclude the release of waste constituents and maintain environmental standards. Failure to obtain delisting for the solidified waste under RCRA would eliminate this disposal technology. Although cement/flyash solidification could remain as a predisposal treatment, the disposal facilities would have to meet RCRA minimum technology requirements.

2.3.1.5 Engineered Low-Level Trench

DOE is considering the engineered low-level trench (ELLT) for the disposal of low-activity (less than 300 millirem per hour), low-level radioactive waste. The trench would have a crushed-stone floor on which containerized wastes would be stacked. The empty spaces between the containers would be filled and the trench covered. A low-permeability cap above the waste would divert percolating water away from the containers. The cap would be covered with soil to grade for protection, and the surface would be contoured to channel the runoff away from the site.

The low-activity portion of the low-level radioactive waste stream which would be disposed of using ELLTs would account for approximately 95 percent of the TC waste by volume but would contain less than 2 percent of the radioactivity (Cook, Grant, and Towler, 1987). With the relatively low radioactivity of this waste, ELLTs would require no engineered structure, liners, or leachate-collection systems. Rather, this technology would rely on appropriate site conditions, waste containers, a low-permeability cap, and postclosure site maintenance to minimize the intrusion of water into the closed trench and to prevent excessive migration of radionuclides into the environment.

2.3.1.6 Low-Level Waste Vault

Vault technology (other than that for RCRA vaults) that complies with DOE Orders is also being considered for disposal of low-level, low-activity (less than 300 millirem per hour) and intermediate-activity (greater than 300 millirem per hour) radioactive waste. A typical low-activity vault would consist of a building-size, reinforced concrete box set on or below the surface of the ground. Containerized wastes would be closely packed in the vault and, when filled, the vault would be closed with a concrete cap or roof. The vault would be covered with soil to grade for the belowground design or mounded with soil for the aboveground design to provide added shielding (Cook, Grant, and Towler, 1987).

As with the ELLT, the relatively low radioactivity of this waste would permit a design requiring no liners or leachate-collection system. Suitable performance would be achieved through proper siting, waste containers, and a sealed concrete structure to minimize the intrusion of water and the migration of radionuclides.

The design of the vault for intermediate-activity waste could be similar to that for the low-activity vault except that it could include an exterior, low-permeability liner and leachate-collection system. Increased stability could be achieved by structural design or by filling any empty spaces in the interior with a suitable material prior to closure (Cook, Grant, and Towler, 1987).

2.3.1.7 Abovegrade Operation

DOE is considering abovegrade operation (AGO) for the disposal of low-activity, low-level radioactive waste. This technology would consist of a stable stack of waste-filled containers enclosed within a low-permeability membrane. It would be situated on a subbase of clay or other low-permeability material and would include interior and exterior leachate-collection systems.

Containerized waste would be stacked in the prepared facility. Empty spaces would be filled with sand to improve stability and minimize subsidence. When the stack was completed, it would be mounded with additional sand and sealed with a cover membrane. The entire mound would then be covered with soil and stabilized with vegetation.

AGO technology involves no engineered structure, but derives its structural stability from the arrangement and integrity of the waste containers. The contoured shape, low-permeability membrane enclosure, high-integrity containers, and double leachate-collection systems would effectively prevent migration of radionuclides from the low-activity waste into the surrounding environment.

2.3.1.8 Greater Confinement Disposal

DOE is considering GCD technologies (boreholes and trenches) for the disposal of low-level, intermediate-activity radioactive waste (greater than 300 millirem per hour).

In a typical design, a large hole about 3 meters in diameter would be bored to a depth of 9 or 10 meters. After a leachate-collection system was installed, the lower 6 meters would be lined with concrete and an interior liner of fiberglass. Containerized wastes would be placed in the lined hole, and any empty spaces would be filled with grout. A concrete cover would seal the waste inside the cylindrical capsule. Closure would include construction of a low-permeability cap to divert percolating water and surface contouring to channel runoff away from the facility.

GCD trenches would have the same shielding and stability objectives as boreholes. A typical design would consist of a concrete-lined trench divided into cells and underlaid by a leachate-collection system. Containerized or bulk waste would be placed in the cells and grouted in place. When filled, the cells would be sealed by a concrete cover. A low-permeability cap and surface contouring would be added.

GCD technology would rely on a combination of several features to prevent migration of radionuclides from the facility. These would include proper siting, a sealed concrete structure, grout encapsulation of waste in place, a low-permeability cap, and a leachate-collection system.

2.3.2 WASTE VOLUMES

This section describes the waste and contaminated material generated on the SRP that require treatment and disposal or storage. Appendix E describes in more detail the types and potential quantities of waste generated.

The SRP generates five types of waste:

- Hazardous waste
- Low-level radioactive waste
- Mixed waste (combined hazardous and low-level radioactive wastes)
- High-level radioactive [including transuranic (TRU)] waste
- Nonhazardous and nonradioactive waste

This EIS considers only the first three preceding waste types; the others have been considered in other NEPA documents. These waste materials are derived from plant operations, maintenance, and planned renovations; from waste held in storage pending treatment or disposal before the startup of new facilities; and contaminated materials from closure or remediation activities at existing waste sites.

Liquid, solid, and semisolid operations waste is generated by plant processes; by maintenance, renovation, and demolition of facilities; and by offsite defense facilities. Interim-storage waste is liquid, solid, and semisolid waste held in storage, pending the startup of new treatment or disposal facilities. Closure-action waste includes contaminated soil or soil-waste mixtures exhumed in the remediation or closure of existing waste sites.

Hazardous, mixed, and low-level radioactive wastes generated at SRP include:

- Hazardous and mixed waste combustible oils, solvents, and solids

- Mixed and low-level radioactive solvents, scintillation solutions, contaminated equipment, building rubble, and job control waste

- Mixed waste sludges from effluent-treatment facilities

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

- Hazardous, mixed, and low-level radioactive waste exhumed from existing waste sites, including contaminated soil

Treatment by effluent treatment facilities using ion exchange, reverse osmosis, neutralization, and filtration to detoxify SRP waste streams is ongoing or planned. In this EIS, this activity is considered "operations." The residuals from these treatment operations are among the wastes considered in this EIS.

All hazardous, mixed, and low-level radioactive wastes are suitable for the application of one or more predisposal treatment technologies. "Predisposal treatment" is the treatment of waste before storage or disposal, to reduce volume or alter the chemical or physical characteristics of the waste, rendering it less toxic or more stable.

The following predisposal technologies could be applied to SRP wastes prior to storage or disposal:

- Incineration - Reduces volume, destroys certain hazardous constituents, and chemically stabilizes combustible wastes or a combustible fraction. Shredding might be used before incineration.
- Compaction - Reduces volume for compressible wastes; sometimes used in conjunction with shredding.
- Evaporation - Reduces volume and physically stabilizes by removing water or other volatile liquid from a waste until a dry salt remains.
- Solidification - Chemically and physically stabilizes by incorporating waste materials in an insoluble solid or crystalline matrix such as grout or concrete.
- Encapsulation - Physically stabilizes waste by enclosing it in a jacket or membrane of impermeable, chemically inert, water-resistant material; increases the disposal volume.

Predisposal treatment substantially affects the volume of waste to be disposed of as well as its characteristics.

Waste volumes and characteristics are important considerations in the design and sizing of a waste management facility. Project-specific details, to be developed during a later stage of planning in conjunction with the regulatory permitting process, could have a substantial effect on waste disposal and storage volumes. These details include the following:

TE

- Existing waste sites at which removal actions are to occur
- Determinations based on site field testing and examination of the quantity of waste and/or contaminated soil to be removed to a hazardous, mixed, or low-level facility
- The future availability or integration of predisposal treatment technologies into the management of SRP wastes (see Appendix D)

This EIS describes maximum and minimum waste volumes from assumptions regarding waste removal from existing sites and the volume reduction or expansion effects of predisposal treatment. Table 2-10 lists the estimated 20-year minimum and maximum volumes of waste as generated.

2.3.3 ALTERNATIVE TECHNOLOGICAL STRATEGIES

TC The waste management strategies - Dedication, Elimination, and Combination - could be carried out using different technologies. The basis for determining the magnitude of environmental impacts is limited to those technologies described in Section 2.3.1, the range of disposal and storage volume capacities (Table 2-10), and assumptions on the use and effects of predisposal treatment. There is a range of environmental impacts associated with the implementation of each strategy as defined in this EIS (Chapter 4). If an alternative strategy with a higher environmental impact and/or minimum technology will continue to ensure regulatory compliance and an acceptable level of environmental protection, then all other strategies which result in reduced environmental impacts would be acceptable as well. Table 2-11 lists the waste management strategies and their associated technologies (see Sections 2.3.3.1, 2.3.3.2, 2.3.3.3, and 2.3.3.4).

With new waste management facilities, the chosen strategy would involve planning to determine the relationships between waste generators and storage, treatment, and disposal facilities. Planning during the regulatory-permitting process would ensure that designs meet applicable regulations and achieve environmental compliance.

TE The following sections describe each strategy in terms of volume capacity requirements, costs, and major advantages and disadvantages. Cost estimates are based on current planning. Cost ranges are provided only as an indication of the magnitude of potential costs of a strategy, along with a list of additional cost considerations (Moyer, 1987). Detailed costing would be developed during the planning for the implementation of the chosen strategy. (See Appendix E.)

2.3.3.1 No Action

The No-Action strategy, the inclusion of which in this EIS is required by NEPA regulations, discloses the consequences of not constructing new facilities to accommodate future waste management needs. Under this strategy, the SRP would continue to operate and generate wastes, meaning that applicable regulations and criteria would not be met. Current facilities would be used until capacity is reached, after which containerized waste would be stored indefinitely in existing structures, on existing pads, or in other secure and safe areas.

TC Under the No-Action strategy, the total estimated 20-year waste volume would be about 748,300 cubic meters.

TC Cost estimates for the No-Action strategy bracket the range of waste volume but do not reflect specific costs of the preparation and use of existing structures and areas for storage. These facilities have not been specifically identified or assessed for such use. The estimated waste-management costs for 20 years of the No-Action strategy would be about $102 million. Life-cycle costs cannot be estimated, but they would include the cost of continued storage or of waste retrieval, treatment, and disposal, including closure and postclosure costs of the disposal facility.

The major advantages of the No-Action strategy are a delay in future expenditures for waste-management facilities and the use of structures on the SRP that otherwise would remain unused.

The disadvantages of this strategy include an unquantified risk of potentially adverse releases of waste due to the lack of adequate waste management facilities. This lack of facilities would not comply with RCRA, DOE Orders, and other applicable regulations. The No-Action strategy is not "reasonable." Finally, no action would delay expenditures for waste management facilities and require a future investment in waste management.

2.3.3.2 Dedication

The Dedication strategy would involve waste management by construction and operation of waste disposal facilities (i.e., nonretrievable) as listed in Table 2-11. These technologies are described in Section 2.3.1. TE

Table 2-11 indicates that there are technologies for each waste category. To provide an environmental assessment (see Chapter 4), this section discusses impacts in terms of the most- and least-protective technologies. TC

For hazardous and mixed wastes, RCRA landfills and vault technology are considered equally capable of providing adequate groundwater protection. However, under the mixed waste category, CFM vault technology is potentially less protective of groundwater; it was, therefore, identified for environmental evaluation. TE

For low-level waste, the vault and GCD technologies for intermediate-activity waste disposal were considered equally protective of groundwater. TE Among the technologies for low-activity waste disposal, the ELLT technology was considered to be the least protective and was used in the evaluations of environmental impacts. TC

Dedication would allow the use of predisposal treatment for volume reduction, detoxification, and solidification. The total 20-year disposal volume, therefore, could range between about 290,400 and 837,700 cubic meters, depending on the predisposal treatments and the volume of waste removed from existing sites. TC

Cost estimates for the Dedication strategy include the waste volume and technologies described above. The 20-year costs are estimated to range from about $194 million to about $895 million, while the life-cycle costs, including postclosure monitoring and maintenance for as long as 100 years, would range from about $221 million to about $976 million. These costs do not include predisposal treatment, with the exception of the CFM vaults, in which cement/flyash solidification is an integral part of the disposal process. TC There is a cost tradeoff between predisposal treatment to reduce waste volume and the construction and operation of larger disposal facilities. The lower disposal cost estimate, which assumes predisposal treatment, is low by an amount equal to the cost of such treatment.

The major advantage of the Dedication strategy is that treated or untreated wastes would be disposed of permanently to comply with applicable regulations and environmental standards. The major disadvantages are that the facilities would be costly to construct and operate, the land for disposal would be dedicated in perpetuity, and, in the event of a failure, retrieval of waste packages could be difficult or impossible if practices such as in-place grouting have occurred.

2.3.3.3 Elimination

TE Waste management under the Elimination strategy would involve the construction and operation of retrievable storage facilities for all containerized wastes using storage buildings, as listed in Table 2-11 and described in Section 2.3.1. The objective would be to delay permanent placement in anticipation of improved future methods of treatment, recycling, or disposal.

The Elimination strategy could benefit from the use of predisposal treatment for volume reduction. However, the use of such treatment should not preclude future waste management options.

TC Wastes under this strategy would be derived from the removal and closure of all existing waste sites, SRP operations for 20 years, and the interim storage facilities currently being used. The estimated total 20-year storage volume would be 3,993,400 cubic meters (991,500 cubic meters if wastes derived from the burial grounds are excluded).

The estimated cost for the Elimination strategy ranges from about $1.09 billion to about $5.98 billion for 20 years of storage, without and including the mixed waste/low-level waste burial grounds, respectively. These costs do not include retrieval before the end of the 20-year operating period. Life-cycle costs cannot be estimated, but would include the cost of continued storage (beyond 20 years) or the cost of waste retrieval, treatment, and disposal, including closure and postclosure costs of the disposal facility.

TC The major advantages of the Elimination strategy would be that no land would be dedicated to waste disposal in perpetuity and that, if a failure occurs, waste recovery and retrieval would be relatively simple. The facilities would be permitted and operated to comply with applicable regulations and environmental standards.

The disadvantages of the Elimination strategy would be that the facilities would be costly to construct and operate, and the waste would not be destroyed, requiring additional expenditures for waste retrieval, treatment, and disposal.

2.3.3.4 Combination

TE While the management of all waste by either disposal (Dedication) or storage (Elimination) is feasible, the management of specific wastes might be made more economical, more technologically feasible, or more environmentally reliable by using elements of each of these strategies. Waste management under the Combination strategy would include the best mix of the disposal and TE storage technologies listed in Table 2-11 (trenches, vaults, and storage facilities). Section 2.3.1 describes the technologies evaluated in this EIS.

Under the Combination strategy, predisposal treatment for volume reduction, detoxification, and solidification could aid the disposal operations. Compaction is the only predisposal treatment currently applicable to the storage part of waste management operations. Based on the mix of disposal and storage technologies, the application of predisposal treatment, and the volume of waste removed from existing waste sites, the 20-year total disposal/storage volume would range from about 305,100 to 855,700 cubic meters of treated and untreated waste. TC

Cost estimates for the Combination strategy include the waste volumes and technologies described above. The estimated 20-year costs would range from about $310 million to about $992 million. Life-cycle costs would range from about $333 million to about $1.03 billion, plus the cost of predisposal treatment. The life cycle costs shown do not include costs for removing waste from a storage facility to a permanent disposal facility. TC

The primary advantage of the Combination strategy is that it would use the best mix of technologies to optimize performance, recover and retrieve waste, minimize costs, and comply with applicable regulations and environmental standards. The major disadvantages are that some land would be dedicated to waste disposal in perpetuity, it would require future expenditures for treatment and disposal of stored wastes, and all of the facilities would be costly to construct and operate.

2.4 DISCHARGE OF DISASSEMBLY-BASIN PURGE WATER

SRP periodically purges water contaminated with radioactivity from the C-, P-, and K-Reactor disassembly basins, thereby reducing tritium concentrations in the reactor disassembly areas, to keep occupational exposures as low as reasonably achievable.

Disassembly-basin water becomes contaminated when tritium and other radionuclides are carried over in process water that adheres to the fuel and target assemblies, and when tritium, as water of hydration, is retained in aluminum oxide on the assemblies. Disassembly-basin water is recirculated through sand filters and deionizers to clarify it and to remove radionuclides; this process does not remove tritium, however, and small residues of other radionuclides also remain. The purge is not continuous, but occurs at a frequency that depends on the type of reactor assemblies and the frequency of assembly discharge operations; typically, the basins are purged twice yearly.

Currently, reactor disassembly-basin water is discharged to C- and P-Area seepage basins and to the K-Area containment basin. The K-Area basin effectively behaves as a seepage basin, and the following discussions treat it as such. Water discharged to the seepage basins either evaporates, carrying tritium to the atmosphere, or migrates to the shallow groundwater, which transports it laterally to outcrop areas along onsite surface streams.

Section 2.4.1 describes the waste management strategies evaluated for the discharge of disassembly-basin purge water.

2.4.1 WASTE MANAGEMENT STRATEGIES

DOE is considering the following strategies for the discharge of reactor disassembly-basin purge water:

- No Action, or continued discharge of disassembly-basin purge water to active reactor seepage and containment basins
- Dedication, the same as No Action
- Elimination, either evaporation of disassembly-basin water or direct discharge to onsite streams
- Combination (the preferred strategy), continued discharge of disassembly-basin purge water to active reactor seepage basins, and assessment of the applicability of mitigating measures such as moderator detritiation

The four following sections describe these strategies.

2.4.1.1 No Action

Under the No-Action waste management strategy, water discharged from reactor disassembly basins would continue to go to reactor area seepage basins. Approximately 30 percent of the tritium released to seepage basins would evaporate, and the remaining tritium and other radionuclides would seep into the groundwater. The other radionuclides would be retarded by adsorption and reduced by radioactive decay to insignificant amounts by the time they reached surface water. Tritium, however, would travel directly with the groundwater, decaying during the 4 to 11 years of subsurface transport to outcrops along surface streams. TE

2.4.1.2 Dedication

The Dedication strategy, like the No-Action strategy, would continue the current practice of periodically discharging disassembly-basin purge water to active reactor seepage and containment basins.

2.4.1.3 Elimination

The Elimination strategy would include evaporation of the disassembly basin purge water or direct discharge to onsite streams.

Purge water from the reactor disassembly basins could be evaporated with small, commercially available evaporators or with waste heat from the reactors. Tritium would be the only radionuclide released to the atmosphere. Liquid discharges to seepage basins would be discontinued. The only liquid releases to the environment would be residual seepage to streams of purge water released to seepage basins before the initiation of the evaporation process. TE

Small, commercially available equipment, consisting of a storage tank, filters, an evaporator, and a stack with a blower, could be installed in each reactor area. Disassembly-basin water would be purged into large storage tanks from which the water would be pumped through sand filters and ion-exchange beds to the evaporator. Steam would be used to heat the water, and the tritiated water vapor would be vented to a stack. Air would be added to dilute and disperse the vapor, which would be visible from the stack under all atmospheric conditions (Du Pont, 1984).

If reactor waste heat were used, lined evaporation ponds would be constructed in each reactor area. Disassembly-basin purge water discharged to these ponds would evaporate to the atmosphere, carrying tritium with it. Other radionuclides would not evaporate. Evaporation would be accelerated through the use of a grid of underwater pipes heated by waste heat from the area's reactor (Du Pont, 1984b).

As for direct discharge, disassembly-basin purge water, diluted with cooling water, could be discharged to nearby onsite streams. Evaporative losses to the atmosphere would be small. However, the main advantage of seepage-basin use, radioactive decay, would be lost. This would be especially significant for those radionuclides that have exceptionally long travel times. Concentrations of tritium and other radionuclides in onsite streams and the Savannah River would reach maximums during purges and drop to lower levels afterward.

2.4.1.4 Combination

The Combination waste management strategy includes continued assessment of mitigation measures and discharges of disassembly-basin purge water to seepage basins, as in the No-Action strategy. DOE has considered detritiation of heavy-water reactor moderator at a central facility as a means of mitigating tritium releases from the Savannah River Plant, including those from disassembly-basin discharges. A moderator-detritiation plant (MDP), constructed to process moderator from each SRP reactor, would effectively reduce equilibrium-moderator tritium concentrations. Because reactor moderator is the source of disassembly-basin-water contamination, a corresponding reduction in basin-water tritium concentrations, and therefore releases, would be expected.

2.5 SUMMARY AND COMPARISON OF ALTERNATIVE WASTE MANAGEMENT STRATEGIES

This section summarizes and compares the four alternative waste management strategies listed in Table 2-1. It encompasses the range of project-level strategies discussed in this EIS for existing waste sites, new disposal facilities, and disassembly-basin purge water. The No-Action strategy would continue current waste management practices and would not include the establishment of new disposal or storage facilities.

Table 2-12 compares the alternative waste management strategies, including the potential environmental impacts; capital, annual operating, lifetime maintenance and monitoring costs; and closure and postclosure costs where applicable. The table does not list schedules for implementation of any of the TE alternatives, including the preferred alternative, because of the need to establish priorities for implementation and to pursue further onsite studies and interactions with regulatory agencies. Final remedial and closure actions would be based on more detailed site-specific modeling and monitoring results and regulatory interactions. The strategy decision will precede any project-specific decisions.

DOE has identified the Combination waste management strategy as its preferred alternative. This strategy complies with applicable environmental regulations and guidelines through a combination of dedication at some existing waste sites and elimination of other selected waste sites, and combined storage and disposal of hazardous, low-level radioactive, and mixed wastes. DOE's preferred strategy is based on project-specific actions, including removal of wastes at selected existing waste sites; groundwater remedial and closure actions at existing waste sites, as required; construction of a combination of retrievable storage, aboveground, and belowground disposal facilities for hazardous, mixed, and low-level radioactive wastes; management of periodic discharges of disassembly-basin purge water from active reactors by discharging filtered, deionized disassembly-basin purge water to seepage and containment basins; and continuing evaluation of tritium-mitigation measures. Tables 2-13 and 2-14 list the project-specific actions for new waste disposal facilities and the discharge of disassembly-basin purge water, respectively.

The following sections provide summaries and more detailed comparisons of the ranges of environmental impacts and costs associated with each of the waste management strategies.

2.5.1 SUMMARY OF ALTERNATIVE WASTE MANAGEMENT STRATEGIES

2.5.1.1 No-Action Strategy

TE

Existing Waste Sites

The No-Action strategy would continue current activities for existing hazardous, low-level radioactive, and mixed waste sites. It would be inconsistent with DOE's policy of complying with all applicable requirements, including groundwater protection. Therefore, it is not considered a "reasonable" approach for those waste sites that are within the scope of this EIS.

New Disposal Facilities

The No-Action strategy would involve no new facilities, such as sites, buildings, landfills, vaults, engineered trenches, and boreholes. For the purposes of this analysis, DOE assumed that the SRP would continue to operate and generate wastes. Existing SRP facilities would be used until their capacities were reached, and then structures, pads, or areas with minimal preparation for indefinite waste storage would be used.

Due to the risk of environmental releases of waste, and because the waste management practices described for No-Action would not comply with applicable regulations, the No-Action strategy is not considered acceptable.

Discharge of Disassembly-Basin Purge Water

The No-Action strategy would continue the present practice of periodic discharges of disassembly-basin purge water to active reactor seepage and containment basins. This would allow retardation on soil and radioactive decay during travel through groundwater to reduce radioactive releases to the environment. The maximum individual and collective doses of the No-Action strategy would be low and would amount to a fraction of the dose from natural background radiation. Because seepage basins are already in use for this purpose, there would be no additional cost of implementation.

2.5.1.2 Dedication Strategy

Existing Waste Sites

Closure with no removal of waste (Dedication strategy) would have the least cost, the lowest occupational risks, and the least disturbance of terrestrial ecology. The Dedication strategy would have the greatest potential to require groundwater corrective action, and as many as 77 waste sites that were not suitable for public use after the institutional control period would have to be dedicated to waste management uses, involving about 300 acres of SRP land.

New Disposal Facilities

The Dedication strategy would involve deposition of hazardous, mixed, and low-level radioactive wastes in permanent disposal facilities constructed on or under the ground surface. Hazardous and mixed waste would be disposed of in above- or belowground double-lined vaults or RCRA-type landfills with double liners and leachate-collection systems and other features meeting the requirements of RCRA, HSWA, and DOE Orders. A technology applicable to a select portion of the mixed waste stream would involve solidification of the waste and discharge into cement/flyash matrix vaults. This technology assumes that the mixed waste can be rendered nonhazardous by solidification and delisted under RCRA. Low-level radioactive wastes would be disposed of in facilities meeting the requirements of DOE Orders, including ELLTs for low-activity wastes (less than 300 millirem per hour), in GCD for intermediate-activity wastes (greater than 300 millirem per hour), in a shielded above- or belowgrade vault, or by stacking contained wastes in an AGO constructed at grade on a pad without a building or vault. TE

Discharge of Disassembly-Basin Purge Water

The Dedication strategy for the discharge of disassembly-basin purge water would continue the current practice of discharging the purge water to active reactor seepage and containment basins.

2.5.1.3 Elimination Strategy

Existing Waste Sites

Removal of wastes at all waste sites (Elimination strategy) would involve high closure expense, occupational risks, disturbance of terrestrial habitat and associated wildlife, and cost of new retrievable storage facilities for the exhumed materials. No SRP land would be required for dedication to waste management uses, however, other than an outfall delta near the old TNX seepage basin.

New Disposal Facilities

The retrievable-storage alternative (Elimination strategy) encompasses technologies using structures designed to accommodate a specific type of waste (e.g., hazardous, mixed, and low-level waste). The retrievable-storage alternatives for hazardous and mixed wastes are similar in technology and would meet applicable standards. These facilities would be designed to achieve essentially zero releases, thereby producing no significant adverse environmental impacts. In the case of mixed waste, in addition to meeting RCRA requirements, they would shield radiation sources. The technologies for low-level waste would consist of engineered storage of waste with various degrees of isolation and shielding to accommodate different levels and types of radioactivity. These facilities would meet the ALARA requirements of DOE Orders. Waste would be removed from retrievable storage facilities in the future and transferred to disposal facilities. This action is not evaluated in this EIS.

Discharge of Disassembly-Basin Purge Water

Under the Elimination strategy, use of the active reactor seepage and containment basins would be discontinued and the purge water would be discharged directly to surface streams currently receiving purge water via outcrops or evaporated to the atmosphere. Although discharges to seepage basins would be discontinued immediately, releases to surface streams from residual seepage from prior use would continue for several years. The maximum individual dose from direct discharge would be low but would average about four times the corresponding no-action or the evaporation doses. The average collective dose for direct discharge would be more than double that of no action, while
TC evaporation would produce about one-third the no-action collective dose within defined regional population groups. The advantages of direct discharge are
TE ease of implementation, insignificant costs, and no need to dedicate the seepage basins and surrounding areas (Du Pont, 1984b).

2.5.1.4 Combination Strategy

Existing Waste Sites

The primary considerations in choosing the Combination strategy (the DOE-preferred alternative) are the reduced environmental effects and occupational risks from remedial and closure actions, the cost of remedial and closure actions, the capacity and cost of new storage and disposal facilities, and the amount of land, if any, that would be dedicated for waste management purposes at the end of the institutional control period. Costs presented do not include costs for transfer of wastes from storage facilities to disposal facilities.

Waste removal prior to closure is identified on a preliminary basis for those selected sites at which such removal is predicted to reduce significantly the peak concentrations of waste constituents in groundwater; other waste sites would be closed without waste removal and dedicated for waste management purposes. All sites would receive groundwater corrective actions as required.

This strategy would provide the same degree of environmental protection and produce fewer ecological and occupational risks at a substantially lower cost than the Elimination strategy. Substantially less land area would have to be dedicated for waste management purposes than under the Dedication strategy.

New Disposal Facilities

The Combination strategy for new disposal facilities would apply a combination of retrievable storage and aboveground or belowground disposal technologies. Its objective would be to optimize the management of wastes with different characteristics within the hazardous, mixed, and low-level radioactive waste streams generated at the SRP. This strategy would comply with the requirements of RCRA, HSWA, and DOE Orders.

The technologies available for shallow land disposal of hazardous, mixed, and low-level wastes involve permanent deposition of wastes below the ground surface. Hazardous and mixed waste facilities are required to meet RCRA and HSWA minimum technology standards, while low-level waste facilities must meet the technology standards under DOE Orders.

Discharge of Disassembly-Basin Purge Water

The Combination strategy includes continued discharge of disassembly-basin purge water to active reactor seepage and containment basins and the continuation of the pursuit of studies of reactor moderator detritiation or other mitigation measures. Moderator detritiation is discussed below to provide an upper range of costs.

2.5.2 ESTIMATED COSTS TE

The costs for each waste management strategy include preliminary capital costs, estimated 20-year life-cycle operating costs, closure costs, and postclosure maintenance and monitoring costs. Groundwater remedial actions treatment and well installation costs are not included. These costs could vary considerably depending on choices of treatment and well locations. An average cost per well installation is about $7,500. TC

Existing Waste Sites

For existing waste sites, capital costs for removal of wastes and closure actions, as required, range from about $2 million for the No-Action strategy TC to about $1.2 billion for removal of waste to the extent practicable at all sites (Elimination strategy). The major part of the estimated cost is for the removal of wastes at the low-level radioactive burial grounds. The estimated costs for existing waste site removal and closure do not include potentially required groundwater corrective actions (e.g., recovery and treatment, installation of barrier walls, or grout curtains). Unit costs for these operations are available but, because site-specific remedial action requirements have not been determined, they have not been calculated.

There are no operating costs associated with the removal of waste and closure at existing waste sites; however, the postclosure maintenance and monitoring TC costs range from about $37 million to about $51 million. Most of this cost is for the low-level radioactive waste burial grounds. Costs presented do not include the cost of transfer of wastes from storage to disposal facilities.

New Disposal Facilities

Estimated capital costs for new waste management facilities range from about $15 million for the No-Action strategy to about $3.6 billion for the Elimination strategy. Estimated operating costs range from about $51 million for the Dedication strategy to a maximum of about $2.4 billion for the Elimination strategy.

TC The closure of new disposal facilities and retrieval/decontamination of new storage facilities ranges from about $19 million to about $48 million. Finally, the estimated postclosure maintenance and monitoring costs range from about $27 million to about $81 million. The estimates do not include the costs of predisposal treatment or the costs of post-storage treatment and disposal.

Discharge of Disassembly-Basin Purge Water

There would be no increase in costs for the direct discharge of disassembly-basin purge water to onsite streams or to the active reactor seepage basins. Costs for capital installations are estimated to be about $7.5 million for evaporation, with 20-year life-cycle operating costs estimated at about $18 million. Costs per person-rem averted are estimated to be about $0.5 million.

TC TE The estimated capital cost of constructing and operating a detritiation facility is about $125 million, with a 20-year operating cost of about $124 million. In a 20-year operating period, total facility costs would be about $250 million. The detritiation facility would ordinarily serve four reactors (C, K, L, and P). Because this EIS addresses only three of these reactors, (C, K, and P), about 75 percent ($187 million) of the total amount is applicable to this analysis. On the basis of these cost values and the dose commitments of this and the No-Action strategy for the 26-year period studied (see Section 4.4.1), the cost per person-rem averted would exceed $3 million.

2.5.3 SITE DEDICATION

2.5.3.1 Existing Waste Sites

Under the No-Action strategy, dedication of currently inactive sites would be required if groundwater constituents exceeded regulatory limits.

The Dedication strategy would require that contaminated areas remaining at existing waste sites not be returned to public use; they would be dedicated for waste management purposes. About 300 acres of SRP land would be involved.

For the Elimination strategy at existing waste sites, no site dedication is expected (except for an outfall delta adjacent to the old TNX seepage basin), because waste and contaminated soil would be removed to the extent practicable. Sites could be used for purposes other than waste management after the 100-year institutional control period.

Under the Combination strategy, sites from which waste had been removed could be returned to public use after the 100-year control period; sites from which waste had not been removed would be dedicated for waste management purposes if they could not be returned to public use.

2.5.3.2 New Disposal Facilities

The No-Action strategy includes an indefinite period of waste storage; site dedication is required only as long as wastes remain in the storage facility or potentially in the event of an accidental release.

Under the Dedication strategy, new disposal facilities would require up to 400 acres, plus buffer zones around the facilities. These areas are insignificant (0.2 percent) in terms of total available SRP natural areas.

Site dedication is not required under the Elimination strategy. Stored wastes would be retrieved and disposed of permanently. The sites used for storage could be returned to a natural condition or be reclaimed for other nonrestricted uses after waste retrieval is completed, although land would be required for disposal sites.

Under the Combination strategy, disposal facilities would be dedicated for waste management purposes. Up to 400 acres, plus buffer zones, would be required. The retrieval storage portion could be returned to other use after wastes are removed to permanent disposal facilities, which would require additional (but currently unknown) land areas.

2.5.3.3 Discharge of Disassembly-Basin Purge Water

Under the No-Action strategy, active reactor seepage and containment basins would continue operating as at present. At the end of the 100-year control period, the basins would be dedicated for waste management purposes as needed if they could not be returned to public use.

Seepage basins for discharge of disassembly-basin purge water would eventually be eliminated under the direct-discharge or the evaporation alternative. Closure and remedial actions could return these areas to public use after the 100-year institutional control period.

2.5.4 GROUNDWATER IMPACTS

Under the No-Action strategy, groundwater in Tertiary (shallow) formations would continue to show chemical and radionuclide concentrations exceeding applicable standards or guidelines in some onsite areas. In addition to any removal and closure actions implemented at existing waste sites, remedial actions could be required to bring groundwater constituent concentrations into compliance with the applicable standards or guidelines. Potential impacts to the Cretaceous sediments aquifer would continue as a result of head reversal changes.

Groundwater withdrawal as part of a required remedial action could have small effects on Tertiary aquifers under the three waste management strategies. Observations of a number of wells in areas involved in groundwater pumping would be maintained to determine the extent of drawdown effects.

New disposal and storage facility construction and operations are not expected to affect groundwater under any of the waste management strategies, because they would be designed to be essentially zero release. No action, by comparison, would pose the greatest risk of short-term groundwater impacts from accidental releases of stored wastes.

Only implementation of the Elimination strategy for disassembly-basin purge-water discharges would halt the release of tritium to the groundwater; other strategies would continue the present minor onsite groundwater impacts.

Offsite groundwater impacts are not expected under any of the waste management strategies for existing waste site removal, closure, and remedial actions or for construction or operation of new disposal and storage facilities, because groundwater flow paths are intercepted by onsite surface streams and the Savannah River. Under the No-Action strategy, DOE is committed to maintaining offsite groundwater quality.

2.5.5 SURFACE-WATER IMPACTS

Surface-water quality would be improved under the three waste management strategies because of groundwater remedial actions at existing waste sites. Under the No-Action strategy, nitrate and tritium would exhibit elevated levels in Four Mile Creek.

New disposal-facility construction and operation are not expected to impact surface streams because of essentially zero or ALARA designs. The No-Action strategy (i.e., continued temporary storage of wastes) has the greatest potential to impact surface streams as a result of accidental releases of stored wastes.

Concentrations of tritium in surface water would increase with direct discharge of disassembly-basin purge water because of a loss of delay time in transit. Under the No-Action, Dedication, or Combination strategy, releases would remain at existing levels.

2.5.6 PUBLIC HEALTH EFFECTS

At existing waste sites, adverse health effects to a hypothetical maximally exposed individual resulting from the No-Action strategy are estimated to occur onsite in the year 2085, assuming termination of institutional control at that time. The Dedication, Elimination, or Combination strategy coupled with potentially required groundwater remedial actions would pose no significant increase in health effects.

A wide range of health effects from accidental releases of stored wastes could occur under the No-Action strategy. The essentially zero or ALARA release designs of new disposal or storage facilities would greatly reduce both hazardous chemical and radiological health effects.

No significant adverse health effects would result from continued discharge of disassembly-basin purge water to seepage basins.

2.5.7 AQUATIC ECOLOGY

Under the No-Action strategy, offsite ecological systems would be protected and onsite streams would continue to show some minor impacts. The Dedication, Elimination, or Combination waste management strategy at existing waste sites would have an overall benefit by eliminating any minor impacts to onsite aquatic ecosystems.

The Dedication, Elimination, and Combination waste management strategies (essentially zero or ALARA designs) for new disposal facilities preclude aquatic ecosystem impacts, but the No-Action strategy could cause a range of short-term aquatic effects from accidental releases.

The Elimination waste management strategy (direct discharge of disassembly-basin purge water to onsite streams) has the greatest potential for aquatic impact. Evaporation to the atmosphere would reduce potential aquatic impacts. Continuation of discharges to seepage basins (No-action, Dedication, or Combination waste management strategy) would continue the current minor level of impacts.

2.5.8 TERRESTRIAL ECOLOGY

Under the No-Action strategy for existing waste sites, offsite terrestrial ecosystems would be protected. Existing open or active sites could have some floral or faunal impacts. The Dedication, Elimination, or Combination waste management strategy would eliminate impacts due to direct exposure to contaminated materials or groundwater. Clearing and development of land are required for construction of new disposal facilities; however, no impacts are expected from hazardous or radioactive contaminants at these facilities because of the essentially zero or ALARA designs of these strategies. Short-term impacts could result from accidental releases of wastes stored under the No-Action strategy.

The discharge of disassembly-basin purge water to seepage basins would cause no significant impacts to terrestrial ecosystems. Under the Elimination waste management strategy, direct discharge of disassembly-basin purge water to onsite streams would increase tritium concentrations and potential impacts, but evaporation would increase atmospheric releases and decrease liquid releases.

2.5.9 HABITAT/WETLANDS

Under the No-Action strategy, previously disturbed habitats would not be disturbed further. Some habitat recovery could occur at closed and inactive waste sites, and potentially minor impacts to wetlands could occur from some sites. Short-term habitat disruption could occur under the Dedication, Elimination, or Combination waste management strategy because of the use of borrow pits for backfill. Wetlands are sufficiently removed from most existing waste sites that any impacts would be minimal. Some sites could require special erosion-control measures during closure to prevent impacts.

DOE estimates that habitat losses from new waste management facility construction could range from less than 50 acres to about 400 acres, depending on the technology adopted and the waste volumes.

Impacts to habitat and wetlands would be insignificant under the No-Action strategy for discharge of disassembly-basin purge water. Direct discharge (Elimination waste management strategy) would increase tritium releases to onsite streams.

2.5.10 ENDANGERED SPECIES

No impacts to endangered species are expected as a result of the implementation of any of the strategies, because no species have been observed in the immediate vicinity of existing waste sites. Habitat losses could occur as described above (Section 2.5.9).

Sites being considered for locations of new disposal facilities are not near any known critical habitat for endangered species; such species have not been sighted near storage facilities, and no impacts are expected.

No impacts to endangered species are expected through any of the disassembly-basin purge-water strategies, because the basins do not serve as habitats for these species.

2.5.11 ARCHAEOLOGICAL AND HISTORIC SITES

No archaeological or historic sites are located near existing waste sites. One archaeological site is near a candidate site for a new disposal/storage facility and would require an additional survey. No archaeological or historic sites would be affected by disassembly-basin purge-water discharge actions; there are no sites in the vicinity of seepage basins.

2.5.12 SOCIOECONOMICS

No impacts are expected for any of the waste management strategies for existing waste sites, new disposal facilities, or disassembly-basin purge-water discharge. The peak workforce is not expected to exceed 200 workers, all of whom would be drawn from the existing workforce.

2.5.13 NOISE

Noise impacts on the Plant from the implementation of the waste management strategies would be minor and short-term. Offsite impacts would be insignificant, due to the distance to the SRP boundary and buffering effects. The No-Action strategy would not increase noise above its current level.

2.5.14 ACCIDENTS/OCCUPATIONAL RISKS

Accident probabilities and occupational risks result from the transport of wastes from existing waste sites where removal would occur; from movement of backfill and capping materials; from fires, spills, and leaks; and from exposure of onsite workers. Special precautions would be required for protection of workers at the low-level radioactive waste burial grounds if the wastes were removed. Accidents at new disposal facilities could involve spills, leaks, and fires; the range of impacts would depend on the volumes and types of wastes handled. The use of high-integrity containers, spill recovery, and other secure waste-disposal provisions would reduce the numbers and impacts of accidents.

If necessary in case of an accident, notification of state agencies in South Carolina and Georgia would be made in accordance with Memoranda of Understanding executed between the Department of Energy, the South Carolina Department of Health and Environmental Control, the South Carolina Emergency Preparedness Division, Office of the Adjutant General; and one between the Department of Energy, the Georgia Department of Defense, the Georgia Emergency Management Agency, and the Georgia Department of Natural Resources, Environmental Protection Division. K-4

No significant occupational risks are expected under any strategy for the discharge of disassembly-basin purge water.

REFERENCES

TC

Cook, J. R., M. W. Grant, and O. A. Towler, 1987. *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.

DOE (U.S. Department of Energy), 1985. "Waste Management Activities for Groundwater Protection at the Savannah River Plant, Aiken, South Carolina; Intent to Prepare an Environmental Impact Statement." 50 *Federal Register* 16534, Washington, D.C.

Du Pont (E. I. du Pont de Nemours and Company), 1984a. *Determination of SRP Waste Site Groupings Based on Potential Interactions*, DPST-84-685, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1984b. *Annual Offsite Tritium Releases Expected from Specified Disposal Options*, DPST-84-361, Savannah River Laboratory, Technical Division, Aiken, South Carolina.

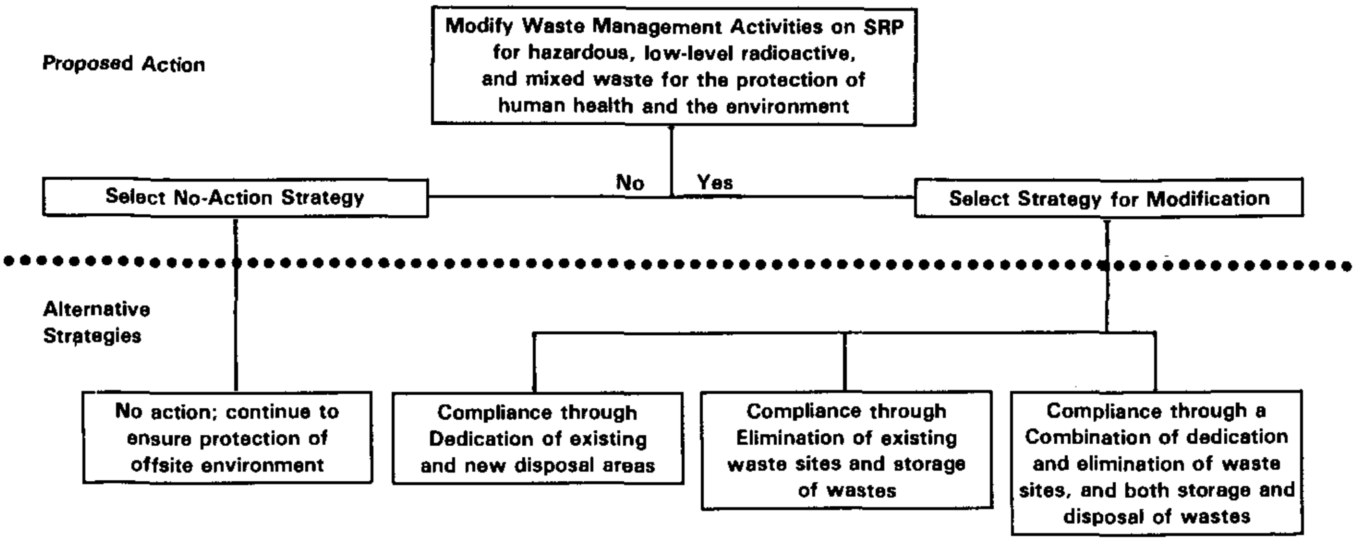
Du Pont (E. I. du Pont de Nemours and Company), 1984c. *Steam Heated Evaporators for Reducing Tritium Releases to the Rivers*, DPST-84-962, Savannah River Laboratory, Technical Division, Aiken, South Carolina.

EPA (U.S. Environmental Protection Agency), 1985. "Hazardous Waste Management Systems: Identification and Listing of Hazardous Wastes; Final Rule and Proposed Rules (40 CFR 261)," *Federal Register* (50 CFR 48886), Washington, D.C., November 27.

ERDA (U.S. Energy Research and Development Administration), 1977. *Final Environmental Impact Statement: Waste Management Operations, Savannah River Plant, Aiken, South Carolina*, ERDA-1537, Washington, D.C.

TC

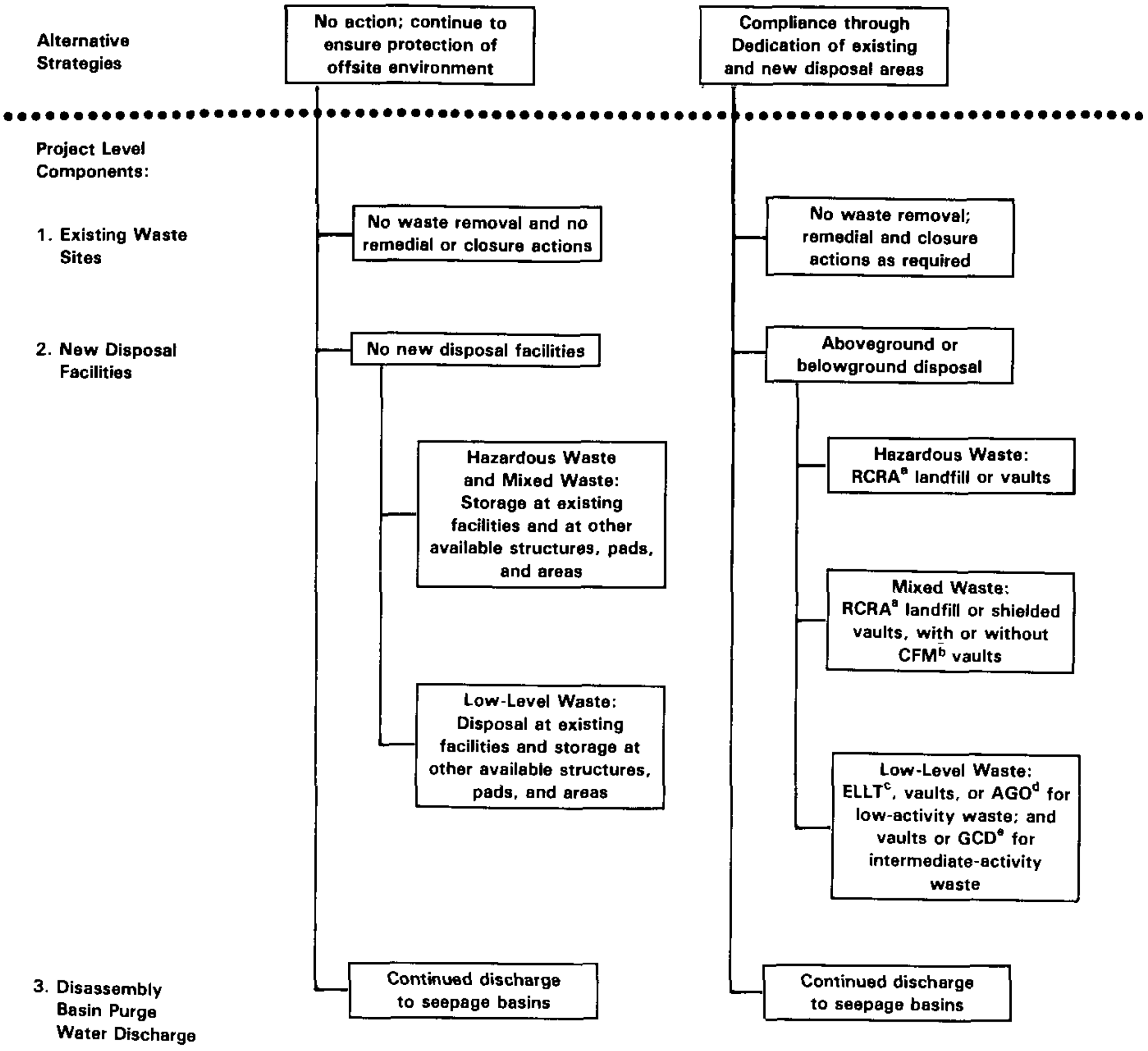
Moyer, R. A., 1987. *Venture Guidance Appraisal Cost Estimates for Groundwater Protection Environmental Impact Statement*, DPSP-87-1008, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.



Legend:

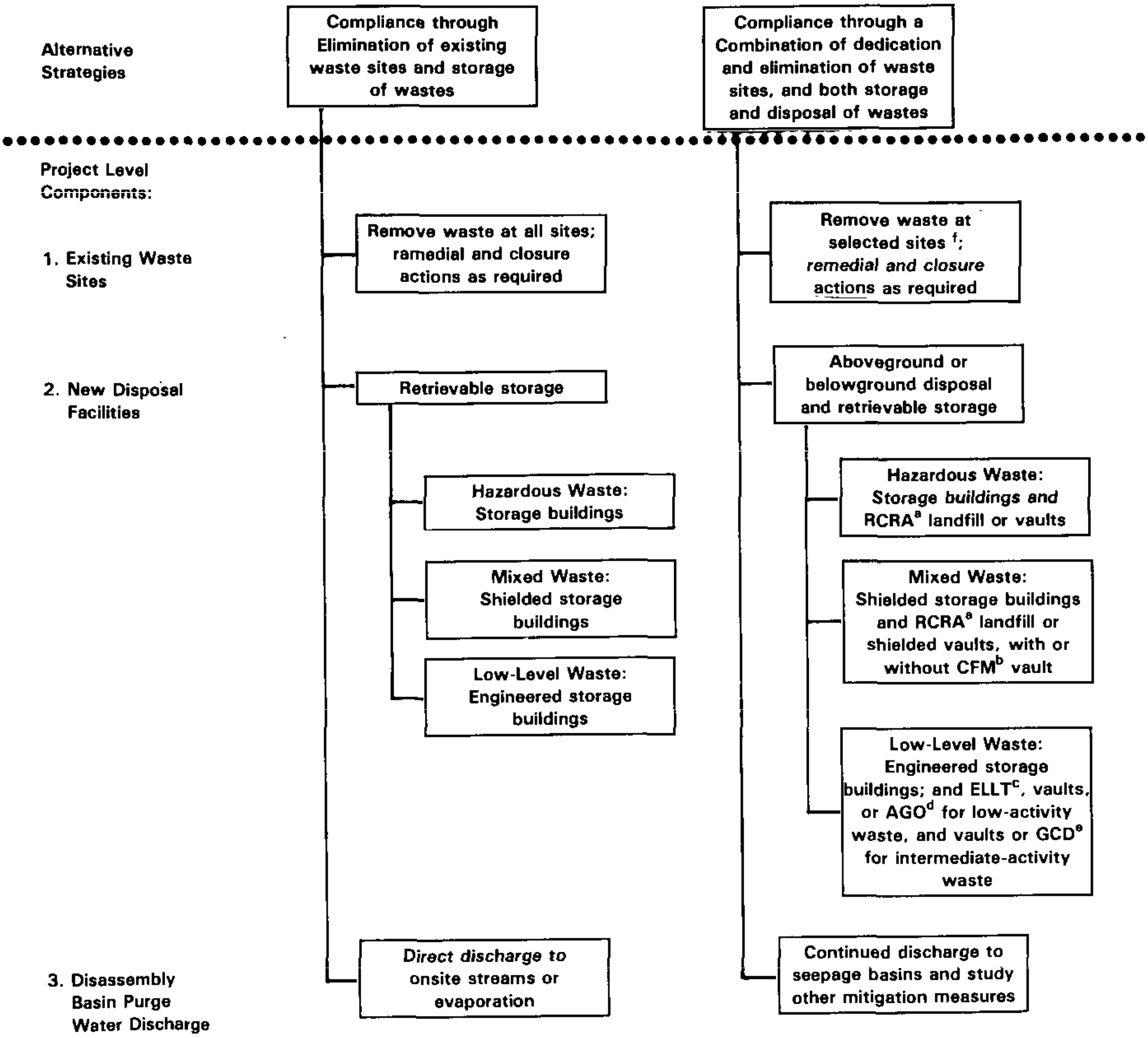
[a] RCRA = Resource Conservation and Recovery Act
[b] CFM = Cement Flyash Matrix
[c] ELLT = Engineered Low-Level Trench
[d] AGO = Abovegrade Operation
[e] GCD = Greater Confinement Disposal
[f] Selected Sites to be identified and determined by regulatory interactions

Figure 2-1. Project-Specific Components of Alternative Strategies (page 1 of 3)



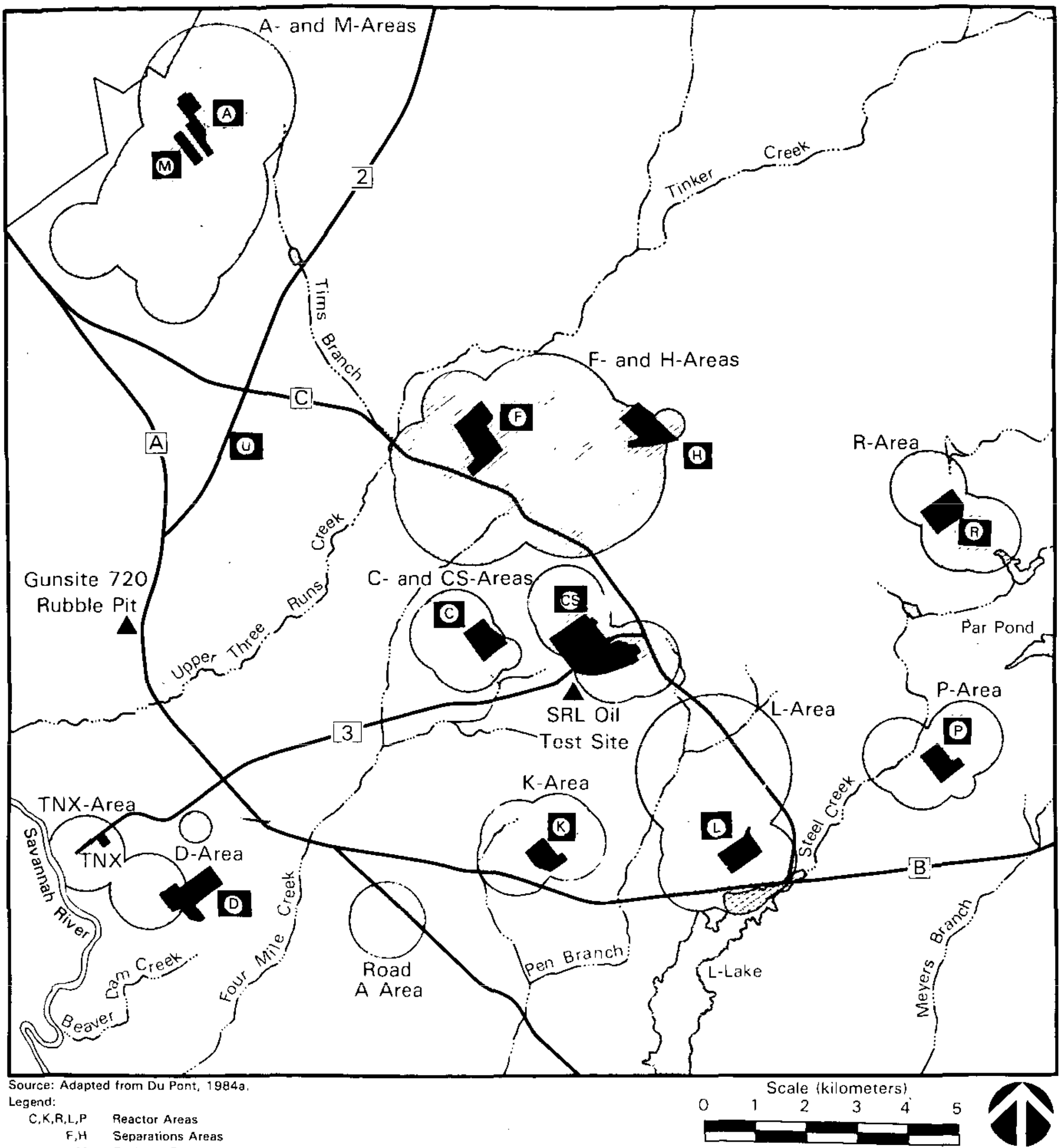
Legend on page 1

Figure 2-1. Project-Specific Components of Alternative Strategies (page 2 of 3)



Legend on page 1

Figure 2-1. Project-Specific Components of Alternative Strategies (page 3 of 3)

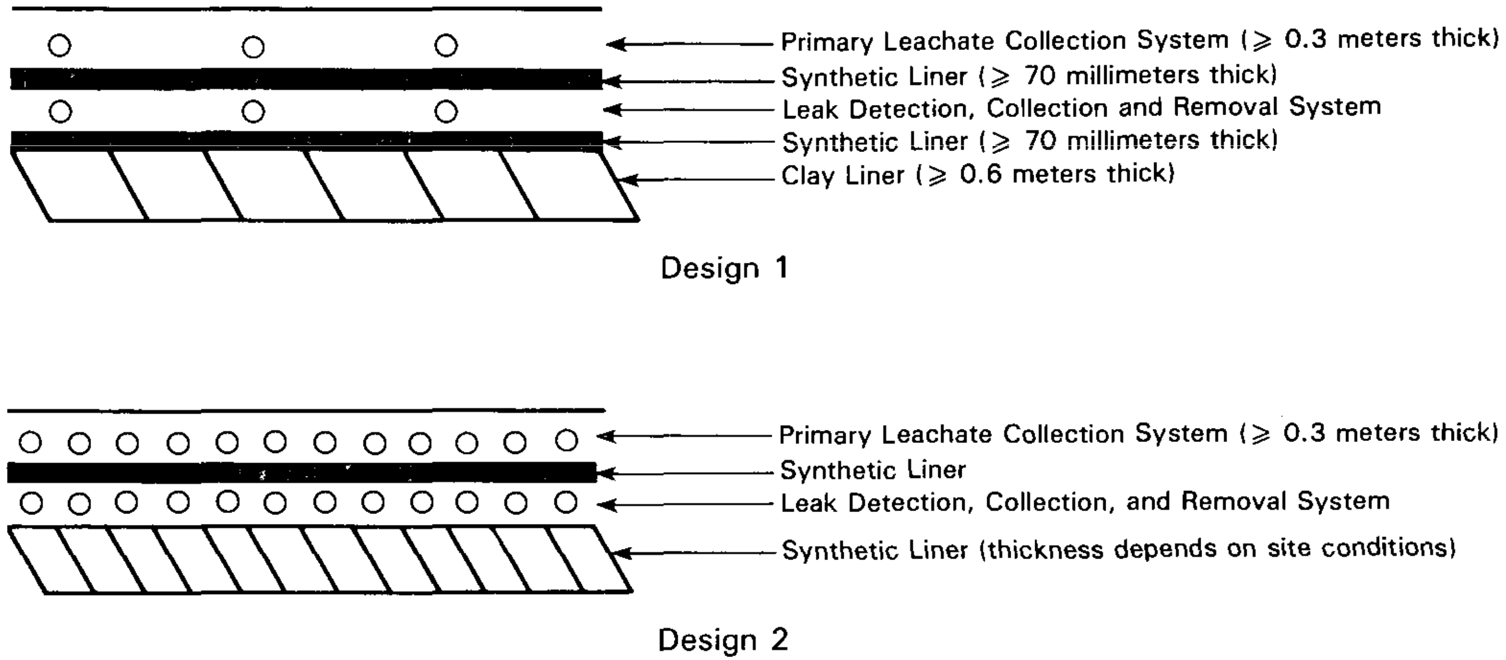


Source: Adapted from Du Pont, 1984a.

Legend:

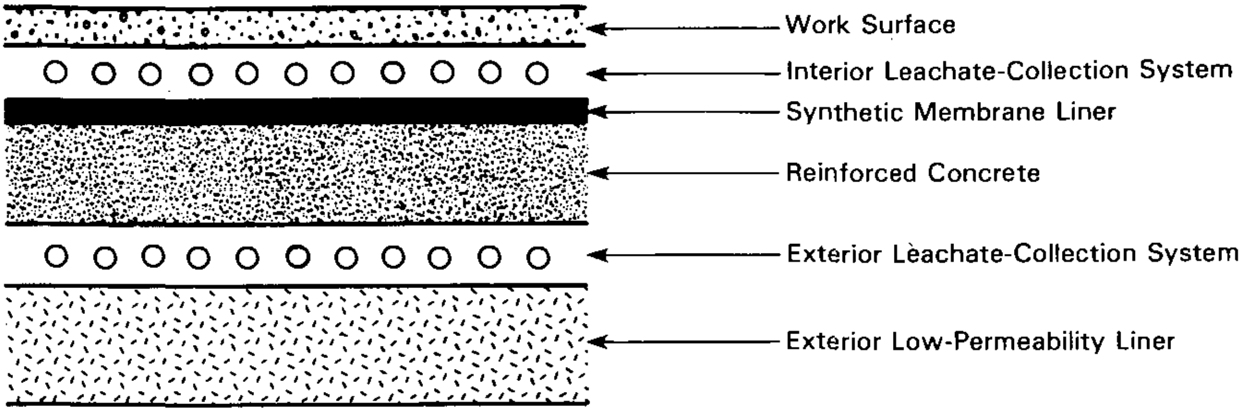
C,K,R,L,P	Reactor Areas
F,H	Separations Areas
M	Fuel and Target Fabrication
D	Steam and Power Plant, Heavy Water Production
A	Savannah River Laboratory and Administration Area
CS	Central Shops
TNX	Pilot Scale Chemical Processing Facility
U	Heavy Water Control Test Facility

Figure 2-2. Geographic Groupings of Waste Sites



Source: EPA, 1985

Figure 2-3. Schematic Diagram of Two Double-Liner Designs for Landfills



Source: Adapted from discussion in Cook, Grant, and Towler, 1987.

Figure 2-4. Schematic Diagram of Liner Systems for Below Ground Vaults (RCRA Type)

Table 2-1. Alternative Waste Management Strategies

Alternative strategy	Section	Facility Category		
		Existing waste sites	New disposal facilities	Disassembly-basin purge water discharge
No action; continue to ensure protection of offsite environment	2.1.1	No waste removal and no remedial or closure actions	No new disposal facilities	Continued discharge to seepage basins
Compliance through Dedication of existing and new disposal areas	2.1.2	No waste removal; remedial and closure actions as required	Aboveground or below-ground disposal	Continued discharge to seepage basins
Compliance through Elimination of existing waste sites and storage of wastes	2.1.3	Remove waste at all sites; remedial and closure actions as required	Retrievable storage	Direct discharge to onsite streams or evaporation
Compliance through a Combination of dedication and elimination of waste sites, and both storage and disposal of wastes	2.1.4	Remove waste at selected sites; remedial and closure actions as required	Aboveground or belowground disposal and retrievable storage	Continued discharge to seepage basins and study of other mitigation measures

Table 2-2. EIS Decisions and NEPA Documentation

SWM/EIS decisions	Future SWM/EIS-based decisions[a]	Regulatory-based interactions related to the SWM/EIS[a]	Other SRP waste management NEPA documentation	Waste management actions documented in regulatory interactions[c]
1. SRP waste management modification strategy	1. Technology and siting for HW and MW disposal facilities	1. Pretreatment facilities	1. Waste Management Operations (ERDA 1537)	1. Management of domestic/industrial waste
2. Technology and siting for LLW disposal facility	2. Specification of additional existing waste sites for removal and closure activities (if necessary)	2. Technology and siting for HW and MW disposal facilities	2. Long-term Management of HLW (DOE/EIS-0023)	2. Waste site closure plans • M-Area Settling Basin and Vicinity • Metallurgical Laboratory Basin • Mixed Waste Burial Ground • CMP Pits • F&H-Area Seepage Basins
3. Specification of existing waste sites for removal and closure activities		3. Specification of additional existing waste sites for removal and closure activities (if necessary)	3. Waste Management Operations (DOE/EIS-0062)[b]	3. Closure of the HW storage buildings
		4. Specification of remedial actions at existing waste sites	4. TRU Waste Management (DOE/EA-0315)	4. Part A and B RCRA permits

---

[a] NEPA documentation will be tiered to the SWM/EIS; specific compliance requirements will be determined through regulatory interactions; level of NEPA analysis/documentation will be determined following specification of regulatory requirements and a comparison of the required actions to the contents of the SWM/EIS.

[b] This is a Supplemental EIS to ERDA-1537.

[c] Some of this documentation is still in draft form and is being reviewed and/or developed in cooperation with the cognizant regulatory agency(s).

Table 2-3. Solid and Low-Level Radioactive Waste Sites[a]

Waste site functional grouping	Potential CERCLA sites	RCRA interim status sites	RCRA S 3004(u)	RCRA Part B status	Potential low-level rad waste	Potential mixed waste	Potential hazardous
			Known releases	Closure plans			
SRL Seepage Basins						X	
Metallurgical Laboratory Basin			X	X			X
Burning/Rubble Pits	A-, C-, CS-, D-, F-, H-, L-, P-, R-Area		X (A, C, F, P, K)				X
Metals Burning Pit/Misc Chem Basin	X						X
Old F-Area Seepage Basin	X					X	
Separations Area Retention Basins					X		
Radioactive Waste Burial Grounds	Old 643-G[b]			643-28G[b]	643-7G[b]	643-28G[b], 643-G[b]	
Bingham Pump Outage Pits					X		
Hydrofluoric Acid Spill Area							X
SRL Oil Test Site	X						X
New TNX Seepage Basin						X	
Road A Chemical Basin	X					X	
L-Area Oil & Chemical Basin	X		X			X	
Waste Oil Basins	D-Area Oil Seepage Basin						X (SCDHEC)
Silverton Road Waste Site	X		X				X
M-Area Settling Basin & Vicinity	X	X	X	X		X	
F-Area Seepage Basins	X	X	X	X		X	

TC

Footnotes on last page of table.

Table 2-3. Solid and Low-Level Radioactive Waste Sites (continued)[a]

Waste site functional grouping	Potential CERCLA sites	RCRA interim status sites	RCRA S 3004(u)	RCRA Part B status	Potential low-level rad waste	Potential mixed waste	Potential hazardous
			Known releases	Closure plans			
Acid/Caustic Basins	L-Area, R-Area						X
H-Area Seepage Basins	X	X	X	X		X	
Reactor Seepage Basins					X		
Ford Building Waste Site					X		
Ford Building Seepage Basin						X	
Old TNX Seepage Basin	X		X			X	
TNX Burying Ground					X		
CMP Pits	X		X	X			X
Gun Site 720 Rubble Pit							X
HW Storage Buildings		X		X			
M-Area Interim Status Facility		X					
MW Storage Tank		X					
MW Storage Building		X					

[a] Waste sites are described in Table 2-4.

[b] Building numbers represent separate management units within the Radioactive Waste Burial Grounds.

TC

TE

Table 2-5. No Action Strategy - Existing Waste Site Program Modifications for No Action (No Removal of Waste and No Closure or Remedial Action)[a]

Site	Waste site	Install new monitoring wells	Monitoring and site upkeep cost (million $)	Site preparation cost (million $)
A- & M-AREAS				
1-1	716-A motor shop seepage basin		0.10	0.00
1-2	Metals burning pit		0.30	0.00
1-3	Silverton road waste site		1.00	0.00
1-4	Metallurgical laboratory basin		0.17	0.00
1-5	Miscellaneous chemical basin	Yes	[b]	0.00
1-6	A-Area burning/rubble pit		0.14[c]	0.00
1-7	A-Area burning/rubble pit		[d]	0.00
1-8 to 1-11	SRL seepage basins		0.26	0.00
1-12	M-Area settling basin		1.00	0.00
1-13	Lost Lake		[e]	0.00
F- & H-AREAS				
2-1	F-Area acid/caustic basin		0.12	0.00
2-2	H-Area acid/caustic basin	Yes	0.16	0.00
2-3	F-Area burning/rubble pit		0.14[c]	0.00
2-4	F-Area burning/rubble pit		[d]	0.00
2-5	H-Area retention basin	Yes	0.20[f]	0.00
2-6	F-Area retention basin	Yes	0.20[f]	0.00
2-7 to 2-9	Radioactive and mixed waste burial grounds		38.0[g]	0.00
2-10 to 2-12	F-Area seepage basins		1.10	0.40
2-13	F-Area seepage basin (old)		0.15	0.05
2-14 to 2-17	H-Area seepage basins		1.8	1.50
R-AREA				
3-1	R-Area burning/rubble pit		0.14[c]	0.00
3-2	R-Area burning/rubble pit		[d]	0.00
3-3	R-Area acid/caustic basin		0.12	0.00
3-4	R-Area Bingham pump outage pit	Yes	0.20[c]	0.00
3-5	R-Area Bingham pump outage pit	Yes	[d]	0.00
3-6	R-Area Bingham pump outage pit	Yes	[d]	0.00
3-7	R-Area seepage basin		1.80[c]	0.00
3-8	R-Area seepage basin		[d]	0.00
3-9	R-Area seepage basin		[d]	0.00
3-10	R-Area seepage basin		[d]	0.00
3-11	R-Area seepage basin		[d]	0.00
3-12	R-Area seepage basin		[d]	0.00
C- & CS-AREAS				
4-1	CS burning/rubble pit		0.14[c]	0.00
4-2	CS burning/rubble pit		[d]	0.00
4-3	CS burning/rubble pit		[d]	0.00
4-4	C-Area burning/rubble pit		0.14	0.00
4-5	Hydrofluoric acid spill area		0.11	0.00
4-6	Ford building waste site	Yes	0.30	0.00
4-7	Ford building seepage basin		0.09	0.00
TNX-AREA				
5-1	D-Area burning/rubble pit		0.14[c]	0.00
5-2	D-Area burning/rubble pit		[d]	0.00
5-3	TNX burying ground	Yes	0.38	0.00
5-4	TNX seepage basin (old)		0.24	0.00
5-5	TNX seepage basin (new)		0.15	0.00

Footnotes on last page of table.

Table 2-5. No Action Strategy - Existing Waste Site Program Modifications for No Action (No Removal of Waste and No Closure or Remedial Action)[a] (continued)

TE

Site	Waste site	Install new monitoring wells	Monitoring and site upkeep cost (million $)	Site preparation cost (million $)
		D-AREA		
6-1	D-Area oil seepage basin		0.13	0.00
		ROAD A AREA		
7-1	Road A chemical basin		0.12	0.00
		K-AREA		
8-1	K-Area burning/rubble pit		0.14	0.00
8-2	K-Area acid/caustic basin		0.12	0.00
8-3	K-Area Bingham pump outage pit	Yes	0.20	0.00
8-4	K-Area seepage/basin		0.12	0.00
		L-AREA		
9-1	L-Area burning/rubble pit		0.14	0.00
9-2	L-Area acid/caustic basin		0.12	0.00
9-3 to 9-9	CMP pits		0.34	0.00
9-10	L-Area Bingham pump outage pit	Yes	0.20[c]	0.00
9-11	L-Area Bingham pump outage pit	Yes	[d]	0.00
9-12	L-Area oil and chemical basin		0.12	0.00
		P-AREA		
10-1	P-Area burning/rubble pit		0.14	0.00
10-2	P-Area acid/caustic basin		0.12	0.00
10-3	P-Area Bingham Pump outage pit	Yes	0.20	0.00
		MISCELLANEOUS AREA		
11-1	SRL oil test site	Yes	0.20	0.00
11-2	Gunsite 720 rubble pit	Yes	0.14	0.00
TOTAL without Burial Grounds			13.34	1.95
TOTAL including Burial Grounds			51.34	1.95

TC

---

[a] Adapted from Moyer, 1987.

[b] Included in costs for site 1-2, Metals Burning Pit.

[c] Group total cost.

[d] Included in Group total above.

[e] Included in costs for Site 1-12 above.

[f] For 100 years of monitoring, cost would be $500,000.

[g] Cost includes $13 million to maintain existing wells within the burial grounds and upgradient plus monitoring for 100 years.

Table 2-6. Dedication Strategy - Existing Waste Site Program Modifications for No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required[a]

TE

Site	Waste site	Basin liquid disposal required	Infil- tration barrier	Closure cost (million $)	Monitoring and site upkeep cost (million $)
	A- & M-AREAS				
1-1	716-A motor shop seepage basin			0.05	0.10
1-2	Metals burning pit		Yes	2.00	0.30
1-3	Silverton road waste site		Yes	1.80	1.0
1-4	Metallurgical laboratory basin	Yes	Yes	0.15	0.17
1-5	Miscellaneous chemical basin		Yes	[b]	[b]
1-6	A-Area burning/rubble pit			0.00	0.14[c]
1-7	A-Area burning/rubble pit			0.00	[d]
1-8 to 1-11	SRL seepage basins	Yes	Yes	2.20	0.29
1-12	M-Area settling basin	Yes	Yes	10.00	1.00
1-13	Lost Lake			[e]	[e]
	F- & H-AREAS				
2-1	F-Area acid/caustic basin	Yes		0.02	0.12
2-2	H-Area acid/caustic basin	Yes		0.02	0.16
2-3	F-Area burning/rubble pit			0.00	0.14[c]
2-4	F-Area burning/rubble pit			0.00	[d]
2-5	H-Area retention basin	Yes	Yes	0.30	0.20[f]
2-6	F-Area retention basin		Yes	0.30	0.20[f]
2-7 to 2-9	Radioactive and mixed waste burial grounds		Yes	100.00	25.00
2-10 to 2-12	F-Area seepage basins	Yes	Yes	7.80	1.10
2-13	F-Area seepage basin (old)	Yes	Yes	1.1	0.15
2-14 to 2-17	H-Area seepage basins	Yes	Yes	21.00	1.8
	R-AREA				
3-1	R-Area burning/rubble pit			0.00	0.14[c]
3-2	R-Area burning/rubble pit			0.00	[d]
3-3	R-Area acid/caustic basin	Yes		0.02	0.12
3-4	R-Area Bingham pump outage pit			0.20[c]	0.00
3-5	R-Area Bingham pump outage pit			[d]	0.00
3-6	R-Area Bingham pump outage pit			[d]	0.00
3-7	R-Area seepage basin		Yes	17.00[c]	1.80[c]
3-8	R-Area seepage basin		Yes	[d]	[d]

TE

Footnotes on last page of table.

Table 2-6. Dedication Strategy - Existing Waste Site Program Modifications for No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required[a] (continued)

TE

Site	Waste site	Basin liquid disposal required	Infiltration barrier	Closure cost (million $)	Monitoring and site upkeep cost (million $)
3-9	R-Area seepage basin		Yes	[d]	[d]
3-10	R-Area seepage basin		Yes	[d]	[d]
3-11	R-Area seepage basin		Yes	[d]	[d]
3-12	R-Area seepage basin		Yes	[d]	[d]
	C- & CS-AREAS				
4-1	CS Burning/rubble pit			0.00	0.14[c]
4-2	CS Burning/rubble pit			0.00	[d]
4-3	CS Burning/rubble pit			0.00	[d]
4-4	C-Area burning/rubble pit			0.00	0.14
4-5	Hydrofluoric acid spill area			0.00	0.11
4-6	Ford building waste site			0.00	0.30
4-7	Ford building seepage basin			0.07	0.09
	TNX-AREA				
5-1	D-Area burning/rubble pit			0.00	0.14[c]
5-2	D-Area burning/rubble pit			0.00	[d]
5-3	TNX burying ground		Yes	0.25	0.38
5-4	TNX seepage basin (old)		Yes	0.38	0.24
5-5	TNX seepage basin (new)	Yes	Yes	2.30	0.15
	D-AREA				
6-1	D-Area oil seepage basin			0.00	0.13
	ROAD A AREA				
7-1	Road A chemical basin		Yes	0.19	0.13
	K-AREA				
8-1	K-Area burning/rubble pit			0.00	0.14
8-2	K-Area acid/caustic basin	Yes		0.02	0.12
8-3	K-Area Bingham pump outage pit			0.20	0.00
8-4	K-Area seepage/basin	Yes	Yes	0.26	0.12

TE

Footnotes on last page of table.

Table 2-6. Dedication Strategy - Existing Waste Site Program Modifications for No Removal of Waste and Implementation of Cost-Effective Remedial and Closure Actions as Required[a] (continued)

TE

Site	Waste site	Basin liquid disposal required	Infiltration barrier	Closure cost (million $)	Monitoring and site upkeep cost (million $)
	L-AREA				
9-1	L-Area burning/rubble pit			0.00	0.14
9-2	L-Area acid/caustic basin	Yes		0.02	0.12
9-3 to 9-9	CMP pits			0.00	0.34
9-10	L-Area Bingham pump outage pit			0.20[c]	0.00
9-11	L-Area Bingham pump outage pit			[d]	0.00
9-12	L-Area oil and chemical basin	Yes	Yes	0.30	0.12
	P-AREA				
10-1	P-Area burning/rubble pit			0.00	0.14
10-2	P-Area acid/caustic basin	Yes		0.02	0.12
10-3	P-Area Bingham pump outage pit			0.20	0.00
	MISCELLANEOUS				
11-1	SRL oil test site		Yes	0.30	0.20
11-2	Gunsite 720 rubble pit			0.03	0.14
TOTAL without Burial Grounds				68.70	12.58
TOTAL including Burial Grounds				168.70	37.58

TC

[a] Adapted from Moyer, 1987.

[b] Included in costs for Site 1-2, Metals Burning Pit.

[c] Group total cost.

[d] Included in group total above.

[e] Included in costs for Site 1-12 above.

[f] For 100 years at monitoring, costs would be $500,000.

Table 2-7. Elimination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from All Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required[a]

Site	Waste site	Basin liquid disposal required	Assumed volume of contaminated soil & waste (m^3)	Backfill volume (m^3)	Infil-tration barrier	Removal & closure cost (million $)	Monitoring and site upkeep cost (million $)
			A- & M-AREAS				
1-1	716-A motor shop seepage basin	Yes	675	2,025		0.12	0.10
1-2	Metals burning pit		21,600	21,600		6.00	0.30
1-3	Silverton road waste site		26,288	26,288	Yes	25.00	1.00
1-4	Metallurgical laboratory basin	Yes	340	900		0.19	0.17
1-5	Miscellaneous chemical basin		72	72		[b]	[b]
1-6	A-Area burning/rubble pit		5,460	22,140		3.6[c]	0.14[c]
1-7	A-Area burning/rubble pit		1,630	6,683		[d]	[d]
1-8 to 1-11	SRL seepage basins	Yes	1,900	1,900	Yes	2.70	0.29
1-12	M-Area settling basin	Yes	28,990	30,000		15.00	1.0
1-13	Lost Lake		16,900	[d]		[e]	[e]
			F- & H-AREAS				
2-1	F-Area acid/caustic basin	Yes	210	700		0.16	0.12
2-2	H-Area acid/caustic basin	Yes	210	700		0.17	0.16
2-3	F-Area burning/rubble pit		1,584	6,494		2.80[c]	0.14[c]
2-4	F-Area burning/rubble pit		2,606	10,889		[d]	[d]
2-5	H-Area retention basin	Yes	6,080	11,500	Yes	2.10	0.20[f]
2-6	F-Area retention basin		9,154	9,824	Yes	2.90	0.20[f]
2-7 to 2-9	Radioactive and mixed waste burial grounds		3,000,000	3,000,000	Yes	1,100.00	25.0
2-10 to 2-12	F-Area seepage basins	Yes	8,000	122,000	Yes	10.00	1.10
2-13	F-Area seepage basin (old)	Yes	5,370	5,370	Yes	3.00	0.15
2-14 to 2-17	H-Area seepage basins	Yes	20,870	237,150	Yes	26.00	1.8
			R-AREA				
3-1	R-Area burning/rubble pit		466	1,902		0.52[c]	0.14[c]
3-2	R-Area burning/rubble pit		719	2,948		[d]	[d]
3-3	R-Area acid/caustic basin	Yes	210	700		0.16	0.12
3-4	R-Area Bingham Pump outage pit		1,600	1,600		2.00[c]	0.00
3-5	R-Area Bingham Pump outage pit		1,200	1,200		[d]	0.00
3-6	R-Area Bingham Pump outage pit		4,200	4,200		[d]	0.00

Footnotes on last page of table.

TC

Table 2-7. Elimination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from All Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required[a] (continued)

Site	Waste site	Basin liquid disposal required	Assumed volume of contaminated soil & waste (m^3)	Backfill volume (m^3)	Infil-tration barrier	Removal & closure cost (million $)	Monitoring and site upkeep cost (million $)
3-7	R-Area seepage basin		710	7,000	Yes	20.00[c]	1.80[c]
3-8	R-Area seepage basin		560	[d]	Yes	[d]	[d]
3-9	R-Area seepage basin		1,090	[d]	Yes	[d]	[d]
3-10	R-Area seepage basin		1,590	[d]	Yes	[d]	[d]
3-11	R-Area seepage basin		2,050[e]	[d]	Yes	[d]	[d]
3-12	R-Area seepage basin		1,080	[d]	Yes	[d]	[d]
			C- & CS-AREAS				
4-1	CS Burning/rubble pit		555	2,276		1.30[c]	0.14[c]
4-2	CS Burning/rubble pit		1,255	5,146		[d]	[d]
4-3	CS Burning/rubble pit		804	3,298		[d]	[d]
4-4	C-Area burning/rubble pit		811	3,325		0.52	0.14
4-5	Hydrofluoric acid spill area		230	230		0.09	0.11
4-6	Ford building waste site		345	345		0.20	0.00
4-7	Ford building seepage basin		76	840		0.15	0.09
			TNX-AREA				
5-1	D-Area burning/rubble pit		1,260	5,166		0.91[c]	0.14[c]
5-2	D-Area burning/rubble pit		856	3,510		[d]	[d]
5-3	TNX burying ground		896	896	Yes	0.69	0.38
5-4	TNX seepage basin (old)		594	4,060		0.60	0.24
5-5	TNX seepage basin (new)	Yes	359	2,529		2.20	0.15
			D-AREA				
6-1	D-Area oil seepage basin		5,742	5,742		0.39	0.14
			ROAD A AREA				
7-1	Road A chemical basin		1,000	5,500	Yes	0.80	0.00

TC

Footnotes on last page of table.

Table 2-7. Elimination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from All Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required[a] (continued)

TC

TE

Site	Waste site	Basin liquid disposal required	Assumed volume of contaminated soil & waste (m^3)	Backfill volume (m^3)	Infil-tration barrier	Removal & closure cost (million $)	Monitoring and site upkeep cost (million $)
			K-AREA				
8-1	K-Area burning/rubble pit		638	2,615		0.38	0.14
8-2	K-Area acid/caustic basin	Yes	210	700		0.19	0.12
8-3	K-Area Bingham pump outage pit		7,700	7,700		2.1	0.00
8-4	K-Area seepage basin	Yes	260	1,600	Yes	0.4	0.12
			L-AREA				
9-1	L-Area burning/rubble pit		617	2,529		0.32	0.14
9-2	L-Area acid/caustic basin	Yes	210	700		0.16	0.12
9-3 to 9-9	CMP pits		1,500	5,500[h]		2.07	0.34
9-10	L-Area Bingham pump outage pit		4,100	4,100		2.40[c]	0.00
9-11	L-Area Bingham pump outage pit		4,200	4,200		[d]	0.00
9-12	L-Area oil and chemical basin	Yes	675	3,500	Yes	0.6	0.12
			P-AREA				
10-1	P-Area burning/rubble pit		1,171	4,802		0.63	0.14
10-2	P-Area acid/caustic basin	Yes	210	700		0.16	0.12
10-3	P-Area Bingham pump outage pit		3,800	3,800		1.20	0.00
			MISCELLANEOUS				
11-1	SRL oil test site		140	140			
11-2	Gunsite 720 rubble pit		35	35			
TOTAL without Burial Ground			213,663	621,269		140.88	11.82
TOTAL including Burial Ground			3,213,663	3,621,269		1,240.88	36.82

TC

---

[a] Adopted from Moyer, 1987.
[b] Included in values for Site 1-2, Metals Burning Pit.
[c] Group total value.
[d] Included in group total above.
[e] Included in values for Site 1-12 above.
[f] For 100 years of monitoring, costs would be $500,000.
[g] Includes abandoned sewer area.
[h] Assumed that 4000 of the 5500 cubic meters is clean fill from previous excavation of contaminated soil.

Table 2-8. Combination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from Selected Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required

TE

Site	Waste site	Basin liquid disposal required)	Assumed volume of contaminated soil & waste (m^3)	Backfill volume (m^3)	Infiltration barrier	Removal & closure cost (million $)	Monitoring and site upkeep cost (million $)
			SITES SELECTED FOR WASTE REMOVAL				
F- & H-Areas							
2-13	F-Area seepage basin (old)	Yes	5,370	5,370	Yes	3.00	0.15
R-Area							
3-7	R-Area seepage basin		710	7,000	Yes	20.00[a]	1.80[a]
3-8	R-Area seepage basin		560	[b]	Yes	[b]	[b]
3-9	R-Area seepage basin		1,090	[b]	Yes	[b]	[b]
3-10	R-Area seepage basin		1,590	[b]	Yes	[b]	[b]
3-11	R-Area seepage basin		2,050	[b]	Yes	[b]	[b]
3-12	R-Area seepage basin		1,080	[b]	Yes	[b]	[b]
Subtotal			12,450	12,370		23.00	1.95

TC

Footnotes on last page of table.

Table 2-8. Combination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from Selected Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required (continued)

TE

Site	Waste site	Basin liquid disposal required	Infiltration barrier	Closure cost (million $)	Monitoring and site upkeep cost (million $)
	SITES NOT SELECTED FOR WASTE REMOVAL				
A- & M-Areas					
1-1	716-A motor shop seepage basin			0.05	0.10
1-2	Metals burning pit		Yes	2.00	0.30
1-3	Silverton road waste site		Yes	1.80	1.00
1-4	Metallurgical laboratory basin	Yes	Yes	0.15	0.17
1-5	Miscellaneous chemical basin		Yes	[d]	[d]
1-6	A-Area burning/rubble pit			0.00	0.14[a]
1-7	A-Area burning/rubble pit			0.00	[b]
1-8 to 1-11	SRL seepage basins	Yes	Yes	2.20	0.29
1-12	M-Area settling basin	Yes	Yes	10.00	1.00
1-13	Lost Lake			[e]	[e]
F- &H-Area					
2-1	F-Area acid/caustic basin	Yes		0.02	0.12
2-2	H-Area acid/caustic basin	Yes		0.02	0.16
2-3	F-Area burning/rubble pit			0.00	0.14[a]
2-4	F-Area burning/rubble pit			0.00	[b]
2-5	H-Area retention basin	Yes	Yes	0.30	0.20[f]
2-6	F-Area retention basin		Yes	0.30	0.20[f]
2-7 to 2-9	Radioactive and mixed waste burial grounds		Yes	100.00	25.00
2-10 to 2-12	F-Area seepage basins	Yes	Yes	7.80	1.10
2-14 to 2-17	H-Area seepage basins	Yes	Yes	21.00	1.80
R-Area					
3-1	R-Area burning/rubble pit			0.00	0.14[a]
3-2	R-Area burning/rubble pit			0.00	[b]
3-3	R-Area acid/caustic basin	Yes		0.02	0.12
3-4	R-Area Bingham pump outage pit			0.20[a]	0.00
3-5	R-Area Bingham pump outage pit			[b]	0.00
3-6	R-Area Bingham pump outage pit			[b]	0.00
C- & CS-Areas					
4-1	CS Burning/rubble pit			0.00	0.14[a]
4-2	CS Burning/rubble pit			0.00	[b]

TC

Footnotes on last page of table.

Table 2-8. Combination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from Selected Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required (continued)

TE

Site	Waste site	Basin liquid disposal required	Infil-tration barrier	Closure cost (million $)	Monitoring and site upkeep cost (million $)
SITES NOT SELECTED FOR WASTE REMOVAL (continued)					
C- & CS-Areas (continued)					
4-3	CS Burning/rubble pit			0.00	[b]
4-4	C-Area burning/rubble pit			0.00	0.14
4-5	Hydrofluoric acid spill area			0.00	0.11
4-6	Ford building waste site			0.00	0.30
4-7	Ford building seepage basin			0.07	0.09
TNX Area					
5-1	D-Area burning/rubble pit			0.00	0.14[a]
5-2	D-Area burning/rubble pit			0.00	[b]
5-3	TNX burying ground		Yes	0.25	0.38
5-4	TNX seepage basin (old)		Yes	0.38	0.24
5-5	TNX seepage basin (new)	Yes	Yes	2.30	0.15
D-Area					
6-1	D-Area oil seepage basin			0.00	0.13
Road A Area					
7-1	Road A chemical basin		Yes	0.19	0.13
K-Area					
8-1	K-Area burning/rubble pit			0.00	0.14
8-2	K-Area acid/caustic basin	Yes		0.02	0.12
8-3	K-Area Bingham pump outage pit			0.20	0.00
8-4	K-Area seepage/basin	Yes	Yes	0.26	0.12
L-Area					
9-1	L-Area burning/rubble pit			0.00	0.14
9-2	L-Area acid/caustic basin	Yes		0.02	0.12
9-3 to 9-9	CMP pits			0.00	0.34
9-10	L-Area Bingham pump outage pit			0.20[a]	0.00
9-11	L-Area Bingham pump outage pit			[b]	0.00
9-12	L-Area oil and chemical basin	Yes	Yes	0.30	0.12

TC

Footnotes on last page of table.

Table 2-8. Combination Strategy - Existing Waste Site Program Modifications for Removal of Waste to the Extent Practicable from Selected Sites, and Implementation of Cost-Effective Remedial and Closure Actions as Required (continued)

TE

Site	Waste site	Basin liquid disposal required	Infiltration barrier	Closure cost (million $)	Monitoring and site upkeep cost (million $)
	SITES NOT SELECTED FOR WASTE REMOVAL (continued)				
P-Area					
10-1	P-Area burning/rubble pit			0.00	0.14
10-2	P-Area acid/caustic basin	Yes		0.02	0.12
10-3	P-Area Bingham Pump outage pit			0.20	0.00
Miscellaneous Area					
11-1	SRL oil test site		Yes	0.30	0.20
11-2	Gunsite 720 rubble pit			0.03	0.14
Subtotal without Burial Grounds				50.60	10.63
Subtotal including Burial Grounds				150.60	35.63
TOTAL without Burial Grounds				73.60	12.58
TOTAL including Burial Grounds				173.60	37.58

TC

[a] Group total value.
[b] Included in group total value above.
[c] Includes 430 cubic meters at abandoned sewer line.
[d] Included in costs for Site 1-2, Metals Burning Pit.
[e] Included in cost for Site 1-12 above.
[f] For 100 years of monitoring, costs would be $500,000.

Table 2-10. Estimated Range of Hazardous, Mixed, and Low-Level Radioactive Waste Volumes (cubic meters)

Waste/type/source	20-year waste volume generated without Burial Grounds	20-year waste volume generated including Burial Grounds	Minimum disposal/ storage volume[a]	Maximum disposal/ storage volume[a] without Burial Grounds[b]	Maximum disposal storage volume including Burial Grounds[b]
<u>Hazardous</u>					
Operations	2,500	2,500	900	2,500	2,500
Interim storage	2,200	2,200	1,600	2,200	2,200
Removal/closure	98,900	98,900	0	98,900	98,900
Total	103,600	103,600	2,500	103,600	103,600
<u>Mixed</u>					
Operations	95,100	95,100	9,500	95,100	95,100
Interim storage	1,900	1,900	400	1,900	1,900
Removal/closure	91,100	1,569,000	0	91,100	1,569,000
Total	188,100	1,666,000	9,900	188,100	1,666,000
<u>Low-Level Radioactive</u>					
Operations	646,600	646,600	278,000	646,600	646,600
Interim storage	0	0	0	0	0
Removal/storage	53,200	1,577,200	0	53,200	1,577,200
Total	699,800	2,223,800	278,000	699,800	2,223,800
Waste Total	991,500	3,993,400	290,400	991,500	3,993,400

[a] Assumes no removal at existing waste sites and maximum volume reduction through predisposal treatment (i.e., Dedication strategy).

[b] Assumes removal at existing waste sites and no volume reduction (i.e., Elimination strategy).

TC

TE

Table 2-11. New Disposal/Storage Facility Alternatives

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, with or without CFM vaults	ELLT, vaults, or AGO for low-activity waste; and vaults or GCD 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	Shielded storage buildings and RCRA landfill or shielded vaults, with or without CFM vault	Engineered storage buildings; and ELLT, vaults, or AGO for low-activity waste, and vaults or GCD for intermediate activity waste

[a] All vaults may be aboveground or belowground.

Table 2-12. Comparison of Alternative Waste Management Strategies

TE

Impact		No action	Dedication	Elimination	Combination (preferred alternative)
Preliminary capital cost (million $)	EWS[a]	$2	$169	$1,241	$174
	NDF[b]	$15	$112-619, plus cost of pretreatment.	$720-3,578, plus cost of pretreatment.	$160-658, plus cost of pretreatment.
	DBPW[c]	$0-Seepage basin discharge	$0-Seepage basin discharge	$0-Direct discharge $7.5-Evaporation[g]	$125-Moderator detritiation (4 reactors)[f] $0-Seepage basin discharge
Estimated 20-year operating cost (million $)	EWS	[d]	[d]	[d]	[d]
	NDF	$86, plus cost of cleanup and damages from accidents.	$51-258	$370-2,398	$73-273
	DBPW	$0	$0	$0-Direct discharge. $18-Evaporation (3 reactors)[g].	$124-Moderator detritiation (4 reactors)[f]. $0-Seepage basin discharge.
Closure/Retrieval	NDF	-	$19-31	Cost of retrieval, treatment, and disposal after storage.	$37-48 plus cost of treatment and disposal after storage.
Postclosure maintenance and monitoring (million $)	EWS	$51	$38	$37	$38
	NDF	Cost of waste management eventually required.	$27-81	-	$52-67
	DBPW	-	-	-	-
Total cost (million $)	All[e]	$154, plus cost of cleanup and damages from accidents and cost of waste management eventually required.	$428-1,184, plus cost of pretreatment[h].	$2,368-7,280, plus cost of pretreatment and cost of retrieval, treatment, and disposal after storage[h].	$545-1,496, plus cost of pretreatment and cost of treatment and disposal after storage[h].
Site dedication	EWS	Dedication of currently inactive sites required if groundwater constituents exceeded regulatory limits and sites could not be returned to public use.	Existing waste sites and contaminated areas that could not be returned to public use after a 100-year institutional period period would become dedicated sites.	No site dedication (except outfall delta at TNX) is expected because waste and contaminated soil would be removed to the extent practical.	Sites from which waste would be removed could be returned to public use after 100-year control period; sites from which waste would not be removed would be

TC

Footnotes on last page of table.

TE

Table 2-12. Comparison of Alternative Waste Management Strategies (continued)

Impact		No action	Dedication	Elimination	Combination (preferred alternative)
					dedicated for waste management purposes if they could not be returned to public use.
	NDF	Indefinite period of waste storage; site dedication would be required as long as wastes remained in the storage facility or if site were to become contaminated by accidental release.	Site dedication would require up to 400 acres, plus buffer zones around the facilities. These areas are 0.2 percent of total SRP natural area.	Site dedication not required. Sites used for storage would be returned to a natural condition or reclaimed for other nonrestricted uses.	Disposal facilities would be dedicated for waste management purposes. Up to 400 acres, plus buffer zones, would be required. Sites for the retrieval storage portion available for other use after wastes are removed to permanent facilities.
	DBPW	Seepage and containment basins would be dedicated as needed.	Same.	Site dedication not needed; seepage basins for discharge would eventually be eliminated under either modification. Closure and remedial actions, as required, would return these areas to public use after the 100-year control period.	Seepage and containment basins would be dedicated as needed.
Groundwater	EWS	Hazardous and radionuclide constituents might exceed applicable standards or guidelines in water-table aquifers at certain sites, but offsite groundwater quality would be protected.	Closure and groundwater remedial actions as required would reduce contaminant concentrations to acceptable standards. Groundwater drawdown effects would be localized and transitory. Observation of these effects would be performed. Observation of these effects would be performed.	Removal of hazardous and radioactive wastes from all sites, closure, and remedial actions as required would reduce contaminant concentrations to acceptable standards. Groundwater drawdown effects would be localized and transitory. Observation of these effects would be performed.	Removal of hazardous and radioactive wastes from selected sites, closure, and remedial actions as required would reduce contaminant concentrations to acceptable standards. Groundwater drawdown effects would be localized and transitory.

Footnotes on last page of table.

Table 2-12. Comparison of Alternative Waste Management Strategies (continued) TE

Impact		No action	Dedication	Elimination	Combination (preferred alternative)
	NDF	Wide range of short-term impacts possible.	New aboveground and belowground disposal facilities would be designed to meet applicable EPA or DOE standards or guidelines (essentially zero release or ALARA). No adverse groundwater effects expected.	Retrievable storage facilities would be designed with zero release or ALARA features to detect and contain spills and leaks. No adverse groundwater effects expected.	All new disposal and storage facilities would be designed for essentially zero or ALARA releases. No adverse groundwater effects expected.
	DBPW	Existing discharge to groundwater and effects would continue.	Same.	Either direct discharge to onsite streams or evaporation would eliminate added impact on groundwater.	Existing discharges to groundwater and effects would continue or, with detritiation, be reduced by about a factor of 2 on the average over the 26-year study period (1987-2012). TC
Surface water	EWS	Four Mile Creek expected to show elevated concentrations of nitrate and tritium.	Some improvement in surface-water quality as a result of closure and remedial actions.	Improvement in surface-water quality as a result of waste removal, closure, and remedial actions.	Same.
	NDF	Surface streams could be affected by accidental releases of stored wastes.	No significant impacts expected.	Same.	Same.
	DBPW	Existing surface water effects from groundwater outcrops at onsite streams would continue.	Same.	The direct discharge alternative would increase surface-water tritium concentrations due to loss of decay period; the evaporation alternative would decrease surface-water tritium concentrations.	Existing surface water effects from groundwater outcrops at onsite streams would continue.
Health effects	EWS	Adverse health effects are predicted to occur to a hypothetically maximally exposed individual onsite after a 100-year period of institutional control.	No significant increase in health effects with implementation of closure and groundwater remedial actions.	No significant increase in health effects, but occupational exposure would be high at all sites with waste removal closure and remedial actions.	No significant increase in health effects with waste removal at selected sites and closure and remedial actions.

Footnotes on last page of table.

TE

Table 2-12. Comparison of Alternative Waste Management Strategies (continued)

Impact		No action	Dedication	Elimination	Combination (preferred alternative)
	NDF	Health effects would result from accidental releases of hazardous chemicals or radionuclides from stored wastes. Level of risk has wide range.	The essentially zero or ALARA release design would prevent radionuclide and hazardous chemical health effects.	Same.	Same.
	DBPW	No significant health effects from continued discharge to seepage basins.	Same.	Health effects not expected to change significantly.	No significant health effects from continued discharge to seepage basins.
Aquatic ecology	EWS	Offsite ecosystems would not be significantly affected. Onsite ecosystems would continue to function with minor impacts.	Closure and groundwater remedial actions as required would reduce potential impacts.	Removal of wastes from all sites to secure disposal facilities and closure and groundwater remedial actions as required would reduce potential impacts.	Removal of wastes at selected sites, closure and remedial actions as required would reduce potential impacts.
	NDF	A range of short-term aquatic impacts possible under the accidental release scenarios.	No impacts expected.	No impacts expected.	No impacts expected.
	DBPW	Minor aquatic impacts would continue under continued discharge to seepage basins.	Same.	No impacts expected.	Minor aquatic impacts would continue under continued or reduced discharge to seepage basins.
Terrestrial ecology	EWS	Offsite terrestrial ecology would be protected. Onsite natural succession would continue. Open sites might cause some floral and faunal impacts.	Direct exposures to open waste sites and groundwater associated impacts would be eliminated as a result of closure and remedial action as required. Use of borrow pits would create minor short-term impacts.	Direct exposures and groundwater-associated impacts would be eliminated as a result of waste removal closure and remedial actions as required. Large backfill requirements would increase potential impacts at borrow pits.	Terrestrial impacts due to direct exposure to open waste sites and groundwater-associated impacts would be eliminated as a result of waste removal at selected sites and closure and remedial actions as required. Use of borrow pits for backfill in closure actions would create minor short-term impacts.

Footnotes on last page of table.

TE

Table 2-12. Comparison of Alternative Waste Management Strategies (continued)

Impact		No action	Dedication	Elimination	Combination (preferred alternative)
	NDF	A range of short-term terrestrial impacts possible assuming accidental releases of present and future wastes stored.	New belowground and aboveground disposal facilities would require clearing and development of land. No contaminant-related impacts expected.	Construction of retrievable storage sites would require clearing and development of land. No contaminant-related impacts expected.	Combination modifications would require clearing and development of land. No contaminant-related impacts expected, due to zero release or ALARA design features.
	DBPW	No significant impacts.	No significant impacts.	Minor impacts to terrestrial ecosystems could result from liquid releases to onsite streams through direct discharge.	No significant impacts.
Habitats/wetlands	EWS	Previously disturbed habitats would be impacted further. Some recovery of habitat could occur at inactive sites. Minor wetlands impacts from some sites could continue.	Short-term habitat disruption could occur at borrow pit areas. Some sites could require erosion control measures during closure.	Same.	Same.
	NDF	Accidental releases of hazardous chemicals and radionuclides could have short-term impacts on wetlands and habitat.	Loss of habitat of up to 400 acres, or 0.2 percent of total SRP natural area.	Same.	Same.
	DBPW	No significant impacts.	No significant impacts.	Increased liquid releases through direct discharge could have minor impacts on existing habitat and wetlands.	No significant impacts.
Endangered species	EWS	No impacts.	No impacts.	No impacts.	No impacts.

Footnotes on last page of table.

Table 2-12. Comparison of Alternative Waste Management Strategies (continued)

Impact		No action	Dedication	Elimination	Combination (preferred alternative)
	NDF	No impacts.	No impacts.	No impacts.	No impacts.
	DBPW	No impacts.	No impacts.	No impacts.	No impacts.
Archaeological and historic sites	EWS	No impacts.	No impacts expected from remedial and closure action.	Same.	Same.
	NDF	No impacts.	One candidate site would require additional archaeological survey.	Same.	Same.
	DBPW	No significant impacts.	No significant impacts.	No significant impacts.	No significant impacts.
Socioeconomics	EWS	No impacts.	No impacts.	No impacts.	No impacts.
	NDF	No impacts.	No impacts.	No impacts.	No impacts.
	DBPW	No impacts.	No impacts.	No impacts.	No impacts.
Noise	EWS	No significant impacts.	No significant impacts.	No significant impacts.	No significant impacts.
	NDF	No significant impacts.	No significant impacts.	No significant impacts.	No significant impacts.
	DBPW	No significant impacts.	No significant impacts.	No significant impacts.	No significant impacts.
Accidents/occupational risks	EWS	Waste transport disposal at unpermitted and storage sites includes risks of fires, spills, leaks, and exposure of onsite workers.	Accidents are related to transportation of backfill and capping materials for closure modifications. No wastes would be transported.	Waste removal and transport to retrievable storage sites by vehicle includes risks of fires, spills, leaks, and exposure of onsite workers. Significant worker exposures possible.	Waste removal and transport to storage and disposal sites by vehicle includes risks of fires, spills, leaks, and exposure of onsite workers.
	NDF	Waste transport to storage facilities includes risks of fires, spills, leaks, and exposure of onsite facility workers.	Accidents involving spills, leaks, and fires could occur during handling.	High-integrity containers, spill recovery, and other secure provisions would reduce impacts from accidents.	Same.

Footnotes on last page of table.

TE

Table 2-12. Comparison of Alternative Waste Management Strategies (continued)

Impact		No action	Dedication	Elimination	Combination (preferred alternative)
	DBPW	No significant occupational risks.	Same.	Same.	Same.

---

[a] EWS = existing waste sites.
[b] NDF = new disposal/storage facilities.
[c] DBPW = disassembly-basin purge water.
[d] No operating costs for existing waste sites; the only costs would be for maintenance and monitoring.
[e] All = ESW + NDF + DBPW.
[f] Life cycle costs for detritiation are $187 million (3 reactors for 20 years of operation/26 year study period).
[g] Life cycle costs for evaporation are $31 million (3 reactors for 20 years of operation).
[h] The higher cost range of the Combination strategy relative to the Dedication strategy is largely due to the moderator detritiation alternative for disassembly-basin purge water and to the removal and disposal of wastes at selected existing waste sites under the Combination strategy.

TC

Table 2-13. Comparison of Project-Specific Actions - New Disposal Facilities

TE

	No action	Action		
Impact	No new disposal facilities	Aboveground or belowground disposal	Retrievable storage	Aboveground or belowground disposal and retrievable storage
Preliminary capital cost (million $)	$15	$112-619, plus cost of pretreatment.	$720-3,578, plus cost of pretreatment.	$160-658, plus cost of pretreatment.
Estimated 20-year operating cost (million $)	$86, plus cost of cleanup and damages from accidents.	$51-258	$370-2,398	$73-273
Closure (million $)		$19-31	Cost of retrieval, treatment, and disposal after storage.	$37-48 plus cost of treatment and disposal after storage.
Postclosure maintenance and monitoring (million $)	Cost of waste management eventually required.	$27-81		$52-67
Site dedication	Indefinite period of waste storage; site dedication would be required as long as wastes remained in the storage facility or if site were to become contaminated by accidental release.	Site dedication would require up to 400 acres, plus buffer zones around the facilities. These areas are 0.2 percent of total SRP natural area.	Site dedication not required. Sites used for storage would be returned to a natural condition or reclaimed for other nonrestricted uses.	Disposal facilities would be dedicated for waste management purposes. Up to 400 acres, plus buffer zones, would be required. Sites for the retrieval storage portion available for other use after wastes are removed to permanent facilities.
Groundwater	Wide range of short-term impacts possible.	New aboveground and belowground disposal facilities would be designed to meet applicable EPA or DOE standards or guidelines (essentially zero' release or ALARA). No adverse groundwater effects expected.	Retrievable storage facilities would be designed with zero release or ALARA features to detect and contain spills and leaks. No adverse groundwater effects expected.	All new disposal and storage facilities would be designed for essentially zero or ALARA releases. No adverse groundwater effects expected.

TC

TE

Table 2-13. Comparison of Project-Specific Actions - New Disposal Facilities (continued)

	No action	Action		
Impact	No new disposal facilities	Aboveground or belowground disposal	Retrievable storage	Aboveground or belowground disposal and retrievable storage
Surface water	Surface streams could be affected by accidental releases of stored wastes.	No significant impacts expected.	Same.	Same.
Health effects	Health effects would result from accidental releases of hazardous chemicals or radionuclides from stored wastes. Level of risk has wide range.	The essentially zero or ALARA release design would prevent radionuclide and hazardous chemical health effects.	Same.	Same.
Aquatic ecology	A range of short-term aquatic impacts possible under the accidental release scenarios.	No impacts expected.	No impacts expected.	No impacts expected.
Terrestrial ecology	A range of short-term terrestrial impacts possible assuming accidental releases of present and future wastes stored.	New belowground and aboveground disposal facilities would require clearing and development of land. No contaminant-related impacts expected.	Construction of retrievable storage sites would require clearing and development of land. No contaminant-related impacts expected.	Combination modifications would require clearing and development of land. No contaminant-related impacts expected, due to zero release or ALARA design features.
Habitats/wetlands	Accidental releases of hazardous chemicals and radionuclides could have short-term impacts on wetlands and habitat.	Loss of habitat of up to 400 acres, or 0.2 percent of total SRP natural area.	Same.	Same.
Endangered species	No impacts.	No impacts.	No impacts.	No impacts.
Archaeological and historic sites	No impacts.	One candidate site would require additional archaeological survey.	Same.	Same.
Socioeconomics	No impacts.	No impacts.	No impacts.	No impacts.
Noise	No significant impacts.	No significant impacts.	No significant impacts.	No significant impacts.

Table 2-13. Comparison of Project-Specific Actions - New Disposal Facilities (continued)

TE

	No action	Action		
Impact	No new disposal facilities	Aboveground or belowground disposal	Retrievable storage	Aboveground or belowground disposal and retrievable storage
Accidents/occupational risks	Waste transport to storage facilities includes risks of fires, spills, leaks, and exposure of onsite facility workers.	Accidents involving spills, leaks, and fires could occur during handling.	High-integrity containers, spill recovery, and other secure provisions would reduce impacts from accidents.	Same.

Table 2-14. Comparison of Project-Specific Actions - Discharge of Disassembly-Basin Purge Water TE

	No action	Action		
Impact	Continued discharge to seepage basins	Continued discharge to seepage basins	Direct discharge to onsite streams or evaporation	Continued discharge to seepage basins and study of other mitigation measures
Preliminary capital cost (million $)	$0	$0	$0-Direct discharge $7.5 Evaporation	$125-Moderator detritiation (4 reactors) $0-Seepage basin discharge
Estimated annual operating cost increases (million $)	$0	$0	$0-Direct discharge $18-Evaporation See Table 2-12	$124-Moderator detritiation (4 reactors) See Table 2-12 $0-Seepage basin discharge
Site dedication	Seepage and containment basins would be dedicated as needed.	Same.	Site dedication not needed; seepage basins for discharge would eventually be eliminated under either modification. Closure and remedial actions, as required, would return these areas to public use after the 100-year control period.	Seepage and containment basins would be dedicated as needed.
Groundwater	Existing discharge to groundwater and effects would continue.	Same.	Either direct discharge to onsite streams or evaporation would eliminate added impact on groundwater.	Existing discharges to groundwater and effects would continue or, with detritiation, be reduced by about a factor of 2 on the average over the 26-year study period (1987-2012).
Surface water	Existing surface water effects from groundwater outcrops at onsite streams would continue.	Same.	The direct discharge alternative would increase surface-water tritium concentrations due to loss of decay period; the evaporation alternative would decrease surface-water tritium concentrations.	Existing surface water effects from groundwater outcrops at onsite streams would continue.
Health effects	No significant health effects from continued discharge to seepage basins.	Same.	Health effects not expected to change significantly.	No significant health effects from continued discharge to seepage basins.

TC

TC

Table 2-14. Comparison of Project-Specific Actions - Discharge of Disassembly-Basin Purge Water (continued)

TE

Impact	No action	Action		
	Continued discharge to seepage basins	Continued discharge to seepage basins	Direct discharge to onsite streams or evaporation	Continued discharge to seepage basins and study of other mitigation measures
Aquatic ecology	Minor aquatic impacts would continue under continued discharge to seepage basins.	Same.	No significant impacts.	Minor aquatic impacts would continue under continued or reduced discharge to seepage basins.
Terrestrial ecology	No significant impacts.	No significant impacts.	Minor impacts to terrestrial ecosystems could result from liquid releases to onsite streams through direct discharge.	No significant impacts.
Habitats/wetlands	No significant impacts.	No significant impacts.	Increased liquid releases through direct discharge could have minor impacts on existing habitat and wetlands.	No significant impacts.
Endangered species	No impacts.	No impacts.	No impacts.	No impacts.
Archaeological and historic sites	No significant impacts.	No significant impacts.	No significant impacts.	No significant impacts.
Socioeconomics	No impacts.	No impacts.	No impacts.	No impacts.
Noise	No significant impacts.	No significant impacts.	No significant impacts.	No significant impacts.
Accidents/occupational risks	No significant occupational risks.	Same.	Same.	Same.

CHAPTER 3

AFFECTED ENVIRONMENT

This chapter describes the existing environment of the Savannah River Plant (SRP) and the nearby region that would be affected by the following modifications considered in this environmental impact statement (EIS):

- Implementation of remedial and closure actions at hazardous, low-level radioactive, and mixed waste sites.
- Establishment of new onsite disposal facilities for hazardous, low-level radioactive, and mixed wastes.
- Potential changes in the discharge of disassembly-basin purge water from C-, K-, and P-Reactors to seepage basins.

3.1 GEOGRAPHY

3.1.1 LOCATION

The Savannah River Plant is located in southwestern South Carolina and occupies an almost circular area of approximately 780 square kilometers (192,700 acres). Figure 3-1 shows the SRP location in relation to major population centers in South Carolina and Georgia. The major physiographic feature is the Savannah River, which forms the southwestern boundary of the Plant and is also the South Carolina-Georgia border. The Plant occupies parts of three South Carolina counties (Aiken, Barnwell, and Allendale).

3.1.2 SITE DESCRIPTION AND LAND USE

The U.S. Government established the SRP area in the 1950s for the production of nuclear materials for national defense. The Plant is a controlled area with limited public access. The facilities, which can be characterized as heavy industry, occupy less than 5 percent of the SRP area.

Figure 3-2 shows the locations of major SRP facilities. P-, K-, and L-Reactors are operating; R-Reactor is in standby status; and C-Reactor is in an extended shutdown. The facilities for fabricating fuel and the target elements to be irradiated in SRP reactors are in M-Area. Two chemical-separations areas (F and H) process irradiated materials. One centrally located site, the Burial Ground, is used to dispose of solid low-level radioactive and mixed wastes; it occupies approximately 200 acres between F- and H-Areas. The Savannah River Laboratory (SRL), adjacent to A-Area, is a process-development laboratory that supports production operations. Other facilities include a heavy-water extraction and recovery plant (D-Area) in standby condition since 1982; production-design test facilities (CMX-TNX Area); central shops (CS-Area) for support; administration areas (A-Area); and a Heavy Water Control Test Facility (U-Area). TC

In addition, the U.S. Department of Energy (DOE) is constructing two facilities near the chemical-separations areas. The Defense Waste Processing Facility (DWPF) will immobilize high-level radioactive waste into a solid, nonleachable borosilicate glass waste form. The Naval Reactor Fuel Material Facility (FMF) will produce nuclear fuel for the U.S. Navy.

Present and previous land use characteristics of the SRP are described in Dukes, 1984.

3.1.3 SOCIOECONOMIC AND COMMUNITY CHARACTERISTICS

DOE produced a comprehensive description of socioeconomic and community characteristics for the area around the Savannah River Plant in 1981 (ORNL, 1981) and in 1984 (DOE, 1984a). Additional information on the topics presented in this section can be found in the updated report.

3.1.3.1 Study Area

TC Approximately 97 percent of SRP employees reside in a 13-county area around the Plant, 9 in South Carolina and 4 in Georgia. The operating and construction force on the Plant has averaged 7500, ranging from a low of 6000 in the 1960s to about 15,600 in September 1987. About 97 percent of this total are employed by E. I. du Pont de Nemours and Company and its subcontractors; the remainder are employed by the U.S. Department of Energy, the University of Georgia, the U.S. Forest Service, and Wackenhut Services, Inc.

TC Aiken County, the City of Aiken, and the small towns immediately around the SRP site have felt the greatest impact of the Savannah River Plant. SRP workers and families comprise roughly one-half of the City of Aiken's nearly 18,000 population (1986) and account in large measure for the high median family incomes in Aiken County.

The greatest percentage of employees reside in the six-county area of Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia. Together, these six counties house approximately 89 percent of the total SRP work force. DOE chose these six counties as the study area for the assessment of potential socioeconomic and community effects of the proposed waste management alternatives because the percentage of employees residing in them has remained essentially the same since the early 1960s.

3.1.3.2 Demography

Table 3-1 lists the 1980 populations in the study area for counties and places of more than 1000 persons. The largest cities in the study area are Augusta, Georgia, and Aiken, North Augusta, and Barnwell, South Carolina. Of the 31 incorporated communities in the study area, 16 have populations under 1000 persons, and 11 have populations between 1000 and 5000 persons. Aiken, Columbia, and Richmond Counties, which comprise the Augusta Standard Metropolitan Statistical Area (SMSA), have a total population of about 327,400; however, most of this population resides outside cities or towns. About two-thirds of the total six-county population reside in rural or unincorporated areas.

In 1980, the estimated population in the 80-kilometer area around the Savannah River Plant was approximately 563,300 persons. The estimated population for the year 2000 in this area is 852,000 persons. This estimate was calculated

Table 3-1. 1980 Population for Counties and Places of 1000 Persons or More[a]

Location	1980 population
Aiken County, South Carolina	105,625
City of Aiken	14,978
Town of Jackson	1,771
City of North Augusta	13,593
City of New Ellenton	2,628
Allendale County, South Carolina	10,700
Town of Allendale	4,400
Town of Fairfax	2,154
Bamberg County, South Carolina	18,118
Town of Bamberg	3,672
City of Denmark	4,434
Barnwell County, South Carolina	19,868
City of Barnwell	5,572
Town of Blackville	2,840
Town of Williston	3,173
Columbia County, Georgia	40,118
City of Grovetown	3,384
City of Harlem	1,485
Richmond County, Georgia	181,629
City of Augusta	47,532
Town of Hephzibah	1,452
Study area total	376,058

[a]Adapted from Bureau of the Census, 1982a,b.

using the 1970-to-1980 growth rate of each county in the 80-kilometer area and assuming the same growth rates would continue in the future. For counties that experienced a negative population growth rate between 1970 and 1980, the calculation assumed that continued population decline would not occur. This total county population estimate for the year 2000 is approximately 12 percent higher than the estimates prepared by the States, based on a comparison with projections prepared by Georgia and South Carolina (ORNL, 1981).

3.1.3.3 Land Use

In the study area near SRP, less than 8 percent of the existing land use is devoted to urban and built-up uses. Most such uses are in and around the Cities of Augusta and Aiken. Agriculture accounts for about 21 percent of total land use; forests, wetlands, water bodies, and unclassified lands that are predominantly rural account for about 70 percent.

The projected future land uses of the study area are similar to existing land-use patterns. Developed urban land is projected to increase by 2 percent in the next 20 years. The largest percentage of this growth is expected to occur in Aiken and Columbia Counties as a result of the expansion of the Augusta metropolitan area (ORNL, 1981).

3.1.3.4 Public Services and Facilities

The study area has nine public school systems. Each county has a county-wide school district except Bamberg, which has two districts, and Barnwell, which has three. In 1982, these districts could accommodate an estimated 3642 new students.

Of the 120 public water systems in the study area, 30 county and municipal systems serve about 75 percent of the population. The other 90 systems are generally smaller and serve individual subdivisions, mobile home parks, or commercial and industrial enterprises. All but four of the municipal and county water systems - the Cities of Aiken, Augusta, and North Augusta, and Columbia County - obtain their water from deep wells. Aiken obtains some of its water from Shaws Creek and Shiloh Springs, while Columbia County and the Cities of Augusta and North Augusta obtain water from the Savannah River upstream of SRP. Restrictions in system capabilities for municipal and county water systems that use groundwater as their supply are due primarily to storage and treatment capacity rather than availability of groundwater.

Most municipal and county wastewater-treatment systems have the capacity to treat additional sewage. Some rural municipalities in Allendale, Bamberg, and Columbia Counties and the City of Augusta in Richmond County have experienced problems in treatment-plant capacities. Programs to upgrade facilities are under way or planned in most of these areas.

3.1.3.5 Housing

Since 1970, the largest increases in the number of housing units have occurred in Columbia, Richmond, and Aiken Counties. Columbia County has grown the fastest, more than doubling its number of housing units. Between 1970 and 1980, Aiken and Richmond Counties both experienced about a 36-percent increase in the number of housing units. In Aiken County, one-fourth of this increase resulted from the high growth rate in the number of mobile homes.

The vacancy rate for owner-occupied housing units for the six-county area in 1980 was 2.3 percent. Individual county rates ranged from 3.6 percent in Columbia County to 0.8 percent in Barnwell County. Vacancy rates for rental units in 1980 ranged from 14.8 percent in Columbia County to 7.1 percent in Bamberg County; the rate in 1980 for the study area was 10.5 percent.

3.1.3.6 Economy

The results of the 1980 Census of Population indicate, between 1970 and 1980, a 35-percent increase in total employment, from 75,732 to 102,326, in establishments with payrolls in the six-county area. Service sector employment increased at these establishments by 65 percent, mirroring a national trend toward a service-based economy. Employment in manufacturing increased by 27 percent, adding more than 9000 employees. Most of the overall expansion in the number of employment positions occurred in Richmond and Aiken Counties.

About 31 percent of the workforce in the six-county area in 1980 was employed in the service sector, and 27 percent in the manufacturing sector. Retail trade was the third largest category, accounting for 15 percent of the workforce. The remaining 25 percent of the workforce was distributed among the seven additional categories of employment reported by the Census. In 1980, fewer than 2 percent of workers in the study area were employed in the category of agriculture, forestry, and fishing, while nearly 4 percent were employed in that category in 1970.

Employed residents of Richmond and Aiken Counties accounted for about 77 percent of the study area's employed population in 1980. The largest sectors of employment for these counties were services and manufacturing. The three counties with the smallest populations and workforce numbers (Allendale, Bamberg, and Barnwell) are also more rural and had a higher proportion of workers engaged in agriculture. In these three counties, however, agriculture employs 11 percent or less of the workforce, while the service and manufacturing sectors employ relatively large percentages of the workforce.

The study area's per capita income level increased from 22 percent below the national average in 1969 to 18 percent below in 1979. Of the six counties, all but Richmond showed a gain in per capita income relative to the national average during the 10-year period.

3.1.4 HISTORIC AND ARCHAEOLOGICAL RESOURCES

As of February 1986, 76 sites in the six-county study area were listed in the National Register of Historic Places. Richmond County had the largest number of sites (27), most of which are in the City of Augusta. Thirty-five National Register sites are in Aiken and Allendale Counties. The remaining 14 sites are scattered throughout the remaining three-county area.

A recent effort undertaken for this environmental impact statement (EIS) involved an intensive archaeological and historical survey of 82 waste sites, which was conducted from October 1985 through January 1986. This survey discovered one prehistoric site (38BR584), represented by an isolated, Early Archaic hafted biface from an area adjacent to the P-Area Burning/Rubble Pit. Due to its limited extent and disturbed context, this site is not considered to be potentially eligible for the National Register of Historic Places. DOE has requested concurrence with its determination of "no effect" on any archaeological or historic resources resulting from activities associated with the proposed closure of the 77 waste sites to the State Historic Preservation Officer (Brooks, 1986). Concurrence of "no effect" was received by DOE on October 6, 1986. TC Q-1

3.2 METEOROLOGY AND CLIMATOLOGY

This section describes of the meteorology of the Savannah River Plant, based on data collected at the SRP and at Bush Field, Augusta, Georgia (Du Pont, 1980a, 1982a; Hoel, 1983; NOAA, 1985). Meteorological tapes for 1975 through 1979 from the onsite meteorological program provided additional data for this characterization.

3.2.1 REGIONAL CLIMATOLOGY

The SRP has a temperate climate, with mild winters and long summers. The region is subject to continental influences, but it is protected from the more severe winters in the Tennessee Valley by the Blue Ridge Mountains to the north and northwest. The SRP and the surrounding area are characterized by gently rolling hills with no unusual topographical features that would significantly influence the general climate.

Winters are mild and, although cold weather usually lasts from late November to late March, less than one-third of the days have a minimum temperature below freezing.

3.2.2 LOCAL METEOROLOGY

3.2.2.1 Average Wind Speed and Direction

The average wind speed measured in Augusta from 1951 to 1981 was 3.0 meters per second. The average recorded at a height of 10 meters on the WJBF-TV tower near Beech Island, about 15 kilometers northwest of the SRP, from 1976 to 1977, was 2.5 meters per second. Table 3-2 lists the average monthly wind speed for Augusta, Georgia, along with the prevailing wind direction for each month. This table also lists the monthly and annual average wind speeds for three levels of the television tower.

On an annual basis, the predominant wind direction is west-northwest to east-southeast, with a secondary maximum of east-northeast to west-southwest. In general, seasonal transport is as follows: winter, northwest to southeast; spring, west to east; summer, toward the southwest through north to northeast; and autumn, toward the southwest and southeast. Because pollutant dispersion depends on atmospheric stability, annual wind roses are available for each SRP tower for seven Pasquill-type stability classes; seasonal wind roses are also available (Hoel, 1983).

3.2.2.2 Precipitation

The average annual rainfall at the SRP from 1952 through 1982 was about 122 centimeters (Table 3-3). The average rainfall at Augusta's Bush Field from 1951 to 1980 was about 112 centimeters (NOAA, 1985). The maximum monthly precipitation was about 31.3 centimeters, recorded in August 1964. Hourly observations in Augusta show that the intensity of rainfall is normally less than 1.3 centimeters per hour.

3.2.3 SEVERE WEATHER

3.2.3.1 Extreme Winds

The strongest winds in the SRP area occur in tornadoes, which can have wind speeds as high as 116 meters per second. The next strongest surface winds occur during hurricanes. During the history of the SRP, only Hurricane

Table 3-2. Average Monthly Wind Speed for Bush Field, Augusta, Georgia, 1951-1981, and WJBF-TV Tower, 1976-1977[a]

	Bush Field		WJBF-TV Tower elevation (m)		
Month	Mean speed (m/sec)	Prevailing direction	10	36	91
Jan.	3.2	W	3.0	4.5	6.1
Feb.	3.4	WNW	2.9	4.6	5.8
Mar.	3.6	WNW	3.3	4.5	5.9
Apr.	3.4	SE	2.8	4.2	5.4
May	2.9	SE	2.5	3.7	5.0
June	2.8	SE	2.4	4.0	4.8
July	2.6	SE	2.0	3.1	4.4
Aug.	2.5	SE	2.1	3.2	4.3
Sept.	2.5	NE	2.1	3.3	4.7
Oct.	2.6	NW	2.4	4.1	5.6
Nov.	2.8	NW	2.4	4.1	5.6
Dec.	3.0	NW	2.7	4.4	6.3
Annual	3.0	SE	2.5	3.9	5.3

[a] Source: Du Pont, 1983a.

Table 3-3. Precipitation at Savannah River Plant, 1952-1982[a]

	Monthly precipitation (cm)		
Month	Maximum	Minimum	Average
Jan.	25.5	2.3	10.7
Feb.	20.2	2.4	11.2
Mar.	27.8	3.8	13.0
Apr.	20.8	1.4	9.1
May	27.7	3.4	10.6
June	27.7	3.9	11.2
July	29.2	2.3	12.5
Aug.	31.3	2.6	11.8
Sept.	22.1	1.4	10.2
Oct.	27.6	0.0	6.2
Nov.	16.4	0.5	6.2
Dec.	24.3	1.2	9.5
Annual			122.2

[a] Source: Du Pont, 1983a.

Gracie, in September 1959, had winds in excess of 34 meters per second. Winter storms with winds as high as 32 meters per second have been recorded occasionally (Du Pont, 1982a). Thunderstorms can generate winds as high as 18 meters per second and even stronger gusts. The highest 1-minute wind speed recorded at Augusta between 1951 and 1984 was 28 meters per second. Table 3-4 lists the extreme wind speeds for 50- and 100-year return periods for three locations about equally distant from the SRP (Simiu, Changery, and Filliben, 1979).

Table 3-4. Extreme Wind Speeds for SRP Area (meters per second)[a]

	Return period	
Station	50-Year	100-Year
Greenville, S.C.	35	38
Macon, Ga.	30	31
Savannah, Ga.	35	39

[a] Adapted from Simiu, Changery, and Filliben, 1979.

3.2.3.2 Thunderstorms

There is an average of 54 thunderstorm days per year at the SRP. The summer thunderstorms occur primarily during the late afternoon and evening; they may be accompanied by strong winds, heavy precipitation, or, less frequently, hail (NOAA, 1985). Summer thunderstorms are attributable primarily to convective activity resulting from solar heating of the ground and radiational cooling of cloud tops. Thunderstorm activity in the winter months is attributable mainly to frontal activity.

3.2.3.3 Tornadoes

In the Southeastern United States, most tornadoes occur in early spring and late summer, with more than 50 percent occurring from March through June. In South Carolina, the greatest percentage of tornadoes occurs in April and May, about 20 percent (Pepper and Schubert, 1978) in August and September. The latter are spawned mainly by hurricanes. One or two tornadoes can be expected in South Carolina during April and May, with one expected each in March, June, July, August, and September (Purvis, 1977).

Weather Bureau records show 278 tornadoes in Georgia over the period from 1916 to 1958 and 258 in South Carolina for the period from 1950 to 1980 (Table 3-5) (Hoel, 1983). The general direction of travel of confirmed tornado tracks in Georgia and South Carolina is southwest to northeast.

Table 3-5. Tornado Occurrence by Month[a]

	Georgia (1916-1958)		South Carolina (1950-1980)	
Montn	Number	Percent	Number	Percent
Jan.	24	8.6	6	2.3
Feb.	23	8.3	14	5.4
Mar.	49	17.6	26	10.1
Apr.	93	33.5	40	15.5
May	20	7.2	53	20.5
June	14	5.0	20	7.8
July	5	1.8	17	6.6
Aug.	10	3.6	25	9.7
Sept.	8	2.9	23	8.9
Oct.	2	0.7	8	3.1
Nov.	15	5.4	11	4.3
Dec.	15	5.4	15	5.8
Total	278		258	

[a] Source: Hoel, 1983.

Occasional tornadoes occur in the SRP area. Investigations of tornado damage near the SRP in 1975 and 1976 indicated wind speeds varying from 45 to 78 meters per second (Du Pont, 1980b). The most recent occurrence of a tornado striking the SRP was on April 23, 1983 (Garrett, 1983).

3.2.3.4 Hurricanes and High Winds

Thirty-eight damaging hurricanes have occurred in South Carolina during the 272 years of record (1700 to 1972); the average frequency was one storm every 7 years. These storms occurred predominantly during August and September. At the SRP, 160 kilometers inland, hurricane wind speeds are significantly lower than those observed along the coast. Winds of 34 meters per second were measured on the 61-meter towers only once during the history of the SRP, when Hurricane Gracie passed to the north on September 29, 1959 (Du Pont, 1982b).

3.2.3.5 Precipitation Extremes

Heavy precipitation can occur in the SRP area in association with either localized thunderstorms or hurricanes. The maximum 24-hour total was about 15.2 centimeters, which occurred during August 1964 in association with Hurricane Cleo.

3.2.4 ATMOSPHERIC DISPERSION

3.2.4.1 Atmospheric Stability

The transport and dispersion of airborne material are direct functions of air movement. Transport direction and speed are governed by the general patterns of airflow (and by the nature of the terrain), whereas the diffusion of airborne material is governed by small-scale, random eddying of the atmosphere (i.e., turbulence). Turbulence is indicated by atmospheric stability classification. The atmosphere in the SRP region is unstable approximately 25 percent of the time, it is neutral 25 percent of the time, and it is stable about 50 percent of the time.

3.2.4.2 Air Quality

The States of South Carolina and Georgia have established air-quality-sampling networks. The SRP operates an onsite sampling network. These networks monitor suspended particulates, sulfur dioxide, and nitrogen dioxide. In 1984, ambient concentrations of these pollutants near the SRP were below the local air-quality standards in effect at that time (Du Pont, 1985a).

3.3 GEOLOGY AND SEISMOLOGY

This section describes the important geologic features in the region surrounding the SRP. These features include the regional geologic setting, seismology, and geologic hazards. Appendix A contains more detailed information.

3.3.1 REGIONAL GEOLOGIC SETTING

3.3.1.1 Tectonic Provinces

The North American continent is divided tectonically into foldbelts of recent or ancient deformation, and into platform areas where flat-lying or gently tilted rocks lie on basements of earlier foldbelts (King, 1969). The Southeastern United States contains two platform areas, the Cumberland Plateau province and the Coastal Plain province, and three foldbelts, the Blue Ridge province, the Valley and Ridge province, and the Piedmont province (Figure 3-3).

The SRP is located in the Aiken Plateau physiographic division of the Upper Atlantic Coastal Plain province of South Carolina (Cooke, 1936; Du Pont, 1980a). The center of the Plant is about 40 kilometers southeast of the Fall Line (Davis, 1902) that separates the Atlantic Coastal Plain tectonic province from the Piedmont tectonic province. Crystalline rocks of Precambrian and Paleozoic age underlie a major portion of the gently seaward-dipping Coastal Plain sediments of Cretaceous and younger age. Sediment-filled basins of Triassic and Jurassic age (exact age is uncertain) occur within the crystalline basement throughout the coastal plain of Georgia and the Carolinas (Du Pont, 1980a). One of these, the Dunbarton Triassic Basin, underlies parts of the Plant (Marine and Siple, 1974; Du Pont, 1980a; Stephenson, Talwani, and Rawlins, 1985).

3.3.1.2 Stratigraphy*

Coastal Plain sediments in South Carolina range in age from Cretaceous to Quaternary; they form a seaward-dipping, thickening, mostly unconsolidated wedge. Near the center of the Plant at H-Area, these sediments are approximately 280 meters thick (Siple, 1967). The base of the sedimentary wedge rests on a Precambrian and Paleozoic crystalline basement, which is similar to the metamorphic and igneous rocks of the Piedmont, and on the siltstone, claystone, and conglomerates of the down-faulted Dunbarton Triassic Basin. Immediately overlying the basement is the Middendorf/Black Creek (Tuscaloosa) Formation (175 meters thick), which is of the Upper Cretaceous age, and which is composed of water-bearing sands and gravels separated by prominent clay units. Overlying the Middendorf/Black Creek is the Ellenton Formation, which is about 18 meters thick and consists of sands and clays interbedded with coarse sands and gravel. Four of the formations shown in Figure 3-3, the Congaree, McBean, Barnwell, and Hawthorn (formation terminology after Siple, 1967), comprise the Tertiary (Eocene and Miocene) sedimentary section, which is about 85 meters thick and consists predominantly of clays, sands, clayey sands, and sandy marls. A calcareous zone in the lower portion of the McBean Formation is associated with void spaces in locations south and east of Upper Three Runs Creek (COE, 1952). The near-surface sands of the Barnwell and Hawthorn Formations generally are loosely consolidated; they can contain thin, sediment-filled fissures (clastic dikes) (Siple, 1967; Du Pont, 1980a). Quaternary alluvium is found at the surface in floodplain areas and as terrace deposits.

3.3.1.3 Geomorphology

The SRP is on the Aiken Plateau (Cooke, 1936), which slopes from an elevation of approximately 200 meters at the Fall Line to an elevation of about 75 meters to the southeast. The surface of the Aiken Plateau, which is highly dissected, is characterized by broad, interfluvial areas and narrow, steep-sided valleys. Because of SRP's proximity to the Piedmont region, it has somewhat more relief than the near-coastal areas, with onsite elevations ranging from 27 to 128 meters above sea level. Relief on the Aiken Plateau is as much as 90 meters locally (Siple, 1967). The plateau is generally well-drained although small, poorly drained depressions occur; these depressions are similar to Carolina bays.

The Aiken Plateau has several southwest-flowing tributaries to the Savannah River. These streams commonly have asymmetrical valley cross-sections, with

---

*The accepted names for stratigraphic units have evolved over the years as additional information on the age of the units and their correlation with similar units in other areas has surfaced. This is reflected in the different names used by authors to identify subsurface units. The stratigraphic nomenclature used in this document is the same as the usage of the various authors whose works have been referenced. Therefore, different portions of the text might use different names for the same geologic units. Similarly, the same name might be used for geologic units or portions of units that are otherwise different. Figure 3-4 shows the correlation of the units used by the various authors. The terminology used in this document is largely that of Siple (1967).

the northwest slope gentler than the southeast slope. This is caused by stream courses that generally parallel the strike of the Coastal Plain formations. Erosion by the water course results in gentle dip slopes on the northwest, or updip, sides of the valleys. The land forms produced by these geomorphic processes are gentle cuestas.

3.3.2 SEISMOLOGY AND GEOLOGIC HAZARDS

The down-faulted Dunbarton Triassic Basin, which underlies the Savannah River Plant, contains several interbasinal faults. However, the sediments overlying these faults show no evidence of basin movement since their deposition during the Cretaceous Period (Siple, 1967; Marine, 1976; Du Pont, 1980a). Other Triassic-Jurassic basins have been identified in the Coastal Plain tectonic province of South Carolina and Georgia; these features can be associated with the South Georgia Rift (Du Pont, 1980a; Popenoe and Zietz, 1977; Daniels, Zietz, and Popenoe, 1983). The Piedmont, Blue Ridge, and Valley and Ridge tectonic provinces, which are associated with Appalachian Mountain building, are northwest of the Fall Line (Figure 3-3). Several fault systems occur in and adjacent to the Piedmont and the Valley and Ridge tectonic provinces; the closest is the Belair Fault Zone, about 40 kilometers from the Plant, which is not capable of generating major earthquakes (Case, 1977). Surface mapping, subsurface boring, and geophysical investigations at the Plant have not identified any faulting of the sedimentary strata that would affect SRP facilities.

Two major earthquakes have occurred within 300 kilometers of the Savannah River Plant: the Charleston earthquake of 1886, which had an epicentral modified Mercalli intensity (MMI) of X, and which occurred about 145 kilometers away; and the Union County, South Carolina, earthquake of 1913, which had an epicentral shaking of MMI VII to VIII, and which occurred approximately 160 kilometers away (Langley and Marter, 1973). An estimated peak horizontal shaking of 7 percent of gravity (0.07g) was calculated for the site during the 1886 earthquake (Du Pont, 1982c). DOE has published site intensities and accelerations for other significant earthquakes (DOE, 1984b).

On June 8, 1985, a minor earthquake with a local magnitude of 2.6 (maximum intensity MMI III) and a focal depth of 0.96 kilometer occurred at the Plant. The epicenter was just to the west of C- and K-Areas. The acceleration produced by the earthquake was less than 0.002g (Stephenson, Talwani, and Rawlins, 1985). Appendix A contains a detailed discussion of earthquakes and other geologic hazards.

3.4 GROUNDWATER RESOURCES

This section discusses the groundwater resources at SRP in terms of the hydrostratigraphy and groundwater hydrology. Appendix A contains more detailed discussions of groundwater resources. Appendix A describes relationships between groundwater and surface water.

3.4.1 HYDROSTRATIGRAPHY

Three distinct hydrogeologic systems underlie the SRP: (1) the Coastal Plain sediments, where groundwater exists in porous sands and clays; (2) the crystalline metamorphic rock beneath the Coastal Plain sediments, where groundwater exists in small fractures in schist, gneiss, and quartzite; and (3) the Dunbarton Basin within the crystalline metamorphic complex, where groundwater exists in intergranular spaces in metamudstones and sandstones. The latter two systems are relatively unimportant as groundwater sources near the Plant. Figure 3-4 shows the lithology and water-bearing characteristics of the hydrostratigraphic units underlying the SRP. Appendix A contains additional detail.

In the central part of the SRP, the McBean Formation (formation terminology after Siple, 1967; see Figure 3-4) is separated from the underlying Congaree Formation by a layer known as the "green clay" (Figure 3-4). This layer, which exhibits a low permeability, is continuous over most of the SRP and thickens towards the southeast. The green clay unit is significant hydrogeologically because it supports a large head differential between the McBean and Congaree Formations. North and west of Upper Three Runs Creek, the green clay is discontinuous and is effective only locally as an aquitard (hydrogeologic confining unit).

In the central part of the SRP, the water table aquifer is separated from the underlying confined aquifer by a thin layer known locally as the "tan clay" (Figure 3-4). The tan clay is discontinuous in F- and H-Areas and, where present in the vicinity of M-Area, is not an important hydrogeologic unit. TC

The lack of continuous aquitard units in the Barnwell, McBean, and Congaree Formations north and west of Upper Three Runs Creek suggests that groundwater in these three units is interconnected hydraulically. However, the clay at the base of the Congaree and the upper clay layer of the Ellenton Formation together form a confining unit that appears to be continuous under the entire SRP. This confining layer provides what is believed to be an effective barrier to downward migration into the sands of the Ellenton-Black Creek (upper Cretaceous Sediments) aquifer. However, current data indicate that volatile organic compounds are present in the Black Creek aquifer in the A/M-Area, suggesting some leakage between the Congaree and the Black Creek. F-16

The South Carolina Hazardous Waste Management Regulations (SCHWMR) and the Resource Conservation and Recovery Act (RCRA) require that the hydrogeologic zones that are most susceptible to impacts from waste management units be determined. These zones have been defined as the unsaturated zone, the uppermost aquifer, the principal confining unit, and the principal confined aquifer (shallowest confined aquifer beneath the SRP). Figure 3-4 shows the relationship of these zones to one another and the correlation of these zones with other stratigraphic nomenclature. The following paragraphs summarize each hydrogeologic zone. The formational terminology used in this discussion is largely that of Geological Consulting Services (Geological Consulting Services, 1986).

The unsaturated zone is a 10- to 45-meter-thick sandy unit containing clay lenses. This zone is comprised of the Upland Unit and, in some areas of the Plant, the Tobacco Road and Dry Branch Formations. TC

The uppermost aquifer is a 35-meter-thick sandy unit composed of two zones. The upper water-table zone, composed primarily of the clay-rich, fine-grained sands of the McBean Formation (in some areas of the Plant, areas of higher water table) includes portions of the Dry Branch and Tobacco Road Formations. The lower zone is composed of the coarse-grained Congaree Formation and the upper sand and clay of the Ellenton Formation.

Based on an evaluation of hydraulic properties as well as head differences between subsurface zones, the lower three units of the Ellenton Formation are believed to form the principal confining zone beneath the Plant. These units form a section approximately 15 meters thick, composed of two clay beds (middle and lower Ellenton) and the lower Ellenton sand lenses. The sands in these lenses are commonly coarse grained, but generally are supported by a clay matrix that impedes fluid movement. The middle clay is generally a dense, low-permeability clay that can be locally discontinuous or more permeable. The lower clay, however, is an average of 3 meters thick (maximum of 15 meters), is dense, has a low permeability, and is believed to be continuous over the SRP area. Table 3-6 summarizes hydraulic conductivity of the Ellenton Formation.

The confined aquifer is a sandy zone averaging about 30 meters in thickness. This zone is capped by the overlying Ellenton Formation confining unit. In this text, the shallowest confined aquifer will be referred to as the Black Creek aquifer. The aquifer beneath the Black Creek will be referred to as the Middendorf aquifer (see Figure 3-4).

3.4.2 GROUNDWATER HYDROLOGY

Groundwater beneath the SRP generally occurs under confined (artesian) conditions, meaning that the groundwater rises to a potentiometric level above the top of the hydrogeologic unit. The water table in the vicinity of the central portion of the SRP generally occurs in the Barnwell Formation at depths of 5 to 15 meters, whereas it occurs near A- and M-Areas at depths of 30 to 40 meters.

3.4.2.1 Hydrologic Properties

The flow of groundwater in the natural environment depends strongly on the three-dimensional configuration of hydrogeologic units through which flow takes place. The geometry, spatial relations, and interconnections of the pore spaces determine the effective porosity (percentage of void space effectively transmitting groundwater) and the hydraulic conductivity of the hydrogeologic unit. These factors largely control groundwater flow through geologic media. In fact, the velocity of groundwater flow is directly proportional to the hydraulic conductivity and to the hydraulic gradient, and is inversely proportional to effective porosity.

TE
TC

The Coastal Plain sediments beneath the SRP are heterogeneous and isotropic with respect to the hydrologic properties controlling groundwater flow. One of the most recognized properties, hydraulic conductivity, is typically 10 to 100 times greater in the direction parallel to bedding than in the direction perpendicular to bedding in sedimentary units like these (Freeze and Cherry, 1979). This results in significantly greater groundwater flow laterally within hydrostratigraphic units than between units (see Tables A-4 and A-5).

Table 3-6. Hydraulic Conductivity (cm/sec) of the Ellenton Formation[a,b]

Geologic Unit	Vertical conductivity		Horizontal conductivity	
	Range	Average	Range	Average
Middle Clay	$2.2 \times 10^{-9} - 1.4 \times 10^{-5}$	1.1×10^{-7}	$1.6 \times 10^{-9} - 7.3 \times 10^{-5}$	8.61×10^{-5}
Lower Sand	$3.5 \times 10^{-9} - 3.9 \times 10^{-4}$	4.4×10^{-5}	$1.1 \times 10^{-8} - 2.6 \times 10^{-4}$	9.39×10^{-5}
Lower Clay	$1.8 \times 10^{-8} - 4.0 \times 10^{-7}$	1.9×10^{-7}	$2.3 \times 10^{-8} - 6.7 \times 10^{-7}$	3.12×10^{-7}

[a] Source: DOE, 1987.
[b] Results of laboratory analysis of industrial samples.

F-17

3.4.2.2 Head Relationships

The elevation of the free-standing groundwater above a sea-level datum is referred to as the hydraulic head. The heads in the Ellenton and Middendorf/Black Creek (Tuscaloosa) Formations are higher than those in the Congaree in the central portion of the SRP, thus preventing the downward movement of water from the Congaree to the Ellenton (see Figure A-5). These relationships are general and might not be valid in the vicinity of production wells. Figures 3-5 and 3-6 show the approximate area of upward head differential in 1982 and 1987.

Figures 3-5 and 3-6 describe the head difference between the water in the Black Creek and Congaree Formations. The two maps show a change due to improved data control (more measuring points) and to a lesser extent, show the effects of pumpage on and off the SRP. Had the data control available in 1987 been available in 1982, it is quite likely the maps would have been very similar. TC

The more recent data (Bledsoe, 1987) are more accurate. The earlier map was based on limited data and was included in the draft EIS because it was the best data available at the time of the publication of the draft EIS.

Parts of the Separations Areas, Burial Grounds, C-Area, and TNX-Area, and the D-Area powerhouse are in the area of upward head differential between the groundwater in the Congaree and that in the Middendorf/Black Creek (Tuscaloosa) Formation. However, A-, M-, K-, and P-Areas are in a region of downward head differential (see Figure 3-6). Because of flow directions and head relationships, the potential for offsite impacts on water quality in the Black Creek aquifer is extremely small. The most important factor for offsite impacts is the prevailing flow direction for water in the Black Creek toward the Savannah River, not toward municipalities that border the Plant. The most important factor for onsite impacts is a significant upward gradient between the Congaree and the Upper Tuscaloosa over some of the SRP (Bledsoe, 1987).

Impacts on the Black Creek aquifer have been confirmed in only one monitoring well cluster on the SRP. This cluster is in the western recharge area (A- and M-Areas), where the clay barrier thins beneath an area where spillage from rail cars and transfer facilities took place during the early days of SRP operation. The migration of these constituents is being defined; their source has been under remediation for nearly 2 years. Data analyzed to date do not define any flow paths for these constituents toward offsite water users. The area of final discharge of the groundwater originating from these sources is the Savannah River. These constituents would require about 150 years to reach TC the river (DOE, 1987). The pumpage of recovery wells (and supply wells for process water) in A- and M-Areas increases this travel time.

F-18 Other impacts to Black Creek in the A/M-Area are suspected due to supposed leaks along well casings.

Where the upward gradient exists between the Black Creek and the Congaree, water is prevented from flowing into the Black Creek aquifer. An exception occurs in areas where large volumes of water are pumped from the Black Creek; in these areas, pumpage could reverse the upward gradient. The area most susceptible to these impacts is H-Area, where the head differential is relatively small and pumpage is great. A modeling study (Duffield, Buss, and Spalding, 1987) indicates that a maximum head differential (downward potential) of about 1.5 meters has developed in the eastern portion of H-Area (see Figure A-5). Moderate pumpage from the Black Creek also occurs in U-Area, the Central Shops Area, TNX-Area, the Classification Yard, and the U.S. Forest Service offices. The potential for reversing the upward gradient that occurs naturally in these areas is significantly less than that in H-Area. Any contaminants that would be drawn into the Black Creek by this pumpage would flow to the pumping well and, therefore, would not impact offsite areas (Duffield, Bass, and Spalding, 1987). C-46

3.4.2.3 Groundwater Flow

Groundwater moves from areas of high potential energy (usually measured as head) to areas of lower energy. Thus, flow is in the direction of decreasing hydraulic gradient. In general, on the Coastal Plain, the gradient is seaward from the higher areas of the Aiken Plateau toward the shore. Of major significance is the modification of this general southeastward movement caused by the incision of the Savannah River and its tributaries.

The groundwaters in the regions of the river and onsite streams are diverted toward hydraulic head lows caused by natural discharge to the surface water. Each stream dissects the hydrogeologic units differently; the smallest streams become natural discharge points for groundwater in the Barnwell Formation, and the Savannah River does the same for groundwater in the deeper formations. Thus, discrete groundwater subunits are created, each with its own recharge and discharge areas. Appendix A describes natural aquifer recharge and discharge areas and water budgets at the SRP.

3.4.3 GROUNDWATER QUALITY

3.4.3.1 Regional Groundwater Quality

The water in the Coastal Plain sediments is generally of good quality, suitable for industrial and municipal use with minimal treatment. It is characterized as soft, slightly acidic, and low in both dissolved and suspended solids (Table 3-7).

3.4.3.2 Groundwater Monitoring Results

A substantial amount of groundwater monitoring data has been generated from SRP monitoring wells over the past several years. Data from groundwater sampling since 1982 were reported in the Technical Summary of Groundwater Quality Protection Program at Savannah River Plant (Christensen and Gordon, 1983), the SRP Environmental Reports for 1985 and 1986 (Zeigler, Lawrimore, and Heath, 1986; Zeigler, Heath, Taus, and Todd, 1987), and in the 26 environmental information documents (EIDs) prepared for this EIS, referenced in Appendixes B and F. TC

This section of the EIS characterizes the affected groundwater environment (e.g., groundwater at the waste site monitoring wells based on the data reported and compiled into a single summary to provide a general understanding of waste site groundwater quality related to applicable standards or criteria. TC

Table 3-7. Average Chemical Analysis of Groundwater From Coastal Plain Formations at the Savannah River Plant[a]

Chemical properties/ chemical constituent[b]	Barnwell Formation	McBean Formation	Congaree Formation	Middendorf/Black Creek (Tuscaloosa) Formation
pH (standard units)	5.6	6.5	6.3	5.4
Total dissolved solids	25.0	46.8	71.0	21.0
Specific conductance (micromhos)	27	57	130[c]	30
Calcium	2.9	8.2	19.6	0.6
Magnesium	0.2	2.5	0.3	2.1
Potassium	0.9	1.2	0.8	1.8
Sodium	2.3	4.2	1.5	4.0
Iron	0.2	0.1	0.2	0.1
Silicon	4.6	5.9	10.1	0.6
Aluminum	0.7	0.6	1.0	NM[d]
Manganese	<0.1	<0.1	<0.1	0.5
Bicarbonate	12.7	31.0	57.4	4.3
Chlorine	3.5	2.8	3.4	0.7
Nitrate (as N)	3.1	0.1	0.1	0.1
Phosphate (as P)	0.1	0.3	0.1	0.2
Fluoride	TR[e]	<0.1	0.1	NM

[a] Adapted from Du Pont, 1983b. Formational terminology after Siple, 1967; see Figure 3-4.

[b] Units are milligrams per liter (except pH and specific conductance).

[c] Only one analysis.

[d] NM - No measurement.

[e] TR - Trace.

Groundwater is monitored at potentially hazardous and mixed waste sites. Parameters analyzed at these sites include heavy metals, nutrients, pesticides, organic solvents, and radiological parameters. Table 3-8 summarizes the results of 39 groundwater-quality parameter measurements related to applicable standards or criteria. For example, 672 tests for silver were reported, none of which exceeded the National Interim Primary Drinking Water Standard of 50 micrograms per liter. Table 3-8 lists the number of values exceeding a standard or criterion (if any) and the number of values not exceeding the standard. In addition, this table lists the maximum value reported for comparison with the standard.

The summary indicates that many groundwater constituents analyzed do not exceed the applicable standard or criterion. On the other hand, several constituents are shown to exceed groundwater standards or criteria at one or more waste site well locations on the SRP.

Exceedance of a standard or criterion does not always indicate contamination from a waste disposal site or operation. Certain constituents can occur naturally at concentrations that exceed standards. Also, contamination associated with a particular site can occur in the wells of another site located hydraulically downgradient. A site-specific evaluation of the data using comparisons of upgradient versus downgradient wells is necessary to determine the constituent contributions of a waste site. Such comparisons are described in detail (in the 26 waste site EIDs and in Looney et al., 1987) for the purposes of selecting waste site modeling parameters and comparing appropriate alternative actions for specific waste sites. TC

In addition, exceedance of a standard or criterion does not automatically indicate a risk to human health or the environment. For example, the standard for iron of 300 micrograms per liter is a secondary drinking-water standard established for aesthetic purposes and is not health-related. Thus, the origin of the standard or criterion listed is important.

Finally, the results of groundwater monitoring to date are considered preliminary because of indications that some earlier results (1982-1984) might have been questionable. In 1984, improvements were made in the procedures for obtaining and preserving samples. Where manual bailing had been used, pumps now ensure adequate flushing of the wells before a sample is taken; also, samples for dissolved metal analyses are filtered to remove suspended solids before preservatives are added (EPA, 1984). In addition, wells constructed of galvanized casings were removed from service and replaced with wells constructed of PVC plastic. These problems (now corrected) are thought to have been responsible for excessively high concentrations of several metals, including zinc, cadmium, lead, and iron, in earlier samples (Zeigler, Lawrimore, and Heath, 1986). C-50

Table 3-9 summarizes recent groundwater monitoring data for radiological constituents for the SRP; it provides the total number of samples reported and the maximum and minimum values for 12 radiological parameters.

Table 3-8. Summary of SRP Groundwater Monitoring Data[a]

Parameter	Units	Standard or criterion (S/C)	Values reported	Values exceeding S/C	Values not exceeding S/C	Maximum value	
pH-acid	units	6.5[b]	1018	955	63	2.3	
pH-alkaline	units	8.5[b]	1018	23	995	12.5	
Silver	mg/L	0.05[c]	672	0	672	(d)	
Arsenic	mg/L	0.05[c]	654	0	654	(d)	
Barium	mg/L	1[c]	597	4	593	2.3	TC
Beryllium	mg/L	0.011[e]	568	29	539	0.31	
Cadmium[f]	mg/L	0.010[c]	704	84	620	0.15	
Chromium	mg/L	0.050[c]	874	51	823	6.3	TC
Copper	mg/L	1[b]	527	0	527	(d)	
Iron[f]	mg/L	0.3[b]	750	302	448	280	
Mercury	mg/L	0.002[c]	817	54	763	3.1	
Manganese	mg/L	0.05[b]	714	218	496	91.	
Lead[f]	mg/L	0.05[e]	781	115	666	4.9	TC
Selenium	mg/L	0.01[c]	653	2	651	.054	
Zinc[f]	mg/L	5[b]	616	32	584	50.	
Chloride	mg/L	250[b]	835	0	835	(d)	
Fluoride	mg/L	1.4[c]	680	1	679	2	
Nitrate-N	mg/L	10[c]	734	127	607	370	
Sulfate	mg/L	400[g]	752	1	751	765	
Hydrogen sulfide	mg/L	0.002[h]	465	1	464	3.0	
Cyanide	mg/L	0.20[b]	200	0	200	(d)	
Phenol	mg/L	3.5[i]	631	0	631	(d)	
TOH	mg/L	0.0007[j]	846	706	140	94.	
Endrin	mg/L	0.0002[c]	580	0	580	(d)	
Lindane	mg/L	0.004[c]	580	1	579	0.01	TC
Methoxyclor	mg/L	0.1[c]	580	0	580	(d)	
Toxaphene	mg/L	0.005[c]	580	0	580	(d)	
2,4-D	mg/L	0.1[c]	592	4	588	0.74	

Footnotes on last page of table.

Table 3-8. Summary of SRP Groundwater Monitoring Data[a] (continued)

Parameter	Units	Standard or criterion (S/C)	Values reported	Values exceeding S/C	Values not exceeding S/C	Maximum value	
2,4,5-TP	mg/L	0.01[e]	592	0	592	(d)	
1,1-dichloroethane	mg/L	4.05[k]	24	0	24	(d)	
1,1,1-trichloroethane	mg/L	0.2[k]	359	4	355	0.26	
Tetrachloromethane	mg/L	0.005[k]	150	6	144	0.14	TC
1,1-dichloroethylene	mg/L	0.007[k]	44	1	43	0.01	
Trans 1,2-dichloroethylene	mg/L	0.27[m]	35	0	35	(d)	
Trichloroethylene	mg/L	0.005[k]	417	187	230	161	
Tetrachloroethylene	mg/L	0.0007[n]	411	146	265	269	
Gross alpha	pCi/L	15[c]	769	104	665	11,500	
Gross beta	pCi/L	0.2[o]	704	476	228	21,000	TC
Radium	pCi/L	5[c]	618	88	530	128	

---

[a] Data compiled from 26 existing waste site Environmental Information Documents, which reported analytical results for samples taken from 1982 to third quarter 1985.

[b] National Secondary Drinking Water Regulations (40 CFR 143).

[c] National Interim Primary Drinking Water Regulations (40 CFR 141).

[d] All values reported below standard or criterion.

[e] EPA, 1976. (Maximum concentrations for protection of freshwater aquatic life.)

[f] Results of metals analyses performed between 1982 and 1984 might be inaccurate because of problems with well construction and sampling protocol. Actual groundwater concentration levels of these metals were probably somewhat less.

[g] 50 FR 46958.

[h] EPA, 1976. (Maximum concentration for protection of freshwater aquatic life; detection limit of analysis procedure was 3 milligrams per liter.)

[i] EPA, 1986a.

[j] No standard or criterion available, conservatively set at standard for tetrachloroethylene (see footnote k below).

[k] EPA, 1986b, 1987 (52 FR 25690). TC

[l] 50 FR 48949 (detection limit of analysis procedure was 0.008 milligram per liter).

[m] EPA, 1981.

[n] 50 FR 48950 (detection limit of analysis procedure was 0.001 milligram per liter).

[o] *No standard or criterion available, set for comparative purposes at the detection limit of 0.2 picocuries per liter.*

Table 3-9. SRP Groundwater Monitoring Data - Radiological Constituents[a]

Parameter	Units	Number of samples	Maximum	Minimum
Alpha[b]	pCi/L	1,539	360	<DL[c]
Nonvolatile beta	pCi/L	1,539	24,000	<DL[c]
Tritium[d]	pCi/mL	1,379	7,000,000	<DL[c]
Cerium-144	pCi/mL	42	0.18	<DL[c]
Cesium-134	pCi/mL	42	0.07	<DL[c]
Cesium-137	pCi/mL	42	0.02	<DL[c]
Chromium-51	pCi/mL	42	2.4	<DL[c]
Cobalt-60	pCi/mL	42	0.25	<DL[c]
Ruthenium-103	pCi/mL	42	0.10	<DL[c]
Ruthenium-106	pCi/mL	42	0.22	<DL[c]
Antimony-125	pCi/mL	42	0.01	<DL[c]
Strontium-89, -90	pCi/mL	31	140	<DL[c]

[a] Data compiled from Zeigler, Lawrimore, and Heath, 1986.

[b] The National Interim Primary Drinking Water Standard for gross alpha is 15 picocuries per liter (40 CFR 141).

[c] Detection limits.

[d] The National Interim Primary Drinking Water Standard for tritium is 20,000 picocuries per liter (40 CFR 141).

3.4.4 GROUNDWATER USE

3.4.4.1 Important Aquifers

As noted in Section 3.4.1, subsurface waters in the vicinity of the SRP include six major hydrostratigraphic units. The geohydrologic characteristics of these units, their areal configurations, and their recharge/discharge relationships control the vertical and horizontal movement of groundwater at the SRP (see Appendix A).

At present, the SRP does not withdraw groundwater from the crystalline, metasediment basement rocks and overlying saprolite. The Middendorf/Black Creek (Cretaceous Sediments) hydrostratigraphic unit, which is 170 to 250 meters thick at the SRP, is the most important regional aquifer in the vicinity of the SRP. At the SRP, the Middendorf/Black Creek consists of two aquifers separated by a clay layer or aquitard, which impedes movement of groundwater between the two aquifers. The lower aquifer (Middendorf) consists of about 90 meters of medium to coarse sand; the overlying aquifer (Black Creek) consists of about 45 meters of well-sorted medium-to-coarse sand. Beneath the SRP, these two aquifers join only by way of wells that withdraw water from both permeable zones.

The upper Middendorf/Black Creek clay unit and the Ellenton clays form an aquitard over most of the SRP. In some areas, the Ellenton and the sands appear to be connected hydrologically.

The Congaree is another important local aquifer. Locally, only the Middendorf/Black Creek exceeds the Congaree's water-producing potential. The Congaree's intermediate depth also makes it attractive for water wells. An extensive clay layer at the base of this unit forms a confining bed that separates the permeable sands of the Congaree hydrologically from the sands in the underlying Ellenton and Middendorf/Black Creek units. The green clay (Figure 3-4), a marker bed at the top of the Congaree, exhibits very low hydraulic conductivity; therefore, it is a significant aquitard, particularly south and east of Upper Three Runs Creek. The SRP does not withdraw large quantities of groundwater from the McBean, Barnwell-Hawthorn, or stream valley alluvium deposits (formation terminology after Siple, 1967). The McBean, however, becomes increasingly more important as an aquifer to the east of the SRP.

The water table is usually in the stream valley alluvium deposits and in the Barnwell. The McBean is usually under semiconfined conditions. In contrast, groundwaters in the Congaree (to the south and east of Upper Three Runs Creek) and the Middendorf/Black Creek are under confined conditions. Middendorf/Black Creek water wells near the Savannah River (e.g., in D-Area) often flow because the potentiometric level of the groundwater is greater than the elevation of the land surface.

3.4.4.2 Regional and Local Groundwater Use

The Middendorf/Black Creek (Tuscaloosa) aquifer, which becomes shallower as it approaches the Fall Line, forms the base for most municipal and industrial water supplies in Aiken County. In Allendale and Barnwell Counties, the Middendorf/Black Creek exists at increasingly greater depths. Consequently, the shallower Congaree and McBean aquifers (formation terminology after Siple, 1967), or their limestone equivalents, supply some municipal, industrial, and agricultural users. The Barnwell, McBean, and Congaree Formations are the primary sources for domestic water supplies in the vicinity of the SRP.

DOE has identified 56 major municipal, industrial, and agricultural groundwater users within 32 kilometers of the center of the SRP (Appendix A). The total pumpage for these users is about 135,000 cubic meters per day.

Talatha community, the closest municipal user (about 11 kilometers from the center of the SRP), uses about 480 cubic meters per day. The Town of Jackson, about 16 kilometers from the center of the SRP, pumps about 1070 cubic meters per day. Of the total municipal pumpage (52,605 cubic meters per day), the Middendorf/Black Creek aquifer supplies about 34,270 cubic meters; the remainder (about 18,335 cubic meters per day) comes from the McBean and the Congaree. Total industrial/agricultural pumpage from the Middendorf/Black Creek aquifer is about 71,940 cubic meters per day; this includes 38,550 cubic meters per day drawn by the SRP.

In addition to the large users discussed above, the South Carolina Department of Health and Environmental Control (SCDHEC) lists 25 small communities and mobile home parks, 4 schools, and 11 small commercial interests as groundwater users. Generally, shallow wells equipped with pumps with capacities of 54 to 325 cubic meters per day serve these and other miscellaneous users; thus, they do not draw large quantities of water. The total estimated withdrawal for these 40 users is less than 2000 cubic meters per day (DOE, 1984b).

A number of domestic wells near the SRP also draw from the shallow aquifers. Two South Carolina state parks (Aiken State Park, with seven wells, and Barnwell State Park, with two) are within a 32-kilometer radius of the Plant (DOE, 1984b). Several shallow wells produce small quantities of water for SRP guardhouses.

3.4.4.3 Relationship of Precipitation and Groundwater Use to Water Levels

TE Figure 3-7 shows hydrographs of five Middendorf/Black Creek (Tuscaloosa) wells and one Ellenton well. Five of these wells are on the SRP. The sixth, AK-183, is 29 kilometers northwest of the center of the SRP in the Middendorf/Black Creek outcrop area; pumpage in the vicinity of the SRP does not influence this well. Winter (December, January, and February) precipitation (plotted at the top of Figure 3-7) is the principal source of groundwater recharge. Generally, high water levels occurred in the Middendorf/Black Creek (Tuscaloosa) in 1974, but from then until 1982 these levels declined. Winter precipitation declined from 1972 to 1981, which might account partially for the declining water levels shown by well AK-183; in addition, since 1975 SRP pumping has increased by about 80 percent, from 14.9 to 26.8 cubic meters per minute. Because of higher winter precipitation in 1982 and 1983, groundwater levels have increased.

TE Figure 3-7 shows the total SRP pumping rate; the highest rates are toward the bottom of the plot to facilitate their comparison to water levels in monitoring wells. Calculations show that the decline in water levels at monitoring wells P7A, P54, and P3A is related primarily to increased SRP groundwater withdrawals (DOE, 1984b). The drawdowns at these wells reflect adjustments to new pumping regimes rather than net depletion of the aquifer (Du Pont, 1983b). Water levels stabilize quickly (within 100 days) after pumping rates change (Mayer et al., 1973). TC

TC Withdrawals from the Middendorf/Black Creek (Tuscaloosa) at SRP could reach about 38 cubic meters per minute without diminishing potential water levels from existing (1960) production wells (Siple, 1967). In addition, this aquifer could produce more water with better-designed well fields. In 1960, the SRP pumpage from the Middendorf/Black Creek was about 19 cubic meters per minute (Siple, 1967); currently, the estimated SRP groundwater use is 27 cubic meters per minute.

3.5 SURFACE-WATER RESOURCES

3.5.1 SURFACE-WATER SYSTEMS

The Savannah River is the principal surface-water system near the SRP. It adjoins the Plant along its southwestern boundary. The total drainage area of the river, 27,388 square kilometers, encompasses all or parts of 41 counties in Georgia, South Carolina, and North Carolina. Over 77 percent of the drainage area is upriver of the SRP (Lower, 1985).

On the Plant, a swamp lies in the floodplain along the Savannah River for a distance of about 16 kilometers; its average width is about 2.4 kilometers. A small embankment or natural levee has built up along the north side of the river from sediments deposited during periods of flooding. On the SRP side of the levee, the ground slopes downward, is marshy, and contains large stands of cypress-tupelo forest and bottomland hardwoods.

The SRP is drained almost entirely by six streams: Upper Three Runs Creek, Four Mile Creek, Beaver Dam Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek (Figure 3-2). These streams rise on the Aiken Plateau and descend 30 to 60 meters before discharging to the Savannah River.

3.5.2 SURFACE-WATER HYDROLOGY

Streamflow in the Savannah River is regulated by five large reservoirs upriver of the SRP: Clarks Hill, Russell, Hartwell, Keowee, and Jocassee (DOE, 1984b; Duke Power Company, 1977). The average annual flow has been stabilized by these reservoirs to 288.8 cubic meters per second near Augusta (Bloxham, 1979) and 295 cubic meters per second near the SRP (DOE, 1984b).

TE

Natural discharge patterns in the Savannah River are cyclic: maximum river flows typically occur in the winter and spring and the lowest flows occur in the summer and fall (Figure 3-8).

Since 1963, the U.S. Army Corps of Engineers has attempted to maintain a minimum flow of 178.4 cubic meters per second below the New Savannah River Bluff Lock and Dam at Butler Creek (River Mile 187.4, near Augusta, Georgia) (COE, 1981). During the 18-year period from 1964 to 1981 (climatic years ending March 31), the average of the 7-day low flow for each year measured at the New Savannah River Bluff Lock and Dam was 181 cubic meters per second (Watts, 1982), or about 2.3 cubic meters per second less than at the SRP (Ellenton Landing, River Mile 156.8).

3.5.3 SURFACE-WATER QUALITY

In the vicinity of the SRP, the Savannah River is classified as a Class B stream under the State of South Carolina's Water Classification Regulations. Class B waters are broadly defined as suitable for secondary-contact recreation and as a source of drinking water after conventional treatment according to approved regulatory regimes (SCDHEC, 1981).

The onsite streams have not been classified by name. However, the regulations provide that "in any case where streams are not otherwise classified and are tributaries to a classified stream, they shall meet the quality standards of the classified stream" (SCDHEC, 1981). Thus, onsite streams at the SRP that are tributaries to the Savannah River are considered to be Class B streams. Routine analyses of samples from onsite stream locations since 1973 indicate that SRP discharges have complied with Class B water classification standards except for those streams receiving thermal discharges where temperature and occasionally dissolved oxygen standards are exceeded.

A two-year Comprehensive Cooling Water Study was initiated in July 1983 to ascertain the effects of thermal discharges on the Savannah River and onsite stream water quality (Du Pont, 1985b). The discussions that follow provide a summary of the water quality of the Savannah River and six major onsite streams.

3.5.3.1 Savannah River

Historically, the Augusta, North Augusta, and Aiken County areas have provided the major sources of pollution to the Savannah River in the area around the SRP. The City of Augusta did not have a secondary sewage treatment facility until 1975. Before 1975, most domestic and industrial wastes were discharged untreated or inadequately treated into the river or into Hawks Gully, Butler Creek, and Spirit Creek, which flow into the river. In the North Augusta and Aiken County areas, domestic and industrial effluents entered the Savannah River directly and via Horse Creek and Little Horse Creek (Matthews, 1982). Treatment facilities for the North Augusta and Aiken County areas did not begin operation until 1979. The SRP also discharges wastewater into the Savannah River under National Pollutant Discharge Elimination System (NPDES) Permit SC0000175. These discharges are primarily thermal effluents, but include domestic and industrial wastes (Lower, 1985).

Variability of water chemistry test results of Savannah River samples has diminished over the past 20 years, primarily because of improved waste treatment and flow stabilization provided by upstream dams. The pH of the river has remained slightly acidic. The river water is relatively soft and well oxygenated. Water temperature ranges from an average winter low of 8°C to more than 24°C during summer months. In the vicinity of the SRP, South Carolina Class B stream water classification standards are met in the Savannah River (Lower, 1985).

Based on samples collected as part of the Comprehensive Cooling Water Study from 1983 to 1985 at monitoring stations upriver of the confluence of the Savannah River with Upper Three Runs Creek and downriver of the confluence of the river with Steel Creek, mean water chemistry data indicated relatively no change in pH values, total suspended solids, alkalinity, chlorides, sulfates, phosphorus species, nitrate-nitrogen and nitrite-nitrogen, and trace metals. Mean dissolved oxygen, ammonia-nitrogen, and total kjeldahl nitrogen concentrations were slightly reduced at the downriver sampling station (Lower, 1985).

3.5.3.2 Onsite Streams

Data collected during recent studies indicate that the major factors affecting the water chemistry of onsite streams include a natural chemical gradient, thermal and current velocity conditions, addition of Savannah River water for reactor secondary cooling, natural transport and transformation processes, and point-source discharges related to SRP operations (Du Pont, 1985b). The following paragraphs describe results of recent water-chemistry samples associated with each onsite stream.

Upper Three Runs Creek

Upper Three Runs Creek tributaries are Tinker Creek and Tims Branch. Typical permitted surface discharges to Tims Branch from the A- and M-Areas include nonprocess cooling water, steam condensates, process effluents, and treated groundwater effluents (M-Area air stripper). In addition, three unnamed tributaries of Upper Three Runs Creek receive permitted ambient-temperature cooling water, steam condensate, powerhouse washdown waters, and ash basin effluents from the Separations Areas (Lower, 1985).

Upper Three Runs Creek is a slightly acid stream that is low in nutrients. The water of this stream is soft (low in calcium and magnesium). Suspended solids concentrations increase from the upper to lower reaches but are low in value at all monitoring stations. The stream has little, if any, buffering capacity to neutralize acids. The temperature of the stream ranges from approximately 8° to 24°C, with lows occurring from December through February. July and August normally constitute the period of highest temperature and lowest flows. The dissolved oxygen content is relatively constant at 8 milligrams per liter, varying slightly with the temperature of the stream; at all stations the water is saturated or nearly saturated with oxygen and exhibits a low chemical oxygen demand (less than 2 milligrams per liter) (Lower, 1984; Du Pont, 1985b). Temperature, pH, and dissolved oxygen meet South Carolina water-classification standards for Class B streams. Concentrations of metals throughout Upper Three Runs Creek reflect both the softness of the stream and the absence of any major industrial discharges (Lower, 1985).

TC

TC

Table 3-10 lists mean results of water chemistry samples of Upper Three Runs Creek from 1983 through 1985 at four sampling stations.

Four Mile Creek

From the Separations Areas, the upper reach of Four Mile Creek receives permitted powerhouse wastewater, cooling water, steam condensate, and sanitary-treatment-plant wastewater discharges. C-Reactor cooling water is discharged to Four Mile Creek. Small quantities of ambient-temperature cooling water and automotive shop effluents are also discharged to Four Mile Creek from the Central Shops (CS) Area.

Since 1973, the water quality of Four Mile Creek has been monitored at SRP Road A-7, a station downstream of F- and H-Area effluents, but upstream of thermal effluents from C-Reactor. Like Upper Three Runs Creek, waters along this reach of Four Mile Creek have low alkalinity, suspended solids, and chemical oxygen demand (Lower, 1984). However, concentrations of nutrients, particularly nitrates (as nitrogen), are higher in Four Mile Creek than in Upper Three Runs Creek. Nitrate-nitrogen concentrations at this station were generally an order of magnitude greater (mean 2.3 milligrams per liter of nitrate-nitrogen) than at all other onsite stream stations and were attributed to outcropping of nitrates from shallow groundwaters in the vicinity of the F- and H-Area seepage basins, which have received large volumes of nitrates.

TC

Downstream of C-Reactor, mean temperatures of Four Mile Creek exceeded those of the Savannah River from 13°C at the creek mouth to 39°C at the cooling water discharge. The pH of thermally affected waters in the Creek, as well as concentrations of major ions and trace metals, reflected the higher pH and concentrations of Savannah River water used as cooling water for C-Reactor. Temperature and dissolved oxygen both did not meet Class B water-classifications standards during periods of C-Reactor operation (Lower, 1985).

TE

Table 3-11 lists mean results of water chemistry samples at five stations along Four Mile Creek from 1983 through 1985.

Table 3-10. Mean Water Chemistry of Upper Three Runs Creek and Tims Branch, 1983-1985[a]

Parameter/units	Station location			
	Road F	Upstream of Road C	Tims Branch upstream of confluence with Upper Three Runs Creek	Mouth
Temperature (°C)	16.1	15.0	15.9	14.7
pH (-)	6.06	6.22	6.66	6.65
Dissolved oxygen (mg/L)	8.13	7.91	8.17	7.84
Suspended solids (mg/L)	8.70	19.0	6.70	28.8
Chlorides (mg/L)	1.60	1.70	1.80	2.10
Sulfates (mg/L)	0.35	0.53	0.26	1.24
Organic carbon (mg C/L)	6.0	8.30	7.10	7.9
Phosphorus (mg P/L)	0.03	0.05	0.04	0.05
Nitrites (mg N/L)	<0.05	<0.05	<0.05	<0.05
Nitrates (mg N/L)	0.18	0.12	0.16	0.11
Arsenic (μg As/L)	1.51	1.20	1.35	1.51
Cadmium (μg Cd/L)	0.26	0.32	0.28	0.49
Chromium (μg Cr/L)	13.5	17.9	9.97	13.5
Copper (μg Cu/L)	2.48	2.47	2.40	2.48
Lead (μg Pb/L)	2.69	2.85	2.08	2.69
Mercury (μg Hg/L)	0.05	0.06	0.07	0.05

[a] Source: Du Pont, 1985b.

Table 3-11. Mean Water Chemistry of Four Mile Creek, 1983-1985[a]

Parameter/units	Station location				
	Upstream of Road 4	Road 3	C-Reactor effluent canal	Road A-12.21	Mouth
Temperature (°C)	16.2	16.4	54.7	39.3	28.4
pH (-)	6.34	6.82	7.29	7.29	7.03
Dissolved oxygen (mg/L)	7.04	7.96	4.81	5.82	5.90
Suspended solids (mg/L)	7.50	8.30	11.9	9.50	9.30
Chlorides (mg/L)	2.60	2.90	5.30	5.00	5.70
Sulfates (mg/L)	0.61	7.70	5.10	4.90	5.70
Organic carbon (mg C/L)	9.70	6.10	9.10	7.80	7.10
Phosphorus (mg P/L)	0.02	0.02	0.10	0.09	0.11
Nitrites (mg N/L)	<0.05	<0.05	0.01	0.01	0.01
Nitrates (mg N/L)	0.02	2.27	0.28	0.44	0.39
Arsenic (µg As/L)	1.58	1.66	3.08	1.89	1.97
Cadmium (µg Cd/L)	0.46	0.35	0.25	0.26	0.21
Chromium (µg Cr/L)	11.7	15.1	17.4	11.9	12.4
Copper (µg Cu/L)	2.02	3.98	3.78	4.65	5.17
Lead (µg Pb/L)	3.09	2.03	2.78	2.13	2.05
Mercury (µg Hg/L)	0.06	0.05	0.05	0.05	0.06

[a] Source: Du Pont, 1985b.

Beaver Dam Creek

DOE placed the heavy-water production facility on standby in 1982. Since then, Beaver Dam Creek has received permitted condenser cooling water from the coal-fired powerhouse in D-Area, neutralization wastewater, sanitary wastewater, ash basin effluent waters, and various laboratory wastewaters.

In relation to onsite nonthermally or postthermally affected streams, water-quality data downstream of the D-Area near the onsite swamp exhibits chemical characteristics of a stream impacted by industrial point-source discharges. Historic water-quality data indicate Beaver Dam Creek near the swamp did not meet South Carolina Class B water-classification standards for temperature, although it met all other Class B requirements routinely. In relation to data collected at Upper Three Runs Creek, historic data also indicate that Beaver Dam Creek was higher in pH and concentrations of alkalinity, chemical oxygen demand, suspended solids, chlorides, sulfates, nutrients, and selected metals (Lower, 1984).

Table 3-12 lists mean results of water chemistry samples at three stations along Beaver Dam Creek from 1983 through 1985.

Pen Branch

The only significant tributary to Pen Branch is Indian Grave Branch, which flows into Pen Branch about 8 kilometers upstream from the onsite swamp. Indian Grave Branch receives K-Reactor cooling water discharge. Other permitted discharges to Pen Branch and Indian Grave Branch include nonprocess cooling water, ash-basin effluent waters, powerhouse wastewater, waste-treatment-plant overflow, reactor process wastewater, and sanitary wastewater, all of which are associated with K-Area operations. The only additional continuous surface discharge to Pen Branch is a small overflow from the sewage-treatment basin at the Central Shops Area near the Pen Branch headwaters (Lower, 1985).

Data from the nonthermal mainstream of Pen Branch indicate water chemistry conditions generally similar to those of Upper Three Runs Creek. Like Upper Three Runs Creek and nonthermal Four Mile Creek waters, nonthermal Pen Branch waters meet South Carolina Class B stream requirements for temperature, pH, and dissolved oxygen. Concentrations of chlorides, sulfates, phosphorous species, and organic carbon are similar in each of these streams (Lower, 1985). TE

TE The water chemistries of thermal Pen Branch and Four Mile Creek waters, particularly for trace-level metals, are similar due to the discharges of large volumes of cooling water withdrawn from the Savannah River. In relation to the Savannah River, thermal Pen Branch waters were slightly higher in pH and lower in dissolved oxygen content; the latter is attributable to elevated stream temperature. Nitrate-nitrogen concentrations closely resembled those of upriver Savannah River water. Conductivity, turbidity, suspended solids, and alkalinity analyses showed the same similar trend (Lower, 1985). TE

Table 3-13 lists mean results of water chemistry samples at five stations along Indian Grave Branch and Pen Branch from 1983 through 1985.

Table 3-12. Mean Water Chemistry of Beaver Dam Creek, 1983-1985[a]

Parameter/units	Station location: Downstream of coal-fired powerhouse	Station location: Downstream of ash basin effluent	Station location: Onsite swamp upstream of confluence with the Savannah River
Temperature (°C)	25.7	24.8	21.7
pH (-)	7.03	6.90	6.81
Dissolved oxygen (mg/L)	7.43	7.25	5.61
Suspended solids (mg/L)	10.7	13.6	15.1
Chlorides (mg/L)	6.20	6.30	5.70
Sulfates (mg/L)	6.82	11.2	7.10
Organic carbon (mg C/L)	11.1	9.80	9.20
Phosphorus (mg P/L)	0.13	0.13	0.09
Nitrites (mg N/L)	0.02	0.02	0.01
Nitrates (mg N/L)	0.31	0.33	0.29
Arsenic (µg As/L)	2.27	3.75	2.02
Cadmium (µg Cd/L)	0.35	0.44	0.23
Chromium (µg Cr/L)	15.9	12.6	19.0
Copper (µg Cu/L)	7.71	8.95	4.45
Lead (µg Pb/L)	4.18	2.34	2.24
Mercury (µg Hg/L)	0.07	0.07	0.06

[a] Source: Du Pont, 1985b.

Table 3-13. Mean Water Chemistry of Indian Grave Branch and Pen Branch, 1983-1985[a]

Parameter/units	Station location				
	Road B	Indian Grave Branch at Road B below K-Reactor effluents	Road A-13	Onsite swamp near Road A-17 and above Pen Branch Boardwalk	Onsite swamp above confluence with Steel Creek
Temperature (°C)	14.6	46.5	42.4	33.2	17.0
pH (-)	6.92	7.43	7.40	8.07	6.91
Dissolved oxygen (mg/L)	8.22	5.38	5.71	7.48	6.76
Suspended solids (mg/L)	10.0	10.4	14.4	4.90	3.20
Chlorides (mg/L)	2.50	5.90	5.60	6.00	5.80
Sulfates (mg/L)	2.60	5.10	4.80	5.00	5.10
Organic carbon (mg C/L)	7.20	7.60	7.60	7.70	8.50
Phosphorus (mg P/L)	0.04	0.11	0.08	0.10	0.06
Nitrites (mg N/L)	<0.05	0.02	0.02	0.01	<0.05
Nitrates (mg N/L)	0.05	0.27	0.30	0.23	0.09
Arsenic (µg As/L)	1.49	3.40	3.56	2.78	1.46
Cadmium (µg Cd/L)	0.22	0.30	0.25	0.21	0.24
Chromium (µg Cr/L)	9.74	15.7	16.5	11.1	11.1
Copper (µg Cu/L)	3.16	5.14	3.47	4.10	3.23
Lead (µg Pb/L)	2.31	3.15	2.07	3.55	1.99
Mercury (µg Hg/L)	0.06	0.06	0.06	0.05	0.05

[a] Source: Du Pont, 1985b.

Steel Creek

Discharges to Steel Creek, before the operation of L-Reactor, included those from the P- and L-Areas and the Railroad Yard. These effluents were discharged either to Steel Creek or to Meyers Branch, its principal tributary. The permitted discharges include ash basin effluent water, nonprocess cooling water, powerhouse wastewater, reactor process effluents, sanitary-treatment-plant effluents, water-treatment-plant wastewaters, and vehicle wash waters (Lower, 1985).

Temperature and dissolved oxygen data from 1960 to 1968 in Steel Creek at Road A, when the Creek received thermal discharges, indicated conditions similar to those in Four Mile Creek and Pen Branch (Jacobsen et al., 1972). Temperature values and dissolved oxygen concentrations for the latter half of 1968 show a return to nonthermal temperature and dissolved oxygen conditions following the placement of L-Reactor on standby in February 1968.

Recent sampling indicates that all major constituent groups - standard parameters, nutrients, major cations, and metals - fall in ranges associated with streams where natural drainage rather than point-source discharges is the dominant input. Calcium concentrations are slightly increased in relation to those in Upper Three Runs Creek, reflecting the natural chemical gradient existing from the northwest to the southeast borders of the SRP (Du Pont, 1985b). South Carolina Class B water-classification standards for temperature, pH, dissolved oxygen, and fecal coliform counts were met routinely (Lower, 1985).

Table 3-14 lists mean results of water chemistry samples at stations along Steel Creek from 1983 through 1985.

DOE identified the construction of L-Lake on Steel Creek as the preferred method for thermal mitigation of the cooling water from L-Reactor heat exchangers after restart (DOE, 1984b). Fifty percent of this 1000-acre lake is maintained below 32.2°C to support a balanced biological community. The lake is about 1200 meters wide at its widest point and extends about 7000 meters along the Steel Creek valley. The normal pool elevation of the lake is 58 meters above mean sea level (MSL). The storage volume at normal pool elevation is about 31 million cubic meters.

The lake is formed by an embankment approximately 800 meters upstream from the Seaboard Coast Line Railroad Bridge across Steel Creek or 1700 meters upstream from Road A. It is 1200 meters long at the crest, which includes approximately 600 meters of low embankment connecting the west end of the main embankment to the natural ground at elevation 61 meters above MSL. The main embankment is about 26 meters high, 12 meters wide at the top, and 200 meters wide at the base. An outlet structure with gates controls the discharge from the lake to a conduit running 220 meters under the embankment. This conduit discharges into a stilling basin to reduce the water velocity before its release into Steel Creek. TE

Lower Three Runs Creek

Lower Three Runs Creek is the second-largest watershed of the SRP streams. In 1958, its headwaters were impounded to form Par Pond for the recirculation of

Table 3-14. Mean Water Chemistry of Meyers Branch and Steel Creek, 1983-1985[a]

Parameter/units	Station location				
	Road B	Above confluence with Meyers Branch	Meyers Branch above confluence with Steel Creek	Road A-19.1	Below delta after confluence with Pen Branch
Temperature (°C)	17.7	17.2	15.3	15.6	17.2
pH (-)	7.08	7.01	6.93	7.01	6.91
Dissolved oxygen (mg/L)	8.44	8.05	8.03	7.54	6.82
Suspended solids (mg/L)	28.0	16.9	4.60	10.7	2.50
Chlorides (mg/L)	5.20	5.30	2.70	4.50	5.20
Sulfates (mg/L)	4.30	5.20	0.90	3.40	4.50
Organic carbon (mg C/L)	6.00	8.60	8.50	8.70	9.00
Phosphorus (mg P/L)	<0.05	0.06	0.02	0.05	0.05
Nitrites (mg N/L)	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrates (mg N/L)	0.19	0.20	0.09	0.14	0.07
Arsenic (μg As/L)	2.69	2.89	1.90	2.50	2.05
Cadmium (μg Cd/L)	0.20	0.26	0.22	0.21	0.24
Chromium (μg Cr/L)	7.15	9.23	10.8	12.1	6.48
Copper (μg Cu/L)	4.46	2.65	2.36	3.47	3.02
Lead (μg Pb/L)	2.13	4.88	1.74	4.62	1.72
Mercury (μg Hg/L)	0.05	0.07	0.05	0.07	0.05

[a] Source: Du Pont, 1985b.

cooling water from P- and R-Reactors. Cooling water from P-Reactor was discharged to Steel Creek until 1963, when it was diverted to Par Pond. Temperature data from just downstream of Par Pond indicate an average temperature about 2°C higher than other nonthermal streams. In addition, reduced dissolved oxygen concentrations, especially during summer months, are observed at this station. Calcium concentrations are higher in the waters of Lower Three Runs Creek than in other onsite streams. Higher concentrations of calcium and total iron indicate that Lower Three Runs Creek is less soft than the other onsite stream waters. Portions of Lower Three Runs Creek are underlain by calcareous deposits (Langley and Marter, 1973), which increase the hardness of the water. These historic water-chemistry trends have been confirmed by more recent water-quality studies (Du Pont, 1985b).

Table 3-15 lists mean results of water chemistry samples at stations along Lower Three Runs Creek from 1983 through 1985.

3.5.4 SURFACE-WATER USE

The Savannah River upstream from the SRP supplies municipal water for Augusta, Georgia, and North Augusta, South Carolina. Downstream, the Beaufort-Jasper Water Authority in South Carolina (River Mile 39.2) withdraws about 19,700 cubic meters per day (0.23 cubic meter per second) to supply domestic water for a population of about 51,000. The Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia (River Mile 29.0) withdraws about 116,000 cubic meters per day (1.35 cubic meters per second) to supply a business-industrial complex near Savannah, Georgia, that has an estimated consumer population of about 20,000 (Du Pont, 1982b). Plant expansions for both systems are planned for the future (i.e., Beaufort-Jasper Water Authority to supply domestic water to 117,000 people and Cherokee Hill Water Treatment Plant to supply a domestic equivalent of 200,000 people in the year 2000).

With the restart of L-Reactor, the maximum SRP withdrawal rate from the river has increased to about 37 cubic meters per second, primarily for use as cooling water in production reactors and coal-fired steam plants. Almost all of this water returns to the river via SRP streams; consumptive water use is about 0.85 cubic meter per second at C- and K-Reactors, 1.25 cubic meters per second at L- and P-Reactors, and about 0.3 cubic meter per second at the D-Area powerhouse (DOE, 1984b).

A cooling water withdrawal of about 2.6 cubic meters per second and a discharge of 0.7 cubic meter per second for both units of the Alvin Vogtle Nuclear Power Plant is expected late in the 1980s (NRC, 1985). Unit 1 began full-power operation in May 1987. TC

The Urquhart Steam Generating Station at Beech Island, South Carolina, withdraws approximately 7.4 cubic meters per second of once-through cooling water. Upstream, recreational use of impoundments on the Savannah River, including water-contact recreation, is more extensive than it is near the SRP and downstream. No uses of the river for irrigation have been identified in either South Carolina or Georgia (Du Pont, 1982b).

Table 3-15. Mean Water Chemistry of Par Pond and Lower Three Runs Creek, 1983-1985[a]

Parameter/units	Station location				
	Near bubble-up	Pumphouse intakes	Road B	Pattersons Mill	Highway 125
Temperature (°C)	30.3	20.9	18.7	15.7	15.5
pH (-)	7.33	7.28	6.92	7.17	7.17
Dissolved oxygen (mg/L)	6.56	8.27	7.14	7.63	7.45
Suspended solids (mg/L)	2.18	3.65	4.30	5.60	4.50
Chlorides (mg/L)	6.25	6.02	6.10	3.70	3.60
Sulfates (mg/L)	5.02	4.97	3.40	1.60	0.70
Organic carbon (mg C/L)	6.46	7.47	10.2	7.90	9.00
Phosphorus (mg P/L)	0.04	0.02	0.04	0.03	0.05
Nitrites (mg N/L)	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrates (mg N/L)	0.05	0.03	0.04	0.09	0.13
Arsenic (μg As/L)	2.42	1.56	2.58	1.94	1.95
Cadmium (μg Cd/L)	0.20	0.31	0.22	0.12	0.26
Chromium (μg Cr/L)	13.6	8.94	10.9	10.8	6.88
Copper (μg Cu/L)	3.12	4.29	3.46	2.45	2.60
Lead (μg Pb/L)	1.58	3.17	1.74	1.25	2.24
Mercury (μg Hg/L)	0.09	0.07	0.06	0.05	0.06

[a] Source: Du Pont, 1985b.

3.6 ECOLOGY

The United States Government acquired the 780-square-kilometer Savannah River Plant in 1951. At that time the land was approximately two-thirds forested and one-third cropland and pasture. The U.S. Forest Service allowed the abandoned fields to pass through vegetational succession or planted them with various pine species. Today, more than 90 percent of the SRP is forested.

Table 3-16 lists recent SRP land utilization, other than the land used for chemical or nuclear processes and support facilities. The SRP, which was designated as a National Environmental Research Park in 1972, is one of the most extensively studied environments in this country (Dukes, 1984).

Table 3-16. Land Utilization, 1983[a]

	Area (acres)
Land	
Open fields	650
Slash pine	35,000
Longleaf pine	37,500
Loblolly pine	48,000
Pine-hardwood (60% pine)	4,000
Hardwood-pine (60% hardwood)	6,300
Scrub oak	2,000
Upland hardwoods	4,500
Bottomland hardwoods	29,000
Other pine	100
Subtotal	167,050
Wetlands	
Creeks/floodplains	24,500
Savannah River swamp	10,000
Par Pond	2,700
Carolina bays	1,000
Other	1,000
Subtotal	39,200
Total	206,250[b]

[a] Adapted from Dukes, 1984.

[b] Exceeds total SRP acreage due to overlap in wetlands and bottomland hardwood acres.

3.6.1 TERRESTRIAL ECOLOGY

3.6.1.1 Soils

A general soils map of the Savannah River Plant (Aydelott, 1977) groups the soil types into 23 mapping units. The dominant types are Fuquay/Wagram Soils (27.3 percent), Dothan/Norfolk soils (9.6 percent), Savannah River swamp and Lower Three Runs corridor (9.4 percent), Troop Loamy Sand, Terrace phase (8.4 percent), Gunter Sand (7.5 percent), and Vaucluse/Blaney Soils (6.5 percent). Together, these units account for approximately 70 percent of the soil types on the SRP.

3.6.1.2 Vegetation

The SRP is near the line that divides the oak-hickory-pine forest and the southern mixed forest. Consequently, it has species representative of each forest association. Prior to its acquisition by the Government, approximately one-third of the SRP was cropland. Except for the production areas and their support facilities, the U.S. Forest Service has reclaimed many previously disturbed areas through natural plant succession or by planting with pine trees. No virgin forest remains in the region (Braun, 1950).

A variety (150 families, 1097 species) of vascular plants exist on the Plant (Dukes, 1984). Typically, a scrub oak community covers the drier sandy areas; longleaf pine, turkey oak, bluejack oak, blackjack oak, and dwarf post oak with ground cover of three awn grass and huckleberry dominate such communities.

Oak-hickory hardwoods are prevalent on more fertile, dry uplands. The characteristic species are white oak, post oak, southern red oak, mockernut hickory, pignut hickory, and loblolly pine with an understory of sparkleberry, holly, greenbriar, and poison ivy. Table 3-17 lists the common and scientific names for selected biota (flora and fauna) on the Plant. TC

3.6.1.3 Wildlife

TE The diversity and abundance of wildlife that inhabit the SRP (Table 3-17) reflect the interspersion and heterogeneity of the habitats existing on the Plant. Because of its mild climate and the variety of aquatic and terrestrial habitats, the SRP contains a varied and abundant herpetofauna (DOE, 1984b; Gibbons and Patterson, 1978). The species on the Plant include 31 snakes, 26 frogs and toads, 17 salamanders, 10 turtles, 9 lizards, and 1 alligator (Dukes, 1984).

Species collected during intensive field studies on Steel Creek, particularly during 1981 and 1982, are representative of species existing in similar creeks and wetland areas (Dukes, 1984). Biologists have identified more than 213 species of birds on the SRP. Gamebird populations such as quail and dove were abundant initially but have declined since the 1960s because the conversion of agricultural fields to forests has resulted in a reduced carrying capacity. Waterfowl on the SRP are mainly winter migrants. Wood ducks are the only waterfowl species to breed consistently in the SRP region, although mallards and hooded mergansers occasionally breed on the SRP.

Table 3-17. Common and Scientific Names for Selected Biota on the SRP

Common Name	Scientific Name
VEGETATION	
White oak	*Quercus alba*
Post oak	*Quercus stellata*
Turkey oak	*Quercus laevis*
Southern red oak	*Quercus falcata*
Black-jack oak	*Quercus marilandica*
Blue-jack oak	*Quercus incana*
Scrub oak	*Quercus* sp.
Dwarf post oak	*Quercus* sp.
Mockernut hickory	*Carya tomentosa*
Pignut hickory	*Carya glabra*
Long-leaf pine	*Pinus palustris*
Loblolly pine	*Pinus taeda*
Squaw-huckleberry	*Vaccinium stamineum*
Sparkleberry	*Vaccinium arboreum*
Holly *Ilex* spp.	
Three-awn grass	*Aristida* spp.
Greenbrier	*Smilax* spp.
Poison ivy	*Rhus radicans*
Poison oak	*Rhus toxicodendron*
AQUATIC FLORA	
Watermilfoil	*Myriophyllum* spp.
Hornwort	*Ceratophyllum* spp.
Alligatorweed	*Alternanthera philoxeroides*
Water-weed	*Elodea* spp.
Arrowhead	*Sagittaria* sp.
WILDLIFE	
Bobwhite quail	*Colinus virginianus*
Mourning dove	*Zenaidura macroura*
Wood duck	*Aix sponsa*
Mallard duck	*Anas platyrhynchos*
Hooded merganser	*Mergus cucullatus*
COMMERCIAL AND RECREATIONALLY VALUABLE SPECIES	
White-tailed deer	*Odocoileus virginianus*
Feral hog (swine)	*Sus scrofa*
Bullfrog	*Rana catesbeiana*
Slider turtle	*Pseudemys* spp.
Florida cooter	*Chrysemys f. floridana*

TC

Table 3-17. Common and Scientific Names for Selected Biota on the SRP (continued)

Common Name	Scientific Name
ENDANGERED AND THREATENED SPECIES	
American alligator[a]	*Alligator mississippiensis*
Southern bald eagle	*Haliaeetus l. leucocephalus*
Wood stork	*Mycteria americana*
Red-cockaded woodpecker	*Picoides borealis*
Smooth coneflower	*Echinacea laevigata*
Pelict trillium	*Trillium reliquum*
Sand-burrowing mayfly	*Dolania americana*
AQUATIC FAUNA	
Mayflies	Ephemeroptera
Dragonflies	Odonata
True flies	Diptera
Snails	Gastropoda
Clams	Pelecypoda
Asiatic clam	*Corbicula fluminea*
Sunfish	*Lepomis* spp.
TC Redbreast	*Lepomis auritus*
Flat bullheads	*Ictalurus platycephalus*
Bowfin	*Amia calva*
Spotted suckers	*Minytrema melanops*
Channel catfish	*Ictalurus punctatus*
Largemouth bass	*Micropterus salmoides*
American eel	*Anguilla rostrata*
White catfish	*Ictalurus catus*
Longnose gar	*Lepisosteus osseus*
Striped mullet	*Mugil cephalus*
Silver redhorse	*Myoxostoma anisurum*
Chain pickerel	*Esox niger*
Quillback carpsucker	*Carpiodes cyprinus*
Shiners	*Notropis* spp.
Brook silverside	*Labidesthes sicculus*
COMMERCIALLY AND RECREATIONALLY VALUABLE SPECIES	
American shad	*Alosa sapidissima*
Channel catfish	*Ictalurus punctatus*
Atlantic sturgeon	*Acipenser oxyrhynchos*
ENDANGERED SPECIES	
Shortnose sturgeon	*Acipenser brevirostrum*

---

[a] Threatened due to similarity of appearance.

3.6.1.4 Commercially and Recreationally Valuable Biota

The ecosystems on the SRP support many commercially and recreationally valuable game populations (Table 3-17); however, DOE restricts recreational use to controlled hunts for white-tailed deer and feral hogs. Many species are highly mobile and migrate offsite where activities such as hunting are allowed. Other resident species that are edible and that migrate offsite include the wood duck, bullfrog, and various species of turtles. The slider turtle is the most abundant turtle known to migrate offsite; other common species that move offsite include the Florida cooter and the snapping turtle (DOE, 1984b). Commercially valuable plant biota on the Savannah River Plant include approximately 175,000 acres of timber managed by the U.S. Forest Service.

TE

3.6.1.5 Endangered and Threatened Species

Three species listed as endangered by the U.S. Fish and Wildlife Service - the bald eagle, the wood stork, and the red-cockaded woodpecker - have been identified on the SRP. In addition, one plant species - smooth coneflower (Echingcea laevigata) - found on the Plant is currently under status review by the U.S. Fish and Wildlife Service. The smooth coneflower occurs along Burma Road, which parallels Upper Three Runs Creek between F-Area and TNX-Area. To date, the U.S. Fish and Wildlife Service has not identified any "critical habitat" on the SRP. (See Table 3-17). The relict trillium (Trillium reliquum), a proposed endangered species, is not found on the Plant but in nearby counties (Aiken and Allendale). It is reported as locally abundant along Savannah River bluffs northwest of Beech Island. The sand-burrowing mayfly (Dolania americana), under status review, is found in Upper Three Runs Creek on the Plant. On June 4, 1987, the U.S. Fish and Wildlife Service reclassified the American alligator from endangered to threatened due to similarity of appearance, because the species is no longer biologically endangered or threatened in seven states, including Georgia and South Carolina (52 FR 21059-21064). The threatened due to similarity of appearance status was retained to ensure against excessive taking and to continue necessary protection to the American crocodile (Crocodylus acutus), a morphologically similar species.

TC
TC
TC
TE

3.6.2 AQUATIC ECOLOGY

3.6.2.1 Aquatic Flora

The Savannah River is the dominant water body on the SRP. Biologists have identified approximately 400 species of algae in the river, with diatoms predominant. Blue-green algae are sometimes common upstream from the site; their abundance is attributed to organic loading from municipal sources. Algal diversity has decreased since 1951, probably because of increased organic loading in the Savannah River upriver of the SRP (ANSP, 1961, 1974).

Aquatic macrophytes in the river, most of which are rooted, are limited to shallow areas of reduced current and to areas along the shallow margins of tributaries. Eight species of vascular plants have been identified in the river adjacent to the SRP, the most abundant being water milfoil, hornwort, alligatorweed, waterweed, and duck potato (DOE, 1984b).

3.6.2.2 Aquatic Fauna

Shallow areas and quiet backwaters and marshes of the Savannah River near the SRP support a diverse aquatic invertebrate fauna. However, the bottom substrate of most open portions of the river consists of shifting sand that does not provide the ideal habitat for bottom-dwelling organisms. During the 1950s, the total number of invertebrate species in the river decreased; this has been attributed primarily to the effects of dredging (Patrick, Cairns, and Roback, 1967). The groups most affected are those sensitive to the effects of siltation and substrate instability. Mayflies and dragonflies predominated
TE among insect fauna in earlier surveys. In more recent surveys, true flies have been dominant (DOE, 1984b). See Table 3-17.

Mollusks such as snails and clams are an important component of the Savannah River invertebrate community, but they do not occur in the drift communities, presumably because their relatively high density (weight) prevents them from floating. The Asiatic clam, Corbicula, is found in the Savannah River and larger tributary streams in the vicinity of the SRP (DOE, 1984b).

The Savannah River and its associated swamp and tributaries are typical of southeastern Coastal Plain rivers and streams; they support a diverse fish fauna. Sixty-six adult fish species were collected as part of the Comprehensive Cooling Water Study (Du Pont, 1985b). The dominant small fishes (excluding minnows) were sunfishes (especially redbreast) and flat bullheads. The dominant large fishes were bowfin, spotted suckers, and channel catfish. Other important species were largemouth bass, American eel, white catfish, longnose gar, striped mullet, silver redhorse, chain pickerel, and quillback carpsucker. The most abundant small forage species were shiners and brook silverside.

3.6.2.3 Commercially and Recreationally Valuable Biota

The Savannah River supports both commercial and sport fisheries. Most fishing is confined to the marine and brackish waters of the coastal regions of South Carolina and Georgia. The only commercial fish of significance near the SRP are the American shad, the channel catfish, and the Atlantic sturgeon
TE (Table 3-17). (The commercial catch of American shad from the Savannah River during 1979 was 57,600 kilograms.)

3.6.2.4 Endangered and Threatened Species

TE Recent fisheries surveys on the Savannah River revealed that the endangered shortnose sturgeon (Table 3-17) spawn in the vicinity of the Savannah River Plant (Du Pont, 1985b). A biological assessment of the potential effects of SRP operations on the shortnose sturgeon in the Savannah River (Muska and Matthews, 1983) was submitted to the National Marine Fisheries Service (NMFS). The NMFS and DOE have concurred that the population of the shortnose sturgeon in the Savannah River would not be jeopardized by SRP operations (Oravetz, 1983).

3.7 RADIATION AND HAZARDOUS CHEMICAL ENVIRONMENT

3.7.1 *RADIATION ENVIRONMENT*

Environmental radiation consists of (1) natural background radiation from cosmic and terrestrial sources and internally deposited natural radionuclides; and (2) man-made radiation from medical diagnosis and therapy, weapons test fallout, consumer and industrial products, and nuclear facilities. The following sections briefly describe the current radiation environment from natural and other offsite sources and radioactivity in the atmospheric, water, and soil environments as a result of SRP activities, as summarized in Table 3-18. TE

3.7.1.1 Radiation Levels from Natural and Other Offsite Sources

Natural radiation sources contribute about 288 millirem per year in the SRP vicinity, 75 percent of the annual dose of 384 millirem received by an average member of the public in this area from all sources. The contribution of cosmic radiation to this dose varies with both latitude and altitude, but averages about 40 millirem per year to an unshielded individual in Georgia and South Carolina (EPA, 1972); this is reduced to about 80 percent of that value (or 32 millirem per year) by buildings. J-38

Local gamma radiation exposure from naturally radioactive daughters of uranium and thorium, and naturally radioactive potassium-40 present in the ground within 80 kilometers of the SRP ranges between 6 and 385 millirem per year (Langley and Marter, 1973). The average unshielded external terrestrial background radiation in the vicinity of SRP averages about 55 millirem per year, and is reduced by buildings and the body to about 33 millirem per year.

Internal radiation from natural sources arises primarily from potassium-40, carbon-14, rubidium-87, and daughters of radium-226 deposited in various organs of the body. The estimated average radiation exposure in the United States from these natural radionuclides internal to the body is 28 millirem per year (BEIR, 1980). Radon emanations in houses, previously not reported, account for an average of 195 millirem (dose to the human lung) per year per individual (Zeigler et al., 1987). TC

Radiation received as a consequence of medical diagnosis and therapy represents the largest single contribution of man-made origin to the average individual dose. In the United States, this dose, averaged over the population, is about 93 millirem per year, or about one-third of that received from natural background in the vicinity of the SRP. All other man-made sources, including such sources as weapons test fallout, consumer and industrial products, nuclear facilities, and air travel, account collectively for less than 10 millirem per year, or about 5 percent of the total annual dose to an average individual (BEIR, 1980). J-38

Other nuclear facilities operating within 80 kilometers of the SRP are the low-level radioactive waste burial site operated by Chem-Nuclear Systems, Inc., near the eastern SRP boundary, and Unit 1 of the Alvin W. Vogtle Nuclear Power Plant. F-9 The Chem-Nuclear facility, which began operating in 1971, releases essentially no radioactivity to the environment, and the incremental radiation dose to the public from both normal operations and the transportation of waste to the burial site is negligible.

TE Table 3-18. Major Sources of Radiation Exposure in the Vicinity of the SRP[a]

J-38

Source of exposure	Dose to average individual (mrem/yr)	Percent of exposure
Natural background radiation		
Cosmic radiation	32.0	
External terrestrial gamma	33.0	
Internal	28.0	
Radon in homes[b]	195.0	
Subtotal	288.0	75.0
Medical radiation		
Diagnostic X-rays	77.0	
Radiopharmaceuticals	14.0	
Subtotal	91.0	23.7
Weapons test fallout	4.6	1.2
Consumer and industrial products	4.5	1.2
Air travel	0.5	0.1
Nuclear facilities (other than SRP)	<0.1	<0.1
SRP environmental radioactivity - 1986	0.05	<0.1
Total	384.0	

[a] Source: Zeigler et al., 1987.
[b] Dose to human lung.

F-9 Unit 1 of the Vogtle Nuclear Power Plant began full-power operation in May 1987; Unit 2 is currently under construction. Based on radionuclide releases reported from 71 commercial power reactors operating at 48 sites in 1981, the average per capita dose to residents within 80 kilometers was about 0.0016 millirem (NRC, 1985). Assuming average performance by the Vogtle plant, the total environmental radiation dose from natural and other offsite sources would not change significantly.

3.7.1.2 SRP Radiation Environment

TC As noted in Table 3-18, SRP releases in 1986 contributed about 0.05 millirem to the average individual within 80 kilometers of the Plant, less than
TC 0.1 percent of the total individual radiation dose from all sources. The major contributor to this dose and to that calculated at the SRP perimeter (see Table 3-19) is tritium released to the atmosphere.

Table 3-19. Atmospheric Releases and Concentrations at SRP Perimeter, 1986[a]

Nuclide	Curies released at emission source	Calculated average concentration at Plant perimeter, (µCi/cm^3)	DOE derived concentration guide, (µCi/cm^3)[b]	Percent of DOE derived concentration guide
		Gases and Vapors		
H-3 (oxide)	2.85×10^{5}	8.8×10^{-11}	2.0×10^{-7}	4.4×10^{-2}
H-3 (elemental)	1.40×10^{5}	4.3×10^{-11}	b	b
H-3 Total	4.25×10^{5}	1.3×10^{-10}	b	b
C-14	5.60×10^{1}	1.8×10^{-14}	5.0×10^{-7}	3.5×10^{-6}
Ar-41	8.32×10^{4}	1.3×10^{-11}	b	b
Kr-85m	1.99×10^{3}	4.7×10^{-13}	b	b
Kr-85	7.10×10^{5}	2.2×10^{-10}	b	b
Kr-87	1.38×10^{3}	1.7×10^{-13}	b	b
Kr-88	2.43×10^{3}	4.9×10^{-13}	b	b
Xe-131m	3.00×10^{-1}	9.3×10^{-17}	b	b
Xe-133	1.06×10^{4}	3.3×10^{-12}	b	b
Xe-135	2.60×10^{3}	7.1×10^{-13}	b	b
I-129	8.70×10^{-2}	2.5×10^{-17}	7.0×10^{-11}	3.5×10^{-5}
I-131	2.64×10^{-2}	7.4×10^{-18}	4.0×10^{-10}	1.9×10^{-6}
		Particulates		
Co-60	8.00×10^{-6}	2.3×10^{-21}		
Se-75	2.10×10^{-5}	6.0×10^{-21}	1.0×10^{-9}	6.0×10^{-10}
Sr-89,90	1.97×10^{-3}	5.6×10^{-19}	9.0×10^{-12}	6.2×10^{-6}
Zr-95	4.38×10^{-3}	1.2×10^{-18}	6.0×10^{-9}	2.1×10^{-7}
Nb-95	9.18×10^{-3}	2.6×10^{-18}	3.0×10^{-9}	8.7×10^{-8}
Ru-103	3.50×10^{-3}	9.9×10^{-19}	2.0×10^{-9}	5.0×10^{-8}
Ru-106	5.90×10^{-2}	1.7×10^{-17}	3.0×10^{-11}	5.6×10^{-5}
Cs-134	6.94×10^{-4}	2.0×10^{-19}	2.0×10^{-10}	9.9×10^{-8}
Cs-137	2.95×10^{-3}	8.4×10^{-19}	4.0×10^{-10}	2.1×10^{-7}
Ce-141	1.90×10^{-5}	5.4×10^{-21}	1.0×10^{-9}	5.4×10^{-10}
Ce-144	1.10×10^{-2}	3.1×10^{-18}	3.0×10^{-11}	1.0×10^{-5}
Os-185	1.40×10^{-4}	4.0×10^{-20}	1.0×11^{-9}	4.0×10^{-9}
U-235,238	1.57×10^{-3}	4.5×10^{-19}	1.0×10^{-13}	4.5×10^{-4}
Pu-238	2.02×10^{-3}	5.7×10^{-19}	3.0×10^{-14}	1.9×10^{-3}
Pu-239	3.36×10^{-4}	9.5×10^{-20}	2.0×10^{-14}	4.8×10^{-4}
Cm-242,244	2.80×10^{-5}	7.9×10^{-21}	4.0×10^{-14}	2.0×10^{-5}
Am-241,243	1.54×10^{-4}	4.4×10^{-20}	2.0×10^{-14}	2.2×10^{-4}

Source: Zeigler et al., 1987.

[a] Derived air concentration guide is that concentration breathed continuously at a rate of 8400 cubic meters per year that will result in an annual dose rate of 100 mrem/year.

[b] *Not applicable to elemental tritium and inert noble gases.*

Atmospheric Environment

J-38 Table 3-19 lists the releases of radioactive materials to the atmosphere from SRP operations in 1986. This table also compares the average concentrations of these materials in the air at the SRP perimeter to DOE concentration guides. These guides are recommended concentration limits for continuous inhalation exposure for persons in uncontrolled areas beyond the SRP boundary, based on a prolonged exposure (expected to last 5 years) of 100 millirem per year. The concentrations at the SRP boundary of all radionuclides released to the atmosphere from the Plant in 1986 were less than 1 percent of the DOE concentration guides (Zeigler et al., 1987).

J-38 Tritium from the SRP was detectable at offsite stations. The maximum tritium oxide concentration observed at an SRP perimeter station was 520 picocuries per cubic meter, which is 0.26 percent of the DOE concentration guides. The concentration in air at all SRP perimeter stations averaged 79 picocuries per cubic meter - 0.04 percent of the concentration guide - compared to 10 picocuries per cubic meter at 160-kilometer-radius stations (Zeigler et al., 1987).

J-38 The small amount of particulate alpha and beta radioactivity released to the atmosphere, primarily from the fuel separations areas, generally is obscured in the area surrounding SRP by worldwide fallout. The four sampling location groups (onsite, SRP perimeter, 40-, and 160-kilometer radius) had essentially the same monthly average particulate alpha and beta concentrations in 1986. The 1986 average alpha activity range at these four location groups was 0.00086 to 0.0013 picocurie per cubic meter, which was similar to the 1985 range of 0.00098 to 0.0012 picocurie per cubic meter (Zeigler et al., 1987).

J-38 In 1986, the particulate beta-gamma concentrations for all sample groups averaged 0.021 to 0.028 picocurie per cubic meter. This is slightly above the average beta-gamma activity reported in 1985. Since 1981, however, there has been a fourfold decline in the average beta activity in air. This decreased activity is attributed to a decline in worldwide fallout from atmospheric nuclear weapons testing. The last announced atmospheric weapons test occurred in China in 1980 (Zeigler, Lawrimore, and Heath, 1986; and Zeigler et al., 1987).

J-38 In 1986, environmental gamma radiation measurements at the air-monitoring stations were within the ranges observed at these stations during the past several years. Variations in background radiation levels are caused by differences in cosmic radiation in the natural radium and thorium content of the soil and the presence of rocks on or near the earth's surface (rocks contain more radium and thorium than soil). The variations in background radiation are reflected in the data listed in Table 3-20 (Zeigler et al., 1987).

Groundwater Environment

TC Solid and liquid low-level radioactive waste is treated and disposed of on the SRP. Radioactive releases from disposal operations enter the shallow groundwater at specific operating areas on the Plant. The migration of radionuclides to groundwater occurs via seepage basins that have received low-level radioactive liquid waste streams and via leachates from buried solid low-level
TC radioactive wastes. The shallow groundwater that contains radioactivity eventually discharges to onsite streams (Stone and Christensen, 1983).

Table 3-20. Air Monitoring Station Radiation Measurements, 1986[a] TE

Locations	Radioactivity measurements (millirem per year) Maximum	Minimum	Average
Plant perimeter	84	47	73
40-km radius	84	47	58
160-km radius	204	40	88

[a]Source: Zeigler et al., 1987.

J-38

Tritium is the most abundant and mobile radionuclide that enters the shallow groundwater. Others include strontium-90, cesium-137, and plutonium-238 and -239. However, because the latter radionuclides tend to adsorb on soil beneath the seepage basins and burial grounds, they migrate very slowly. The soil column acts as a mechanism which removes many radionuclides from groundwater. However, technetium-99 and iodine-129 are long-lived and mobile in the groundwater environment. These radionuclides have been detected in groundwater by special techniques. They occur at very low levels that cannot be measured by accepted standard routine monitoring procedures (Stone and Christensen, 1983). TE

Waste sites that are the principal contributors of tritium to shallow groundwater include the K-Area containment basin, the F- and H-Area seepage basins, and the radioactive waste Burial Grounds (Stone and Christensen, 1983).

Tritium is the only radionuclide detected migrating via shallow groundwater TE from the K-Area containment basin to Pen Branch. Weekly flow measurements combined with tritium concentrations indicated the migration of 6130 curies in 1986 (Zeigler et al., 1987). Tritium concentrations in groundwater exceed the EPA drinking-water standard of 20,000 picocuries per liter (Stone and Christensen, 1983). In 1986, the total measured migration of tritium was 1770 curies from the F-Area seepage basins and 12,570 curies from the H-Area seepage basins and the low-level radioactive waste burial grounds. J-38 The tritium from these sources mix and cannot be distinguished from each other. The amounts of strontium-90 migration from F- and H-Area seepage basins are 0.16 and 0.08 curie, respectively (Zeigler et al., 1987).

A tritium plume in shallow groundwater is present at all active reactor TC seepage basins. The basin in L-Area and the backfilled basins in R-Area have been inactive for many years. Tritium plumes already have reached surface streams in these areas (Pekkala et al., 1987). Tritium concentrations in TC groundwater around the P- and C-Area seepage basins exceed the EPA drinking-water standard of 20,000 picocuries per liter. Groundwater in R-Area contains strontium-90 in excess of the EPA drinking-water standard (8 picocuries per liter). Elevated levels of nonvolatile beta activity in monitoring wells near the P- and C-Area seepage basins suggest that groundwater near these basins contains strontium-90 above 8 picocuries per liter. Radionuclides have also been detected in shallow groundwater at the L-Area oil and chemical basin and the Savannah River Laboratory seepage basins (Stone and Christensen, 1983). Additional waste site groundwater monitoring and groundwater transport modeling data and information are given in the 26 Environmental Information Documents (EIDs) prepared in support of this EIS. These documents are referenced in Appendixes B and F.

TC Wells in the deep Middendorf/Black Creek (Tuscaloosa) aquifer provide drinking water for many areas of the SRP and for surrounding towns. Drinking water supplies from onsite and offsite wells in the Middendorf/Black Creek are routinely sampled and analyzed by the SRP for alpha, nonvolatile beta, and tritium. The analytical results for 1984, 1985, and 1986 are summarized in Tables 3-21 through 3-23. Alpha and nonvolatile beta values greater than the lower level of detection are attributed to the naturally occurring radium and thorium that exist in groundwater in the SRP area (Zeigler et al., 1987). Tritium levels are occasionally greater than the lower level of detection, but are well below the drinking-water standard of 20,000 picocuries per liter. Elevated levels of tritium in onsite deep wells are under study by DOE.

Surface-Water Environment

TE J-38 Table 3-24 lists liquid releases from the SRP and resulting concentrations in surface water for 1986, together with their Derived Concentration Guides (DCGs). The release of tritium accounts for more than 99 percent of the total radioactivity introduced into streams and rivers from SRP activities; 28,000 curies were transported in the Savannah River in 1985. After dilution by SRP streams and the Savannah River, tritium concentrations averaged 3900 picocuries per liter in the river below the Plant at Highway 301.

TC J-38 Radionuclides in onsite streams include both releases directly to the streams and migration in shallow groundwater from seepage basins and waste burial sites. Table 3-25 lists mean concentration values reported for 1986 with their DCGs. Even before dilution in the Savannah River, these concentrations in onsite streams are very small percentages of their respective DCGs.

Soil Environment

Radioactive materials are found in surface soils on and in the vicinity of the SRP as a result of deposition processes from the atmosphere. A major portion of the area-wide deposit has resulted from atmospheric nuclear weapons testing. The cumulative deposit of strontium-90 and cesium-137 in the 30°-40° north latitude band (where the SRP is located) has been estimated to be about 63 and 101 millicuries per square kilometer, respectively (United Nations, 1982). Corresponding cumulative deposition values for plutonium-238 and -239 are 0.03 and 1.15 millicuries per square kilometer, respectively.

TE J-38 Releases from the SRP have contributed to soil radionuclide concentrations. Appendix B describes such contributions from waste management activities in subsurface soils. Airborne materials have been deposited primarily in proximity to the F- and H-Area stacks. Sampling onsite and in the SRP vicinity have produced the deposition values for 1986, listed in Table 3-26. These values are similar to or less than those estimated from nuclear weapons testing. The measured strontium-90 outside the SRP represents only a small fraction of the estimated worldwide deposition rate; cesium-137 is measured at about 30 percent of the estimated deposition rate, and the values for

Table 3-21. Tritium Concentrations in Drinking Water from Onsite and Offsite Deep Wells, 1984-1986[a]

	Tritium concentration (pCi/liter)					
	1984[d]		1985[d]		1986[e]	
Location [b,c]	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
			ONSITE			
C-Area	LLD[f]	LLD	1700	LLD	570	LLD
Central Shops	LLD	LLD	1500	LLD	LLD	LLD
D-Area	390	360	530	500	950	460
F-Area	LLD	LLD	270	LLD	LLD	LLD
Firing range	1600	1500	1800	1400	1800	610
Forestry Building	1400	1000	1200	710	1400	1100
H-Area	1400	LLD	580	LLD	690	LLD
K-Area	280	LLD	1500	LLD	1800	LLD
L-Area	LLD	LLD	470	LLD	LLD	LLD
P-Area	LLD	LLD	1700	LLD	5600	LLD
TC	480	220	260	LLD	LLD	LLD
105-K Building	NR[g]	NR	NR	NR	410	LLD
105-P Building	NR	NR	NR	NR	5500	LLD
221-H Building	NR	NR	NR	NR	1200	1200
701-8G Barricade 8	NR	NR	NR	NR	3600	3600
701-12G Barricade 7	NR	NR	NR	NR	8000	8000
701-13G Barricade 6	NR	NR	NR	NR	2300	2300
			OFFSITE			
Allendale	LLD	LLD	260	LLD	LLD	LLD
Bath	260	LLD	230	LLD	LLD	LLD
Jackson	360	LLD	570	570	630	460
Langley	LLD	LLD	240	LLD	LLD	LLD
New Ellenton	LLD	LLD	280	LLD	450	400

[a] Sources: Du Pont 1985a; Zeigler, Lawrimore, and Heath, 1986; Zeigler et al., 1987.
[b] Data are not reported for locations at which tritium concentrations of all samples were less than the lower level of detection.
[c] Wells are assumed to be screened in the Middendorf/Black Creek only.
[d] Lower level of detection = 210 pCi/liter.
[e] Lower level of detection = 380 pCi/liter.
[f] LLD = Concentration is less than the lower level of detection.
[g] NR = Not reported or not sampled.

TC

Table 3-22. Alpha Concentrations in Drinking Water from Onsite and Offsite Deep Wells, 1984-1986[a]

Location [b,c]	Alpha concentration (pCi/liter)					
	1984[d]		1985[d]		1986[e]	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
			ONSITE			
A-Area	LLD[f]	LLD	0.27	LLD	LLD	LLD
C-Area	0.62	0.57	0.59	LLD	1.10	LLD
Central Shops	0.39	LLD	0.25	LLD	LLD	LLD
Classification yard	0.62	0.33	0.25	LLD	LLD	LLD
Emergency Operations Ctr.	0.31	0.31	0.25	0.25	LLD	LLD
F-Area	LLD	LLD	0.76	0.55	3.4	LLD
Firing range	2.6	2.5	2.1	1.4	2.2	LLD
Forestry Building	1.6	0.47	1.2	0.83	1.3	LLD
H-Area	1.9	1.8	2.6	1.7	1.1	LLD
K-Area	0.94	LLD	0.58	LLD	LLD	LLD
L-Area	0.39	0.31	0.34	LLD	LLD	LLD
P-Area	0.49	0.23	0.50	0.33	LLD	LLD
Par Pond Lab, 905-89G	0.39	LLD	LLD	LLD	LLD	LLD
TC	2.6	1.3	0.59	0.50	1.6	0.70
TNX	0.62	0.23	0.42	0.42	0.70	LLD
105-C Building	NR[g]	NR	NR	NR	0.87	LLD
105-K Building	NR	NR	NR	NR	1.3	LLD
105-L Building	NR	NR	NR	NR	0.61	LLD
221-F Building	NR	NR	NR	NR	3.5	3.5
221-H Building	NR	NR	NR	NR	3.3	3.3
681-1G	0.41	0.31	LLD	LLD	LLD	LLD
			OFFSITE			
Allendale	0.23	LLD	LLD	LLD	LLD	LLD
Bath	0.32	LLD	0.31	LLD	0.58	LLD
Blackville	0.24	LLD	LLD	LLD	LLD	LLD
Jackson	0.86	0.39	0.61	0.25	2.3	LLD
Langley	0.55	0.47	0.27	LLD	1.4	1.3
New Ellenton	0.24	LLD	LLD	LLD	2.1	LLD

[a] Sources: Du Pont 1985a; Zeigler, Lawrimore, and Heath, 1986; Zeigler et al., 1987.

[b] Data are not reported for locations at which alpha concentrations of all samples were less than the lower level of detection.

[c] Wells are assumed to be screened in the Middendorf/Black Creek only.

[d] Lower level of detection = 0.22 pCi/liter.

[e] Lower level of detection = 0.57 pCi/liter.

[f] LLD = Concentration is less than the lower level of detection.

[g] NR = Not reported or not sampled.

TC

Table 3-23. Nonvolatile Beta Concentrations in Drinking Water from Onsite and Offsite Deep Wells, 1984-1986[a]

	Nonvolatile beta concentration (pCi/liter)					
	1984[d]		1985[d]		1986[e]	
Location [b,c]	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
ONSITE						
A-Area	1.6	1.6	LLD	LLD	LLD	LLD
C-Area	1.6	LLD[f]	0.81	LLD	LLD	LLD
Central Shops	1.7	LLD	1.4	LLD	LLD	LLD
Classification yard	2.0	0.97	1.2	0.81	2.4	LLD
D-Area	1.7	1.2	1.6	LLD	2.4	LLD
Emergency Operations Ctr.	1.2	1.2	0.92	0.92	LLD	LLD
F-Area	2.2	1.8	4.1	4.1	6.8	2.0
Firing range	3.6	3.6	3.2	2.7	3.7	LLD
Forestry Building	2.0	LLD	1.3	1.1	2.0	LLD
H-Area	4.7	4.6	5.1	2.8	6.2	1.8
K-Area	1.6	1.0	1.4	1.1	2.9	2.0
L-Area	1.1	0.87	1.8	1.7	LLD	LLD
P-Area	1.5	1.3	1.4	1.0	1.6	LLD
Par Pond Lab, 905-89G	1.1	LLD	LLD	LLD	LLD	LLD
Par Pond pumphouse	NR[g]	NR	2.7	2.7	4.3	LLD
TC	2.7	1.9	1.6	1.5	2.5	LLD
TNX	3.1	2.8	3.1	3.1	4.9	1.8
105-C Building	NR	NR	NR	NR	2.0	LLD
105-K Building	NR	NR	NR	NR	4.0	LLD
105-L Building	NR	NR	NR	NR	1.8	LLD
105-P Building	NR	NR	NR	NR	3.7	LLD
221-F Building	NR	NR	NR	NR	9.6	9.6
221-H Building	NR	NR	NR	NR	6.5	6.5
681-3G	3.8	3.2	3.5	2.8	3.9	2.0
704-S DWPF	NR	NR	NR	NR	1.6	LLD
OFFSITE						
Blackville	1.7	1.5	1.0	LLD	2.3	LLD
Jackson	1.1	LLD	1.5	LLD	4.6	LLD
Langley	1.3	1.2	1.8	1.2	3.1	LLD
New Ellenton	LLD	LLD	LLD	LLD	3.4	LLD

TC

---

[a] Sources: Du Pont 1985a; Zeigler, Lawrimore, and Heath, 1986; Zeigler et al., 1987.
[b] Data are not reported for locations at which nonvolatile beta concentrations of all samples were less than the lower level of detection.
[c] Wells are assumed to be screened in the Middendorf/Black Creek only.
[d] Lower level of detection = 0.80 pCi/liter.
[e] Lower level of detection = 1.60 pCi/liter.
[f] LLD = Concentration is less than the lower level of detection.
[g] NR = Not reported or not sampled.

Table 3-24. Liquid Releases and Concentrations for 1986[a] TE

Nuclide	Curies released at emission source	Derived conc. guide (pCi/L)[b]	Below SRP[c]	Beaufort-Jasper[d]	Port Wentworth[e]
			Conc. (pCi/L)	Conc. (pCi/L)	Conc. (pCi/L)
H-3	2.8×10^{4} (f)	3,000,000	3,900 (g)	3,100 (g)	3,400 (g)
Sr-89,-90	3.6×10^{-1} (f)	300	1.7×10^{-1}	4.0×10^{-2}	4.4×10^{-2}
I-129	2.2×10^{-2}	60	3.5×10^{-3}	2.5×10^{-3}	2.7×10^{-3}
Cs-137	1.1×10^{-1}	20,000	1.1×10^{-1}	1.2×10^{-2}	1.3×10^{-2}
Uranium	4.4×10^{-2}	4,000	7.0×10^{-3}	4.9×10^{-3}	5.4×10^{-3}
Pu-239	8.5×10^{-3}	5,000	1.3×10^{-3}	9.4×10^{-4}	1.0×10^{-3}

J-38

---

[a] Source: Zeigler et al., 1987.

[b] Derived water concentration guide is the concentration that when consumed at a rate of 730 liters per year will result in an annual dose rate of 100 mrem. TE

[c] Savannah River just downriver from the SRP.

[d] Beaufort-Jasper drinking water.

[e] Port Wentworth drinking water.

[f] Includes releases to streams and groundwater migration from seepage basins.

[g] Measured concentrations. All other concentrations were calculated from nuclide releases measured on the Plant using models verified by tritium measurements. TC

TE

Table 3-25. Radioactivity in Onsite Streams[a]

Radionuclide	Derived concentration guide[b] (pCi/L)	Savannah River, upstream of plant	Concentration, Mean (pCi/L)					
			Upper Three Runs Creek[c]	Four Mile Creek[c]	Beaver Dam Creek[d]	Pen Branch[c]	Steel Creek[c]	Lower Three Runs Creek[e]
H-3	2,000,000	360	2200	130,000	54,000	52,000	2500	3700[c]
Cr-51		j	f	j	f	j	j	j
Co-60	5,000	j	f	j	f	j	j	j
Zn-65		j	f	j	f	j	j	j
Sr-89, 90	1,000[g]	0.31	f	7.1	f	0.05	0.79	0.40[c]
Zr-95, Nb-95	40,000[l]	j	f	j	f	j	j	j
Ru-103, 106	6,000[h]	j	f	j	f	j	j	j
I-131	3,000	j	m	j	f	j	j	j
Cs-134	2,000	j	0.09	2.0[m]	f	0.02[m]	0.87[m]	2.8[m]
Cs-137	3,000	j	f	f	f	f	f	f
Ce-141, 144	7,000[i]	j	f	j	f	j	j	j
U/Pu	300[k]	j	0.16	0.20	f	0.17	f	0.18

J-38

TE

[a] Source: Zeigler et al., 1987.
[b] DOE Interim Order DOE 5480.1A.
[c] Measured at Road A.
[d] 400-D Effluent.
[e] Measured at Patterson Mill.
[f] Not reported.
[g] DCG for Sr-90.
[h] DCG for Ru-106.
[i] DCG for Ce-144.
[j] Less than the Lower Limits of Detection.
[k] DCG for Pu-239.
[l] DCG for Zr-95.
[m] Chem. Cs (Zeigler, Heath, Taus, and Todd, 1987, Table 2-22).

J-38

TE Table 3-26. Radioactivity Deposited in Soil, 1986[a]

J-38

Location	Deposition[b] (mCi/km², 5-cm depth)			
	Sr-90	Cs-137	Pu-238	Pu-239[c]
F-Area[c] average[d]	4.0 ± 2.5	60 ± 5.9	0.74 ± 0.11	5.5 ± 0.33
H-Area[c] average[d]	4.9 ± 2.5	84 ± 5.5	2.0 ± 0.18	5.1 ± 0.31
SRP perimeter average[d]	3.6 ± 2.3	38 ± 3.2	0.047 ± 0.04	0.87 ± 0.14
160-km radius average[d]	12 ± 22	32 ± 3.8	0.049 ± 0.050	0.53 ± 0.11

TE [a] Source: Zeigler et al., 1987.

[b] The ± value = 2-sigma counting error.

[c] F- and H-Area samples collected 2000 feet from 200-foot stack in each cardinal direction.

TC [d] The ± value = 2 standard deviations from the mean.

plutonium-238 and -239 are very close to those estimated on a worldwide basis. This confirms the observation that deposited cesium-137 is retained on soils more strongly than strontium-90, but less so than plutonium-238 and -239.

3.7.2 HAZARDOUS CHEMICAL ENVIRONMENT

Hazardous chemicals are used and produced as byproducts of certain SRP operations. Also, hazardous or potentially hazardous chemicals have been disposed of at known sites on the Plant. The following sections describe the existing hazardous chemical environment on the SRP for the atmosphere, groundwater, surface water, and soils.

3.7.2.1 Atmospheric Environment

Emissions from the seven SRP coal-fired powerplants include sulfur dioxide, nitrous oxides, and smoke. All were within applicable emission standards in 1986 (Zeigler et al., 1987; see Section 3.2.4.2). J-38

3.7.2.2 Groundwater Environment

At the Plant, 168 waste sites have been identified that have been or are being used for the disposal or storage of wastes. The majority of these sites contain nonradioactive wastes. Criteria waste sites are described in detail in Appendix B. Thirty-seven sites might have received or potentially contain hazardous wastes; 19 are low-level radioactive sites; and 21 potentially are mixed waste sites. Appendix B includes a history of waste disposal; evidence of past and existing contamination; waste characteristics (i.e., the types, forms, quantities, and concentrations of waste); the chemical and physical properties of the waste; and the potential for transport (volatility, mobility in soil, and solubility in water).

The nonradioactive wastes disposed of at the Plant include the following categories (Christensen and Gordon, 1983):

Nonhazardous solids - Wood, lumber, concrete blocks and slabs, bricks, glass, fenceposts, tires, rubber, and trash

Nonvolatile organics - Fuel, motor oil and grease, waste oil, and paint

Anions - Coal pile runoff, acids, caustics, ash sluice, liquid chemicals, and hydrofluoric acid

Pesticides - Biocidal compounds used either in plant operation or plant maintenance

Metals - Heavy and reactive metals, metal shavings, and mercury

Volatile organics - Chlorinated hydrocarbons, chlorinated biphenyls, solvents, and other organics

Groundwater at 55 of the waste disposal sites was monitored for hazardous constituents in 1986. Types of potential groundwater contaminants include chlorinated organics, heavy metals, and nitrates. Levels of contamination range from detectable limits to greater than drinking-water standards. About half of the radioactive, nonradioactive, and mixed waste sites for which groundwater monitoring data exist have some contaminants that exceed drinking-water standards.

Groundwater contaminants have been identified in the F-, H-, and M-Area seepage basins. These basins have been used to dispose of a variety of industrial chemicals. Suspected or confirmed contaminants include the following (Zeigler et al., 1987):

F-Area seepage basins - Acid, cadmium, chromium, lead, sodium, and nitrate J-38

H-Area seepage basins - Acid, lead, chromium, mercury, nitrate, and sodium

M-Area seepage basin - Organics, lead, nitrate, and sodium

Extensive monitoring of the M-Area settling basin site has defined a plume of
organic compounds in groundwater (Zeigler et al., 1987). Maximum J-38
concentrations of 269,000 parts per billion of trichloroethylene, 161,000
parts per billion of tetrachloroethylene, and 260 parts per billion of
1,1,1-trichloroethane were detected in monitoring wells in 1983 (Du Pont,
1984). A groundwater treatment (air stripping) program has been initiated in J-38

J-38 this area, and none of the organic compounds has been detected in offsite groundwater (Zeigler et al., 1987).

Since organic compounds were detected in the M-Area groundwater, all SRP drinking-water supplies are analyzed for these constituents. No significant concentrations were detected in 1984. However, trichloroethylene at 1 to 7 parts per billion (slightly above the minimum detectable concentration) was detected on a few occasions in 1984 in the 3/700-Area (Du Pont, 1985a).

J-38 At several of the remaining waste disposal sites monitored in 1986, preliminary data indicate that concentrations of some chemicals and metals might be higher than ambient levels. Groundwater monitoring has indicated the presence or possible presence of groundwater contaminants at the following sites:

TC Silverton Road waste site - Volatile organics (trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane), barium, cadmium, chromium, and mercury (which were found infrequently in excess of EPA drinking-water standards) (Scott, Killian, Kolb, Corbo, and Bledsoe, 1987)

TC Chemicals, metals, and pesticides (CMP) pits - Volatile organics (methylene chloride, tetrachloroethylene, toluene, and benzene) and bis(2-ethylhexyl)phthalate (Scott, Kolb, Price, and Bledsoe, 1985)

TC Savannah River Laboratory seepage basins - Chromium and lead (occasionally detected in excess of EPA drinking-water standards), and volatile organics (trichloroethylene, tetrachloroethylene) (Fowler et al., 1987)

TC Old TNX basin - Acid, mercury, manganese, nickel, and nitrate (Dunaway et al., 1987)

TC Radioactive waste burial grounds - Mercury (Jaegge et al., 1987)

TC Metals burning pit/miscellaneous chemical basin site - Trichloroethylene (Pickett, Muska, and Marine, 1987)

Additional waste site groundwater monitoring and groundwater transport modeling data and information in chemical contaminants are available in the EIDs prepared in support of this EIS in 1987. They are referenced fully in Appendixes B and F. J-38

3.7.2.3 Surface-Water Environment

Water-quality monitoring for nonradioactive parameters was initiated for SRP onsite streams as early as 1959. Routine water-quality monitoring of the streams began in 1971. An extensive sampling program was conducted in 1985 (see Chapter 5). The results of this monitoring indicate that concentrations of pesticides, herbicides, and polychlorinated biphenyls (PCBs) in Savannah

River and onsite stream water were below the limits of detection in 1984, 1985, and 1986. J-38 In 1984, aldrin, 2,4-dichlorophenoxyacetic acid, and malathion were detected in river sediment; however, with the exception of 2,4-dichlorophenoxyacetic acid, concentrations were near the detection limit (Du Pont, 1985a; Zeigler, Lawrimore, and Heath, 1986). Of these three compounds, only malathion exceeded detection limits during 1986 (Zeigler, Heath, Taus, and Todd, 1987). TE J-38 Also, sediment from Lower Three Runs Creek and Par Pond contained higher than normal concentrations of silvex, 2,4-dichlorophenoxyacetic acid, heptachlor, and endrin aldehyde. The presence of these compounds is attributed to forestry and agricultural applications. Other compounds detected in sediment from SRP streams include aldrin, endosulfan, and gamma-benzene hexachloride = 1,2,3,4,5,6-hexachlorocychlohexane (Zeigler et al., 1987). In 1985, detectable quantities of beta-benzene hexachloride and alpha-benzene hexachloride were reported in river sediment. Detectable quantities of beta-benzene hexachloride were also present in river sediment in 1986. J-38 Concentrations of alpha-benzene hexachloride were near the minimum detectable concentration, while those for beta-benzene hexachloride were somewhat higher (Zeigler et al., 1987).

Sediments from the Par Pond pumphouse and most locations in the onsite streams contained detectable levels of beta-benzene hexachloride. Other chemicals reported in measurable quantities in sediments from SRP streams were the pesticides 4,4-DDD, 4,4-DDE, 4,4-DDT, and heptachlor (Zeigler et al., 1987). J-38 There is no significant difference between upriver and downriver concentrations. These data indicate that the occasional positive pesticides, herbicides, and PCB concentrations detected in SRP water and sediments originate off the site (Zeigler, Lawrimore, and Heath, 1986).

3.7.2.4 Soils Environment

At the existing waste sites, information on soil contaminated with hazardous material is limited primarily to the soil underlying nonradioactive or mixed waste sites. Potential soil contaminants are those associated with the wastes disposed at nonradioactive or mixed waste sites; these include nonvolatile organics, anions, pesticides, heavy metals, and volatile organics (Stone and Christensen, 1983). Suspected soil contaminants or contaminants identified from borings or sediment sampling and analyses at waste sites include the following:

M-Area settling basin and vicinity (above reference background levels) (mixed waste site) - Barium, chromium, copper, lead, manganese, magnesium, nickel, bis(2-ethyl hexyl)phthalate, tetrachloroethylene, 1,1,1-trichloroethylene, methylene chloride, toluene, di-n-octyl phthalate, tetrachlorobiphenyl, pentachlorobiphenyl, and hexachlorophenyl (Pickett, Muska, and Colven, 1987) TC

Old TNX seepage basin - Silver, chromium, copper, mercury, nickel, and cyanide (Dunaway et al., 1987)

F-Area seepage basins - Mercury (Killian et al., 1987a) TC

H-Area seepage basins - Chromium and mercury (Killian et al., 1987b)

TC CMP Pits (following soil excavation) - Volatile organics (mostly less than 1 part per million) and pesticides (less than 10 parts per million) (Scott, Kolb, Price, and Bledsoe, 1987)

3.8 CONTROL AND SECURITY

Access to the SRP is controlled at primary roads by permanently manned barricades. Other roads are closed to traffic by gates or fixed barricades. The entire perimeter of the SRP, with the exception of its Savannah River boundary, is fenced. Additionally, the site is posted against trespass under State of South Carolina and Federal statutes. Operating areas are separately fenced and patrolled continuously by armed security personnel.

The following sections present site-specific information on site location and accessibility. Table 3-27 lists the existing waste sites and indicates if TE they are enclosed by perimeter fence lines.

3.8.1 NEW FACILITIES

Although specific sites have not been approved for the new facilities described below, all proposed sites are inside the SRP perimeter fence. The proposed security measures for each facility would be the same, regardless of the exact site selected.

One or two security fences would be constructed surrounding the facilities, depending on the security regulations in effect at the expected time of operation of the facilities. Normal access to the area would be through a main gate that would be controlled by operating personnel. Other gates, including any railroad gates, would remain locked during normal operation.

A perimeter road would be constructed adjacent to the outer fence suitable for all-weather travel by security patrols and maintenance personnel. Additional roads would be installed as required so patrol personnel would be able to observe clearly all operating areas of the storage/disposal facility. Tall lighting poles would be constructed to make the entire area visible at night. The lights should be connected to an emergency power supply.

3.8.2 INSTITUTIONAL CONTROLS

Institutional control of low-level radioactive waste sites, although not specified in DOE Order 5820.2, is required under 10 CFR 61.7(b)(4) for a period as long as 100 years to permit "The disposal of Class A and Class B waste without special provision for intrusion protection...." This document assumes that stable governmental control would exist for 100 years. The minimum period of monitoring required by the EPA regulations for hazardous waste is 30 years after the closure of the site.

The facility would be designed with a goal of "zero maintenance." During the period of institutional control, any repairs that might be necessary are expected to be minor. After the institutional control period, the system should continue to perform well for many years.

Table 3-27. Fenced/Unfenced SRP Waste Sites

TE

Area	Fenced	Unfenced
A- and M-Areas		
Silverton Road waste site		X
Waste oil basins		X
Metals burning pit/miscellaneous chemical basin		X
Metallurgical laboratory basin		X
Burning/rubble pits[a]		X
M-Area settling basin	X	
SRL seepage basins	X	
F- and H-Areas		
Acid/caustic basins[b]		X
F-Area seepage basins	X	
Old F-Area seepage basin		X
H-Area seepage basins	X	
Mixed waste management facility	X	
Separations area retention basins[c]	X	
Radioactive waste burial grounds	X	
R-Area		
Reactor seepage basins	X	
Bingham pump outage pits		X
C- and CS-Areas		
Hydrofluoric acid spill area		X
Ford Building seepage basin	X	
Ford Building waste site		X
TNX Area		
Old TNX seepage basin	X	
New TNX seepage basin		X
TNX burying ground	X	
Road A Area		
Road A chemical basin		X
L-Area		
CMP pits		X
L-Area oil and chemical basin	X	
Miscellaneous areas		
SRL oil test site		X
Gun site 720 rubble pit		X

TC

[a] Only the F-Area burning/rubble pit is fenced.
[b] Only the H-Area basin is fenced.
[c] Only the H-Area retention basin is fenced.

3.8.3 POSTINSTITUTIONAL CONTROL

Postinstitutional control is the period after about 100 years during which control of access to the disposal site is assumed to be lost. For calculational purposes, the general population is assumed to occupy the site and build houses, farm the land, drill wells, and raise livestock during the postinstitutional control period.

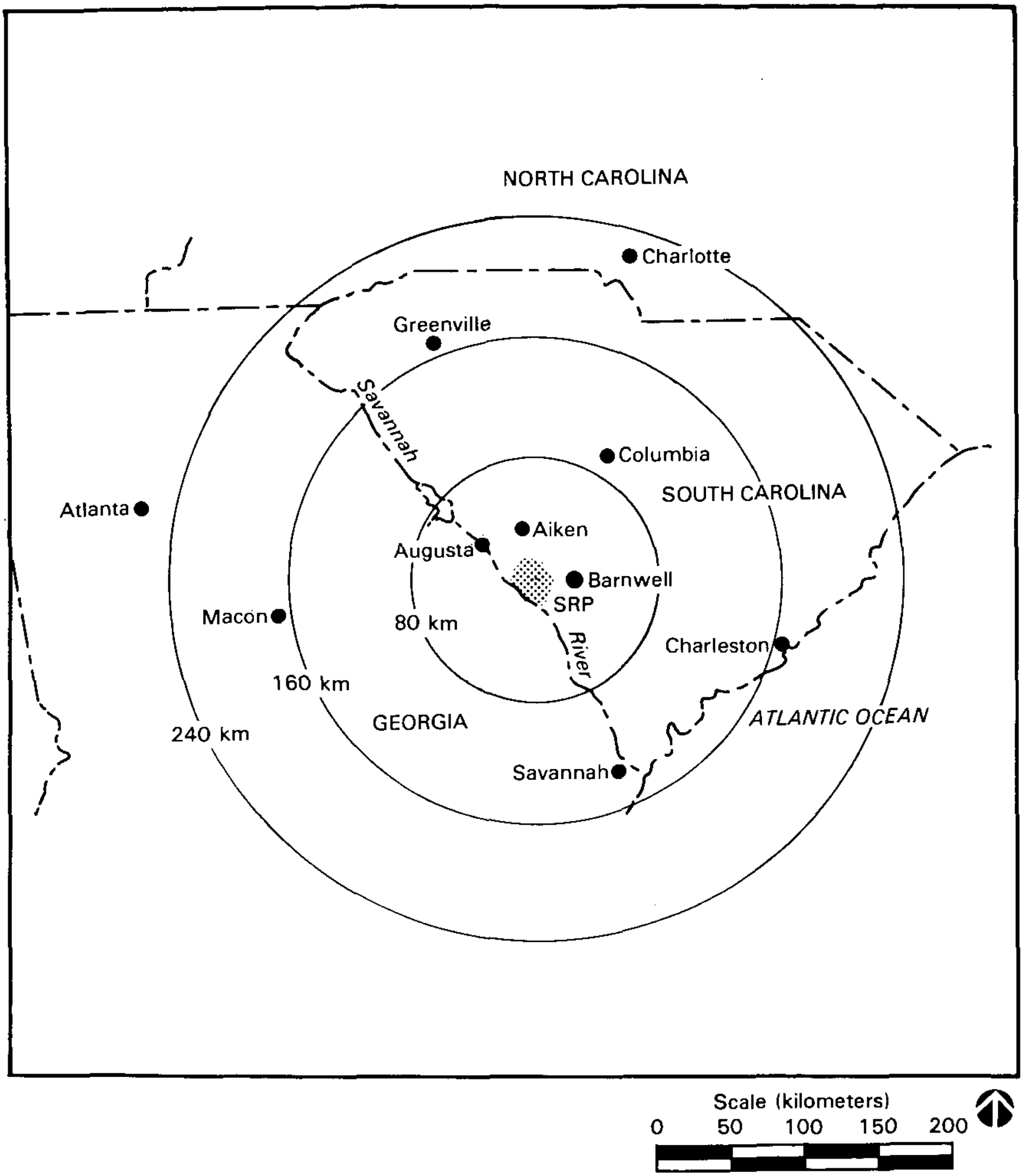
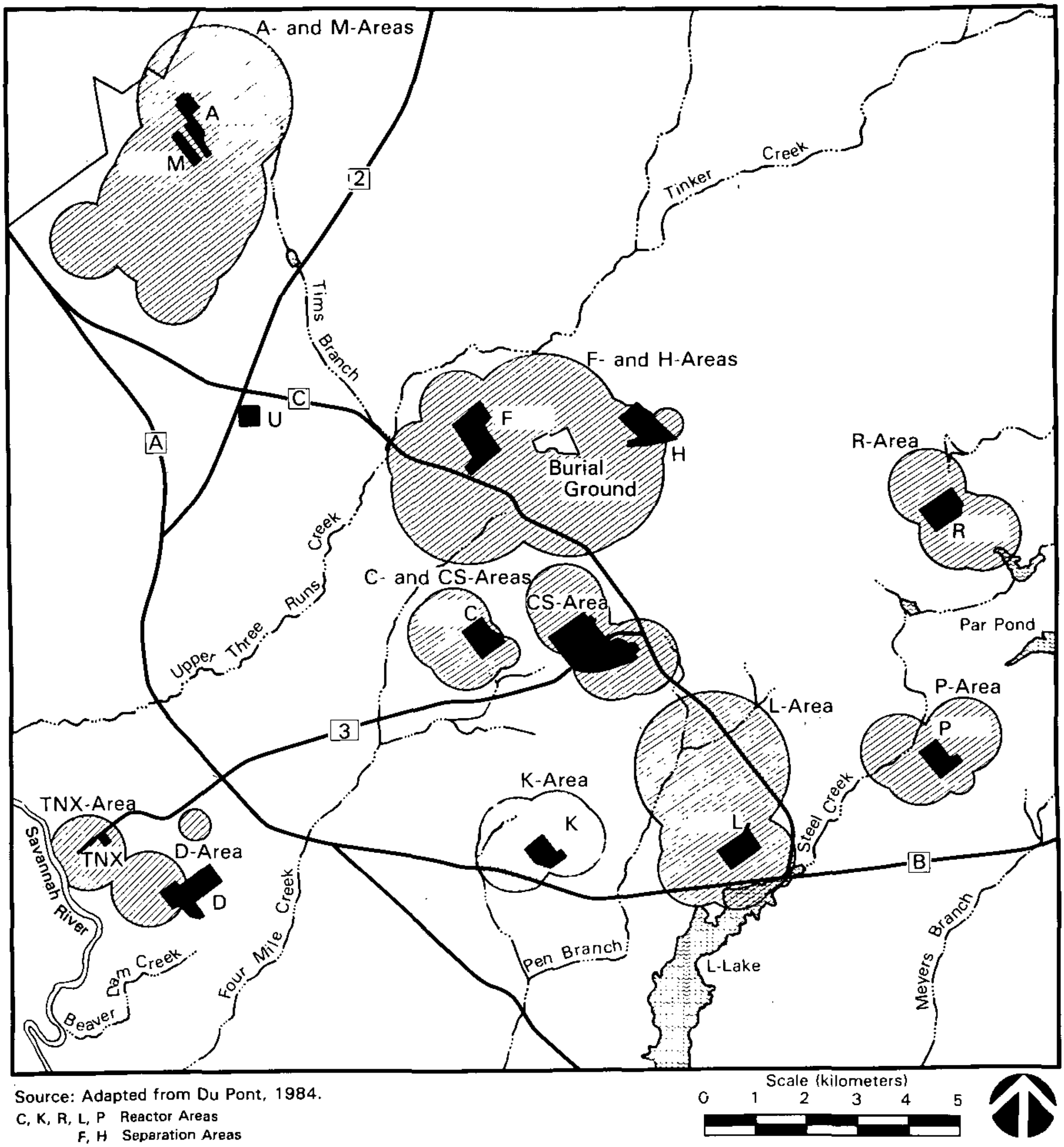


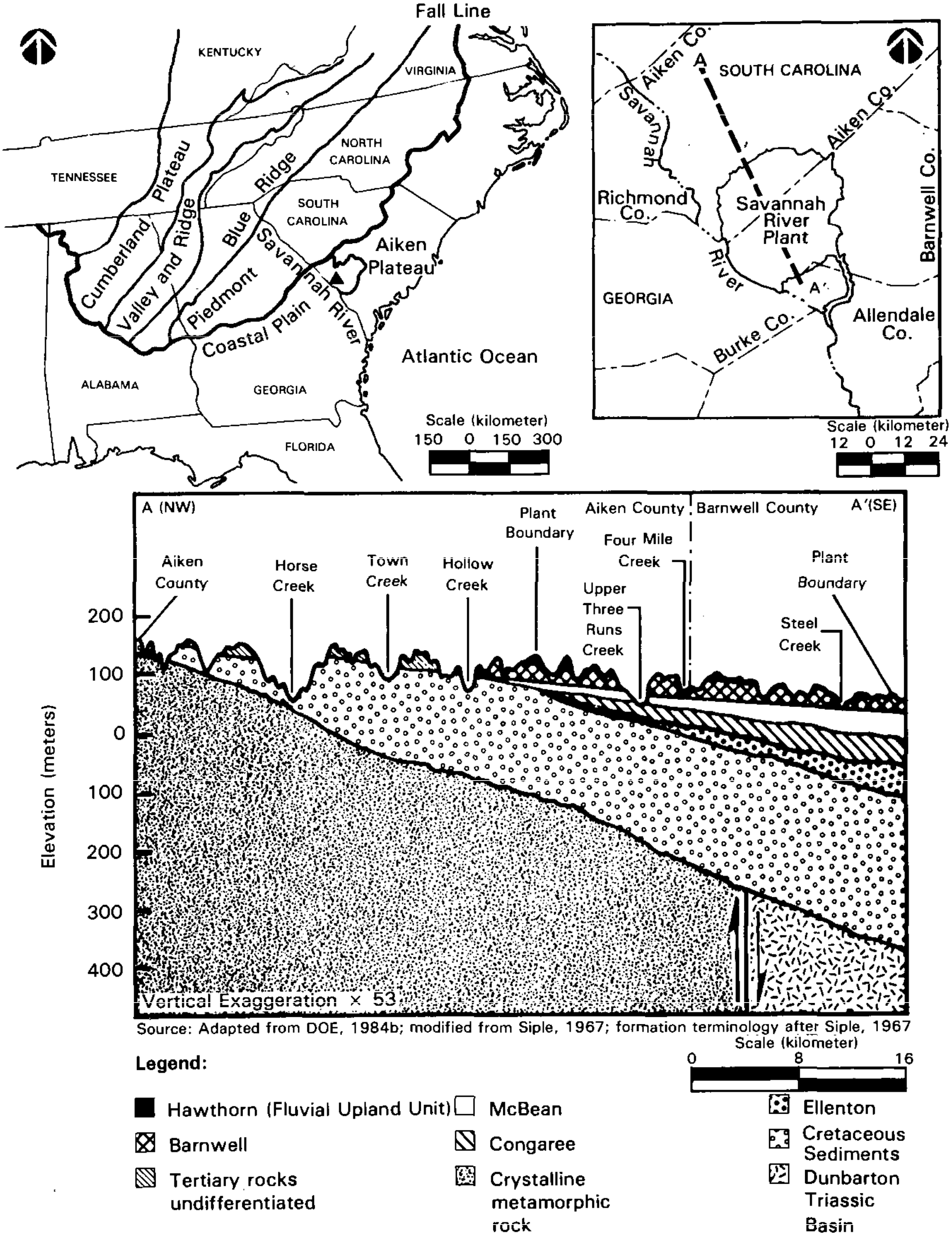
Figure 3-1. SRP Location in Relation to Surrounding Population Centers



Source: Adapted from Du Pont, 1984.

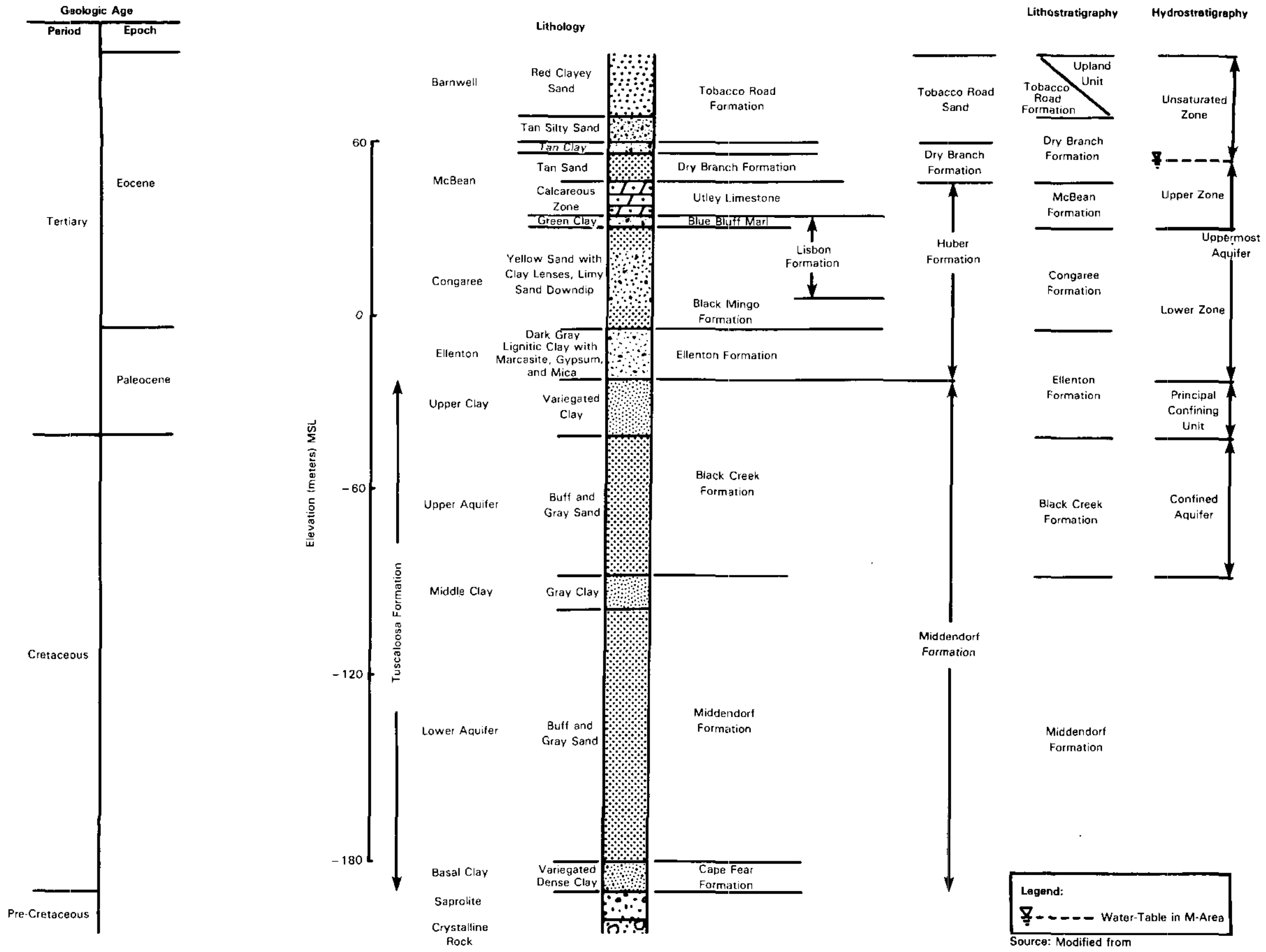
C, K, R, L, P	Reactor Areas
F, H	Separation Areas
M	Fuel and Target Fabrication
D	Steam and Power Plant, Heavy Water Production
A	Savannah River Laboratory and Administration Area
CS	Central Shops
TNX	Pilot Scale Chemical Processing Facility
U	Heavy Water Control Test Facility

Figure 3-2. Portion of Savannah River Plant Site



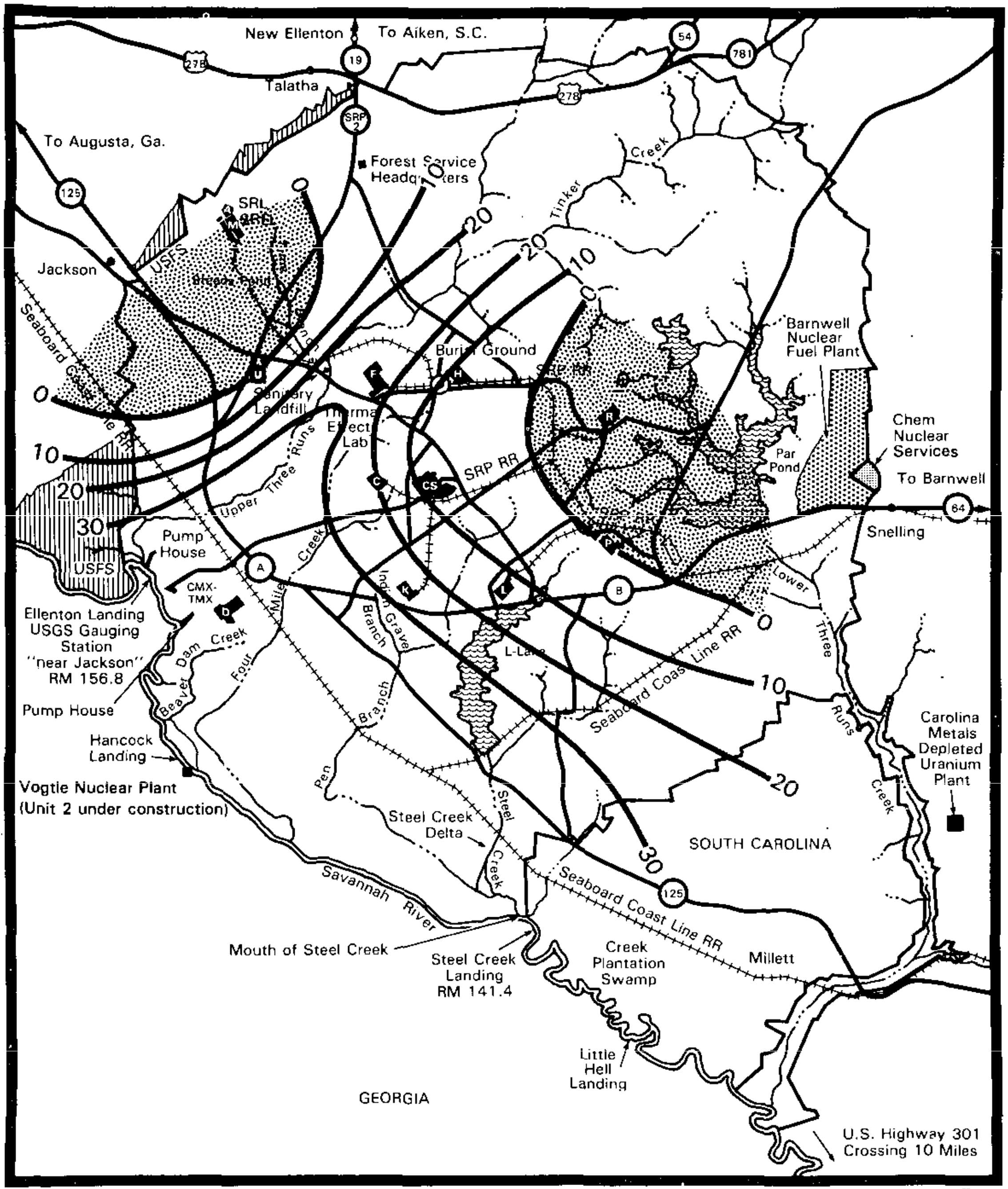
Source: Adapted from DOE, 1984b; modified from Siple, 1967; formation terminology after Siple, 1967

Figure 3-3. Generalized Northwest to Southeast Geologic Profile and SRP Regional Site Locator



Source: Modified from Christensen and Gordon, 1983.

Figure 3-4. Tentative Correlation of Stratigraphic Terminology of Southwestern South Carolina Coastal Plain



Source: Developed form Figures A-10 and A-11.

Legend:

C,K,R,L,P	Reactor Areas
F,H	Separations Areas
M	Fuel and Target Fabrication
D	Steam and Power Plant, Heavy Water Production
A	Savannah River Laboratory and Administration Area
CS	Central Shops
RM	River Mile
U	Heavy Water Control Test Facility

Scale (kilometers)

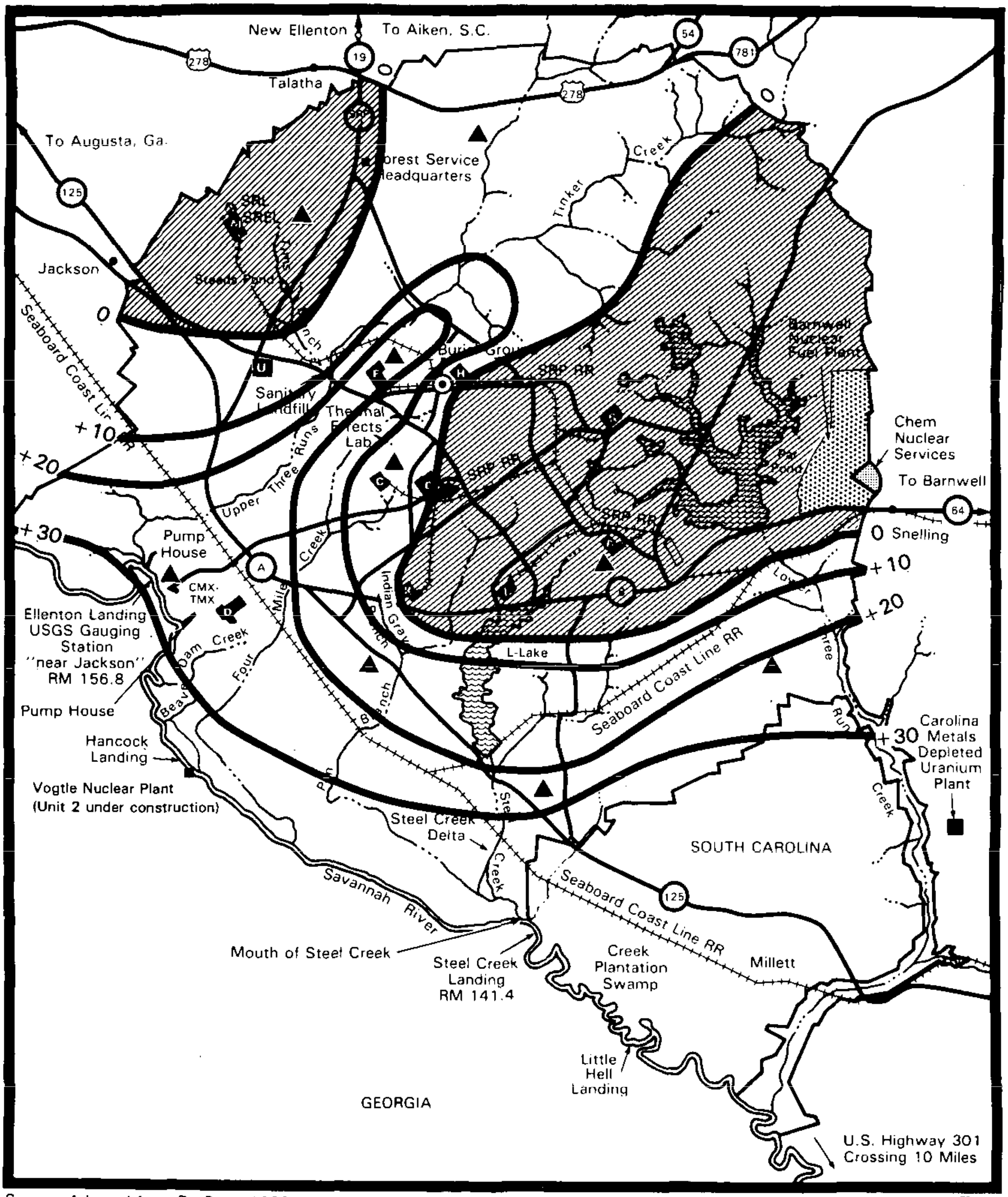
0 2 4 6 8

Road A = Highway 125

Contours indicate areas where head in Upper Cretaceous sediments is greater than head in Congaree. Contour interval equals 10 feet (1.0 foot = 0.3048 meter).

▨ Area where head in the Upper Cretaceous sediments aquifer is less than head in the Congaree Formation.

Figure 3-5. Head Difference Between Upper Cretaceous Sediments Aquifer and Congaree Formation at Savannah River Plant (1982)



Source: Adapted from Du Pont, 1983b.

Legend:

C,K,R,L,P	Reactor Areas
F,H	Separations Areas
M	Fuel and Target Fabrication
D	Steam and Power Plant, Heavy Water Production
A	Savannah River Laboratory and Administration Area
CS	Central Shops
RM	River Mile
U	Heavy Water Control Test Facility

Road A = Highway 125

Contours indicate areas where head in Upper Cretaceous sediments is greater than head in Congaree. Contour interval equals 10 feet (1.0 foot = 0.3048 meter).

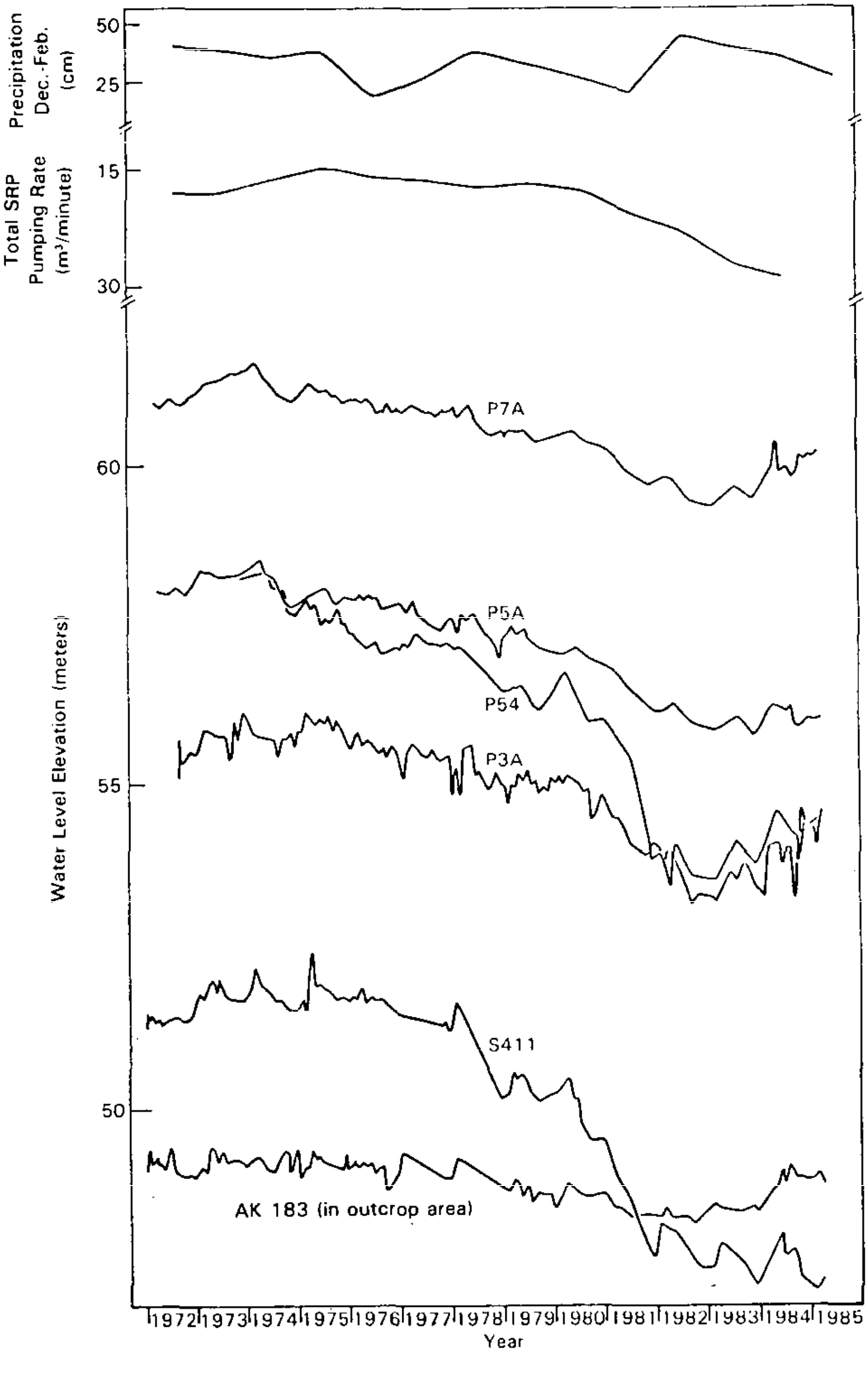
▨ Area of Downward Gradient

▲ Observation Well Cluster

Scale (kilometers)

0 2 4 6 8

Figure 3-6. Head Difference Between Upper Cretaceous Sediments Aquifer and Congaree Formation at Savannah River Plant (1987)



Source: Du Pont, 1983b; drawing updated by Marine, 1985.

Note: Figure A-23 shows the well locations; well S411 is screened in the Ellenton Formation; the remaining wells are screened in the Middendorf/Black Creek.

Figure 3-7. Hydrographs of Tuscaloosa and Ellenton Wells

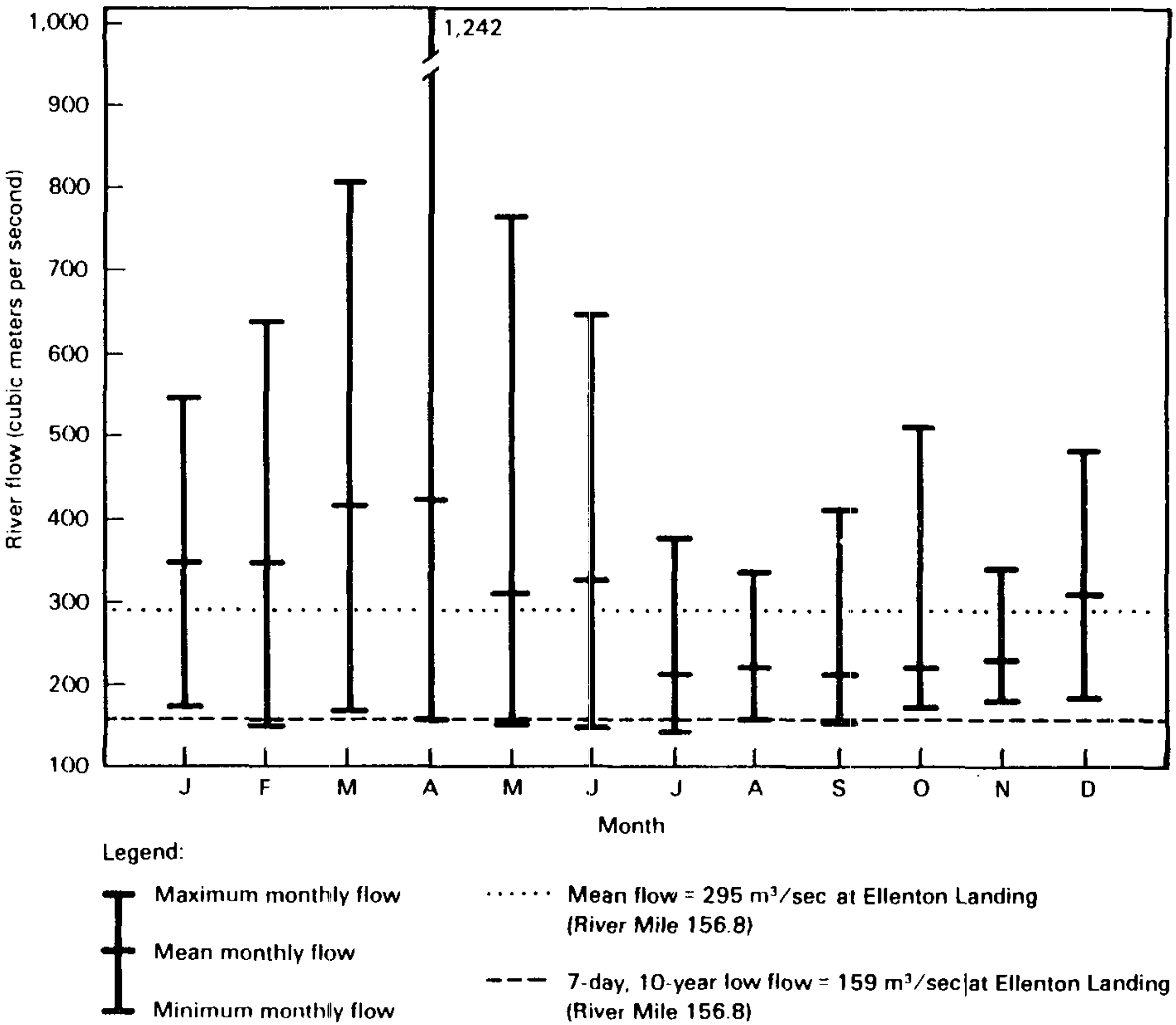


Figure 3-8. Mean Monthly Flow Rates of the Savannah River from 1964-1981 at River Mile 187.5 (Data Derived from USGS Gaging Station Near Augusta, Georgia)

REFERENCES

ANSP (Academy of Natural Sciences of Philadelphia), 1961. Savannah River Biological Monitoring, South Carolina and Georgia, May-June and August-September 1960.

ANSP (Academy of Natural Sciences of Philadelphia), 1974. Savannah River Biological Monitoring, South Carolina and Georgia, May and September 1972.

Aydelott, D.G., 1977. Soils of the Savannah River Project, Aiken, S.C., U.S. Forest Service, Aiken, South Carolina.

BEIR (Committee on Biological Effects of Ionizing Radiations), 1980. The Effects on Populations of Exposures to Low Levels of Ionizing Radiation, BEIR III, Division of Medical Sciences, Assembly of Life Sciences, National Research Council, National Academy of Sciences, Washington, D.C.

Bledsoe, H. W., 1987. Head Difference Between Congaree and "Tuscaloosa" Aquifers, DPST-87-592, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina. TC

Bloxham, W., 1979. "Low Flow Frequency and Flow Duration of South Carolina Streams," South Carolina Water Resources Commission Report, Number II.

Braun, E. L., 1950. Deciduous Forests of Eastern North America, Hafner Publishing Company, New York.

Brooks, M. J., 1986. An Intensive Archaeological and Historical Survey of the Existing Hazardous, Low-Level Radioactive and Mixed Waste Sites, Savannah River Plant, South Carolina, University of South Carolina, South Carolina Institute of Archaeology and Anthropology, Savannah River Plant Archaeological Research Program.

Bureau of the Census (U.S. Department of Commerce), 1982a. 1980 Census of Population, General Population Characteristics, Georgia, PC80-1-B12, U.S. Government Printing Office, Washington, D.C.

Bureau of the Census (U.S. Department of Commerce), 1982b. 1980 Census of Population, General Population Characteristics, South Carolina, PC80-1-B42, U.S. Government Printing Office, Washington, D.C.

Case, E. G., 1977. "Reports on Recent Fault Movements in Eastern U.S.," Memorandum SECY-77-411 from the Office of Nuclear Reactor Regulation to the Commissioners of the U.S. Nuclear Regulatory Commission.

Christensen, E. J., and D. E. Gordon, 1983. Technical Summary of Groundwater Quality Protection Program at Savannah River Plant, Volume I, Site Geohydrology and Solid and Hazardous Wastes, DPST 83-829, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

COE (U.S. Army Corps of Engineers), 1952. Geologic-Engineering Investigations, Savannah River Plant, Vicksburg, Mississippi.

COE (U.S. Army Corps of Engineers), 1981. Final Environmental Impact Statement, Operation and Maintenance of Clarks Hill Lake, Savannah River, Georgia and South Carolina, Savannah District, Savannah, Georgia.

Cooke, C. W., 1936. Geology of the Coastal Plain of South Carolina, Bulletin 867, U.S. Geological Survey, Reston, Virginia.

Daniels, D. L., I. Zietz, P. Popenoe, 1983. "Distribution of Subsurface Lower Mesozoic Rocks in the Southeastern United States, as Interpreted from Regional Aeromagnetic and Gravity Maps," in Studies Related to the Charleston, South Carolina, Earthquake of 1886--Tectonics and Seismicity, Professional Paper 1313-K, U.S. Geological Survey, Reston, Virginia.

Davis, W. M., 1902. Elements of Physical Geography, Ginn Custom Publishing, Lexington, Massachusetts.

DOE (U.S. Department of Energy), 1984a. Socioeconomic Data Base Report for Savannah River Plant, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1984b. Final Environmental Impact Statement, L-Reactor Operation, Savannah River Plant, Aiken, South Carolina, DOE/EIS-0108, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1987. Application for a Post-Closure Permit, M-Area Hazardous Waste Management Facility, Volume III, Revision 2, Savannah River Operations Office, Aiken, South Carolina.

Duffield, G. M., D. R. Buss, and C. P. Spalding, 1987. Characterization of Groundwater Flow and Transport in the General Separations Areas, Savannah River Plant: Evaluation of Closure Cap Effectiveness, Mixed Waste Management Facility (643-28G), prepared for E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina, by GeoTrans, Inc., Herndon, Virginia.

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.

Duke Power Company, 1977. Oconee Nuclear Station Environmental Summary Report, 1971-1976, Volumes 1 and 2, Charlotte, North Carolina.

Dunaway, J. K. W., W. F. Johnson, L. E. Kingley, R. V. Simmons, and H. W. Bledsoe, 1987. Environmental Information Document, Old TNX Seepage Basin, DPST-85-710, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1980a. Preliminary Safety Analysis Report, Defense Waste Processing Facility, Reference Case, DPST-80-250, Chapter 3, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1980b. Environmental Information Document, Defense Waste Processing Facility, DPST-80-249, Vols. 1 and 2, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1982a. Environmental Monitoring in the Vicinity of the Savannah River Plant--Annual Report for 1981, DPSPU-82-30-1, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1982b. Environmental Information Document, L-Reactor Reactivation, DPST-81-241, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1982c. Update of Seismic Design Criteria for the Savannah River Plant, Vols. 1 and 2, DPE-3699, Wilmington, Delaware.

Du Pont (E. I. du Pont de Nemours and Company), 1983a. Environmental Information Document, L-Reactor Reactivation, Supplement No. 1, DPST-83-470 (Approval Draft), Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983b. Technical Summary of Groundwater Quality Protection Programs at the Savannah River Plant, DPST-83-829, E. J. Christensen (ed.), Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1984. Environmental Monitoring in the Vicinity of the Savannah River Plant, Annual Report for 1983, DPSPU-84-30-1, Savannah River Plant, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1985a. Environmental Report for 1984, DPSPU-85-30-1, Savannah River Plant, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1985b. Comprehensive Cooling Water Study, DP-1697, J. B. Gladden, M. W. Lower, H. E. Mackey, W. L. Specht, E. W. Wilde, editors, Vol. 1-11, Savannah River Laboratory, Aiken, South Carolina.

EPA (U.S. Environmental Protection Agency), 1972. Estimates of Ionizing Radiation Doses in the United States, 1960-2000, ORP/CSD 72-1, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1976. Quality Criteria for Water, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1981. Health Effects Advisory: 10-Day SNARLS, Office of Drinking Water, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1984. Guidelines Establishing Test Procedures for the Analysis of Pollutants under the Clean Water Act, (40 CFR 136), Final Rule, 49 FR 2-210, Washington, D.C. TC

EPA (U.S. Environmental Protection Agency), 1986a. Quality Criteria for Water, 1986, EPA 440/5-86-001, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1986b. Health Assessment for 1,1-Dichloroethane, EPA 540/1-86-027, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1987. Final Rule Volatile Synthetic Organic Chemicals, Federal Register, 52 FR 25690, Washington, D.C. TC

Fowler, B. F., B. B. Looney, R. V. Simmons, and H. W. Bledsoe, 1987. 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.

Freeze, R. A., and J. A. Cherry, 1979. Groundwater, Prentice-Hall, Inc., Englewood Cliffs, N.J.

Garrett, A. J., 1983. April 23, 1983 Tornado at the Savannah River Plant, prepared for U.S. Department of Energy by E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Geological Consulting Services, 1986. Subsurface Geology of the A and M Areas at the Savannah River Plant, Aiken, South Carolina, Report of Investigations Submitted for U.S. Department of Energy Contract No. DE-AC09-76SR00001.

Gibbons, J. W., and K. K. Patterson, 1978. The Reptiles and Amphibians of the Savannah River Plant, SRP-NERP-2, Savannah River Plant National Environmental Research Park Publication, Aiken, South Carolina.

Hoel, D. D., 1983. Climatology of the Savannah River Plant Site, DPST-83-705, E. I. du Pont de Nemours and Company, Aiken, South Carolina.

Jacobsen, W. R., R. J. Brown, E. W. Rabon, and L. J. Tilly, 1972. Thermal Discharges from the Savannah River Plant, DPST-72-428, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Jaegge, W. J., N. L. Kolb, B. B. Looney, I. W. Marine, O. A. Towler, and J. R. Cook, 1987. 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, 1987a. 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, 1987b. Environmental Information Document, H-Area Seepage Basin, DPST-85-706, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

King, P. B., 1969. The Tectonics of North America - A Discussion To Accompany the Tectonic Map of North America, Scale 1:5,000,000, Professional Paper 628, U.S. Geological Survey, Reston, Virginia.

Langley, T. M., and W. L. Marter, 1973. The Savannah River Plant Site, USAEC Report No. DP-1323, 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, W. F. Johnson, and J. A. Smith, 1987. 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.

Lower, M. W., 1984. Compilation of Historic Floodplain Sediment Data Base, DPST 84-298, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Lower, M. W., 1985. SRP Surface Water Systems: Hydrology, Quality and Use, DPST-85-611, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Marine, I. W., 1976. Structural and Sedimentational Model of the Buried Dunbarton Triassic Basin, South Carolina and Georgia, ERDA Report DP-MS-74-39, Technical Information Center, Oak Ridge, Tennessee.

Marine, I. W., 1985. Letter to P. H. Feldhausen, NUS Corporation, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Marine, I. W. and G. E. Siple, 1974. "Buried Triassic Basin in Central Savannah River Area, South Carolina and Georgia," Geol. Soc. America Bull., Vol. 85, p. 317.

Matthews, R. A., 1982. Biological Surveys on the Savannah River in the Vicinity of the Savannah River Plant (1951-1976), PD-1531, Savannah River Ecology Laboratory, University of Georgia, Aiken, South Carolina.

Mayer, P. G., J. M. Palms, R. B. Platt, H. L. Ragsdale, and D. J. Shure, 1973. The Environmental Monitoring Program for the Allied-Gulf Nuclear Fuel Processing Plant, August 1970-July 1973, Report EMP-113, Emory University, Atlanta, Georgia.

Muska, C. F., and R. A. Matthews, 1983. Biological Assessment for the Shortnose Sturgeon, Acipenser brevirostrum Le Sueur 1818, the Savannah River Plant, DPST-83-754, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

NOAA (National Oceanic and Atmospheric Administration), 1985. 1984 Local Climatological Data: Annual Summary with Comparative Statistics, Augusta, Georgia (Bush Field), Environmental Data Service, National Climatic Center, Asheville, North Carolina.

NRC (U.S. Nuclear Regulatory Commission), 1985. Population Dose Commitments Due to Radioactive Releases from Nuclear Power Plant Sites in 1981, NUREG/CR-2850 (PNL-4221), Vol. 3, prepared by Pacific Northwest Laboratory for Office of Resource Management, Division of Budget and Analysis, Washington, D.C.

ORNL (Oak Ridge National Laboratory), 1981. Socioeconomic Baseline Characterization for the Savannah River Plant, 1981, ORNL/Sub-81/13829/5, National Technical Information Service, Springfield, Virginia.

Oravetz, C. A. (Chief, Protected Species Branch, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service), 1983. Letter to M. J. Sires, Assistant Manager, Health, Safety, and Environment, U.S. Department of Energy, Savannah River Operations Office, F/SERV 23:AM:CF, St. Petersburg, Florida.

Patrick, R., J. Cairns, Jr., and S. S. Roback, 1967. "An Ecosystematic Study of the Fauna and Flora of the Savannah River Plant," in Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 118, No. 5, pp. 109-407.

Pekkala, R. O., C. E. Jewell, W. G. Holmes, and I. W. Marine, 1987. Environmental Information Document, Reactor Seepage Basins, DPST-85-707, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Pepper, D. W., and J. F. Schubert, 1978. Tornado Activity at SRP during 1976, DP-1451, Savannah River Laboratory, E. I. du Pont de Nemours and Company, Aiken, South Carolina.

Pickett, J. B., C. F. Muska, and W. P. Colven, 1987. 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.

Pickett, J. B., C. F. Muska, and I. W. Marine, 1987. Environmental Information Document, Metals Burning Pit/Miscellaneous Chemical Basins, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Popenoe, P., and I. Zietz, 1977. The Nature of the Geophysical Basement Beneath the Coastal Plan of South Carolina and Northeastern Georgia, U.S. Geological Survey Professional Paper 1028, pp. 119-137.

Purvis, J. C., 1977. South Carolina Tornadoes, 1972-1976, South Carolina Preparedness Agency, Columbia, South Carolina.

SCDHEC (South Carolina Department of Health and Environmental Control), 1981. Water Classification Standards, Columbia, South Carolina.

Scott, S. C., N. L. Kolb, V. Price, and H. W. Bledsoe, 1987. Environmental Information Document, CMP Pits, DPST-85-712E, 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, 1987. Environmental Information Document, Silverton Road Waste Site, DPST-85-702, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Simiu, E., M. J. Changery, and J. J. Filliben, 1979. Extreme Wind Speeds at 129 Stations in the Contiguous United States, NBS Building Science Services 118, U.S. Department of Commerce, National Bureau of Standards, Washington, D.C.

Siple, G. E., 1967. Geology and Ground Water of the Savannah River Plant and Vicinity, South Carolina, Geological Survey Water-Supply Paper 1841, United States Government Printing Office, Washington, D.C.

Stephenson, D. E., P. Talwani, and J. Rawlins, 1985. Savannah River Plant Earthquake of June 1985, prepared for U.S. Department of Energy by E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Stone, J. A., and E. J. Christensen, 1983. Technical Summary of Groundwater Quality Protection Program at Savannah River Plant, Volume II, Radioactive Waste, DPST 83-829, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

United Nations, 1982. Sources and Effects of Ionizing Radiation, United Nations Scientific Committee on the Effects of Atomic Radiation, 1982. Report to the General Assembly, with Annexes, United Nations Sales Section, New York.

Watts, J. R., 1982. Useful Characteristics of the Savannah River, DPST-82-578, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Zeigler, C. C., E. M. Heath, L. B. Taus, and J. L. Todd, 1987. U.S. Department of Energy - Savannah River Plant Environmental Report for 1986, DPSPU-87-30-1, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Zeigler, C. C., I. B. Lawrimore, and E. M. Heath, 1986. U. S. Department of Energy - Savannah River Plant Environmental Report for 1985, DPSPU-86-30-1, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential environmental consequences of adopting several strategies for the modification of the management of existing waste sites, the construction of new storage/disposal facilities, and the management of disassembly-basin purge water for hazardous, low-level radioactive, and mixed wastes at the Savannah River Plant (SRP), and the consequences of considering the No-Action strategy, as required by the National Environmental Policy Act (NEPA). TE

4.1 ALTERNATIVE WASTE MANAGEMENT STRATEGIES

The alternative strategies for the modification of the SRP waste management program that have been identified involve combinations of various actions for the management of existing waste sites, the construction of new storage/disposal facilities, and the management of disassembly-basin purge water. These strategies also consider the implications for the long-term dedication of SRP land areas, institutional control, and monitoring. TE

These waste management strategies are interrelated; modifications of one can affect another. For example, a modification that calls for the removal of waste from all existing waste sites for disposal elsewhere cannot be paired with the No-Action strategy for new disposal facilities. Thus, the alternative strategies listed in Table 2-1 and described throughout this environmental impact statement (EIS) as integral entities are logical outgrowths of needed SRP waste management actions and recently issued regulations.

This EIS characterizes these alternative strategies as:

- No Action - continuation of the present program for waste management to provide protection of the offsite environment
- Dedication - compliance with groundwater protection and other requirements by dedication of existing and new disposal areas TE
- Elimination - compliance with groundwater protection and other requirements through the elimination of existing waste sites and the provision of retrievable storage of wastes TE
- Combination - compliance with groundwater protection and other requirements by a combination of dedication of some and elimination of other waste sites, and of storage of some and disposal of other wastes TE

This chapter treats, in turn, the environmental consequences of adopting alternative strategies for the modification of the waste management program. Section 4.2 describes alternative strategies for managing existing waste sites. These strategies are complex; they are represented in this analysis by

TE preliminary field data and atmospheric, groundwater, and health effects modeling information presented to include the range of environmental consequences and costs. The implementation of specific actions at individual locations would be determined by interactions with regulatory agencies based on future site-specific modeling and monitoring results not currently available for the majority of the sites.

Section 4.3 presents the environmental consequences of the construction of new disposal/storage facilities; Section 4.4 describes the effects of modifications to the discharge of disassembly-basin purge water; and Section 4.5 presents the consequences of potential accidents associated with remedial, removal, and closure actions at existing waste sites. Section 4.6 presents the effects of the decontamination and decommissioning of potential new facilities; Section 4.7 describes cumulative effects; Section 4.8 describes mitigation measures; and Section 4.9 describes unavoidable/irreversible impacts. Section 4.10 summarizes the environmental consequences of the preferred strategy.

TC Data and information related to environmental consequences, health effects, and costs of the alternative waste management strategies are taken from the Environmental Information Documents (EIDs) used as support documents for this EIS.

4.2 ALTERNATIVE WASTE MANAGEMENT STRATEGIES AT EXISTING WASTE SITES

This section describes the environmental consequences of the implementation of four strategies for the management of existing waste sites that contain or might contain hazardous, low-level radioactive, or mixed waste. They represent the strategies described fully in Section 2.1; they consist of the following:

- No Action - No removal of waste at existing sites, and no closure or remedial actions
- Dedication - No removal of waste at existing waste sites, and implementation of cost-effective closure and remedial actions, as required
- Elimination - Removal of waste to the extent practicable from all existing waste sites, and implementation of cost-effective closure and remedial actions, as required
- Combination - Removal of waste to the extent practicable at selected existing waste sites, and implementation of cost-effective closure and remedial actions, as required

The following sections describe these strategies. The description of each strategy summarizes the range of actions that are considered feasible for the existing sites; identifies the predicted effects of these actions on contaminants in groundwater and surface water in each geographic grouping of sites (see Section 2.2) and compares them to relevant standards; assesses public exposures to and health risks from chemical and radioactive waste constituents; and presents impacts on aquatic, terrestrial, archaeological and historic, and socioeconomic resources.

The assessments in these sections are based on calculated groundwater and surface-water concentrations of waste constituents that are likely to be present at existing waste sites and that are predicted by computer codes to exceed applicable standards. | TE

The transport models used in these analyses (predominantly the PATHRAE code; see Appendix H) consider a variety of pathways from the waste source to the human environment, including the following:

- Contaminated groundwater movement to water wells (hypothetically assumed to be 1 meter and 100 meters downgradient from each waste site) and to actual surface streams | TE
- Erosion of waste materials from a site and movement to a surface stream
- Consumption of food produced from farmland reclaimed over a waste site and consumption of crops produced through natural biointrusion on land over a waste site
- For radioactive constituents, direct exposure to gamma radiation
- Inhalation of volatile gaseous or particulate material in the air
- Ingestion of foods containing waste materials deposited from the atmosphere on the ground surface

PATHRAE modeling is applied to an individual waste site (e.g., metallurgical laboratory basin), to contiguous sites modeled as a single group (e.g., SRL seepage basins), and as the worst-case impact analysis (based on hydrogeology and source conditions) of a class of sites that serve similar functions but are in several different SRP areas (e.g., acid/caustic basins).

The analyses in this section are based on individual waste site source-term information (Looney et al., 1987) and the 1- and 100-meter well concentrations presented in Appendix F. The initial emphasis is on potential cumulative groundwater effects within geographic groupings. Cumulative effects could occur if groundwater contaminated from an upgradient waste site travels beneath another waste site and receives additional leachate from the second site. | TE

Potential plume interaction is determined by summing the predicted peak concentrations at all 100-meter wells in a geographic grouping, regardless of the time of peak occurrence. This summation is used as a screening device to establish a hypothetical upper limit of potential cumulative effects. | TE Actually, as the groundwater travels slowly beyond the 100-meter well, the peak concentration would be attenuated by dilution with uncontaminated groundwater recharge and the spreading that occurs as a contaminant flows through the porous media. In addition, one site probably would not be located precisely downgradient from another, and the centroid of the original contaminant plume probably would not be under the second site at the same time the peak contaminant flux was entering the groundwater from that site.

Therefore, this method establishes a conservative upper limit to potential interactions because it does not consider the spatial or temporal nature of | TE contaminant plumes or the decay and dilution that occur as they travel. If the sum (for each constituent) of the peak concentrations at each 100-meter well does not exceed standards, no further examination is made. If the sum exceeds standards, the specific pathways, time of occurrence, and source conditions of the affected waste sites are examined to see if realistic cumulative effects could occur. The 100-meter well concentrations were used in this analysis because they reflect at least the initial attenuation that occurs in this process.

TE With the potential for plume interaction established in Section 4.2.1.1, Sections 4.2.2.1, 4.2.3.1, and 4.2.4.1 examine groundwater impacts under remedial and closure actions that are consistent with the Dedication, Elimination, and Combination strategies. Closure generally reduces predicted peak concentrations. However, in these sections the absolute peak concentrations at the 1-meter well are presented to identify the potential for postclosure groundwater remedial actions under each of these three waste management strategies.

TE The time periods for analysis of potential environmental consequences are based on two assumptions: first, the U.S. Department of Energy (DOE) will not relinquish control of the SRP for 100 years beyond 1985, which is reasonable in light of current production planning and projected scheduling for site decommissioning; and second, analyses to 1000 years are sufficient to describe the long-term consequences, as suggested by guidelines of the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Environmental Protection Agency (EPA).

The sites and constituents to be modeled for this EIS were determined as follows:

1. Available data were reviewed to determine the materials disposed of at each site and the constituents found in soil or groundwater.

2. Measured or predicted soil and groundwater concentrations were compared to threshold selection criteria established for each constituent, corresponding to or less than EPA maximum contaminant levels (MCLs). If the quantities or concentrations exceeded the selection criteria values, the material was selected for environmental assessment.

3. If large amounts of specific chemicals were believed to have been disposed of at the site, those materials were included for assessment, even if soil and groundwater characterization data did not indicate their presence.

TE TE The following sections present predicted peak groundwater concentrations that exceed maximum contaminant limits (MCLs) or other standards for each strategy and waste site grouping. These sections contain tables (e.g., Table 4-3) that list the predicted peak concentrations and corresponding applicable standards of modeled constituents for combinations of strategy and waste site groupings. The "applicable standard" values in these tables are derived from several sources, primarily the National Primary Drinking Water Regulations (40 CFR 141; EPA, 1985a, 1987). Radiation dose calculation methodology of the International Commission on Radiological Protection (ICRP, 1978) was used to determine radionuclide concentrations that yield an effective whole-body dose of 4 millirem per year, calculated on a basis of 2 liters per day for drinking-water intake. Drinking-water regulations based on this methodology are anticipated (EPA, 1986a). For consistency, all radionuclide MCLs were calculated in this manner. Current drinking-water regulations, however, use 1963 dose calculation models and assumption that yield different values (e.g., tritium and strontium-90 regulations are 20,000 and 8 picocuries per liter, TE respectively). In addition, if two or more radionuclides are present, MCLs are adjusted so that the sum of the doses does not exceed 4 millirem per year.

The following sections also present risk assessments for each strategy and waste grouping in terms of carcinogenic risks from radioactive and nonradioactive wastes, and noncarcinogenic risks from other hazardous chemicals. Carcinogenic risks are the product of exposure (either chemical or radiological) and the unit cancer risk (UCR). These risks are additive; that is, the risks from chemical exposures can be summed and equivalent radiological risks added to obtain a combined risk estimate expressed as the increase in probability for 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 exposures over a period of 50 years, which encompasses the year of peak exposure. Radiological risks, however, were calculated for an exposure period of the peak year only. Thus, to produce a common risk basis for both chemical and radiological carcinogenesis, radiological risks calculated as lifetime risk per year of exposure are multiplied by 50 to produce a conservative estimate of lifetime-exposure risk comparable to that originally calculated for chemical carcinogenesis. This EIS considers lifetime carcinogenic risks calculated to be less than 1 in 100 million (1 x 10^{-8}) for individual constituents to be not significant.

As a perspective on carcinogenic risks, the average risk in the United States of a person dying from cancer is about 1.9 x 10^{-3} (or almost 2 chances in 1000) per year. However, rates in individual states range from a low of about 0.76 x 10^{-3} (in Alaska, with a very young population on average) to a high of 2.4 x 10^{-3} (in Florida, which has an older average population). The average risk of dying from lung cancer is about 5 x 10^{-4} per year; about one in four cancer deaths is due to this cause. The lifetime (age-adjusted) average risk of death by cancer is about 9 x 10^{-2} (or 9 chances in 100).

EPA has adopted a lifetime risk value of 1 x 10^{-6} as a reference point for the management and regulation of carcinogens in the environment. Thus, an incremental risk from an environmental carcinogen at the EPA guideline limit would raise the risk to an average U.S. resident of death by cancer from 0.09 to 0.090001. Similarly, at an incremental annual risk of 1 x 10^{-6} from a TC particular exposure, the total annual risk to an average individual of death by cancer would rise from 0.0019 to 0.001901.

To provide a perspective on common risks, Table 4-1 gives a range of estimated TC risks of dying in a single year for some human activities that are based on E-137 various occupations, lifestyles, accidents, and environmental exposures, incidents, or situations.

A noncarcinogenic risk from chemical constituents is defined as the ratio of the average daily 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 less than 1 of calculated risk means that no health effect is likely; the smaller the value, the greater the margin of safety. Individual noncarcinogenic risk values can be summed to form a hazard index that also is compared conservatively to a threshold of 1. Because SRP waste sites do not have more than (at most) several dozen waste constituents, individual constituent noncarcinogenic hazard index values of less than 1 in 100 (1×10^{-2}) are considered not significant in these assessments; that is, the sum of several dozen risks of 0.01 each would still be much less than 1, and hence no health effect would be expected.

Finally, the evaluations of alternatives in this section are based for the most part on preliminary information and simplified modeling assumptions, which predict groundwater and/or surface-water concentrations to exceed current standards at some time in the future (or at present). However, these concentrations cannot be compared directly to monitoring results at the sites described in this EIS. These predictions represent a preliminary indication of the probable need for, or benefit from, closure or remedial actions under defined circumstances, for providing estimates and comparisons in this EIS. In practice, the need for and types of closure or remedial actions will be determined by direct interaction with regulatory authorities, based on detailed site-specific data and evaluations and in conformance with the standards then in effect. TE

4.2.1 NO-ACTION STRATEGY (NO REMOVAL OF WASTE AND NO CLOSURE OR REMEDIAL ACTION)

Under no action, existing waste at all sites would remain in place and each site would be retained in its present condition; however, the addition of wastes to currently active sites would be discontinued as treatment facilities became available. Existing basins would not be backfilled and liquids contained in these basins, including periodic rainfall, would continue to dissipate by evaporation or infiltration into the soil.

Actions such as cleanup at M-Area would continue to be taken to protect the offsite environment. Additional groundwater monitoring wells would be installed at the sites listed in Table 4-2 to ensure the detection of contaminant plumes. All existing and new wells would be monitored as required. TE

Fences, pylons, and signs would be installed to keep out terrestrial and aquatic animals and unauthorized persons, and all waste sites would be inspected periodically for erosion or subsidence. Weed control, grass mowing, and maintenance of signs and fences would be provided, as in other SRP areas. E-140

4.2.1.1 Groundwater Impacts[1]

The primary impact posed by existing waste sites is on groundwater and its potential uses, either directly or after movement to surface waters. The following paragraphs discuss these impacts at various waste sites by geographic groups. The sites or parameters discussed (and included in the corresponding tables) are those for which the model predicts exceedances of appropriate MCLs or comparable health-based criteria.

---

[1] Data and information related to all environmental impacts are taken from the Environmental Information Documents (EIDs) used as supporting or background documents for this EIS.

Table 4-2. Additional Groundwater Monitoring Wells

Site Group Number	Site	Buildings	Number
1-5	Miscellaneous chemical basin	731-5A	5
2-2	H-Area acid/caustic basin	904-75G	4
2-5	H-Area retention basin	281-3H	2
2-6	F-Area retention basin	281-3F	4
3-4 to 6	R-Area Bingham pump outage pits	643-8G to 10G	4
TC 4-6	Ford Building waste site	643-11G	4
5-3	TNX burying ground	643-5G	16
8-3	K-Area Bingham pump outage pit	643-1G	4
9-10, 11	L-Area Bingham pump outage pits	643-2G, 3G	4
10-3	P-Area Bingham pump outage pit	643-4G	4
11-1	SRL oil test site	080-16G	4
11-2	Gunsite 720 rubble pit	N80,000: E27,350[a]	4

[a] SRP map coordinates

Table 4-3 summarizes no-action peak 100-meter well constituent concentrations (and their respective years of occurrence) for the 12 modeled waste sites in the A- and M-Areas, with the corresponding MCLs. This table lists each constituent with a sum exceeding its MCL. These exceedances clearly are due to individual waste sites that exceed their MCLs, except for lead.

TC An analysis of the specific pathways and inventory of the affected waste sites demonstrated that there is also little, if any, potential for cumulative effects from lead. Groundwater beneath the M-Area settling basin and Lost Lake is postulated to travel southeastward to outcrops in Upper Three Runs Creek while the water-table aquifer beneath the other sites in this area has a westward gradient. Therefore, the lead plumes from the M-Area settling basin and vicinity would not be expected to converge with those from the other sites. This results in a potential cumulative concentration from the other sites of 0.056 milligram per liter for lead.

TC The peak concentrations listed for the A-Area burning/rubble pits are from modeling of the C-Area burning/rubble pit. However, the estimated disposal mass of lead at the A-Area pits is zero. When the burning/rubble pit values are subtracted from the above subtotals, the realistic potential cumulative concentration is 0.018 milligram per liter for lead. This is below the MCL of this constituent (0.05 milligram per liter).

TE For the F- and H-Areas, a three-dimensional flow model (McDonald and Harbaugh, 1984) and the Sandia Waste Isolation and Flow Transport model (NRC, 1986), have been used to simulate the variable hydrostratigraphic and boundary conditions that exist throughout the F- and H-Areas (Killian et al., 1987). TE In general, the models predict that a contaminant released from the F-Area seepage basin would travel through the Barnwell and McBean aquifers before outcropping at Four Mile Creek. A contaminant released from the H-Area seepage basins would travel only through the Barnwell aquifer before reaching

Four Mile Creek. From the radioactive and mixed waste burial grounds (643-G, 643-7G, and 643-28G), most of the contaminant would travel through the Barnwell, McBean, and Congaree aquifers to an outcrop at Upper Three Runs Creek, although some of the contaminant would travel through the Barnwell and McBean aquifers and outcrop to Four Mile Creek.

Contaminants from other waste sites in F- and H-Areas travel in a direction influenced by the water-table divide that bisects the radioactive waste burial grounds. Groundwater in the northern part of the area travels toward Upper Three Runs Creek, and in the southern part of the area toward Four Mile Creek. The modeling results indicate a low potential for contaminants to enter the Middendorf/Black Creek (Tuscaloosa) aquifer from waste sites in F- and H-Areas. However, recent studies have shown that the upward head gradient near H-Area has declined from 1.5 meters to 0.61 meter between 1972 and 1986 (Bledsoe, 1987). Because the head differential is small, large volumes of water pumped from the Black Creek aquifer in portions of the H-Area potentially could reverse the upward gradient, thereby effectively eliminating the hydraulic barrier to downward flow. A modeling study (Duffield, Buss, and Spalding, 1987) indicates that a maximum downward potential of about 1.5 meters has developed in the eastern portion of H-Area. Future SRP actions will consider the need for preserving the upward head gradient and the implications of it being adversely affected.

TC

Table 4-4 lists the summation of peak constituent concentrations that exceed their applicable standards and the predicted contaminant concentrations associated with individual waste sites in the F- and H-Areas under no action. The radioactive waste burial grounds, F-Area seepage basins, and H-Area seepage basins are the primary sources of groundwater contaminants in F- and H-Areas. Of the 17 constituents identified in Table 4-4, an individual waste site is the primary source of 13. The four remaining constituents (nitrate, trichloroethylene, tetrachloroethylene, and iodine-129) arise from several waste sites in F- and H-Areas; however, the groundwater flows from these sites are unlikely to mix, considering their separation distances and different directions of groundwater flow before reaching onsite streams. Therefore, the individual contaminant concentrations associated with each waste site in Table 4-4 appropriately identify potential groundwater-quality impacts for no action.

There are 12 sites in the R-Area grouping; the three Bingham pump outage pits (sites 4 to 6) and the six reactor seepage basins (sites 7 to 12) are treated as single sites for analysis purposes, as are the two burning/rubble pits.

Table 4-5 lists peak 100-meter well concentrations (with the year of occurrence) and their sums for each contaminant exceeding its applicable standard in the R-Area group under no action. As indicated in the table, essentially all of the radioactive contamination derives from the seepage basins; tritium, strontium, and cesium-137 all exceed their standards. In addition, trichloroethylene exceeds the standard at the burning/rubble pits, and lead and tetrachloroethylene at the acid/caustic basin.

Of the seven sites considered in C-Area and the Central Shops (CS) Area, three have evidence of contamination: C-Area burning rubble pit (site 4), hydrofluoric acid spill area (site 5), and the Ford Building seepage basin (site 7).

Table 4-6 lists peak 100-meter well concentrations and their sums (over all sites) and regulatory standards for all contaminants reported in the C- and CS-Area under no action. Tritium exceeds the standards at the Ford Building seepage basin. Trichloroethylene exceeds the standard at the C-Area burning/rubble pit. The cumulative concentration for lead in C- and CS-Areas is above its MCL due to the summing of concentrations from several sites. The C-Area burning/rubble pit, however, is approximately 2 kilometers from the hydrofluoric acid spill area and 3 kilometers from the Ford Building seepage basins. Beneath the Ford Building seepage basin, groundwater flows toward Pen Branch, and beneath the C-Area burning/rubble pit it flows toward Four Mile Creek. Therefore, the plume from the burning/rubble pit is not likely to interact with the plumes from the other waste sites. This fact, coupled with the marginal exceedance of the drinking water standard (0.054 milligram per TC liter versus a standard of 0.05 milligram per liter) suggests that the cumulative concentration of lead would not exceed the standard.

Table 4-7 lists the summations of constituent concentrations that exceed applicable standards and the predicted contaminant concentrations associated with individual sites in the TNX-Area group. Concentrations of chromium, TC lead, nitrate, tetrachloromethane, and trichloroethylene are predicted to exceed applicable standards in groundwater at the TNX-Area. Individual waste sites are the primary source of contamination for these five constituents. TC Nitrate concentration is predicted to exceed standards at both the new and old TNX seepage basins. Potentially, nitrate plumes from these two sites could interact.

The direction of groundwater flow in the TNX-Area is toward the Savannah River. In this area, the potentiometric levels generally increase with depth, indicating that groundwater moves vertically upward from the Middendorf/Black Creek to the Congaree, and from the Congaree to the water-table aquifer (Dunaway et al., 1987). Therefore, there is a low potential for contaminants to enter the Middendorf/Black Creek and Congaree aquifers from waste sites in the TNX-Area.

The D-Area oil seepage basin (Building 631-G) is the only waste site in D-Area. PATHRAE simulations project that the concentration of tetrachloroethylene at the 100-meter well (0.017 milligrams per liter) exceeded its health-based standard (0.0007 milligrams per liter) in 1978 for all closure TC options including no action. As in the nearby TNX-Area, the direction of groundwater flow in D-Area is toward the Savannah River. Similarly, because of higher head in the Middendorf/Black Creek, contamination of this aquifer is unlikely.

The Road A chemical basin is the only potential source of groundwater impacts in the Road A Area. Groundwater monitoring data for water-table wells at the Road A chemical basin indicate that lead, gross alpha, and radium were detected in June 1984 at levels above regulatory standards or guidelines. However, quarterly groundwater sampling since June 1984 has not detected levels of these constituents above the applicable standards (Pickett, Muska, and Bledsoe, 1987). PATHRAE simulations, based on estimated inventories for lead, and uranium-238, project that the concentrations of these constituents in the water-table aquifer for no action would remain within regulatory standards at a distance of 100 meters from the basin (see Appendix F).

The direction of flow in the water-table aquifer near the basin is to the west, toward the bottomland wetlands of Four Mile Creek approximately 200 meters from the basin and about 15 meters lower in elevation. Although there is a potential for a downward flow of water in the water-table aquifer to the Congaree Formation, the more probable discharge for the water-table aquifer is the wetlands.

Four sites are considered in K-Area: burning/rubble pit (site 1), acid/caustic basin (site 2), Bingham pump outage pit (site 3), and K-Area seepage basin (site 4). Table 4-8 lists for no action the peak 100-meter well concentrations, their sum over all the sites, and the applicable regulatory standards. Trichloroethylene exceeds its standard at the burning/rubble pit and lead and tetrachloroethylene at the acid/caustic basin. Tritium from the K-Area seepage basin exceeds its standard.

Table 4-9 lists the peak concentrations for constituents exceeding appropriate standards from the 12 waste sites in L-Area under no action. The cumulative concentrations in L-Area for the 12 constituents listed are all above their MCLs as the result of single waste site sources rather than cumulative effects.

Groundwater flow beneath the majority of the waste sites in this area is toward Pen Branch. However, the groundwater beneath the L-Area acid/caustic basin and the L-Area oil and chemical basin would travel to Steel Creek.

There are three sites in P-Area: the burning/rubble pit (site 1), acid/caustic basin (site 2), and Bingham pump outage pit (site 3). Table 4-10 lists peak concentrations at the 100-meter well for no action, the sum for all sites of these concentrations, and the applicable health-based standards. TE Trichloroethylene from the burning/rubble pit, and lead and tetrachloroethylene from the acid/caustic basin, exceed applicable standards. Groundwater flow in P-Area is generally toward Lower Three Runs Creek except beneath the burning/rubble pit, where the groundwater flow is toward Steel Creek.

The SRL oil test site (Building 080-16G) and the Gunsite 720 rubble pit (at SRP coordinates N80,000:E27,350) are miscellaneous waste sites; Appendix F describes their environmental impacts and health effects in detail. Estimates of the environmental releases were not determined at either site because chemical constituents did not exceed threshold selection criteria. No adverse environmental impacts are anticipated from these facilities for any closure action.

Summary of Groundwater Impacts Under No-Action Strategy

TE Based on the analyses described above for the No-Action strategy, and as indicated in Tables 4-3 through 4-10, health-based standards in groundwater at the hypothetical 100-meter wells are predicted to be exceeded at 66 of the 77 individual waste sites. The constituents predicted to exceed MCLs or other health based standards are:

- Radionuclides, principally tritium
- Organic chemicals, principally trichloroethylene and tetrachloroethylene
- Metals, principally lead
- Nitrate

Table 4-10. Peak Concentrations at 100-Meter Well for No Action, P-Area

Waste management facility	Site number	PATHRAE peak concentrations[a] Chemicals (mg/L) Pb	 Trichloroethylene	 Tetrachloroethylene
P-Area burning/ rubble pit[b]	10-1	0.038 (1982)	1.8[c] (1983)	(d)
P-Area acid/ caustic basin[b]	10-2	0.054[c] (1971)	(d)	0.094[c] (1972)
Sum of concentration[g]		0.092[c]	1.8[c]	0.094[c]
Standard[e]		0.05	0.005	0.0007

TC

---

[a] Year of peak concentration shown in parentheses; years prior to 1985 are indications of present concentration.

[b] Concentrations are from PATHRAE modeling for largest inventory waste management unit in this functional grouping; actual peak concentrations are dependent on the inventory of this unit.

[c] Concentration exceeds regulatory standard.

[d] Constituent did not meet threshold selection criteria for PATHRAE modeling.

[e] Sources: Lead and trichloroethylene (EPA, 1985a, 1987). Tetrachloroethylene (EPA, 1985b). TE

4.2.1.2 Surface-Water Impacts

The impacts evaluated by PATHRAE from surface-water pathways are (1) groundwater movement to the Savannah River via surface streams and (2) erosion of waste materials and movement to surface streams. PATHRAE contaminant releases for the erosion pathway were predicted to be zero for most sites and minimal releases for all others because of low erosion rates (approximately 0.2 millimeter per year). There is no direct discharge of existing waste to surface streams except for NPDES outfalls. TC

The projected peak concentrations in the streams as a result of groundwater discharges were evaluated against the MCLs or criteria for protection of public health. The results of these assessments are summarized in Table 4-11

Table 4-11. Waste Constituents[a] in Surface Water for No Action

TC

Stream	Contaminant	Current instream concentration[b]	Projected peak instream concentration	Maximum contaminant level[c]
Upper Three Runs Creek	Tetrachloroethylene	LLD[d]	0.0035	0.0007
Four Mile Creek	Nitrate	3.0	20	10
	Phosphate	0.020	0.022	NS[f]
	Naphthalene	LLD	0.0014	NS
	Trimethylbenzene	NA[e]	0.003	NS
	Tritium	8.5×10^5	8.7×10^5	8.7×10^4
	Cesium-137	LLD	140	110
Pen Branch	Phosphate	0.1	0.1	NS
	Freon®	NA	0.0067	NS

[a] Chemicals in mg/L, radionuclides in pCi/L.

[b] Sources: Upper Three Runs Creek (Pickett, Colven, and Bledsoe, 1987); Four Mile Creek (Killian et al., 1987); Pen Branch (Pekkala et al., 1987).

[c] Sources: 40 CFR 141, except as follows: tetrachloroethylene (EPA, 1985b). ICRP Publication 30 (ICRP, 1978) methodology was used to determine radionuclide concentrations that yield an annual effective whole-body dose of 4 millirem.

[d] LLD = instream concentration less than lower limit of detection.

[e] NA = instream concentration not available.

[f] NS = drinking water standard not available.

for Upper Three Runs Creek, Four Mile Creek, and Pen Branch. In a number of instances, constituents are listed for which there are no MCLs or comparable criteria.

TE

Contaminants to be released via groundwater discharge under no action are predicted not to exceed their respective MCLs (or criteria) in Pen Branch, Steel Creek, Lower Three Runs Creek, or the Savannah River, although criteria do not exist for the constituents listed for Pen Branch. Tetrachloroethylene is the only contaminant predicted to exceed standards in Upper Three Runs Creek.

Contaminant releases to Four Mile Creek are projected to include 2 inorganic substances, 2 organic compounds, and 20 radionuclides, of which only 3 - nitrate, cesium 137, and tritium - are projected to exceed MCLs, although 2 constituents do not have comparable criteria. The nitrate concentration is projected to peak at 20 milligrams per liter. The current instream concentration and MCL are 3.0 and 10 parts per million, respectively. The concentration for cesium-137 is projected to peak at 140 picocuries per liter or 40 picocuries per liter above the standard of 100 picocuries per liter. The current instream concentration of tritium is 850,000 picocuries per liter, a concentration that exceeds the MCL (Killian et al., 1987). The projected peak concentration of tritium in Four Mile Creek is 870,000 picocuries per liter. In addition, the release of other radionuclides (not listed in Table 4-11) to Four Mile Creek was projected. The sum of the projected instream concentrations for these radionuclides, excluding tritium, results in an annual dose of 6.6 millirem to a hypothetical consumer of drinking water from Four Mile Creek, which exceeds the EPA community drinking-water standard of 4 millirem per year.

4.2.1.3 Radiological Doses

Table 4-12 lists peak annual doses to the maximally exposed individual resulting from releases from each of the 21 low-level radioactive and mixed waste sites, and their years of occurrence, under the No-Action strategy. These doses are based on the maximally exposed individual residing on the SRP after institutional control is relinquished, assumed to be in the year 2085. The groundwater-well pathway is the most significant, contributing at least 95 percent of the total dose at all those sites (except two), with peak annual doses of 25 millirem or more. The exceptions are the F-Area and H-Area seepage basins, where direct gamma contributes almost all the 1000-millirem and 440-millirem annual doses, respectively. The atmospheric pathway is responsible for the peak annual dose from the old TNX seepage basin, the SRL seepage basins, and the M-Area settling basin and Lost Lake. The reclaimed farm pathway is responsible for the entire dose from the TNX burying ground. TC

Five sites would exceed both the DOE annual dose limit of 100 millirem from all pathways and the 4-millirem EPA annual drinking-water dose limit under no action: the R-Area reactor seepage basins (2900 millirem in 2094), the F-Area seepage basins (1000 millirem in 2085), the old F-Area seepage basin (400 millirem in 2312), the H-Area seepage basins (440-millirem in 2085), and the L-Area oil and chemical basin (190 millirem in 2098). All sites would comply individually with the 25-millirem DOE annual dose limit for the atmospheric pathway. TC TC

Three additional sites would exceed the 4-millirem EPA annual drinking-water dose limit: the H-Area retention basin (72 millirem from the 1-meter well in 2085), the radioactive waste burial grounds (27 millirem from the 1-meter well in 2420), and the Road A chemical basin (30 millirem from the 1-meter well in 2985).

The cumulative annual dose calculated to be received in 1985 from all pathways by the maximally exposed individual residing at the SRP boundary is 14.6 millirem; it would increase to 3920 millirem in 2085. This value is the sum of the 1000 millirem direct gamma dose from the F-Area seepage basin and the post-2085 (2900 millirem) dose from the R-Area seepage basins. The cumulative annual doses received by the population in the SRP region* in 1985 and 2085 are 58 and 48 person-rem, respectively. TC

---

*The atmospheric pathway contribution to the population dose is based on an exposed population of 585,000 within an 80-kilometer radius of the SRP. The groundwater-to-river pathway contribution to the population dose is based on a user population of 100,000.

TE

Table 4-12. Peak Annual Doses to Maximally Exposed Individual from Radiological Releases for No Action

Low-level and mixed waste sites	Maximum annual individual dose (mrem)[a]	Year of peak dose
H-Area retention basin	73	2085
F-Area retention basin	0.37	2313
R-Area Bingham pump outage pits	0.20	2085
R-Area reactor seepage basins	2900	2094
Ford Building waste site	0	
TNX burying ground	1.4×10^{-4}	2085
K-Area Bingham pump outage pit	0.20	2085
K-Area reactor seepage basin	0.30	2085
L-Area Bingham pump outage pits	0.20	2085
P-Area Bingham pump outage pit	0.20	2085
SRL seepage basins	0.69	1985
M-Area settling basin and Lost Lake	0.16	1985
Radioactive waste burial ground, mixed waste management facility (new), and radioactive waste burial ground (old)	27	2420
F-Area seepage basins	1000	2085
F-Area seepage basin (old)	400	2312
H-Area seepage basins	440	2085
Ford Building seepage basin	1.4	2334
TNX seepage basin (old)	12.3	1985
TNX seepage basin (new)	3.2	2563
Road A chemical basin	30	2985
L-Area oil and chemical basin	190	2098

[a] All doses (in millirem) are not necessarily additive.

4.2.1.4 Health Effects

This section discusses health effects resulting from no action, which are divided into effects from radiological and chemical releases. Appendix I describes the methodology employed for estimating and assessing health risks of the waste management strategies.

Radiological

Table 4-13 lists lifetime health risks to the maximally exposed individual resulting from the peak annual radioactive releases from 21 low-level and mixed waste sites for the No-Action strategy. The health risk is assumed eventually to total 280 radiation-induced excess fatal cancers and genetic disorders as a result of a collective dose of 1 million person-rem.

Table 4-13. Radiological Health Risks to the Maximally Exposed Individual from the Peak Annual Doses for No Action

Low-level and mixed waste sites	Maximum individual risk (HE for peak year dose)	Lifetime exposure risk[a]
H-Area retention basin	2.1×10^{-5}	1.1×10^{-3}
F-Area retention basin	1.0×10^{-7}	5.0×10^{-6}
R-Area Bingham pump outage pits	5.6×10^{-8}	2.8×10^{-6}
R-Area reactor seepage basins	8.1×10^{-4}	4.1×10^{-2}
Ford building waste site	0	0
TNX burying ground	3.9×10^{-11}	2.0×10^{-9}
K-Area Bingham pump outage pit	5.6×10^{-8}	2.8×10^{-6}
K-Area reactor seepage basin	8.4×10^{-8}	4.2×10^{-6}
L-Area Bingham pump outage pits	5.6×10^{-8}	2.8×10^{-6}
P-Area Bingham pump outage pit	5.6×10^{-8}	2.8×10^{-6}
SRL seepage basins	1.9×10^{-7}	9.5×10^{-6}
M-Area settling basin and Lost Lake	4.5×10^{-7}	2.3×10^{-6}
Radioactive waste burial ground, mixed waste management facility (new), and radioactive waste burial ground (old)	7.6×10^{-6}	3.8×10^{-4}
F-Area seepage basins	2.8×10^{-4}	1.4×10^{-2}
F-Area seepage basin (old)	1.1×10^{-4}	5.5×10^{-3}
H-Area seepage basins	1.2×10^{-4}	6.0×10^{-3}
Ford Building seepage basin	3.9×10^{-7}	2.0×10^{-5}
TNX seepage basin (old)	3.4×10^{-6}	1.7×10^{-4}
TNX seepage basin (new)	9.0×10^{-7}	4.5×10^{-5}
Road A chemical basin	8.4×10^{-6}	4.2×10^{-4}
L-Area oil and chemical basin	5.3×10^{-5}	2.7×10^{-3}

TC

[a] Assumes a 50-year exposure at peak year dose.

Under no action, health risks to the maximally exposed individual as a result of exposures during 1985 at the SRP boundary, and to an onsite resident during 2085, total 4.1×10^{-6} and 1.1×10^{-3}, respectively. The corresponding maximum lifetime risks from 50 years of exposure at the peak rate would be 2.0×10^{-4} and 5.5×10^{-2}, respectively.

The health effects predicted to occur in the population in the SRP region from the collective doses delivered in 1985 and 2085 under no action are 1.6×10^{-2} and 1.3×10^{-2} excess cancer deaths, respectively. Effects of lifetime exposure at the same rate in that population would total 0.81 and 0.67 excess cancer deaths, respectively.

Chemical

Total carcinogenic risk is the lifetime risk associated with concurrent exposure to multiple carcinogenic substances, assuming a whole-body additive model for carcinogenesis. Total noncarcinogenic risk, similarly, is defined by the EPA Hazard Index, which is the summation of the fractional ADIs for each substance at the receptor at a specified time (see Appendix I). TE The following paragraphs present groundwater/surface-water pathway risks in relation to geographic groupings. Atmospheric and occupational pathway risks are discussed on a facility-wide basis.

Groundwater and Surface-Water Pathway

Tables 4-14 and 4-15 summarize the risks posed under the No-Action strategy by the sites in each geographic group via the groundwater/surface-water pathway, assuming relinquishment of DOE control in 2085.

TC <u>A- and M-Area Geographic Grouping</u>. The maximum total nonradiological carcinogenic risk for 50-year exposures peaking in 2085 is 3.8×10^{-4} at the 100- meter well in M-Area. The maximum risk for the dominant carcinogenic chemical is 1.6×10^{-1}, posed by tetrachloroethylene at the 1-meter well in 2021 and the 100-meter well in 2020.

TC The M-Area settling basin also poses the maximum total noncarcinogenic hazard index for 2085 (2.3×10^{-1} for the reclaimed farm pathway). The maximum hazard index for the dominant noncarcinogenic chemical (6.2×10^{2}) is due to nitrate at the 1-meter well in 1991 and the 100-meter well in 1990.

TC <u>F- and H-Area Geographic Grouping</u>. The maximum total nonradiological carcinogenic risk from 50-year exposures peaking in 2085 for this grouping is posed by the 100-meter well at the F-Area burning/rubble pit (9.4×10^{-10}). The maximum risk for the dominant carcinogenic chemical is 1.7×10^{-4} from trichloroethylene at the 1-meter well, peaking in 1978. The risk from trichloroethylene at the 100-meter well peaked in 1983 at 1.6×10^{-4}.

TC The highest total noncarcinogenic hazard index in 2085 is 4.6, posed by the mixed waste management facility and old radioactive waste burial grounds at the 100-meter well. The maximum hazard index (6.9×10^{1}) for the dominant noncarcinogenic chemical is presented by nitrates at both the 1- and 100-meter wells at the F-Area seepage basin in 1987. TC Mercury creates risks of 5.0 to the reclaimed farm receptors in 2085 at the F-Area seepage basin, 9.5 at the H-Area seepage basins, and 1.4 at the mixed waste management facility/radioactive waste burial grounds.

<u>R-Area Geographic Grouping</u>. All strategies present the same carcinogenic risks for the groundwater/surface-water pathway. The R-Area burning/rubble pits total carcinogenic risks are not significant for exposures peaking in TC 2085. Trichloroethylene presented risks of 1.7×10^{-4} at the 1-meter well and 1.6×10^{-4} for the 100-meter well from exposures peaking in 1978 and 1983, respectively.

TC The R-Area acid/caustic basin presents the highest noncarcinogenic hazard index of 2.1×10^{-2} in 2085 for the reclaimed farm pathway. Sulfate is the dominant noncarcinogenic chemical; it reached a peak hazard index of 2.9 at the 1-meter well and 100-meter well in 1971.

C-Area and CS-Area Geographic Grouping. The carcinogenic risks for the groundwater/surface-water pathway are identical for all four strategies. Carcinogenic risks for this pathway are predicted only for the burning/rubble pits (three in CS-Area and one in C-Area), which are identical. The total carcinogenic risks for 50-year exposures following 2085 are not significant. The dominant carcinogenic chemical is trichloroethylene, which created a peak risk in 1978 at the 1-meter well (1.7×10^{-4}), and in 1983 at the 100-meter well (1.6×10^{-4}). TC

The highest total noncarcinogenic risk in 2085 is posed by the Ford Building seepage basin, with a maximum risk of 1.2×10^{-2} for the reclaimed farm pathway. The dominant noncarcinogenic chemical in the geographic grouping is fluoride, which posed a maximum hazard index of 4.5 at the hydrofluoric acid spill area 1-meter well in 1975. TC TC

TNX-Area Geographic Grouping. The highest total carcinogenic risk under no action for 50-year exposures following 2085 is 4.8×10^{-4} presented by the 100-meter well at the D-Area oil basin. The maximum risk for the dominant carcinogenic chemical was presented by trichloroethylene from hypothetical exposures at the D-Area burning/rubble pits 1-meter well (1.7×10^{-4}), peaking in 1978. These conditions are the same under all strategies. The only site in this grouping where risks varied is the new TNX seepage basin. TC

The new TNX seepage basin presents the highest noncarcinogenic hazard index in this grouping. In 2085, this index peaks at the 1-meter well (2.4×10^{-1}). In the same year, mercury creates a hazard index of 1.8 at the assumed reclaimed farm receptor at the old TNX seepage basin. The risk for the dominant noncarcinogenic chemical, nitrate, will peak at the 1-meter well in 1987 (hazard index of 2.5×10^{2}). The noncarcinogenic risks vary from option to option only for the new TNX seepage basin. TC

Road A Chemical Basin. The carcinogenic and noncarcinogenic risks for all strategies are the same. The basin poses no carcinogenic risk.

The highest total noncarcinogenic risk in 2085 is not significant. The peak chemical-specific hazard index was posed by lead at the 1-meter well in 1975 (5.4×10^{-1}) and is predicted to reach 4.1×10^{-1} at the 100-meter well in 1980.

K-Area Geographic Grouping. The carcinogenic risks in this grouping are the same for all strategies. The highest total carcinogenic risk for 50-year exposures following 2085 is not significant. The maximum risks presented by trichloroethylene, the dominant carcinogenic chemical, were 1.7×10^{-4} in 1978 at the 1-meter well and 1.6×10^{-4} in 1983 at the 100-meter well. TC

The only significant noncarcinogenic risk under no action for 2085 is 2.1×10^{-2} at the reclaimed farm pathway for the K-Area acid/caustic basin. Sulfate is the dominant noncarcinogenic chemical, with a hazard index of 2.9×10^{0} in 1971 at the 1-meter well and 100-meter well of the K-Area acid/caustic basin. TC

L-Area Geographic Grouping. The carcinogenic risks are identical for all strategies. The CMP pits pose the highest total carcinogenic risk for 50-year exposures following 2085 at the 100-meter well (1.2×10^{-6}). The maximum TC

TC risk for tetrachloroethylene, the dominant carcinogenic chemical, was 1.0×10^{-2}, posed at the 1-meter well in 1997.

TC Under no action, the L-Area oil and chemical basin poses the greatest noncarcinogenic hazard index for 2085 of 2.2 at the 1-meter well. This is the highest risk in that year for any strategy. The peak risk for the dominant noncarcinogenic chemical is from silvex, with a hazard index of 4.8 in 2012 at the 1-meter well at the CMP pits.

TC <u>P-Area Geographic Grouping</u>. The carcinogenic risks for the groundwater/surface-water pathway are identical for all four strategies. The P-Area burning/rubble pit presents the highest (but not significant) total carcinogenic risk for 50-year exposures following 2085. The highest chemical-specific carcinogenic risks were due to trichloroethylene at the 1-meter (1.1×10^{-4}) and 100-meter (1.6×10^{-1}) wells in 1978 and 1983, respectively.

TC The P-Area acid/caustic basin poses the highest noncarcinogenic risks, under no action. In 2085, the noncarcinogenic hazard index, 2.1×10^{-2}, is predicted to peak for the reclaimed farm pathway. The maximum hazard index for the dominant noncarcinogenic chemical is 2.9, created by sulfate in 1971 at the 1-meter well and the 100-meter well.

TE Atmospheric Pathways

Table 4-16 lists risks to the maximally exposed individual and to the population due to atmospheric carcinogens and the major chemical contributors. These risks are presented for each hazardous or mixed waste site for three selected exposure years: 1985 (start of remedial actions), 2085 (assumed start of public occupation of the SRP), and 2985 (end of 1000-year period). Noncarcinogenic atmospheric releases are all predicted to produce insignificant risks, both individually and collectively (i.e., hazard index less than 1×10^{-2}).

The major contributors to total risk due to airborne carcinogens are associated with the SRL seepage basins, the M-Area air stripper, and the L-Area oil and chemical basin. The major chemical contributors to the risk are chromium-VI and trichloroethylene; Table 4-16 indicates that risks are generally higher for 2085 than for 1986 because the maximally exposed individual is assumed to be closer to the waste site. This results in higher exposures, even though the source strength might have decreased due to leaching over the previous 100 years.

4.2.1.5 Ecological Impacts

TC In order to assess the potential ecological impacts of the No-Action alternative, four pathways through which waste-site constituents can reach the environment were identified: (1) biointrusion, (2) surface erosion of waste constituents due to water and subsequent transport to surface waters, (3) movement of waste constituents through the unsaturated zone to the groundwater and subsequent transport to a surface outcrop, and (4) consumption of contaminated basin waters and, at some sites, aquatic plants.

The exposure concentrations were screened by comparing them to various ecological benchmark criteria. The first benchmark for each constituent, a lower screening level, represents an ecologically protective concentration (SAIC, 1987) and is based on EPA Water Quality Criteria for the Protection of Aquatic Life or equivalent numbers from the technical literature. Any constituent that exceeded the lower screening level by a factor of more than 10 was compared to additional ecological benchmarks to define further the extent (if any) of the potential ecological effects. These additional benchmarks are based on either (1) LC-50s and EC-50s for taxa specific to the SRP ecosystem to assess effects on the aquatic community; (2) the EPA National Interim Primary Drinking Water Standards (EPA, 1977) and, if these were exceeded, chronic no-effect concentrations of metal and organic (except volatile solvents) in mammalian diets to screen for possible effects from consumption of surface waters by terrestrial wildlife; or (3) dietary concentrations shown to be toxic to birds and mammals to assess consumption of contaminated aquatic biota. For those waste sites with radionuclide constituents, EPA National Interim Drinking Water Standards were used as first-level benchmarks for comparison of potential exposure concentrations in surface waters. For tritium, known no-effect concentrations in fish were used as second-level benchmarks. Benchmarks for soil are based on the Department of Energy's Threshold Guidance Limits (DOE, 1985) as presented in Looney et al. (1987a). These soil and water criteria are based on human health concerns and so are conservative. The various quotients (comparing calculated concentrations to benchmarks) form the basis for quantification of potential ecological impacts from each waste site. TC

Potential impacts of no action on aquatic ecosystems could result from the contamination of groundwater and subsequent outcrop to SRP streams and wetlands. Results of PATHRAE analyses indicate that with certain exceptions no action would not significantly alter the quality of existing streams and wetlands of the SRP. Of these streams where water quality would be affected by no action: Four Mile Creek would be impacted by contaminants attributable to the Radioactive Waste Burial Grounds, Road A chemical basin, and the Fand H-Area seepage basins; Upper Three Runs Creek would be impacted by contaminants attributable to the M-Area Settling Basin; Indian Grave Branch would be impacted by contaminants attributable to the K-Reactor Seepage Basin; and Pen Branch would be impacted by contaminants attributable to the CMP Pits. A comparison of groundwater outcrop concentrations with tested aquatic organism toxicity benchmarks, however, indicates no adverse effects except possibly for iodine-129 from the F- and H-Area seepage basins. No toxicity information is available for iodine-129; therefore, the potential aquatic effects due to the groundwater outcrop and diluted stream concentrations of this constituent cannot be assessed. Thus, streams where impacts to the aquatic biota are likely to occur under no action are limited to Four Mile Creek. TC

PATHRAE modeling indicates that the Savannah River could receive groundwater that contains contaminants attributable to the old TMX Area in concentrations which could be toxic to aquatic biota near the outcrop. However, impacts should be negligible because of the limited area of the outcrop and the rapid dilution of outcrop waters to non-toxic concentrations from mixing with Savannah River water. TC

Potential impacts to terrestrial organisms from no action could result from consumption of contaminated standing water in open basins or contaminated undiluted groundwater at the outcrops and biointrusion. The SRP consists of numerous open basins with standing water, at least during wet periods, at various waste sites. Of the open basin waste sites at the SRP, the H-Area retention basin, the M-Area settling basin, the new TNX seepage basin, the SRL seepage basins, and the F- and H-Area seepage basins contain contaminants that exceed the EPA drinking water standards. However, the effects on wildlife that consume the contaminated standing water should be minimal in view of the conservative nature of the drinking water standards when applied to wildlife and the low probability that significant numbers of wildlife would consistently drink the water from the basins (Zeigler et al., 1987). TC

Contaminated groundwater that exceeds EPA drinking water quality would outcrop at Four Mile Creek, Pen Branch, Indian Grave Branch, Upper Three Runs Creek, and the Savannah River. The contaminants in the groundwater that outcrop at Four Mile Creek would be attributable to the radioactive waste burial grounds and F-Area seepage basins; at Pen Branch to the Ford Building seepage basin; at Indian Grave Branch to the K-Area seepage basin; at Upper Three Runs Creek to the M-Area settling basin; and at the Savannah River to the old TNX seepage basin. However, the effects on wildlife that consume the contaminated undiluted groundwater at the outcrop should be neglible in view of the conservative nature of human drinking water standards when applied to wildlife and the low probability that wildlife would consistently drink the undiluted groundwater at the outcrops. TC

Many waste sites on the SRP contain soil concentrations of contaminants that could be toxic to terrestrial organisms, primarily vegetation. These sites include the F- and H-Area retention basins, F- and H-Area seepage basins, K-Area seepage basin, Radioactive Waste Burial Grounds, old and new TNX seepage basins, M-Area settling basin, Lost Lake, L-Area oil and chemical basin, Ford Building seepage basin, R-Area seepage basins, and the SRL seepage basins. Impacts to vegetation could include reduced plant growth and increased plant mortality. In most cases, based on food chain uptake calculations, the predicted waste concentrations within vegetation would be below the levels considered to be toxic to herbivorous wildlife. TC

Endangered or threatened species reported on the SRP include the American alligator (Alligator mississippiensis), bald eagle (Haliaeetus leucocephalus), red-cockaded woodpecker (Picoides borealis), wood stork (Mycteria americana), and shortnose sturgeon (Acipenser brevirostrum). In addition to these species, a sand burrowing mayfly (Dolanio americana) is undergoing review for threatened or endangered status. Based on the surveys conducted on the SRP, habitat near waste sites is generally not suitable for endangered species and none of these species, except the sand burrowing mayfly and the American alligator, reside within the immediate vicinity of any of the waste sites. Populations of the sand burrowing mayfly have been collected in the section of Upper Three Runs Creek near the old F-Area seepage basin. An American alligator was located in the M-Area settling basin where it has resided since 1985. Bald eagles have been sighted in flight near the H-Area, the Road A chemical basin area, the Gunsite 720 Rubble Pit Area, and the L-Area. However, there were no active bald eagle nest sites near any of these areas. Available information on the shortnose sturgeon indicates little potential for its presence in onsite streams. The U.S. Fish and Wildlife Service has not designated any critical habitats on the SRP. TC

No impacts are expected to occur to either the sand burrowing mayfly or the American alligator under no action. Because no adverse impacts are expected to occur to the aquatic or terrestrial biota attributable to the old F-Area seepage basin, no impacts are likely to occur to the sand burrowing mayfly. Based on the fact that the American alligator residing in the M-Area settling basin for the last two years shows no obvious adverse effects from living within the basin, and because there will be no activities under no action, no impacts to this reptile are expected. However, due to a lack of specific data, this evaluation does not consider long-term effects. TC

Potential impacts of no action on wetlands could result from contaminated groundwater outcropping into streams and/or their associated wetlands and adversely affecting the water quality, contaminated basin overflow during heavy rains of waste sites located near wetlands, and erosion of sediments from waste sites located near wetlands. Streams on the SRP whose water quality would be adversely affected by the outcropping of contaminated groundwater have been considered above. Most contaminated basins are sufficiently removed from wetlands so that basin overflow during heavy rains would not be a problem or the contaminants within the basins are not of ecological concern. However, where basins are near wetlands and have contamination of ecological concern, impacts could occur. Because no activities are planned under no action, impacts related to sedimentation are not applicable.

4.2.1.6 Other Impacts

Archaeological Impacts

No significant archaeological or historic sites are known to exist within, or immediately adjacent to, the existing waste site areas (Brooks, 1986). However, during an intensive field survey, one prehistoric site was discovered adjacent to the P-Area burning/rubble pit. This site is represented by a single, isolated surface find. Two selective shovel tests in the vicinity of the find have confirmed that it was from an isolated, disturbed context. Insufficient content and integrity of deposits indicates little potential for yielding additional information to enhance understanding of the prehistory of the region. Consequently, this site is not considered eligible for inclusion in the National Register of Historic Places (Brooks, 1986). Therefore, (1) none of the proposed P-Area burning/rubble pit closure actions would have an adverse effect on this archaeological site, and (2) no further archaeological work is recommended, either at this site or at any existing waste site surveyed. A request was made to the South Carolina State Historical Preservation Officer (SHPO) for concurrence with a determination of "no effect" for the proposed actions at the 77 waste sites. Concurrence of "no effect" was received by DOE on October 6, 1986. Q-1

Socioeconomic Impacts

The No-Action strategy would have no socioeconomic impacts because it would not require any additional workers for construction.

4.2.2 DEDICATION STRATEGY (NO REMOVAL OF WASTE AT EXISTING WASTE SITES, AND IMPLEMENTATION OF COST-EFFECTIVE REMEDIAL AND CLOSURE ACTIONS AS REQUIRED)

This section describes modifications at existing waste sites that include closure and could include further remedial actions, consistent with the Dedication strategy in which waste is not removed at any of the existing waste sites, and the sites, with buffer zones, are dedicated for waste management purposes.

Closure would be applied to inactive waste sites to reduce infiltration, control surface-water runoff, and reduce erosion and leachate generation. Closure techniques include capping, grading, and revegetation; runoff diversion and collection; and leachate control systems. Although individual site remediation requirements would be determined by interactions with regulatory agencies, for this EIS, remedial actions refer to measures that are applied in addition to closure to control past or continuing releases of contaminants. Remedial actions include *in situ* treatment, groundwater pumping and treatment, and containment or diversion. Appendix C presents more information on remedial, treatment, and closure techniques.

TC

Intermedia exchange or transfer of contaminants from corrective or remedial actions applied to contaminated groundwater may result in transfer of quantities of contaminants to other environmental media. For example, air stripping of groundwater contaminanted with volatile organic chemicals results in airborne releases of these compounds. While there is no impact to nearby soils, vegetation, or surface streams, close coordination with regulatory agencies is necessary for proper permitting and approval of these practices. Similar conditions would apply in the case of reinjection of treated groundwater to local aquifers or disposal of groundwater through NPDES outfalls, disposal of sludges from liquid effluent treatment facilities, and disposal of spent ion exchange media or carbon filters contaminated with radioactivity or hazardous organic compounds. Incineration of organic solvents presents still another form of intermedia transfer when halogenated solvents, nitrogen, or sulfur-containing materials are converted to acidic off-gases that could be released to the atmosphere, or are combined in air scrubber sludges as a result of neutralization or other absorbent mechanisms in stack scrubber systems. End products from hazardous or radioactive waste pretreatments pose similar concerns that must be evaluated before process selections are finalized.

Under the Dedication strategy, all existing basins that had not been filled previously would be backfilled after any water has been removed. Table 4-17 lists the basins containing water and methods of disposal for the contained liquids. Bottom sediments or sludges would be stabilized before backfilling.

Low-permeability infiltration barriers would be installed to cap selected waste sites (Table 4-18) to minimize the migration of material remaining in the ground into the groundwater. These selections are based on projections of constituent migration made for the No-Action strategy (Section 4.2.1) to provide a basis for preliminary cost estimates for this EIS.

Table 4-17. Basin Liquid Disposal Methods

Site				
Number	Name	Building	Method	
1-4	Metallurgical laboratory basin	904-110G	Batch neutralization and discharge to stream	
1-8	SRL seepage basin	904-53G	Move to basin 904-55G	
1-9	SRL seepage basin	904-53G	Move to basin 904-55G	TC
1-10	SRL seepage basin	904-54G	Move to basin 904-55G	
1-11	SRL seepage basin	904-55G	Allow to drain and dry	
1-12	M-Area settling basin[a]	904-51G	Decant to Lost Lake	TC
1-13	Lost Lake[a]	904-112G	Allow to drain	
2-1	F-Area acid/caustic basin	904-74G	Neutralize and discharge to stream	
2-2	H-Area acid/caustic basin	904-75G	Neutralize and discharge to stream	
2-5	H-Area retention basin	281-3H	Disposed to operating H-Area retention basin	
2-10	F-Area seepage basin[a]	904-41G	Allow to drain and dry	
2-11	F-Area seepage basin[a]	904-42G	Allow to drain and dry	
2-12	F-Area seepage basin[a]	904-43G	Allow to drain and dry	
2-13	F-Area seepage basin (old)	904-49G	Allow to drain and dry	
2-14	H-Area seepage basin[a]	904-44G	Allow to drain and dry	TC
2-15	H-Area seepage basin[a]	904-45G	Allow to drain and dry	
2-16	H-Area seepage basin[a]	904-46G	Allow to drain and dry	
2-17	H-Area seepage basin[a]	904-56G	Allow to drain and dry	
3-3	R-Area acid/caustic basin	904-77G	Neutralize and discharge to stream	
5-5	TNX seepage basin (new)	904-102G	Transfer to TNX effluent treatment plant	
8-2	K-Area acid/caustic basin	904-80G	Neutralize and discharge to stream	
8-4	K-Area reactor seepage basin	904-65G	Allow to dry	
9-2	L-Area acid/caustic basin	904-79G	Neutralize and discharge to stream	
9-12	L-Area oil and chemical basin	904-83G	Remove water to storage/ disposal facility	TC
10-2	P-Area acid/caustic basin	904-78G	Neutralize and discharge to stream	

---

[a] Closure plans have been prepared or filed for these basins. TC

Remedial actions would be performed as needed to conform to groundwater protection requirements resulting from interactions with regulatory agencies and on detailed site-specific information. Additional groundwater monitoring wells would be installed and existing and new wells would be monitored in conformance with post-closure care requirements.

Table 4-18. Waste Sites Assumed To Be Capped with Low-Permeability Barriers

A- and M-Areas	
1-2	Metals burning pit
1-3	Silverton Road waste site
1-4	Metallurgical Lab. basin
1-5	Miscellaneous chemical basin
1-8	Through 1-11 SRL seepage basins
1-12	M-Area settling basin
F- and H-Areas	
2-5	H-Area retention basin
2-6	F-Area retention basin
2-7	Radioactive waste burial ground
2-8	Mixed-waste management facility
2-9	Radioactive waste burial ground
2-10	F-Area seepage basin
2-11	F-Area seepage basin
2-12	F-Area seepage basin
2-13	F-Area seepage basin (old)
2-14	H-Area seepage basin
2-15	H-Area seepage basin
2-16	H-Area seepage basin
2-17	H-Area seepage basin
R-Area	
3-7	R-Area reactor seepage basin
3-8	R-Area reactor seepage basin
3-9	R-Area reactor seepage basin
3-10	R-Area reactor seepage basin
3-11	R-Area reactor seepage basin
3-12	R-Area reactor seepage basin
TNX-Area	
5-3	TNX burying ground
5-4	TNX seepage basin (old)
5-5	TNX seepage basin (new)
Road A Area	
7-1	Road A chemical basin
K-Area	
8-4	K-Area reactor seepage basin
L-Area	
9-12	L-Area oil and chemical basin
Miscellaneous Areas	
11-1	SRL oil test site

TC

Fences, pylons, and signs would be erected at appropriate sites as needed. Inspection and maintenance (mowing, etc.) would be performed routinely as part of overall good housekeeping practices.

4.2.2.1 Groundwater Impacts

The following paragraphs describe groundwater impacts from implementation of no-removal-and-closure actions at the various waste sites in each geographic group.

The results of the model analyses indicate that remedial actions might be required at some sites to reduce the predicted concentration of certain constituents in the groundwater to within the applicable standards. A number of actions could provide remediation (see Appendix C). One corrective action would be groundwater extraction and treatment to remove constituents, such as volatile organic compounds. Such a system is now in operation in M-Area. For this EIS, the feasibility of groundwater extraction at appropriate sites is assumed at the waste sites discussed in the sections that follow. However, the choice of actual remedial action would depend on the results of site-specific investigations and regulatory agency agreement.

TE

Groundwater pumping is an accepted method for the extraction of contaminants and, in certain cases, is also a cost-effective method for the limitation of contaminant transport into surrounding water bodies. However, such pumping can affect groundwater extraction at other wells.

A beneficial impact realized in the M-Area groundwater remedial action is the removal of more than 99 percent of volatile organic compounds (VOCs) from the recovered groundwater. After one year of operation, more than 55,000 pounds of VOCs were removed from the groundwater. TC

Another impact that could result from groundwater extraction is ground surface subsidence; that is, the elevation of the ground surface could be reduced measurably as the water table is lowered or as the pressure in a confined aquifer is reduced. However, due to the limited drawdown expected, such effects are considered to be insignificant.

Hydraulic effects of groundwater pumping could be limited through the use of reinjection in conjunction with the pumping. Extracted and treated groundwater meeting applicable National Pollutant Discharge Elimination System (NPDES) requirements also could be discharged to nearby surface streams.

The potential need for groundwater corrective action in a geographic group following the implementation of the Dedication strategy is indicated when peak constituent concentrations in the 1- and 100-meter wells are predicted to exceed MCLs or comparable criteria. This differs from no action, which protects the offsite environment but does not necessarily meet criteria for the protection of onsite groundwater. Further, because these exceedances can occur at either a 1-meter or a 100-meter well, individual site contributions are not added to determine if there is a potential for cumulative effects in a geographic grouping. Actual monitoring data and more detailed site-specific modeling would be required to determine the extent and nature of groundwater corrective actions in an area. TE

The predicted peak concentrations for the acid/caustic basins and the burning/rubble pits are from PATHRAE modeling for the site in each of these two functional groups that has the largest inventory of contaminants. These upper-bound impact predictions are for the L-Area acid/caustic basin and the C-Area burning/rubble pit. Actual peak concentrations for the other acid/caustic basins and burning/rubble pits would depend on site-specific inventories, which could be considerably lower.

Table 4-19 lists constituents in A- and M-Areas that are predicted to exceed MCLs and that could require remedial action under the Dedication strategy. The predominant contaminants are trichloroethylene and tetrachloroethylene. Others that exceed MCLs are tetrachloromethane, 1,1,1-trichloroethylene, arsenic, barium, cadmium, nickel, nitrate, and tritium. TC

Five chemical and 13 radionuclide constituents are predicted to exceed MCLs and require remedial actions in F- and H-Areas for the Dedication strategy, as indicated in Table 4-20. The chemical constituents are lead, mercury, nitrate, trichloroethylene, and tetrachloroethylene. The radionuclides are strontium-90, yttrium-90, nickel-63, cobalt-60, technetium-99, cesium-134 and 137, uranium-238, plutonium-238 and -239, iodine-129, neptunium-237, and tritium. TC

Groundwater pumped from recovery wells would be processed to achieve concentrations within MCLs. Treated groundwater could be discharged to Four Mile Creek or Upper Three Runs Creek, the natural discharge locations for the water-table aquifer, or could be injected to recharge that aquifer. Discharge to streams would conform to NPDES and RCRA requirements and would not impact these water bodies. Reinjection would essentially increase the travel time of constituents in the groundwater, which could be an effective method of reducing the concentration of short half-life isotopes such as tritium. Groundwater withdrawal with discharge to surface waters would have an insignificant effect on water-table elevations in F- and H-Areas.

Table 4-21 lists lead, trichloroethylene, tetrachloroethylene, cesium-137, tritium, strontium-90, and yttrium-90 as the constituents predicted to exceed MCLs in R-Area under the Dedication strategy. The R-Area reactor seepage basins are the only sources of radionuclides that are predicted to exceed standards. Potentially all of the contaminants predicted to exceed standards in the R-Area could be treated. If groundwater pumping were employed, the drawdown effects would probably be localized and transitory. If drawdown were found to be a problem, the treated water would be reinjected into the aquifer from which it was withdrawn. Otherwise, the treated water would be discharged to nearby onsite streams in compliance with NPDES requirements.

Chromium, trichloroethylene, and tritium are the only constituents in C- and CS-Areas predicted to exceed MCLs under the Dedication strategy (Table 4-22). All the contaminants identified as exceeding standards potentially could require treatment to meet regulatory standards. The considerations of drawdown effects, reinjection, or surface discharge resulting from any groundwater extraction would be the same as those described above for R-Area.

Table 4-23 lists the constituents in TNX-Area that are predicted to exceed MCLs under the Dedication strategy (barium, chromium, lead, nitrate, trichloroethylene, and tetrachloromethane). Groundwater would be pumped from recovery wells and processed to reduce contaminant levels to within MCLs or requirements established through regulatory interactions. Treated groundwater would be discharged to the Savannah River swamp, the natural location of outcropping for the water-table aquifer. Drawdown of the water-table due to groundwater withdrawal is expected to be local and insignificant.

The D-Area oil seepage basin (Building 631-G) is the only waste management unit in D-Area. PATHRAE simulations project that the concentration of tetrachloroethylene at the 1-meter well (0.02 milligrams per liter) exceeded its health-based standard (0.0007 milligrams per liter) in 1977 for all actions including the Dedication strategy. As in the nearby TNX-Area, the direction of groundwater flow in D-Area is toward the Savannah River. Likewise, because of higher head in the Middendorf/Black Creek, contamination of this aquifer is unlikely.

The constituent concentrations in the miscellaneous waste sites grouping did not meet the threshold selection criteria for PATHRAE modeling. All constituents at these sites would be expected to be within MCLs under the Dedication strategy. Therefore, groundwater corrective actions are not considered likely in those areas. Under the Dedication strategy, the concentration of uranium-238 at the Road A chemical basin is predicted to be 270 picocuries per liter in the year 2985, which is above its MCL (24 picocuries per liter).

Four constituents predicted to exceed MCLs in K-Area under the Dedication strategy are lead, chromium, trichloroethylene, tetrachloroethylene, and tritium (Table 4-24). Additional corrective actions, such as contaminated groundwater withdrawal and treatment, could be employed to meet regulatory standards and protect human health and the environment.

The considerations of drawdown effects, reinjection, or surface discharge resulting from any groundwater extraction would be the same as those described for R-Area above.

Table 4-25 identifies 10 chemical and five radioactive constituents in L-Area that are predicted to exceed MCLs under the Dedication strategy. Most of the chemical constituents are organics, issued to originate primarily from the CMP pits; these are 2,4,5-TP (silvex), 2,4-D, endrin, toxaphene, benzene, trichloroethylene, tetrachloroethylene, dichloromethane, and chloroethylene. The other chemical constituent that exceeds MCLs in L-Area is lead. Radioactive constituents include tritium, cobalt-60, strontium-90, yttrium-90, and americium-241. TC

Additional corrective actions, such as the installation of a groundwater extraction system to reduce the levels of listed contaminants, could result in intermedia impacts both individually at each site and cumulatively, as discussed above.

Lead, trichloroethylene and tetrachloroethylene are predicted to exceed MCLs in P-Area under the Dedication strategy (Table 4-26). TC

If an action such as groundwater extraction and treatment is undertaken to meet regulatory standards, the drawdown effects are expected to be localized and transitory. If drawdown were found to be a problem, the treated water would be reinjected into the aquifer from which it was withdrawn. Otherwise, the treated water would be discharged to nearby onsite streams, probably to the natural aquifer outcrop. Such discharges would be in compliance with all pertinent standards.

Summary of Groundwater Effects Under Dedication Strategy

This analysis indicates that groundwater corrective action could be required at 9 of the 11 geographic groups because of constituent concentrations in groundwater that exceed MCLs or comparable criteria. The predominant constituents predicted by PATHRAE code to exceed MCLs are nitrate, lead, trichloroethylene, tetrachloroethylene, tritium, and strontium-90. TC

4.2.2.2 Surface-Water Impacts

As a result of closure and groundwater remedial actions to be conducted under this strategy, the concentrations of tritium, tetrachloroethylene, and nitrate which are calculated to exceed MCLs in surface water for no action would be brought into compliance. TE Corrective action could consist of groundwater withdrawal and treatment, with subsequent discharge of treated groundwater to onsite streams in compliance with applicable NPDES permits.

Table 4-24. Peak Concentrations for Dedication Strategy, K-Area

		PATHRAE - Peak concentrations[a]			
		Chemicals (mg/L)		Radionuclides (pCi/L)	
Waste Management facility	Site number	Pb	Trichloro-ethylene	Tetrachloro-ethylene	H-3
K-Area burning/ rubble pit	8-1	(b)	1.9 (1978)	(b)	(b)
K-Area acid/ caustic basin	8-2	0.054 (1971)	(b) (1971)	0.094 (1971)	(b)
K-Area reactor seepage basin	8-4	(b)	(b)	(b) (1960)	7.2×10^6
Standard[c]		0.05	0.005	0.0007	8.7×10^4

---

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: EPA, 1985a, 1985b (tetrachloroethylene), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem.

4.2.2.3 Radiological Doses

For the Dedication strategy, Table 4-27 lists peak annual doses to the maximally exposed individual from the 21 low-level radioactive and mixed-waste sites, and their years of occurrence. These doses assume that the maximally exposed individual resides on the SRP after institutional control is relinquished in 100 years. The groundwater-well pathway is the most significant, contributing more than 95 percent of the total dose at those sites with peak annual doses of 0.10 millirem or more, with the exception of the old TNX seepage basin. At that site, resuspension of contaminated dust from the unvegetated outfall delta results in a first year dose of 12.3 millirem. The reclaimed-farm pathway contributes all the 0.071-millirem and 1.4×10^{-4} millirem doses from the SRL seepage basins and the TNX burying ground, respectively.

The R-Area seepage basins are predicted to exceed the 4-millirem EPA annual drinking-water dose limit and the 100-millirem DOE annual dose limit for all pathways via water consumption from the 1-meter well under the Dedication strategy (630 millirem in 2111). Six additional sites predicted to exceed the 4-millirem EPA annual drinking-water limit after closure only (no groundwater

Table 4-26. Peak Concentrations for Dedication Strategy, P-Area

		PATHRAE - Peak Concentration[a]		
		Chemicals, mg/L		
Waste management facility	Site number	Pb	Trichloro-ethylene	Tetrachloro-ethylene
P-Area burning/ rubble pit	10-1	(b)	1.9 (1978)	(b)
P-Area acid caustic basin	10-2	0.054 (1971)	(b)	0.094 (1971)
Standard[c]		0.05	0.005	0.0007

TC

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: EPA, 1985a, 1985b (tetrachloroethylene), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year. TE

remediation), are the H-Area retention basin (81 millirem from the 1-meter well in 2085), the radioactive waste burial grounds (14 millirem from the 100-meter well in 2085), the F-Area seepage basins (5.7 millirem from the 1-meter well in 2985), the old F-Area seepage basin (34 millirem from the 1-meter well in 2370), the Road A chemical basin (4.3 millirem from the 1-meter well in 2985), and the L-Area oil and chemical basin (6.1 millirem from the 1-meter well in 2185). The complete Dedication strategy (i.e., closure and remedial action as required) would reduce these doses to below the 4-millirem annual EPA drinking-water dose limit. All sites comply individually with the 25-millirem DOE annual dose limit for the atmospheric pathway. TC

The annual doses received from all pathways by the maximally exposed individual residing at the SRP boundary during the year of closure and onsite during TC
the peak exposure year (2111) are 12.3 and 6.4×10^2 millirem, respectively. The latter dose neglects the implementation of postclosure groundwater remedial actions, which would reduce that dose to less than 10 millirem per year (including about 8.7 millirem from direct exposure to the TC
unreclaimed outfall delta).

The annual collective doses received by the population during the first year and 100 years (2085) from the time of implementation of the Dedication strategy are 3.9 and 3.0 person-rem, respectively, of which the atmospheric TC

Table 4-27. Peak Annual Doses to the Maximally Exposed Individual from Radiological Releases for the Dedication Strategy

TC

Low-level and mixed waste sites	Maximum individual dose (mrem)	Year of Peak dose
H-Area retention basin	81	2085
F-Area retention basin	0.057	2318
R-Area Bingham pump outage pits	0.20	2085
R-Area reactor seepage basins	630	2111
Ford Building waste site	0	
TNX burying ground	1.4×10^{-4}	2085
K-Area Bingham pump outage pit	0.20	2085
K-Area reactor seepage basin	0.22	2085
L-Area Bingham pump outage pits	0.20	2085
P-Area Bingham pump outage pit	0.20	2085
SRL seepage basins	0.071	2085
M-Area settling basin and Lost Lake	0.0072	2085
Radioactive waste burial ground, mixed waste management facility (new), and radioactive waste burial ground (old)	14.0	2085
F-Area seepage basins	5.7	2985
F-Area seepage basin (old)	34	2370
H-Area seepage basins	1.3	2185
Ford Building seepage basin	0.57	2393
TNX seepage basin (old)	12.3	1985
TNX seepage basin (new)	1.4	2614
Road A chemical basin	4.3	2985
L-Area oil and chemical basin	6.1	2185

TC pathway of the old TNX seepage basin releases alone contributes more than 65 percent. Appropriate remedial actions could reduce these doses further.

4.2.2.4 Health Effects

Radiological

The health effects presented in this section are based on the Dedication strategy doses without further groundwater remedial action. Table 4-28 lists lifetime health risks to the maximally exposed individual resulting from peak annual radioactive releases from 21 low-level and mixed waste sites.

TC The fatal health risks to the maximally exposed individual residing at the SRP boundary from exposures during the year of closure (1985 assumed) and residing onsite during the peak year (2111), are 3.4×10^{-6} and 1.8×10^{-4}, respectively. The corresponding maximum lifetime risks would be 1.7×10^{-4} and 9.0×10^{-3}, respectively, assuming a 50-year exposure at the peak annual rate.

Table 4-28. Radiological Health Risks to Maximally Exposed Individual from the Peak Annual Doses for the Dedication Strategy

Low-level and mixed waste sites	Maximum individual risk (HE for peak year dose)	Lifetime exposure risk[a]
H-Area retention basin	2.3×10^{-5}	1.2×10^{-3}
F-Area retention basin	5.6×10^{-8}	8.0×10^{-7}
R-Area Bingham pump outage pits	3.4×10^{-8}	2.8×10^{-6}
R-Area reactor seepage basins	1.8×10^{-4}	9.0×10^{-3}
Ford Building waste site	0	0
TNX burying ground	3.9×10^{-9}	2.0×10^{-9}
K-Area Bingham pump outage pit	5.6×10^{-8}	2.8×10^{-6}
K-Area reactor seepage basin	6.2×10^{-8}	3.1×10^{-6}
L-Area Bingham pump outage pits	5.6×10^{-8}	2.8×10^{-6}
P-Area Bingham pump outage pit	5.6×10^{-8}	2.8×10^{-6}
SRL seepage basins	2.0×10^{-8}	1.0×10^{-6}
M-Area settling basin and Lost Lake	2.0×10^{-9}	1.0×10^{-7}
Radioactive waste burial ground, mixed waste management facility (new), and radioactive waste burial ground (old)	3.9×10^{-7}	2.0×10^{-4}
F-Area seepage basins	1.6×10^{-6}	8.0×10^{-5}
F-Area seepage basin (old)	9.5×10^{-6}	4.8×10^{-4}
H-Area seepage basins	3.6×10^{-7}	1.8×10^{-5}
Ford Building seepage basin	1.6×10^{-7}	8.0×10^{-6}
TNX seepage basin (old)	3.4×10^{-6}	1.7×10^{-4}
TNX seepage basin (new)	3.9×10^{-7}	2.0×10^{-5}
Road A chemical basin	1.2×10^{-6}	6.0×10^{-5}
L-Area oil and chemical basin	1.7×10^{-6}	8.5×10^{-5}

TC

[a] Assumes a 50-year exposure at peak year dose.

The number of fatal health effects predicted for the population in the SRP region as a result of exposures during the year of closure and during the one-hundredth year (2085) are 1.1×10^{-3} and 8.4×10^{-4}, respectively. Lifetime effects of exposures at the same rate would total 5.5×10^{-2} and 4.2×10^{-2} cancer deaths, respectively. TC

Appropriate remedial actions could reduce the doses and health effects further.

Chemical

Groundwater/Surface-Water Pathway

Tables 4-29 and 4-30 summarize the risks posed under the Dedication strategy in each geographic region via the groundwater/surface-water pathway.

For the A- and M-Area geographic grouping, the highest total carcinogenic risk for 50-year exposures following 2085 is 1.2×10^{-2}, presented by the M-Area TC settling basin at the 100-meter well. The peak risk is 1.3×10^{-1}, due to tetrachloroethylene at the miscellaneous chemical basin 1-meter well and 100-meter well from exposures peaking in 2024 and 2033, respectively.

The M-Area settling basin also presents the highest noncarcinogenic risks for exposures in 2085, with hazard indexes of 2.1 at the 100-meter well and 2.9×10^{-1} at the 1-meter well. Maximum chemical-specific, noncarcinogenic hazard indexes are also posed by nitrate in these wells: 2.1×10^{2} in the 1-meter and 100-meter wells for exposures in 2052.

TC In the F- and H-Area geographic grouping, the highest total carcinogenic risk from 50-year exposures following 2085 presented under the Dedication strategy by the 100-meter well is insignificant. However, the peak risk for the dominant carcinogenic chemical (1.7×10^{-4}) was presented by trichloroethylene from hypothetical exposures peaking at the 1-meter well in 1978.

The mixed-waste management facility and old radioactive waste burial grounds present the highest noncarcinogenic risks from exposures in 2085, with hazard indexes of 1.1 in the 1-meter well and 5.5 in the 100-meter well. The dominant noncarcinogenic chemicals are nitrates, presenting an ADI fraction of 6.9×10^{1} in 1987 at both the 1- and 100-meter wells at the F-Area seepage basins.

All four strategies present the same carcinogenic and noncarcinogenic risks for the groundwater/surface-water pathway for the R-, C-, CS-, TNX-, Road A, K-, and P-Area geographic groupings. The carcinogenic risks are the same under all strategies for the L-Area geographic grouping. See Section 4.2.1.4.

TC The total noncarcinogenic risks for exposures in 2085 under the Dedication strategy are greatest for the 1-meter well at the L-Area oil and chemical basin (hazard index of 3.8×10^{-1}). As under the No-Action strategy, the dominant noncarcinogenic chemical risk of 4.8 is posed by silvex at the CMP pits 1-meter well in 2012.

Atmospheric Pathway

Table 4-31 lists risks to the maximally exposed individual and to the population for the Dedication strategy due to carcinogenic atmospheric releases. Risks due to noncarcinogenic releases are not considered significant for the three selected years. Major contributors to total risk due to carcinogenic releases are from burning/rubble pits and the M-Area air stripper. The major chemical contributors to the risk are trichloroethylene and chromium-VI. Risks are generally higher for 2085 than for 1985 because the maximally exposed individual is assumed to be much closer to the waste site. This results in higher exposures, even though the source strength might have decreased due to leaching over the previous 100 years.

4.2.2.5 <u>Ecological Impacts</u>

TC Potential impacts of the Dedication strategy on aquatic ecosystems would be similar to those discussed in Section 4.2.1.5. This is true since in most cases the diluted concentrations of contaminants subjected to PATHRAE analysis did not significantly change under any of the closure actions. It is likely that the wastes evaluated on the basis of contaminant concentrations of downgradient wells and stream dilution would also not change since many wastes have already leached to the groundwater and would continue to outcrop for years. TC

The Dedication strategy would eliminate potential impacts to wildlife resulting from the consumption of contaminated standing water and biointrusion, as described in Section 4.2.1.5. All open basins would be drained, backfilled, and revegetated. Thus, none of the waste sites would have open basins to retain water, and the contaminated soils would be buried. If the roots of the vegetation do not penetrate into the contaminated layer, biointrusion should not be a problem. Proper site maintenance would prevent establishment of deep-rooted plants. This strategy would not eliminate potential impacts to wildlife from consuming undiluted groundwater at the outcrop. The potential impacts related to the consumption of undiluted groundwater would be similar to those described in Section 4.2.1.5. TC

Noise and habitat disturbance related to the Dedication strategy could adversely impact wildlife. These impacts could eliminate use of the sites by some animals; however, impacts would be short-term. Current information does not permit an accurate determination of potential impacts from borrow pit activities, although these are not expected to be significant in the context of overall site land uses. As indicated in Section 4.2.1.5, some endangered and threatened species, including a candidate species, exist on the SRP. Based on surveys conducted on the SRP, none of these species have been found to reside within the immediate vicinity of any of the waste sites with the exception of the candidate species, the sand burrowing mayfly, located within 200 meters of the Old F-Area Seepage Basin, and an American alligator residing in the M-Area Settling Basin. As noted in Section 4.2.1.5, bald eagles have been sighted flying in the vicinity of a number of waste sites, but there are no active nest sites that have been located near any of these sites. Impacts should not occur to the sand burrowing mayfly if erosion control measures are closely followed. The American alligator residing in the M-Area Settling Basin would be displaced due to closure. Eagle flights near sites could be temporarily affected due to noise and disturbance; however, no adverse long-term impacts would occur. TC

The Dedication strategy would eliminate the potential impacts to wetlands from contaminated basin overflow, but would not eliminate potential impacts from contaminated groundwater; sedimentation impacts are also possible. Because all open basins would be drained, backfilled, and revegetated, the potential for basin overflow would be removed. The discussion of contaminated groundwater affecting wetlands is presented in Section 4.2.1.5. As mentioned above, levels of groundwater contaminants are not expected to change significantly under any closure actions; thus, impacts to wetlands and their associated wildlife could occur. Impacts to wetlands located near waste sites could arise due to erosion from closure activities. However, proper erosion control measures could prevent or reduce such impacts. Most sites, however, are sufficiently removed from wetlands that sedimentation impacts would not likely occur. TC

4.2.2.6 Other Impacts

Occupational Risk

TC Carcinogenic and noncarcinogenic risks have been estimated for workers at one site under the Dedication strategy: the M-Area settling basin and associated areas (overflow ditch and seepage area and Lost Lake), which are to be drained prior to closure. For protected workers at this site, the total carcinogenic risk would be 7.1×10^{-10} and the total noncarcinogenic risk would be 7.9×10^{-4} from airborne materials.

TE Archaeological/Historical Impacts

The Dedication strategy would not affect any archaeological and/or historic resources. A survey in the existing waste site areas located no significant sites requiring impact mitigation (see Section 4.2.1.6).

TE Socioeconomic Impacts

Socioeconomic impacts for this strategy would be insignificant because the projected peak construction workforce would not exceed 200 persons and would be drawn from the existing construction workforce employed on the Plant. Because these workers already reside in the SRP area, no additional impacts to local communities and services due to inmigrating workers are expected to occur.

4.2.3 ELIMINATION STRATEGY (REMOVAL OF WASTE TO THE EXTENT PRACTICABLE FROM EXISTING WASTE SITES, AND IMPLEMENTATION OF COST-EFFECTIVE REMEDIAL AND CLOSURE ACTIONS AS REQUIRED)

Under the Elimination strategy, buried waste and contaminated soil at all existing waste sites would be excavated, packaged, and transported to one of five SRP storage/disposal facilities: the existing sanitary landfill, a new low-level radioactive waste facility, a new hazardous waste facility, a new mixed waste facility, or the cement/flyash matrix (CFM) facility in Y-Area. TE Table 4-32 lists the estimated volumes of waste and contaminated soil in each existing waste site. Recovery of this waste would require slightly greater volumes to be excavated and transported to a suitable storage/disposal facility. Table 4-32 also lists the volumes of backfill required, the distance from each waste site to the storage/disposal facility, and the facility utilized. TE The volumes and distances are preliminary values used in this EIS only to describe the likely range of impacts of the proposed actions.

TE Any liquids in the open basins would be managed as indicated in Table 4-17 before any excavation is begun. Low-permeability infiltration barriers would be installed to cap the excavated waste sites listed in Table 4-33.

Following waste removal and closure, additional groundwater monitoring wells would be installed as required, and existing and new wells would be monitored TC in accordance with requirements. As in the case of the Dedication strategy, remedial actions would be performed as required (see Section 4.2.2).

TE Good housekeeping practices would continue, including the installation of new fences and pylons.

Table 4-33. Excavated Waste Sites Assumed to be Capped with Low Permeability Barrier

A- and M-Areas	
1-3	Silverton Road waste site
1-8	SRL seepage basin
1-9	SRL seepage basin
1-10	SRL seepage basin
1-11	SRL seepage basin
F- and H-Areas	
2-5	H-Area retention basin
2-6	F-Area retention basin
2-7	Radioactive waste burial ground
2-8	Mixed-waste management facility
2-9	Radioactive waste burial ground
2-10	F-Area seepage basin
2-11	F-Area seepage basin
2-12	F-Area seepage basin
2-13	F-Area seepage basin (old)
2-14	H-Area seepage basin
2-15	H-Area seepage basin
2-16	H-Area seepage basin
2-17	H-Area seepage basin
R-Area	
3-7	R-Area reactor seepage basin
3-8	R-Area reactor seepage basin
3-9	R-Area reactor seepage basin
3-10	R-Area reactor seepage basin
3-11	R-Area reactor seepage basin
3-12	R-Area reactor seepage basin
TNX Area	
5-3	TNX burying ground
Road A Area	
7-1	Road A chemical basin
K-Area	
8-4	K-Area reactor seepage basin
L-Area	
9-12	L-Area oil and chemical basin

TC

4.2.3.1 Groundwater Impacts

The following paragraphs discuss groundwater impacts from waste constituents released from the various waste sites in each geographic group. They also present peak constituent concentrations predicted by the PATHRAE computer code to exceed MCLs or comparable criteria in each geographic group following implementation of the Elimination strategy. Corrective actions could be required to bring these constituent levels to within health-based concentration limits. TE

Table 4-34 lists constituents in A- and M-Areas predicted to exceed MCLs or comparable criteria under the Elimination strategy. The primary constituents are trichloroethylene and tetrachloroethylene. Others are tetrachloromethane, 1,1,1-trichloroethylene, arsenic, barium, cadmium, lead, nickel, nitrate, and tritium. Groundwater remediation would follow the same general pattern described in Section 4.2.2.1. TC

Implementation of the Elimination strategy at all existing waste sites in F- and H-Areas is not predicted to change the concentration of chemical contaminants in the groundwater from that calculated in the Dedication strategy, as indicated in Table 4-20. Table 4-35 lists the radioactive constituents predicted to exceed MCLs or comparable criteria in F- and H-Areas. Potential groundwater impacts are similar to those described in Section 4.2.2.1. Groundwater remedial action would be implemented as required to reduce the concentration of constituents to below applicable standards. TE

TC Table 4-36 lists lead, trichloroethylene, tetrachloroethylene, cesium-137, tritium, strontium-90, and yttrium-90 as the constituents predicted to exceed MCLs or comparable criteria in R-Area under the Elimination strategy. The R-Area reactor seepage basins are the sources of radionuclides that exceed standards. Strontium-90 and yttrium-90 would be the only substances reduced by this strategy, compared to the No-Action strategy.

Remedial action, such as contaminated groundwater withdrawal and treatment to meet regulatory standards, could be implemented for all the contaminants determined to exceed standards.

The Elimination strategy in C- and CS-Areas results in predictions of the same peak concentrations as those under no action (see Table 4-22), with the exception of chromium from the Ford Building seepage basin, which is reduced to below its MCL. This strategy could require contaminated groundwater withdrawal and treatment or some other action after closure to meet regulatory standards for those contaminants determined to exceed standards.

TC The Elimination strategy at existing waste sites in the TNX, K- and P-Areas is not predicted to reduce the peak concentrations of contaminants in the groundwater below those presented for the Dedication strategy in Tables 4-23, 4-24, and 4-26, respectively. The Elimination strategy in D-, Road A and L-Areas also leaves peak concentrations unchanged with the exception of americium-241 in L-Area, which is reduced to below its MCL (see Table 4-25). Groundwater remedial action could be required to reduce the concentration of constituents listed to below applicable standards.

TC PATHRAE predicts the peak constituent concentrations in the miscellaneous waste site grouping to be within MCLs or comparable criteria. Groundwater corrective action is not expected to be required in these areas under any strategy.

Summary of Groundwater Effects

C-67 TC Groundwater corrective action could be required at 9 of the 11 geographic groups, because the constituent concentrations exceed MCLs or comparable criteria. The number of groups is unchanged from that estimated for the Dedication strategy, but the extent of required remedial actions is expected to be less under the elimination strategy. The predominant constituents predicted by PATHRAE to exceed MCLs or comparable criteria under the Elimination strategy are nitrate, lead, trichloroethylene, tetrachloroethylene, tritium, and strontium-90.

4.2.3.2 Surface-Water Impacts

The closure and remedial actions to be conducted under this strategy would result in surface-water quality improvements similar to those identified in Section 4.2.2.2.

4.2.3.3 Radiological Doses

For the Elimination strategy, Table 4-37 lists peak annual doses to the maximally exposed individual from 21 low-level radioactive and mixed waste sites, and their years of occurrence. These doses assume that the maximally exposed

Table 4-36. Peak Concentrations for Elimination Strategy, R-Area

		PATHRAE - Peak concentration[a]						
		Chemicals (mg/L)		Radionuclides (pCi/L)				
Waste management facility	Site number	Pb	Trichloroethylene	Tetrachloroethylene	Cs-137	H-3	Sr-90	Y-90
R-Area burning/ rubble pits	3-1 3-2	(b)	1.9 (1978)	(b)	(b)	(b)	(b)	(b)
R-Area acid/ caustic basin	3-3	0.054 (1971)	(b)	0.094 (1971)	(b)	(b)	(b)	(b)
R-Area reactor seepage basins	3-7 through 3-12	(b)	(b)	(b)	3300 (1965)	1.5×10^8 (1963)	93[c] (2111)	93[c] (2111)
Standard[d]		0.05	0.005	0.0007	110	8.7×10^4	42	550

TC

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] The facilitated transport peak for Sr-90 and Y-90 is predicted to have been 720 pCi/L in 1965. The listed value is the predicted future peak, which is affected by waste removal and closure.

[d] Sources: EPA, 1985a, 1985b (tetrachloroethylene), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year.

Table 4-37. Peak Annual Doses to Maximally Exposed Individual and Years of Occurrence for Elimination Strategy

Low-level and mixed waste site	Maximum individual dose (mrem)	Year of peak dose
H-Area retention basin	47	2085
F-Area retention basin	0.0006	2318
R-Area Bingham pump outage pits	0.0058	2115
R-Area reactor seepage basins	6.3	2111
Ford Building waste site	0	
TNX burying ground	1.4×10^{-4}	2085
K-Area Bingham pump outage pit	0.0058	2115
K-Area reactor seepage basin	0.22	2085
L-Area Bingham pump outage pits	0.0058	2115
P-Area Bingham pump outage pit	0.0058	2115
SRL seepage basins	0.053	2085
M-Area settling basin and Lost Lake	0.0073	1985
TC Radioactive waste burial ground, mixed waste management facility (new), and radioactive waste burial ground (old)	14.0	2085
F-Area seepage basins	0.45	2685
F-Area seepage basin (old)	0.48	2085
H-Area seepage basins	1.0	2185
Ford Building seepage basin	0.22	2393
TNX seepage basin (old)	12.3	1985
TNX seepage basin (new)	0.014	2614
Road A chemical basin	0.043	2985
L-Area oil and chemical basin	1.4	2085

TC individual resides on the SRP after institutional control is relinquished in 2085. The groundwater-well pathway is the most significant, and is responsible for the dose at all sites with peak annual doses of 0.10 millirem or more, except at the old TNX seepage basin, where resuspension of contaminated dust from the unclosed outfall delta results in a first-year (1985) dose of 12.3 millirem. The atmospheric pathway is responsible for doses in the M-Area settling basin and its vicinity. At the TNX burying ground and the SRL seepage basin, the reclaimed farm pathway is responsible.

TC All sites comply with the 100-millirem DOE annual dose limit for all pathways. Three sites are predicted to exceed the 4-millirem EPA annual drinking-water limit after the implementation of the Elimination strategy (but with no groundwater remediation): the radioactive waste burial grounds (14 millirem from the 100-meter well in 2085), the R-Area seepage basins (6.3 millirem from the 1-meter well in 2111) and the H-Area retention basin (47 millirem from the 1-meter well in 2085). All sites comply individually with the 25-millirem DOE annual dose limit for the atmospheric pathway.

The complete implementation of this strategy (i.e., closure and remedial action as required) would reduce the peak annual drinking-water dose to below the 4-millirem EPA annual limit.

The annual doses received from all pathways by the maximally exposed individual residing at the SRP boundary during the year of closure and onsite during the peak exposure year (2085) are 13 and 57 millirem, respectively. TC

The annual collective doses received by the population during the first year and 100 years (2085), from the time of implementation of the elimination option, are 30 and 3.0 person-rem, respectively. More than 95 percent of the dose during each of these years arises from the atmospheric pathway. TC

4.2.3.4 Health Effects

Radiological

The health effects presented in this section are based on the Elimination strategy without further remedial action. Table 4-38 lists lifetime health risks to the maximally exposed individual resulting from peak annual radioactive releases from 21 low-level and mixed waste sites.

The fatal health risks to the maximally exposed individual residing on the SRP boundary from exposures during the year of closure and residing onsite during the peak year (2085) would be 3.7×10^{-6} and 1.6×10^{-5}, respectively. The corresponding maximum lifetime risks would be 1.8×10^{-4} and 8.0×10^{-4}, respectively, assuming a 50-year exposure at the peak annual rate. TC

The number of fatal health effects that would be predicted in the population in the SRP region from exposures during the year of waste removal and closure, and in 2085, are 8.5×10^{-3} and 8.3×10^{-4}, respectively. TC

Chemical

Groundwater and Surface-Water Pathway

Tables 4-39 and 4-40 summarize the risks under the Elimination strategy in each geographic grouping via the groundwater/surface-water pathway.

For the A- and M-Area geographic grouping, the highest total carcinogenic risk for 2085 would occur at the M-Area settling basin 100-meter well (3.5×10^{-4}). TC The peak carcinogenic risk for tetrachloroethylene (2.9×10^{-1}) would occur at both the 1- and 100-meter wells of the miscellaneous chemical basin in 1990 and 1999.

The M-Area settling basin would present the highest noncarcinogenic risk in 2085 at the 100-meter well (5.0×10^{-2}). The peak noncarcinogenic risks are also presented by this site. Nitrate would peak in the 1-meter well at 5.4×10^{-2} in 1995, and in the 100-meter well in 1994. TC

In the F- and H-Area geographic grouping, the highest total carcinogenic risk in 2085 is presented by the F-Area burning/rubble pit; it is not significant. Trichloroethylene created the peak carcinogenic risk at the 1-meter well of

Table 4-38. Radiological Health Risks to Maximally Exposed Individual from the Peak Annual Dose for Elimination Strategy

Low-level and mixed waste sites	Maximum individual risk (HE for peak year dose)	Lifetime exposure risk[a]
H-Area retention basin	1.3×10^{-5}	6.5×10^{-4}
F-Area retention basin	1.7×10^{-10}	8.5×10^{-9}
R-Area Bingham pump outage pits	1.6×10^{-9}	8.0×10^{-7}
R-Area reactor seepage basins	1.8×10^{-6}	9.0×10^{-5}
Ford Building waste site	0	0
TNX burying ground	3.9×10^{-11}	2.0×10^{-9}
K-Area Bingham pump outage pit	1.6×10^{-9}	8.0×10^{-8}
K-Area reactor seepage basin	6.2×10^{-8}	3.1×10^{-6}
L-Area Bingham pump outage pits	1.6×10^{-9}	8.0×10^{-8}
P-Area Bingham pump outage pit	1.6×10^{-9}	8.0×10^{-8}
SRL seepage basins	1.5×10^{-8}	7.5×10^{-7}
M-Area settling basin and Lost Lake	2.0×10^{-9}	1.0×10^{-7}
Radioactive waste burial ground, mixed waste management facility (new), and radioactive waste burial ground (old)	3.9×10^{-6}	2.0×10^{-4}
F-Area seepage basins	1.3×10^{-7}	6.5×10^{-6}
F-Area seepage basin (old)	1.3×10^{-7}	6.5×10^{-6}
H-Area seepage basins	2.8×10^{-7}	1.4×10^{-5}
Ford Building seepage basin	6.2×10^{-8}	3.1×10^{-6}
TNX seepage basin (old)	3.4×10^{-6}	1.7×10^{-4}
TNX seepage basin (new)	3.9×10^{-9}	2.0×10^{-7}
Road A chemical basin	1.2×10^{-8}	6.0×10^{-7}
L-Area oil and chemical basin	3.9×10^{-7}	2.0×10^{-5}

[a] Assumes a 50-year exposure at peak year dose.

TC the F-Area burning/rubble pit (1.7×10^{-4}) in 1978. A similar risk (1.6×10^{-4}) was presented at the 100-meter well in 1983.

The mixed waste management facility and old radioactive waste burial grounds present the highest noncarcinogenic risks. In 2085, the 100-meter well would present a hazard of 5.3. Nitrate is the dominant noncarcinogenic chemical, TC creating a peak hazard index of 6.9×10^{1} in 1987 for both the 1- and 100-meter wells of the F-Area seepage basins.

In the R-Area and the C- and CS-Area geographic grouping, all four strategies present the same carcinogenic and noncarcinogenic risks (see Section 4.2.1.4).

TC In the TNX-Area geographic grouping, the total carcinogenic risks from 50-year exposures following 2085 are highest at the D-Area oil basin 100-meter well (4.8×10^{-8}). The risk for the dominant carcinogen, trichloroethylene, peaked at the D-Area burning/rubble pit 1-meter well in 1978 (1.7×10^{-4}), and at the 100-meter well in 1983 (1.6×10^{-4}).

Noncarcinogenic risks presented under this alternative are the same as those presented under no action (see the discussion in Section 4.2.1.4).

In the Road A and the K-Area geographic groupings, carcinogenic and noncarcinogenic risks are the same for all four strategies (see Section 4.2.1.4).

In the L-Area geographic grouping, carcinogenic risks are the same for all four strategies (see Section 4.2.1.4). The L-Area oil and chemical basin poses the highest noncarcinogenic risk in 2085 at the 1-meter well (hazard index = 2.8×10^{-1}). The peak risk for the dominant noncarcinogenic chemical is the same for all strategies (see Section 4.2.1.4).

In the P-Area geographic grouping, the carcinogenic and noncarcinogenic risks are the same for all options (see the discussion of these risks in Section 4.2.1.4).

Atmospheric Pathway

Table 4-41 lists risks to the maximally exposed individual and to the population for the Elimination strategy due to carcinogenic atmospheric releases. Risks due to noncarcinogenic releases are considered not significant for the three selected years. Major contributors to total risk due to carcinogenic releases are those from the M-Area air stripper; the chemical contributor to the risk is trichloroethylene. TE

4.2.3.5 Ecological Impacts

Potential impacts to aquatic ecosystems resulting from the Elimination strategy are similar to those discussed in Section 4.2.2.5.

TC

Potential impacts to terrestrial ecosystems resulting from the Elimination strategy are similar to those discussed in Section 4.2.2.5. Removal of wastes would eliminate potential impacts from biointrusion. Potential impacts at borrow pit areas would increase due to the greater amount of backfill required for closure.

As discussed in Section 4.2.2.5, only the American alligator residing in the M-Area settling basin is likely to be directly impacted by closure activities. Proper erosion control measures should prevent impacts to the sand burrowing mayfly, a candidate species found within 200 meters of the old F-Area seepage basin. Bald eagles which have been sighted flying near some waste sites should not be seriously affected by closure activities.

Potential impacts to wetlands and their associated wildlife would be similar to those discussed in Section 4.2.2.5. Proper erosion control would reduce the potential for impacts where wetlands are close to waste sites.

4.2.3.6 Other Impacts

Occupational Risk

Individual and collective occupational risks to protected workers due to atmospheric releases of nonradioactive materials from waste removal and closure of sites are very low and are considered to be insignificant. Specifically:

- The total individual occupational carcinogenic risk (i.e., incremental lifetime probability of death from cancer) to an average worker is 1.6×10^{-7} for waste removal and closure of hazardous and mixed waste sites. This risk conservatively assumes that the average worker is involved in the cleanup of all the sites. The total collective occupational carcinogenic risk to all workers involved in these activities (i.e., a crew of nine persons) is 1.4×10^{-6}.

- The total individual occupational noncarcinogenic risk (i.e., hazard index) to an average worker is 3.9×10^{-1} for waste removal and closure of hazardous and mixed waste sites. This risk conservatively assumes that the average worker is involved in the cleanup of all the sites.

For occupational risks to cleanup workers and transportation workers attributed to direct gamma exposure and to atmospheric releases of radioactive materials due to waste removal and closure of waste sites, the highest total doses and associated carcinogenic risks are as follows:

- Radioactive waste burial ground, mixed waste management facility, and radioactive waste burial ground - 4200 millirem total dose to cleanup worker (1.2×10^{-3} risk) and 2200 millirem total dose to transportation worker (6.2×10^{-4}); the collective dose to all workers involved in these activities is 31.5 person-rem with a group risk of 8.8×10^{-3}.

- F-, H-, and R-Area seepage basins - 940 to 4200 millirem total dose to cleanup worker (2.6×10^{-4} to 1.2×10^{-3} risk) and 300 to 340 millirem total dose to transportation worker (8.4×10^{-5} to 9.5×10^{-5} risk); the collective dose to all workers involved in these activities is 6.7 to 26.0 person-rem with a group risk of 1.9×10^{-3} to 7.3×10^{-3}.

- H-Area retention basins - 600 millirem total dose to cleanup worker (1.7×10^{-4} risk) and 240 millirem total dose to transportation worker (6.7×10^{-5} risk); the collective dose to all workers involved in these activities is 4.3 person-rem with a group risk of 1.2×10^{-3}.

- M-Area settling basin and vicinity - 46.5 millirem total dose to the cleanup work (1.3×10^{-5} risk) and 23.3 millirem total dose to the transportation worker (6.5×10^{-6} risk); the collective dose to all workers involved in these activities is 0.35 person-rem with a group risk of 9.9×10^{-5}.

- L-Area oil and chemical basin - 24 millirem total dose to the cleanup worker (6.7×10^{-6} risk) and 12 millirem total dose to the transportation worker (3.4×10^{-6} risk); the collective dose to all workers involved in these activities is 0.18 person-rem with a group risk of 5.0×10^{-5}.

Archaeological Impacts TE

No significant archaeological and/or historic resources have been identified; therefore, no impacts would be observed (see Section 4.2.1.6).

Socioeconomic Impacts TE

Socioeconomic impacts for this strategy would be insignificant, because the projected peak construction workforce would not exceed 200 persons and would be drawn from the existing construction workforce employed on the Plant. Because these workers already reside in the SRP area, no additional impacts to local communities and services due to inmigrating workers are expected to occur.

Air Emissions Due to Transportation

The transportation of hazardous, mixed, and low-level waste from existing sites to new sites 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. The effects of these emissions would be small and limited to short distances from the vehicles due to the nature of the sources, which are near-ground releases. All applicable emission standards would be met during construction.

4.2.4 COMBINATION STRATEGY (REMOVAL OF WASTE TO THE EXTENT PRACTICABLE FROM SELECTED EXISTING WASTE SITES, AND IMPLEMENTATION OF COST-EFFECTIVE REMEDIAL AND CLOSURE ACTIONS AS REQUIRED)

Under this strategy, waste would be removed from selected existing waste sites (see Section 4.2.4.1), all sites would be closed, and remedial actions would TE be implemented as required. As indicated in the preceding section, the removal of waste from all existing sites (the Elimination strategy) does not always result in a reduction of peak concentrations of waste constituents in groundwater and in consequent groundwater remedial action requirements. At the same time, the removal process introduces a degree of occupational risk not present in the Dedication strategy that should not be undertaken without a balancing benefit.

Section 4.1 indicates that decisions on specific actions at particular sites would be adopted following interactions with regulatory agencies based on TC detailed site-specific information and studies. To provide a basis for comparison of alternative strategies, this EIS assumes that waste removal before closure would be instituted at those sites where the predicted concentration of at least one constituent substantially exceeds its applicable standard if the site is closed without waste removal and when closure with waste removal significantly reduces predicted peak groundwater concentration of the constituent. TE

Because this strategy combines the Dedication - including dewatering, backfilling, capping, revegetation, runoff diversion, and leachate controls (i.e., closure without removal) - and the Elimination (i.e., waste removal) strategies, it is called the Combination strategy.

4.2.4.1 Groundwater Impacts

TC

For the purposes of this EIS, concentration reductions were judged to be significant if the peak groundwater concentration under the Dedication strategy was at least three times greater than the peak concentration under the Elimination strategy, and the peak concentration under the Dedication strategy exceeded its standard by at least a factor of three. These are believed to be reasonable (but very preliminary) indications that post-closure groundwater cleanup would be required under the Dedication strategy and that waste removal before closure would significantly reduce the extent of or eliminate the need for groundwater cleanup. The final waste removal decision at specific waste sites would be determined through regulatory interactions and further modeling and monitoring efforts.

One waste site in the F- and H-Areas (the old F-Area seepage basin) and six waste sites in the R-Area (the R-Area reactor seepage basins) satisfy the criteria described above. These sites, the affected constituents, and their predicted peak concentrations for closure with and without waste removal are presented in Table 4-42.

In the F- and H-Area geographic grouping, removal of waste to the extent practicable from the old F-Area seepage basin is predicted to reduce significantly the release of uranium-238, resulting in groundwater concentrations that are calculated to be less than applicable standards (see Appendix F). Contaminant releases to the groundwater at other waste sites in F- and H-Areas would not be affected by this action (see Section 4.2.2.1).

In the R-Area geographic grouping, the six inactive reactor seepage basins would be selected for waste removal. Such an action would decrease peak strontium-90 (and yttrium-90) concentrations by a factor of 100 from those that would exist if closure was the only action taken (Section 4.2.2.1). Groundwater remedial actions would be provided as necessary to reduce contaminant (e.g., strontium-90) concentrations further to values established through regulatory interactions.

Because no waste sites would be selected for waste removal in the A and M, C and CS, TNX, D, Road A, K, L, P, and miscellaneous areas, discussions for the Dedication strategy in Section 4.2.2.1 apply.

4.2.4.2 Surface-Water Impacts

The closure and remedial actions to be conducted under this strategy would result in surface-water quality improvements similar to those identified in Section 4.2.2.2 for the Dedication strategy (no waste removal and closure).

4.2.4.3 Radiological Doses

TC

Peak annual doses to the maximally exposed individual from the 21 low-level radioactive and mixed waste sites and their years of occurrence are the same for the Combination strategy as for the Dedication strategy (see Table 4-27), except for the R-Area reactor seepage basins and the old F-Area seepage basin from which waste would be removed under this strategy. The doses for the latter sites are the same as those under the Elimination strategy (see Table 4-27). The groundwater-well pathway is the most significant, contributing

Table 4-42. Combination Strategy - Sites Selected for Waste Removal

	Peak groundwater concentration (Year of peak in parentheses)				
	Applicable standard (pCi/L)[a]	(Dedication) No removal and closure (pCi/L)	(Elimination) Removal and closure (pCi/L)	Ratio[b]	TC
F- and H-Areas					
F-Area seepage basin (old)					
Uranium-238	24	310 (2370)	3.1[c,d] (2370)	100	TC
R-Area					
R-Area reactor seepage basins					
Strontium-90	42	9300 (2111)	93 (2111)	100	
Yttrium-90	550	9300 (2111)	93[c] (2111)	100	

---

[a] ICRP Publication 30 (ICRP, 1978) methodology was used to calculate the radionuclide concentrations that yield an annual effective whole-body dose of 4 mrem. TE

[b] No removal concentration divided by removal concentration.

[c] Below applicable standard.

[d] Peak concentration for facilitated transport fraction is 21 picocuries per liter for year 1956. TC

more than 95 percent of the total dose at those sites with peak annual doses of 0.10 millirem or more, with the exception of the old TNX seepage basin, where resuspension of contaminated dust from the unclosed outfall delta results in a first-year dose of 12.3 millirem. The reclaimed farm pathway is responsible for the entire dose from the SRL seepage basins and from the TNX burying ground. TC TC

All sites comply individually with the DOE annual dose limits of 100 millirem for all pathways and 25 millirem for the atmospheric pathway (40 CFR 61). Without remedial action, 6 sites are each predicted to exceed the 4-millirem EPA annual drinking-water limit after implementation of the Combination strategy; they are the R-Area reactor seepage basins (6.3 millirem from the 1-meter well in 2111), the F-Area seepage basins (5.7 millirem from the 1-meter well in 2985), the H-Area retention basin (81 millirem from the 1-meter well in 2085), the Road A chemical basin (4.3 millirem from the 1-meter well in 2985), the L-Area oil and chemical basin (6.1 millirem from the 1-meter well in 2185), and the radioactive waste burial grounds (14.0 millirem from the 100-meter well in 2085). TC TC

The complete implementation of this strategy, including remedial action as required, would reduce the peak annual drinking water dose to below the EPA annual 4-millirem limit.

TC The annual doses received from all pathways by the maximally exposed individual residing at the SRP boundary during the year of closure and onsite during the peak exposure year (2085) would be 12.3 and 91 millirem, respectively. The annual collective doses received by the population during the first year, and 100 years (2085) after implementation of the Combination strategy, would be 4.2 and 3.0 person-rem, respectively, of which the atmospheric pathway would contribute more than 65 percent.

4.2.4.4 Health Effects

Radiological

TC The lifetime health risks from peak annual releases for the Combination strategy are the same as those for the Dedication strategy (see Section 4.2.2.4) for all sites except the R-Area seepage basins and the old F-Area seepage basin which produce the same risks as in Section 4.2.3.4.

TC The fatal health risks to the maximally exposed individual residing at the SRP boundary from exposures during the year of closure and residing onsite during the peak year (2085) are 3.4 x 10^{-6} and 2.5 x 10^{-5}, respectively. The corresponding maximum lifetime risks would be 1.7 x 10^{-4} and 1.3 x 10^{-3}, respectively, assuming a 50-year exposure at the peak annual rate.

TC The number of fatal health effects that would be predicted in the population in the SRP region from exposures during the year of waste removal and closure and 100 years from that time (2085) are 1.2 x 10^{-3} and 8.3 x 10^{-4}, respectively.

Chemical

The only waste site selected for removal of waste under the Combination strategy that would have chemical-related health effects different than those of the Dedication strategy (Section 4.2.2.4) is the old F-Area seepage basin. The health effects for this site under the Combination strategy would be the same as those presented for the Elimination strategy (Section 4.2.3.4). The only differences in these chemical-related health effects is a reduction of the peak noncarcinogenic health risks from the reclaimed farm pathway and a minimal increase in health risks to individuals due to atmospherically released carcinogens.

TE The peak noncarcinogenic hazard index for the reclaimed farm pathway under the Dedication strategy is 7.1 x 10^{-7}, which is reduced to 7.1 x 10^{-9} under the Combination or Elimination strategies. The health risk from atmospherically released carcinogens to the maximally exposed individual is zero in 1986 under the Dedication strategy and 8.4 x 10^{-15} under the Combination or Elimination strategies. This health risk, like all health risks due to atmospherically released carcinogens, is not considered significant.

4.2.4.5 Ecological Impacts

Potential aquatic impacts resulting from the Combination strategy would be similar to those discussed previously in Section 4.2.2.5.

Potential impacts of the Combination strategy to terrestrial organisms include those that result from consumption of contaminated standing water in open basins, biointrusion, noise, and/or habitat disturbance. As indicated in Section 4.2.1.5, the SRP contains numerous open basins with standing water, at least during wet periods, at various waste sites. Of the open basins that were indicated to contain contaminants that exceed the EPA drinking water standards (see Section 4.2.1.5), the Combination strategy proposes only to drain the surface water from the new TNX seepage basin, SRL seepage basins, and F- and H-Area seepage basins. Thus, the H-Area retention basin and the M-Area settling basin would still contain contaminated standing water that exceeds the EPA drinking-water criteria and could potentially impact wildlife that consume the water. However, the effects to wildlife that consume the contaminated standing water should be minimal in view of the conservative nature of the drinking water standards when applied to wildlife, and the low probability of significant numbers of wildlife consistently drinking the water from the basins.

Some waste sites on the SRP contain soils that are contaminated at levels sufficient to cause toxic effects to terrestrial organisms, as indicated in Section 4.2.1.5. The Combination strategy would remove contaminated soil and waste only from the R-Area seepage basin. The remaining waste sites will retain their wastes; however, the sites would be covered, regraded, and revegetated. Thus, assuming site maintenance prevents root penetration to the waste layer, impacts via the biointrusion pathway should not occur.

Impacts of noise and habitat disturbance would be similar to those discussed in Section 4.2.2.5. Impacts at borrow pits would be bracketed by the requirements of the Dedication and Elimination strategies.

Impacts to endangered species and wetlands would be similar to those discussed in Section 4.2.2.5.

4.2.4.6 Other Impacts

Occupational Risk

Total occupational risks to protected workers due to atmospheric releases of nonradioactive materials from removal of waste at selected existing waste sites would be very low, and would be considered not significant. Specifically:

- The total individual occupational carcinogenic risk (i.e., incremental lifetime probability of death from cancer) to an average worker is 1.6×10^{-10} for waste removal and closure of the old F-Area seepage basin. The total collective occupational carcinogenic risk to all workers involved in these activities is 1.5×10^{-9}. TC

- TC The total individual occupational noncarcinogenic risk (i.e., hazard index) to an average worker is 7.1×10^{-4} for the removal and closure of the old F-Area seepage basin.

- No nonradiological constituents met the selection criteria for the R-Area reactor seepage basins. Therefore, the nonradiological risks for waste removal and closure of these sites is assumed to be zero.

Individual and collective occupational risks to cleanup workers and to transportation workers due to atmospheric releases of radioactive materials from removal of waste at the selected existing waste sites are presented below:

- Old F-Area seepage basin - 3.1 millirem total dose to the cleanup worker (8.7×10^{-7} risk) and 1.6 millirem total dose to the transportation worker (4.5×10^{-7} risk); the collective dose to all workers involved in these activities is 2.3×10^{-2} person-rem with a group risk of 6.6×10^{-6}.

- TC R-Area reactor seepage basins - 4200 millirem total dose to the cleanup worker (1.2×10^{-3} risk) and 300 millirem total dose to the transportation worker (8.4×10^{-5} risk); the collective dose to all workers involved in these activities is 26.0 person-rem with a group risk of 7.3×10^{-3}. TC

Archaeological and Historic Resources

This strategy would not involve any archaeological or historic resources; therefore, no impacts would be observed. (See Section 4.2.1.6.)

Socioeconomic Impacts

Socioeconomic impacts for this alternative would be insignificant, because the projected peak construction workforce would not exceed 200 persons and would be drawn from the existing construction workforce employed on the Plant. Because these workers already reside in the SRP area, no additional impacts to local communities and services due to inmigrating workers are expected.

Air Emissions Due to Transportation

The transportation of hazardous, mixed, and low-level waste from existing sites to new sites 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 from the vehicles, due to the nature of the sources, which are near-ground releases. All applicable emission standards would be met during construction.

4.2.5 COMPARISON OF ALTERNATIVE ACTIONS AT EXISTING WASTE SITES

This section compares the modifications to existing waste sites that would be implemented under the four alternative waste management strategies and their potential environmental consequences. The four strategies are as follows:

- No action - No removal of waste at existing waste sites, and no closure or remedial actions

- Dedication - No removal of waste at existing waste sites, and implementation of cost-effective closure and remedial actions, as required

- Elimination - Removal of waste to the extent practicable from all existing waste sites, and implementation of cost-effective closure and remedial actions, as required

- Combination - Removal of waste to the extent practicable at selected existing waste sites, and implementation of cost-effective closure and remedial actions, as required

4.2.5.1 Comparison of Strategies

The No-Action strategy presented in Section 2.1.1 provides continued protection of the offsite environment. Waste removal, closure, and remedial actions would not take place at the SRP, but measures considered necessary to protect the offsite environment would be implemented. Waste sites would be protected against erosion; weeds and grass would be mowed; groundwater monitoring wells would be installed; existing and new wells would be monitored; and fences would be installed to keep out animals and unauthorized personnel. The removal of volatile organics from the groundwater in the Tertiary sediments in M-Area through a system of recovery wells routed to an air stripper would be continued. The monitoring and protective activities described for no action would be included in the three remedial and closure actions described below.

No-removal remedial and closure actions would be included in the Dedication strategy presented in Section 2.1.2. Releases of hazardous substances from existing waste sites would be controlled through the closure of such sites (if not already closed). Further remedial actions could be required to control groundwater contaminant plume migration and other corrective actions (excluding removal) could be initiated at the sites to prevent further releases of hazardous substances. Dedication for waste management purposes of waste sites and contaminated (hazardous and radioactive) areas that could not be returned to public use after a 100-year institutional control period would be required. Existing basins that had not been filled would be backfilled after water was removed. The cost and analysis of environmental consequences for this strategy are based on the assumption that a low-permeability infiltration barrier would be installed at 34 of the 77 sites.

Waste-removal-at-all-sites remedial and closure actions would be included in the Elimination strategy presented in Section 2.1.3 (compliance through elimination of existing waste sites and storage of wastes). Under this strategy, the hazardous, low-level radioactive, and mixed waste (including contaminated soil) would be removed from all existing waste sites to the extent practicable. After a *maximum* 100-year institutional control period, these areas could be returned to the public. In addition to waste removal and closure, further remedial action to control the migration of hazardous and radioactive substances that have already been released from the site could be required.

Waste-removal-at-selected-sites remedial and closure actions would be included in the Combination strategy presented in Section 2.1.3 (compliance through a combination of dedication, elimination of existing waste sites, and storage of wastes). Wastes (including contaminated soil) would be removed from selected existing waste sites based on environmental and human health benefits and cost-effectiveness. The areas from which waste had been removed could be returned to the public after the institutional control period. Sites from which waste was not removed would be dedicated for waste management purposes if they were not suitable for public use after the institutional control period. As with no removal, releases from existing waste sites would be controlled through closure (with or without waste removal), and compliance with groundwater-protection requirements would be achieved through the closure actions and, if necessary, further remedial actions and other corrective measures to control groundwater contaminant plume migration. The cost and environmental analysis for this approach are based on the preliminary evaluation that waste removal from the old F-Area seepage basin, and the six R-Area reactor seepage basins, would be most beneficial. The sites from which waste would not be removed would receive the same closure action as those in the no-waste-removal approach. Additional remedial action under this strategy could be required, but such actions would be fewer than those for the Dedication strategy because of the removal of waste at the selected sites.

4.2.5.2 Comparison of Environmental Consequences

This section compares the environmental consequences of the four strategies at existing waste sites that contain or might contain hazardous, low-level radioactive, or mixed waste. Table 4-43 summarizes these environmental consequences. These consequences are in addition to those that are explicit in the definitions of the remedial, removal, or closure actions (e.g., waste remains in or is removed from the waste sites).

Onsite Groundwater

Under no action, certain hazardous and radioactive constituents either exceed or are predicted to exceed applicable standards in the groundwater in Tertiary (near-surface) formations. Therefore, this strategy would not comply with current groundwater protection requirements. After the period of institutional control, small public water supply wells could be screened into these aquifers. By that time, most constituents in the groundwater may have decayed or dispersed to concentrations that are below regulatory, human health, and environmental concern. Dedication of areas where groundwater constituents are still above levels of concern would be necessary under no action.

By comparison, the concentration of constituents in these Tertiary sediments generally would be lower due to the implementation of the three other strategies. Also, remedial action (i.e., groundwater cleanup) could be implemented to reduce these contaminants to concentrations that are below regulatory, human health, and environmental concern.

Remedial actions that could be required could cause adverse effects through drawdown of these shallow aquifers. If detailed studies indicate that these effects would occur, recharge of the aquifers with the treated groundwater would be considered. Another reason for returning the treated groundwater is that tritium, which is not practical to remove with current technology, would have additional time to decay until it reaches outcrops at onsite streams.

Under no action, there is a slight probability of contamination of the groundwater underlying the Black Creek formation, a primary source of irrigation and drinking water. An upward head reversal over some areas of the SRP precludes the leakage of groundwater through the Ellenton Clay, which separates the Tertiary and Black Creek formations. This head reversal does not exist in the A-, M-, CS-, K-, H-, P-, and R-Areas. In A- and M-Areas, the existing recovery wells lower the head (and the concentration of contaminants) in the shallow aquifers and, therefore, minimize the flow from the Tertiary sediments into the Black Creek formation. The results of recent observations are presented in Appendixes B and F.

Closure and remedial actions would protect the major drinking-water aquifers.

Offsite Groundwater

The effects of any of the four strategies on offsite groundwater would not be significant. Groundwater flow in the Tertiary formations is almost entirely to onsite streams. One exception is a groundwater divide that passes through the A- and M-Areas. Most of the waste sites in the A- and M-Areas are west of this divide. Groundwater is believed to flow laterally to the west from these sites until it enters the Congaree Formation near the Plant boundary. The water would then flow slowly downward into the Black Creek Formation. By the time any hazardous or radioactive constituents entered the Black Creek Formation, they would be diluted to concentrations well below (health-based) regulatory limits, even under no action.

Surface Water

Nitrate, tritium, and cesium-137 concentrations are predicted to exceed regulatory limits in Four Mile Creek under the No-Action strategy, and tetrachloroethylene is predicted to exceed its MCL in Upper Three Runs Creek. All other concentrations in the onsite streams and the Savannah River are predicted to be below regulatory standards. No constituents in surface water would exceed applicable standards under any of the three closure and remedial action strategies. Groundwater cleanup could reduce those concentrations to below regulatory limits.

TC

Radiological Doses

TE

Total cumulative (all waste sites) annual dose to the maximum individual from all pathways due to radiological releases at the SRP boundary under the No-Action strategy was estimated to be 14.6 millirem in 1985. This dose is well below the 100-millirem DOE annual limit. The corresponding onsite peak dose in 2085 is estimated to be 3920 millirem, which would be received primarily by the assumed use of an onsite shallow-aquifer drinking-water well adjacent to the R-Area and direct gamma exposure at the F-Area seepage basins (see Section 4.2.1.3). This emphasizes the need for rather extensive site dedication at the end of institutional control under the No-Action strategy. Remedial actions would be taken as required under the other three alternative strategies to ensure that doses are below the 100-millirem DOE annual limit.

TC

TE

Health Effects

Under the No-Action strategy, there would be essentially no adverse health effects during the period of institutional control. Based on conservative assumptions, adverse health effects could occur as a result of exposures onsite beginning after the period of institutional control. Dedication of

TC waste sites, including implementation of appropriate remedial actions, could avoid these adverse effects. Under any of the closure and remedial action strategies, appropriate actions (e.g., groundwater cleanup) would be taken to ensure that the concentrations of hazardous and radioactive constituents in the groundwater are brought to levels below regulatory human health and ecological concern. Human health at the waste sites would be protected either by removal of the hazardous and radioactive waste and surrounding soil or by dedication, based on the specific remedial and closure action chosen.

Other Impacts

TE The primary environmental consequences for these strategies, other than those discussed above, include ecological effects and occupational risks from site closure activities.

Under the No-Action strategy, offsite ecology would be protected. Slight onsite aquatic ecological effects could occur due to releases of radioactive or hazardous constituents to surface streams. Terrestrial ecology could be affected under the Dedication, Elimination, and Combination strategies, due to closure actions (e.g., borrow areas for backfilling). Under the Elimination and Combination strategies, terrestrial ecology would be affected due to the removal and transport of the waste to suitable new onsite storage or disposal facilities.

TE There would also be some occupational risks under the Elimination and Combination strategies from waste removal due to worker exposure to radiological and hazardous substances. In some cases, waste removal could require many crews working for short periods of time to ensure individual doses do not exceed occupational limits.

The transportation of hazardous, mixed, and low-level waste from existing sites to new sites 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. The effects of these emissions would be small and limited to short distances from the vehicles due to the nature of the sources, which are near-ground releases. All applicable emission standards would be met during construction.

Accidents

The environmental impacts and risk of potential accidents associated with each strategy are discussed in Section 4.5.

Nonradioactive Air Releases

Risks and health effects from air releases are predicted to be low for all four strategies. Public risks are generally greatest at the end of institutional control because it is assumed that the maximally exposed individual would be at the waste sites rather than at the SRP boundary in 2085, when the institutional control period would end.

Risk would decrease steadily until 2985, the end of the modeling period. The second-highest risk year is 1985, the assumed year of closure actions. For example, under no action, total lifetime carcinogenic risk due to nonradioactive atmospheric releases to the maximally exposed individual in 1985 is about 5.6×10^{-8}. In 2085, this risk is predicted to be about 1.7×10^{-6}. By 2985, the risk would decrease to less than 5×10^{-8}. The three closure and remedial action values are even lower. Noncarcinogenic risks due to nonradioactive releases are not significant.

TC

4.3 STRATEGIES FOR NEW WASTE MANAGEMENT FACILITIES

DOE is considering the construction of new waste management facilities for hazardous, mixed, and low-level radioactive wastes at the Savannah River Plant. DOE estimates that the capacity of the present low-level waste disposal facility will be exhausted by early 1989 and that the hazardous and mixed waste interim storage facilities will reach capacity by 1992.

DOE is considering four alternative strategies for future waste management at SRP:

- No Action
- Dedication
- Elimination
- Combination

Each strategy would be implemented through one or more technologies. Chapter 2 describes the alternative strategies and their associated technologies. Table 2-9 lists the waste management strategies and the technologies that form the basis of this environmental evaluation. Appendix E describes the technologies.

This section provides the range of potential environmental impacts associated with the new waste management facilities of each strategy, and the basis for future decisions on project-specific actions and the design and location of a new low-level radioactive waste management facility. Each waste management strategy has been defined in terms of technologies and facilities, which would be designed and operated to comply with all applicable regulations and requirements. Since there are several alternative technologies which could be selected to implement a strategy, the potential environmental impacts lie within a range defined by the least-protective and most-protective technologies. All technologies selected for consideration in this EIS are capable of providing adequate waste management in compliance with regulations; however, the most-protective technology may differ from the least-protective technology by superior structural characteristics or additional back-up systems such as liners or leachate collection.

TC

To ensure that the impact evaluations consider all possible technological options, waste volumes, and waste characteristics (i.e., within the limitations set by the strategy), the EIS takes a conservative approach. Evaluations are based on the least-protective technological alternative of each strategy. If a technology is acceptable in terms of demonstrated regulatory compliance, all other (more protective) technologies under that strategy would be acceptable as well.

The environmental impacts described in the following sections are both quantitative and qualitative. Some analyses (i.e., atmospheric, groundwater, and surface-water modeling) were conducted relative to specific sites due to the need for or availability of site-related parameters. (Appendix E discusses the selection and location of candidate sites used for evaluation purposes.) Some analyses, such as those for archaeological and historic resources, were conducted at the three or four highest-ranked candidate sites. Other analyses (e.g., noise) were based on conditions known to exist at most SRP locations. Table 4-44 lists the bases of impact evaluations in each environmental category.

The accuracy of quantitative impacts (i.e., modeling results) is affected by assumptions, the potential ranges of significant parameters, and available project-specific details. On the average, these results are within a factor of 5 level of accuracy, and provide a determination of the relative performance of a strategy as a basis for comparative evaluations and preliminary strategy selection.

4.3.1 NO-ACTION STRATEGY

The No-Action strategy was developed and evaluated in compliance with the guidelines of the Council on Environmental Quality (CEQ) for implementing NEPA regulations. It assesses the consequences of taking no action to provide the needed facilities for current and future waste management. The strategy is defined as continuing waste management with no new facilities. For evaluation purposes, the No-Action strategy can be described as a form of "makeshift" indefinite storage. Structures that are currently unused would be used to store wastes in appropriate containers until their capacity was reached, after which waste would be stored in other available (unused or abandoned) structures and pads, followed by storage on minimally prepared open areas at existing waste sites. Bulk storage of wastes would not be used. (Refer to Appendix E.)

TC

4.3.1.1 Groundwater and Surface Water

Wastes would be stored without pretreatment and without protection, detection, or backup containment systems, which would increase the risk of an accidental release of waste to the environment. This could range from no release to the release of all waste stored; the potential impacts to groundwater and surface water could range from no significant impacts to massive and gross contamination.

Offsite groundwater would not be affected by adopting the No-Action strategy because the groundwater flow paths in the vicinity of the low-level waste burial ground, mixed waste management facility, and other probable storage locations terminate at onsite streams or the Savannah River.

4.3.1.2 Nonradioactive Atmospheric Releases

No significant air-quality impacts would result from the use of heavy equipment to prepare storage areas and handle the waste containers. However, for the reasons discussed in Section 4.3.1.1, these could range from no significant impact to severe impacts from toxic plumes resulting from a storage area fire.

Table 4-44. Basis for New Waste Management Facility Impact Evaluations

Environmental category	Basis of evaluation
Groundwater	Impact of technology analyzed using computer model or presumption of facility compliance with regulations; assumptions include (1) candidate Site B (RCRA-type facilities for hazardous or mixed waste), Site L (DOE-type facilities for delisted mixed waste), or Site G (DOE-type facilities for low-level radioactive waste); (2) waste stream consists of operations and interim storage wastes; and (3) some pretreatment. TC
Surface water	Same as basis for groundwater.
Nonradiological air	Impacts based on the presumption that wastes are containerized at the treatment or generating facility before delivery for disposal or storage.
Ecology	Impacts based on a conservative estimate of the land area required for the most land-intensive technologies, assuming maximum waste volumes and various ecological features, as determined at the candidate sites.
Radiological releases	Same as basis for 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.

4.3.1.3 Ecology

The amounts of waste releases discussed above could produce ecological impacts ranging from no significant impact to severe and detrimental impacts, depending on the type of waste involved, the location, the pathways, and the effectiveness of cleanup activities.

Construction of facilities would not occur under this strategy; therefore, impacts on the ecology from new construction (i.e., clearing and development of land) would not occur.

4.3.1.4 Radiological Releases

TE Although the No-Action strategy objectives would be to prevent releases of radiological contaminants to the environment, the risk of a serious release, although unquantified, is higher with no action than with any of the other strategies.

4.3.1.5 Archaeological and Historic Resources

The No-Action strategy would not impact any archaeological or historic resources because only existing structures, pads, and disposal sites would be used for the indefinite storage of waste, and resources which may have been in these areas have either been recovered or destroyed by previous construction practices.

4.3.1.6 Socioeconomics

The No-Action strategy contains an inherent increased risk of an accidental release of waste to the environment ranging from no release to release and dispersion of all waste stored in this manner. The potential socioeconomic impacts could be substantial with a large-scale, catastrophic accidental release because of the temporary workforce required for cleanup, the possible shutdown of affected SRP operations and associated layoffs, and the potential offsite effects on property demand and values due to public reactions.

4.3.1.7 Site Dedication/Institutional Control

The No-Action strategy would not result in the permanent placement of wastes at a candidate site, but rather would include an indefinite period of makeshift storage, which would preserve the ability to retrieve the waste. Site dedication would be required only as long as the wastes remained on the site or in the event of a significant accidental release.

4.3.1.8 Noise

Noise produced by the operation of equipment during preparation and operation of the storage areas would be negligible at the nearest offsite area. In areas where workers could be exposed to equipment noise, they would wear protective equipment in accordance with applicable standards and regulations.

4.3.1.9 Other Impacts

Health Effects

With the unquantified risk of contaminant releases under no action, there is an unquantified but directly related risk of human health effects from potential releases of hazardous chemicals and radionuclides.

Occupational Risks

With the unquantified risk of contaminant releases under no action, there is an unquantified but directly related risk to workers due to potential interaction with hazardous chemicals and radionuclides.

Accidents

Section 4.6 describes the environmental impacts and risks of potential accidents from the movement of waste.

4.3.2 DEDICATION STRATEGY

Waste management under the Dedication strategy would include new disposal facilities to manage hazardous, mixed, and low-level radioactive wastes. Dedication implies that wastes would not be retrieved; therefore, disposal sites would be dedicated in perpetuity for waste management to ensure long-term environmental and public health protection.

Table 2-9 lists the technologies included in the Dedication strategy. The minimum technological alternatives identified for evaluation of groundwater, surface water, and radiological releases are Resource Conservation and Recovery Act (RCRA) landfills and RCRA-type vaults for hazardous waste; RCRA landfills and RCRA-type vaults for some, and cement/fly ash matrix (CFM) vaults for other mixed wastes; and engineered low-level trenches (ELLTs) and vaults or greater confinement disposal (GCD) for low-level radioactive waste.

TC

Groundwater and atmospheric modeling conducted to quantify environmental impacts and health risks have projected exceedances of environmental or health standards, which generally result from conservative modeling assumptions. For example, if a structural failure occurred in the future and the modeling predicted contamination, this EIS assumes that DOE would take the appropriate actions to avoid or mitigate the conditions. The EIS limits the comparison of impacts to the end of the 100-year institutional control period.

4.3.2.1 Groundwater and Surface Water

Technologies for hazardous and mixed waste (i.e., RCRA landfills and vaults) would meet or exceed RCRA minimum technology standards and achieve the goal of ("essentially zero") releases. The combined effects of high-integrity waste containers, the filling of void spaces to prevent subsidence, double liners (primary and secondary), double-leachate monitoring and collection systems, low permeability caps, surface drainage facilities, and maintenance would provide the necessary containment and backup systems to ensure that wastes or waste constituents are not released to the environment. Groundwater modeling beyond the institutional control period indicates that eventually both technologies would fail. However, during the period of monitoring and maintenance, no significant impacts should occur.

TC

For mixed wastes, CFM vaults represent the minimum technology (i.e., no liners, no leachate collection). Modeling indicates that no groundwater or surface-water would exceed standards but that uranium-238 would exceed the derived standard, and that a peak concentration would occur after 10,000 years; however, this exceedance is qualified because the model does not include chemical solubility limits for uranium. Radionuclides are not expected to exceed their derived standards in groundwater or surface water. (Note: The derived standard is the concentration of a radionuclide that yields an annual effective whole-body dose of 4 millirem per year, which is the Interim Primary Drinking Water Standard.) (Refer to Appendix G.)

TC

Groundwater modeling for low-level radioactive waste facilities predicts that, for all radionuclides except tritium and uranium-234, the concentrations are well below derived standards. When solubility controls are considered, the uranium concentration should not exceed the derived standard.

TE

Tritium from intermediate-activity vaults or GCD facilities is predicted to reach its peak concentration (70 times the derived standard) in the groundwater about 38 years after closure (i.e., during the institutional control period). The model assumes that facilities would contain no liners and no leachate collection. However, an exceedance of the derived standard for tritium is not expected to occur during the 100 years after closure, because vault and GCD technologies include leachate collection systems to intercept and recover tritium. Continued DOE recovery of tritium would ensure that the SRP meets groundwater standards. DOE could also choose to segregate and store intermediate-activity tritium wastes for decay in place.

In summary, DOE does not expect chemical and radioactive constituents to exceed actual or derived standards in SRP groundwaters or surface waters from new hazardous, mixed, and low-level radioactive disposal facilities under the Dedication strategy.

4.3.2.2 Nonradioactive Atmospheric Releases

The construction of waste disposal facilities under the Dedication strategy 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.

All waste would be delivered in sealed disposal containers and, therefore, would result in no air releases. Thus, no significant air quality impacts are anticipated.

4.3.2.3 Ecology

The operation and dedication of facilities is not expected to involve constituent releases that would exceed groundwater or surface-water standards; no waste-related adverse impacts on aquatic and terrestrial ecology are expected.

Construction of the facilities could require clearing and development of as much as 400 acres for facilities and roads. Existing or potential wildlife habitat would be destroyed; however, the maximum acreage amounts to only about 0.2 percent of the available habitat on the SRP and would constitute an insignificant impact.

TC

Although endangered and threatened species [i.e., bald eagle, red-cockaded woodpecker, wood stork, American alligator, and shortnose sturgeon] are known to exist on the SRP, none are known to occur on or near any candidate site.

Short-term soil erosion impacts to swamps or surface streams could occur as a result of construction; however, these would be minimized by erosion control measures.

Belowground technologies risk uptake of waste constituents by vegetation if roots are allowed to penetrate the facilities and reach the waste. To prevent this, shallow-rooted plants would be used to stabilize soils during closure; these plants would be maintained by mowing during the postclosure institutional control period.

4.3.2.4 Radiological Releases

Modeling of releases and transport showed that peak radiological doses from mixed wastes exceeded the 4 millirem per year standard in groundwater, but not in the Savannah River or in food grown onsite. The model predicted that uranium-238 would not meet standards. However, if solubility limits for uranium are considered, no exceedance is expected. (See Appendix G.) TE

Modeling for low-level radioactive facilities showed that the sum of all radionuclides except intermediate-activity waste tritium and uranium were well below the 4 millirem per year standard. If solubility limits for uranium are considered, no exceedance of the dose standard is expected. Also, if liners and leachate collection systems for tritium are assumed to function, plus extended institutional control as necessary to ensure that groundwater standards are achieved, no dose exceedances due to tritium are expected. TE

In summary, peak doses due to releases of mixed or low-level radioactive wastes are not expected to exceed the 4 millirem per year drinking-water standard.

4.3.2.5 Archaeological and Historic Resources

The Dedication strategy would not impact any archaeological or historic resources. A survey of five of the six top-ranked candidate sites located no significant archaeological or historic sites requiring impact mitigation. However, if Candidate Site K were selected for low-level waste facilities, an archaeological survey would take place.

4.3.2.6 Socioeconomics

The socioeconomic impacts of the Dedication strategy are expected to be negligible, because no significant increase in the existing SRP construction workforce would be required.

4.3.2.7 Site Dedication/Institutional Control

Disposal of hazardous, mixed, or low-level radioactive wastes under the Dedication strategy would require the dedication of a disposal area as large as 400 acres plus a buffer zone.

Operational life and closure of the facilities would extend for at least 20 years. After closure, an institutional control period of at least 100 years would then be implemented. Beyond that, site dedication and full institutional control in perpetuity would ensure that the site would never be entered inadvertently. The placement of permanent markers to inform future generations, the implementation of security measures, and the accompanying dedication of land-use buffer zones would be key components of the site dedication program.

4.3.2.8 Noise

Noise produced by the operation of heavy equipment during construction and operation of the facilities would be negligible at the nearest SRP boundary. In the construction areas and other areas where workers could be exposed to equipment noise, they would wear protective equipment in accordance with applicable standards and regulations.

4.3.2.9 Other Impacts

Occupational Risks

Because contaminant releases to the environment are not expected to occur, and sealed waste containers would be used, risks to workers are expected to be negligible.

Accidents

The environmental impacts and risk of potential accidents from the movement of waste to the facility are discussed in Section 4.6.

4.3.3 ELIMINATION STRATEGY

Waste management under the Elimination strategy includes sufficient retrievable storage facilities to accommodate all hazardous, mixed, and low-level radioactive wastes for a 20-year period (see Table 2-9). Waste would be stored rather than disposed of, in anticipation of future methods of treatment, recycling, or disposal. Following retrieval of the waste, the land could be used for other nonrestricted purposes or returned to a natural condition.

TC Storage facilities would be permitted and operated in accordance with applicable regulations (e.g., 40 CFR 264 and 270).

For the period of operation, storage buildings would be monitored and inspected on a continual basis. Special design would facilitate early detection and rapid recovery of any spilled or leaked wastes. The environmental evaluation assumes that no waste would be released from the facilities.

Because the impacts are assessed for the 20-year period of operation, the evaluation of the Elimination strategy is more limited than that of the Dedication strategy. No postoperational impacts are considered, and no consideration is given to impacts from the construction and operation of the future management facilities that would be required to treat or dispose of the waste. TE

4.3.3.1 Ground and Surface-Water Effects

The retrievable-storage facilities of the Elimination strategy would meet the zero-release goals of the applicable regulations. Groundwater and surface water would not be contaminated with waste constituents.

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.

4.3.3.2 Nonradioactive Atmospheric Releases

The construction of the retrievable-storage facilities under the Elimination strategy 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.

All waste would be delivered in high-integrity storage containers and, therefore, would result in no air releases. No air-quality impacts are anticipated.

4.3.3.3 Ecology

To avoid siting the facilities in sensitive areas, the retrievable-storage and all ancillary facilities described in Section 2.3.5 would comply with applicable regulations. The facilities would be constructed to minimize the impacts on habitats, wetlands, endangered and threatened species, and migratory waterfowl in the vicinity. Construction would require the clearing and development of currently undeveloped sites for structures, roads, and fences. The loss of as much as 400 acres of habitat would represent 0.2 percent of the 184,200 acres of wildlife habitat on the SRP, an insignificant ecological impact. Releases to the environment are not expected with this alternative; no contaminant-associated impacts on ecology are projected.

4.3.3.4 Radiological Releases

The retrievable-storage facilities under the Elimination strategy would meet or exceed RCRA or as low as reasonably achievable (ALARA) requirements with respect to facilities, structures, and waste containers. Because they would be properly constructed, operated, and maintained, all potential spills or leaks of mixed or low-level waste would be contained within the storage unit and a rapid and thorough cleanup response would be facilitated. Thus, radiological releases to the environment through any pathway are not expected to occur with this alternative.

4.3.3.5 Archaeological and Historic Resources

Based on field studies, the retrievable-storage facilities under the Elimination strategy would not impact any archaeological or historic resources. The archaeological survey of five of the six top-ranked candidate sites located no significant resources requiring impact mitigation. However, if Candidate Site K were selected to implement low-level waste facilities, an archaeological survey would be performed.

4.3.3.6 Socioeconomics

The socioeconomic impacts of the Elimination strategy are expected to be negligible because no significant increase in the existing SRP construction work force would be required.

4.3.3.7 Site Dedication/Institutional Control

The Elimination strategy would not require permanent site dedication. Following retrieval and removal of the waste, the facilities could be removed and the site returned to a natural condition or reclaimed for other nonrestricted use. This strategy presumes that technologies for treatment, recycling, or disposal will be available by the end of the 20-year operational life of the facilities.

4.3.3.8 Noise

Noise produced by the operation of heavy equipment during construction and operation of the waste storage facilities would be negligible at the nearest offsite area. In the construction areas and in other areas where workers could be exposed to excessive equipment noise, they would wear protective equipment in accordance with applicable standards and regulations.

4.3.3.9 Other Impacts

Occupational Risks

Because contaminant releases to the environment are not expected to occur, and high-integrity waste containers would be used, risks to workers are expected to be negligible.

Accidents

The environmental impacts and risks of potential accidents from the movement of waste to the facilities are discussed in Section 4.6.

4.3.4 COMBINATION STRATEGY

Waste management under the Combination strategy consists of an optimum mix of disposal and storage technologies for hazardous, mixed, and low-level radioactive waste characteristics and volumes. The technologies for implementing the Combination strategy are listed in Table 2-9. The technologies identified for evaluation of groundwater, surface-water, and radiological releases are the same as those for the Dedication strategy. TC

Modeling has been conducted for those cases in which disposal is part of the Combination strategy. Although some exceedances of environmental or health standards have been projected, they result from modeling assumptions. Impacts are evaluated to the end of the 100-year institutional control period.

Under the Combination strategy, the storage of wastes, assumed to be part of this strategy, would result in no releases of waste constituents to the environment during its 20-year period of operation and thereafter.

4.3.4.1 Groundwater and Surface Water

No waste releases are expected from any storage facilities during their 20-year operational period or thereafter, and releases of hazardous contaminants from hazardous and mixed waste disposal facilities are not expected to occur.

The Combination strategy assumes that tritium, carbon-14, and iodine-129 wastes would be segregated from the intermediate-activity waste streams and stored. Modeling indicates that all radionuclides, with the exception of uranium-234, remain at concentrations below derived standards in groundwater and surface water. Although uranium-234 is shown to exceed the derived standard slightly, when solubility limits are considered, it is projected to remain well below its standard. Thus, no significant groundwater and surface-water impacts are expected through the institutional control period under the Combination strategy. TE

4.3.4.2 Nonradioactive Atmospheric Releases

The construction of storage and disposal facilities under the Combination strategy 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.

All waste would be delivered in sealed disposal or storage containers; therefore, there would be no air releases. Thus, there would be no air-quality impacts.

4.3.4.3 Ecology

The operation and dedication of facilities is not expected to involve constituent releases that would exceed groundwater or surface-water standards; no waste-related adverse impacts on aquatic and terrestrial ecology are expected.

Construction of the facilities could require clearing and development of as much as 400 acres for facilities and roads. Existing or potential wildlife habitat would be destroyed; however, the maximum acreage amounts to only about 0.2 percent of the available habitat on the SRP and would constitute an insignificant impact.

Although endangered and threatened species [i.e., bald eagle, red-cockaded woodpecker, wood stork, American alligator, and shortnose sturgeon] are known to exist on the SRP, none are known to exist on or near any candidate site. TE

Short-term soil erosion could occur to onsite surface streams and wetlands as a result of construction; however, these would be minimized by erosion control measures.

Belowground technologies risk uptake of waste constituents by vegetation if, following closure, roots are allowed to penetrate the facilities and reach the waste. To prevent this, shallow-rooted plants would be used to stabilize soils during closure; these plants would be maintained by mowing during the postclosure institutional control period.

4.3.4.4 Radiological Releases

Assuming that tritium, carbon-14, and iodine-129 are segregated and stored, and ignoring the model results for uranium based on previous discussions, radiological dose predictions from mixed and low-level radioactive disposal facilities are well below the 4-millirem-per-year standard. TE

4.3.4.5 Archaeological and Historic Resources

The Combination strategy would not impact any archaeological or historic resources. If Candidate Site K were selected for low-level waste facilities, an archaeological survey would be performed.

4.3.4.6 Socioeconomics

The socioeconomic impacts of the Combination strategy are expected to be negligible, because no significant increase in the existing SRP construction force would be required.

4.3.4.7 Site Dedication/Institutional Control

The disposal areas plus a buffer zone of the Combination strategy would require dedication of as much as 400 acres.

Operational life and closure of the facilities would extend for at least 20 years. Following closure, an institutional control period of at least 100 years would be implemented. Dedication and full institutional control would ensure that the sites would never be entered inadvertently. The placement of permanent markers to inform future generations, the implementation of security measures, and the accompanying dedication of land-use buffer zones would be key components of the site dedication program.

4.3.4.8 Noise

Noise produced by the operation of heavy equipment during construction and operation of the facilities would be negligible at the nearest offsite area. In the construction areas and in other areas where workers could be exposed to equipment noise, they would wear protective equipment in accordance with applicable standards and regulations.

4.3.4.9 Other Impacts

Occupational Risks

Contaminant releases to the environment are not expected to occur, and high-integrity waste containers would be used; therefore, risks to workers are expected to be negligible.

Accidents

The environmental impact and risk of potential accidents from the movement of waste to the facility are discussed in Section 4.6.

4.3.5 SUMMARY AND COMPARISON

Table 4-45 summarizes the environmental impacts of modifying SRP waste management activities with respect to new waste management facilities under each of the four strategies. This evaluation is detailed enough to include the potential impacts of each strategy. The No-Action strategy would continue potential significant environmental impacts to water resources, air, ecology, public health and socioeconomics, and has a potential need for dedication of land if contamination occurs by an uncontrolled release of waste. The No-Action strategy would not comply with environmental laws and regulations. However, no impacts would be expected in the areas of archaeological/historic resources, and noise.

TE

For the period of evaluation [i.e., 120 years for the Dedication strategy (20 years of operation plus 100 years of institutional control), 20 years for the Elimination strategy (20 years of operation only), and 120 years or 20 years for disposal and storage under the Combination strategy], Table 4-45 indicates that no significant impacts would be expected from these strategies on water resources, air, ecology, public health, archaeological and historic resources, socioeconomics, and noise. However, beyond the 100-year institutional control period, releases of waste constituents could occur under various facility designs (e.g., no low-permeability cap, RCRA landfill rather than vault). DOE could revise such designs, mitigate the problem by removing or immobilizing the wastes, or demonstrate environmental compliance through an extended period of monitoring and postclosure maintenance.

The Dedication strategy and the disposal portion of the Combination strategy could require dedication of as much as 400 acres of land to waste management in perpetuity and possible postclosure care beyond the period of institutional control. Conversely, the Elimination strategy and the storage portion of the Combination strategy would require no direct dedication of land in perpetuity, but would require DOE to develop and implement the waste management technologies required to retrieve and treat or dispose of the stored waste.

4.4 STRATEGIES FOR DISCHARGING DISASSEMBLY-BASIN PURGE WATER

This section summarizes the radiological impacts associated with the strategies being considered for disassembly-basin purge-water discharges from C-, K-, and P-Reactors.

- No Action - Continued use of active reactor seepage and containment basins for discharge of disassembly-basin purge water.
- Dedication - Same as the No-Action strategy.
- Elimination - Evaporation of disassembly-basin purge water through commercially available equipment or direct discharge of the purge water to onsite streams.

- Combination - Continued discharge of disassembly-basin purge water to active reactor seepage and containment basins and continued evaluation of feasible tritium mitigation measures (e.g., reactor moderator detritiation). This section contains an analysis of detritiation to provide an estimate of costs and environmental impacts.

4.4.1 BACKGROUND

Reactor disassembly-basin purge water becomes contaminated with tritium (radioactive hydrogen isotope) and other radionuclides when fuel, targets, and other irradiated components are transferred to the disassembly basin from the reactor. Each irradiated assembly brings tritium oxide into the disassembly basin. The tritium oxide is dissolved in droplets of deuterium oxide (nonradioactive "heavy water") adhering to the surface and is also absorbed in the aluminum oxide cladding of the assembly. The tritium oxide dissolves in the disassembly-basin water and becomes distributed uniformly throughout the disassembly basin.

Disassembly-basin water is recirculated through deionizers and sand filters to remove radionuclides and to improve water quality. This process does not remove tritium, and small amounts of other radionuclides also remain in the water.

The disassembly-basin water must be purged periodically to keep tritium concentrations at safe levels for workers. During purges, fresh filtered water is added to the basin at the same rate contaminated water is purged from the basin through an ion-exchange system. The purge is not continuous but occurs at a frequency that depends on the type of reactor assemblies and the frequency of discharge operations. Typically, the reactor basins are purged twice yearly.

Preliminary groundwater monitoring data recently have identified the presence of volatile organic constituents in the vicinity of the C-Area seepage basin. Because these compounds are not introduced with the disassembly-basin purge water, investigations are in progress to identify their origin as well as the effect of continued use of the basin on their distribution in the groundwater. For evaluation purposes, however, these constituents are not considered because they are unique to the C-Area and must be managed on the basis of more specific evaluations than those employed herein, and because their presence does not affect the radiological doses used as a primary factor in the comparisons.

Table 4-46 lists the average annual and cumulative amount of tritium discharged from the reactor disassembly basins, which is the same for each strategy except the Combination strategy with detritiation. Values presented for 1987 to 2000 are based on annual release rates (Du Pont, 1984a). For 2001 to 2012, the release rates are assumed to be identical to those for 2000.

The amount of discharged tritium that ultimately reaches the environment depends on which strategy is implemented. Detritiation is the only method that would reduce the total discharge of this radionuclide. Others would simply alter the pathways through which discharged tritium could be accessible to the public.

TC

Table 4-46. Predicted Tritium Discharge from Reactor Disassembly Basins

Discharge alternative	Average annual release[a] (Ci/yr)	Cumulative release[a] (Ci)
Detritiation - Combination	4,000	103,000
Evaporation - Elimination	15,200	396,000
Direct discharge - Elimination	15,200	396,000
No Action - Combination, Dedication	15,200	396,000

[a] 1987-2012.

Small amounts of radionuclides other than tritium remain in the disassembly-basin water at the time of purge. Annual and cumulative releases of these nuclides from reactor disassembly basins are listed in Table 4-47; these releases are assumed to be the same for each strategy.

Table 4-47. Annual and Cumulative Discharges of Non-tritium Radionuclides from Reactor Disassembly Basins[a] (Ci)

Radionuclide	Annual release (Ci)	Cumulative release[b] (Ci)
Phosphorus-32	3.6×10^{-3}	9.4×10^{-2}
Sulfur-35	2.9×10^{-2}	7.4×10^{-1}
Chromium-51	5.4×10^{-1}	1.4×10^{1}
Cobalt-58, 60	1.1×10^{-3}	2.9×10^{-2}
Strontium-89	2.1×10^{-4}	5.5×10^{-3}
Strontium-90	6.0×10^{-4}	1.6×10^{-2}
Yttrium-91	1.5×10^{-2}	4.0×10^{-1}
Zirconium-95	3.3×10^{-2}	8.6×10^{-1}
Ruthenium-106	1.0×10^{-3}	2.7×10^{-2}
Antimony-125	2.4×10^{-2}	6.2×10^{-1}
Iodine-131	2.1×10^{-2}	5.4×10^{-1}
Cesium-134	1.5×10^{-2}	4.0×10^{-1}
Cesium-137	1.3×10^{-1}	3.4
Cerium-144	5.7×10^{-2}	1.5
Promethium-147	8.4×10^{-3}	2.2×10^{-1}
Unidentified beta-gamma[c]	2.7×10^{-1}	6.9
Unidentified alpha[d]	9.6×10^{-4}	2.5×10^{-2}

[a] Adapted from DOE, 1984.
[b] 1987-2012.
[c] Assumed to be strontium-90.
[d] Assumed to be plutonium-239.

TC Radiological doses were calculated for each year of the 26-year NUS study period (1987-2012) for each strategy (using methods and parameters in NRC, 1977 and ICRP, 1978). Discussions for the various strategies in the following sections present the maximum doses for any single year and annual average values over the 26-year period.

Doses presented in this analysis are effective whole-body doses (EWBDs). EWBDs are calculated by summing doses weighted by their relative risk (ICRP, 1977). Throughout this analysis, the term "dose," as applied to individual EWBDs, represents a 50-year dose-equivalent commitment. The term "collective dose" refers to the 50-year dose equivalent received by the population that additionally incorporates the 100-year environmental dose-commitment concept.

The maximum individual dose is that received by an offsite individual whose location and habits maximize the dose.

Collective doses ("population doses") resulting from atmospheric releases have been calculated for the population projected to be residing within 80 kilometers of the SRP. Collective doses resulting from liquid releases include doses to the downstream water users who consume drinking water from the Beaufort-Jasper and Port Wentworth water-treatment plants (Du Pont, 1984a; DOE, 1984).

4.4.2 NO-ACTION STRATEGY (CONTINUATION OF DISCHARGE TO SEEPAGE BASINS)

With the No-Action strategy, the current practice of discharging disassembly-basin purge water to the C- and P-Area seepage basins and the K-Area containment basin would continue. Water discharged to the seepage basins would either evaporate or migrate to the groundwater, where it would be transported TC to outcrop areas along surface streams. Groundwater transport of radionuclides other than tritium would be negligible.

Annual tritium releases to the environment calculated for the 26-year study period as described in Section 4.4.1 are shown in Table 4-48.

TE Radiation-induced health effects from releases under the No-Action strategy over the 26-year study period are calculated to total 0.029 excess fatalities.

Table 4-49 presents the highest annual and average annual EWBDs to the maximally exposed individual and the collective dose calculated over the 26-year study period.

The highest annual maximum individual dose of 0.047 millirem occurs in 1991 for the No-Action strategy; the annual average maximum individual dose is 0.04 millirem. These doses are about 0.05 percent or less of the DOE radiation protection standards. The average collective dose of 4.0 person-rem in 2012 is less than 0.004 percent of the exposure of about 103,000 person-rem to the population from natural radiation sources.

4.4.3 DEDICATION STRATEGY

The Dedication strategy is identical in concept to the No-Action strategy; that is, it continues disassembly-basin purge water discharges to active reactor seepage and containment basins.

Table 4-48. Tritium Releases to Environment Associated with the No-Action Strategy

Release pathway	Maximum annual release (Ci/yr)	Average annual release[a] (Ci/yr)	Cumulative release[a] (Ci)
Atmospheric	6,100[b]	4,570	119,000
Liquid	8,850[c]	7,110	185,000
Combined	13,200[d]	11,700	304,000

[a] 1987-2012.

[b] The maximum annual atmospheric tritium release occurs during the years 1987 through 1989.

[c] The maximum annual liquid tritium release occurs in 1991.

[d] This number represents the highest annual total tritium release through the atmospheric and liquid pathways combined, which occurs in 1991, and is not the sum of the maximum annual atmospheric and liquid releases; this release occurs in 1991. TC

Table 4-49. Highest Annual and Average Annual EWBD Associated with the No-Action Strategy

Receptor/exposure pathway	Highest annual dose[a]	Average annual dose[a]
Maximally exposed individual (mrem/year)		
Atmospheric	0.009	0.01
Liquid	0.038	0.03
Total	0.047[b]	0.04
Population (person-rem/year)		
Atmospheric	0.38	0.35
Liquid	4.94	3.70
Total	5.32[c]	4.05

[a] 1987-2012.

[b] The highest annual maximum individual dose occurs in 1991.

[c] The highest annual collective dose occurs in 2012.

4.4.4 ELIMINATION STRATEGY

The Elimination strategy, as applied to the management of disassembly-basin purge water, includes either evaporation to the atmosphere or direct discharge of the purge water to onsite surface streams.

With evaporation, all disassembly-basin purge water is assumed to be evaporated to the atmosphere, as described in Section 2.4. Tritium would be the only radionuclide released to the atmosphere, because all others would be retained in the evaporator. The only liquid releases would be from residual seepage of tritium released to the seepage basins earlier. The seepage of nontritium radionuclides is negligible.

TE

Annual tritium releases to the environment (atmospheric and liquid pathways) were calculated for the 26-year study period as described in Section 4.4.1. Table 4-50 presents the maximum and average annual tritium releases to the environment, as well as the cumulative tritium release for the 26-year study period.

Table 4-51 presents the highest annual and average annual EWBDs to the maximally exposed individual and the collective dose calculated over the 26-year study period.

The highest annual maximum individual dose of 0.074 millirem occurs in 1989 for the Elimination strategy with evaporation, and the annual average maximum individual dose is 0.041 millirem. These doses are about 0.1 percent or less of the DOE radiation protection standards. The average annual collective dose of 1.67 person-rem in 1989 is less than 0.002 percent of the exposure of about 103,000 person-rem to the same population from natural radiation sources.

Table 4-50. Tritium Releases to Environment Associated with the Elimination Strategy (Evaporation)

Release pathway	Maximum annual release (Ci/yr)	Average annual release[a] (Ci/yr)	Cumulative release[a] (Ci)
Atmospheric	20,300[b]	15,230	396,000
Liquid	7,570[c]	1,910	49,700
Combined	27,400[d]	17,100	446,000

[a] 1987-2012.

[b] The maximum annual atmospheric tritium release occurs annually during the years 1987 through 1989.

[c] The maximum annual liquid tritium release occurs in 1990.

TC

[d] This number represents the highest annual total tritium release through the atmospheric and liquid pathways combined, which occurs in 1989, and is not the sum of the maximum annual atmospheric and liquid releases; this release occurs in 1989.

Radiation-induced health effects from releases under the evaporation alternative over the 26-year study period are calculated to total 0.012 excess fatality.

Radiation-induced health effects from releases under the direct discharge alternative over the 26-year study period are calculated to total 0.068 excess fatality.

Table 4-51. Highest Annual and Average Annual EWBDs Associated with the Elimination Strategy (Evaporation)

Receptor/exposure pathway	Highest annual dose[a]	Average annual dose[a]
Maximally exposed individual (mrem/yr)		
Atmospheric	0.044	0.033
Liquid	0.030	0.008
Total	0.074[b]	0.041
Collective (person-rem/yr)		
Atmospheric	1.41	1.17
Liquid	1.56	0.51
Total	2.96[b]	1.67

[a] 1987-2012.

[b] The highest annual maximum individual and collective doses occur in 1989.

Direct Discharge

With direct discharge, all disassembly-basin purge water would be discharged directly to surface-water streams. In addition, residual seepage of tritium to surface water from seepage basin use prior to the initiation of this alternative would contribute to liquid releases.

Annual tritium releases to the environment (atmospheric and liquid pathways) were calculated for the 26-year study period as described in Section 4.4.1. TC

Table 4-52 presents the maximum and average annual tritium releases as well as the cumulative tritium release to the environment. Radionuclides other than tritium in the disassembly-basin purge water (presented in Table 4-47) are assumed to be released directly to onsite streams.

Table 4-53 presents the highest annual and average annual EWBDs to the maximally exposed individual and the collective dose calculated over the 26-year study period.

The highest annual maximum individual dose of 0.204 millirem occurs in 1989 for the direct discharge, and the annual average maximum individual dose is 0.16 millirem. These doses are about 0.2 percent or less of the DOE radiation protection standards. The average annual collective dose of 9.4 person-rem is less than 0.009 percent of the exposure of about 103,000 person-rem to the same population from natural radiation sources.

Table 4-52. Tritium Releases to Environment Associated with the Elimination Strategy (Direct Discharge)

Release pathway	Maximum annual release (Ci/yr)	Average annual release[a] (Ci/yr)	Cumulative release[a] (Ci)
Atmospheric	0	0	0
Liquid	27,400[b]	17,100	446,000
Combined	27,400[b]	17,100	446,000

[a] 1987-2012.

[b] The maximum annual liquid tritium release occurs in 1989.

Table 4-53. Maximum and Average Annual EWBDs Associated with the Elimination Strategy (Direct Discharge)

Receptor/exposure pathway	Highest annual dose[a]	Average annual dose[a]
Maximally exposed individual (mrem/year)		
Atmospheric	0	0
Liquid	0.204	0.16
Total	0.204[b]	0.16
Collective (person-rem/year)		
Atmospheric	0	0
Liquid	12.1	9.40
Total	12.1[c]	9.40

[a] 1987-2012.

[b] The highest annual dose to the maximum individual occurs in the year 1989.

[c] The highest annual collective dose occurs in 2012.

4.4.5 COMBINATION STRATEGY

The Combination strategy includes the continuation of disassembly-basin purge water discharges to active reactor seepage and containment basins while DOE continues to assess tritium-mitigation measures such as reactor moderator detritiation. Other mitigation measures are discussed in Section 4.8.

The consequences of the continuation of discharging purge water to active seepage basins are discussed in Sections 4.4.1 and 4.4.2.

Detritiation of the reactor moderator in a central facility has been considered for all SRP reactors. A moderator detritiation plant (MDP) would be expected to reduce equilibrium moderator tritium levels by a factor of about 10. The moderator is the source of the tritium that contaminates the disassembly-basin water, so a corresponding reduction in disassembly-basin purge water tritium concentrations and releases from this source would be expected.

Water discharged to the seepage basins would either evaporate, carrying tritium with it to the atmosphere, or move down to the groundwater, where it would be transported laterally to outcrop areas along surface streams.

The nontritium radionuclides (see Table 4-47) would seep into the ground and experience radioactive decay and retardation by adsorption (DOE, 1984). These processes would reduce nontritium releases to surface waters to insignificant levels.

Tritium would move with the groundwater and undergo radioactive decay during travel to surface outcrops. The amount of tritium expected to be released from the seepage basins has been calculated assuming that 30 percent of tritium released to the basins evaporates and that the remaining 70 percent migrates to streams while undergoing radioactive decay.

Radiation-induced health effects from releases over the 26-year study period are calculated to total 0.014 excess fatality.

Average annual collective EWBDs within the defined impact areas (80-kilometer radius and downstream Savannah River water users) associated with the alternative strategies range from about 1.7 person-rem with evaporation to 9.4 person-rem with direct discharge. These doses to the affected population are a small fraction of the naturally occurring background doses to the same population.

The half-life of tritium (12.3 years) will result in doses to individuals beyond the defined impact areas, particularly for atmospherically released tritium from evaporation. Although minuscule, these doses can be summed through a much larger population (e.g., the U.S. population or the world) to arrive at hypothetical collective doses significantly greater than those for evaporation presented in Tables 4-51 and 4-54 (although still an insignificant percentage of the naturally occurring dose to the same population). However, this approach to dose assessment is not recommended by national and international radiation standards organizations as a basis for judging alternative radiation protection practices. Although this type of collective dose has not been calculated for this EIS, atmospheric discharge of tritium can contribute substantially greater theoretical collective doses per curie released than do liquid discharges at the SRP, with correspondingly greater (although still insignificant) health effects. TC

4.4.6 COMPARISON OF ENVIRONMENTAL CONSEQUENCES

When compared with no action, detritiation would decrease the total tritium released to the environment from the reactor seepage basins by a factor of about 2, while the total tritium released from evaporation and direct discharge would increase from no action. TC

Table 4-54. Average Annual EWBD to the Maximally Exposed Individual for Each Strategy (mrem/yr)

	Combination	Elimination		Combination/ Dedication
Exposure pathway	Detritiation	Evaporation	Direct discharge	No Action
Atmospheric	0.004	0.033	0.000	0.010
Liquid	0.018	0.008	0.160	0.030
Total	0.022	0.041	0.160	0.040

The average annual effective whole-body dose received by the maximally exposed individual for each strategy is presented in Table 4-54. The doses range from 0.022 millirem per year for detritiation to 0.16 millirem per year for direct discharge and represent small fractions of the 93 millirem per year received by an individual from natural background radiation (DOE, 1984).

Average annual collective EWBDs associated with the various strategies range from about 1.7 person-rem per year with evaporation to 9.4 person-rem per year TC with direct discharge. The average annual collective EWBD for detritiation is 1.87 person-rem per year. The dose associated with natural background radiation delivered to the same population would be 103,000 person-rem per year. Collective doses associated with each strategy, therefore, represent less than 0.01 percent of the dose received from natural background radiation. The corresponding health effects and doses are not significant.

The cost benefit of detritiation would be more than $3 million per person-rem averted, compared to no action. The average annual cost benefit of the evaporation would be about $500,000 per person-rem averted, compared to no action. There would be little difference in the cost of implementing direct discharge and the No-Action strategy for discharge of DBPW. The cost benefits of these TC tritium management strategies were calculated from the capital and operating costs given in Tables 2-11 and 2-12 and from the EWBDs given above.

4.5 ACCIDENTS

The environmental impacts and risk of potential accidents associated with closure have been analyzed for each of the individual waste sites used for the disposal of hazardous and radioactive materials. The selected closure action would be implemented in such a manner that the risk to the public from accidental releases of materials from the site would be minimal.

The potential accidents and consequences associated with each action for each waste site are related to the materials at the site. The potential accident scenarios are based on the processes proposed to be used and the hazards associated with these materials.

Several of these events are defined to include spillage of waste from a steel box. These boxes are ruggedly constructed and difficult to breach. It was not considered cost-effective or necessary to analyze the structure of the box to determine under what conditions it would fail, because the consequences of such an event were judged to be relatively minor. The probability of box failure in an accident was assumed conservatively to be 0.25.

The accident scenarios considered are natural events such as tornadoes, hurricanes, floods, and earthquakes, and industrial accidents such as falls, fires, cave-ins, and container spills. The natural events were analyzed using historical data on probability and severity. Industrial accidents were analyzed using labor-hour estimates based on commercial cost-estimating handbooks and industrial accident rate tabulations. The number of workdays of construction labor required to accomplish the waste-removal and no-waste-removal options was estimated. This estimate was used to calculate the probability of each potential accident. The major accident types are described below. (Palmiotto, 1986, provides further explanations for each accident.)

- Tornado. The major effect of a tornado would be entrainment of dust laden with contaminants, with possible dispersion off the waste site. Dispersal could occur during the excavation activities.

- Hurricane and high straight wind. If high winds occur during excavation of the waste sites, there is the potential for pickup and dispersal of waste-site contaminants.

- Flooding. Flooding of a waste site during closure options was dismissed from consideration because of the location of the waste sites, and because the level of the Savannah River is controlled by three major hydroelectric dams upstream from the sites. In addition, measures would be taken on the SRP to prevent flooding during heavy rains.

- Earthquake. The only effect of an earthquake pertinent to this analysis is the failure of a berm or dike at the waste site or during excavation of a site. During excavation operations, such an accident could result in injuries and equipment damage. An unusually heavy rain could leave water in a site, but the combined probability of such a rain and a major earthquake is exceedingly small. Dikes are estimated to fail in a MM IX earthquake, which has a frequency of occurrence estimated to be less than once in 10,000 years. If the earthquake were to occur while men were in an excavation trench, a cave-in could result in personnel injuries or fatalities.

- Industrial accident. The likelihood of personnel injuries through an industrial accident was evaluated by applying published accident rates to the number of labor-hours required for each closure option. The labor estimates were developed from the quantification of each activity required for a closure, such as the number of cubic meters of earth to be removed, the number of square meters of land to be leveled and seeded, and the number of meters of fence to be constructed. The source of data for this analysis was the background information prepared for preliminary cost estimates for each waste site and includes standard project estimating guides.

- Fire. Two causes of fire were considered: a natural forest fire, and an industrial fire initiated by material being excavated or by equipment used for site closure. The former fire has been dismissed as a concern because the forests on the Plant are managed, and controlled burning of underbrush is conducted. The SRP firefighting team would be able to protect material at an excavation site from an adjacent fire. Fires associated with fuel or hydraulic fluid occasionally occur with heavy construction equipment. This event is analyzed because dispersal of waste or employee injury could occur. Fire initiated in an excavation or by excavating equipment could easily be smothered by readily available equipment.

- Explosion. No explosive materials were identified on the waste sites or in adjacent areas. Therefore, explosion as an accident initiator was dismissed.

- Container puncture. This accident initiator applies to sites where drums are stored. During excavation these units could be punctured, potentially spreading contamination. Puncture of a unit containing soil or sediment removed from the basin is discussed under other scenarios.

- Equipment collision. A collision of mobile heavy equipment could occur on any construction site. This scenario includes collisions involving any of the mobile equipment onsite (i.e., trucks, forklifts, and front-end loaders) and also covers waste-box punctures.

- Toppling of large equipment. Large excavation equipment such as draglines and backhoes could be used for closure of a site. A check of construction industry accident statistics revealed that relatively major accidents with such equipment occur often enough that they should be considered. This accident is defined to include such events as dragline structural failure, cable breaks, and grade cave-in resulting in the toppling of a backhoe or dragline.

- Employee injury during construction. During any excavation and heavy construction project of this size, there would be some employee injuries, almost all nonfatal. This scenario includes nonfatal accidents such as falls, equipment-related injuries to hand or eyes, and minor burns.

- Operator contamination. This includes any contamination to workers by exposure to or contact with hazardous materials contained on the site during closure activities.

- Waste box drop and breach. During excavation, the contaminated soil and sediment would be placed in steel boxes for transportation to a storage or disposal area. Some waste boxes could be dropped during handling by forklifts or cranes. This event is defined to include only drops that result in a breach of the box, either by puncture or by opening of its lid. Employee injuries are excluded.

- Cave-in. During excavation and closure, workers must enter the waste sites to perform tests, rig equipment, and excavate the sediment and soils. Cave-ins are a possible cause of injuries and fatalities to construction workers.

- Truck accident and fire. This includes a truck accident and fire when waste is being transported to the storage and disposal areas.

- Truck accident and spill. This includes a truck accident in which the waste box is breached or opened, resulting in spillage of waste materials.

- Truck accident and fatality. A certain percentage of truck accidents result in operator fatalities. This scenario includes truck accident fatalities during the transportation of waste materials to storage and disposal areas.

- Fall of box from truck. This includes a waste box falling from a truck during transit due to rigging or driving errors, resulting in spillage of contents.

Table 4-55 summarizes the accidents described above, including the initiator and the consequence. Risks were calculated for certain accidents in which the consequences allowed such an assessment to be made; these occurrences are (1) employee injury, (2) truck accident and fatality, and (3) fatal construction accident. The results of these assessments are presented in Tables 4-56 through 4-59 for each site for the no-action, no-waste-removal-and-closure, complete-waste-removal and closure, and selected-waste-removal strategies, respectively.

4.6 DECONTAMINATION AND DECOMMISSIONING

The proposed new facilities ultimately would require decontamination and decommissioning. Decontamination and decommissioning of the proposed facilities would be included in an overall site decontamination and decommissioning plan, which would be subject to environmental and public review before implementation.

Three basic decommissioning methods are defined: DECON, ENTOMB, and SAFSTOR (Calkins, 1980). DECON involves the immediate removal of all radioactive materials to levels that are considered acceptable to permit the property to be released for unrestricted use (NRC, 1981). Chemical decontamination of the structure and the internals would be followed by the dismantling, transportation, and burial of the internals. As the final step, the outer structure would be demolished and the site restored to its precommissioning status.

Table 4-55. Closure Accidents

Initiator	Accident	Consequence
Tornado	High winds disperse soil	Minimal dispersion of soil at waste site but not beyond SRP boundary; potential serious personnel injury
Straight wind	High winds disperse wet soil	Minimal dispersion of wet soil onsite, none offsite
Earthquake	Failure of excavation site (basin walls, berms, etc.)	Minimal dispersion of soil onsite; potential personnel injury
Container puncture	Waste containers at site	Loss of contents at site; cleanup initiated (Gunsite 720 rubble pit) A few suspected empty containers at site; no probable impact (hydrofluoric acid spill area)
Equipment collision	Mobile equipment collides; possible puncture of waste containers	Releases (where applicable) confined to the immediate area of the site; possible personnel injury
Failure of equipment	Large equipment toppling	Dispersion of waste material at site; possible personnel injury
Fall/equipment-related injuries	Employee injury	Minor personnel injury
Contamination	Inadvertent contamination to workers at site	Minor contamination; immediate decontamination; minor personnel injury
Drop and breach	Waste container dropped and puncture or lid opening occurs	Release of waste at site; cleanup initiated; minor or no personnel injury
Equipment fire	Fuel or hydraulic fuel catches fire	Minor personnel injury; damage to equipment

Table 4-55. Closure Accidents (continued)

Initiator	Accident	Consequence
Cave-in	During excavation of material with equipment	Personnel injury or possible fatality
Accident and fire	Accident resulting in fire	SRP fire department response; minimum personnel injury; damaged equipment
Accident and spill	Truck accident during transport; waste container damaged and breached	Waste release confined to accident site; cleanup initiated
Accident and fatality	Truck accident while in transit to disposal area	Fatality to driver
Fall of box from truck	Rigging or driving errors result in spillage of waste container contents	Release of waste at site of accident; cleanup initiated
Truck accident	Truck with fill and another vehicle collide, or single vehicle accident occurs	Potential personnel injury; material released at accident site; cleanup initiated
Fatal construction accident	Construction accident	Fatality

ENTOMB is the encasement of the facility in a material possessing long-lived structural integrity until a time when the dose level is amenable to unrestricted use. This would be the method used for sites where the radioactivity would decrease to acceptable limits within a reasonable time. A reasonable time period for ENTOMB is approximately 100 years (NRC, 1981).

SAFSTOR involves placing a facility and equipment in temporary storage within acceptable risk levels for subsequent decontamination and unrestricted facility use. SAFSTOR has six major phases:

- Chemical decontamination
- Mechanical decontamination and fixing of residual radioactivity
- Equipment deactivation
- Preparation for interim care
- Interim care (surveillance and maintenance)
- Final dismantling

In demolition and restoration, all above-grade portions of the plant structures would be demolished by conventional methods, such as explosive and impact balls. The site would then be graded and revegetated.

Pending the results of further studies and reviews, decommissioning of the proposed facilities and equipment is expected to be conducted via SAFSTOR. Startup of the proposed new facilities would be spread over time, as would future decontamination and decommissioning.

Impacts from decontamination and decommissioning would be very small. Projections of these impacts specific to the proposed facilities and equipment have not been made; estimates, however, have been prepared (Manion and LaGuardia, 1976) for the decontamination and decommissioning of commercial power reactors of pressurized-water-reactor (PWR) design. The estimated dose to a member of the public for the DECON option was 3.0×10^{-5} millirem per year (lung) during the period of the decontamination and decommissioning operation. Both ENTOMB and SAFSTOR were projected to result in even lower doses.

The proposed new facilities would handle only low-level radioactive, hazardous, and mixed wastes. These proposed facilities are:

1. Low-level radioactive waste storage/disposal facility
2. Hazardous and mixed wastes storage/disposal facilities TE
3. Cement/flyash matrix storage/disposal (Y-Area)

4.7 CUMULATIVE EFFECTS

Cumulative effects are discussed in the following sections for the alternative waste management strategies described in Section 2.1, in conjunction with the effects of existing and planned facilities at or near the Savannah River Plant. The discussion is based on an analysis of a range of environmental impacts to provide minimum and maximum cumulative effects. TE

4.7.1 EXISTING AND PLANNED FACILITIES

4.7.1.1 Facilities Near SRP

Eight facilities located within 16 kilometers of the Savannah River Plant are included in the cumulative effects analysis. These include the Vogtle Electric Generating Plant of Georgia Power Company, directly across the Savannah River from the SRP; the Chem-Nuclear Services, Inc., plant in Barnwell County, South Carolina, east of the SRP; and RCRA and CERCLA sites in South Carolina, as listed in Table 4-60.

The Vogtle Electric Generating Plant is a two-unit nuclear powerplant under construction. Unit 1 was licensed to operate at full power by the Nuclear Regulatory Commission in May 1987. Chem-Nuclear Services, Inc., operates a low-level radioactive waste burial ground.

Table 4-60. RCRA and CERCLA Sites in South Carolina

Name	City	County	Direction from SRP
	CERCLA		
Admiral Home Appliances	Williston	Barnwell	East-northeast
Barnwell Seed & Supply	Barnwell	Barnwell	East
Barnwell Town Dump	Barnwell	Barnwell	East
Kimberly-Clark Corporation	Beech Island	Aiken	Northwest
Simpkins farm site	Beech Island	Aiken	Northwest
	RCRA		
Sandoz, Incorporated	Martin	Allendale	South

4.7.1.2 Effluent Treatment Facilities at SRP

The M-Area liquid effluent treatment facility (LETF) was designed and constructed to treat liquid effluents from the fuel and target fabrication facility. The facility eliminates the use of the M-Area settling basin. The LETF includes a chemical transfer facility, a dilute effluent treatment facility, process modifications for rinsewater reduction, and temporary storage tanks. Treatment includes physical-chemical treatment, precipitation, solids separation, evaporation, filtration, and neutralization. The treated liquid effluent from this treatment facility, which meets NPDES discharge limits, is discharged to Tims Branch.

The M-Area LETF was constructed adjacent to existing M-Area facilities in a developed and controlled area on a grassy site. Temporary construction impacts such as noise, dust, and fumes were controlled to minimal levels. Required permits for construction of this wastewater-treatment facility were issued. No adverse effects are expected to impact SRP wildlife, wetlands, or archaeological sites due to LETF construction or operation. Operation of the facility began in the spring of 1985. The sludges from the LETF are stored temporarily in new tanks in M-Area. A spill prevention control and countermeasure (SPCC) plan has been established.

F- and H-Area Effluent Treatment Facility

The F- and H-Area effluent treatment facility (ETF), located in H-Area, would be designed, constructed, and operated to store and treat routine wastewater and spills from the chemical separations facilities in F- and H-Areas. Operation of this new facility will eliminate the present discharge of these effluents to the F- and H-Area seepage basins (DOE, 1986). Current planning calls for startup of the facility following the closure of the seepage basins in November 1988. The facility would provide improved treatment of routine process effluents and contaminated cooling or storm water. Unit treatment processes consist of two stages of filtration, including iron removal and carbon filtration; reverse osmosis; neutralization; and ion exchange; with TC combined evaporation of filter backwash, reverse-osmosis reject streams, and ion-exchange regeneration waste. Recycling of evaporator overheads and treated effluent that exceeds discharge limits is included. Dewatered solids from the coarse filtration step would be disposed of in the burial ground or in the Y-Area facility (CMF). Evaporator bottoms (waste concentrate) would be transferred to the H-Area waste tank farm. Tritium is not removed in the treatment process. The estimated discharge of 30,000 curies per year from the ETF into Upper Three Runs Creek would be partially offset by decreases in atmospheric releases and tritiated groundwater outcrops due to closure of the F- and H-Area seepage basins (DOE, 1986). Storage basins are provided to contain large flows of contaminated cooling water or storm water. TC

TNX-Area Effluent Treatment Plant

This facility is scheduled to begin operation in early 1988; it is designed to treat small-volume nonradioactive process effluents for NPDES discharge. The treatment processes include flow equalization, neutralization, and solids removal. Filter cake would be disposed of in the SRP sanitary landfill.

4.7.1.3 Waste Treatment, Storage, or Disposal Facilities at SRP

TC Consolidated Incinerator Facility

An incinerator would be designed and constructed to incinerate a variety of hazardous wastes (e.g., contaminated soil, sludges, and liquid and solid wastes). The incinerator would consist of a primary rotary kiln, a secondary combustion chamber, and an off-gas treatment system including evaporative coolers and particulate and chloride removal systems. The process would allow simultaneous destruction of solids and aqueous and organic liquid wastes. Plans call for upgrading the incinerator to permit mixed waste incineration.

Hazardous Waste Redrumming Facility

EPA and the South Carolina Department of Health and Environmental Control (SCDHEC) require redrumming hazardous wastes contained in leaking or inadequate drums to comply with current RCRA regulations. This facility would be used to:

- Transfer liquid hazardous waste from leaking 208-liter drums to other drums
- Overpack 208-liter drums using 314-liter drums
- Transfer liquid hazardous waste from 208-liter drums and overpack into 314-liter drums
- Solidify liquid hazardous waste with absorbent
- Compact used drums with a crusher, and overpack in 314-liter drums
- Provide space for interim material handling storage

No radioactive releases are expected. Leaks, spills, or other liquids would be contained, collected, and processed. Activated carbon filters would absorb organic vapors from the facility exhaust air before venting the air to the atmosphere. TE

Cement/Flyash Matrix (Y-Area) Waste Storage/Disposal Facility

Y-Area will be designed to store, treat, and dispose of 4400 cubic meters of waste per year. The waste, very low in radioactivity, will be the concentrate from several effluent-treatment facilities. Facilities contributing to this waste load are M-Area, the F- and H-Area effluent treatment facility, the Fuel Materials Facility, and the Fuel Production Facility. In addition, beta-gamma and hazardous waste incinerator residues may also be disposed of in this facility.

The waste salt solutions and precipitated solids will be solidified in a cement/flyash or cement/slag matrix, similar to saltstone. Blast furnace slag is being considered in place of flyash due to its unique chemical reducing properties that would immobilize chromium. The alternative process being considered for disposal of this waste would containerize the dry waste salts in packages with structural properties for disposal in the mixed waste disposal facility. TC

Environmental emissions or releases are expected to be below applicable standards, due to disposal in CFM vaults or the mixed-waste disposal facility.

Z-Area Saltstone Disposal Facility

The Z-Area disposal facility is designed for disposal of both low-level radioactive and hazardous wastes, specifically partially decontaminated salt solution resulting from processing of high-level radioactive liquid wastes in the Defense Waste Processing Facility (DWPF). The solution contains sodium chromate and has a high pH, both of which cause the solution to be characterized as hazardous under SCDHEC regulations. The partially dewatered salt solution would be mixed with cement and water, or other media, to form a relatively nonleachable solid monolith saltcrete, suitable for long-term disposal in permitted vaults. TC

4.7.1.4 Other Facilities at SRP

Defense Waste Processing Facility

The DWPF is being constructed to process high-level radioactive liquid wastes currently stored as insoluble sludges, precipitated salt, and supernatant liquid in single or double tanks in the F- and H-Area tank farms. The process includes the removal of wastes from tank storage; immobilization of the high-level sludge and recovered cesium, strontium, and plutonium in borosilicate glass; encapsulation of the waste and glass mixture in steel canisters; storage of the canisters in a surface facility until shipment to a repository; and processing of the decontaminated salt into saltcrete monoliths (See discussion of Z-Area above). TC

Fuel Materials Facility

The Fuel Materials Facility (FMF) has been designed and constructed and would be operated to provide a second source of fuel materials employing enriched uranium for the Nuclear Navy Propulsion Program. The facility is located within F- and H-Areas. Air emissions would be controlled through the total containment concept, which consists of air locks, forced air circulation, enclosures and hoods on cabinets, high efficiency particulate air (HEPA) filters, and exhaust stack capability.

Liquid wastes include process recovery and laboratory effluents, sanitary wastes, cooling-system blowdown, and steam condensates. Process wastes would be neutralized, evaporated, mixed with concrete, and encapsulated in steel containers for burial in the SRP burial ground. Solid, low-level radioactive wastes would be placed in the SRP burial ground.

Fuel Production Facility

Construction of the Fuel Production Facility (FPF) was planned to begin in December 1986. The process involved, using an onsite uranium recycle process and powder metallurgy, would replace the current casting and machining process used to form fuel billet cores.

Solid wastes from the facility containing trace amounts of uranium, including rags, plastic bags, and gloves, would be disposed of in the burial ground or incinerated. The volume of solid waste is expected to be less than that generated by the current process.

Liquid chemical wastes such as acids or caustics from the process would be treated in the F- and H-Area ETF (see Section 4.7.1.2). Air emissions would be multiple HEPA-filtered.

Tritium-Loading Facility

This facility, also called the Replacement Tritium Facility, is designed to replace and upgrade some of the tritium processing and loading functions in the present tritium-loading facility. Construction is underway, and the facility is scheduled to be completed in 1990. TC

Routine operation of the new facility would substantially reduce atmospheric releases. Tritium-contaminated solid waste generation and storage/disposal rates are expected to decrease. Mercury would be eliminated in the new process, thus eliminating storage and disposal needs for mercury-contaminated wastes. There would be no releases of liquid effluents to onsite streams or to groundwater. A beneficial cumulative impact in the reduction of radioactive releases and consequent offsite doses to the public is anticipated.

4.7.1.5 Demonstration Facilities at SRP

Among the demonstration facilities active or planned at the SRP are the following:

TC

- Abovegrade operation
- Beta-gamma incinerator
- Box/drum compactor
- Greater confinement disposal

Abovegrade Operation (AGO)

This one-year demonstration facility is designed to store solid low-level radioactive wastes over existing filled waste trenches in the SRP burial ground. The waste would be placed in stackable rigid containers on composite clay and gravel storage pads. The waste would be covered with sand, a puncture-resistant fabric, an impermeable cover, and finally a clay cover. There would be no atmospheric or solid waste releases from the site. Liquid releases would be monitored. The impermeable barriers would reduce rainwater percolation into the wastes or into the underlying waste trenches.

Beta-Gamma Incinerator

TC

This demonstration facility is designed to incinerate low-level radioactive waste in both liquid and solid forms. The process has two stages, using an air-deficient pyrolysis chamber at 900°C followed by an 1100°C afterburner operating in excess air. Also included in the design is a spray quench tower and HEPA filter. Capacity of the incinerator is 181 kilograms per hour of solids or 1500 liters per hour of liquid wastes.

Box-Drum Compactor

This demonstration facility is designed to handle solid low-level radioactive wastes by compaction, reducing waste volumes by factors of 4 or 5 to 1. Following compaction, the wastes would be placed in 1.2-meter by 1.2-meter by TC 1.8-meter steel boxes for disposal in the low-level burial ground. Environmental releases from the facility are expected to be insignificant. There are no liquid releases. HEPA filters would remove and retain radioactive particulates from the facility ventilation/exhaust air system.

Greater Confinement Disposal

The GCD demonstration is designed to dispose of low-level radioactive wastes in lined 9-meter-deep auger holes or in short trenches with vertical walls. TC The wastes (in rigid containers) or contaminated metallic objects would be stabilized in place with self-leveling grout. The facilities would be capped when filled. The potential for leachate generation is small due to the presence of grout and the cap. Monitoring of leachate is included in the design.

4.7.2 GROUNDWATER

4.7.2.1 Groundwater Withdrawal

The withdrawal of groundwater from the Middendorf/Black Creek (Tuscaloosa) aquifer in support of existing and projected SRP operations is not expected to affect offsite water levels in the aquifer (DOE, 1984). However, as discussed in Section 4.2.1, the groundwater withdrawal in support of remedial actions at the existing waste sites could physically impact the water table outside the SRP boundary. Careful monitoring of the water table during startup of any remedial action would determine if there are impacts to the water-table aquifers.

The offsite facilities identified in Section 4.7.1.1 are not expected to contribute to the SRP's withdrawal rate and its associated drawdown. The Vogtle

Nuclear Plant withdraws groundwater from areas unaffected by the SRP. The offsite facilities are not expected to contribute to the SRP's withdrawal rate and any associated drawdown.

4.7.2.2 Groundwater Quality

The groundwater quality under the Plant would be improved as a result of the implementation of the Elimination alternative strategy. The remedial actions would be such that the groundwater quality from one area of the SRP would not adversely impact the groundwater in another.

Based on apparent groundwater-flow direction, groundwater from beneath the Vogtle Nuclear Plant, the Kimberly-Clark Corporation, the Simpkins farm, Barnwell Seed and Supply, the Barnwell Town Dump, and the Admiral Home Appliance site does not appear to come in contact with the groundwater from beneath the other facilities identified in Section 4.7.1, or the groundwater affected by the SRP. Therefore, these facilities should not contribute to the cumulative impact on groundwater quality.

The new retrievable-storage facilities, the ETFs, the other operating facilities, and the demonstration facilities would be designed and constructed so that they do not release contaminants to the groundwater. These facilities would be properly maintained and would not contribute to a cumulative impact on groundwater quality.

TC Under the No-Action strategy, the quality of the groundwater under the SRP would continue to be affected.

4.7.3 SURFACE WATER

4.7.3.1 Surface-Water Use

The Chem-Nuclear Services facility, the CERCLA sites, the Sandoz, Inc., RCRA site, the new disposal facilities, the ETFs, the waste treatment, storage, or disposal facilities, the other operating facilities, and the demonstration facilities are not expected to use surface water from the Savannah River. The Vogtle Nuclear Plant withdraws a few cubic meters per second from the river for use as cooling-system makeup water, a portion of which would be returned as blowdown. The SRP is estimated to withdraw 37 cubic meters per second, while the average flow of the Savannah River is 285 cubic meters per second (DOE, 1984). Under average conditions, the cumulative surface-water use is projected to be about 14 percent of the Savannah River, compared to 13 percent for the SRP alone. In addition, the major portion of this withdrawal is used for cooling water and is returned to the river via onsite streams. Thus, the cumulative impact is not expected to be significant.

TC 4.7.3.2 Surface-Water Quality

Existing waste sites would be remediated so that contamination from these sites does not adversely affect surface-water quality. The new retrievable-storage facilities, the ETFs, the other operating facilities, and the demonstration facilities would be designed, constructed, operated, and maintained so that discharges would not adversely impact surface-water quality. The

Vogtle Nuclear Plant has been designed, constructed, and will be operated and maintained so discharges do not adversely impact surface-water quality.

Any potential contamination from the Admiral Home Appliances, the Barnwell TC Seed and Supply, and the Barnwell town dump CERCLA sites is expected to enter the Salkehatchie River watershed and should not be expected to contribute to cumulative impacts on the Savannah River.

Any potential contamination from the Kimberly-Clark Corporation and the Simpkins farm CERCLA sites probably enters the Savannah River above the SRP. TE Considering the groundwater flow rates in this area, the contamination would take more than 100 years to reach the Savannah River and is not expected to contribute significantly to the water quality of the river.

There are no liquid discharges from the Chem-Nuclear Services facility to contribute to the cumulative effects on surface-water quality.

Under the No-Action strategy, the quality of surface streams on the SRP would continue to be affected as a result of existing waste sites. The other facilities identified in Section 4.7.1.1 are not expected to contribute to the cumulative impact on surface-water quality.

4.7.4 HEALTH EFFECTS

4.7.4.1 Exposure to Radioactive Substances

The evaluation of health effects has considered cumulative effects from the operation of all nuclear facilities on and in the vicinity of the SRP. These facilities consist of four production reactors with associated support facilities; hazardous, low-level, and mixed waste sites; and planned operations at the SRP, including the ETF, the DWPF, the FMF, and the FPF. The Vogtle TC Electric Generating Station and the Chem-Nuclear Services, Inc., low-level radioactive disposal site are also included in the evaluation of the cumulative health effects. The risk estimator used to project health effects is 280 cancers and genetic effects per 1 million person-rem of collective dose.

Existing Waste Sites

Using the risk estimator mentioned above and the cumulative doses presented in Appendix H, Table 4-61 lists the cumulative health effects that could be experienced by the population from radiation received in the year 2000 for the TC No-Action strategy and during the first year after implementation of the other three strategies. Remedial actions at the waste sites were not considered in calculating these health effects. The recipient population of the air component of the health effects is assumed to lie within an 80-kilometer radius of the SRP. The recipient population of the liquid component of the health effects is assumed to be the Savannah River water users downstream from the SRP.

New Retrievable-Storage Facilities

The changes in health effects that could be imparted to the water user TE population downstream from the SRP due to implementation of the action strategies (i.e, Dedication, Elimination, and Combination) discussed in

Table 4-61. Collective Cumulative Health Effects from Atmospheric and Liquid Releases for Alternative Actions at Existing Waste Sites

Component	No action	No waste removal and closure[a]	Waste removal at selected sites[a]	Waste removal and closure[a]
Atmospheric	2.9×10^{-2}	1.4×10^{-2}	1.4×10^{-2}	2.2×10^{-2}
Liquid	1.2×10^{-2}	1.2×10^{-2}	1.2×10^{-2}	1.2×10^{-2}
Combined	4.1×10^{-2}	2.6×10^{-2}	2.6×10^{-2}	3.4×10^{-2}(b)

[a] Remedial actions taken at appropriate waste sites would reduce the tabulated health effects.

[b] Waste removal and closure result in comparatively higher cumulative health effects than either no-waste-removal and closure or waste removal at selected sites. This is because additional radionuclides could be set airborne from excavation performed during the year the waste removal and closure action is implemented.

Section 4.3 are insignificant. Because no atmospheric releases would result from implementation of any of the action strategies, the cumulative atmospheric component of the health effects would not be affected. Consequently, implementation of any of the waste storage facility alternatives would result in an insignificant change in the number of 4.1×10^{-2} health effects.

Disassembly-Basin Purge Water

Using the health risk estimator of 280 cancers and genetic effects per 1 million person-rem of collective dose, and the peak collective annual doses resulting from the three alternative strategies (excluding no action) for discharging disassembly-basin purge water (Section 4.4), calculations were made to determine the cumulative health effects that could be experienced by the population within an 80-kilometer radius of the SRP and the population using Savannah River water downstream from the SRP.

The change in the health effects resulting from each alternative is calculated by considering the peak annual dose of a 26-year study period. The rationale for considering a time range of 26 years is presented in Sections 2.4 and 4.4. The changes in these health effects, when combined with the no-action health effects given in Table 4-61, result in the cumulative annual health effects that could be experienced by the population after the implementation of the alternatives. These cumulative health effects are listed in Table 4-62.

Conclusion

Table 4-61 indicates that for the existing waste sites, the no-waste-removal-and-closure action and the waste removal at selected sites action result in the largest decrease in cumulative health effects.

Table 4-62. Collective Cumulative Health Effects from Atmospheric and Liquid Releases for Alternative Actions for Disassembly-Basin Purge Water Discharge

TC

Component	Combination Detritiation	Elimination Evaporation	Direct discharge	No action
Atmospheric	2.9×10^{-2}	2.9×10^{-2}	2.9×10^{-2}	2.9×10^{-2}
Liquid	1.2×10^{-2}	1.1×10^{-2}	1.4×10^{-2}	1.2×10^{-2}
Combined	4.1×10^{-2}	4.0×10^{-2}	4.3×10^{-2}	4.1×10^{-2}

TC

For the new retrievable-storage or waste disposal alternatives, there is no significant change in the cumulative health effects.

As indicated in Table 4-62, for the discharge of disassembly-basin purge water, evaporation is the only alternative that could result in a decrease in cumulative health effects when the collective doses are confined to the regional population. The direct-discharge alternative results in the highest cumulative health effects.

TC

4.7.4.2 Exposure to Hazardous Substances

This section presents the cumulative health effects from exposure to hazardous substances. The majority of the cumulative health risks focus on the release of contaminants to the Savannah River with subsequent human exposure; however, because air and groundwater exposures could occur, they also are presented.

Existing Waste Sites

The Elimination strategy (waste removal at all sites) defines the lowest carcinogenic risk alternative for existing waste sites at the SRP as summarized in Table 4-63 for risks due to exposure via groundwater or surface water.

TC

Table 4-63. Carcinogenic Risks for Groundwater and Surface-Water Exposure (Elimination Strategy)

Exposure	Range of total risk (2085)		Range of maximum risk (year of occurrence)	
Groundwater	3.3×10^{-4} -	0	9.7×10^{-2} - (1997)	7.1×10^{-7} (2044)
Surface water	4.5×10^{-10} -	0	3.4×10^{-4} - (2026)	5.2×10^{-13} (2035)

TC

The maximum total risk associated with groundwater in 2085 occurs at the old TNX seepage basin. However, a maximum risk occurs at the CMP pits in 1997 due to the presence of tetrachloroethylene. By 2085, this risk would be reduced.

The maximum total risk for surface water in 2085 occurs at the CMP pits. The overall maximum risk is found at some of the burning/rubble pits (C- and CS-Areas). In 2026, the maximum risk would be due to the presence of trichloroethylene. These risks would be reduced by the year 2085.

TE Noncarcinogenic risks were also estimated. Most of the ratios of dose to ADI were less than 1, indicating little risk of noncarcinogenic (toxic) health effects. The ratio of dose to ADI did not exceed 1 in any surface waters and was usually less than 10^{-6}.

The air pathway was modeled through 2985 for both the exposed population and the maximally exposed individual. For the most part, individual health risks via the atmospheric pathway were low after implementation of the lower bound. Risks in a few areas were somewhat higher, but they decrease rapidly after 2085. These areas with high population risks include M-Area settling basin with an overall maximum risk of 2.34×10^{-3} in 2015, C-Area burning/rubble pit, and the old TNX seepage basin. Even where the risks to the population are highest, the risks for the maximally exposed individual are less than 10^{-8}. Individual risks apparently peak during site closure or waste removal activities, while the population risks peak in about 2085. After the site is reopened for habitation, risks rapidly reduce immediately and asymptotically approach zero.

New Retrievable-Storage Facilities

All new retrievable-storage facilities would be constructed to applicable (e.g., RCRA) regulations; therefore, no release of contaminants is expected. No adverse health effects are predicted.

Disassembly-Basin Purge Water

There are no releases of hazardous substances from current discharges or modifications of discharges of disassembly-basin purge water. Therefore, there would be no exposures or risks.

TE For the No-Action strategy, carcinogenic risks are somewhat higher than for the Elimination strategy. These risks are summarized in Table 4-64.

TC Table 4-64. Carcinogenic Risks for Groundwater and Surface-Water Exposure (No-Action Strategy)

TC

Exposure	Range of total risk (2085)	Range of maximum risk (year of occurrence)
Groundwater	7.5×10^{-3} - 0	2.1×10^{-1} (1993) - 1.2×10^{-5} (2001)
Surface water	4.5×10^{-10} - 0	2.4×10^{-4} (2026) - 5.2×10^{-13} (2035)

The maximum total risk associated with groundwater in 2085 would occur at the M-Area settling basin. However, a maximum risk would occur in 1993 due to the presence of tetrachloroethylene. By 2085, this risk is reduced by a factor of about 100.

The maximum total risk for surface water in 2085 would occur at the CMP pits. The overall maximum risk would be found at the burning/rubble pits. The maximum risk is 2.4×10^{-4} (which would occur in 2026), due to the presence of trichloroethylene. These risks are reduced by 2085.

Noncarcinogenic risks were also estimated. Most of the ratios of dose to ADI TC were less than 1, indicating little risk of noncarcinogenic (toxic) health effects. The ratio of dose to ADI did not exceed 1 in any surface waters and was usually less than 10^{-9}. Most potential noncarcinogenic health effects are associated with groundwater exposures (phosphate, nitrate, and mercury) in which the ratio of dose to ADI exceeds unity.

The air pathway was modeled through 2985 for both the exposed population and the maximally exposed individual. For the most part, individual health risks via the atmospheric pathway were low (less than 10^{-7}), even without remedial action. In a few cases, risks were somewhat higher, but they decrease rapidly after 2085.

Areas with high population risks include all the geographic areas except the Road A chemical basin. The maximum risks for the exposed population range from 3.4×10^{-3} to 1.4×10^{-4}. These peaks all occur in 1985 or 1986.

New Retrievable-Storage Facilities

All new retrievable-storage facilities would be designed and constructed to applicable (e.g., RCRA) regulations, and therefore no release of contaminants is expected. No adverse health effects are predicted.

Disassembly-Basin Purge Water

There are no releases of hazardous substances from current discharges or modifications of discharges of disassembly-basin purge water; therefore, there would be no nonradiological exposures or risks.

4.7.5 OTHER CUMULATIVE EFFECTS

This section discusses cumulative impacts from waste removal and closure at existing waste sites and the establishment of new retrievable-storage facilities, in conjunction with alternatives for disassembly-basin purge-water treatment and other existing or planned disposal and treatment facilities on the SRP. It also discusses additional cumulative impacts from offsite hazardous waste facilities and cumulative impacts affecting ecology, air quality, the socioeconomic structure, and archeological and historic resources.

4.7.5.1 Ecological

The Elimination strategy is not expected to have any aquatic ecological TC impacts, either directly or indirectly. At all existing sites, wastes would be removed, sites closed, and groundwater treated and released if required. New waste facilities would be designed on an essentially zero-release basis, so groundwater contamination would not occur.

Potential cumulative terrestrial impacts include the bioaccumulation of contaminants by plants growing in or near waste sites and the disruption of vegetation, wildlife, and their habitats. Because wastes would be removed from all existing waste sites under the Elimination strategy, the potential for bioaccumulation of contaminants by plants is insignificant. This also reduces the potential toxicological impact to wildlife that feed on the plants. Where new waste sites for retrievable storage of hazardous, mixed, or low-level wastes are proposed, land would be cleared and developed, disrupting existing vegetation, wildlife, and their habitats. The significance of these impacts cannot be determined until the areas to be disturbed are assessed ecologically. In terms of the overall SRP area, these land disruptions are insignificant. Disruption of wildlife would also occur due to the presence of human activities at existing and proposed waste sites. Such disruption would be of short duration at existing waste sites, and longer at new storage facilities.

No significant potential cumulative impacts to local wetlands are expected under the lower-bound alternative. Wetland communities on the SRP consist primarily of bottomland hardwood forests, with smaller acreages of cypress/tupelo, scrub/shrub, and emergent marsh communities (Jensen et al., 1982) along onsite streams and the Savannah River. Most waste sites are sufficiently removed from wetlands, and proposed remedial actions include erosion control measures. Significant impacts to wetlands are not expected to occur.

No potential impacts are expected to occur to threatened or endangered species, because no critical habitats or species have been found in the immediate vicinity of existing or proposed facilities.

TC Under the No-Action strategy, there is a potential for direct and indirect contamination of onsite streams, including the Savannah River. Based on the PATHRAE analysis performed for existing waste sites, particularly the radioactive waste burial ground and the F- and H-Area seepage basins, aquatic biota of Four Mile Creek could be affected adversely by concentrations of cadmium, chromium, lead, mercury, and tritium, because these are expected to exceed EPA aquatic biota criteria. Many onsite streams presently exceed these EPA criteria. The aquatic biota of these streams are probably being subjected to some stress under present conditions.

Potential cumulative terrestrial impacts under this alternative involve impacts to wildlife and vegetation that come into contact with contaminated waters and soils, which can result indirectly in a toxicological impact to wildlife if such plants are consumed. Wildlife can be impacted directly if they use standing contaminated waters at unfenced existing waste sites.

Potential minor impacts to wetlands could occur if contaminated waters in basins of existing waste sites overflow into nearby wetlands. The SRL seepage basins, the M-Area settling basin, and the old TNX seepage basin are near wetlands. Operation of the old TNX seepage basin has caused levels of mercury and gross beta to exceed the EPA aquatic biota criteria in the TNX swamp.

Onsite and Offsite Facilities

Onsite and offsite facilities include those cited in Sections 4.7.1.1 and through 4.7.1.4. The potential cumulative impacts to the environment from these facilities cannot be determined accurately, because little is known about their operations and releases. The Savannah River is presently above the aquatic biota criteria for lead, mercury, and silver, which is representative of existing water-quality conditions. Thus, aquatic biota of the river might already be subjected to stress as a result of all the facilities in the general area.

4.7.5.2 Air Quality

Air contaminants from potential sources other than the SRP are sufficiently distant that their effects on cumulative risk assessment would be negligible. Therefore, the risk assessments due to air releases discussed in Section 4.1 are considered applicable for cumulative effects for both onsite and offsite sources.

4.7.5.3 Socioeconomic

No more than 200 workers would be required for development of any of the proposed alternatives. Because these workers would be drawn from the existing construction workforce at the Plant, cumulative effects are expected to be negligible.

4.7.5.4 Archaeological and Historic Sites

No significant archaeological and historic sites have been identified at any of the existing waste sites or at any of the proposed alternative disposal/storage facilities. Therefore, the cumulative effects of implementing any of the alternatives are expected to be insignificant.

4.8 MITIGATION MEASURES

This section discusses mitigation measures that could reduce or offset potential environmental impacts and that are not part of the proposed action or alternatives (e.g., remedial action). Based on the identification of environmental consequences for the alternatives considered in the EIS, consideration might be given to the establishment of further programs to reduce radiological and nonradiological releases or to reduce potential ecological effects.

4.8.1 ENVIRONMENTAL CONSEQUENCES

The environmental consequences of the proposed action and alternatives are described fully in Sections 4.2, 4.3, and 4.4 for existing waste sites, new disposal facilities, and discharge of disassembly-basin purge water, respectively.

4.8.1.1 Existing Waste Sites

For the removal of wastes at selected existing waste sites, followed by closure and potentially required groundwater remedial actions (the preferred alternative), the environmental consequences, except for the No-Action strategy, during the 100-year institutional control period are largely beneficial. Health risk assessment and ecological impact modeling results generally are within or below acceptable ranges. Potential impacts to surface-water streams described in Section 4.7.5 are based on water-quality criteria that are nonenforceable concentration levels. Transient peak year health effects or established concentration standard (MCL) exceedances are fairly well defined and are postulated to occur briefly in groundwater (hypothetical wells) that is not currently used for onsite domestic supplies. Migration of these peak plume effects toward offsite receptors (i.e., the Savannah River) is predicted to occur in periods ranging from decades to centuries.

Through dilution or other physico-chemical or biological processes, it is reasonable to assume that order-of-magnitude reductions in health risk values or concentrations would occur. Modeling results for a 1000-year period have postulated these reductions. Implementation of short-term, immediate groundwater remedial actions would contain contaminated plumes, thereby preventing or reducing the extent of offsite migration of the plume.

Groundwater flow patterns mitigate any short-term migration of plumes to water supplies offsite. For example, the juncture of water-table aquifers in the northwest portion of the Plant with the deeper Middendorf/Black Creek or Congaree aquifers diverts the path of the potentially contaminated plumes TC through nearly a 90-degree change of flow direction that could result in ultimate discharge (after about 150 years) into the Savannah River or bordering swamps. Elsewhere on the Plant, water-table aquifers outcrop directly into onsite streams. Times of travel of plumes from seepage basins to outcrops vary from years to decades. Site dedication and exclusion ensure mitigation of potential environmental impacts well beyond the period of institutional control.

4.8.1.2 New Disposal Facilities

Construction and operation of new storage/disposal facilities under the preferred Combination strategy for hazardous, low-level radioactive, and mixed wastes that are designed to meet stringent regulatory requirements for essentially zero release would impose no permanent adverse impacts within the periods of operation (20 years), postclosure care, and monitoring during the 100 years of institutional control. Site dedication following closure would ensure maximum environmental protection in the long term.

4.8.1.3 Discharge of Disassembly-Basin Purge Water

Continuation of the discharge of disassembly-basin purge water to existing seepage and containment basins continues the current level of environmental releases and offsite doses of radioactivity.

4.8.2 MITIGATION MEASURES

4.8.2.1 Existing Waste Sites

Further mitigation of environmental consequences associated with the proposed action does not appear to be feasible with state-of-the-art technology.

However, many research and development studies are evaluating emerging technologies that show promise for future application. DOE would track these efforts to implement those technologies that offer future feasibility. The range of technologies should be directed toward the reduction of waste volumes, waste minimization through process charges, and the detoxification and destruction of retrievably stored hazardous wastes rather than toward an emphasis on permanent land burial or disposal. TC

The nature of radioactive waste, by contrast, does not lend itself to destruction or removal of the essential inherent radioactivity by direct physical, chemical, or biological means. Isolation, shielding, burial, and immobilization are currently the most reasonable alternatives for these wastes. Nevertheless, research and development efforts in the separation and fixation of radioactivity, particularly tritium, should be followed.

4.8.2.2 New Disposal Facilities

These facilities, by the nature of their design, would be essentially zero-release installations. Under the Combination strategy, as a mitigation measure, retrievable wastes would be available for future implementation of emerging technologies designed to destroy or detoxify hazardous, mixed, or low-level wastes.

4.8.2.3 Discharge of Disassembly-Basin Purge Water

Moderator detritiation through chemical or physico-chemical methods can be considered a mitigation measure. Other mitigative approaches that have been suggested are collection of tritiated groundwater at outcrops along surface streams and recycling of the water to seepage basins to allow another cycle of radioactive decay to occur; control of primary system heat-exchanger leakage; use of waste heat from various operations for barometric evaporation of tritiated streams; and vacuum evaporation with recovery.

4.9 UNAVOIDABLE/IRREVERSIBLE IMPACTS

4.9.1 STRATEGIES FOR EXISTING WASTE SITES

This section describes the adverse impacts of the strategies for the existing waste sites that cannot be avoided by reasonable mitigation measures. It also describes irreversible and irretrievable commitments of resources and short-term use and long-term productivity impacts of these strategies.

4.9.1.1 Unavoidable Adverse Impacts

Adoption of the No-Action strategy would result in the continued release of chemical and radionuclide contaminants from the existing waste sites. These releases are projected to result in contaminant concentrations in onsite groundwater and surface-water resources that exceed maximum contaminant levels established under the Safe Drinking Water Act. The groundwater contamination would occur at the following SRP areas: A, M, L, F, H, TNX, R, C, CS, K, P, and Road A. For surface-water resources, only nitrate and tritium in Four Mile Creek are expected to exceed maximum contaminant levels (Section 4.2.1 and Appendix F).

The carcinogenic and noncarcinogenic risks resulting from the release of non-radioactive chemicals have been calculated for the No-Action strategy. The maximum total carcinogenic risk at a well 100 meters downgradient from a waste site in 2085 (the year in which institutional site control is relinquished) would be 2.5 x 10^{-3} health effect per year at the M-Area settling basin. The maximum risk at a 100-meter well for tetrachloroethylene, the dominant carcinogenic chemical, would be 2.1 x 10^{-1} health effect per year in 1993 at the M-Area settling basin. The maximum total noncarcinogenic risk at a 100-meter well in 2085 would be 1.1 x 10^{2} times greater than the acceptable daily intake at the old TNX seepage basin. The maximum risk at a 100-meter well for nitrate, the dominant noncarcinogenic, would be 3.8 x 10^{2} times greater than the acceptable daily intake in 1991 at the M-Area settling basin (Section 4.1.1.6 and Appendix J).

The adverse health effects of the nonradioactive contaminants for the atmospheric pathway have been assessed for an exposed population and a maximally exposed individual. The maximum carcinogenic risk for the exposed population under the No-Action strategy would be 3.4 x 10^{-3} health effect per year in 1986 at the SRL seepage basins. The maximum carcinogenic risk for the maximally exposed individual would be 1.4 x 10^{-7} health effect per year in 2085 at the H-Area seepage basins. The maximum total noncarcinogenic risk for an exposed population would be 1.9 x 10^{1} times the acceptable daily intake in 2085 at the H-Area seepage basins. The maximum total noncarcinogenic risk for a maximally exposed individual would be 4.8 x 10^{-3} of the acceptable daily intake in 2085 at the H-Area seepage basins (see Section 4.2.1.6 and Appendix J).

The health risks associated with the release of radioactive contaminants under the No-Action strategy have also been determined. These health risks consist of radiation-induced cancers and genetic disorders. The cumulative health risks to the maximally exposed individual residing at the SRP boundary during 1985 and within the SRP site boundary during the peak year (2085) would be 9.8 x 10^{-7} and 3.9 x 10^{-4} health effects per year, respectively. The annual cumulative number of health effects imparted to the population in the SRP region, in 1985 and in 2085, would be 9.5 x $10^{-3}$and 5.3 x 10^{-3} health effects per year, respectively (see Section 4.2 and Appendix I).

Adverse impacts to ecological resources could also occur under the No-Action strategy. Analyses indicate that Four Mile Creek could be affected adversely by concentrations of several contaminants that exceed EPA water-quality criteria for aquatic life. The use of open basins by aquatic organisms and terrestrial wildlife could also result in direct exposure to contaminants. The impacts associated with chronic exposures and potential biological accumulation are unknown. Wetland areas that are immediately adjacent to the SRL and M-Area seepage basins could also be affected by basin overflow during heavy rains (see Section 4.2 and Appendix F).

The closure and remedial actions that would occur under the strategies other than no action would reduce nonradioactive and radioactive contaminant releases via the groundwater, surface-water, and atmospheric pathways to within regulatory standards. Associated health effects would also be reduced from those anticipated under the No-Action strategy. However, adverse impacts could occur as a result of the implementation of closure and remedial actions.

Closure actions could include the backfilling of selected basins. Disruption of terrestrial habitats and effects on natural productivity could occur at the closure sites and other SRP areas from the creation of new or the expansion of existing borrow pits for backfill materials. Also, these operations would have associated occupational risks. Remedial action could include groundwater withdrawal and treatment at selected sites. Groundwater withdrawal would result in the drawdown of water-table aquifers. However, this drawdown would be small and localized and would not affect SRP drinking-water wells. The effluent from the groundwater treatment facilities could be discharged to local onsite streams. The subsequent increased flows in the receiving streams could cause changes in their ecologic structure. Further study would be required to quantify the potential impacts from closure and remedial actions.

4.9.1.2 Irreversible and Irretrievable Commitments of Resources

Resources that would be irreversibly and irretrievably committed during the implementation of the existing waste site strategies include (1) materials that cannot be recovered or recycled and (2) materials consumed or reduced to unrecoverable forms. For the actions under consideration, irretrievable resource use would include contaminated materials and equipment that could not be reused and energy consumed during the closure and remedial actions. However, the current level of planning for the existing waste site strategies does not permit a quantification of these resource consumption rates.

4.9.1.3 Short-Term Uses and Long-Term Productivity

The short-term effects of the existing waste site strategies would include the loss of upland sites for their natural productivity. The amount of uplands required for borrow pits and remedial actions has not been determined but would be expected to be minimal. In the long term, the natural vegetation at these sites could become reestablished through the process of natural succession. In addition, the land (about 300 acres) associated with certain waste sites would remain dedicated to waste disposal under the No-Action strategy.

4.9.2 STRATEGIES FOR NEW DISPOSAL FACILITIES

This section describes the adverse impacts of the strategies for the new disposal facilities that cannot be avoided by reasonable mitigation measures. It also describes irreversible and irretrievable commitments of resources and short-term use and long-term productivity impacts of these strategies.

4.9.2.1 Unavoidable Adverse Impacts

Construction and operation of new disposal facilities would impact undeveloped upland areas on the SRP. The clearing of this land could be expected to result in the loss of wildlife habitat, the loss of animals with limited home ranges, and the redistribution of more mobile species. The land requirements for new disposal facilities would require a maximum of about 400 acres.

There will be an unavoidable contribution to the radiological dose received by individuals who are downstream Savannah River water users and by persons living on the SRP site following institutional control. Based on conservative modeling and summation of peak doses, the downstream contribution amounts to less than one ten-thousandth of the 4 millirem per year drinking-water dose standard. For onsite residents (after institutional control) doses would be higher but are still expected to remain well under the 4 millirem/year standard. Radiological doses under the No-Action strategy were not modeled but could result in substantially higher values in the event of a large accidental release.

Under the No-Action strategy, wastes would continue to be disposed of in existing facilities until the capacities of these facilities had been attained. After that, the wastes would be stored onsite in the safest manner possible without the construction of new facilities. The release of hazardous or radioactive constituents and the associated health and environmental effects would be insignificant as long as no leaks or spills occurred. However, because the release-containment systems required in RCRA and Atomic Energy Act (AEA) facilities would not be present at the no-action facilities, the risk of serious accidental release would be much greater than for any of the other strategies.

4.9.2.2 Irreversible and Irretrievable Commitments of Resources

Resources that would be irreversibly and irretrievably committed during the implementation of the new disposal facilities include materials that cannot be recovered or recycled, and materials consumed or reduced to unrecoverable forms. For the actions under consideration, irretrievable resources would include contaminated materials and equipment that could not be reused and energy consumed during the construction and operation of the facilities. However, the current level of planning for the new disposal facilities does not make it possible to quantify these resource-consumption rates.

4.9.2.3 Short-Term Uses and Long-Term Productivity

In the short term, the construction and operation of the facilities would affect up to 400 acres of uplands. Over the long term, upland vegetation could become reestablished through the process of natural succession only with the Elimination strategy. For the Dedication and Combination strategies, the associated land would remain dedicated to waste disposal.

4.9.3 STRATEGIES FOR DISCHARGE OF DISASSEMBLY-BASIN PURGE WATER

Four strategies are considered for the discharge of disassembly-basin purge water: No-Action, Dedication, Elimination, and Combination. They are discussed in detail in Sections 2.4 and 4.4. This section discusses impacts associated with the strategies that could not be avoided by reasonable mitigation measures. It also discusses irreversible and irretrievable commitments of resources, short-term uses, and long-term environmental implications.

4.9.3.1 Unavoidable Adverse Impacts

The discharge of disassembly-basin purge water would lead to unavoidable radiation exposure to man, regardless of which strategy is implemented. These exposures would be negligible in comparison to those associated with natural background radiation. Section 4.4 presents the estimated radiation exposures to man associated with each strategy.

4.9.3.2 Irreversible and Irretrievable Commitments of Resources

Resources that would be irreversibly and irretrievably committed with the implementation of a particular strategy include materials that cannot be recovered or recycled, and materials consumed or reduced to unrecoverable forms. The implementation of a particular strategy would require irretrievable commitments of energy. The actual amount of committed energy required would depend on the final engineering design. Small amounts of radioactive waste could require land commitment for final disposal.

4.9.3.3 Short-Term Uses and Long-Term Productivity

Short-term effects of waste management operation include the unavailability of site areas for natural productivity and wildlife habitat. Detritiation would require the greatest site area, with the construction of the moderator detritiation plant. The implementation of evaporation would also require a relatively large commitment of area for either the construction of an evaporation pond or the installation of commercial evaporators. Direct discharge would require only the area needed to pipe water from the reactors to onsite streams. No action would require the commitment of the seepage basins currently in use. Following decommissioning and decontamination, the area could revert to its natural state with minimal long-term effects.

4.10 PREFERRED ALTERNATIVE WASTE MANAGEMENT STRATEGY

4.10.1 RATIONALE FOR SELECTION

DOE has identified the Combination waste management strategy as its preferred alternative. This strategy provides compliance with applicable environmental regulations (RCRA, Hazardous and Solid Waste Amendments of 1984, and South Carolina Hazardous Waste Management Act) and DOE guidelines through combinations of site dedication, elimination of selected waste sites, and storage and disposal of hazardous, low-level radioactive, and mixed wastes. DOE's preferred waste management strategy is based on lower tier project-level actions, including removal of wastes at selected existing waste sites; remedial and closure actions at existing waste sites, as required; the construction of retrievable storage and aboveground or belowground disposal facilities for hazardous, mixed, and low-level radioactive wastes; and the management of periodic discharges of disassembly-basin purge water from C-, K-, and P-Reactors by discharging filtered, deionized disassembly-basin purge water to active reactor seepage and containment basins.

4.10.1.1 Existing Waste Sites

The primary considerations in choosing the preferred waste management strategy are the reduced environmental effects and occupational risks from remedial and closure actions, the cost of remedial and closure actions, the capacity and cost of new storage and disposal facilities, and the amount of land, if any, that would be dedicated to waste management at the end of the institutional control period.

4.10.1.2 New Disposal Facilities

The preferred strategy would apply a combination of retrievable storage and aboveground or belowground disposal technologies to optimize the management of wastes with different characteristics within the hazardous, mixed, and low-level radioactive waste streams generated at the SRP. The implementation of this strategy would comply with the requirements of RCRA, HSWA, SCHWMA, and DOE Orders.

The Combination strategy for the construction of new storage and disposal facilities for the management of hazardous, mixed, and low-level radioactive waste consists of:

TE 1. Buildings for retrievable storage of selected wastes of all three types

2. RCRA landfill or vaults for the disposal of hazardous waste

TC 3. RCRA landfills or vaults, including or not including CFM vaults, for the disposal of mixed waste

4. ELLTs, vaults, or AGOs for the disposal of low-activity radioactive wastes

5. Vaults or GCD for the disposal of intermediate-activity, low-level radioactive wastes.

Optional technologies in Items 2 and 5 are considered equivalent in terms of groundwater protection capabilities. Options that include CFM vaults in Item 3 and ELLTs in Item 4 were selected to represent the minimium or least protective technology in their waste management roles. The environmental impacts of the Combination strategy lie within each of the categories listed. No preference has been determined among technologies, although DOE is placing emphasis on the concept and use of vaults. TC

4.10.1.3 Discharge of Disassembly-Basin Purge Water

The Combination strategy includes the continued discharge of disassembly-basin purge water to active reactor seepage and containment basins and the pursuit of studies to assess reactor moderator detritiation or other mitigation measures. This EIS discusses moderator detritiation to provide an estimate of costs and a description of beneficial or mitigative impacts.

4.10.2 ADVANTAGES

4.10.2.1 Existing Waste Sites

TC Waste removal at selected sites, closure, and remedial actions would have lower costs, insignificant ecological effects, and fewer occupational risks than full-scale waste removal and closure actions and would require less storage and disposal capacity. At the sites tentatively selected for waste removal, the concentrations and extent of constituents in the groundwater that are above regulatory standards could be reduced significantly. Only a small fraction of SRP land would require dedication for waste management purposes at the end of the institutional control period.

4.10.2.2 New Disposal Facilities

The advantages of the preferred strategy are:

- Waste disposal would be permanent.
- Disposal would comply with applicable regulations.
- Facilities would comply with environmental standards.
- Storage of wastes would comply with applicable regulations, assuming waivers on long-term storage would be granted.
- A mix of disposal and storage technologies could be selected to optimize performance and minimize cost.

TC

4.10.2.3 Discharge of Disassembly-Basin Purge Water

The continued discharge of disassembly-basin purge water to seepage basins and the continued assessment of tritium-mitigation measures, such as reactor moderator detritiation, result in the lowest off-site doses and allow for continued evaluation of future mitigation options. Annual off-site doses due to tritium could be reduced substantially. No additional costs or equipment for continued discharge are required.

TC

4.10.3 DISADVANTAGES

4.10.3.1 Existing Waste Sites

The primary disadvantage of the preferred strategy is that dedication for waste management purposes would be required for those sites in which waste was not removed and that could not be returned to public use after the institutional control period.

4.10.3.2 New Disposal Facilities

The disadvantages of new disposal facilities are twofold:

- The high cost of construction and operation, some land dedication, and grouting of waste packages could make retrieval difficult in the event it became necessary.
- Additional costs would be required in future for treatment and disposal of wastes placed in retrievable storage.

4.10.3.3 Discharge of Disassembly-Basin Purge Water

A disadvantage of mitigation of tritium releases is the continued contamination of shallow groundwater resources. A long lead time is associated with continued studies and implementation of feasible measures. Optimistic estimates for detritiation to reach its full potential range from 5 to 10 years.

TC

4.10.4 ENVIRONMENTAL IMPACTS

4.10.4.1 Groundwater

Existing Waste Sites

The implementation of the preferred strategy at selected existing waste sites, plus closure and remedial actions as required, would reduce onsite groundwater contaminant concentration levels to meet applicable standards. Potential drawdown effects in water-table aquifers would be localized and transitory and would be observed throughout groundwater remedial actions that employed recovery wells or groundwater pumping.

New Disposal Facilities

All new disposal and storage facilities would be designed for essentially zero or ALARA releases. No significant adverse groundwater effects are expected as a result of the implementation of the preferred strategy.

Discharge of Disassembly-Basin Purge Water

The continued discharge of disassembly-basin purge water to active reactor seepage and containment basins would maintain the current level of effects to groundwater. An assessment of mitigation measures for tritium releases, such as reactor moderator detritiation, could result in the establishment of feasible technologies in the future that would reduce tritium concentrations.

4.10.4.2 Surface Water

Existing Waste Sites

The implementation of the preferred alternative could result in an improvement of surface-water quality. Waste removal, closure, and remedial activities, if required, would reduce the level of surface-water contaminant concentrations to regulatory limits or below.

New Disposal Facilities

No significant impacts to surface-water quality are expected with the implementation of the preferred alternative strategy. The goals of RCRA (i.e., essentially no releases from hazardous or mixed waste facilities) and the ALARA concept for low-level radioactive waste facilities would ensure insignificant levels of impact.

Discharge of Disassembly-Basin Purge Water

Existing surface-water effects from groundwater outcrops of reactor seepage basin subsurface flows would continue. Travel times vary from 4 to 11 years, allowing for partial radioactive decay of the tritium (12.3-year half-life). Transport modeling indicates there is little lateral dispersion of migrating tritium in these paths. Detritiation or other mitigation measures, if applicable, would result in a reduction of tritium concentrations in onsite streams.

4.10.4.3 Health Effects

Existing Waste Sites

The implementation of the preferred alternative would result in no increase in health effects with waste removal, closure, and remedial actions at existing waste sites.

New Disposal Facilities

Essentially zero release and the ALARA design would prevent radionuclide and hazardous chemical health effects.

Discharge of Disassembly-Basin Purge Water

No significant health effects would occur as a result of the continued discharge of disassembly-basin purge water to active reactor seepage and containment basins.

4.10.4.4 Ecology

Existing Waste Sites

The removal of wastes at selected sites and closure and remedial actions, as required, would reduce potential aquatic impacts as a result of the implementation of the preferred alternative strategy. Terrestrial impacts that result from direct exposure to open waste sites and groundwater-associated impacts would be eliminated by waste removal at selected sites and closure and remedial actions as required. The use of borrow pits for backfill in closure actions would create minor short-term terrestrial impacts.

New Disposal Facilities

No aquatic impacts are expected from the implementation of the preferred strategy for new disposal and storage facilities. The strategy would result in minor short-term impacts from the clearing and development of land. No contaminant-related terrestrial impacts are expected, due to zero release or ALARA designs of new facilities.

Discharge of Disassembly-Basin Purge Water

Minor aquatic impacts would continue, as at present, under continued or mitigated discharge to active reactor seepage and containment basins. No significant terrestrial ecological impacts are expected.

4.10.4.5 Other Impacts

Existing Waste Sites

Short-term disruptions of habitats could occur at borrow pit areas. Some waste sites could require erosion-control measures during site-closure activities. No impacts are expected to endangered species, archaeological and historic sites, or socioeconomic resources, or from noise as a result of the implementation of the preferred strategy.

New Disposal Facilities

Construction of disposal and storage facilities for the preferred strategy would result in a loss of habitat totaling up to 400 acres, or about 0.2 percent of the entire SRP natural area. No impacts are expected for endangered species, socioeconomic resources, nor are any noise-related impacts anticipated. One candidate waste-disposal site would require an additional archaeological survey.

Discharge of Disassembly-Basin Purge Water

No significant impacts to habitats or wetlands are expected from the implementation of the preferred strategy. Endangered species, archaeological and historic sites, and socioeconomic resources would not be impacted, nor would there be noise-related impacts.

4.10.5 ACCIDENTS AND OCCUPATIONAL RISKS

4.10.5.1 Existing Waste Sites

Waste removal and transport to storage and disposal sites by vehicles involve the risks of fires, spills, leaks, and exposure of onsite workers. These are short-term risks, occurring only during waste-removal activities.

4.10.5.2 New Disposal Facilities

High-integrity containers, spill recovery, and other secure provisions would reduce contaminant-related impacts from accidents. Long-term handling of wastes (20-year estimated facility lifetimes) requires strict control measures.

4.10.5.3 Discharge of Disassembly-Basin Purge Water

No significant occupational risks are associated with the preferred alternative.

4.10.6 SITE DEDICATION

4.10.6.1 Existing Waste Sites

Sites from which waste was removed could be returned to public use after the 100-year institutional control period. Sites from which waste was not removed would be dedicated for waste management purposes if they could not be returned to public use.

4.10.6.2 New Disposal Facilities

New disposal facilities would be dedicated for waste management purposes. Up to 400 acres, including buffer zones, would be required, except for the retrievable-storage-facility portion, which could be returned to public use after wastes had been removed to permanent disposal facilities.

4.10.6.3 Discharge of Disassembly-Basin Purge Water

Seepage and containment basins would be dedicated as needed due to the continued discharge of disassembly-basin purge water to these basins. The implementation of feasible mitigation measures would allow DOE to discontinue the use of the basins and evaluate actions to return them and their surrounding areas to public use after the 100-year institutional control period.

Table 4-14. Total Noncarcinogenic Risks for No-Action, Groundwater/Surface-Water Pathway in Each Geographic Grouping

Worst-case site	Hazard index, 2085 exposures				Maximum risk for dominant noncarcinogenic chemical Hazard index (year of peak exposure)			
	1-meter well	100-meter well	River outfall	Reclaimed farm	1-meter well	100-meter well	River outfall	Reclaimed farm
M-Area settling basin	5.2×10^{-3}	4.0×10^{-2}	0	2.3×10^{-1}	6.2×10^{2} (1991) Nitrate	6.2×10^{2} (1990) Nitrate	NS[a]	2.2×10^{-1} (2085) Mercury
Mixed waste management facility and old radioactive waste burial grounds	7.5×10^{-1}	4.6	NS	1.4	6.9×10^{1}(b) (1987) Nitrate	6.9×10^{1}(b) (1987) Nitrate	NS	9.5(b) (2085) Mercury
R-Area burning/rubble pit(d)	NS	NS	NS	2.1×10^{-2}(c)	2.9×10^{0}(c) (1971) Sulfate	2.9×10^{0}(c) (1971) Sulfate	NS	2.1×10^{-2}(c) (2085) Mercury
Ford building seepage basin	NS	NS	NS	1.2×10^{-2}	4.5[e] (1975) Fluoride	9.5×10^{-1}(e) (1977)	NS	1.2×10^{-2} (2085) Mercury
New TNX seepage basin	2.4×10^{-1}	3.4×10^{-3}	NS	1.8×10^{0}(g)	2.5×10^{2} (1987) Nitrate	1.4×10^{2}(g) (1986) Nitrate	NS	1.8×10^{0} (2085) Mercury
Road A chemical basin	NS	NS	NS	NS	5.4×10^{-1} (1975) Lead	4.1×10^{-1} (1980) Lead	NS	NS
K-Area burning/rubble pit(d)	NS	NS	NS	2.1×10^{-2}(c)	2.9×10^{0}(c) (1971) Sulfate	2.9×10^{0}(c) (1971) Sulfate	NS	2.1×10^{-2}(c) (2085) Mercury
L-Area oil & chemical basin	2.2	2.1×10^{-1}	NS	2.0×10^{-2}	4.8×10^{0}(f) (2012) Silvex	2.7×10^{0}(f) (2016) Silvex	NS	2.0×10^{-2} (2085) Mercury
P-Area burning/rubble pit(d)	NS	NS	NS	2.1×10^{-2}(c)	2.9×10^{0}(c) (1971) Sulfate	2.9×10^{0}(c) (1971) Sulfate	NS	2.1×10^{-2}(c) (2085) Mercury

[a] NS = Not significant; hazard index is less than 1.0×10^{-2}.
[b] Values reported are for the F-Area seepage basins.
[c] Values are for L-Area acid/caustic basin.
[d] Values are for C-Area burning/rubble pit.
[e] Values reported are for the hydrofluoric acid spill area.
[f] Values reported are for the CMP pits.
[g] Values reported are for the Old TNX Seepage Basin.
[h] Values reported are for the H-Area seepage basins.

TC

Table 4-15. Total Nonradiological Carcinogenic Risks for No Action, Groundwater/Surface-Water Pathway in Each Geographic Grouping

Worst-case site	Risks[a], 2085 Exposures[b]				Maximum risk[a] for dominant carcinogenic chemical (year of peak exposure)			
	1-meter well	100-meter well	River outfall	Reclaimed farm	1-meter well	100-meter well	River outfall	Dominant chemical
M-Area settling basin	4.9×10^{-5}	3.8×10^{-4}	0	3.8×10^{-8}	1.6×10^{-1} (2021)	1.6×10^{-1} (2020)	7.0×10^{-8} (2199)	Tetrachloroethylene
F-Area burning/rubble pit[c]	NS[d]	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
R-Area burning/rubble pit[c]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene[c]
C-Area burning/rubble pit	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
D-Area oil basin	NS	4.8×10^{-8}	NS	0	$1.7 \times 10^{-4(c)}$ (1978)	$1.6 \times 10^{-4(c)}$ (1978)	NS	Trichloroethylene
Road A chemical basin	0	0	0	0	0	0	0	
K-Area burning/rubble pit[c]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
CMP pits	1.1×10^{-7}	1.2×10^{-6}	NS	0	1.0×10^{-2} (1997)	6.0×10^{-3} (2000)	NS	Tetrachloroethylene
P-Area burning rubble pit[c]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene

[a] Risk = incremental lifetime probability of death from cancer.
[b] 50-year exposure period following 2085.
[c] Values reported are for C-Area burning/rubble pit.
[d] NS = Not significant; risk is less than 1.0×10^{-8}

TC

Table 4-16. Risks[a] to the Population and the Maximally Exposed Individual Attributable to Atmospheric Nonradiological Carcinogens for No Action

	1985 releases			2085 releases			2985 releases		
Site	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor
SRL seepage basins	1.33×10^{-3}	2.3×10^{-8}	Chromium VI, Arsenic	6.51×10^{-5}	1.61×10^{-8}	Chromium VI	NS[b]	NS	-
F-Area seepage basins	1.97×10^{-5}	NS	Chromium VI	4.56×10^{-6}	NS	Chromium VI	NS	NS	-
Radioactive burial grounds	0	0	-	0	0	-	0	0	-
Silverton Road waste site	NS	NS	-	NS	NS	-	0	0	-
HFI spill area	-	-	-	-	-	-	-	-	-
CMP pit 19G	0	0	-	0	0	-	0	0	-
CMP pit 18.3G	2.71×10^{-8}	NS	Chloroethylene	NS	NS		0	0	-
CMP pits 18.1G or 18.2G	3.58×10^{-8}	NS	Trichloroethylene	NS	NS	-	0	0	-
CMP pit 17.1G	0	0	-	0	0	-	0	0	-
CMP pit 17G	1.21×10^{-5}	NS	Toxaphene	NS	NS	-	0	0	-
Old TNX seepage basin	NS	NS	-	NS	NS	-	0	0	-
Old TNX seepage basin outfall	1.33×10^{-4}	NS	Chromium VI	4.44×10^{-5}	1.10×10^{-8}	Chromium VI	NS	NS	-
Motor shop oil basin	-	-	-	-	-	-	-	-	-
SRP oil test site	-	-	-	-	-	-	-	-	-
Gunsite 720 rubble pit	-	-	-	-	-	-	-	-	-
Metallurgical laboratory basin	9.01×10^{-6}	NS	Chromium VI	1.98×10^{-6}	NS	Chromium VI	NS	NS	-
Lost Lake	3.50×10^{-5}	NS	Chromium VI	7.64×10^{-6}	NS	Chromium VI	NS	NS	-
M-Area overflow ditch and adjacent seepage area	2.15×10^{-4}	NS	Nickel	1.66×10^{-4}	4.11×10^{-8}	Nickel	2.36×10^{-8}	NS	Nickel
L-Area oil and chemical basin	5.88×10^{-4}	NS	Chromium VI	1.49×10^{-4}	3.70×10^{-8}	Chromium VI	NS	NS	-
D-Area oil basin	NS	NS	-	NS	NS	-	0	0	-
M-Area air stripper	8.98×10^{-4}	1.51×10^{-8}	Trichloroethylene	-	-	-	-	-	-

Footnotes on last page of table.

TC

Table 4-16. Risks[a] to the Population and the Maximally Exposed Individual Attributable to Atmospheric Nonradiological Carcinogens for No Action (continued)

Site	1985 releases			2085 releases			2985 releases		
	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor
M-Area settling basin and process sewerline	2.35×10^{-4}	NS	Nickel	1.98×10^{-4}	4.92×10^{-8}	Nickel	1.77×10^{-8}	NS	Nickel
H-Area seepage basin	2.25×10^{-4}	NS	Chromium VI	5.52×10^{-5}	1.37×10^{-8}	Chromium VI	NS	NS	
Ford Building seepage basin	7.8×10^{-6}	NS	Chromium VI	1.8×10^{-6}	NS	Chromium VI	NS	NS	-
Road A chemical basin	-	-	-	-	-	-	-	-	-
Acid/caustic basins	6.32×10^{-6}	NS	Arsenic, Chromium VI	6.05×10^{-7}	NS	Chromium VI	NS	NS	-
Old F-Area seepage basin	7.21×10^{-7}	NS	Cadmium, Chromium VI	4.68×10^{-8}	NS	Chromium VI	NS	NS	-
New TNX seepage basin	1.37×10^{-5}	NS	Chromium VI	7.13×10^{-6}	NS	Chromium VI	NS	NS	-
Burning/rubble	3.31×10^{-5}	NS	Chromium VI	7.54×10^{-6}	NS	Chromium VI	NS	NS	-
Metals burning pit	NS	NS	-	NS	NS	-	NS	NS	-
TOTAL[c]	3.75×10^{-3}	5.59×10^{-8}		7.08×10^{-4}	1.72×10^{-6}		4.72×10^{-8}	NS	

TC

[a] Risks to the population are the number of excess cancers; risks to the maximally exposed individual are the excess lifetime cancer probabilities.

[b] NS = Not significant, incremental lifetime risk to the maximally exposed individual is less than 1.0×10^{-8}; associated risk to the population is also not significant.

[c] Total risks include contributions from sites designated NS.

Table 4-19. Peak Concentrations for Dedication Strategy, A- and M-Area

Waste management facility	Site number	PATHRAE – peak concentration[a]									
		Chemicals (mg/L)									Radionuclides (pCi/L)
		As	Ba	Cd	Ni	NO_3	Trichloroethylene	Tetrachloroethylene	Tetrachloromethane	1,1,1-trichloroethane	H-3
Metals burning pit	1-2	(b)	(b)	(b)	(b)	(b)	0.1 (1978)	0.0021 (1980)	(b)	(b)	(b)
Silverton Road waste site	1-3	(b)	(b)	(b)	(b)	(b)	0.13 (1976)	0.14 (1979)	(b)	(b)	(b)
Metallurgical laboratory basin	1-4	(b)	(b)	(b)	(b)	(b)	0.0067 (2086)	(b)	0.38 (2086)	(b)	(b)
Miscellaneous chemical basin	1-5	(b)	(b)	(b)	(b)	(b)	(b)	100 (2024, 2033)	(b)	(b)	(b)
A-Area burning/rubble pits	1-6, 1-7	(b)	(b)	(b)	(b)	(b)	1.9 (1978)	(b)	(b)	(b)	(b)
SRL seepage basins	1-8, 1-9, 1-10, 1-11	0.073 (2435)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	3.2×10^5 (1962)
M-Area settling basin and vicinity	1-12, 1-13	(b)	1.8 (2532)	0.018 (2570)	0.039 (2052)	2900 (2052)	18 (2058, 2059[d])	91 (2072)	(b)	1.2 (2058, 2057[d])	(b)
Standard[c]		0.05	1.0	0.01	0.013	10	0.005	0.0007	0.005	0.2	8.7×10^4

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: EPA, 1985a, 1985b (tetrachloroethylene), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year.

[d] At 100-meter well.

TC

Table 4-20. Peak Concentrations for Dedication Strategy, F- and H-Area

Waste management facility	Site number	PATHRAE - Peak chemical concentrations (mg/L)[a]				
		Pb	Hg	NO_3	Trichloroethylene	Tetrachloroethylene
F-Area acid/caustic basin	2-1	0.054 (1971)	(b)	(b)	(b)	0.094 (1971)
H-Area acid/caustic basin	2-2	0.054 (1971)	(b)	(b)	(b)	0.094 (1971)
F-Area burning/rubble pits	2-3, 2-4	(b)	(b)	(b)	1.9 (1978)	(b)
Rad/mixed waste burial grounds	2-7, 2-8 2-9	1.9 (1957)	0.0065 (1957)	(b)	(b)	(b)
F-Area seepage basins	2-10, 2-11 2-12	(b)	(b)	1000 (1987)	(b)	(b)
F-Area seepage basin (old)	2-13	(b)	(b)	1600 (1956)	0.58	(b)
H-Area seepage basin	2-14, 2-15 2-16, 2-17	(b)	(b)	480 (1985)	(b)	(b)
Standard[c]		0.05	0.002	10	0.005	0.0007

TC

Footnotes on last page of table.

Table 4-20. Peak Concentrations for Dedication Strategy, F- and H-Area (continued)

Waste management facility	Site number	PATHRAE - Peak radionuclide concentrations (pCi/L)[a]												
		Sr-90	Y-90	Ni-63	Co-60	Tc-99	Cs-134	Cs-137	U-238	Pu-238	Pu-239	Np-237	H-3	I-129
H-Area retention basin	2-6	3800 (2021)	3800 (2021)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Rad/mixed waste burial grounds	2-7, 2-8 2-9	1000 (1957)	1000 (1957)	4.4×10^5 (1957)	2500 (1957)	1.3×10^4 (1957)	230 (1957)	940 (1957)	41 (1957)	670 (1957)	83 (1957)	(b)	2.1×10^9 (1957)	(b)
F-Area seepage basins	2-10, 2-11 2-12	(b)	(b)	(b)	(b)	(b)	(b)	(b)	48 (2985)	(b)	(b)	(b)	4.5×10^7 (1957)	88 (2036)
F-Area seepage basin (old)	2-13	(b)	(b)	(b)	(b)	(b)	(b)	(b)	310 (2370)	(b)	(b)	(b)	(b)	(b)
H-Area seepage basin	2-14, 2-15 2-16, 2-17	1800 (1975)	1800 (1975)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	0.90 (2735)	1.9×10^7 (1956)	130 (2008)
Standard[c]		42	550	1.0×10^4	210	4200	74	110	24	14	13	0.14	8.7×10^4	20

TC

TC

---

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: EPA, 1985a, 1985b (tetrachloroethylene), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year.

Table 4-1. Common Risks

Risk of death	Occupation	Lifestyle	Accidents	Environmental
1 in 100 (10^{-2})	Stuntman	-	-	-
1 in 1000 (10^{-3})	Race car driver Fireman Miner Farmer Policeman	Smoking (1 pack a day)	Skydiving Rockclimbing Canoeing Driving motor vehicle	-
1 in 10,000 (10^{-4})	Truck driver Engineer Banker Insurance agent	Heavy drinking	All home accidents Frequent air travel	-
1 in 100,000 (10^{-5})	-	Use of contraceptive pills Light drinking Diagnostic X-rays	Skiing Home fires Fishing Poisoning	Substances in drinking water Living below dam Natural background radiation
1 in 1,000,000 (10^{-6})	-	Smallpox vaccination Eating charcoaled steak, one per week	Occasional air travel (one flight per year)	Living next to nuclear power plant Hurricane, tornado Lightning
1 in 10,000,000 (10^{-7})	-		-	Animal bite or insect sting

Adapted from: EPRI Journal, July/August 1985

TC

Table 4-3. Peak Concentrations at 100-Meter Well for No Action, A- and M-Areas

Waste management facility	Site number	PATHRAE peak concentrations[a]										
		Chemicals (mg/L)										Radionuclides (pCi/L)
		As	Ba	Cd	Pb	Ni	NO_3	Tetrachloroethylene	Tetrachloromethane	1,1,1-Trichloroethane	Trichloroethylene	H-3
Metals burning pit	1-2	(b)	(b)	(b)	(b)	(b)	(b)	0.0019[c] (1994)	(b)	(b)	0.91[c] (1989)	(b)
Silverton Road waste site	1-3	(b)	(b)	(b)	0.0074 (1980)	(b)	(b)	0.076[c] (1985)	(b)	(b)	0.071[c] (1982)	(b)
Metallurgical laboratory	1-4	(b)	(b)	(b)	0.0031 (1993)	(b)	(b)	(b)	1.6[c] (1994)	0.52[c] (1991)	0.026[c] (1992)	(b)
Misc. chemicals basins	1-5	(b)	(b)	(b)	(b)	(b)	(b)	220[c] (1991)	(b)	(b)	(b)	(b)
A-Area burning/ rubble pit[d]	1-6, 1-7	(b)	(b)	(b)	0.038 (1982)	(b)	(b)	(b)	(b)	(b)	1.8[c] (1983)	(b)
SRL seepage basins	1-8 to 1-11	0.21[c] (2135)	(b)	0.0024 (2295)	0.0079 (1988)	0.0004 (1988)	(b)	(b)	(b)	(b)	(b)	200,000[c] (1968)
M-Area settling basin	1-12, 1-13	(b)	3.7[c] (2261)	0.031[c] (2318)	0.074[c] (1991)	0.12[c] (1990)	9200[c] (1990)	170[c] (2020)	(b)	4.1[c] (1990)	62[c] (1991)	(b)
Sum of concentrations		0.21[c]	3.7[c]	0.033[c]	0.13[c]	0.12[c]	9200[c]	390[c]	1.6[c]	4.6[c]	64.[c]	200,000[c]
Standard[e]		0.05	1.0	0.010	0.050	0.013	10	0.0007	0.005	0.200	0.005	87,000

TC

[a] Year of peak concentration shown in parentheses. Years prior to 1985 are indications of present conditions.
[b] Constituent did not meet threshold selection criteria for PATHRAE modeling.
[c] Concentration exceeds regulatory standards.
[d] Concentrations are from PATHRAE modeling for largest inventory waste management unit in this functional grouping; actual peak concentrations are dependent on the inventory of this unit.
[e] Sources: EPA, 1985a, 1985b (tetrachloroethylene health-based standard), and EPA, 1987; nickel from EPA, 1986b. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an effective whole-body dose of 4 millirem per year.

Table 4-4. Peak Concentrations at 100-Meter Well for No Action, F- and H-Areas

		PATHRAE - Peak contaminant concentrations[a]																
		Chemicals (mg/L)						Radionuclides (pCi/L)										
Waste management facility	Site number	Pb	Hg	NO_3	Xylene	Trichloro-ethylene	Tetrachloro-ethylene	Co-60	Cs-137	H-3	I-129	Ni-63	Pu-238	Sr-90	Tc-99	U-238	Np-237	Pu-239
F-Area acid/caustic basin[b]	2-1	0.054[e] (1971)	(c)	(d)	(d)	(d)	0.094[e] (1972)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)
H-Area acid/caustic basin[b]	2-2	0.054[e] (1971)	(c)	(d)	(d)	(d)	0.094[e] (1972)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)
F-Area burning/ rubble pits[b]	2-3, 2-4	0.038 (1982)	(d)	(d)	(d)	1.8[e] (1983)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)
H-Area retention basin	2-5	(d)	(d)	(d)	(d)	(d)	(d)	(d)	46 (1984)	(d)	(d)	(d)	5.1 (1985)	16 (1983)	(d)	(d)	(d)	(d)
F-Area retention basin	2-6	(d)	(d)	(d)	(d)	(d)	(d)	(d)	0.21 (1971)	(d)	(d)	(d)	(d)	5.3 (1971)	(d)	(d)	(d)	(d)
Rad/mixed waste *burial ground*	2-7, 2-8 *2-9*	0.68[e] *(1963)*	0.0023[e] *(1963)*	(d)	0.7[e] *(2057)*	(d)	(d)	470[e] *(1961)*	290[e] *(1962)*	5.6×10^{8}(e) *(1962)*	(c)	150,000[e] *(1963)*	220[e] *(1963)*	310[e] *(1962)*	4600[e] *(1963)*	15 *(1963)*	0.4[e] *(2778)*	0.43[e] *(1963)*
F-Area seepage basins	2-10, 2-11 2-12	0.0029 (1987)	0.0001 (1987)	1000[e] (1987)	(d)	(d)	(d)	(c)	3.1 (1967)	2.7×10^{7}(e) (1964)	220[e] (1990)	(d)	0.13 (1969)	8.5[e] (2105)	(d)	52[e] (2985)	(d)	(d) (1987)
F-Area seepage basin (old)	2-13	(c)	(c)	69[e] (1964)	(d)	0.023[e] (1965)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(c)	(d)	0.9 (1964)	(d)	0.0056 (1964)
H-Area seepage basins	2-14, 2-15 2-16, 2-17	0.0049 (1986)	0.0002 (1986)	480[e] (1986)	(d)	(d)	(d)	(c)	1.2 (1967)	1.0×10^{7}(e) (1965)	210[e] (1990)	(d)	(c)	1.1 (2135)	65 (1986)	(c)	1.3[e] (2375)	1.3 (1986)
Sum of concentrations		0.83[e]	0.0026[e]	1500[e]	0.7[e]	1.8[e]	0.19[e]	470[e]	340[e]	6.0×10^{8}(e)	430[e]	150,000[e]	230[e]	340[e]	4700[e]	68[e]	1.7[e]	1.7[e]
Standard[f]		0.05	0.002	10	0.62	0.005	0.0007	210	110	87,000	20	10,000	14	42	4200	24	0.14	13

TC

[a] Year of occurrence given in parentheses; years prior to 1985 are indications of present conditions.
[b] Concentrations are from PATHRAE modeling for largest inventory waste management unit in this functional grouping; actual peak concentrations are dependent on the inventory of this unit.
[c] Modeled concentration is insignificant (<1/100 of standard).
[d] Constituent did not meet threshold selection criteria for PATHRAE modeling.
[e] Concentration exceeds regulatory standards.
[f] Applicable standards obtained from the following sources: Pb, Hg, NO_3, and trichloroethylene (EPA, 1985a, and EPA, 1987); xylene (EPA, 1981, "Advising Opinion for Xylenes"); radionuclides, ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year.

Table 4-5. Peak Concentrations at 100-Meter Wells for No Action, R-Area

Waste management facility	Site number	PATHRAE peak concentrations[a]					
		Chemicals (mg/L)			Radionuclides (pCi/L)		
		Pb	Trichloro-ethylene	Tetrachloro-ethylene	H-3	Sr-90	Cs-137
R-Area burning/ rubble pit[b]	3-1, 3-2	0.038 (1982)	1.8[c] (1983)	(d)	(d)	(d)	(d)
R-Area acid/ caustic basin[b]	3-3	0.054[c] (1971)	(d)	0.094[c] (1972)	(d)	(d)	(d)
R-Area bingham pump outage pits	3-4, 3-5, 3-6	(d)	(d)	(d)	(d) (2109)	0.16 (1962)	0.62
R-Area seepage basins	3-7 to 3-12	(d)	(d)	(d)	6.5×10^{7}[c] (1969)	370^{2}[c] (1970)	1700[c] (1970)
Sum of concentrations		0.092[c]	1.8[c]	0.094[c]	6.5×10^{7}[c]	370[c]	1700[c]
Standard[e]		0.050	0.005	0.0007	87,000	42	110

TC

[a] Year of peak concentration is in parentheses; years prior to 1985 are indications of present conditions.

[b] Concentrations are from PATHRAE modeling for largest inventory waste management unit in this functional grouping; actual peak concentrations are dependent on the inventory of this unit.

[c] Concentration exceeds regulatory limits.

[d] Constituent did not meet threshold selection criteria for PATHRAE modeling.

[e] Standards obtained from following sources: Pb and trichloroethylene (EPA, 1985a, 1987), tetrachloroethylene (EPA, 1985b); ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year.

TC

Table 4-6. Peak Concentrations at 100-Meter Well for No Action, C-Area and Central Shops

		PATHRAE peak concentrations[a]		
		Chemicals (mg/L)		Radionuclides (pCi/L)
Waste management facility	Site number	Pb	Trichloroethylene	H-3
C-Area burning/ rubble pit	4-4	0.038 (1982)	1.8[b] (1983)	(c)
Hydrofluoric acid spill area	4-5	0.015 (1977)	(c)	(c)
Ford Building seepage basin	4-7	0.001 (1986)	(c)	7.0×10^{6}(b) (1973)
Sum of concentrations		0.054[b]	1.8[b]	7.0×10^{6}(b)
Standard[d]		0.05	0.005	87,000

---

[a] Year of peak concentrations shown in parentheses; years prior to 1985 are indications of present conditions.

[b] Concentration exceeds regulatory standards.

[c] Constituent did not meet threshold selection criteria for PATHRAE modeling.

[d] Standards obtained from the following sources: Pb and trichloroethylene (EPA, 1985a, 1987). ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year.

Table 4-7. Peak Concentrations at 100-Meter Well for No Action, TNX-Area

		PATHRAE - Peak contaminant concentrations[a]				
		Chemicals (mg/L)				
Waste management facility	Site number	Cr	Pb	NO_3	Tetrachloromethane	Trichloroethylene
D-Area burning/ rubble pits[b]	5-1, 5-2	0.026 (1982)	0.038 (1982)	(c)	(c)	1.8[d] (1983)
TNX burying ground	5-3	(c)	(c)	1.5 (1964)	(c)	(c)
TNX seepage basin (old)	5-4	0.077[d] (1986)	0.054[d] (1986)	2000[d] (1986)	0.028[d] (1987)	0.49[d] (1986)
TNX seepage basin (new)	5-5	0.0035 (1990)	(c)	1900[d] (1990)	(c)	(c)
Sum of concentrations		0.11[d]	0.092[d]	3900[d]	0.028[d]	2.3[d]
Standard[e]		0.05	0.05	10	0.005	0.005

TC

[a] Year of peak concentration is shown in parentheses; years prior to 1985 are indications of present conditions.

[b] Concentrations are from PATHRAE modeling for largest inventory waste management unit in this functional grouping; actual peak concentrations are dependent on the inventory of this unit.

[c] Constituent did not meet threshold selection criteria for PATHRAE modeling.

[d] Concentration exceeds regulatory standards.

[e] Applicable standards obtained from the following sources: Cr, Pb, NO_3, tetrachloromethane and trichloroethylene (EPA, 1985a, 1987).

TC

Table 4-8. Peak Concentrations at 100-Meter Well
for No Action, K-Area

Waste management facility	Site number	PATHRAE peak concentrations[a]				
		Chemicals (mg/L)			Radionuclides (pCi/L)	
		Pb	Trichloroethylene	Tetrachloroethylene	H-3	
K-Area burning/rubble pit[b]	8-1	0.038 (1982)	1.8[c] (1983)	(d)	(d)	TC
K-Area acid/caustic basin[b]	8-2	0.054[c] (1971)	(d)	0.094[c] (1972)	(d)	
K-Area seepage basin	8-4	(d)	(d)	(d)	4.4×10^{6}(c) (1967)	
Sum of concentrations		0.092[c]	1.8[c]	0.094[c]	4.4×10^{6}(c)	TC
Standard[e]		0.05	0.005	0.0007	87,000	

[a] Year of peak concentration shown in parentheses; years prior to 1985 are indications of present concentration.

[b] Concentrations are from PATHRAE modeling for largest inventory waste management unit in this functional grouping; actual peak concentrations are dependent on the inventory of this unit.

[c] Concentration exceeds regulatory standard.

[d] Constituent did not meet threshold selection criteria for PATHRAE modeling.

[e] Source: Pb, and trichloroethylene (EPA, 1985a, 1987); tetrachloroethylene (EPA, 1985b). ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole body dose of 4 millirem. TC

Table 4-9. Peak Concentrations at 100-Meter Well for No Action, L-Area

Waste management facility	Site number	PATHRAE peak concentrations[a]											
		Chemicals (mg/L)											Radionuclide (pCi/L)
		Cr	Pb	Benzene	Chloro-ethylene	2,4-D	Dichloro-methane	Endrin	Silvex	Tetrachloro-ethylene	Toxaphene	Trichloro-ethylene	H-3
L-Area acid/caustic basins[b]	9-2	0.00063 (1971)	0.54[d] (1971)	(c)	(c)	(c)	(c)	(c)	(c)	0.094[d] (1972)	(c)	(c)	(c)
CMP pits	9-3 to 9-9	0.0011 (1994)	0.065[d] (1994)	0.21[d] (1995)	0.22[d] (1994)	0.41[d] (1995)	0.22[d] (1994)	0.0005[d] (2786)	1.3[d] (2016)	47[d] (2000)	0.13[d] (2006)	1.2[d] (1996)	(c)
L-Area bingham pump outage pits	9-10, 9-11	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
L-Area oil and chemical basin	9-12	0.098[d] (2495)	0.017 (1979)	(c)	(c)	(c)	(c)	(c)	(c)	0.016[d] (1979)	(c)	(c)	3.2×10^{8}(d) (1967)
Sum of concentrations[e]		0.10[d]	0.14[d]	0.21[d]	0.22[d]	0.41[d]	0.22[d]	0.00054[d]	1.3[d]	47[d]	0.13[d]	1.2[d]	3.2×10^{8}(d)
Standard[e]		0.05	0.05	0.005	0.002	0.1	0.06	0.0002	0.01	0.0007	0.005	0.005	87,000

TC

TC

---

[a] Year of peak concentration shown in parentheses. Years prior to 1985 are indications of present conditions.

[b] Concentrations are from PATHRAE modeling for largest inventory waste management unit in this functional grouping; actual peak concentrations are dependent on the inventory of this unit.

[c] Constituent did not meet threshold selection criteria for PATHRAE modeling.

[d] Concentration exceeds regulatory standards.

[e] Sources: EPA, 1985a, 1985b (tetrachloroethylene and dichloromethane), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year. TC

Table 4-21. Peak Concentrations for Dedication Strategy, R-Area

Waste management facility	Site number	PATHRAE - Peak concentrations[a]						
		Chemicals (mg/L)			Radionuclides (pCi/L)			
		Pb	Trichloro-ethylene	Tetrachloro-ethylene	Cs-137	H-3	Sr-90	Y-90
R-Area burning/ rubble pits	3-1, 3-2	(b)	1.9 (1978)	(b)	(b)	(b)	(b)	(b)
R-Area acid/ caustic basin	3-3	0.054 (1971)	(b)	0.094 (1971)	(b)	(b)	(b)	(b)
R-Area reactor seepage basins	3-7 through 3-12	(b)	(b)	(b)	3300 (1965)	1.5×10^8 (1963)	9.3×10^3 (2111)	9.3×10^3 (2111)
Standard[c]		0.05	0.005	0.0007	110	8.7×10^4	42	550

TC

TC

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: EPA, 1985a, 1985b (tetrachloroethylene), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem.

Table 4-22. Peak Concentrations for Dedication Strategy, C- and CS-Areas

		PATHRAE - Peak concentrations[a]			
		Chemicals (mg/L)			Radionuclides (pCi/L)
Waste management facility	Site number	Cr	Pb	Trichloro-ethylene	H-3
CS-Area burning/ rubble pits	4-1, 4-2, 4-3	(b)	(b)	1.9 (1978)	(b)
C-Area burning/ rubble pits	4-4	(b)	(b)	1.9 (1978)	(b)
Hydrofluoric acid spill area	4-5	(b)	0.07 (1975)	(b)	(b)
Ford Building seepage basin	4-10	0.073 (2393)	(b)	(b)	1.1×10^7 (1966)
Standard[c]		0.05	0.05	0.005	8.7×10^4

TC

TC

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: EPA, 1985a, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem.

Table 4-23. Peak Concentrations for Dedication Strategy, TNX Area

		PATHRAE - Peak concentrations[a]					
		Chemicals (mg/L)					
Waste management facility	Site number	Ba	Cr	Pb	NO_3	Trichloroethylene	Tetrachloromethane
D-Area burning/rubble pits	5-1, 5-2	(b)	(b)	(b)	(b)	1.9 (1978)	(b)
TNX Burying Ground	5-3	(b)	(b)	(b)	12 (1958)	(b)	(b)
TNX seepage basin (old)	5-4	(b)	0.079 (1983)	0.056 (1983)	2100 (1983)	0.51 (1983)	0.029 (1983)
TNX seepage basin (new)	5-5	1.3 (2110)	0.062 (2614)	(b)	1000 (2005)	(b)	(b)
Standard[c]		1.0	0.05	0.05	10	0.005	0.005

TC

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: EPA, 1985a, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem.

Table 4-25. Peak Concentrations for Dedication Strategy, L-Area

Waste management facility	Site number	PATHRAE - Peak concentration for chemicals (mg/L)[a]									
		Pb	Silvex	Trichloro-ethylene	Tetrachloro-ethylene	Dichloro-methane	Chloro-ethylene	Benzene	2,4-D	Endrin	Toxaphene
L-Area burning/ rubble pit	9-1	(b)	(b)	1.9 (1978)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
L-Area acid/ caustic basin	9-2	0.054 (1971)	(b)	(b)	0.094 (1971)	(b)	(b)	(b)	(b)	(b)	(b)
CMP pits	9-3 through 9-9	0.11 (1992)	2.3 (2012)	2.1 (1994)	82 (1997)	0.38 (1992)	0.38 (1992)	0.36 (1993)	0.72 (1993)	0.00093 (2708)	0.23 (2003)
L-Area oil and chemical basin	9-11	(b)	(b)	(b)	0.016 (1979)	(b)	(b)	(b)	(b)	(b)	(b)
Standard[c]		0.05	0.01	0.005	0.0007	0.06	0.002	0.005	0.1	0.0002	0.005

TC

TC

Footnotes on last page of table.

Table 4-25. Peak Concentrations for Dedication Strategy, L-Area (continued)

Waste management facility	Site number	PATHRAE - Peak concentration[a] for Radionuclide (pCi/L)				
		H-3	Co-60	Sr-90	Y-90	Am-241
L-Area burning/ rubble pit	9-1	(b)	(b)	(b)	(b)	(b)
L-Area acid/ caustic basin	9-2	(b)	(b)	(b)	(b)	(b)
CMP pits	9-3 through 9-9	(b)	(b)	(b)	(b)	(b)
L-Area oil and chemical basin	9-11	4.6×10^8 (1962)	7300 (1976)	2100 (1980)	2100 (1980)	5.3 (2211)
Standard[c]		8.7×10^4	210	42550	2.5	

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more sites are given.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: EPA, 1985a, 1985b (tetrachloroethylene and dichloromethane), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem.

Table 4-29. Total Nonradiological Carcinogenic Risks for Dedication Strategy, Groundwater/Surface-Water Pathway in Each Geographic Grouping

	Total Risks[a], 2085 Exposures[b]				Maximum risk[a] for dominant carcinogenic chemical (year of peak exposure)			
Worst-case site	1-meter well	100-meter well	River outfall	Reclaimed farm	1-meter well	100-meter well	River outfall	Dominant chemical
M-Area settling basin	1.7×10^{-3}	1.2×10^{-2}	0	NS[c]	1.3×10^{-1}(d) (2024)	1.3×10^{-1}(d) (2033)	6.0×10^{-8} (2231)	Tetrachloroethylene
F-Area burning/rubble pit[c]	NS	NS	NS	NS	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
R-Area burning/rubble pit[e]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
C-Area burning/rubble pit	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
D-Area oil basin	NS	4.8×10^{-8}	NS	0	1.7×10^{-4}(e) (1978)	1.6×10^{-4}(e) (1983)	NS	Trichloroethylene
Road A chemical basin	0	0	0	0	0	0	0	
K-Area burning/rubble pit[e]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
CMP pits	1.1×10^{-7}	1.2×10^{-6}	NS	0	1.0×10^{-2} (1997)	6.0×10^{-3} (2000)	NS	Tetrachloroethylene
P-Area burning/rubble pit[e]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene

TC

TC

[a] Risk = incremental lifetime probability of death from cancer.
[b] 50-year exposure period following 2085.
[c] NS = Not significant; risk is less than 1.0×10^{-8}
[d] Values reported are for miscellaneous chemical basin.
[e] Values reported are for C-Area burning/rubble pit.

Table 4-30. Total Noncarcinogenic Risks for Dedication Strategy, Groundwater/Surface-Water Pathway in Each Geographic Grouping

Worst-case Site	Hazard index, 2085 exposures				Maximum risk for dominant noncarcinogenic chemical hazard index (year of peak exposure)			
	1-meter well	*100-meter well*	*River outfall*	*Reclaimed farm*	1-meter well	100-meter well	River outfall	Reclaimed farm
M-Area settling basin	2.9×10^{-1}	2.1×10^{0}	0	NS[a]	2.1×10^{2} (2052) Nitrate	2.1×10^{2} (2052) Nitrate	NS	NS
Mixed waste management facility and old radioactive waste burial grounds	1.1×10^{0}	5.5×10^{0}	NS	NS	$6.9 \times 10^{1(b)}$ (1987) Nitrate	$6.9 \times 10^{1(b)}$ (1987) Nitrate	NS	$2.1 \times 10^{-2(c)}$ (2085) Mercury
R-Area burning/rubble pit[d]	NS	NS	NS	$2.1 \times 10^{-2(c)}$	$2.9 \times 10^{0(c)}$ (1971) Sulfate	$2.9 \times 10^{0(c)}$ (1971) Sulfate	NS	$2.1 \times 10^{-2(c)}$ (2085) Mercury
Ford building seepage basin	NS	NS	NS	NS	$4.5 \times 10^{0(e)}$ (1975) Fluoride	$9.5 \times 10^{-1(e)}$ (1977)	NS	NS
New TNX seepage basin	4.4×10^{-1}	1.2×10^{-2}	NS	$1.8 \times 10^{0(g)}$	$1.4 \times 10^{2(g)}$ (1983) Nitrate	$1.4 \times 10^{2(g)}$ (1986) Nitrate	NS	$1.8 \times 10^{0(g)}$ (2085) Mercury
Road A chemical basin	NS	NS	NS	NS	5.4×10^{-1} (1975) Lead	4.1×10^{-1} (1980) Lead	NS	NS
K-Area burning/rubble pit[d]	NS	NS	NS	$2.1 \times 10^{-2(c)}$	$2.9 \times 10^{0(c)}$ (1971) Sulfate	$2.9 \times 10^{0(c)}$ (1971) Sulfate	NS	$2.1 \times 10^{-2(c)}$ (2085) Mercury
L-Area oil & chemical basin	3.8×10^{-1}	2.0×10^{-1}	NS	NS	$4.8 \times 10^{0(f)}$ (2012) Silvex	$2.7 \times 10^{0(f)}$ (2016) Silvex	NS	$2.1 \times 10^{-2(c)}$ (2085) Mercury
P-Area burning/rubble pit[d]	NS	NS	NS	$2.1 \times 10^{-2(c)}$	$2.9 \times 10^{0(c)}$ (1971) Sulfate	$2.9 \times 10^{0(c)}$ (1971) Sulfate	NS	$2.1 \times 10^{-2(c)}$ (2085) Mercury

TC

---

[a] NS = Not significant; hazard index is less than 10^{-2}.
[b] Values reported are for the F-Area seepage basin.
[c] Values reported are for L-Area acid/caustic basin.
[d] Values reported are for the C-Area burning/rubble pit.
[e] Values reported are for the hydrofluoric acid spill area.
[f] Values reported are for the CMP pits.
[g] Values reported are for the Old TNX seepage basin.

Table 4-31. Risks[a] to Population and Maximally Exposed Individual Attributable to Atmospheric Nonradiological Carcinogens for Dedication Strategy

Site	1985 exposure			2085 exposure			2985 exposure		
	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor
SRL seepage basins	0	0	–	0	0	–	0	0	–
F-Area seepage basins	0	0	–	0	0	–	0	0	–
Radioactive burial grounds	0	0	–	0	0	–	0	0	–
Silverton Road waste site	0	0	–	NS	NS	–	0	0	–
HFI spill area	–	–	–	–	–	–	–	–	–
CMP pit 19G	0	0	–	0	0	–	0	0	–
CMP pit 18.3G	2.71×10^{-8}	NS	Chloroethylene	NS	NS	–	0	0	–
CMP pits 18.1G or 18.2G	3.58×10^{-8}	NS	Trichloroethylene	NS	NS	–	0	0	–
CMP pit 17.1G	0	0	–	0	0	–	0	0	–
CMP pit 17G	1.21×10^{-5}	NS	Toxaphene	NS	NS	–	0	0	–
Old TNX seepage basin	0	0	–	NS	NS	–	0	0	–
Old TNX seepage basin outfall	–	–	–	–	–	–	–	–	–
Motor shop oil basin	–	–	–	–	–	–	–	–	–
SRP oil test site	0	0	–	0	0	–	0	0	–
Gunsite 720 rubble pit	0	0	–	0	0	–	0	0	–
Metallurgical laboratory basin	0	0	–	NS	NS	–	NS	0	–
Lost Lake	2.74×10^{-6}	NS	Chromium VI	7.64×10^{-8}	NS	Chromium VI	NS	NS	–
M-Area overflow ditch and adjacent seepage area	5.04×10^{-6}	NS	Nickel	1.66×10^{-6}	NS	Nickel	NS	NS	–
L-Area oil and chemical basin	0	0	–	NS	NS	–	0	0	–
D-Area oil basin	NS	NS	–	NS	NS	–	0	0	–
M-Area air stripper	8.98×10^{-4}	1.51×10^{-8}	Trichloroethylene	–	–	–	–	–	–
M-Area settling basin and process sewer line	0	0	–	NS	NS	–	NS	NS	–

Footnotes on last page of table.

Table 4-31. Risks[a] to Population and Maximally Exposed Individual Attributable to Atmospheric Nonradiological Carcinogens for Dedication Strategy (continued)

Site	1985 exposure			2085 exposure			2985 exposure		
	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor
H-Area seepage basin	0	0	-	0	0	-	0	0	-
Ford Building seepage basin	0	0	-	0	0	-	0	0	-
Road A chemical basin	-	-	-	-	-	-	-	-	-
Acid/caustic basins	NS	NS	-	NS	NS	-	0	0	-
Old F-Area seepage basin	0	0	-	NS	NS	-	NS	NS	-
New TNX seepage basin	0	0	-	NS	NS	-	0	0	-
Burning/rubble pits	3.31×10^{-5}	NS	Chromium VI	7.54×10^{-6}	NS	Chromium VI	NS	NS	-
Metals burning pit	0	0	-	NS	NS	-	NS	NS	-
TOTAL[c]	9.43×10^{-4}	1.58×10^{-8}	-	9.28×10^{-6}	1.16×10^{-8}	-	NS	NS	-

[a] Risks to the population are the number of excess cancers; risks to the maximally exposed individual are the excess lifetime cancer probabilities.
[b] NS = Not significant; incremental risk to maximally exposed individual is less than 1.0×10^{-8}; associated risk to the population is also not significant.
[c] Total risks include contributions from sites designated NS.

Table 4-32. Elimination Strategy Excavation and Transport Requirements

Geographic grouping/waste sites		Waste volume (m^3)	Backfill volume (m^3)	Transport Distance (km)	Storage/disposal facility
A- and M-Areas					
1-1	716-A motor shop seepage basin	Drummed liquid		8.7	HW
		675 (soil)	2,025	7.3	Sanitary landfill
1-2	Metals burning pit	21,600	21,600	6.8[a]	HW or incinerate
1-3	Silverton Road waste site	26,288	26,288	8.9[a]	Y-Area
1-4	Metallurgical laboratory basin	340	900	13.0	HW
1-5	Miscellaneous chemical basin	72	72	6.8[a]	HW or incinerate
1-6	A-Area burning/rubble pit	5,460	22,140	6.7	HW
1-7	A-Area burning/rubble pit	1,630	6,683	6.7	HW
1-8 to 11	SRL seepage basins	1,900	1,900	16.9	LLW
1-12	M-Area settling basin	28,990	30,000	9.9	MW
1-13	Lost Lake	16,900	b	7.4	MW
F- and H-Areas					
2-1	F-Area acid/caustic basin	210	700	10.0	HW
2-2	H-Area acid/caustic basin	210	700	11.8	HW
2-3	F-Area burning/rubble pit	1,584	6,494	7.2	HW
2-4	F-Area burning/rubble pit	2,606	10,889	7.2	HW
2-5	H-Area retention basin	6,080	11,500	3.3	LLW
2-6	F-Area retention basin	9,154	9,824	2.2	LLW
2-7 to 2-9	Radioactive waste burial grounds	3,000,000	3,000,000	10.5	MW
2-10 to 2-12	F-Area seepage basins	8,000	122,000	8.7	MW/HW
2-13	F-Area seepage basin (old)	5,370	5,370	9.1	MW/HW
2-14 to 2-17	H-Area seepage basins	20,870	237,150	11.3	MW/HW
R-Area					
3-1	R-Area burning/rubble pit	466	1,902	19.9	HW
3-2	R-Area burning/rubble pit	719	2,948	19.9	HW
3-3	R-Area acid/caustic basin	210	700	19.3	HW
3-4	R-Area Bingham pump outage pit	1,600	1,600	11.8	LLW
3-5	R-Area Bingham pump outage pit	1,200	1,200	11.8	LLW
3-6	R-Area Bingham pump outage pit	4,200	4,200	11.8	LLW
3-7 to 3-12	R-Area reactor seepage basins	7,080	7,000	12.4	LLW
C- and CS-Areas					
4-1	CS burning/rubble pit	555	2,276	12.8	HW
4-2	CS burning/rubble pit	1,255	5,146	13.4	HW
4-3	CS burning/rubble pit	804	3,298	14.5	HW
4-4	C-Area burning/rubble pit	811	3,325	15.5	HW/MW
4-5	Hydrofluoric acid spill area	230	230	15.0	MW/HW
4-6	Ford Building waste site	345	345	8.8	LLW
4-7	Ford Building seepage basin	76	840	15.1[a]	Appropriate onsite S/D facility

TC

Footnotes on last page of table.

Table 4-32. Elimination Strategy Excavation and Transport Requirements (continued)

Geographic grouping/waste sites		Waste volume (m^3)	Backfill volume (m^3)	Transport Distance (km)	Storage/disposal facility	TE
TNX Area						
5-1	D-Area burning/rubble pit	1,260	5,166	9.5	HW	
5-2	D-Area burning/rubble pit	856	3,510	9.5	HW	
5-3	TNX burying ground	896	896	18.7	LLW	TC
5-4	TNX seepage basin (old)	594	4,060[c]	9.6	HW/MW	
5-5	TNX seepage basin (new)	359	2,529	9.6	HW/MW	
D-Area						
6-1	D-Area oil seepage basin	5,742	5,742	11.7	Sanitary landfill	
Road A Area						
7-1	Road A chemical basin	1,000	5,500[d]	11.9[a]	LLW or MW/HW	
K-Area						
8-1	K-Area burning/rubble pit	638	2,615	16.3	HW	
8-2	K-Area acid/caustic basin	210	700	16.7	HW	
8-3	K-Area Bingham pump outage pit	7,700	7,700	14.9	LLW	
8-4	K-Area reactor seepage basin	260	1,600	14.0[e]	Appropriate MW/HW or LLW	
L-Area						
9-1	L-Area burning/rubble pit	617	2,529	19.4	HW	
9-2	L-Area acid/caustic basin	210	700	19.0	HW	TC
9-3 to 9-9	CMP pits	1,500	5,500	16.7[a]	Incinerate	
9-10	L-Area Bingham pump outage pit	4,100	4,100	11.9	LLW	
9-11	L-Area Bingham pump outage pit	4,200	4,200	11.8	LLW	
9-12	L-Area oil and chemical basin	675	3,500	19.3[a]	HW/MW and LLW	
P-Area						
10-1	P-Area burning/rubble pit	1,171	4,802	22.4	HW	
10-2	P-Area acid/caustic basin	210	700	21.7	HW	
10-3	P-Area Bingham pump outage pit	3,800	3,800	13.7	LLW	
Miscellaneous areas						
11-1	SRL oil test site	140	140	11.3	Sanitary landfill	
11-2	Gunsite 720 rubble pit	35	35	4.4	MW/HW	
	TOTAL	3,291,160				

---

[a] Distance is to hazardous/mixed waste facilities.
[b] Included in total for the M-Area settling basin.
[c] 4060 m^3 excavated clean material reused for backfill.
[d] 4500 m^3 excavated clean material reused for backfill.
[e] Distance is to low-level radioactive waste facility.

Table 4-34. Peak Concentrations for the Elimination Strategy, A- and M-Areas

		PATHRAE - Peak concentration[a]										
		Chemicals (mg/L)										Radionuclide (pCi/L)
Waste management facility	Site number	As	Ba	Cd	Ni	NO_3	Pb	Trichloroethylene	Tetrachloroethylene	Tetrachloromethane	1,1,1-Trichloroethane	H-3
Silverton Road waste site	1-3	(b)	(b)	(b)	(b)	(b)	(b)	0.13 (1976)	0.14 (1979)	(b)	(b)	(b)
Metallurgical laboratory basin	1-4	(b)	(b)	(b)	(b)	(b)	(b)	0.022 (2000)	(b)	1.3 (2001)	0.44 (1999)	(b)
A-Area burning/ rubble pits	1-6, 1-7	(b)	(b)	(b)	(b)	(b)	(b)	1.9 (1978)	(b)	(b)	(b)	(b)
SRL seepage basins	1-8, 1-9, 1-10, 1-11	0.073 (2405)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	3.2×10^5 (1962)
M-Area settling basin and vicinity	1-12, 1-13	(b)	3.0 (2252)	0.016 (2301)	0.095 (1995)	7900 (1995)	0.065 (1995)	53 (1996)	170 (2018, 2020[d])	(b)	3.5 (1995, 1996[d])	(b)
Standard[e]		0.05	1.0	0.01	0.013	10	0.05	0.005	0.0007	0.005	0.2	8.7×10^4

TC

TC

---

[a] Year of occurrence in parentheses. Only the constituents with peak concentrations that exceed standards at one or more waste sites are given. 1-meter well concentrations except where noted.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Peak concentration is higher and earlier than the Dedication option because the site is assumed to be capped under the Dedication strategy and not capped under the Elimination strategy. This also occurs at several other sites.

[d] At 100-meter well.

[e] Sources: EPA, 1985a, 1986b (tetrachloroethylene and nickel), and EPA, 1987. ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year.

Table 4-35. Peak Concentrations for the Elimination Strategy, F- and H-Area

Waste management facility	Site number	PATHRAE - Peak radionuclide concentration (mg/L)[a]													
		Sr-90	Y-90	Ni-63	Co-60	Tc-99	Cs-134	Cs-137	U-238	Pu-238	Pu-239	I-129	H-3	NP-237	
H-Area retention basin	2-6	2200 (2021)	2200 (2021)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	
Rad/mixed waste burial grounds	2-7, 2-8, 2-9	1000 (1957)	1000 (1957)	4.4×10^5 (1957)	2500 (1957)	1.3×10^4 (1957)	230 (1957)	940 (1957)	41 (1957)	670 (1957)	83 (1957)	(b)	2.1×10^9 (1957)	(b)	TC
F-Area seepage basins	2-10, 2-11, 2-12	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	88 (2036)	4.5×10^7 (1957)	(b)	
H-Area seepage basin	2-14, 2-15, 2-16, 2-17	1800 (1975)	1800 (1975)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	130 (2008)	1.9×10^7 (1956)	0.86 (2735)	TC
Standard[c]		42	550	1.0×10^4	210	4200	74	110	24	14	13	20	8.7×10^4	0.14	

[a] Year of occurrence in parentheses. Only constituents with peak concentrations that standards at one or more waste sites are given. 1 meter well concentrations except where noted.

[b] Constituent did not meet threshold selection criteria for PATHRAE modeling or peak concentration is within regulatory standard.

[c] Sources: 40 CFR 141; ICRP Publication 30 (ICRP, 1978) methodology was used to determine concentrations that yield an annual effective whole-body dose of 4 millirem per year.

Table 4-39. Total Nonradiological Carcinogenic Risks for Elimination Strategy, Groundwater/Surface-Water Pathway in Each Geographic Grouping

	Total risks,[a] 2085 exposures[b]				Maximum risk[a] for dominant carcinogenic chemical (year of peak exposure)			
Worst-case site	1-meter well	100-meter well	River outfall	Reclaimed farm	1-meter well	100-meter well	River outfall	Dominant chemical
M-Area settling basin	4.5×10^{-5}	3.5×10^{-4}	0	NS[c]	2.9×10^{-1}(d) (1990)	2.9×10^{-1}(d) (1999)	6.9×10^{-8} (2199)	Tetrachloroethylene
F-Area burning/rubble pit[c]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
R-Area burning/rubble pit[d]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
C-Area burning/rubble pit	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
D-Area oil basin	NS	4.8×10^{-8}	NS	0	1.7×10^{-4}(e) (1978)	1.6×10^{-4}(e) (1983)	NS	Trichloroethylene
Road A chemical basin	0	0	0	0	0	0	0	
K-Area burning/rubble pit[d]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene
CMP pits	1.1×10^{-7}	1.2×10^{-6}	NS	NS	1.0×10^{-2} (1997)	6.0×10^{-3} (2000)	NS	Tetrachloroethylene
P-Area burning rubble pit[e]	NS	NS	NS	0	1.7×10^{-4} (1978)	1.6×10^{-4} (1983)	NS	Trichloroethylene

[a] Risk = Incremental lifetime probability of death from cancer.
[b] 50-year exposure period following 2085.
[c] NS = Not significant; risk is less than 1.0×10^{-8}.
[d] Values reported are for the Miscellaneous Chemical Basin.
[e] Values reported are for C-Area burning/rubble pit.

TC

Table 4-40. Total Noncarcinogenic Risks for Elimination Strategy, Groundwater/Surface-Water Pathway in Each Geographic Grouping

	Hazard index, 2085 exposures				Maximum risk for dominant noncarcinogenic chemical, hazards index (year of peak exposure)			
Worst-case site	1-meter well	100-meter well	River outfall	Reclaimed farm	1-meter well	100-meter well	River outfall	Reclaimed farm
M-Area settling basin	6.3×10^{-3}	5.0×10^{-2}	0	NS[a]	5.4×10^{2} (1995) Nitrate	5.4×10^{2} (1994) Nitrate	NS	NS
Mixed waste management facility and old radioactive waste burial grounds	9.8×10^{-1}	5.3×10^{0}	NS	NS	6.4×10^{1}(b) (1987) Nitrate	6.9×10^{1}(b) (1987) Nitrate	NS	NS
R-Area burning/rubble pit[d]	NS	NS	NS	NS	2.9×10^{0}(c) (1971) Sulfate	2.9×10^{0}(c) (1971) Sulfate	NS	NS
Ford building seepage basin	NS	NS	NS	NS	4.5×10^{0}(e) (1975) Fluoride	9.5×10^{-1}(e) (1977)	NS	NS
New TNX seepage basin	NS	1.2×10^{-2}	NS	1.8×10^{0}(g)	1.4×10^{2}(g) (1983) Nitrate	1.4×10^{2}(g) (1986) Nitrate	NS	1.8×10^{0}(g) (2085) Mercury
Road A chemical basin	NS	NS	NS	NS	5.4×10^{-1} (1975) Lead	4.1×10^{-1} (1980) Lead	NS	NS
K-Area burning/rubble pit[d]	NS	NS	NS	NS	2.9×10^{0}(c) (1971) Sulfate	2.9×10^{0}(c) (1971) Sulfate	NS	NS
L-Area oil and chemical basin	2.8×10^{-1}	2.0×10^{-1}	NS	NS	4.8×10^{0}(f) (2012) Silvex	2.7×10^{0}(f) (2016) Silvex	NS	NS
P-Area burning/rubble pit[d]	NS	NS	NS	0	2.9×10^{0}(c) (1971) Sulfate	2.9×10^{0}(c) (1971) Sulfate	NS	NS

TC

[a] NS = Not significant; hazard index is less than 1.0×10^{-2}.
[b] Values reported are for the F-Area seepage basins.
[c] Values reported are for L-Area acid/caustic basin.
[d] Values reported are for the C-Area burning/rubble pit.
[e] Values reported are for the hydrofluoric acid spill area.
[f] Values reported are for the CMP pits.
[g] Values reported are for the Old TNX seepage basin.

Table 4-41. Risks[a] to Population and Maximally Exposed Individual Attributable to Atmospherically Released Nonradiological Carcinogens for Elimination Strategy

Site	1985 exposure			2085 exposure			2985 exposure			
	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor	
SRL seepage basins	6.31×10^{-7}	NS	Arsenic	0	0	-	0	0	-	TC
F-Area seepage basins	NS	NS	-	0	0	-	0	0	-	
Radioactive burial grounds	8.22×10^{-8}	NS	Cadmium	0	0	-	0	0	-	
Silverton Road waste site	NS	NS	-	NS	NS	-	0	0	-	TC
HFI spill area	-	-	-	-	-	-	-	-	-	
CMP pit 19G	NS	NS	-	0	0	-	0	0	-	
CMP pit 18.3G	NS	NS	-	NS	NS	-	0	0	-	TC
CMP pits 18.1G and 18.2G	NS	NS	-	NS	NS	-	0	0	-	
CMP pit 17.1G	0	0	-	0	0	-	0	0	-	
CMP pit 17G	1.20×10^{-7}	NS	Toxaphene	NS	NS	-	0	0	-	
Old TNX seepage basin	7.06×10^{-8}	NS	Chromium VI	NS	NS	-	0	0	-	TC
Old TNX seepage basin outfall	-	-	-	-	-	-	-	-	-	
Motor shop oil basins	-	-	-	-	-	-	-	-	-	
SRP oil test site	-	-	-	-	-	-	-	-	-	
Gunsite 720 rubble pit	-	-	-	-	-	-	-	-	-	
Metallurgical laboratory basin	NS	NS	-	NS	NS	-	NS	NS	-	
Lost Lake	2.74×10^{-6}	NS	Chromium VI	7.64×10^{-8}	NS	Chromium VI	NS	NS	-	TC
M-Area overflow ditch and adjacent seepage area	5.04×10^{-6}	NS	Nickel	1.66×10^{-6}	NS	Nickel	NS	NS	-	
L-Area oil and chemical basin	1.03×10^{-7}	NS	Chromium VI	NS	NS	-	0	0	-	
D-Area oil basin	NS	NS	-	NS	NS	-	0	0	-	
M-Area air stripper	8.98×10^{-4}	1.51×10^{-8}	Trichloroethylene	-	-	-	-	-	-	
M-Area settling basin and process sewer line	2.38×10^{-7}	NS	Nickel	NS	NS	-	0	0	-	

Footnotes on last page of table.

Table 4-41 Risks[a] to Population and Maximally Exposed Individual Attributable to Atmospherically Released Nonradiological Carcinogens for Elimination Strategy (continued)

Site	1985 exposure			2085 exposure			2985 exposure		
	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor	Population	Maximum exposed individual	Major contributor
H-Area seepage basin	1.18×10^{-7}	NS	Chromium VI	0	0	-	0	0	-
Ford Building seepage basin	NS	NS	-	0	0	-	0	0	-
Road A chemical basin	-	-	-	-	-	-	-	-	-
Acid/caustic basins	NS	NS	-	0	0	-	0	0	-
Old F-Area seepage basin	NS	NS	-	NS	NS	-	NS	NS	-
New TNX seepage basin	NS	NS	-	NS	NS	-	0	0	-
Burning/rubble pits	1.12×10^{-6}	-	Chromium VI	7.28×10^{-8}	-	Chromium VI	NS	NS	-
Metals burning pit	NS	NS	-	NS	NS	-	NS	NS	-
TOTAL[c]	9.07×10^{-4}	1.51×10^{-8}	-	1.81×10^{-6}	NS	-	NS	NS	-

[a] Risks to the population are the number of excess cancers; risks to the maximally exposed individual are the excess lifetime cancer probabilities.
[b] NS = Not significant; risk to the maximally exposed individual is less than 1.0×10^{-8}; associated risk to the population is also not significant.
[c] Total risks include contributions from sites designated NS.

— [illegible] —

?

Table 4-43. Existing Waste Site Impacts for Each Waste Management Strategy

Environmental Category	No Action	Dedication	Elimination	Combination
Onsite Groundwater	Certain hazardous and radioactive constituents will exceed applicable standards in the tertiary formations. After period of institutional control (100 years), some areas of contaminated groundwater in the tertiary formations would remain. Dedication of these areas of contaminated groundwater would be required at the end of the institutional control period. Very low potential for contamination in the Black Creek and Middendorf Formations.	Site closure (without waste removal) would reduce the mobility and concentrations of contaminants in the groundwater. Post-closure groundwater cleanup, if required, would ensure that groundwater constituents are within regulatory human health and environmental concern by the end of the institutional control period.	Relative to Dedication, waste removal and closure would further reduce the expected peak concentrations of contaminants in the groundwater at some waste sites. Groundwater cleanup, if required, would ensure that groundwater contaminants are below levels of concern by the end of institutional control period.	Post-closure groundwater conditions would not differ significantly from the Elimination strategy. Groundwater cleanup, if required, would ensure that groundwater contaminants are below levels of concern by the end of the institutional control period.
Offsite Groundwater	Offsite groundwater quality is not affected by actions at the SRP. Potentially contaminated groundwater outcrops in onsite streams or the Savannah River before leaving the plant boundary.	No impact.	No impact.	No impact.
Surface Water	Nitrate and tritium plumes are predicted to exceed regulatory limits in Four Mile Creek.	All constituent concentrations in all onsite streams and the Savannah River are predicted to be below regulatory standards.	Same as Dedication.	Same as Dedication.
Radiological Doses	Estimated current total annual offsite dose is 14.4 millirem, below the 100-millirem DOE limit. Onsite peak annual dose after institutional control period is conservatively estimated to be 3900 millirem. Dedication of such areas would be required.	Closure and groundwater cleanup actions would ensure that all doses are below the 100 millirem per year DOE limit.	Same as Dedication.	Same as Dedication.

Table 4-43. Existing Waste Site Impacts for Each Waste Management Strategy (continued)

Environmental Category	No Action	Dedication	Elimination	Combination
Health Effects	No adverse health effects during the period of institutional control. Based on conservative assumptions, adverse health effects could occur as a result of exposures onsite beginning after the period of institutional control (i.e., dedication required).	Appropriate actions (e.g., groundwater cleanup) would be taken to ensure that the concentrations of hazardous and radioactive constituents are reduced to levels that would protect human health and the environment.	Same as Dedication.	Same as Dedication.
Ecology	Offsite ecology is protected. Slight onsite aquatic ecological effects could occur due to concentrations of tritium and nitrate in Four Mile Creek.	Closure and remedial actions would mitigate adverse effects on aquatic ecology. Slight terrestrial ecology effects would occur (e.g, at borrow areas for backfilling and capping waste sites).	Same as Dedication, plus additional effects to terrestrial ecology due to removal and transport of waste to new onsite storage facility.	Same as Elimination, but effects due to waste removal and transport would be limited to the sites selected for waste removal.
Occupational Risks	No significant risk.	Very low potential risk identified only at the M-Area settling basin and vicinity.	Risk is due to atmospheric releases of radioactive materials during waste removal and transport to new storage facility.	Risks described for elimination are limited to the sites selected for waste removal.
Site Dedication	Potentially all existing waste sites discussed in Section 4.2 (about 300 acres) plus a significant amount of adversely impacted areas (see onsite groundwater, radiological doses, and health effects).	Potentially all existing waste sites discussed in Section 4.2. Total required area of dedication is about 300 acres (i.e., less than 0.2 percent of the total area of the SRP).	None.	Sites selected for waste removal would not require dedication. Total required area of dedication is about 270 acres.
Regulatory Compliance	Would not comply with current groundwater protection requirements.	Meets all applicable regulations.	Meets all applicable regulations.	Meets all applicable regulations.

Table 4-45. 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 as Dedication	Same as Dedication
Radiological releases	Potentially 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	Potential substantial impacts due to temporary cleanup workforce, SRP unit shutdowns and layoffs, and public perception of offsite property values	No impact	No impact	No impact

Table 4-45. New Waste Management Facility Impacts for Each Waste Management Strategy (continued)

Environmental category	No action	Dedication	Elimination	Combination
Noise	No impact	No impact	No impact	No impact
Site dedication	Potential site dedication of land contaminated by accidental releases	Dedication of as much as 400 acres of land for waste management in perpetuity	No dedication of land in perpetuity	Dedication of as much as 400 acres of land for waste management in perpetuity
Institutional	Would result in DOE's noncompliance with environmental laws and regulations	Possible site maintenance and monitoring indefinitely beyond institutional control period	Commitment could require research and development, planning, engineering, and construction of future waste management facilities for stored waste	Possible site maintenance and monitoring indefinitely beyond institutional control period. Commitment could require research and development, planning, engineering, and construction of future waste management facilities for stored waste

Table 4-56. Accident Risks for No Action

Location	Employee injury	Fatal truck accident	Fatal construction accident
SRL seepage basins	NA[a]	NA	NA
Metallurgical laboratory basin	NA	NA	NA
Burning/rubble pits	NA	NA	NA
R-Area	NA	NA	NA
A-Area	NA	NA	NA
C-Area	NA	NA	NA
CS-Area	NA	NA	NA
K-Area	NA	NA	NA
P-Area	NA	NA	NA
D-Area	NA	NA	NA
F-Area	NA	NA	NA
L-Area	NA	NA	NA
Metals burning pit/ miscellaneous chemical basin	NA	NA	NA
Old F-Area seepage basin	NA	NA	NA
Separations Area retention basins			
F-Area	NA	NA	NA
H-Area	NA	NA	NA
Radioactive waste burial grounds	NA	NA	NA
Bingham pump outage pits	$1.3 \times 10^{-3(b)}$	NA	NA
Hydrofluoric acid spill area	NA	NA	NA
SRL oil test site	NA		
New TNX seepage basin	$2.7 \times 10^{-3(b)}$	NA	NA
Road A chemical basin	NA	NA	NA
L-Area oil and chemical basin	NA	NA	NA
Waste oil basins			
D-Area	NA	NA	NA
Motor shop	NA	NA	NA
Silverton Road waste site	NA	NA	NA
F-Area seepage basin	$9.2 \times 10^{-2(b)}$	NA	NA
Acid/caustic basins			
F-Area	NA	NA	NA
H-Area	NA	NA	NA
K-Area	NA	NA	NA
L-Area	NA	NA	NA
P-Area	NA	NA	NA
R-Area	NA	NA	NA
H-Area seepage basins	$2.5 \times 10^{-1(b)}$	NA	NA
Reactor seepage basins			
P-Area	NA	NA	NA
R-Area	NA	NA	NA
K-Area	NA	NA	NA
Ford Building waste sites	NA	NA	NA
Ford Building seepage basin	NA	NA	NA
Old TNX seepage basin	NA	NA	NA
TNX burying ground	NA	NA	NA
CMP pits	NA	NA	NA
Gunsite 720 rubble pit	NA	NA	NA
Total risk	3.5×10^{-1}	NA	NA

[a] NA = Not applicable because of the nature of the closure option or because of the nature of the disposal site.

[b] No action at these sites reflects finite injury risks under continued use.

Table 4-57. Accident Risks for No-Waste-Removal and Closure

Location	Employee injury	Fatal truck accident	Fatal construction accident
SRL seepage basins			
(a)	8.2×10^{-1}	NA[b]	NA
(c)	NA	NA	NA
Metallurgical laboratory basin	4.5×10^{-3}	2.3×10^{-5}	NA
Burning/rubble pits			
R-Area	NA	NA	NA
A-Area	NA	NA	NA
C-Area	NA	NA	NA
CS-Area	NA	NA	NA
K-Area	NA	NA	NA
P-Area	NA	NA	NA
D-Area	NA	NA	NA
F-Area	NA	NA	NA
L-Area	NA	NA	NA
Metals burning pit/miscellaneous chemical basin	1.7×10^{-1}	NA	1.2×10^{-2}
Old F-Area seepage basin	7.2×10^{-2}	NA	5.3×10^{-4}
Separations Area retention basins			
F-Area	2.8×10^{-2}	NA	NA
H-Area	2.8×10^{-2}	NA	NA
Radioactive waste burial grounds	9.5	NA	7.0×10^{-2}
Bingham pump outage pits	1.3×10^{-3}	NA	NA
Hydrofluoric acid spill area	NA	NA	NA
SRL oil test site	1.8×10^{-1}	NA	NA
New TNX seepage basin	3.0×10^{-2}	NA	NA
Road A chemical basin	1.3×10^{-2}	NA	NA
L-Area oil and chemical basin	NA	5.0×10^{-6}	NA
Waste Oil Basins			
D-Area	2.1×10^{-3}	NA	NA
Motor shop	9.1×10^{-2}	NA	NA
Silverton Road waste site	1.7×10^{-1}	NA	NA
F-Area seepage basin	7.2×10^{-1}	NA	5.3×10^{-3}
Acid/caustic basins			
F-Area	2.9×10^{-3}	NA	2.1×10^{-5}
H-Area	3.1×10^{-3}	NA	2.3×10^{-5}
K-Area	3.6×10^{-3}	NA	2.6×10^{-5}
L-Area	8.4×10^{-3}	NA	6.1×10^{-5}
P-Area	3.6×10^{-3}	NA	2.6×10^{-5}
R-Area	3.1×10^{-3}	NA	2.3×10^{-5}
H-Area seepage basins	1.8	NA	1.8×10^{-2}
Reactor seepage basins			
K-Area	2.1×10^{-1}	NA	NA
R-Area	1.8	NA	NA
Ford Building waste sites	3.6×10^{-2}	7.4×10^{-6}	NA
Ford Building seepage basin	1.2×10^{-2}	NA	8.5×10^{-5}
Old TNX seepage basin	4.8×10^{-2}	NA	NA
TNX burying ground			
(a)	1.9×10^{-2}	NA	1.4×10^{-4}
(c)	1.5×10^{-2}	NA	1.1×10^{-4}
CMP pits	NA	NA	NA
Gunsite 720 rubble pit	6.8×10^{-3}	NA	NA
Total risk	1.6×10^{1}	3.5×10^{-5}	1.1×10^{-1}

---

[a] No waste removal with cap.

[b] NA = Not applicable because of the nature of the closure option or because of the nature of the disposal site.

[c] No waste removal without cap.

Table 4-58. Accident Risks for Complete Waste Removal and Closure

Location	Employee injury	Fatal truck accident	Fatal construction accident
SRL seepage basins	4.9×10^{-1}	6.1×10^{-4}	NA
Metallurgical laboratory basins	1.8×10^{-2}	1.1×10^{-4}	NA
Burning/rubble pits			
R-Area	3.0×10^{-2}	3.9×10^{-4}	NA
A-Area	1.6×10^{-1}	3.8×10^{-4}	NA
C-Area	3.7×10^{-1}	1.9×10^{-3}	NA
CS-Area	1.5×10^{-1}	3.8×10^{-4}	NA
K-Area	5.4×10^{-2}	1.4×10^{-4}	NA
P-Area	4.5×10^{-1}	1.9×10^{-3}	NA
D-Area	1.1×10^{-1}	4.2×10^{-4}	NA
F-Area	2.0×10^{-1}	2.7×10^{-4}	NA
L-Area	4.5×10^{-2}	1.6×10^{-4}	NA
Metals burning pit[a]	2.8×10^{-1}	2.0×10^{-3}	2.0×10^{-3}
Miscellaneous chemical basin[b]	6.5×10^{-1}	2.0×10^{-3}	4.7×10^{-3}
Old F-Area seepage basin			
(c)	2.0×10^{-1}	7.0×10^{-4}	1.4×10^{-3}
(d)	1.6×10^{-1}	4.4×10^{-6}	1.2×10^{-3}
Separations Area retention basins			
F-Area	2.5×10^{-1}	5.0×10^{-4}	NA
H-Area	1.1×10^{-1}	2.2×10^{-4}	NA
Radioactive waste burial grounds	4.2×10^{1}	1.4×10^{-1}	3.1×10^{-1}
Bingham pump outage pits	1.0×10^{-1}	2.7×10^{-4}	NA
Hydrofluoric acid spill area	1.2×10^{-2}	1.5×10^{-5}	NA
SRL oil test site	1.1×10^{-4}	6.3×10^{-6}	NA
New TNX seepage basin	3.2×10^{-2}	3.0×10^{-5}	NA
Road A chemical basin	1.6×10^{-1}	3.4×10^{-4}	1.5×10^{-3}
L-Area oil and chemical basin	3.2×10^{-2}	5.6×10^{-5}	
Waste oil basins			
D-Area	1.6×10^{-1}	2.8×10^{-4}	NA
Motor shop	1.3×10^{-1}	3.2×10^{-6}	NA
Silverton road waste site	9.2×10^{-1}	1.1×10^{-3}	NA
F-Area seepage basin	6.6×10^{-1}	3.3×10^{-4}	4.8×10^{-3}
Acid/caustic basins			
F-Area	8.1×10^{-3}	2.3×10^{-5}	6.0×10^{-5}
H-Area	8.3×10^{-3}	1.4×10^{-5}	6.0×10^{-5}
K-Area	9.5×10^{-3}	4.7×10^{-5}	6.9×10^{-5}
L-Area	1.4×10^{-2}	3.1×10^{-5}	1.0×10^{-4}
P-Area	9.7×10^{-3}	2.9×10^{-5}	6.8×10^{-5}
R-Area	8.3×10^{-3}	1.5×10^{-5}	6.0×10^{-5}
H-Area seepage basins	1.1	1.9×10^{-3}	7.9×10^{-3}
Reactor seepage basins			
K-Area	2.4×10^{-1}	4.5×10^{-4}	NA
R-Area	2.8	2.2×10^{-3}	NA
Ford Building waste sites	3.6×10^{-2}	4.1×10^{-5}	NA
Ford Building seepage basin	1.3×10^{-2}	5.7×10^{-6}	9.2×10^{-5}
Old TNX seepage basin	1.1×10^{-2}	4.9×10^{-5}	NA
TNX burying ground			
(e)	3.1×10^{-2}	1.4×10^{-4}	2.3×10^{-4}
(f)	3.3×10^{-2}	1.1×10^{-4}	2.4×10^{-4}
CMP pits	4.7×10^{-1}	8.8×10^{-5}	NA
Gunsite 720 rubble pit	4.8×10^{-3}	4.6×10^{-6}	NA
Total risk	5.3×10^{1}	1.6×10^{-1}	3.3×10^{-1}

---

[a] Disposal in hazardous waste repository.
[b] Incineration and returned to site backfill.
[c] Excavated waste sent to waste disposal facility.
[d] Excavated waste placed in basin in H-Area.
[e] Waste removed to low-level radioactive waste facility.
[f] No waste found during excavation and sampling.

Table 4-59. Accident Risks for Waste Removal and Closure at Selected Sites

Location	Employee injury	Fatal truck accident	Fatal construction accident
SRL seepage basins			
(a)	8.2×10^{-1}	NA[b]	NA
Metallurgical laboratory basin	4.5×10^{-3}	2.3×10^{-5}	NA
Burning/rubble pits			
R-Area	NA	NA	NA
A-Area	NA	NA	NA
C-Area	NA	NA	NA
CS-Area	NA	NA	NA
K-Area	NA	NA	NA
P-Area	NA	NA	NA
D-Area	NA	NA	NA
F-Area	NA	NA	NA
L-Area	NA	NA	NA
Metals burning pit/miscellaneous chemical basin	1.7×10^{-1}	NA	1.2×10^{-2}
Old F-Area seepage basin	7.2×10^{-2}	NA	5.3×10^{-4}
(c)	2.0×10^{-1}	7.0×10^{-4}	1.4×10^{-3}
(d)	1.6×10^{-1}	4.4×10^{-6}	1.2×10^{-3}
Separations Area retention basins			
F-Area	2.8×10^{-2}	NA	NA
H-Area	2.8×10^{-2}	NA	NA
Radioactive waste burial grounds	9.5	NA	7.0×10^{-2}
Bingham pump outage pits	1.3×10^{-3}	NA	NA
Hydrofluoric acid spill area	NA	NA	NA
SRL oil test site	1.8×10^{-1}	NA	NA
New TNX seepage basin	3.0×10^{-2}	NA	NA
Road A chemical basin	1.3×10^{-2}	NA	NA
L-Area oil and chemical basin	NA	5.0×10^{-6}	NA
Waste Oil Basins			
D-Area	2.1×10^{-3}	NA	NA
Motor shop	9.1×10^{-2}	NA	NA
Silverton Road waste site	1.7×10^{-1}	NA	NA
F-Area seepage basin	7.2×10^{-1}	NA	5.3×10^{-3}
Acid/caustic basins			
F-Area	2.9×10^{-3}	NA	2.1×10^{-5}
H-Area	3.1×10^{-3}	NA	2.3×10^{-5}
K-Area	3.6×10^{-3}	NA	2.6×10^{-5}
L-Area	8.4×10^{-3}	NA	6.1×10^{-5}
P-Area	3.6×10^{-3}	NA	2.6×10^{-5}
R-Area	3.1×10^{-3}	NA	2.3×10^{-5}
H-Area seepage basins	1.8	NA	1.8×10^{-2}
Reactor seepage basins			
K-Area	2.1×10^{-1}	NA	NA
R-Area	1.8	2.2×10^{-3}	NA
Ford Building waste sites	3.6×10^{-2}	7.4×10^{-6}	NA
Ford Building seepage basin	1.2×10^{-2}	NA	8.5×10^{-5}
Old TNX seepage basin	4.8×10^{-2}	NA	NA
TNX burying ground			
(a)	1.9×10^{-2}	NA	1.4×10^{-4}
(c)	1.5×10^{-2}	NA	1.1×10^{-4}
CMP pits	NA	NA	NA
Gunsite 720 rubble pit	6.8×10^{-3}	NA	NA
Total risk	1.6×10^{1}	2.9×10^{-3}	1.1×10^{-1}

---

[a] No waste removal with cap.

[b] NA = Not applicable because of the nature of the closure option or because of the nature of the disposal site.

[c] Excavated waste sent to waste disposal facility.

[d] Excavated waste placed in basin in H-Area.

REFERENCES

TC Bledsoe, H. W., 1987. Head Difference Between Congaree and "Tuscaloosa" Aquifers, DPST-87-592, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Brooks, M. J., 1986. An Intensive Archaeological and Historical Survey of the Existing Hazardous, Low-Level Radioactive and Mixed Waste Sites, Savannah River Plant, South Carolina, University of South Carolina, South Carolina Archaeological Research Program.

Calkins, G. D., 1980. Thoughts on Regulation Changes for Decommissioning, NUREG-0590 Rev 2, (U.S. Nuclear Regulatory Commission)Office of Standards Development, Washington, D.C.

TC DOE (U.S. Department of Energy), 1984. Final Environmental Impact Statement, L-Reactor Operation, Savannah River Plant, Aiken, S.C., DOE/EIS-0108, Savannah River Operations Office, Aiken, South Carolina.

TC DOE (U.S. Department of Energy), 1985. Threshold Limit Guidance, DOE/LLW-41T, Report by EG&G for the National Low-Level Radioactive Waste Management Program, Department of Energy, Idaho Falls, Idaho.

TC DOE (U.S. Department of Energy), 1986. F/H Effluent Treatment Facility (ETF), H-Area, Savannah River Plant Compliance with the National Environmental Policy Act (NEPA), Memorandum to File, Savannah River Operations Office, Aiken, South Carolina.

Dunaway, J. K. W., W. F. Johnson, R. V. Simmons, H. W. Bledsoe, and J. A. Smith 1987. Environmental Information Document, Old TNX Seepage Basin, DPST-85-710. E. I. du Pont de Nemours and Co., Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1984a. Annual Offsite Tritium Releases Expected from Specified Disposal Options, DPST-84-361, Savannah River Laboratory, Technical Division, Aiken, South Carolina.

TC EPA (U.S. Environmental Protection Agency), 1977. National Interim Primary Drinking Water Regulations, EPA-570/9-76-003, Washington, DC.

EPA (U.S. Environmental Protection Agency), 1981. Advisory Opinion for Xylenes (Dimethylbenzenes), Office of Drinking Water, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985a. "National Primary Drinking Water Regulations," (40 CFR Part 141), Federal Register (50 FR 45880), Washington, D.C., November 13.

EPA (U.S. Environmental Protection Agency), 1985b. "Hazardous Waste Management Systems; Identification and Listing of Hazardous Wastes; Final Rule and Proposed Rules" (40 CFR 261), Federal Register (50 FR 48886), Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1986a. "Water Pollution Control; National Primary Drinking Water Regulations; Radionuclides, Advanced Notice of Proposed Rulemaking" (40 CFR 141), Federal Register (51 FR 34836), Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1986b. Quality Criteria For Water, 1986, EPA 440/5-86-001, Office of Water Regulations and Standards, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1987. Final Rule Volatile Synthetic Organic Chemicals, Federal Register (52 FR 25690), Washington, D.C.

TC

EPRI (Electric Power Research Institute), 1985. Measuring and Managing Environmental Risk, Palo Alto, California.

ICRP (International Commission on Radiological Protection), 1977. Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Pergamon Press, Oxford, England.

ICRP (International Commission on Radiological Protection), 1978. Limits for Intake of Radionuclides for Workers, ICRP Publication 30, Pergamon Press, Oxford, England. TC

Jensen, J. R., M. E. Hodgson, E. J. Christensen, and H. E. Mackey, Jr., 1982. Savannah River Plant Wetlands Map, Scale 1:48000, University of South Carolina and E. I. du Pont de Nemours and Co., Aiken, South Carolina.

Killian, T. H., N. L. Kolb, P. Corbo, and I. W. Marine, 1987. Environmental Information Document, F-Area Seepage Basins, DPST-85-704, 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, W. F. Johnson, and J. A. Smith, 1987. 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.

Looney, B. B., J. B. Pickett, C. M. King, W. G. Holmes, W. F. Johnson, and J. A. Smith, 1987a. 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. TC

Manion, W. J. and T. S. LaGuardia, 1976. Decommissioning Handbook, DOE/EV/10128-1, U.S. Department of Energy, Office of Nuclear Waste Management, Washington, D.C.

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.

NRC (U.S. Nuclear Regulatory Commission), 1977. Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I. Regulatory Guide 1.109, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), 1981. Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586, Office of Standards Development, Washington, D.C.

TC NRC (U.S. Nuclear Regulatory Commission), 1986. Theory and Implementation for SWIFT II, NUREG/CR-3328, Saudia National Laboratories, Albuquerque, New Mexico.

Palmiotto, C. A., and C. Comiskey, 1986. Accident Analysis Methodology for EIS Criteria Waste Site, DPSP-86-1112, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Pekkala, R. O., C. E. Jewell, W. G. Holmes, R. V. Simmons, and I. W. Marine, 1987. Environmental Information Document, Ford Building Seepage Basin, DPST-85-709, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Pickett, J. B., W. P. Colven, and H. W. Bledsoe, 1987. Environmental Information Document, M-Area Settling Basin and Vicinity, DPST-85-703, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Pickett, J. B., C. F. Muska, and H. W. Bledsoe, 1987. Environmental Information Document, Road A Chemical Basin, DPST-85-699, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina. TC

TC SAIC (Science Applications International Corporation), 1987. Ecological Assessment of Closure Options for the Savannah River Plant Waste Sites, CORR-87-0116, Report by SAIC for E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

TC Zeigler, C. C., E. M. Heath, L. B. Taus, and J. L. Todd, 1987. U. S. Department of Energy - Savannah River Plant Environmental Report for 1986, DPSPU-87-30-1, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

CHAPTER 5

STUDIES AND MONITORING

Since 1951, an intensive environmental surveillance program has been conducted at the Savannah River Plant (SRP). This program involves monitoring the compositions of effluents from SRP facilities, measuring radioisotope and chemical concentrations in the SRP environs, assessing the ecological health of the overall SRP environment, and determining SRP compliance with applicable standards. Analytical studies supplement the measurements and yield assessments of the impacts of operations. The results of this environmental program are reported annually to the public (e.g., Zeigler et al., 1986; Zeigler et al., 1987). J-38

The SRP environmental monitoring program for radioactivity is one of the largest and most comprehensive in the United States. In recent years, monitoring has been performed in a 5180-square-kilometer area in the immediate vicinity of the Plant, and representative samples were collected from an additional 77,700-square-kilometer area. In this entire area of 82,880 square kilometers, 20 types of samples were collected and analyzed for all types of radioactivity. In 1985, approximately 65,000 analyses were performed on 15,000 samples; in 1986, 85,000 determinations were performed on 15,000 samples. E-156 Approximately 480,000 samples and 1,770,000 analyses have been generated since the environmental radioactive monitoring program began in 1951 (Du Pont, 1985a; Zeigler et al., 1986; Zeigler et al., 1987). J-38

The environmental surveillance program includes the monitoring of onsite and offsite air, water from SRP streams and the Savannah River, SRP groundwater, and samples of soil, vegetation, food, drinking water, animals, and fish for their radionuclide content. In addition, the U.S. Department of Energy's (DOE's) Remote Sensing Laboratory conducts periodic aerial radiological surveys of the Plant and surrounding areas. The South Carolina Department of Health and Environmental Control (SCDHEC) and the Georgia Department of Natural Resources (GDNR) also conduct independent radiological monitoring programs in the vicinity of the SRP (DOE, 1984a). A comprehensive evaluation of the SRP radiological monitoring program was conducted in 1986 by John E. Till, Ph.D., of Radiological Assessments Corporation. Recommendations from this reviewer have contributed to the 1986 program (Zeigler et al., 1987). E-156

In addition to monitoring for radioactivity, the Plant monitors the physical properties (e.g., temperature) and nonradioactive chemical and metal content of liquid effluents, streams, groundwater, and the Savannah River. It also monitors drinking water, sediment, and air for potential contaminants. This program generated approximately 4000 samples and 40,000 analyses in 1985; in 1986, 4,000 samples were analyzed. The SRP laboratories performed some of the analyses, but offsite commercial laboratories have performed most groundwater and liquid effluent discharge nonradioactive analyses; a review of the nonradiological monitoring program was conducted by International Technology Corporation in late 1986 (Du Pont, 1985a; Zeigler et al., 1986; Zeigler et al., 1987). E-156

The following sections describe recent studies and monitoring activities associated with the management of wastes on the Plant. (For details of other

J-38 studies and monitoring programs, see Du Pont, 1985a; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987; GDNR, 1983; and SCDHEC, 1983.)

5.1 MONITORING REQUIREMENTS AND COMMITMENTS

Many of the monitoring activities and studies are in response to specific regulations and DOE commitments. For example, the South Carolina Hazardous Waste Management Regulations (SCHWMR) require groundwater monitoring at the F- and TC H-Area seepage basins, and the M-Area settling basin. Specifically, the uppermost aquifer must be monitored with at least one upgradient and three downgradient wells. Table 5-1 lists the three classes of monitored parameters and the sampling frequencies. The groundwater surface elevation must be determined each time a sample is taken. A groundwater sampling and analysis plan must be developed to guide these activities. This plan must include sample collection, preservation, and shipment techniques; analytical procedures; and chain-of-custody controls.

The SCHWMR and the Resource Conservation and Recovery Act (RCRA) require detection and compliance monitoring of groundwater. Detection monitoring is performed to determine if contaminants have been introduced into the groundwater as a result of waste management facility operation. It involves a statistical evaluation of the quality of groundwater upgradient and downgradient from the facility. Such monitoring is performed at both an upgradient location and at a compliance point, a specific location at which concentrations of contaminants cannot exceed established limits. If statistically significant contamination is detected, compliance monitoring is initiated to assess whether the contamination exceeds the established limits. TE If it does, and if the exceedance can be traced to releases from the facility, corrective action will be taken to reduce concentrations to comply with the appropriate standards.

On November 7, 1985, representatives of DOE and SCDHEC signed Administrative Consent Order 85-70-SW. In signing this consent order, DOE committed to the following studies and monitoring activities:

- Complete installation of monitoring wells at the compliance points at M-, F-, and H-Areas within 120 days of SCDHEC approval of locations, depths, and construction, but no later than the date specified by the SCDHEC in its approval of the Part B Permit Application. The locations, depths, and construction are to be in accordance with the requirements of SCHWMR for compliance-point monitoring wells.

- Submission of quarterly status reports on M-, F-, and H-Areas, summarizing the results of determinations made under SCHWMR. The SCDHEC will approve or comment on each report within 30 days of receipt.

Another DOE commitment concerns the funding and implementation of the Groundwater Protection Plan for the SRP pursuant to Public Law 98-181: all groundwater mitigation proposals will be subject to the National Environmental Policy Act (NEPA) review process.

Public Law 98-181 (DOE, 1984b, Appendix A), enacted in November 1983, required TE discontinuing use of the settling basin in the M-Area of the Savannah River

Table 5-1. South Carolina Hazardous Waste Management Regulations: Groundwater-Monitoring Analyses[a]

Parameter	Collection frequency	Concentration limit[b]
	DRINKING WATER	
Arsenic	Quarterly for first year	0.05
Barium		1.0
Cadmium		0.01
Chromium		0.05
Fluoride		1.4-2.4
Lead		0.05
Mercury		0.002
Nitrate-nitrogen		10
Selenium		0.01
Silver		0.05
Endrin		0.0002
Lindane		0.004
Methoxychlor		0.1
Toxaphene		0.005
2,4-D		0.1
2,4,5-TP Silvex		0.01
Radium		5 pCi/liter
Gross alpha		15 pCi/liter
Gross beta		4 mrem/yr
Turbidity		1 TU
Coliform bacteria		1 per 100 ml
	GROUNDWATER QUALITY	
Chloride	Quarterly for first year; at least annually thereafter	None
Iron		
Manganese		
Phenols		
Sodium		
Sulfate		
	GROUNDWATER CONTAMINATION	
pH	Quarterly for first year; at least semi-annually thereafter	None
Specific conductance		
Total organic carbon		
Total organic halogen		

---

[a] SCHWMR R.61-79.265.90-.94

[b] In milligrams per liter unless otherwise indicated.

Plant within 2 years of the date of enactment and developing a plan for protecting groundwater at the Plant. The purpose of the plan was to identify components of the groundwater-protection program, as mandated by Public Law TE 98-181. It includes the schedule for discontinuing the use of the M-Area settling basin; provisions for discontinuing the use of seepage basins associated with F- and H-Areas; provisions for the implementation of other actions to mitigate any significant adverse effects of onsite or offsite groundwater and of chemical contaminants in seepage basins and adjacent areas, including the removal of such contaminants where necessary; and provisions for continuing the expanded program of groundwater-impact monitoring, in consultation with the appropriate South Carolina agencies (DOE, 1984b).

In response to commitments made in the GWPP, DOE has accomplished the following:

- Discontinued the use of the M-Area settling basin (DOE, 1985a)
- TE Completed the M-Area effluent-treatment facility (ETF)
- Initiated cleanup of volatile organic compounds in the M-Area groundwater (DOE, 1985a) via groundwater recovery wells and an air stripper
- Submitted a preliminary engineering report for the F- and H-Area ETF
- Completed a report describing the hydrogeology of the Plant and identified groundwater contamination (Du Pont, 1983)
- Developed an implementation plan for mitigation actions at those waste sites discussed in the preceding item (DOE, 1984b, Appendix D)
- TC Completed the SRP Baseline Hydrogeologic Investigation (Bledsoe, 1984; Bledsoe, 1987; Zeigler et al., 1986).

An SRP Baseline Hydrogeologic Investigation Program has been implemented to address the stratigraphic and hydrogeologic data needs of the Plant. The immediate objective of this program is the installation of 18 clusters of approximately 8 wells each at key locations across the Plant. The wells will (1) provide information on the lithology, stratigraphy, and hydrogeology of the Plant, and (2) serve as high-quality observation wells for monitoring the groundwater quality, hydraulic-head relationships, gradients, and flow paths, and for tracking parameter changes as water use changes on and off the Plant.

The program has three phases:

- Phase I (completed 1984) - installation of 20 observation wells at 3 cluster sites
- Phase II (completed 1985) - installation of 56 observation wells at 8 cluster sites
- TC Phase III (completed 1987) - installation of a total of 132 wells

Phases I and II concentrated on the collection of data from SRP areas on which little or no data existed. Phase III is designed to fill data gaps. The benefit of the entire program will be the establishment of a reliable, high-quality SRP hydrogeologic data base (Bledsoe, 1984; Bledsoe, 1987; Zeigler et al., 1986). TC

5.2 EXISTING WASTE SITE MONITORING

The groundwater underlying the Plant is subject to a continuing program of analysis for radioactive and nonradioactive constituents. Many monitoring wells have been installed in the water-table and underlying aquifers at waste disposal sites to gather information about the fate of materials discarded at these sites (Du Pont, 1983).

Several improvements were made in well construction and sampling technique in 1984 and 1985. In 1984, pumps were installed to provide adequate flushing of wells before sampling. In addition, all samples for metals analyses were filtered before preservation (40 CFR 136). These steps were taken because results indicated that inadequate flushing and particulate matter in the samples analyzed for metals were contributing to the questionable results that had been obtained previously (Zeigler, Lawrimore, and O'Rear, 1985). C-52

In 1985, galvanized well casings were removed from service and replaced by polyvinyl chloride (PVC) casings. Galvanized casings contributed to apparent contamination by several metals (zinc, cadmium, lead, and iron). Subsequent sample analyses have confirmed this relationship (Zeigler et al., 1986).

Groundwater from 325 wells is monitored at 59 potential hazardous and mixed waste management facilities and miscellaneous sites (Zeigler et al., 1987). TC SCDHEC has approved 4 of the 46 locations as interim-status hazardous waste management facilities. Three of the four are seepage basins (F-Area, three basins; H-Area, four basins; and M-Area, one basin and a lake) that have been used for many years to dispose of wastewater containing a variety of industrial chemicals. TC

Contamination of plants can result from the absorption of radioactive materials from the soil or from radioactivity deposited from the atmosphere. Soil and grass (generally bermuda) are analyzed routinely for radioactivity because of their year-round availability and large surface coverage.

Table 5-2 summarizes the availability and quantity of groundwater monitoring and soil sampling data at existing waste sites. The Environmental Information Documents (EIDs) with their corresponding source document numbers (DPST 688-713) are given for reference. The number of sites in each functional group is given, along with the dates that site activity ended. The number and types of monitoring wells and the year of beginning monitoring and frequency of sampling are shown. Soil sampling information is given as is an abbreviated list of chemical and radioactive constituents selected for analysis/assessment in the EIS (Looney et al., 1987). TC

Table 5-2. Existing Waste Sites Availability of Groundwater Monitoring and Soil Sampling Data

			Well Sampling						
Waste site functional grouping	DPST No.	Total no. of sites	Date closed	Number of wells	Date begun	Frequency(c)	Soil sampling	Selected constituents for EIS analysis	Comments
SRL Seepage Basins	688	4	10/82	9	1982	Q	1983 Soil Cores	Heavy metals, F, Na, PO_4, H-3, and other radionuclides	Basin 4 is dry
Metallurgical Laboratory Basin	689	1	11/85	3	1984	Q	Extensive	Cr, Pb, Hg, VOCs	
Burning/Rubble Pits	690	15	1973-81	60	1984	Q	None	Cr, Pb, Na, VOCs	4 wells at each pit
Metals Burning Pit/Misc Chem Basin	691	2	1974	4 & 0	1983-84	Q	None - Metal Pit, cores at Chem Basin	VOCs	Wells at Metal Pit
Old F-Area Seepage Basin	692	1	5/55	4	1984	Q	4 Sediments 1986	Ba, Cd, Cr, Pb, Hg, NO_3, Na, TCE, Sr-90, Y-90, U-238, Pu-239	
Separations Area Retention Basins	693	2	1973	2 in H-Area	1984	Q	Sediments F & H	Sr-90, Cs-137, Pu-238	No wells in F-Area
Radioactive Waste Burial Grounds	694	3	Open	(a)	1970s	(a)	Soils & lysimeters	Cd, Pb, Hg, VOCs, radionuclides	643-G - closed in 1972
Bingham Pump Outage Pits	695	7	1957-58	None	-	-	None	Co-60, Sr-90, Cs-137, Pm-147	
Hydrofluoric Acid Spill Area	696	1	Spill Area	4	1985	Q	None	Pb, F	Spill uncertain
SRL Oil Test Site	697	1	Test Site	None	-	-	Extensive	None; test plots for biodegradation	Testing planned in 1987
New TNX Seepage Basin	698	1	Open	4(b)	1980-83	Q	Sediments 1985	Ba, Ni, Cr, NO_3, PO_4, Na, U^n, VOCs	
Road A Chemical Basin	699	1	1973	4	1983-84	Q	None	Pb, U-238	
L-Area Oil & Chemical Basin	700	1	1979	4	1982	Q	Soil Cores 1985	Cd, Cr, Pb, Hg, Ni, VOCs, H-3, and other nuclides	
Waste Oil Basins	701	2	D-Area 1975	6 and 2	1984	Q	None	Tetrachloroethylene - D-Area, Motor shop - none	Motor shop closed in 1983
Silverton Road Waste Site	702	1	1974	16(d)	1981-84	Q	Soils in 1983	Pb, VOCs	

Footnotes on last page of table.

TC

Table 5-2. Existing Waste Sites Availability of Groundwater Monitoring and Soil Sampling Data (continued)

			Well sampling						
Waste site functional grouping	OPST No.	Total no. of sites	Date closed	Number of wells	Date begun	Frequency(c)	Soil sampling	Selected constituents for EIS analysis	Comments
M-Area Settling Basin & Vicinity	703	2	1984	8-RCRA	1982	Q	Extensive	Ba, Cd, Cr, Cu, CN, Pb, Hg, Ni, NO_3, EHP, PO_4, PCB, Ag, Na, U^d, VOCs, Zn	Remedial action in 1985
F-Area Seepage Basins	704	3	Open	13-Rad 17 RCRA	1981-82 1981-84	Q	Soil in 1971 & 1984	Ba, Cd, Cr, Pb, Hg, NO_3, Na, PO_4, H-3, and other nuclides	
Acid/Caustic Basins	705	6	1982	20	1984-85	Q	Sediments in 1985	As, Cr, Cu, Se, Hg, VOCs, Na, PO_4, SO_4	No wells in H-Area
H-Area Seepage Basins	706	4	3 Open	28 RCRA 16 Rad	1981-82	Q	Extensive	Cd, Cr, Pb, Hg, Ag, NO_3, Na, H-3, and other nuclides	1 basin inactive 1962
Reactor Seepage Basins	707	7	K-Area 1960	39-R-Area 4-K-Area	1958	Q	K-Area 1 core, R-Area 9	H-3, Co-60, Sr-90, Cs-137, Pm-147, Pu-239	R-Area closed 1964
Ford Building Waste Site	708	1	Uncertain	None	-	-	None	None	Nearby wells
Ford Building Seepage Basin	709	1	1984	5	1984	Q	Soil cores 1985	Pb, Hg, Cr, PO_4, alpha, Co-60, Cs-137, Sr-90, Eu-155, H-3	
Old TNX Seepage Basin	710	1	1980	7	1980-85	Q	Sediments, delta and basin	Cr, Ag, Ni, Hg, Pb, NO_3, VOCs, H-3, Th-232, U-235, U-238	
TNX Burying Ground	711	1	1953	None	-	-	None	Uranyl nitrate	Explosion in 1953
CMP Pits	712	7	1979	7 21	1975-79 1982-84	Q	Shallow and deep cores	Cr, Pb, Zn, pesticides, VOCs, including benzene	Excavated in 1984, 7 wells grouted
Gun Site 720 Rubble Pit	713	1	Unknown	None	-	-	None	None	No records

[a] Numerous grid, monitoring, trench and borehole wells have been installed since the early 1970s. See Jaegge et al., 1987, for details.
[b] Original 4 wells were replaced in 1983.
[c] Q = quarterly.
[d] Includes clusters of wells.
U^n = Natural uranium
U^d = Depleted uranium
VOC = Volatile organic compounds
EHP = Bis-2-ethyl hexyl phosphate
TCE = Trichloroethylene
PCB = Polychlorinated biphenyl

TC

5.2.1 F- AND H-AREAS

TC Routine environmental monitoring is conducted at the F- and H-Area seepage basins (Ashley, Padezanin, and Zeigler, 1984; DOE 1985b; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987). For radiation monitoring, composite samples of the influent flow of the basins are taken from the flow proportional continuous monitor once a week. In addition, dip samples from the basins and groundwater monitoring well samples are taken once a quarter. The vegetation surrounding the basins is sampled once a year. Each sample is analyzed for gross alpha and beta, gamma spectrum, and strontium-89 and -90. The radioactivity released to the seepage basins is reported in the Health Protection Monthly Radioactive Release Report.

TC Monitoring wells were installed in 1951. These wells are used to measure water-table elevations in the Separations Area. They are also used to monitor any groundwater contamination in the vicinity of F- and H-Areas. These wells are sampled for radioactivity and for Primary Drinking-Water Standard metals (Zeigler et al., 1986; Zeigler et al., 1987).

Soil samples were collected from the four quadrants around the F- and H-Areas and at the SRP boundary. In addition, two control samples were taken approximately 160 kilometers from the SRP. Soil cores were composited by location and analyzed for plutonium-238 and -239, strontium-90, and gamma-emitting radionuclides (Zeigler et al., 1986; Zeigler et al., 1987). The migration of radioactivity from the F- and H-Area seepage basins was measured with continuous samplers and flow recorders in Four Mile Creek. Groundwater from the F-Area seepage basin flows to outcrops on Four Mile Creek (FM) between two sample locations.

Most of the H-Area seepage basin outcrop from basins 1 through 3 occurs between two sample locations. Additional outcrop from H-Area seepage basin 4 and the burial ground occurs between two other sample locations. The tritium from these two facilities mixes; beyond this mixing point the source of tritium cannot be determined.

F-Area Seepage Basins

J-38 In 1985, groundwater at the F-Area seepage basin was monitored routinely at eight wells and at nine wells in 1986. Two wells were nearly dry in 1986; no samples were analyzed (Zeigler et al., 1987). The radioactivity detected in seepage basin wells will be diluted by groundwater and eventually will either decay or flow with groundwater to Four Mile Creek. Acid, sodium, and nitrate have also been detected at the seepage basin compliance point; accordingly, detection monitoring has been replaced by compliance monitoring, as required by the SCHWMR and the RCRA.

H-Area Seepage Basins

Groundwater below the H-Area seepage basins was monitored routinely at 16 wells between the seepage basins and Four Mile Creek.

H-Area Retention Basins

In 1985, wells were installed around the two H-Area retention basins. No samples were collected at these wells in 1986 (Zeigler et al., 1987). J-38

5.2.2 RADIOACTIVE WASTE BURIAL GROUNDS

A program to monitor the migration of radionuclides from their storage locations has been under way since the startup of the waste-disposal/storage site. The U.S. Army Corps of Engineers installed the first monitoring wells (nine perimeter wells) in 1956. Monitoring has increased over the years of operation, and additional wells were installed in 1963 and 1969. In 1972 and 1973, 11 new wells were installed in this area; in 1975, 35 wells were installed at the perimeter of the burial ground (Buildings 643-G and 643-7G). Sixteen of the wells installed between 1963 and 1975 replaced the nine original perimeter wells. In 1978 and 1979, five new cluster wells were installed at the perimeter of the burial ground outside the fenced area. Groundwater at the burial ground is analyzed quarterly for alpha, nonvolatile beta, and tritium. Routine monitoring is performed at 16 wells inside the facility and 35 J-38 wells along the perimeter. In addition, there is an extensive grid monitoring system of 87 wells for migration and modeling studies (DOE 1985b; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987). J-38

The area around the waste monitoring trailer has a history of contaminated vegetation dating to 1965, when vegetation contaminated with strontium-89 and -90 was found. J-38 Soil core samples at that time indicated high concentrations of nonvolatile beta within 0.6 meter of the surface of the soil. The area was cleared of vegetation and treated with a herbicide at that time.

During 1985, vegetation was collected inside the radioactive waste burial ground (Buildings 643-G and 643-7G). The samples were analyzed to determine if the vegetation had experienced a significant uptake of radioactivity from the waste buried there.

Vegetation collected from 51 locations inside the burial ground was composited by location for analysis. This collection method provides coverage of a large part of the facility while keeping the number of samples to a minimum. The samples were analyzed for alpha, nonvolatile beta, and gamma-emitting radionuclides (DOE 1985b; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987). TC

In 1986, an extensive system of 87 groundwater monitoring wells was sampled TC for concentrations of alpha, nonvolatile beta, and tritium in the groundwater beneath the solid waste storage facility. Some of these wells are used for routine monitoring; others are used for research to determine possible migration pathways and for development of groundwater models (Zeigler et al., 1987). TC

5.2.3 REACTOR SEEPAGE BASINS

Groundwater is currently monitored at 70 wells in and around the reactor seepage basins and K-Area containment basin. Three wells in R-Area were dry J-38 in 1986 (Zeigler et al., 1986; Zeigler et al., 1987).

In addition, vegetation samples were collected near each reactor seepage basin. Samples from a maximum of eight locations outside the fence of each seepage basin were composited for alpha, beta, strontium-89, and strontium-90 analyses (Zeigler et al., 1986).

5.2.4 M-AREA

J-38 Groundwater monitoring from over 200 wells is presently being performed at the M-Area settling basin. This monitoring is in response to the detection in 1984, 1985, and 1986 of halogenated organics, nitrate, and sodium (Zeigler et al., 1986; Zeigler et al., 1987).

5.2.5 OTHER MONITORING ACTIVITIES

Because the environmental monitoring program at the SRP is one of the largest and most comprehensive in the United States, this EIS cannot describe all of the studies and monitoring activities conducted on the SRP. (More information on such activities can be obtained from Du Pont, 1985a, b; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987; GDNR, 1983; and SCDHEC, 1983.) However, in response to this EIS, the South Carolina Institute of Archaeology and Anthropology, University of South Carolina, conducted an intensive archaeological and historical survey of 82 existing hazardous, low-level radioactive, and mixed waste sites located in the upland sandhills zone of the SRP (Brooks, 1986). The Institute also carried out an intensive archaeological and historical survey and testing of six new low-level radioactive, hazardous, and mixed waste storage and disposal facilities located primarily in the same area (Brooks, Hanson, and Brooks, 1986). TC

5.2.5.1 Drinking-Water Monitoring

Communities near the Plant get drinking water from deep wells or surface-water bodies. Drinking-water supplies from 22 onsite facilities and 14 surrounding towns are sampled and analyzed for alpha, nonvolatile beta, and tritium. In addition, the SRP and SCDHEC routinely analyze water from 14 SRP drinking-water sources for the total number of bacteria multiplying at 35°C on an agar medium (standard plate count), total coliform bacteria, pH, and residual chlorine. They also analyze some systems for turbidity, hardness, and carbon dioxide (Zeigler et al., 1986; Zeigler et al., 1987). TC

5.2.5.2 Surface-Water Supplies

Two water treatment plants downstream from the Plant supply treated Savannah River water to customers in Beaufort and Jasper Counties, South Carolina, and in Port Wentworth, Georgia. The Beaufort-Jasper plant serves a consumer population of approximately 50,000. Treated water from the Port Wentworth plant is used primarily for manufacturing and other industrial purposes. The Port Wentworth water treatment plant has an effective consumer population of about 20,000.

Samples of raw and finished water at both plants are collected daily and composited for monthly alpha, nonvolatile beta, and tritium analyses. Additional monitoring of raw and finished water from the plants for low levels of cobalt-60 and cesium-137 is provided by continuous samplers. Results of 1985 analyses for alpha, nonvolatile beta, tritium, cobalt-60, and cesium-137 were reported quarterly to the plants and to the States of Georgia and South Carolina. SCDHEC performs independent tritium and nonvolatile beta analyses of water samples at the Beaufort-Jasper treatment facility. Results of these analyses are compared to SRP data. GDNR also collects drinking-water samples from the Port Wentworth facility monthly and analyzes them for alpha, nonvolatile beta, and tritium concentrations (DOE, 1984a; Zeigler et al., 1986; Zeigler et al., 1987). TC

5.2.5.3 Groundwater Supplies

The SRP collects groundwater samples from several monitoring wells and analyzes them for radioactivity (Du Pont, 1985a). The SCDHEC monitors for concentrations of alpha, nonvolatile beta, and tritium in groundwater from wells in six nearby communities and from additional wells around the Barnwell Nuclear Fuel Plant. The GDNR monitors for the same parameters at 10 Georgia locations. Both State programs are conducted quarterly (DOE, 1984a; Zeigler et al., 1986; Zeigler et al., 1987). TC

5.3 EXISTING WASTE SITES - FUTURE MONITORING

5.3.1 GROUNDWATER QUALITY ASSESSMENT PLAN

The Groundwater Quality Assessment Plan was designed to determine the extent, concentration, and rate of migration of hazardous waste constituents in the groundwater system. The plan involves monitor-well installation, water-quality sampling and analysis, hydrogeologic data collection, and data evaluation (Du Pont, 1985c).

5.3.1.1 M-Area Settling Basin

To define the extent and concentration of waste constituents in the groundwater at M-Area, a two-phase well-installation program was designed. Phase I, initiated in September 1984, consisted of the installation of 58 monitor wells in 15 clusters. The placement of the wells was designed to expand, horizontally and vertically, the existing monitoring network. The installation of the Phase I wells was completed in May 1985 (Du Pont, 1985c).

A hydrogeologic data collection program was incorporated as an integral part of the Groundwater Quality Assessment Plan (Du Pont, 1985c). The objectives of this program are to define the geometry of the pertinent hydrologic units at the site and to quantify the water retention and transmission characteristics of each unit. The hydrogeologic data collection program has three basic program elements: (1) geologic data collection and testing, (2) aquifer pump testing, and (3) potentiometric data collection.

The final element of the Groundwater Quality Assessment Plan is evaluation of the data. Graphic, analytic, and numeric techniques are used to determine the extent of groundwater contamination and the rates of contaminant migration. DOE submits annual reports of groundwater-quality assessment to SCDHEC. These assessment reports will propose and describe required additional studies.

5.3.1.2 F-Area Seepage Basins

In F-Area, 17 wells in 4 hydrogeologic zones will be monitored quarterly for the indicator parameters and groundwater-quality parameters listed in Table 5-1. All these parameters will be monitored annually. In addition, the indicator parameters will be monitored semiannually. This semiannual sampling will include nitrate and sodium. Other constituents identified as groundwater contaminants will be added to the monitoring program (Du Pont, 1985c).

This monitoring program will be used to detect any hazardous constituents that might enter the groundwater from the F-Area basins. Each quarter, the analyses will be studied for the appearance of hazardous constituents and changes in groundwater flow rate or direction. The annual groundwater-quality assessment reports will present the results. These reports will also propose and describe required studies (Du Pont, 1985c).

5.3.1.3 H-Area Seepage Basins

In H-Area, 28 wells in 4 hydrogeologic zones will be monitored quarterly for the indicator parameters and groundwater-quality parameters listed in Table 5-1, and for mercury, sodium, and nitrate. Other constituents identified as groundwater contaminants will be added to the monitoring program as identified (Du Pont, 1985c). The annual groundwater-quality assessment reports will present results of these analyses, along with information from F- and M-Areas. These reports will also describe additional studies or monitoring activities required.

5.3.2 MONITORING ASSOCIATED WITH WASTE MANAGEMENT FACILITY CLOSURE AND POSTCLOSURE

DOE submitted closure plans for the metallurgical laboratory basin (Du Pont, 1985d) and the mixed waste management facility (DOE, 1985c), and a postclosure permit application for the M-Area hazardous waste management facility (DOE, 1985a), to SCDHEC in 1985, in accordance with the SCHWMR. The following sections describe the monitoring commitments associated with these closure and postclosure plans.

5.3.2.1 Metallurgical Laboratory Basin

Monitoring commitments associated with closure of the metallurgical laboratory basin include the commitment to monitor wells 1A, 2, and 3A quarterly for the parameters listed in Table 5-1 (Du Pont, 1985d).

5.3.2.2 Mixed Waste Management Facility

The DOE will complete the following in conjunction with site closure: a borrow study to identify sources of material for the final cover; a compaction study to determine the physical characteristics of the waste and overburden; and studies of the effects of overburden on subsidence in the trenches (DOE, 1985c).

In addition, the DOE has proposed a detection monitoring program to determine if groundwater contamination is occurring. The proposed monitoring well system will determine the quality of both background groundwater (i.e., groundwater not affected by operations of low-level radioactive waste disposal facilities) and groundwater past the point of compliance. The monitoring of downgradient groundwater quality at the compliance point is required by RCRA.

The detection monitoring system will consist of 27 wells, including the upgradient wells. This system assumes three wells per cluster in the uppermost aquifer. Each cluster will have three screened zones with discrete functions: the uppermost screen will monitor the zone near the top of the water table; the middle screen will monitor the zone above the "tan clay" near the top of this subunit; and the bottom screen will monitor the lowermost strata of the aquifer near the top of the "green clay." The exact number of wells per cluster will be determined during drilling when the lithology has been assessed. To provide an accurate groundwater characterization, the background monitoring well cluster will be approximately 1370 meters from the mixed waste management facility. The remaining 24 detection monitoring wells will be downgradient wells (DOE, 1985c).

The detection well system will fulfill RCRA requirements. Data from the proposed well clusters will describe thoroughly the site hydrogeology in the uppermost aquifer for the mixed waste management facility.

5.3.2.3 M-Area Settling Basin and Lost Lake

Hazardous constituents have been detected during interim-status monitoring at the M-Area settling basin and Lost Lake. Therefore, detection monitoring is not applicable to this site, and compliance point monitoring will be performed (DOE, 1985a).

The groundwater monitoring well system will consist of nine downgradient wells grouped in three clusters, and one upgradient cluster of three wells. The upgradient well cluster will be 122 meters from the M-Area settling basin on the axis of the groundwater ridge. Because the M-Area basin is approximately 30 meters above the water table, leakage from the basin might cause water-table mounding beyond the areal limits of the basin. Placing the upgradient wells 122 meters from the basin will preclude facility-induced contamination (DOE, 1985a).

5.3.3 WASTE SITE CHARACTERIZATION PROGRAM

The Savannah River Laboratory is developing and implementing characterization programs for determining the extent of chemical and/or radionuclide contamination at SRP waste sites. The data collected from these programs will provide the technical basis for the final closure of these waste sites according to applicable State and Federal regulations. Characterization programs have been completed for the Savannah River Laboratory (SRL), M-Area, Old TNX, and metal-
lurgical laboratory seepage basins and H-Area (for tritium in the Congaree TC
Formation). Additional characterization programs are in progress for the
L-Area oil and chemical basin and the Ford Building seepage basin and are
planned for the New TNX seepage basin (Zeigler et al., 1986). A summary of J-38
1986 activities is presented in Zeigler et al., 1987.

5.4 *NEW DISPOSAL FACILITIES*

5.4.1 HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984

New landfills and surface impoundments, as well as replacement units and expansions of existing facilities, were required to meet minimum technological requirements (MTRs) after November 8, 1986. These requirements include a double liner, a leachate collection system, a leak detection system for new units after May 1987, and groundwater monitoring.

TC In February 1987, EPA issued proposed regulations for the monitoring and control of air emissions at hazardous waste treatment, storage, and disposal facilities. Such facilities include, but are not limited to, monitored retrievable storage facilities, surface impoundments, and landfills such as the new disposal facilities for low-level radioactive wastes and mixed wastes.

To comply with the HSWA, DOE submitted an Exposure Information Report (EIR) to SCDHEC and EPA in August 1985. The EIR contained information important to assessing the potential for exposure of the public to waste disposal in the interim-status facilities (Zeigler et al., 1986).

TE

5.4.2 PROPOSED MONITORING AT NEW DISPOSAL/STORAGE FACILITIES

TE

The groundwater monitoring system at the new disposal/storage facilities must permit determination of the impact of these facilities on groundwater in the TC aquifers above the Black Creek/Middendorf (Tuscaloosa). The system must have the following features:

- Well placement that will permit the collection of representative samples of groundwater, including groundwater upgradient from the facility
- Casings that will maintain the integrity of the monitoring-well bore
- Measures to prevent the contamination of groundwater samples

TE To meet these requirements, the monitoring system will consist of a series of well clusters spaced about every 46 meters at the boundary of a facility. The TE wells will have 6-meter screens placed at 15-meter depth intervals to the top of the Ellenton Formation (Cook, Grant, and Towler, 1987a, b).

The monitoring program will involve the collection of monthly samples from each monitoring position. The samples will be analyzed for chemical (inorganic and organic) and radionuclide species expected to be in the waste that is disposed of or stored in the facilities.

Surface water in the vicinity of the new storage and disposal facilities will be monitored for chemicals and radionuclides; it will consist of the rainwater runoff and standing water in streams that draw water from the land area around the facility. The storage and disposal facilities will have an engineered surface-water drainage system that will impound the water in one or more locations for monitoring and treatment, if needed, before releasing it to plant streams.

Air monitoring will be provided as needed, depending on the amount of rainfall in the area. Moreover, rainfall and air collection and monitoring systems will be in operation on the perimeter of the storage and disposal facilities. Such systems have been in use on the Plant for many years; they collect rainfall and examine it for radioactivity or collect air samples on filters and examine them (Cook, Grant, and Towler, 1987a, b).

TE

5.5 ANALYTICAL STUDIES

Analytical studies are designed to use and supplement the data gathered in the monitoring studies described previously in this chapter. Such analytical studies can be used to increase knowledge of (1) the site, (2) the impacts of site operations on the environment, and (3) actions required to mitigate the environmental impacts of site operations. Appendix H contains details on the models used in this analysis and the basis for their selection.

5.5.1 GROUNDWATER-FLOW MODELING

The SRL manages the regional groundwater-flow modeling program. This program is a management tool that helps planners make decisions about groundwater resources at the Plant. Modeling is conducted in three phases (Zeigler et al., 1986):

- System conceptualization
- Model calibration
- Simulation

Under this program, a numerical groundwater-flow model was developed for a 78-square-kilometer area that underlies the A/M-Area. The purpose of this model is to predict and evaluate the efficacy of the groundwater remedial-action program. The model was used to simulate the flow patterns of groundwater and the effects of recovery-well operations on these patterns. After an initial model calibration, various pumping scenarios were examined. The results were used to relocate two perimeter wells of the recovery-well network to enhance chlorocarbon-plume capture.

TE

5.5.2 ENVIRONMENTAL INFORMATION DOCUMENTS AND PATHRAE MODELING

For the preparation of this EIS, DOE requested E. I. du Pont de Nemours and Company (Du Pont) to provide technical support of groundwater modeling, human health risk assessment, and ecological impacts for the alternatives associated with the closure of hazardous, low-level radioactive, and mixed waste sites, and for the proposed new disposal/storage facilities.

TE

Du Pont categorized the existing waste sites that were originally identified for inclusion in the EIS into 26 functional groupings. The technical approach involved preparing an Environmental Information Document (EID) for each of the 26 groupings (complete reference citations for the 26 EIDs are given in Appendixes B and E). Part I of each EID, which encompasses the nature of contaminant disposal, the geohydrologic setting, and waste site characterization, was completed in 1985. Part II, which includes estimates of environmental hazards associated with each closure option for each grouping, was completed late in 1986. Environmental Information Documents for the proposed new disposal

TC facilities were also prepared, as were EIDs related to transport modeling, chemical constituent selection, quality assurance, geochemical parameters, and human health effects.

The PATHRAE computer code was chosen to calculate the human health risks associated with the subsurface transport of contaminants for each alternative evaluated on a comparative basis. PATHRAE was originally developed for the EPA for performance assessment calculations at low-level radioactive waste disposal sites. The code has been modified to perform transport and risk calculations for nonradioactive constituents. Pathways modeled using PATHRAE include

- Groundwater to wells
- Groundwater to surface streams
- Waste erosion and movement to surface streams
- Consumption of food from a reclaimed farm over the waste site
- Consumption of crops from natural biointrusion into the basin
- Direct gamma exposure

Computer code calculations were also made to determine, for each waste site alternative, the risks to human populations from the atmospheric transport of contaminants. Atmospheric pathways evaluated include the inhalation of polluted air, the ingestion of contaminated foodstuffs by individuals and the offsite population, and the risks to occupational personnel from airborne contaminants generated during actual waste site closure operations. The computer codes used to model the atmospheric pathways are SESOIL, MARIAH, XOQDOQ, CONEX, TERREX, MILENIUM, MAXIGASP, and POPGASP (see Appendix H for more details).

5.5.3 TRANSPORT OF HEAVY METALS AND RADIONUCLIDES

Research continues on the development of a geochemical model for predicting the chemical speciation, mass transport, and fate of metals and radionuclides in aquatic systems on the Plant. The geochemical model MEXAMS (Metal Exposure Analysis Modeling System) has been installed on the site computer system. The basic components of MEXAMS are the geochemical model MINTEQ and an aquatic exposure assessment model, EXAMS. The interfacing of these two models provides information on the chemistry and behavior of metals, as well as the transport processes influencing their migration and ultimate fate in aquatic systems. Simulations for cadmium, copper, and nickel in SRP streams indicate TC that the MEXAMS model will be a useful tool in predicting the transport and fate of metals (Zeigler et al., 1986; Zeigler et al., 1987).

5.5.4 ENVIRONMENTAL RADIOMETRICS

At present, a specially constructed ultra-low-level counting facility is being used to analyze concentrations of radioactive isotopes at environmental-background levels. Other analyses are being conducted to develop specific information about the transport and fate of long-lived radionuclides such as technetium, uranium, and plutonium. A state-of-the-art underground counting facility will improve sensitivity and sample processing.

REFERENCES

Ashley, C., P. C. Padezanin, and C. C. Zeigler, 1984. Environmental Monitoring at the Savannah River Plant, Annual Report For 1983, DPSPU-84-302, Health Protection Department, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Bledsoe, H. W., 1984. SRP Baseline Hydrogeologic Investigation - Phase I, DPST-84-833, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Bledsoe, H. W., 1987. Head Difference Between Congaree and "Tuscaloosa" Aquifers, DPST-87-592, E. I. du Pont de Nemours and Company, Technical Division, Savannah River Laboratory, Aiken, South Carolina. TC

Brooks, M. J., 1986. An Intensive Archaeological and Historical Survey of the Existing Hazardous, Low-Level Radioactive and Mixed Waste Sites, Savannah River Plant, South Carolina, University of South Carolina, South Carolina Institute of Archaeology and Anthropology, Savannah River Plant Archaeological Research Program.

Brooks, M. J., G. T. Hanson, and R. D. Brooks, 1986. An Intensive Archaeological Survey and Testing of Alternative, New Low-Level Radioactive and Hazardous/Mixed Waste Storage/Disposal Facilities, Savannah River Plant, Aiken and Barnwell Counties, South Carolina, Savannah River Plant Archaeological Research Program, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia, South Carolina.

Cook, J. R., M. W. Grant, and O. A. Towler, 1987a. 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.

TE

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

DOE (U.S. Department of Energy), 1984a. Final Environmental Impact Statement, L-Reactor Operation, Savannah River Plant, Aiken, S.C., Vol. 1, DOE/EIS-0108, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1984b. Groundwater Protection Plan for the Savannah River Plant, prepared in accordance with Public Law 98-181, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1985a. Application for a Post-Closure Permit, Savannah River Plant, United States Department of Energy, Volume III, M-Area Hazardous Waste Management Facility, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1985b. Savannah River Interim Waste Management Program Plan - FY-1986, DOE/SR-WM-86-1, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1985c. Closure Plan for Mixed Waste Management Facility, Savannah River Operations Office, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983. Technical Summary of Groundwater Quality Protection Program at Savannah River Plant, DPST-83-829, E. J. Christensen and D. E. Gordon, editors, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1985a. U.S. Department of Energy, Savannah River Plant, Environmental Report for 1984, DPSPU-85-30-1, Health Protection Department, Savannah River Plant, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1985b. Comprehensive Cooling Water Study Annual Report, DP-1697, Vols. 1-11, J. B. Gladden, M. W. Lower, H. E. Mackey, W. L. Specht, and E. W. Wilde (editors), Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1985c. Savannah River Plant Groundwater Quality Assessment Plan, Vols. 1-4, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1985d. Closure Plan for the Metallurgical Laboratory Basin at the Savannah River Plant, prepared for the U.S. Department of Energy, Savannah River Operations Office, Aiken, South Carolina.

GDNR (Georgia Department of Natural Resources), 1983. Environmental Radiological Surveillance Report, Summer 1980-Summer 1982, Environmental Protection Division, Social Circle, Georgia.

SCDHEC (South Carolina Department of Health and Environmental Control), 1983. Summary Report: Radiological Environmental Monitoring Around the Savannah River Plant, Columbia, South Carolina.

Zeigler, C. C., I. B. Lawrimore, and W. E. O'Rear, 1985. Environmental Monitoring at the Savannah River Plant, Annual Report for 1984, DPSPU-85-302, Health Protection Department, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Zeigler, C. C., I. B. Lawrimore, E. M. Heath, and J. E. Till, 1986. Savannah River Plant Environmental Report, Annual Report for 1985, DPSPU-86-30-1, prepared for the U.S. Department of Energy by the Health Protection Department, E.I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

J-38 Zeigler, C. C., E. M. Heath, L. B. Taus, and J. L. Todd, 1987. Savannah River Plant Environmental Report, Annual Report for 1986, DPSPU-87-30-1, prepared for the U.S. Department of Energy by the Health Protection Department, E.I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

CHAPTER 6

FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS

This chapter summarizes the Federal and State of South Carolina environmental requirements that are applicable to the implementation of the proposed action for this environmental impact statement (EIS), which is the modification of waste management activities at the Savannah River Plant (SRP) for hazardous, low-level radioactive, and mixed wastes to protect groundwater, human health, and the environment. The purpose of the proposed action and the specific modifications considered is to identify and select a waste management strategy for SRP hazardous, low-level radioactive, and mixed wastes that can be implemented to achieve compliance with groundwater-protection requirements.

Section 6.1 describes general requirements that have broad applicability to SRP operations, including statutory requirements, administrative and executive orders, and an interagency agreement. Section 6.2 describes specific requirements for hazardous, low-level radioactive, and mixed waste management, and summarizes the applicability of these requirements to U.S. Department of Energy (DOE) operations.

6.1 GENERAL ENVIRONMENTAL REQUIREMENTS

6.1.1 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) was signed on January 1, 1970 (42 USC 434-1). Its purpose was to establish (1) a national policy for the protection of the environment and (2) the Council on Environmental Quality (CEQ). The CEQ issued its Final Guidelines for implementation on August 1, 1973. Congress amended NEPA on July 3, 1975, and again on August 9, 1975. On November 29, 1978, the CEQ proposed regulations implementing NEPA; the final regulations are codified in 40 CFR 1500-1508.

The requirements of NEPA specify that if a Federal action might have a significant effect on the quality of the human environment, the agency involved must prepare a detailed EIS.

6.1.2 EXECUTIVE ORDER 12088: FEDERAL COMPLIANCE WITH POLLUTION CONTROL STANDARDS

In addition to the authority of Congress and Federal and state administrative agencies to establish and enforce environmental standards, the President of the United States has the authority to issue Executive Orders (EOs) to clarify environmental policies. EO 12088 of October 13, 1978, "Federal Compliance with Pollution Control Standards," states that the head of each executive agency is responsible for ensuring that the agency takes all necessary actions for the prevention, control, and abatement of environmental pollution with respect to Federal facilities and activities under its control. Each agency head is also responsible for compliance with applicable pollution-control standards, such as those defined under the Clean Water Act (CWA) and Clean Air Act (CAA).

6.1.3 ADMINISTRATIVE ORDERS

DOE has developed a uniform system of communicating policy and procedures to its employees. The system is based on administrative directives, or DOE Orders, which contain information on procedures, responsibilities, and authorities for performing DOE's various functions.

In general, DOE Orders establish general policy guidance and assign general responsibility for implementation. At the Savannah River Plant, DOE Orders are implemented through Savannah River Operations Office Orders, which specify procedures and responsibilities for implementation. The numbering system for these Orders parallels that of the corresponding DOE Orders.

The following DOE Orders are generally applicable to waste management activities under the environmental and health and safety protection programs on the SRP:

- DOE Order 5480.1B, Environmental Protection, Safety, and Health Protection Standards
- DOE Order 5480.12, General Environmental Protection Program Requirements (Draft) TC
- DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards
- DOE Order 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

Chapters I, XI, and XII of DOE Order 5480.1B have the most direct applicability to this EIS. Chapter I sets forth the environmental protection, safety, and health protection standards applicable to all DOE operations. DOE policy states that the Department will comply with all legally applicable Federal and state standards. In the event of conflicts between prescribed and recommended standards, those providing the greatest protection apply. This chapter also covers responsibilities and lines of authority for DOE officials. Chapter XI of this Order provides *inter alia* radiation-protection standards for occupational and nonoccupational exposures and guidance on keeping exposures as low as reasonably achievable (ALARA). It also provides concentration guides for airborne effluents, liquid effluents, and drinking water, and establishes exposure standards aimed at achieving ALARA dosage rates for individuals and population groups in uncontrolled areas. This chapter also sets monitoring requirements to ensure that these standards are met. Chapter XII establishes requirements for DOE operations to ensure (1) control of sources of environmental pollution and (2) compliance with environmental protection laws and with EO 12088.

TC DOE Order 5480.12 is a draft Order, issued on May 12, 1987, for internal DOE review. When it is issued, this Order will be an "umbrella" directive for the oversight of environmental programs that are the responsibility of the Assistant Secretary for Environment, Safety and Health. It will also restructure several DOE Orders.

DOE Order 5480.4 provides requirements for the application of mandatory environmental, safety, and health (ES&H) standards applicable to all DOE operations; it also lists ES&H standards and identifies sources of mandatory and reference standards. TC

DOE Order 5484.1 establishes the requirements and procedures for reporting information having environmental protection, safety, or health-protection significance for DOE operations.

6.2 SPECIFIC REQUIREMENTS

Since the passage of the Resource Conservation and Recovery Act (RCRA) in 1976 and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980, DOE has become subject to regulatory programs for the management of solid, nonradiological hazardous waste. The following sections summarize the specific requirements of these statutes and other environmental protection requirements applicable to Federal agencies.

6.2.1 ATOMIC ENERGY ACT

6.2.1.1 Federal Statute

Congress passed the Atomic Energy Act (AEA) of 1954 to ensure that research and development of atomic energy for both peaceful and military purposes were coordinated and timely, and that the processing of source, byproduct, and special nuclear materials would be managed in the national interest. The Act established the Atomic Energy Commission (AEC) to administer its provisions.

In 1974, the Energy Reorganization Act (Public Law 93-438) divided the responsibilities of the AEC between the Energy Research and Development Administration and the U.S. Nuclear Regulatory Commission. In 1977, the DOE Organization Act (Public Law 95-91) further centralized the administration of national programs related to energy-policy formulation, research and development activities, and demonstration-project development.

With respect to agency jurisdiction over waste management activities on the SRP, Section 1271 of the AEA (42 USC 2018) confers to DOE full jurisdiction over source, special nuclear, and byproduct materials. In addition, Section 84 of the AEA requires that management of byproduct materials must be performed in conformance with general standards of EPA (under the Solid Waste Disposal Act, as amended) that are applicable to similar hazardous material. TC TC

On May 1, 1987, DOE issued a final interpretive rule (52 FR 15937), effective June 1, 1987, relative to byproduct material. This rule interpreted the AEA definition of the term "byproduct material," as it applies to DOE-owned or -produced radioactive waste substances which are also hazardous within the meaning of RCRA. The effect of the rule is that all DOE waste which is hazardous under RCRA will be subject to regulation under both RCRA and the AEA. The hazardous waste will come under EPA SCDHEC jurisdiction. E-29

6.2.1.2 DOE Order 5820.2

On February 6, 1984, DOE issued Administrative Order 5820.2, which establishes policies and guidelines for the management of radioactive waste, waste byproducts, and radioactively contaminated surplus facilities. The objective of this Order is to ensure that DOE operations involving the management of radioactive waste, waste byproducts, and surplus facilities adequately protect the public health and safety in accordance with radiation-protection standards. This Order defines key terms and specifies lines of authority. Chapter III establishes the policies and guidelines for managing low-level waste, and specifies site selection, design criteria, and disposal-site operations. In addition, it details requirements for disposal, site closure, and postclosure. Chapter IV deals with the management of wastes contaminated with naturally occurring radionuclides. Chapter V discusses the decontamination and decommissioning of surplus facilities.

DOE has issued radiological protection guidelines for two programs that involve radioactive waste management and decontamination: the Formerly Utilized Sites Remedial Action Program (FUSRAP) and the Surplus Facilities Management Program. These guidelines, which are limited in scope to the two programs, use the latest technical data and emphasize the need for site-specific radionuclide concentration criteria for waste management and decontamination. They do, however, present Allowable Residual Contamination Limits (ARCLs) for a number of radionuclides and materials, including naturally occurring radionuclides in soil, radon decay products in air, external gamma radiation levels, and surface contamination. The guidelines for surface contamination cover most naturally occurring and manmade radionuclides.

6.2.2 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

TE CERCLA (Public Law 96-510), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 (Public Law 99-499), provides liability, compensation, cleanup, and emergency response by the Federal Government for hazardous substances released into the environment, and for the cleanup of inactive hazardous waste disposal sites.

6.2.2.1 Federal Statute

There are three types of Government cleanup and response actions: (1) immediate removals, for which emergency action is required (e.g., to avert fire or explosion or to prevent the contamination of a drinking-water supply); (2) planned removals, for which a prompt response is required to minimize danger to the public or the environment; and (3) remedial actions taken at sites identified on the National Priorities List. Section 107(g) of CERCLA specifies the liability of DOE. According to this section, Departments of the Federal Government are both "procedurally and substantively" subject to compliance with CERCLA. In other words, "remedial actions" for CERCLA sites are to be undertaken at all Federal facilities. C-85

TE Congress enacted the Superfund Amendments and Reauthorization Act on October 17, 1986. Section 120 of the Act establishes requirements for Federal facilities, including liability and the applicability of state requirements to remediation activities at Federal facilities. Section 121 addresses cleanup standards, including a degree of cleanup of hazardous substances that ensures protection of human health and the environment.

6.2.2.2 Federal Regulations

The National Contingency Plan (40 CFR 300), which was established under Section 105 of CERCLA, defines responses to actual or threatened releases of oil or hazardous substances to the environment. It calls for Remedial Investigations/Feasibility Studies for all remedial actions. These studies determine the nature and extent of the threat presented by the release of a hazardous substance and evaluate proposed remedies. They include sampling, monitoring, assessing exposure as necessary, and gathering sufficient information to determine the necessity for and the proposed extent of remedial action.

6.2.2.3 DOE Order 5480.14: Comprehensive Environmental Response, Compensation, and Liability Act

DOE developed its policy on emergency response under CERCLA and issued DOE Order 5480.14 on April 26, 1985. This Order specifies official responsibilities and lines of authority. In addition, it describes a response program with five phases:

- Installation Assessment - The preliminary identification of potential sites based on records review, screening for manufacturing-process specifications, raw-materials identification, and byproduct specification; records of disposal practices, locations, and quantities disposed are used to evaluate past operations at a potential site.

- Confirmation and Site Characterization - Actual onsite sampling and modeling to confirm the presence of contamination and the extent of migration, and an analysis of pathways of exposure (exposure assessment).

- Engineering Assessment - The design of remedial-action alternatives for the site and selection of the most cost-effective alternative that meets the site's predetermined objectives for recommendation to DOE Headquarters.

- Remedial Actions - The implementation of the selected alternative and the processing of funding documentation after DOE Headquarters concurrence.

- Compliance and Verification - Consolidation and documentation of the entire process. According to this Order, DOE is to complete this phase by April 26, 1995.

6.2.3 RESOURCE CONSERVATION AND RECOVERY ACT AND HAZARDOUS AND SOLID WASTE AMENDMENTS

In 1976, Congress passed RCRA (Public Law 94-580, 42 USC 6901 et seq.) to provide a national program for the management, transportation, treatment, and disposal of hazardous waste. In addition to RCRA, Congress passed the Hazardous and Solid Waste Amendments (HSWA) of 1984. These amendments instituted

C-86 an accelerated schedule for Part B permit application submittals, restricted landbased disposal of hazardous wastes, specified an annual inspection program for Federal facilities, required an inventory of Federal hazardous-waste facilities, set up a permitting program for underground storage tanks, established a waste-minimization program, and set a closure schedule for the use of surface impoundments.

6.2.3.1 Federal Statutes

RCRA enabled the states to implement EPA-approved permitting programs, involving a detailed "cradle-to-grave" manifest tracking system for all wastes that the U.S. Environmental Protection Agency (EPA) has designated as hazardous. Wastes are hazardous if they exhibit the characteristics of ignitability, corrosivity, reactivity, or toxicity using a specified extraction procedure, and if they are listed in Subpart D of 40 CFR 261, which provides industry and EPA waste numbers, descriptions, and a hazard code, and identifies the waste source as either specific or nonspecific. Other wastes are hazardous if they are discarded commercial chemical products, off-specification species, containers, and spill residues thereof, as defined in 40 CFR 261.

Under RCRA, the permitting of treatment, storage, or disposal facilities is a two-part process. The first part involves the submittal of a Part A application containing certain basic information about the facility. DOE filed a Part A application with EPA for the SRP that addressed waste-management activities at the F-, H-, and M-Area seepage basins; hazardous-waste-storage buildings 710-U, 709-G, 709-2G, and 709-4G; and mixed waste storage facility 633-29G, mixed waste oil storage tank S-32, and the process waste interim-storage facility. These basins and storage buildings are defined under RCRA as hazardous-waste-management units. F-30

The second part of the permitting process involves the submittal of a Part B application, containing substantially more detailed information about individual interim-status waste-management units. DOE-SR filed its Part B application in February 1985 and September 1986. TC

With regard to the HSWA, Table 6-1 summarizes the requirements applicable to the SRP and the status of SRP compliance.

6.2.3.2 Federal Regulations

TE EPA regulations for implementing RCRA are codified at 40 CFR 260-271. These regulations provide a system of standards for owners and operators of hazardous-waste storage, treatment, and disposal facilities; specific procedures on the manifest-tracking system; an identification and classification of hazardous waste; listing and delisting requirements; requirements for transporters of hazardous waste; interim-status standards; closure and post-closure care requirements; standards for landfills, incinerators, and surface impoundments; and permitting requirements. They also stipulate financial responsibility, insurance, personnel training, and liability requirements.

TC
C-86 The HSWA restrict land disposal of hazardous waste, including solvents, unless EPA determines that such prohibition is not required to protect human health and the environment. The Amendments also require EPA to promulgate

Table 6-1. Compliance of SRP Interim-Status Facilities with 1984 Hazardous and Solid Waste Amendments

Requirements	Status of SRP compliance	
Interim status of land-disposal facilities terminates unless a Part B permit application is submitted and compliance with groundwater-monitoring requirements is certified by November 8, 1985.	A Part B permit application submitted in February 1985 and September 1986 included F-, H-, seepage and M-Area settling basins. Compliance with groundwater monitoring requirements was certified by November 8, 1985.[a]	TC
Owners and operators of interim-status facilities other than land-disposal units and incinerators must submit Part B permit applications or lose interim status in October 1992.	A Part B permit application submitted in February 1985 included interim-status hazardous-waste-storage facilities.[a] In July 1986, interim status was expanded to include 643-29G.	TC
Permit applications for land-disposal facilities must provide information on public exposure to hazardous wastes.	An Exposure Information Report was submitted in August 1985.	
Owners and operators of interim-status surface impoundments must apply for applicable exemptions from minimum technological requirements by November 1986 or forfeit eligibility for exemption.	SRP interim-status surface impoundments do not meet minimum criteria for exemption. They will be replaced by effluent-treatment facilities.	
Section 3004(u) of HSWA requires corrective action for releases of hazardous wastes or constituents from any Solid Waste Management Unit (SWMU) at a storage, treatment, or disposal facility that is seeking or otherwise subject to a RCRA permit.	SRP has been responsive to the requirements of EPA's National Corrective Action Strategy for SWMUs.	C-89
Surface impoundments not meeting minimum technological requirements can no longer receive, store, or treat hazardous wastes as of November 1988.	Closure dates for F- and H-Area seepage basins and the startup date for the effluent-treatment facility will be determined.	

[a] Part B permits have been issued for the M-Area settling basin and hazardous waste buildings. TC

regulations specifying levels or methods of waste treatment that would substantially diminish the toxicity or reduce the migration of hazardous constituents of the waste. After such pre-treatment, the waste can be disposed of in specified types of land-disposal facilities meeting minimum technological requirements. Appendix D of this EIS addresses various pretreatment technologies considered applicable to SRP waste management activities.

In addition, the HSWA impose new minimum technological requirements (MTRs) on new landfills or surface impoundments. Permits for these units require the installation of two or more liners, a leachate-collection system, and groundwater monitoring. New units and replacements or lateral expansions of existing landfills, surface impoundments, and waste piles under interim status must conform to these minimum technological requirements, with respect to TE wastes received beginning May 8, 1985. Appendix E of this EIS describes this type of new hazardous/mixed waste storage/disposal facility.

The Hazardous and Solid Waste Amendments of 1984 (HSWA) nullify the current exemption from groundwater monitoring for double-lined facilities, but they permit the U.S. Environmental Protection Agency (EPA) to grant individual exemptions if stringent leakage prevention requirements are met.

TC With certain exceptions, existing surface impoundments operating under interim status must comply with the new MTRs by November 8, 1988. The exceptions are (1) surface impoundments with one nonleaking liner at which groundwater monitoring is conducted and that are located more than 0.4 kilometer from an underground drinking-water source, and (2) wastewater-treatment impoundments that satisfy certain prescribed standards.

6.2.3.3 State Statute

The State of South Carolina passed its Hazardous Waste Management Act (Act 436) in 1978 (Code of Laws of South Carolina, Title 44, Health, Chapter 56). This enabling statute and four subsequent amendments that were enacted through June 5, 1985, authorized the South Carolina Department of Health and Environmental Control (SCDHEC) to issue regulations equivalent to those issued by EPA, including a Hazardous Waste Contingency Fund. SCDHEC has adminis- TE tered the Fund and the permitting and enforcement programs since EPA granted it authorization on November 8, 1985.

6.2.3.4 State Regulations

The requirements of the hazardous-waste-management program administered by the State are described in the South Carolina Hazardous Waste Management Regulations (R.61-79.124 through R61-79.270). Hazardous-waste management at the SRP is currently being conducted under Interim Status Standards.

Under interim status, facilities must comply with Interim Status Standards (R.61-79.265) and must not engage in hazardous-waste activities or processes not specified in Part A of the application.

The SRP Groundwater Quality Assessment Plan required by the State regulations was revised and resubmitted to SCDHEC in June 1985. The submission addressed monitoring at the F-, H-, and M-Area seepage basins and contained monitoring data in fulfillment of the requirement to report these data annually.

6.2.3.5 DOE Order 5480.2: Hazardous and Radioactive Mixed Waste Management

DOE Order 5480.2 establishes hazardous-waste-management procedures for facilities operated under authority of the AEA, as amended. The requirements follow, to the extent practical, regulations issued by the EPA pursuant to RCRA.

Under the provisions of DOE Order 5480.2, managers of operations offices must develop an Implementation Plan that complies with the technical hazardous-waste-management requirements of 40 CFR 260-265.

The DOE Savannah River Operations Office developed an Implementation Plan for DOE Order 5480.2 in June 1984. The hazardous-waste-management Implementation Plan requires compliance with all Federal and State permitting processes, identifies the responsibilities of DOE-SR staff and contractors in ensuring compliance with RCRA, and formalizes the program needed to achieve such compliance.

6.2.3.6 Regulations Applicable to Closure and Remedial Action Activities at Existing Waste Sites

This section summarizes closure and remedial action requirements contained in DOE Orders and EPA regulations. DOE policy requires compliance with applicable Federal and state standards. If a conflict exists between regulations, DOE determines and applies those providing the greatest protection. All closure plans are subject to public review at hearings. C-90

The following sections describe the regulations related to hazardous, low-level radioactive, and mixed waste management facilities on the SRP.

Table 6-2 summarizes regulations that govern closure and remedial action activities at specific hazardous-waste management facilities on the SRP. The Resource Conservation and Recovery Act (RCRA) regulates SRP waste management unit closure. At a minimum, all units are subject to the requirements for corrective action for solid waste management units (40 CFR 264.101 and R.61-79.264.101). These corrective action requirements were promulgated to implement RCRA Section 3004(u). SRP actions necessary to comply with these requirements and the specific units to which they will apply will be delineated as a special condition to the SRP RCRA operating permit that is scheduled for issuance Fall 1987.

Additional requirements apply to hazardous waste units closed after November 19, 1980, but vary depending on precisely when the unit closes:

C-92

Date That Unit Closes	Closure Regulation	Post-Closure Regulation
After receiving an operating permit	264*	264
After 1/26/83 (without operating permit)**	265*	264
On or before 1/26/83 (without operating permit)**	265	265

The Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA) may also impact SRP hazardous waste management unit closure. CERCLA Section 120 requires assessment of waste sites for listing on the National

---

* 264 = 40 CFR 264 and R.61-79.264
265 = 40 CFR 265 and R.61-79.265

** This date may change. Groundwater monitoring (264 Subpart F) is required if the unit received hazardous waste after 7/26/82. On 3/28/86, EPA proposed to change the 1983 date to match the 7/26/82 monitoring date.

Table 6-2. Regulations and Statutes Applicable to SRP Waste Management Facilities

	Agency	Regulation/ Statute	Issue date	Description
	DOE	Order 5480.1B, Chapter XI	9/21/84	Requirements for radiation protection
	DOE	Order 5480.2	12/13/82	Hazardous and radioactive mixed waste management
	DOE	Order 5480.4	5/15/84	Environmental protection, safety, and health protection standards
	DOE	Order 5480.12	5/12/87	General environmental protection program requirements (draft)
	DOE	Order 5480.14	4/26/85	Comprehensive Environmental Response, Compensation, and Liability Act Program
	DOE	Order 5484.1	2/24/81	Environmental protection, safety, and health protection information reporting requirements
	DOE	Order 5820.2	2/6/84	Radioactive waste management
TC	DOE	10 CFR 962 (52 FR 15937)	5/1/87	Byproduct material final rule
TE	EPA	42 USC 300 (PL-93-523)	12/16/74	Safe Drinking Water Act, as amended
	EPA	PL-99-339	6/19/86	Safe Drinking Water Act, amendments of 1986
TC	EPA	PL-94-580	10/21/76	Resource Conservation and Recovery Act (RCRA)
	EPA	PL-96-510	12/11/80	Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)
	DOE	PL-98-181	9/30/83	Supplemental Appropriations Bill
TC	EPA	40 CFR 300	11/20/85	National oil and hazardous substances contingency plan
	EPA	PL 98-616	11/8/84	Hazardous and Solid Waste Amendments of 1984
	EPA	PL 99-499	10/17/86	Superfund Amendment and Reauthorization Act of 1986

Table 6-2. Regulations and Statutes Applicable to SRP Waste Management Facilities

Agency	Regulation/ Statute	Issue date	Description
SCDHEC	R.61-79.124 to R.61-79.270	6/22/84	South Carolina hazardous waste management regulations (SCHWMR)
SCDHEC	R.61-68 to R.61-69	9/8/71	South Carolina water classifications and standard regulations

F-32

Priority List (NPL). Sites qualifying for NPL listing must be investigated and, as appropriate, cleaned up in accordance with National Contingency Plan requirements (40 CFR 300 et seq.).

6.2.4 FEDERAL SAFE DRINKING WATER ACT

The SDWA is designed to protect the quality of public water supplies and all sources of drinking water. EPA has authorized South Carolina to regulate both areas. To protect the quality of public water supplies, the State has adopted a set of primary drinking-water regulations, which includes numerical TC standards for a number of heavy metals, pesticides and herbicides, and radioactivity. Another provision of the SDWA, the Underground Injection Control Program, is designed to protect groundwater quality. Injection wells are not now and have not in the past been used for the disposal of wastewater TE at the SRP.

SCDHEC administration and enforcement of the SDWA consists of construction permits, preliminary site inspections, final construction inspections, monthly sampling collections, and regular operations-and-maintenance inspections.

The Safe Drinking Water Act Amendments of 1986 (SDWAA - Public Law 99-339) was signed into law in June 1986. The law substantially broadens the Federal Government's role in protecting groundwater against contamination. EPA can give grants to states to protect public drinking-water supplies at the wellhead. States must develop protection plans that meet minimum criteria to qualify for Federal grants. Regulation of groundwater remains the domain of the states. The "wellhead protection area" is defined as the surface and subsurface area surrounding a well or wells supplying a public water system through which contaminants are reasonably likely to move to reach the well or wells.

6.2.5 FLOODPLAIN/WETLANDS ENVIRONMENTAL REVIEW

According to EO 11900, "Protection of Wetlands," construction in wetlands should be avoided unless there are no practicable alternatives and all practicable measures have been included in the program to minimize harm to wetlands that might result from such use. Early review of the proposed action is to be provided to the public.

According to EO 11988, "Floodplain Management," each Federal agency must review its proposed actions to determine if any action will occur in a floodplain. The potential effects of an action that will occur in a floodplain must be evaluated, and the agency shall consider alternatives to avoid adverse effects and incompatible development in floodplains. DOE Regulation 10 CFR 1022 (Compliance Wetland Environmental Review with Floodplain Requirements) also applies. TC

6.2.6 OTHER REQUIREMENTS

TE Public Law 98-181 requires DOE to take action to terminate the use of "seepage basins associated with the fuel fabrication area" (M-Area) on the SRP. Another provision required the Secretary of Energy to develop a groundwater-protection plan within six months after enactment; DOE has complied with both of these provisions.

TE In association with the termination of the use of the M-Area seepage basin, DOE submitted a closure plan in September 1984. Revisions to the plan were submitted in March and July 1985, and public hearings were held in July 1986. A postclosure care permit application for this basin was submitted with the SRP Part B permit application. Interim status is in effect until final administrative disposition of the Part B permit application. Revisions to the application were submitted in April 1987. TC

C-93 The DOE Savannah River Operations Office operates under a Memorandum of Agreement (MOA) signed April 8, 1985, with SCDHEC. This agreement sets forth the relationship between DOE and SCDHEC regarding activities at the Savannah River Plant. The MOA specifies the procedures for nondisclosure of information on the grounds of national security, specifies jurisdictional and enforcement issues, and recognizes the requirements of the NEPA process.

Other laws and orders (Fish and Wildlife Coordination Act, Endangered Species Act, Farmland Protection Policy Act, Migratory Bird Treaty Act, Anadromous Fish Conservation Act, National Historic Preservation Act, Noise Control Act, and South Carolina Non-Game and Endangered Species Conservation Act) are generally applicable to Federal actions.

LIST OF PREPARERS

NAME	Cynthia L. Anthony
AFFILIATION	NUS Corporation
EDUCATION	M.R.P., Regional Planning, University of North Carolina B.A., Geography, Syracuse University
EXPERIENCE TECHNICAL SPECIALTY	Five years. Socioeconomic impact studies, including demographics, community infrastructure, land use, and economic analyses.
EIS RESPONSIBILITY	Prepared archaeological and historical sections of Chapters 3 and 4. Performed technical reviews of portions of Chapters 3 and 4.

NAME	Daniel L. Bonk
AFFILIATION	NUS Corporation
EDUCATION	M.S., Civil Engineering, University of Pittsburgh
EXPERIENCE TECHNICAL SPECIALTY	Eight years. Geotechnical and environmental engineering, including site investigation, geotechnical laboratory testing, design of wet and dry disposal facilities, specification development, and construction monitoring.
EIS RESPONSIBILITY	Coauthor of sections in Chapter 4 and Appendixes B, C, D, F, G; contributed to sections in Chapter 4 and Appendixes A and J.

NAME	Bruce H. Bradford
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Civil Engineering (Water Resources Systems), Colorado State University M.S., Civil Engineering, University of Missouri at Rolla B.S., Civil Engineering, University of Missouri at Rolla
EXPERIENCE TECHNICAL SPECIALTY	Twenty years. Hydrology, hydraulics, water resources, and other civil engineering disciplines. Registered Professional Engineer in New Jersey, Georgia, and South Carolina.
EIS RESPONSIBILITY	Assistant Principal Investigator and Task Manager for existing waste site sections, including Chapter 5 and Sections 2.2 and 4.1, and Appendixes B, C, F, and H.

NAME	Philip N. Brandt
AFFILIATION	NUS Corporation
EDUCATION	B.S., Wildlife and Fisheries Sciences, Texas A&M University
EXPERIENCE TECHNICAL SPECIALTY	Seven years. Ecological baseline studies, permitting and regulatory analyses.
EIS RESPONSIBILITY	Prepared portions of Chapter 3. Assisted in preparation of responses to scoping comments in Appendix K.

NAME	Ronald M. Burd
AFFILIATION	NUS Corporation
EDUCATION	B.S., Chemistry, Lebanon Valley College Graduate studies: Franklin and Marshall College, University of Pittsburgh
EXPERIENCE TECHNICAL SPECIALTY	Thirty-six years. Environmental science, hazardous waste, water and wastewater management.
EIS RESPONSIBILITY	Principal Investigator for EIS preparation; prepared Cover Sheet, Foreword, Summary, Section 2.5, and Chapter 1.

NAME	Jon A. Cudworth
AFFILIATION	NUS Corporation
EDUCATION	J.D., Thomas M. Cooley Law School M.S., Resource Development, Michigan State University B.S., Resource Development, Michigan State University
EXPERIENCE TECHNICAL SPECIALTY	Eight years. Environmental law and regulatory compliance, biological sciences.
EIS RESPONSIBILITY	Prepared portions of Chapter 6.

NAME	John A. Davis
AFFILIATION	NUS Corporation
EDUCATION	B.A., Environmental Studies, Edimboro State College
EXPERIENCE TECHNICAL SPECIALTY	Eight years. Land use and cultural resources; preparation of environmental reports, assessments, and impact statements; design and implementation of field studies.
EIS RESPONSIBILITY	Performed technical reviews of cultural resources baseline and impact assessments.

NAME	Raymond J. Dever
AFFILIATION	NUS Corporation
EDUCATION	M.S.E., Water Resources, Princeton University M.S., Environmental Engineering, California Institute of Technology B.A./B.S., Urban Studies/Civil Engineering, Brown University
EXPERIENCE TECHNICAL SPECIALTY	Twelve years. Environmental impact studies; surface and groundwater modeling and monitoring; facilities planning for water supply, wastewater, sludge, and solid waste; regulatory compliance.
EIS RESPONSIBILITY	Performed technical review of surface-water, groundwater, and regulatory sections of Chapters 3, 4, 5, and 6, and Appendixes A, B, F, G, and H.

NAME	Rachel S. Diamond
AFFILIATION	NUS Corporation
EDUCATION	M.R.P., Regional Planning, University of Pennsylvania B.A., Ecology, Rutgers College
EXPERIENCE TECHNICAL SPECIALTY	Six years. Regulatory analysis, environmental policies, environmental impact studies, terrestrial ecology, facility siting studies.
EIS RESPONSIBILITY	Prepared sections of Chapter 6.

NAME	John A. DiMarzio
AFFILIATION	NUS Corporation
EDUCATION	M.S., Geology, George Washington University B.S., Geology, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Four years. Geologic studies: paleontology, stratigraphy, geomorphology, geologic mapping. Hydrogeologic studies: groundwater modeling, groundwater flow, and contaminant transport. Regulatory compliance: CERCLA, SDWA, and RCRA.
EIS RESPONSIBILITY	Prepared geology and seismology sections for Chapter 3 and Appendix A; groundwater resources section for Chapter 3; studies and monitoring - Chapter 5; ongoing and planned monitoring sections for Appendix B; three existing facility groundwater and surface-water releases descriptions for Appendix F; portions of surface-water and groundwater effects sections for Appendix G; and surface-water and groundwater impacts sections for Chapter 4.

NAME	David K. Dougherty
AFFILIATION	NUS Corporation
EDUCATION	B.S., Biochemistry, University of Delaware
EXPERIENCE TECHNICAL SPECIALTY	Thirteen years. Health physicist specializing in the assessment of environmental effects of radioactive discharges from nuclear facilities.
EIS RESPONSIBILITY	Review of radiological dose calculations and health effects, and review of new low-level radioactive waste disposal alternatives.

NAME	Kurt A. Eckerstrom
AFFILIATION	NUS Corporation
EDUCATION	B.A., Environmental Conservation, University of Colorado
EXPERIENCE TECHNICAL SPECIALTY	Two years. Staff environmental scientist/geographical information system specialist; general ecology, environmental impact assessments, and site selection studies.
EIS RESPONSIBILITY	Principal author for ecology sections of Chapter 4 and Appendix F.

NAME	Yawar H. Faraz
AFFILIATION	NUS Corporation
EDUCATION	B.S., Nuclear Engineering, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Four years. Environmental, radiological impact assessments of normal and abnormal operations of nuclear facilities. Emphasis on dose calculations.
EIS RESPONSIBILITY	Prepared radiological dose and health effects sections for Chapter 4. Prepared portions of Appendix I. Reviewed radiological sections of Appendix F.

NAME	Peter H. Feldhausen
AFFILIATION	NUS Corporation
EDUCATION	M.S., Geology, University of Wisconsin B.S., Geology, University of Wisconsin
EXPERIENCE TECHNICAL SPECIALTY	Twenty-eight years. Registered geologist and geophysicist; environmental assessment, geology/ seismology, hydrology, radioactive cesium transport, alternative cooling water, wetlands assessment.
EIS RESPONSIBILITY	Assisted in preparation of geology, seismology, water quality and resources, and solute transport sections in Chapters 3 and 4 and Appendix A, predisposal techniques and waste volumes in Appendixes D and E.

NAME	David W. Freeman
AFFILIATION	NUS Corporation
EDUCATION	B.S., Nuclear Science, Virginia Polytechnic Institute
EXPERIENCE TECHNICAL SPECIALTY	Three years. Radiological impact assessments, radioactive waste management, radiological environmental monitoring, regulatory analysis, and licensing support.
EIS RESPONSIBILITY	Work Element Manager for disassembly basin purge-water discharge analysis (Sections 2.4 and 4.4).

NAME	Salinda J. Garvick
AFFILIATION	NUS Corporation
EDUCATION	M.S., Forest Resources (Fish Biology), University of Georgia B.S., Biology (Marine), Millersville State University
EXPERIENCE TECHNICAL SPECIALTY	Three years. Environmental research, freshwater and marine fisheries ecology, analytical chemistry, toxicology, fish physiology, and some thermal and impingement assessment effects.
EIS RESPONSIBILITY	Prepared parts of the aquatic and terrestrial ecology sections for Chapter 4 and Appendixes F and G.

NAME	Morton I. Goldman
AFFILIATION	NUS Corporation
EDUCATION	Sc.D., Massachusetts Institute of Technology M.S., Nuclear Engineering, Massachusetts Institute of Technology M.S., Sanitary Engineering, Massachusetts Institute of Technology B.S., Civil Engineering, New York University
EXPERIENCE TECHNICAL SPECIALTY	Thirty-eight years. Corporate Technical Director; senior management of site evaluation, safety and environmental assessment, and environmental impact evaluation. Professional Engineer.
EIS RESPONSIBILITY	Primary reviewer for NUS Corporation.

NAME	Jimmy H. Ho
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Civil Engineering, Utah State University M.S., Civil Engineering, Colorado State University M.S., Nuclear Engineering, National Tsing Hua University (Taiwan)
EXPERIENCE TECHNICAL SPECIALTY	Ten years. Environmental monitoring of radionuclides; hydrologic and ecologic impacts of precipitation and soil erosion; computer modeling of water routing, sediment transport, and nutrient losses; thermal impact on water quality; modeling of water quality; modeling of groundwater flows and contaminant transport.
TC EIS RESPONSIBILITY	Prepared parts of the groundwater remediation impacts sections in Chapter 4 and Appendixes C and H.

NAME	Rosalind Huang
AFFILIATION	NUS Corporation
EDUCATION	M.S., Physics, University of Maryland B.S., Physics, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Seventeen years. Computer programming for solving problems in shielding and radiation and for processing meteorological data; development of plots, users guides, and documentation; verification and quality review of programs.
EIS RESPONSIBILITY	Performed technical review of radiological impacts in Appendixes F and G and Chapters 2 and 4.

NAME	Amy E. Hubbard
AFFILIATION	NUS Corporation
EDUCATION	M.R.P., Regional Planning, University of Pennsylvania B.A., Geology, Franklin and Marshall College
EXPERIENCE TECHNICAL SPECIALTY	Seven years. Geology, health risk assessment, environmental assessment, and hydrogeology.
EIS RESPONSIBILITY	Prepared cumulative health impacts for hazardous substances.

NAME	John R. Jansen
AFFILIATION	U.S. Department of Energy, Savannah River Operations Office
EDUCATION	M.S., Geography, University of Wisconsin, Milwaukee B.A., Geography, University of Georgia
EXPERIENCE TECHNICAL SPECIALTY	Thirteen years. Ecology, environmental impact assessment, and waste management.
EIS RESPONSIBILITY	Primary reviewer for Savannah River Operations Office.

NAME	Gary J. Jellick
AFFILIATION	NUS Corporation
EDUCATION	M.S., Soil Science, The Pennsylvania State University B.S., Agronomy, The Pennsylvania State University
EXPERIENCE TECHNICAL SPECIALTY	Four years. Certified professional soil scientist. Soil and waste management, vadose zone contamination, soil and groundwater monitoring plans, and environmental assessments.
EIS RESPONSIBILITY	Contributor to Section 4.1 and Appendixes B and F.

NAME	Mary Alice Jennison
AFFILIATION	NUS Corporation
EDUCATION	B.S., Environmental Science, Florida Institute of Technology
EXPERIENCE TECHNICAL SPECIALTY	Three years. Statutory/regulatory analysis, site-specific environmental compliance plans, environmental compliance reference books, environmental assessments, and impact statements.
EIS RESPONSIBILITY	Contributed to Chapter 1.

NAME	Jasper G. Maltese
AFFILIATION	NUS Corporation
EDUCATION	M.S., Operations Research, George Washington University B.S., Mathematics, Fairleigh Dickinson University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-five years overall experience, ten years experience in safety and accident studies of complex systems and operations. Several years experience in reliability and risk assessment of systems.
EIS RESPONSIBILITY	Work Element Manager, prepared accidents sections of EIS. Co-work Element Manager, prepared decontamination and decommissioning section of EIS.

NAME	Barton C. Marcy, Jr.
AFFILIATION	NUS Corporation
EDUCATION	M.S., Zoology-Ichthyology, University of Connecticut B.S., Biology, Wake Forest University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-three years. Environmental impact studies, ichthyoplankton and entrainment studies, fisheries, and impingement, aquatic ecology, and marine biology.
EIS RESPONSIBILITY	Principal technical reviewer of EIS for NUS Corporation.

NAME	Robert S. Markwell
AFFILIATION	NUS Corporation
EDUCATION	B.S., Environmental Resource Management, The Pennsylvania State University
EXPERIENCE TECHNICAL SPECIALTY	Three years. Environmental risk assessment, environmental sampling, chemical fate and transport analysis, waste management assessment.
EIS RESPONSIBILITY	Prepared Section 4.1.1.6.

NAME	David C. Navecky
AFFILIATION	NUS Corporation
EDUCATION	M.S., Water Resources Management, Michigan State University B.S., Environmental Science, The Pennsylvania State University
EXPERIENCE TECHNICAL SPECIALTY	Three years. Hydrology/water quality baseline and impact assessment studies, analysis of and compliance planning with water quality regulations.
EIS RESPONSIBILITY	Assisted in the preparation of water-quality sections in Chapter 4 and Appendix F; waste site descriptions in Appendix B; and unavoidable/irreversible impacts in Chapter 4.

NAME	Daniel B. Nugent
AFFILIATION	NUS Corporation
EDUCATION	B.S., Meteorology, The Pennsylvania State University
EXPERIENCE TECHNICAL SPECIALTY	Three years. Air quality studies and risk assessment.
EIS RESPONSIBILITY	Reviewed air-quality sections.

NAME	Richard S. Nugent
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Marine Science, University of Miami M.S., Biology, Boston College B.S., Biology, Boston College
EXPERIENCE TECHNICAL SPECIALTY	Eighteen years. Environmental impact studies, aquatic ecology, marine and estuarine ecology, water quality.
EIS RESPONSIBILITY	Reviewed comparative impact sections in Chapters 2 and 4, and assisted in preparation of sections in Chapter 4.

NAME	Joseph F. O'Brien
AFFILIATION	NUS Corporation
EDUCATION	M.Engr., Water Resource Engineering, Clemson University M.S., Chemistry, Lehigh University B.A., Chemistry, Lehigh University
EXPERIENCE TECHNICAL SPECIALTY	Thirteen years. Flooding analyses; surface-water quality studies; groundwater flow and transport analyses.
EIS RESPONSIBILITY	Prepared Sections 3.5 and 3.6 and Appendix A, Section A.3.

NAME	James L. Oliver
AFFILIATION	NUS Corporation
EDUCATION	B.S., Biology, Murray State University
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Environmental research, limmological studies, thermal effects, icthyoplankton and zooplankton studies, entrainment and impingement, and fisheries ecology.
EIS RESPONSIBILITY	Performed technical review of ecology sections in Chapters 3 and 4 and Appendixes F and G.

NAME	Jane M. Patarcity
AFFILIATION	NUS Corporation
EDUCATION	M.S., Hygiene, Health Aspects of Water Quality, University of Pittsburgh B.S., Biological Science, University of Pittsburgh
EXPERIENCE TECHNICAL SPECIALTY	Five years. Public health, water quality, aquatic biology, and risk assessment associated with exposure to chemical constituents.
EIS RESPONSIBILITY	Prepared hazardous chemical environment sections for Chapter 3, ecological impacts of proposed alternatives for Chapter 4, and impacts sections for Appendix F.

NAME	William L. Poppe
AFFILIATION	NUS Corporation
EDUCATION	Illinois Institute of Technology and University of Maryland (two years) Registered Professional Land Surveyor and Land Planner
EXPERIENCE TECHNICAL SPECIALTY	Thirty-four years. Land surveying, site planning, and civil engineering design.
EIS RESPONSIBILITY	Principal author and Work Element Manager for engineering and site description sections (2.1, 4.1, Appendixes E and F).

NAME	Amiram Roffman
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Atmospheric physics, New Mexico Institute of Mining and Technology M.Sc., Physics and Meteorology, Hebrew University (Israel)
EXPERIENCE TECHNICAL SPECIALTY	Twenty-two years. Environmental studies in the areas of air quality, meteorology, program and project management. Responsible for the development of technical tools used in air quality and meteorological studies, managing large numbers of projects including environmental analysis studies and field programs. Extensive regulatory interface and expert testimony.
EIS RESPONSIBILITY	Prepared hazardous air releases sections; had input into occupational impact sections.

NAME	Haia K. Roffman
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Geochemistry, New Mexico Institute of Mining and Technology M.Sc., Organic Chemistry, Hebrew University (Israel) B.Sc., Inorganic Chemistry, Hebrew University (Israel)
EXPERIENCE TECHNICAL SPECIALTY	Twenty-three years. Environmental studies in the areas of chemical contamination in air, water, and soils. Responsible for the preparation of environmental impact statements, environmental assessments, and remedial investigations - feasibility studies.
EIS RESPONSIBILITY	Prepared chemistry and toxicology sections in Appendixes F and I and Chapter 4.

NAME	Irwin J. Samec
AFFILIATION	NUS Corporation
EDUCATION	M.U.R.P., Urban and Regional Planning, Michigan State University B.A., Sociology, Illinois Wesleyan University
EXPERIENCE TECHNICAL SPECIALTY	Sixteen years. Environmental impact statements and assessments, socioeconomic and land-use analyses, transportation studies, water resources and quality.
EIS RESPONSIBILITY	Principal technical reviewer of Draft EIS for NUS Corporation.

NAME	James R. Schinner
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Wildlife Biology, Michigan State University M.S., Zoology, University of Cincinnati B.S., Zoology, University of Cincinnati
EXPERIENCE TECHNICAL SPECIALTY	Fourteen years. Terrestrial ecosystems studies and impact evaluations for a number of industrial projects, including nuclear and fossil fuel powerplants. Work has included analysis of impacts of SO_2 and salt drift on vegetation, endangered species evaluations, and a timber harvest study.
EIS RESPONSIBILITY	Work Element Manager for the preparation of various sections of Chapter 4.

NAME	Robert L. Schlegel
AFFILIATION	NUS Corporation
EDUCATION	Degree of Nuclear Engineering, Columbia University M.S., Nuclear Engineering, Columbia University B.S., Chemical Engineering, Massachusetts Institute of Technology
EXPERIENCE TECHNICAL SPECIALTY	Twenty-four years. Radiological assessments of normal and abnormal operations of nuclear facilities. Emphasis on dose calculations and resulting health effects.
EIS RESPONSIBILITY	Coordinated and reviewed radiological sections for Chapters 3 and 4 and Appendix H. Contributed to preparation of Appendixes F and I.

NAME	Michael Septoff
AFFILIATION	NUS Corporation
EDUCATION	M.S., Meteorology/Oceanography, New York University B.S., Meteorology, City College of New York
EXPERIENCE TECHNICAL SPECIALTY	Meteorology/air quality, impact assessments, health and risk assessments, permitting related to EPA requirements and state and federal agencies.
EIS RESPONSIBILITY	Task Leader for preparation of air sections in Chapters 3 and 4, and Appendixes F and G.

NAME	John O. Shipman
AFFILIATION	NUS Corporation
EDUCATION	A.B., English Literature, Georgetown University
EXPERIENCE TECHNICAL SPECIALTY	Twenty years. Technical publications; editing/writing/management; multidiscipline documents; environmental documents; NEPA documents. Publications quality control.
EIS RESPONSIBILITY	Edited EIS. Prepared Table of Contents, List of Preparers, Distribution List, Glossary, and Index.

NAME	Sonce A. Silvernale
AFFILIATION	NUS Corporation
EDUCATION	M.S., Oregon State University B.S., Arizona State University
EXPERIENCE TECHNICAL SPECIALTY	Eleven years. Soil mapping and interpretations for agricultural and engineering applications. Experience with siting studies for nuclear powerplants, nuclear waste repositories, coal mines, oil shale, and hard rock mining.
EIS RESPONSIBILITY	Prepared section describing characteristics of existing low-level radioactive waste sites at SRP for Appendix B.

NAME	Dennis M. Smith
AFFILIATION	NUS Corporation
EDUCATION	B.S., Environmental Health, Colorado State University
EXPERIENCE TECHNICAL SPECIALTY	Ten years of industrial environmental health experience. Environmental chemical hazard assessment; contaminant fate and transport analysis; public, environmental, and occupational health risk assessment and risk management.
EIS RESPONSIBILITY	Wrote Appendix I; directed the preparation of sections of Chapter 4; provided technical support of various other sections.

NAME	Stephen L. Sperry
AFFILIATION	NUS Corporation
EDUCATION	B.L.A., Landscape architecture, Syracuse University M.L.A., Landscape architecture, Harvard University
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Environmental planning, remote sensing, Geographic Information Systems (GIS) applications.
EIS RESPONSIBILITY	Technical input for Chapter 4.

NAME	Seshagiri Rao Tammara
AFFILIATION	NUS Corporation
EDUCATION	M.S., Chemical and Environmental Engineering, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Thirteen years. Environmental engineering consulting, evaluations and analyses with respect to air, water, and radiological impacts; thermal performance analyses.
EIS RESPONSIBILITY	Prepared portions of Appendixes E, F, G, and I, and sections of Chapters 2 and 4.

NAME	Jerry Tkac
AFFILIATION	NUS Corporation
EDUCATION	Towson State University Frederick Community College
EXPERIENCE TECHNICAL SPECIALTY	Eighteen years. Engineering design and drafting; site planning and land development, storm water management, piping systems, highways, collection basins, building and equipment locations.
EIS RESPONSIBILITY	Prepared site maps for waste site descriptions in Chapter 2 and Appendix B.

NAME	Alan L. Toblin
AFFILIATION	NUS Corporation
EDUCATION	M.S., Chemical Engineering, University of Maryland B.E., Chemical Engineering, The Cooper Union
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Hydrologic transport analyses.
EIS RESPONSIBILITY	Prepared portions of Appendix F and Section 4.1. Performed technical review of portions of Section 4.2 and Appendixes F, G, and I.

NAME	William D. Trimbath
AFFILIATION	NUS Corporation
EDUCATION	Ph.D. candidate, Civil Engineering, University of Pittsburgh M.S., Civil Engineering, Hydrology and Water Pollution Control, University of Pittsburgh B.S., Civil Engineering, West Virginia University
EXPERIENCE TECHNICAL SPECIALTY	Thirteen years. Registered Professional Engineer, Pennsylvania and North Dakota, civil engineering, hazardous wastes, hydrologic geotechnical investigations and designs, feasibility studies.
EIS RESPONSIBILITY	Assisted in preparation of Chapters 2 and 4, participated in writing portions of Appendixes B through J.

NAME	Richard L. Van Tassel
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Civil Engineering, Carnegie Mellon University M.S., Civil Engineering, Carnegie Institute of Technology B.E., Civil Engineering, Youngstown University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-two years. Civil engineering, evaluation of site conditions, proposed remedial actions and construction.
EIS RESPONSIBILITY	Prepared sections of Chapters 2 and 4.

NAME	Robert H. Werth
AFFILIATION	NUS Corporation
EDUCATION	B.A., Physics, Gordon College
EXPERIENCE TECHNICAL SPECIALTY	Eleven years. Environmental impact studies, sound level studies, noise impact assessments, air quality analysis, permitting.
EIS RESPONSIBILITY	Prepared noise impacts sections in Chapter 4.

NAME	Patricia L. Wherley
AFFILIATION	NUS Corporation
EDUCATION	B.A., Geography, The George Washington University
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Environmental impact studies, demographics, land use and socioeconomic studies, regulatory analyses, public participation programs.
EIS RESPONSIBILITY	Performed technical reviews of geography, archaeological, historical, and socioeconomic sections of Chapters 3 and 4 and Appendix G.

NAME	Philip C. Whitney
AFFILIATION	NUS Corporation
EDUCATION	B.S., Civil Engineering, University of Maine
EXPERIENCE TECHNICAL SPECIALTY	Thirty-eight years. Construction supervision, civil/structural design and engineering of thermal, hydroelectric, and nuclear power, HV and EHV transmission, paper mills, and other heavy industry. Site and environmental studies, investigations, and assessments.
EIS RESPONSIBILITY	Prepared portions of Appendix E.

NAME	James C. Williamson
AFFILIATION	NUS Corporation
EDUCATION	B.S., Fisheries and Wildlife Biology, Michigan State University
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Waste treatment/pollution control research, analytical laboratory, wastewater/solid waste facilities plans, land disposal feasibility studies, environmental monitoring, NEPA documentation, siting studies, guidance documents, remedial action plans, impact assessment, mitigation, project management.
EIS RESPONSIBILITY	Work Element Manager. Prepared portions of Chapters 2, 3, and 4, Appendixes A, D, E, and G. Assisted in overall coordination and management of EIS.

NAME	William E. Wisenbaker
AFFILIATION	U.S. Department of Energy, Savannah River Operations Office
EDUCATION	M.B.A., Management, Georgia State University B.S., Chemistry, University of Georgia
EXPERIENCE TECHNICAL SPECIALTY	Twenty years. Air quality measurements, ecology, environmental impact assessment, compliance with regulations, environmental monitoring.
TC EIS RESPONSIBILITY	Principal reviewer of EIS for DOE, Savannah River Operations Office

NAME	Carl R. Yates
AFFILIATION	NUS Corporation
EDUCATION	M.S., Biology, West Virginia University B.S., Biology, University of Pittsburgh at Johnstown
EXPERIENCE TECHNICAL SPECIALTY	Four years. Radiological environmental monitoring programs, sample collection audits, land-use surveys, radiochemistry, aquatic ecology.
EIS RESPONSIBILITY	Prepared descriptive radiological sections for Chapter 3.

NAME	Joseph G. Yeasted
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Civil Engineering, Massachusetts Institute of Technology M.S., Civil Engineering, Carnegie Mellon University B.S., Civil Engineering, Carnegie Mellon University B.A., Mathematics, St. Vincent College
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Registered professional engineer in Pennsylvanie; water resources management, planning, hydrology, hydraulics, fluid mechanics, and matematical modeling of natural water systems; water-quality studies, hazardous and utility waste management, groundwater and remedial investigation, feasibility studies.
EIS RESPONSIBILITY	As a Work Element Manager, supervised preparation of portions of Chapters 2, 3, and 4; and Appendixes B, F, G, H, and I.

NAME	Gregory L. Zimmerman
AFFILIATION	NUS Corporation
EDUCATION	B.S., Environmental Engineering, The Pennsylvania State University
EXPERIENCE TECHNICAL SPECIALTY	Nine years. Data validation, contaminant transport modeling, material safety data sheet preparation, evaluation of technical feasibility and economics of various methods of treating leachate, contaminated groundwater, and other waste streams.
EIS RESPONSIBILITY	Prepared cumulative effects sections for onsite groundwater and for onsite and offsite facilities in Chapter 4; helped prepare health effects tables for Appendix I and sections on the new disposal facilities for Chapter 4.

LIST OF PREPARERS[a]

	Area of Responsibility																			
	Sections								Appendix											
NAME	S	1	2	3	4	5	6		A	B	C	D	E	F	G	H	I	J	K	L
C. L. Anthony				X	X															
D. L. Bonk					X			X		X	X	X		X	X			X		
B. H. Bradford			X		X	X				X	X			X		X				X
P. N. Brandt	X	X	X	X															X	
R. M. Burd	X	X	X																	X
J. A. Cudworth							X													
J. A. Davis				X	X															
R. J. Dever				X	X	X	X	X		X				X	X	X				
R. S. Diamond							X													
J. A. DiMarzio				X	X	X		X		X				X	X					
D. K. Dougherty					X									X	X		X			
K. A. Eckerstrom					X									X						
Y. H. Faraz					X									X			X			
P. H. Feldhausen				X				X				X	X							
D. W. Freeman			X		X															
S. J. Garvick																				
M. I. Goldman[b,c]	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
J. H. Ho					X						X					X				
R. Huang			X		X									X	X					
A. E. Hubbard				X	X															
J. R. Jansen[d]	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
G. J. Jellick					X					X				X						
M. A. Jennison		X																		
J. G. Maltese					X															
B. C. Marcy[b,c]	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
R. S. Markwell					X															
D. C. Navecky					X					X				X						
O. B. Nugent				X	X															
R. S. Nugent				X	X									X						
J. F. O'Brien				X				X												
J. L. Oliver				X	X									X	X					
J. M. Patarcity				X	X									X						
W. L. Poppe			X		X								X	X						
A. Roffman[b]	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
H. K. Roffman					X									X			X			
I. J. Samec[b]	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
J. R. Schinner					X															
R. L. Schlegel				X	X									X			X			
M. Septoff				X	X									X	X					
J. O. Shipman[e]	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
S. A. Silvernale										X										

LIST OF PREPARERS[a]

	Area of Responsibility																			
	Sections								Appendix											
NAME	S	1	2	3	4	5	6		A	B	C	D	E	F	G	H	I	J	K	L
D. M. Smith					X												X			
S. L. Sperry					X															
S. R. Tammara			X		X								X	X	X		X			
J. Tkac			X							X										
A. L. Toblin					X									X	X		X			
W. D. Trimbath			X		X					X	X	X	X	X	X	X	X	X		
R. L. Van Tassel			X		X															
R. H. Werth					X															
P. L. Wherley				X	X										X					
P. C. Whitney													X							
J. C. Williamson			X	X	X			X				X	X		X					X
W. E. Wisenbaker[d]	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
C. R. Yates				X																
J. G. Yeasted			X	X	X					X				X	X	X	X			
G. L. Zimmerman					X												X			

---

[a] This final environmental impact statement was reviewed and approved in accordance with DOE Order 5440.1C, Implementation of the National Environmental Policy Act.

[b] Primary Reviewer of Draft EIS for NUS Corporation.

[c] Primary Reviewer of Final EIS for NUS Corporation. TC

[d] Primary Reviewer for DOE Savannah River Operations Office.

[e] Technical Editor.

DISTRIBUTION LIST FOR FINAL ENVIRONMENTAL IMPACT STATEMENT

UNITED STATES CONGRESS

United States Senate

Honorable Strom Thurmond

Honorable Ernest F. Hollings

Honorable James A. McClure
Ranking Minority Member
Committee on Energy and Natural Resources

Mr. Proctor Jones
Staff Director
Subcommittee on Energy and Water Development
Committee on Appropriations

Mr. Peter D. Prowitt
Staff Director
Committee on Environment and Public Works

Honorable Robert T. Stafford
Ranking Minority Member
Committee on Environment and Public Works

Mr. Arnold L. Punaro
Staff Director
Committee on Armed Services

Honorable John Warner
Ranking Minority Member
Committee on Armed Services

Honorable John H. Glenn, Jr.
Chairman, Committee on Governmental Affairs

Mr. Robert F. Bott
Professional Staff Member
Subcommittee on Strategic Forces and Nuclear Deterrence
Committee on Armed Services

Honorable Sam Nunn

Honorable Wyche Fowler, Jr.

Honorable J. Bennett Johnston
Chairman, Committee on Energy and Natural Resources

Honorable John C. Stennis
Chairman, Committee on Appropriations

Honorable Quentin N. Burdick
Chairman, Committee on Environment and Public Works

Honorable Sam Nunn
Chairman, Committee on Armed Services

Honorable Mark O. Hatfield
Ranking Minority Member
Committee on Appropriations

Honorable J. Bennett Johnston
Chairman, Subcommittee on Energy and Water Development
Committee on Appropriations

Honorable Mark O. Hatfield
Ranking Minority Member
Subcommittee on Energy and Water Development
Committee on Appropriations

Honorable William V. Roth, Jr.
Ranking Minority Member
Committee on Governmental Affairs

Honorable J. James Exon
Chairman, Subcommittee on Strategic Forces and Nuclear Deterrence
Committee on Armed Services

Honorable Strom Thurmond
Ranking Minority Member
Subcommittee on Strategic Forces
and Nuclear Deterrence
Committee on Armed Services

United States House of Representatives

Honorable Butler Derrick

Honorable Floyd D. Spence

Honorable Les Aspin
Chairman, Committee on Armed Services

Honorable Norman Lent
Ranking Minority Member
Committee on Energy and Commerce

Honorable John D. Dingell
Chairman, Committee on Energy and
Commerce

Honorable Philip R. Sharp
Chairman, Subcommittee on Energy
and Power
Committee on Energy and Commerce

Honorable Samuel Stratton
Chairman, Subcommittee on Procurement
and Military Nuclear Systems
Committee on Armed Services

Honorable John D. Dingell
Chairman, Subcommittee on Oversight
and Investigations
Committee on Energy and Commerce

Honorable Carlos J. Moorhead
Ranking Minority Member
Subcommittee on Energy and Power
Committee on Energy and Commerce

Honorable Norman Lent
Ranking Minority Member
Subcommittee on Oversight and
Investigations
Committee on Energy and Commerce

Honorable William F. Clinger, Jr.
Ranking Minority Member
Subcommittee on Environment, Energy
and Natural Resources
Committee on Government Operations

Honorable Lindsay Thomas

Honorable Doug Barnard

Honorable Arthur Ravenel, Jr.

Honorable William L. Dickinson
Ranking Minority Member
Committee on Armed Services

Honorable Jamie Whitten
Chairman, Committee on Appropriations

Honorable Silvio Conte
Ranking Minority Member
Committee on Appropriations

Honorable Tom Bevill
Chairman, Subcommittee on Energy and
Water Development
Committee on Appropriations

Honorable John Myers
Ranking Minority Member
Subcommittee on Energy and Water
Development
Committee on Appropriations

Honorable Robert Badham
Ranking Minority Member
Subcommittee on Procurement and
Military Nuclear Systems
Committee on Armed Services

Mr. Hunter Spillan
Staff Assistant
Subcommittee on Energy and Water
Development
Committee on Appropriations

Honorable Jack Brooks
Chairman, Committee on Government
Operations

Mr. Robert E. Schafer
Professional Staff Member
Subcommittee on Procurement and Military Nuclear Systems
Committee on Armed Services

Honorable Mike Synar
Chairman, Subcommittee on Environment, Energy and Natural Resources
Committee on Government Operations

Honorable Frank Horton
Ranking Minority Member
Committee on Government Operations

FEDERAL AGENCIES

Director
Heritage Conservation and Recreation Service
Department of the Interior

Department of Commerce
Office of Environmental Affairs

Department of Labor
Occupational Safety and Health Administration

Ms. Melanie A. Miller
Vogtle Licensing Project Manager
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission

Mr. John C. Villforth, Director
National Center for Devices and Radiological Health
Department of Health and Human Services

U.S. Arms Control and Disarmament Agency

Department of State
ATTN: Director
Office of Environmental Affairs

Mr. Carl Schafer
Director of Environmental Policy
Department of Defense Headquarters

Mr. Christopher S. Herndobler
United States General Accounting Office

Mr. Vartkes Bronssalian
Senior Desk Officer
Office of Management and Budget

Mr. Hugh L. Thompson, Jr., Director
Office of Nuclear Material Safety and Safeguards
Nuclear Regulatory Commission

Department of Justice
Land and Natural Resources Division

Forest Service
Office of the Chief
Department of Agriculture

Office of Radiation Programs
Environmental Protection Agency

Ms. Barbara Gittleman, Budget Examiner
Office of Management and Budget

Advisory Council on Historic Preservation

Dr. Frank Press, President
National Academy of Sciences

Mr. Jim Reisa
Environmental Studies and Toxicology
National Academy of Sciences

Department of the Interior
ATTN: Director
Environmental Project Review

Mr. Richard E. Sanderson, Director
Office of Federal Activities
Environmental Protection Agency

Ms. Dinah Bear, General Counsel
Council on Environmental Quality

Regional Offices of Federal Agencies

Mr. Sheppard Moore
Environmental Protection Agency
Region IV

Mr. Arthur G. Linton
Federal Activities Coordinator
Enforcement Division
Environmental Protection Agency
Region IV

Mr. Frank Reed, Director
Office of Congressional and
External Affairs
Environmental Protection Agency
Region IV

Mr. Steve Gilbert
Fish and Wildlife Service
Department of the Interior

Colonel Stanley Genega
Savannah District
U.S. Army Corps of Engineers

Regional Director
National Park Service
Department of the Interior

Mr. James W. Pulliam, Jr.
Regional Director (AE)
Office of the Environment
U.S. Fish and Wildlife Service
Department of the Interior

Mr. Clarence Ham
Charleston District
U.S. Army Corps of Engineers

Mr. John E. Alcock
Regional Forester
Southern Regional Office
U.S. Department of Agriculture
Forest Service

Mr. William Abercrombie
State Conservationist
Soil Conservation Service
U.S. Department of Agriculture

Mr. Ken Clark
Public Affairs Officer
Nuclear Regulatory Commission

Mr. Frank Redmon, Chief
Environmental Assessment Branch
Office of Policy and Management
Environmental Protection Agency
Region IV

Mr. Roger L. Banks
Field Supervisor
Division of Ecological Services
Fish and Wildlife Service
U.S. Department of the Interior

Dr. Gerald Miller
Environmental Protection Agency
Region IV

Lt. Colonel Stewart Bornhoft
Charleston District
U.S. Army Corps of Engineers

Mr. Warren T. Parker
Field Office Supervisor
Endangered Species Office
Fish and Wildlife Service
Department of the Interior

Mr. Charles Oravetz, Chief
Protected Species Management Branch
Southeast Regional Office
National Marine Fisheries Service
U.S. Department of Commerce

Brigadier General C. E. Edgar, III
Division Engineer
South Atlantic Division
U.S. Army Corps of Engineers

Mr. Lee A. DeHihns
Region IV Acting Administrator
Environmental Protection Agency

Mr. Rod Cherry, District Chief
Water Resources Division
U.S. Geological Survey

Dr. David E. Clapp
Office of the Director
Center for Environmental Health
Centers for Disease Control
Department of Health and Human Services

Department of Energy Offices

Mr. Joe LaGrone, Manager
Oak Ridge Operations Office
U.S. Department of Energy

Mr. R. G. Romatowski, Manager
Albuquerque Operations Office
U.S. Department of Energy

Ms. Wanda P. Rachels, Director
Atlanta Support Office
Savannah River Operations Office
U.S. Department of Energy

Mr. Leo E. Little, Area Manager
Grand Junction Project Office
U.S Department of Energy

Mr. N. C. Aquilina, Manager
Nevada Operations Office
U.S. Department of Energy

Mr. W. H. Hannum, Director
West Valley Project Office
Idaho Operations Office
U.S. Department of Energy

Mr. J. Phil Hamric
Assistant Manager, Nuclear Programs
Idaho Operations Office
U.S. Department of Energy

Mr. Virgil Trice
Office of Defense Waste and Transportation Management
U.S. Department of Energy

Ms. Debbie Bergquist
Office of Chief Counsel
Idaho Operations Office
U.S. Department of Energy

Mr. Robert M. Carosino
Office of Chief Counsel
Richland Operations Office
U.S. Department of Energy

Ms. Jo Ann Elferink, Manager
San Francisco Operations Office
U.S. Department of Energy

Mr. Donald Ofte, Manager
Idaho Operations Office
U.S. Department of Energy

Mr. Stanley R. Sulak
Executive Director
Office of Inspector General
U.S. Department of Energy

Mr. Hilary Rauch, Manager
Chicago Operations Office
U.S. Department of Energy

Mr. M. J. Lawrence, Manager
Richland Operations Office
U.S. Department of Energy

Office of Assistant Inspector General for Inspections
U.S. Department of Energy

Mr. Karl E. Goodwin
Chief, Reactor Branch
Nuclear Materials Production Division
U.S. Department of Energy

Mr. Peter J. Dirkmaat
Radiological Safety Branch
Operational Safety Division
Idaho Operations Office
U.S. Department of Energy

Mr. K. R. Absher, Chief
Reactor Operations Branch
Defense Production Operations Division
Richland Operations Office
U.S. Department of Energy

Ms. Liz Bracken
Richland Operations Office
U.S. Department of Energy

National Laboratories

Dr. Richard Adams
Energy Systems Department
Battelle-Pacific Northwest
Laboratory

Mr. Emmett B. Moore, Jr.
Office of Technology, Planning
and Analysis
Environmental and Safety Risk
Management
Battelle-Pacific Northwest
Laboratory

Mr. Tom Beasley
Argonne National Laboratory

Mr. Thomas Row, Program Director
Nuclear Waste Program
Oak Ridge National Laboratory

Mr. Frank A. Guevara
Los Alamos National Laboratory

Mr. Harley Freeman
Battelle-Pacific Northwest
Laboratory

Mr. Larry E. Boing
Waste Management Operations
Argonne National Laboratory

Dr. J. R. Naidu
Safety and Environmental
Protection Division
Brookhaven National Laboratory

Ms. Shirley Gydesen
Technical Information
Hanford Technical Library
Battelle-Pacific Northwest
Laboratory

Mr. Tim E. Myrick
Radioactive Waste Management
Operations Division
Oak Ridge National Laboratory

Dr. R. M. Reed
Oak Ridge National Laboratory

Mr. Andrew P. Hull
Safety and Environmental
Protection Division
Brookhaven National Laboratory

Mr. D. W. Lee
Oak Ridge National Laboratory

Technical Information
Battelle-Pacific Northwest
Laboratory
ATTN: Fran Stanley

Ms. Joan Walsh
Document Library
Knolls Atomic Power Laboratory

Mr. C. M. Seabourn
Los Alamos National Laboratory

Other Countries

Librarian
Australian Atomic Energy Commission

Dr. Gheorghe T. Vasaru
State Committee for Nuclear Energy
Institute of Isotopic and Molecular
Technology
Romania

STATE OF SOUTH CAROLINA

Honorable Carroll A. Campbell, Jr.
Governor of South Carolina

Honorable Nick Theodore
Lieutenant Governor of South Carolina

Honorable T. Travis Medlock
Attorney General

Mr. Bill Newberry
Low-Level Waste Compact
Office of Executive Policy and Programs
Office of the Governor

Mr. Danny Cromer
Grant Services
Office of the Governor

Mr. Warren Tompkins
Chief of Staff
Office of the Governor

Dr. Harry Miley
Executive Assistant
Office of the Governor

Ombudsman Office
State Clearinghouse
Office of the Governor

Mr. Tucker Eskew
Press Secretary
Office of the Governor

State Legislators

Honorable Thomas L. Moore
South Carolina Senate

Honorable Ryan Shealy
South Carolina Senate

Honorable Larry E. Gentry
South Carolina House of Representatives

Honorable Thomas E. Huff
South Carolina House of Representatives

Honorable William H. Jones
South Carolina House of Representatives

Honorable Harriet H. Keyserling
South Carolina House of Representatives
Committee on Energy

Honorable Charles Sharpe
South Carolina House of Representatives

Honorable Nikki G. Setzler
South Carolina Senate

Honorable Addison Joe Wilson
South Carolina Senate

Honorable Timothy F. Rogers
South Carolina House of Representatives

Honorable Irene K. Rudnick
South Carolina House of Representatives

Honorable D. M. McEachin, Jr.
South Carolina House of Representatives

Honorable Joseph B. Wilder
South Carolina House of Representatives

Honorable John C. Lindsay, Member
South Carolina Joint Legislative Committee on Energy

Honorable Milford D. Burris, Member
South Carolina Joint Legislative
Committee on Energy

Honorable Thomas E. Garrison, Member
South Carolina Joint Legislative
Committee on Energy

Honorable Thomas W. Edwards, Jr.,
Chairman
South Carolina Joint Legislative
Committee on Energy

Honorable Harvey S. Peeler, Jr.,
Member
South Carolina Joint Legislative
Committee on Energy

Honorable William N. Cork, Member
South Carolina Joint Legislative
Committee on Energy

Honorable Luther L. Taylor, Jr.,
Member
South Carolina Joint Legislative
Committee on Energy

Honorable Phil P. Leventis, Member
South Carolina Joint Legislative
Committee on Energy

Administrative Assistant
South Carolina Joint Legislative
Committee on Energy

State Agencies

Mr. H. G. Shealy, Chief
Bureau of Radiological Health
South Carolina Department of Health
and Environmental Control

Mr. O. E. Pearson, Chief
Bureau of Air Quality Control
South Carolina Department of Health
and Environmental Control

Mr. Jack Smith, Attorney
South Carolina Coastal Council

Mr. James A. Joy, III, Chief
Bureau of Water Pollution Control
South Carolina Department of Health
and Environmental Control

Mr. Paul S. League
Legal Counsel
Water Resources Commission

Mr. Michael D. Jarrett, Commissioner
South Carolina Department of Health
and Environmental Control

Mr. William Harry Busbee
South Carolina Department of
Agriculture

Mr. R. Lewis Shaw
Deputy Commissioner
Environmental Quality Control
South Carolina Department of Health
and Environmental Control

Mr. R. K. Cauthen
District Director
Lower Savannah District Office
South Carolina Department of Health
and Environmental Control

Mr. R. E. Malpass, Chief
Bureau of Water Supply and Special
Programs
South Carolina Department of Health
and Environmental Control

Mr. Alfred H. Vang
Executive Director
Water Resources Commission

Dr. H. Wayne Beam
Executive Director
South Carolina Coastal Council

Mr. J. Mac Holladay, Director
South Carolina State Development
Board

Mr. Mac Smurthwaite
Associate Director
National Business Development
South Carolina State Development Board

Dr. Fred Carter
Executive Assistant
Office of Executive Policy and Programs
Finance and Grants Management Division

Mr. N. M. Hurley, Chief
Bureau of Environmental Quality Control Labs
South Carolina Department of Health and Environmental Control

Mr. Hartsill W. Truesdale, Chief
Bureau of Solid and Hazardous Waste Management
South Carolina Department of Health and Environmental Control

Mr. James Waddell, Jr., Chairman
South Carolina Coastal Council

Dr. James A. Timmerman, Jr.
Executive Director
South Carolina Wildlife and Marine Resources Department

Local Officials

Honorable J. W. Wall, Jr., Chairman
Allendale County Council

Honorable Robert O. Collins, Chairman
Barnwell County Council

Honorable Rodman Lemon
Mayor of Barnwell

Honorable E. T. Moore
Mayor of Snelling

Honorable H. Odell Weeks
Mayor of Aiken

Honorable Henry C. Chambers
Mayor of Beaufort

Honorable Thomas Greene
Mayor of North Augusta

Honorable Hoyt Dunseith
Mayor of Jackson

Honorable Eugene B. Fickling
Mayor of Blackville

Honorable William Holmes
Mayor of Allendale

Honorable Carrol H. Warner, Chairman
Aiken County Council

Honorable Thomas B. Brady
Mayor of Williston

Chairman
Jackson Town Council

Honorable Randy W. Shaw
Mayor of New Ellenton

Local Agencies

Mr. Roland Windham, City Manager
City of Aiken

Mr. Eric P. Thompson, Executive Director
Lower Savannah Council of Governments

Mr. W. Scott Barnes
County Administrator
Aiken County

City Administrator
City of North Augusta

Mr. James A. Moore
Greater Aiken Chamber of Commerce

Director
Low Country Council of Governments

Mr. Bobby R. Mauney
Aiken County Civil Defense

Mr. Edward E. Duryea
General Manager
Beaufort-Jasper County Water
Authority

Mr. Drew Wilder
Barnwell Chamber of Commerce

Director
Aiken County Planning Commission

Mr. Dan Lee, President
Chamber of Commerce of Greater
North Augusta

Dr. Robert Alexander, President
Greater Aiken Chamber of Commerce

STATE OF GEORGIA

Honorable Joe Frank Harris
Governor of Georgia

Ms. Barbara Morgan
Press Secretary
Office of the Governor

State Legislators

Honorable Thomas F. Allgood
Georgia Senate

Honorable Frank A. Albert
Georgia Senate

Honorable Jack Connell
Georgia House of Representatives

Honorable George M. Brown
Georgia House of Representatives

Honorable Charles W. Walker
Georgia House of Representatives

Honorable Charles Thomas
Georgia House of Representatives

Honorable Sam P. McGill
Georgia Senate

Honorable Mike Padgett
Georgia House of Representatives

Honorable Dick Ransom
Georgia House of Representatives

Honorable Donald E. Cheeks
Georgia House of Representatives

Honorable William S. Jackson
Georgia House of Representatives

State Agencies

Mr. J. L. Ledbetter, Director
Georgia Environmental Protection
Division
Georgia Department of Natural
Resources

Mr. J. L. Setser, Chief
Program Coordination Branch
Environmental Radiation Programs
Environmental Protection Division
Georgia Department of Natural
Resources

Mr. Jim Hardeman
Environmental Radiation Programs
Environmental Protection Division
Georgia Department of Natural Resources

Mr. C. H. Badger, Administrator
Georgia State Clearinghouse
Office of Planning and Budget

Mr. Charles Griffen, Director
Port Planning and Harbor Development
Georgia Port Authority

Mr. Leon Kirkland
Game and Fish Division
Georgia Department of Natural Resources

Mr. Fred Lehman, Program Manager
Surface Water Supply
Georgia Department of Natural Resources

Public Information Officer
Georgia State Department of Defense
Civil Defense Division

Mr. Peter Malphurs
State Environmental and Location Engineer
Department of Transportation

Local Officials

Chairman
Chatham County Commission

Honorable George L. DeLoach
Mayor of Waynesboro

Chairman
Burke County Commissioners

Honorable Charles A. Devaney
Mayor of Augusta

President
Augusta City Council

Honorable John P. Rousakis
Mayor of Savannah

Local Agencies

Director
Central Savannah River Area Planning and Development Commission

Director
Columbia County Planning and Zoning Commission

Director
Augusta-Richmond County Planning Commission

Mr. Charles H. Bellman
Executive Vice President
Chamber of Commerce of Greater Augusta

Mr. Ken Matthews
Savannah Area Chamber of Commerce

County Administrator
Burke County

County Administrator
Richmond County

Mr. Bob Stuntz
Chamber of Commerce of Greater Augusta

County Extension Agent
Richmond County Extension Service

ENVIRONMENTAL GROUPS

National

The Nature Conservancy

National Audubon Society

Environmental Defense Fund

Environmental Policy Institute

National Wildlife Federation

Defenders of Wildlife

Sierra Club Foundation

Sierra Club

League of Women Voters of the United States

Natural Resources Defense Council, Inc.

South Carolina

Dr. Judith E. Gordon
Nuclear Coordinator
South Carolina Chapter
Sierra Club

Ms. Frances Close Hart
Board Chairperson
Energy Research Foundation

Ms. Betty Spence
The South Carolina Wildlife Federation

Ms. Janet T. Orselli
Research Consultant
Radiation Awareness

Mr. Terrence Larimar
National Audubon Society

Mr. Michael Gooding
GROW

Mr. Brett Bursey
GROW

Mr. B. A. Bursey
Federation for Progress

The Audubon Society

Palmetto Alliance

Piedmont Organic Movement

Dr. Mary T. Kelly, President
League of Women Voters of South Carolina

Ms. Polly Holden
National Audubon Society

Ms. Ruth Thomas, President
Environmentalists, Inc.

Dr. Zoe Tsagos
League of Women Voters of Northern Beaufort County

Georgia

Miss Geraldine LeMay
League of Women Voters of Georgia

Mr. Jeff Bridgers, Coordinator
Citizens For Clean Air

Ms. Virginia Brown
League of Women Voters of Georgia

Mr. G. Robert Kerr
The Georgia Conservancy

Ms. J. Y. Shorthouse
Georgians Against Nuclear Energy

Ms. Rebecca R. Shortland, Editor
Georgia Water Line
The Georgia Conservancy

Mr. Dan Siler, III
Georgians Against Nuclear Energy

Mr. Peter L. Patrick
Athens Progressive Resource Center

Mr. Randy Tatel
Athens Progressive Resource Center

Mr. Hans Neuhauser
Coastal Director
The Georgia Conservancy

Mr. Ken Hinman
Ogeechee Audubon Society

Mr. Neil Dulohery, Vice Chairman
Students for Environmental Awareness

Other States

Dr. Ruth Patrick
Division of Limnology and Ecology
Academy of Natural Sciences of Philadelphia

Ms. Liz Paul
Groundwater Alliance

Mr. Alexander Sprunt, IV
Research Director
National Audubon Society

Ms. Annette Chmielewski
Environmental Defense Fund

Mr. Robert R. Grant, Jr.
Section Leader
Division of Environmental Research
Academy of Natural Sciences of Philadelphia

Mr. Larry Caldwell, Vice President
Hanford Oversight Committee

READING ROOMS AND LIBRARIES

Department of Energy

Library
Department of Energy
Germantown, MD

Freedom of Information Reading Room
U.S. Department of Energy
Forrestal Building
Washington, DC

Public Reading Room
Albuquerque Operations Office
National Atomic Museum
Albuquerque, NM

Public Reading Room
Richland Operations Office
Richland, WA

Public Reading Room
Idaho Operations Office
Idaho Falls, ID

Public Reading Room
Nevada Operations Office
Las Vegas, NV

Public Reading Room
Oak Ridge Operations Office
Federal Building
Oak Ridge, TN

Freedom of Information Public Document Room
University of South Carolina at Aiken
Gregg-Graniteville Library
Aiken, SC

Public Reading Room
Energy Resources Center
San Francisco Operations Office
Oakland, CA

Public Reading Room
Chicago Operations Office
Argonne, IL

South Carolina

Richland County Public Library
Columbia, SC

Beaufort County Library
Beaufort, SC

Greenville County Library
Greenville, SC

Spartanburg County Library
Spartanburg, SC

Mrs. Rhea Hebert, Librarian
Nancy Carson Public Library
North Augusta, SC

Allendale-Hampton-Jasper Regional
Library
Allendale, SC

Mrs. Betsy Ristroph, Librarian
Aiken County Public Library
Aiken, SC

Mrs. Frankie H. Cubbedge, Librarian
Gregg-Graniteville Library
University of South Carolina at Aiken
Aiken, SC

Mrs. Sandra Hummel, Librarian
Barnwell County Public Library
Barnwell, SC

Charleston County Library
Charleston, SC

Orangeburg County Free Library
Orangeburg, SC

Mrs. Carol Bowling
Aiken-Bamberg-Barnwell-Edgefield
Regional Library
Aiken, SC

South Carolina State Library
Columbia, SC

Georgia

Mr. A. Ray Rowland, Librarian
Reese Library
Augusta College
Augusta, GA

Screven-Jenkins Regional Library
Sylvania, GA

Atlanta Public Library
Atlanta, GA

Warren C. Gibbs Memorial Library
Evans, GA

Statesboro Regional Library
Statesboro, GA

Miss Wanda J. Calhoun, Director
Augusta - Richmond County Public
Library
Augusta, GA

Chatham-Effingham-Liberty
Regional Library
Savannah, GA

Burke County Library
Waynesboro, GA

Washington Memorial Library
Macon, GA

INDIVIDUALS AND ORGANIZATIONS

South Carolina

Ms. Susan R. Graber

Mr. Ted Harris

Mr. Mark Paley

Sister Ellen Robertson

Colonel Charles Stockell

Ms. Evelyn J. Bush

Mr. J. S. McMillan

Dr. F. John Vernberg

Mr. Joab M. Dowling

Mr. James S. Chandler, Jr.

Mr. Donald J. Colquhoun

Mr. John S. Wilson

Mr. R. I. Newman

Ms. Dorcas J. Elledge

Dr. Charles E. Feigley

Mr. Richard L. Shealy

Ms. Susan L. Gawarecki

Mr. T. M. King

Mr. Thomas Mack

Ms. Evelyn T. Couch

Mr. John Maderz

Mr. Roger D. Wensil

Mr. Henry J. McMaster

Ms. Juanita K. Keisler

Dr. W. P. Bebbington

Ms. Mary Lou Seymour

Mr. Arthur H. Dexter

Dr. S. J. Rosansky

Mr. Michael Ryan

Ms. Karen L. Arrington

Dr. Carl D. Schulz

Ms. Stephanie Sanzone

Mr. Rick Myers

Dr. Geoffrey I. Scott

Dr. William D. Anderson, Jr.

Ms. Beatrice D. Jones

Mr. Paul F. Highberger

Envirodyne Engineers, Inc.

Ms. Diane Mahoney

Mr. Frank S. Watters

Mr. Richard Dickison

Mr. Charles R. Holmes

Dr. Richard Hegg

Mr. Ralph F. Cullinan

Ms. Liza Morris

Ms. Jenny Tansil

Ms. Barbara Gerth

Mr. Edwin L. Barnhart

Mr. Dick Scott

Mr. Stuart M. Andrews, Jr.

Mr. G. D. Crowe

Ms. Frieda Carter

Mr. Robert W. Folsom

Mr. Mark A. Petermann

Mr. James N. Burleson

<u>Georgia</u>

Mrs. F. Levering Neely

Mr. Phil McCall

Dr. Deborah A Kearney

Ms. Barbara W. Wise

Mr. Robert J. Buschbacher

Mr. John C. Snedeker

Mr. Donald Webster

Mr. Ira Davis

Mr. Sumner C. Rosenberg

Ms. Amy G. Darden

Ms. Judy L. Rodgers

Mr. Todd Clay

Environmental Information Manager
Georgia Power Company

Mr. Bob Woodall

Dr. Edmund D. Boothe

Mr. Alan S. Ortiz

Mr. Donald S. Delikat

Mr. Dan Yost

Ms. Catherine Roulo

Mr. M. E. Clinton

Ms. Carol S. Thorup

Mr. B. L. Maulsby

Mr. Dwight H. Evans

Mr. Steve D. Ealy

Dr. S. David Stoney, Jr.

Mr. Terry Wallace

Ms. Dorethea Smith

Dr. Thomas Kozel

Ms. Carol E. Shipley

Mr. George Nelson

Mr. William F. Lawless

Mr. William H. Wheeler

Ms. Becky Kear

Dr. D. William Tedder

Ms. Amy D. Estelle

Ms. Geri Hopp

Ms. Ann Welch

Mr. Don Stanley

Mr. E. C. Brooks

Mr. David M. Yeh

Mr. James Pearson

Mr. Harvey Buckner

Other States

Mr. E. F. Ruppe, Vice President
Petrochemicals Department, AED
E. I. du Pont de Nemours and Company

Mr. Dan Warren

Ms. Kathryn Flowers

Mr. Bob Civiak

Mr. Fred Schmidt

Mr. Jim Beard

Ms. Evelyn Cosias

Mr. Jay Pride

Mr. Thomas H. Tank

Ms. Ann H. Hansen

Ms. Laura Christensen

Mr. J. R. Trabalka

Mr. John Schuman

Mr. Sam Schillaci

Mr. R. T. Goss

Prof. Gene Majerowicz

Dr. Arthur Sutherland

Ms. Kathryn C. Bearden

Mr. J. H. Roecker

Mr. Craig T. Rightmire

Ms. Dorothy L. Sander

Mr. J. Brian Haworth

Mr. Robert L. Greyell

Mr. William A. Lochstet

Ms. Betty Desimone

Mr. J. Sanchez

Ms. Flo Butler

Ms. Debbie Rykaczewski

Mr. Fred Yost

Ms. Gwen Bjorkman

Mr. Don Wodrich

Mr. Paul Piciulo

Mr. Dewey E. Large

Mr. Don J. Wilkes

Ms. Marci Ryan

Mr. Larry Long

Mr. W. A. Laseter

Ms. Nelda Stanley

E. I. du Pont de Nemours and Company
Petrochemicals Department, AED
ATTN: Document Custodian

Mr. Stuart L. Clark

Mr. John L. Knabenschuh

Ms. Mary H. Savage

Dr. Larry W. Jones

Ms. Kathy R. Atchison

Mr. Erik A. Rehtlane

Mr. D. E. Wood

Mr. W. A. Mihalco

Mr. Mason Chipman

Ms. Judith L. Wheat

Ms. Janet MacNeil

Dr. Bruno Loran

Ms. Traci Kunillopoolosa

Mr. Tim Poff

Ms. Wendy Brown

Mr. Charles Venuto

Mr. Raymond Rose

Mr. Mike Coony

Mr. Michael R. Harris

Mr. Bob Cochran

Mr. Peter D. Spawn

Mr. David Albright

Mr. G. F. Williamson

Mr. N. K.

Mr. Donald

Mr. Richar

Ms. Jocely

Mr. Tim C

nd

chmal

coloff

GLOSSARY

absorbed dose

Energy transferred to matter when ionizing radiation passes through it; measured in rads.

absorber

Material, such as concrete and steel shielding, that absorbs and diminishes the intensity of ionizing radiation.

absorption

The process by which the number and energy of particles or photons entering a body of matter are reduced by interaction with the matter.

acceptable daily intake (ADI)

The amount of toxicant intake (in milligrams per day) for a 70-kilogram person that is not expected to result in adverse effects after chronic exposure. (See fractional ADI.)

acclimation

Physiological and behavioral adjustments of an organism to changes in its immediate environment.

acclimatization

The acclimation or adaptation of a particular species over several generations to a marked change in the environment.

activation

The process of making a material radioactive by bombardment with neutrons, protons, or other nuclear particles.

activation products

Nuclei formed by the bombardment of material with neutrons, protons, or other nuclear particles.

activity

A measure of the rate at which a material is emitting nuclear radiation, usually given as the number of nuclear disintegrations per unit of time. (See curie.)

adaptation

A change in structure or habit of an organism that produces an adjustment to the environment.

ADI

See acceptable daily intake.

adsorption

The adhesion of a substance to the surface of a solid or solid particles.

Atomic Energy Commission (AEC)

A five-member commission established by the Atomic Energy Act of 1954 to supervise the use of nuclear energy. The AEC was dissolved in 1975 and its functions were transferred to the Nuclear Regulatory Commission (NRC) and to the Energy Research and Development Administration (ERDA), which became the Department of Energy (DOE).

air quality

A measure of the levels of pollutants in the air.

air-quality standards

The prescribed level of pollutants in the outside air that cannot be exceeded legally during a specified time in a specified area.

air sampling

The collection and analysis of air samples for detection or measurement of substances.

alpha (α) particle

A positively charged particle, consisting of two protons and two neutrons, that is emitted during certain radioactive decay from the nucleus of certain nuclides; it is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

ambient air

The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. (It is not the air in immediate proximity to emission sources.)

anion

A negatively charged ion. (See ion.)

aquatic biota

The sum total of living organisms of any designated aquatic area.

aquiclude

A saturated geologic unit that is incapable of transmitting significant quantities of water under ordinary hydraulic gradients.

aquifer

A saturated geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients; the water can be pumped to the surface through a well, or it can emerge naturally as a spring.

aquitard

A less permeable bed in a stratigraphic sequence. They are not permeable enough to transmit significant quantities of water. TC

archaeological sites (resources)

Areas or objects modified or made by man, and the data associated with these features and artifacts.

arcuate

A curved or bent axial trace in a fold. (The fold would be called "arcuate.")

arenaceous limestone

Limestone with a texture or appearance of sand.

arkose

A sandstone containing 25 percent or more of feldspars, usually derived from silicic igneous rocks (e.g., granite).

artesian well

A well in a confined aquifer with a water level that rises above the top of the aquifer; if it rises above the ground surface, the well is known as a flowing artesian well.

ash

Inorganic residue remaining after ignition of combustible substances.

atmosphere

The layer of air surrounding the earth.

backfill

Material such as stone, clean rubble, or soil that is used to refill an excavation.

background exposure

See exposure to radiation.

background radiation

Ionizing radiation present in the environment from cosmic rays and from natural sources in the earth; background radiation varies considerably with location. (See natural radiation.)

bedrock

Any solid rock exposed at the earth's surface or overlain by unconsolidated surface material such as soil, gravel, or sand.

benthic region

The bottom of a body of water; this region supports the benthos.

benthos

The plant and animal life whose habitat is the bottom of a sea, lake, or river.

beta particle

An elementary particle emitted from a nucleus during radioactive decay; it is negatively charged, identical to an electron, and easily stopped, as by a thin sheet of metal.

biological dose

The radiation dose absorbed in biological material (measured in rem).

biochemical oxygen demand (BOD)

A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water; the greater the amount of organic waste, the greater the BOD.

biological shield

A mass of absorbing material placed around a radioactive source to reduce the radiation to a level safe for humans.

biosphere

The portion of the earth and its atmosphere capable of supporting life.

biostratigraphy

The study of stratigraphy via fossilized remains.

biota

The plant and animal life of a region.

borosilicate glass

A strong, chemically and thermally resistant glass made primarily of sand and borax; for waste management, high-level waste is incorporated into the glass to form a leach-resistant, nondispersible (immobilized) material.

British thermal unit (Btu)

A unit of heat; the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit. One Btu equals 1055 joules (or 252 calories).

burial ground

A place for burying unwanted materials in which the earth acts as a receptacle to prevent the dispersion of wastes in the environment and the escape of radiation.

$^\circ$C (degree Celsius)

The Celsius temperature scale is related to the Fahrenheit scale as follows:

$$^\circ F = {}^\circ C \times \frac{9}{5} + 32$$

calcareous cement

A calcium-carbonate-based cement.

calcareous zone or formation

A stratigraphic unit composed largely of calcium carbonate (calcite or limestone).

calcine

The process in which the water portion of slurried waste is driven off by evaporation at high temperature in a spray chamber, leaving a residue of dry solid unmelted particles, also referred to as the calcine.

cancer

The name given to a group of diseases that are characterized by uncontrolled cellular growth.

canister

A metal (steel) container into which immobilized radioactive waste is sealed.

canyon building

A heavily shielded building used in the chemical processing of radioactive materials; operation and maintenance are by remote control.

carbon dioxide (CO_2)

A colorless, odorless, nonpoisonous gas that is a normal component of the ambient air; it is an expiration product of normal plant and animal life.

carbon monoxide (CO)

A colorless, odorless gas that is toxic if breathed in high concentration over a certain period of time; it is a normal component of most automotive exhaust systems.

carcinogen

An agent capable of producing or inducing cancer.

carcinogenic

Capable of producing or inducing cancer.

Carolina bay

Ovate, intermittently flooded, marshy depression of a type occurring abundantly on the Coastal Plain from New Jersey to Florida.

cask (radioactive materials)

A heavily shielded massive container for holding radioactive material.

cation

A positively charged ion. (See ion.)

CFM vault

A waste disposal vault designed specifically for RCRA delisted, effluent treatment facility, and mixed waste sludges that have been solidified using a cement/flyash matrix and cast in place in the disposal vault. The designs of such facilities must meet the requirements set forth in DOE Orders for the disposal of low-level radioactive waste.

clarifier

A tank or other vessel used to accomplish removal of settleable solids.

clastic dike

A sedimentary dike formed by broken rocks from overlying or underlying material.

common carriers

Vehicles such as trucks, trains, barges, and planes, that are licensed to transport the wide assortment of goods and materials distributed regularly across the country.

Comprehensive, Environmental Response Compensation, and Liability Act (CERCLA)

Establishes National Priority List (NPL) of abandoned hazardous waste sites ("Superfund").

concentration

The quantity of a substance contained in a unit quantity of a sample (e.g., milligrams per liter, or micrograms per kilogram).

condensate

Liquid water obtained by cooling the steam (overheads) produced in an evaporator system; also, any liquid obtained by cooling saturated vapor.

coolant

A substance, usually water, circulated through a processing plant to remove heat.

correlatable

Able to establish a connection between geological formations or events.

cretaceous

End of Mesozoic era, between 136 and 65 million years ago.

crystalline metamorphic rock

Rock consisting wholly of crystals.

cuesta

A ridge formed from sedimentary rock, steep on one side, but with a gentle slope on the other.

cumulative effects

Additive environmental, health, and socioeconomic effects that result from a number of similar activities in an area.

curie (Ci)

A unit of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second; also a quantity of any nuclide or mixture of nuclides having 1 curie of radioactivity.

daughter

A nuclide formed by the radioactive decay of another nuclide, which is called the parent.

Darcy's law

$$v = -K \frac{dh}{dl}$$

The empirical physical law that describes groundwater flow under saturated or unsaturated conditions; the darcy is a unit of permeability and is related to hydraulic conductivity.

decay heat (radioactivity)

The heat produced by the decay of radionuclides.

decay, radioactive

The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide; the process results in the emission of nuclear radiation (alpha, beta, or gamma radiation).

decommissioning

Removing facilities such as processing plants, waste tanks, and burial grounds from service and reducing or stabilizing radioactive contamination; includes the following concepts:

- The decontamination, dismantling, and return of an area to its original condition without restrictions
- Partial decontamination, isolation of remaining residues, and continued surveillance and restrictions

decomposition

The breakdown of a substance into its constituent parts.

decontamination (radioactive)

The removal of radioactive contaminants from surfaces of equipment by cleaning or washing with chemicals, by wet abrasive blasting using glass frit and water, or by chemical processing.

Defense Waste Processing Facility (DWPF)

Facility designed to process high-level defense waste into a suitable form for permanent storage or disposal; under construction at the SRP.

demography

The statistical study of human populations, including population size, density, distribution, and such vital statistics as age, sex, and ethnicity.

depositional regimes

A geologic term referring to the systematic laying or throwing down of material over a substantial area.

detritus

Dead organic tissues and organisms in an ecosystem.

dip

The angle that a structural surface (e.g., a bedding or fault plane) makes with the horizontal, measured perpendicular to the strike of the substance.

disposal

Placement of wastes in a facility such that the wastes remain isolated from the environment permanently or until decay has progressed to a point where releases pose no threat or hazard.

distillation

Separation process achieved by creating two or more coexisting zones that differ in temperature, pressure, or composition.

dose

The energy imparted to matter by ionizing radiation; the unit of absorbed dose is the rad, which is equal to 0.01 joule per kilogram of irradiated material in any medium.

dose commitment

The dose an organ or tissue would receive during a specified period of time (e.g., 50 to 100 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a 1-year release.

dose equivalent

The product of the absorbed dose from ionizing radiation and such factors that account for differences in biological effectiveness due to the type of radiation and its distribution in the body; it is measured in rem (Roentgen equivalent man).

dose rate

The radiation dose delivered per unit time (e.g., rem per year).

dosimeter

A small device (instrument) carried by a radiation worker that measures *radiation dose* (*e.g.*, *film* badge *or ionization chamber*).

drawdown

The height difference between the water level in a formation and the water level in a well caused by the withdrawal of groundwater.

ecology

The science dealing with the relationship of all living things with each other and with the environment.

ecosystem

A complex of the community of living things and the environment forming a functioning whole in nature.

effluent

A liquid waste, discharged into the environment, usually into surface streams.

effluent standards

Defined limits of waste discharge in terms of volume, content of contaminants, temperaturé, etc.

electron

An elementary particle with a unit negative charge and a mass 1/1837 of the proton; electrons surround the positively charged nucleus and determine the chemical properties of the atom.

element

One of the 105 known substances that cannot be divided into simpler substances by chemical reactions; all nuclides of an element have the same atomic number.

eluate

The liquid resulting from removing the adsorbed material from an ion-exchange medium.

emission standards

Legally-enforceable limits on the quantities or kinds of air contaminants that might be emitted into the atmosphere.

endangered species

Species of plants and animals that are threatened with either extinction or serious depletion in an area.

energy

The capacity to produce heat or do work. Electrical energy is measured in units of kilowatt-hours.

environmental dose commitment (EDC)

A dose representing exposure to and ingestion of environmentally available radionuclides for 100 years following a 1-year release of radioactivity.

environmental fate

The result of the physical, biological, and chemical interactions of a substance released to the environment.

environmental impact statement (EIS)

A document prepared pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 for a major Federal action significantly affecting the quality of the human environment.

environmental transport

The movement of a substance through the environment; includes the physical, chemical, and biological interactions undergone by the substance.

eocene

Lower tertiary period, after paleocene but before oligocene.

epidemiology

The study of diseases as they affect populations.

epoch

Length of geologic time.

estuarine

Pertaining to an area where salt and fresh water come together; area affected by tides.

exposure to radiation

The incidence of radiation on living or inanimate material by accident or intent:

- Background - exposure to natural background ionizing radiation
- Occupational - exposure to ionizing radiation that takes place during a person's working hours
- Population - exposure to a number of persons who inhabit an area

$^\circ$F (degree Fahrenheit)

The Fahrenheit temperature scale is related to the Celsius scale as follows:

$$^\circ C = \frac{(^\circ F - 32)}{1.8}$$

facies

A group of rocks that differ from surrounding rocks.

fall line

Imaginary line marking the point that most rivers drop steeply from the uplands to the lowlands.

fallout

The descent to earth and deposition on the ground of particulate matter (which can be radioactive) from the atmosphere.

fanglomerates

Sedimentary rock of water-worn heterogeneous fragments of every size, settling in an alluvial fan and cementing into rock.

fault

A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred in the past.

faunal

Animal and plant fossils of a certain rock unit.

feldspar

Most common group of aluminum silicate minerals (containing other metals, such as potassium, sodium, and iron) that forms rock.

ferruginous

Containing iron oxide.

fission

The splitting of a heavy atomic nucleus into two approximately equal parts, which are nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons; can occur spontaneously or can be induced by neutron bombardment.

fission products

Nuclei formed by the fission of heavy elements (primary fission products); also, the nuclei formed by the decay of the primary fission products, many of which are radioactive.

fluvial

Relating to, or living in or near, a river.

flux

Rate of flow through a unit area.

food chain

The pathways by which any material entering the environment passes from the first absorbing organism through plants and animals to humans.

fractional ADI

A defined fraction of an acceptable daily intake of an individual substance, or the sum of such fractions for each of a number of substances. (See acceptable daily intake.)

fracture porosity

Breaking in a rock, resulting in porosity.

fuller's earth

Fine grained natural earth substance; has high absorbency and consists mostly of hydrated aluminum silicates.

gamma rays (λ)

High-energy, short-wavelength, electromagnetic radiation accompanying fission and emitted from the nucleus of an atom; gamma rays are very penetrating and require dense (e.g., lead) or a thick layer of materials for shielding.

gamma spectrometry

Identification and quantification of radioisotopes by measurement of the characteristic gamma rays emitted by elements undergoing radioactive decay.

genetic effects

Radiation effects that can be transferred from parent to offspring; radiation-induced changes in the genetic material of sex cells.

geologic repository (mined geologic repository)

A facility for the disposal of nuclear waste; the waste is isolated by placement in a continuous, stable geologic formation at depths greater than 1000 feet.

geology

The science that deals with the earth: the materials, processes, environments, and history of the planet, especially the lithosphere, including the rocks, their formation and structure.

glass frit

Ground or powdered glass.

glauconitic

Mineral aggregate containing glauconite (a complex silicate mineral containing iron, aluminum, sodium, potassium, calcium, and magnesium), giving it a green color.

gneiss

Rock formed from bands of granular minerals alternating with bands of minerals that are flakey or have elongate prismatic habits.

gradient

Slope, particularly of a stream or land surface.

groundwater

The supply of water under the earth's surface in an aquifer.

gypsum

Mineral containing hydrated calcium sulfate ($CaSO_4 \bullet 2H_2O$).

half-life (biological)

The time required for a living organism to eliminate, by natural processes, half the amount of a substance that has entered it.

half-life (effective)

The time required for a radionuclide in an organism to reduce its activity by half as a combined result of radioactive decay and biological elimination.

half-life (radiological)

The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; varies for specific radioisotopes from millionths of a second to billions of years.

half-thickness

The thickness of any absorber that will reduce the intensity of a beam of radiation to one half its initial intensity.

halogens

The group of five chemically related nonmetallic elements that include fluorine, chlorine, bromine, iodine, and astatine.

health physics

The science concerned with the recognition, evaluation, and control of health hazards from ionizing radiation.

health risk

The probability that a specified health effect will occur from a defined exposure to a toxic chemical or radiation.

health risk assessment

An evaluation and interpretation of available scientific evidence on the toxicity of a substance, its presence in the environment at some level, and its accessibility for human exposure, providing a judgment and, if appropriate, an estimate of the probability that risk exists.

heating value

The heat released by combustion of a unit quantity of a fuel, measured in joules or Btus.

heavy metals

Metallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations; many exhibit cumulative effects.

heavy water (D_2O)

Water in which the molecules contain deuterium (D_2), an isotopic form of hydrogen that is heavier than ordinary hydrogen, and oxygen.

High-efficiency particulate air (HEPA) filter

A type of filter designed to remove 99.9 percent of the particulates as small as 0.3 micron in diameter from a flowing air stream.

high-level waste

High-level liquid waste or the products from the solidification of high-level liquid waste or irradiated fuel elements, if discarded without reprocessing.

historic resources

The sites, districts, structures, and objects considered limited and non-renewable because of their association with historic events, persons, or social or historic movements.

holocene

Epoch of quaternary period from end of the pleistocene (10,000 years ago) epoch to the present time.

horneblende

Most common mineral of the amphibole group.

hydraulic conductivity

Water flow rate in volume per unit time through a unit cross-section under a unit hydraulic gradient. (See Darcy's law; hydraulic gradient.)

hydraulic gradient

The difference in hydraulic head as a function of distance between wells. (See Darcy's law.)

hydraulic (water) head

Height of water with a free surface above a subsurface point.

hydrocarbons (HC)

Organic compounds consisting primarily of hydrogen and carbon; emitted in automotive exhaust and from the incomplete combustion of fossil fuels such as coal.

hydrograph

Graph showing water characteristics such as velocity or flow, in relation to time.

hydrologic regimen

Total quantity and characteristic behavior of water in a drainage basin.

hydrology

The science dealing with the properties, distribution, and circulation of natural water systems.

hydrosphere

The water portion of the surface of the earth, as distinguished from the solid portion (the lithosphere).

hydrostratigraphic unit (HSU)

Rock or soil body extending laterally for a considerable distance.

induced radioactivity

Radioactivity created when substances are bombarded with neutrons, as in a reactor.

indurated

Soil or rock compacted and hardened by heat, pressure, and cementation.

inert gas

A gas such as argon, xenon, or krypton that is ordinarily totally unreactive. Also called noble gases.

intensity (radioactive)

The energy or the number of photons or particles of radiation incident on a unit area per unit of time; the number of atoms disintegrating per unit of time.

interfluvial

Falling in the area between two streams.

intergranular porosity

Porosity between grains of rock.

interim storage (waste)

Temporary storage of drums, sealed canisters, or other vessels containing immobilized hazardous or radioactive wastes in a shielded or unshielded storage facility, until transfer to a Federal repository or other permanent disposal/storage facility.

intermediate-activity waste

Low-level radioactive waste or mixed waste with radioactivity of 300 millirem per hour or more at 7.6 centimeters from the surface of the container.

intruder

A member of the public similar to the maximally exposed individual who, after a 100-year institutional control period, remains on the site 24 hours a day; lives in a house on the site; consumes all food from crops and animal products grown on the site; drinks water from a well drilled on the site; breathes the air on the site; and moves about on the site.

ion

An atom or molecule that has gained or lost one or more electrons and has, thus, become electrically charged. Negatively charged ions are anions; positively charged ions are cations.

ion exchange

The process in which a solution passes over an ion-exchange medium, which removes the soluble ions by exchanging them with labile ions from the medium; this process is reversible, so the adsorbed ions can be eluted from the medium, and the medium can be regenerated.

ion-exchange resin

Polymeric spheres (usually polystyrene-divinylbenzene copolymers) containing bound groups that carry an ionic charge, either positive or negative, in conjunction with free ions of opposite charge that can be displaced.

ionization

The process whereby ions are formed from atoms or molecules; nuclear radiation can cause ionization, as can high temperatures and electric discharges.

ionizing radiation

Radiation capable of displacing electrons from atoms or molecules, thereby producing ions.

irradiation

Exposure to radiation.

isotope

An atom of a chemical element with a specific atomic number and atomic weight; isotopes of the same element have the same number of protons but different numbers of neutrons.

joule

A unit of energy or work equivalent to 1 watt per second, 0.737 foot-pound, or 4.18 calories.

kaolin

Clay mineral group characterized by a silicon-oxygen sheet and an aluminum-hydroxyl sheet alternately linked to form a two-layer crystal lattice.

kilometer

A metric unit of length equal to 0.62137 mile or 1000 meters.

leachate

Liquid that has percolated through solid waste or other media and has extracted dissolved or suspended materials from the solids into the liquids.

leaching

The process whereby a soluble component of a solid or mixture of solids is extracted as a result of percolation of a liquid around and through the solid.

leukemia

A form of cancer characterized by extensive proliferation of non-functional immature white blood cells (leukocytes).

life-cycle cost

The total cost associated with the management of waste throughout its existence or for some specified period of time (e.g., 100 years). TC

lignite

A brownish-black coal of low Btu value between stages of peat and sub-bituminous coal.

limonite

Hydrous ferric oxides occurring naturally but having unknown origins.

liters per second (lps)

A metric unit of flow rate equal to 15.85 gallons per minute.

lithology

Rock descriptions by color, structure, grain size, etc.

lithosphere

The solid part of the earth, composed predominantly of rock.

long-lived nuclides

Radioactive isotopes with half-lives greater than about 30 years.

low-activity waste

Low-level radioactive or mixed waste with radioactivity of less than 300 millirem per hour at 7.6 centimeters from the container.

low-level waste

Radioactive waste not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct material.

man-rem

See person-rem.

margin of safety (MOS)

The ratio between the risk value (see fractional ADI) for noncarcinogens and 1; the smaller the risk value, the larger the MOS; the smaller the MOS, the higher the risk.

marine terrace

Narrow coastal strip altered by marine deposit and erosion.

maximum contaminant level (MCL)

Maximum permissible level of a contaminant in drinking water, based on a 70-kilogram adult consuming 2 liters of water a day (from National Primary Drinking Water Standards).

maximum permissible dose

That dose of ionizing radiation established by competent authorities as an amount below which there is no appreciable risk to human health; at the same time, it is below the lowest level at which a definite hazard is believed to exist.

mica

Variously colored, or colorless mineral silicates, crystallizing in monoclinic forms that separate into thin leaves.

micro (µ)

Prefix indicating one millionth. One microgram (µg) = 1/1,000,000 of a gram or 10^{-6} gram.

micrometer (μm)

A unit of length equal to one one-millionth (10^{-6}) of a meter.

micron

A micrometer (10^{-6} meter). (Note: "micrometer" is the preferred usage.)

Middendorf/Black Creek

Upper Cretaceous age formations of high water yield, colloquially referred to as the lower and upper Tuscaloosa Formations; the Middendorf Formation is separated from the overlying Black Creek Formation by a clay aquitard known as the "mid-Tuscaloosa clay."

migration

The natural travel of a material through the air, soil, or groundwater.

moderator

A material used to decelerate neutrons from fission to thermal energies.

molecule

A group of atoms held together by chemical forces; the smallest unit of a compound that can exist by itself and retain all its chemical properties.

monoclinal

Strata varying from the horizontal in one direction only.

mutagen

An agent (physical, chemical, or radioactive) capable of inducing mutation (above the spontaneous background level).

mutagenesis

The occurrence or induction of mutation, a genetic change that is passed on from parent to offspring.

mutation

An inheritable change in the genetic material (in a chromosome).

nano

Prefix indicating one thousandth of a micro unit; one trillionth; 1 nanocurie = 10^{-9} curie.

National Register of Historic Places

A list maintained by the National Park Service of architectural, historic, archaeological, and cultural sites of local, state, or national significance.

natural radiation; natural radioactivity

Background radiation: cosmic, soil, rocks.

neutron

An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

neutron flux

Number of neutrons flowing through a unit area per unit time.

NO_x

Refers to the oxides of nitrogen, primarily NO and NO_2. These are often produced in the combustion of fossil fuels. In high concentrations, they constitute an air pollution problem.

nodes

The intersection of horizontal and vertical grids.

nuclear energy

The energy liberated by a nuclear reactor (fission or fusion) or by radioactive decay.

nuclear reaction

A reaction in which an atomic nucleus is transformed into another element, usually with the liberation of energy as radiation.

nucleus

The small positively charged core of an atom, which contains nearly all the mass of the atom.

nuclide

An atomic nucleus specified by its atomic weight, atomic number, and energy state; a radionuclide is a radioactive nuclide.

organic degreasers

Cleaning agents having organic chemical structures, such as trichloroethane, trichloroethylene, tetrachloroethylene, and tetrachloromethane (carbon terachloride). Trade names include Perchlor and Trichlor, or Perclene and Triclene.

outcrop

The exposure of bedrock or strata projecting through overlying soil.

Paleocene

Epoch of Tertiary period between the Gulfian of the Cretaceous period (65 million years ago) and before the Eocene (55 million years ago) period.

particulates

Solid particles small enough to become airborne.

parts per million (ppm)

The unit commonly used to represent the degree of concentration. In air, ppm is usually volume pollutant per 1,000,000 volumes of air; in water, a weight per 1,000,000 weight units.

pascal

A metric unit of pressure; 101,000 pascals is equal to 14.7 pounds per square inch (psi).

pD

The negative log of the deuterium (heavy hydrogen) ion concentration (activity) in solution; analogous to the term pH, which refers to the hydrogen (protium) ion concentration (activity). (See <u>pH</u>.)

peneplain

Almost featureless, plain land surface.

perched

A water-bearing area of small lateral dimensions lying above a more extensive aquifer.

permeability

Capacity of rock to transmit a fluid. (See <u>Darcy's law</u>.) | TC

person-rem

The radiation dose commitment to a given population; the sum of the individual doses received by a population segment.

pH

A measure of the hydrogen ion concentration (activity) in an aqueous solution; specifically, the negative logarithm of the hydrogen ion concentration. Acidic solutions have a pH from 0 to 7; basic solutions have a pH greater than 7.

phosphatic marl

Soft, loose, earthy phosphates that crumble easily.

photon

Electromagnetic radiation; a quantum of electromagnetic energy having properties of both a wave and a particle but without mass or electric charge.

physiography

Description of earth surface features, including air, water, and land.

Piedmont province

Large area forming a plateau at the base of the Appalachian mountains, extending from New Jersey to Alabama.

piezometric maps

Lines of equal groundwater pressure drawn on a map.

piezometric surface

The surface to which water in an aquifer would rise by hydrostatic head.

pisolitic clay

Clay that exhibits an internal structure of pea-sized clay grains.

Plant (or SRP) stream

Any natural stream on the Savannah River Plant; surface drainage is via these streams to the Savannah River.

Pleistocene

Epoch of the Quaternary period, between Pliocene (1.8 million years ago) and Holocene (10,000 years ago).

Pliocene

Epoch of the Tertiary period, between Miocene (5 million years ago) and Pleistocene (1.8 million years ago).

pounds per square inch (psi)

A measure of pressure; atmospheric pressure is about 15 psi.

plume

The elongated pattern of contaminated air or water originating at a point-source emission, such as a smokestack, or a waste source, such as a hazardous waste disposal site.

pyrite

Isometric mineral: FeS_2 (iron sulfide).

quality factor (radioactive)

The factor by which absorbed dose, in rads, is multiplied to obtain a quantity expressing the irradiation incurred by various biological tissues, taking into account the biological effectiveness of the various types of radiation.

quartz

Crystalline silica: SiO_2.

quartzite

Very hard, metamorphosed sandstone.

Quaternary age

The period from the end of the Tertiary (1.8 million years ago) to the present time.

radiation

The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally-occurring radiation is indistinguishable from induced radiation.

radiation absorbed dose (rad)

The basic unit of absorbed dose equal to the absorption of 0.01 joule per kilogram of absorbing material.

radioactivity

The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

radioisotopes

Nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons and that spontaneously emit particles of electromagnetic radiation.

RCRA vault

A waste disposal vault designed to meet RCRA minimum technology standards.

recommended maximum contaminant level (RMCL)

Proposed maximum permissible level of a contaminant in drinking water.

residence time

The period of time during which a substance remains in a designated area.

Resource Conservation and Recovery Act (RCRA)

Federal legislation that regulates the transport, treatment, and disposal of solid and hazardous wastes.

risk assessment

A process of combining the hazard per unit exposure for a substance with the probable exposure to that substance to produce an estimate of risk or hazard to exposed individuals or the population from that substance. (See health risk assessment.)

roentgen (R)

A unit of exposure to ionizing radiation equal to or producing 1 coulomb of charge per cubic meter of air.

roentgen equivalent man (rem)

The unit of dose for biological absorption; equal to the product of the absorbed dose in rads, a quality factor, and a distribution factor.

saltcrete

A mixture of partially decontaminated salts and concrete.

sandstone

Clastic rock containing large individual particles visible to the unaided eye.

sanitary landfilling

An engineered method of solid waste disposal on land in an acceptable manner; waste is spread in thin layers, compacted to the smallest practical volume, and covered with soil at the end of each working day.

saprolite

A rock that is earthy, soft, clay-rich, extremely decomposed.

Savannah River Ecology Laboratory (SREL)

An ecological research institution operated by the University of Georgia under contract from DOE.

Savannah River Laboratory (SRL)

A nuclear research facility operated by E. I. du Pont de Nemours and Company under contract from DOE.

Savannah River Plant (SRP)

A 780-square-kilometer (192,700-acre), controlled-access area near Aiken, South Carolina, containing industrial facilities that produce nuclear materials for national defense.

schist

Strongly foliated crystalline rock formed by dynamic metamorphism that can be split easily into thin slabs, or flakes.

scrubber

An air pollution control device that uses a liquid spray to remove pollutants from a gas stream by absorption or chemical reaction.

sedimentation

The settling of excess soil and mineral solids of small particle size contained in water.

seep lines

Small zone where water leachate percolates slowly to the surface; a series of groundwater or leachate springs.

seepage basin

An excavation in the ground to receive aqueous streams containing chemical and radioactive wastes. Insoluble materials settle on the floor of the basin and soluble materials seep with the water through the soil column, where they are removed partially by ion exchange or other absorption processes with the soil. Dikes prevent overflow or surface runoff.

seismic

Pertaining to any earth vibration, especially an earthquake.

seismicity

The tendency for the occurrence of earthquakes.

settling tank

A tank in which settleable solids are removed by gravity.

shield

An engineered body of absorbing material used to protect personnel from radiation.

short-lived nuclides

Radioactive isotopes with half lives no greater than about 30 years (e.g., cesium-137 and strontium-90).

siliceous cement

Cement with an abundance of silica.

siltstone

Silt having the texture and composition of shale, but lacking its fine lamination.

sink

An area from which water drains or is removed.

sludge

The precipitated solids (primarily oxides and hydroxides) that settle to the bottom of the vessels containing liquid wastes.

slurry

A suspension of solid particles (sludge) in water.

stationary source

A source of emissions into the environment that is fixed, as a stack or chimney, rather than moving, as an automobile.

storage (waste)

Retention of radioactive or hazardous waste in a man-made container (such as a drum, tank, or vault) in a manner that permits retrieval, as distinguished from disposal, which implies no retrieval.

storage coefficient

Volume of water released from storage in a vertical column of 1.0 square foot when the water table declines 1.0 foot.

stratified

Formed or arranged in layers.

stratigraphy

Division of geology dealing with the definition and description of rocks and soil, both major and minor natural divisions.

strike

The direction or trend that a structural surface (e.g., a bedding or fault plane) takes as it intersects the horizontal.

sulfur dioxide (SO_2)

A heavy pungent colorless gas (formed in the combustion of coal); SO_2 in high concentration is considered a major air pollutant.

sulfur oxides (SO_x)

Primarily SO_2 and SO_3; a common air pollutant.

supernatant; supernate

The portion of a liquid above settled materials in a tank or other vessel.

surface water

All water on the earth's surface, as distinguished from groundwater.

surficial deposit

Most recent geological deposit lying on bedrock or on or near the earth's surface.

Tertiary age

First period of Cenozoic era, thought to be between 65 and 1.8 million years ago.

threshold dose

The minimum dose of a given substance that produces a measurable environmental response factor.

total suspended particulates (TSP)

The concentration of particulates in suspension in the air, irrespective of the nature, source, or size of the particulates.

toxicity

The quality or degree of being poisonous or harmful to plant or animal life.

tracer injection detection test

Injection of dye in water to trace water flow.

transmissivity

The rate at which water of prevailing kinematic viscosity is transmitted through a unit width under a unit hydraulic gradient.

transuranic (TRU) waste

Without regard to source or form, radioactive waste that at the end of institutional control periods is contaminated with transuranium radionuclides with half-lives greater than 20 years in concentrations greater than 100 nCi/g.

transuranium elements

Elements above uranium in the periodic table; all 13 known transuranic elements are radioactive and are produced artificially.

Triassic period

First period of the Mesozoic era; thought to be between 225 and 190 million years ago.

tritium (H-3)

A radioactive isotope of hydrogen, a weak beta emitter with a half-life of 12.3 years.

turbidity

Measure of sediment or suspended foreign particle concentration in solution.

Tuscaloosa

See Middendorf/Black Creek.

unconsolidated

Loosely arranged or unstratified sediment.

unit cancer risk (UCR)

The excess risk due to a continuous lifetime exposure to one unit of carcinogen concentration, expressed as a probability; also called carcinogenic potency factor.

vadose zone

The unsaturated zone in soil above the water table.

vault

A reinforced concrete structure for storing canisters of immobilized high-level radioactive waste.

venting

Release of gases or vapors under pressure to the atmosphere.

volatile organic compounds

A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures, such as benzene, acetone, chloroform, and methyl alcohol.

waste, hazardous (RCRA)

Any solid waste (can also be semisolid or liquid, or contain gaseous material) having the characteristics of ignitability, corrosivity, toxicity, or reactivity, defined by RCRA and identified or listed in 40 CFR 261. For this EIS, "hazardous" refers to substances or constituents, used in their everyday sense, without specific regard to technical or regulatory definitions, unless indicated.

waste, mixed

Waste having both hazardous and low-level radioactive content.

waste, radioactive

Materials from nuclear operations that are radioactive or are contaminated with radioactive materials, and for which there is no practical use or recovery is impractical.

watershed

The area drained by a given stream.

water table

The upper surface of the groundwater.

zero release

Refers to the design of hazardous waste disposal/storage sites that meet minimum requirements for secure disposal/storage; derived from RCRA regulations.

zooplankton

Planktonic (floating) animals that supply food for fish.

LIST OF ACRONYMS AND ABBREVIATIONS

ADI	acceptable daily intake
AEC	U.S. Atomic Energy Commission
BOD	biochemical oxygen demand
Btu	British thermal unit
cc	Cubic centimeters, cm^3 or cc (1 cc = 1 milliliter)
CCDF	Complementary cumulative distribution function
CEQ	President's Council on Environmental Quality
CERCLA	Comprehensive, Environmental Response Compensation, and Liability Act
CFM	cement/flyash matrix
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	Curie
COE	U.S. Army Corps of Engineers
CTF	chemical transfer facility
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy - Headquarters
DOE-SR	U.S. Department of Energy - Savannah River Operations Office
DOI	U.S. Department of the Interior
DPSOL	Du Pont Savannah Operating List
DPSOP	Du Pont Savannah Operating Procedure
DWPF	Defense Waste Processing Facility
D_2O	heavy water or deuterium oxide
EA	environmental assessment
ED	Environmental Division, DOE-SR

EDC	environmental dose commitment
EIS	environmental impact statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERDA	U.S. Energy Research and Development Administration
ESA	Endangered Species Act
FEIS	final environmental impact statement
FHETF	F- and H-Area effluent treatment facility
FMF	Fuel Materials Facility
FMF-EA	Fuel Materials Facility - Environmental Assessment
FONSI	Finding of No Significant Impact
FWCA	Fish and Wildlife Coordination Act
FWS	U.S. Fish and Wildlife Service
g/L	grams per liter
HC	hydrocarbon
HEPA	high-efficiency particulate air (filter)
HSU	hydrostratigraphic unit
HSWA	Hazardous Solid Waste Amendments
HWCTR	Heavy Water Components Test Reactor
LETF	liquid effluent treatment facility
lps	liters per second
LSS	liquid scintillation solvents
MCL	maximum contaminant level
mg	milligram (one-thousandth of a gram)
ml	milliliter (one-thousandth of a liter)
mm	millimeter (one-thousandth of a meter)

MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
mrem	millirem (one-thousandth of a rem)
NAAQS	National Ambient Air Quality Standards
nCi	nanocuries (10^{-9} curie)
NEPA	National Environmental Policy Act of 1969 (42 USC 4321 et seq.)
NERP	National Environmental Research Park
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	U.S. Nuclear Regulatory Commission
NSPS	New Source Performance Standards
PCB	polychlorinated biphenyl
ppb	parts per billion (10^{-9}) (one thousandth of a part per million)
PSD	prevention of significant deterioration
R	roentgen
rad	radiation absorbed dose
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RMCL	recommended maximum contaminant level
SCDHEC	South Carolina Department of Health and Environmental Control
SCWMRD	South Carolina Wildlife and Marine Resources Department
SCWRC	South Carolina Water Resource Commission

SHPO	State Historic Preservation Office
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SPCC	Spill Prevention Control and Countermeasure
SREL	Savannah River Ecology Laboratory
SRL	Savannah River Laboratory
SRLUC	Savannah River Land Use Committee
SRP	Savannah River Plant
TRU	transuranic
TSP	total suspended particulates
TSS	total suspended solids
UCR	unit cancer risk
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VOC	volatile organic compounds

INDEX

A

AGO, 2-41, 2-65, 4-125
Accidents, 2-27, 2-72, 4-2, 4-5, 4-86, 4-91, 4-94, 4-96, 4-98, 4-110 through 4-115, 4-144
Agriculture, 3-5, 3-7
Air quality, 3-12, 4-92, 4-131, 4-133
Air stripper, 2-21, 3-34, 4-28, 4-54, 4-71, 4-81, 5-4
Alligator, 3-46, 3-48 through 3-49, 4-32 through 4-33, 4-57, 4-71, 4-92, 4-97
Archaeology, 3-69, 5-10, 5-17
Atmospheric dispersion, 3-12
Atomic Energy Act, 1-1, 4-138, 6-3

B

Beaufort-Jasper, 3-43, 4-104, 5-10 through 5-11
Beaver Dam Creek, 3-32, 3-38 through 3-39
Burial ground, 2-12, 2-17, 3-1, 4-22 through 4-23, 4-36, 4-50, 4-51, 4-61, 4-66, 4-68, 4-74, 4-88, 4-120, 4-122, 4-124 through 4-125, 4-132, 5-8 through 5-9

C

CERCLA, 1-3 through 1-4, 2-1 through 2-2, 2-12, 4-120 through 4-121, 4-126 through 4-127, 6-3, 6-5, 6-9 through 6-10
CFM, 2-37, 2-40, 2-47, 4-58, 4-91, 4-123, 4-140
Cancer, 4-5, 4-23, 4-51, 4-74, 4-79
Chemical releases, 4-22
Climatology, 3-7 through 3-8, 3-72
Closure, 1-3 through 1-4, 2-6, 2-8 through 2-9, 2-12, 2-20 through 2-21, 2-27, 2-37, 2-41, 2-42, 2-44, 2-48, 2-51, 2-59, 2-65, 2-71, 3-1, 3-7, 3-66, 3-70, 4-2, 4-4, 4-7, 4-13, 4-16, 4-33 through 4-36, 4-45 through 4-46, 4-49 through 4-50, 4-51, 4-54, 4-57 through 4-58, 4-64, 4-67, 4-71, 4-74 through 4-82, 4-85 through 4-87, 4-92 through 4-93, 4-97 through 4-98, 4-110 through 4-115, 4-121 through 4-122, 4-128, 4-130 through 4-131, 4-134, 4-136 through 4-137, 4-139 through 4-140, 4-142 through 4-143, 4-148, 5-12 through 5-13, 5-15 through 5-18, 6-4, 6-6 through 6-7, 6-9, 6-12
Combination strategy, 2-9, 2-27, 2-31, 2-48, 2-49, 2-66, 2-67, 2-69, 2-70, 4-75 through 4-79, 4-81, 4-96 through 4-99, 4-1024-108, 4-134 through 4-135, 4-140
Compaction, 2-43, 4-125, 5-12
Congaree Formation, 3-17 through 3-18, 4-16, 4-85, 5-13
Containment basin, 2-49, 3-55, 5-9
Cumulative effects, 1-3, 4-2 through 4-4, 4-8, 4-16, 4-37, 4-120, 4-127, 4-131, 4-133

D

D-Area, 2-12, 2-19, 3-1, 3-20, 3-29, 3-38, 3-43, 4-13, 4-27, 4-41, 4-68
DWPF, 3-1, 4-123, 4-127
Decommissioning, 4-2, 4-4, 4-113, 4-120, 4-139, 4-146 through 4-148, 6-4
Decontamination, 4-2, 2-68, 4-113 through 4-115, 4-120, 4-139, 6-4
Dedication strategy, 2-6, 2-21, 2-27, 2-47, 2-50, 2-65, 2-67, 2-69, 4-34, 4-37, 4-41 through 4-42, 4-45 through 4-46, 4-49 through 4-50, 4-51, 4-54 through 4-58, 4-61, 4-64, 4-75 through 4-76, 4-78, 4-81, 4-91 through 4-93, 4-96, 4-99, 4-104
Defense Waste Processing Facility, 2-10, 3-70, 4-123
Detritiation, 2-10, 2-50, 2-51, 2-67, 2-68, 4-102, 4-103, 4-108 through 4-110, 4-129, 4-135, 4-139 through 4-142
Disassembly basin purge water, 2-50

D (continued)

Disassembly basin, 2-2, 2-50, 4-102
Dose, 2-65, 2-66, 2-68, 3-51 through 3-52, 3-73, 4-4 through 4-5, 4-20 through 4-23, 4-46, 4-49 through 4-50, 4-51, 4-66 through 4-68, 4-74, 4-77 through 4-78, 4-80, 4-85, 4-92 through 4-93, 4-98, 4-104 through 4-110, 4-115, 4-120, 4-127 through 4-128, 4-130 through 4-131, 4-137 through 4-138
Drinking water, 1-2, 2-1, 3-25, 3-28, 3-32, 3-56 through 3-59, 3-71, 4-4, 4-13, 4-20 through 4-21, 4-31 through 4-32, 4-78 through 4-79, 4-82, 4-92, 4-104, 4-135, 4-146 through 4-147, 5-1, 5-3, 5-10, 6-2, 6-10 through 6-11

E

EID, 5-15
ELLT, 2-40, 2-41, 2-47
ETF, 2-40, 4-121 through 4-122, 4-124, 4-127, 4-146, 5-4
Earthquake, 3-16, 3-70, 3-75, 4-111, 4-114
Ecology, 2-21, 2-27, 2-65, 2-71, 3-45 through 3-46, 3-49, 3-73, 4-86, 4-89 through 4-90, 4-92, 4-95, 4-97, 4-99, 4-131, 4-143
Effluent treatment facility, 2-40, 4-121, 4-123, 4-146
Elimination strategy, 2-8, 2-21, 2-27, 2-31, 2-48, 2-50, 2-65, 2-70, 4-58 through 4-61, 4-64, 4-66 through 4-68, 4-70 through 4-73, 4-75 through 4-76, 4-78, 4-81, 4-94 through 4-96, 4-99, 4-105 through 4-108, 4-129 through 4-132, 4-138
Engineered low-level trench, 2-36, 2-40
Environmental Information Document, 3-70, 3-72 through 3-74, 4-146 through 4-148, 5-15
Environmental effects, 2-10, 2-66, 4-138 through 4-139
Erosion, 2-20, 2-71, 3-16, 4-3, 4-7, 4-19, 4-28, 4-33 through 4-34, 4-57, 4-71, 4-81, 4-93, 4-97, 4-132, 4-143, 5-16

F

F-Area, 2-17 through 2-18, 2-27, 2-31, 3-49, 3-55, 3-63, 3-65, 3-67, 3-72, 4-8, 4-10, 4-21 through 4-24, 4-32 through 4-33, 4-35 through 4-36, 4-49 through 4-50, 4-51, 4-54, 4-57, 4-61, 4-66 through 4-68, 4-71, 4-76 through 4-80, 4-82, 4-85, 4-147, 5-5, 5-8, 5-12
FMF, 3-4, 4-123, 4-127
Floodplain, 3-14, 3-30, 3-73, 4-95, 6-11 through 6-12
Four Mile Creek, 2-70, 3-32, 3-35, 3-37 through 3-38, 3-41, 4-8, 4-10, 4-13, 4-16, 4-20 through 4-21, 4-31 through 4-32, 4-41, 4-85, 4-132, 4-135 through 4-136, 5-8
Fuel Materials Facility, 2-40, 4-123

G

GCD, 1-2, 2-10, 2-36, 2-41, 2-42, 2-47, 2-65, 4-91 through 4-92, 4-125, 4-140,
Genetic disorders, 4-22, 4-136,
Geology, 3-12, 3-70, 3-72, 3-75
Greater confinement disposal, 1-2, 2-10, 2-41, 4-91, 4-124 through 4-125
Groundwater models, 5-9
Groundwater, 1-1 through 1-5, 2-1 through 2-2, 2-6, 2-8 through 2-9, 2-12, 2-15, 2-20 through 2-21, 2-27, 2-31, 2-47, 2-49, 2-50, 2-59, 2-65, 2-71, 2-74, 3-6, 3-16 through 3-18, 3-20, 3-23 through 3-30, 3-34, 3-54 through 3-56, 3-62 through 3-64, 3-69 through 3-72, 3-75, 4-1 through 4-4, 4-7 through 4-8, 4-10, 4-13, 4-16, 4-19 through 4-21, 4-24 through 4-28, 4-31 through 4-37, 4-41, 4-45 through 4-46, 4-49 through 4-50, 4-51 through 4-54, 4-57 through 4-58, 4-61, 4-64, 4-66 through 4-67, 4-69 through 4-70, 4-75 through 4-77, 4-81 through 4-82, 4-85 through 4-86, 4-88 through 4-89, 4-91 through 4-93, 4-95 through 4-97, 4-102, 4-104,

G (continued)

4-109, 4-122, 4-124 through 4-127, 4-129 through 4-137, 4-140 through 4-143, 4-147, 5-1 through 5-18, 6-1, 6-7 through 6-9, 6-11 through 6-12

H

H-Area, 2-17 through 2-18, 2-40, 3-14, 3-20, 3-23, 3-35, 3-55 through 3-56, 3-62 through 3-63, 3-65, 3-67, 3-72, 4-8, 4-10, 4-21 through 4-24, 4-31 through 4-32, 4-35 through 4-36, 4-39 through 4-40, 4-49 through 4-50, 4-51, 4-54, 4-61, 4-66 through 4-68, 4-74, 4-76 through 4-77, 4-79, 4-121 through 4-124, 4-132, 4-136, 4-146, 5-2, 5-4 through 5-5, 5-8 through 5-9, 5-12 through 5-13, 6-7
HSWA, 1-2 through 1-3, 2-1 through 2-2, 2-31, 2-65, 2-67, 4-140, 5-14, 6-5 through 6-8
Habitat, 2-65, 2-71, 2-72, 3-49 through 3-50, 4-32, 4-57, 4-79, 4-92, 4-95, 4-97, 4-137, 4-139, 4-144
Hazardous and Solid Waste Amendments, 1-2, 2-1, 4-139, 5-14, 6-7 through 6-8, 6-10
Hazardous waste, 1-1 through 1-4, 2-2, 2-15, 2-42, 2-74, 3-17, 3-66, 3-70, 4-58, 4-91, 4-122 through 4-123, 4-139 through 4-140, 4-146, 5-2 through 5-3, 5-5, 5-11 through 5-12, 5-14, 5-17, 6-3 through 6-6, 6-8 through 6-9, 6-11
Health effects, 2-70, 4-2, 4-16, 4-22 through 4-23, 4-50, 4-51, 4-67, 4-78, 4-85 through 4-86, 4-90, 4-104, 4-106, 4-109 through 4-110, 4-127 through 4-131, 4-134, 4-136, 4-143, 5-16
Heavy metals, 1-2, 3-25, 3-63, 3-65, 5-16, 6-11
High level waste, 1-2
Housing, 3-6
Hurricane, 3-8, 3-11, 4-111
Hydroelectric, 4-111

I

Impoundments, 3-43, 5-14, 6-6 through 6-8
Incineration, 2-43, 4-34, 4-122
Indian Grave Branch, 3-38, 3-40, 4-31 through 4-32
Institutional control period, 2-8 through 2-10, 2-21, 2-27, 2-31, 2-65, 2-66, 2-68, 2-69, 3-66, 3-68, 4-81 through 4-82, 4-86, 4-91 through 4-93, 4-96 through 4-99, 4-134, 4-139, 4-141, 4-144 through 4-145

L

L-Lake, 3-41
Land use, 3-1, 3-4 through 3-6
Landfill, 2-36, 2-37, 4-58, 4-99, 4-122, 4-140,
Lost Lake, 2-17, 4-8, 4-21 through 4-23, 4-32, 4-35, 4-50, 4-51, 4-58, 4-66, 4-68, 5-13
Low-level waste, 2-40, 2-47, 2-48, 2-66, 2-67, 4-75, 4-80, 4-86 through 4-88, 4-93, 4-95, 4-98, 6-4
Lower Three Runs Creek, 3-41, 3-43 through 3-44, 3-65, 4-16, 4-20

M

M-Area, 1-1, 1-5, 2-17, 2-21, 2-40, 3-1, 3-17, 3-20, 3-34, 3-63 through 3-65, 3-67, 3-70, 3-74, 4-7 through 4-8, 4-21 through 4-24, 4-28, 4-31 through 4-33, 4-35 through 4-38, 4-50, 4-51, 4-54, 4-57 through 4-58, 4-62, 4-66 through 4-68, 4-71, 4-74, 4-79, 4-81, 4-121, 4-123, 4-130 through 4-132, 4-136, 4-148, 5-2, 5-4 through 5-5, 5-10 through 5-13, 5-15, 5-17, 6-6 through 6-8, 6-12
Maximum contaminant levels, 4-4, 4-135
Metallurgical Laboratory Basin, 2-17, 3-67, 4-3, 4-35, 5-12, 5-18
Meteorology, 3-7 through 3-8
Mitigation, 2-9 through 2-10, 2-51, 2-59, 2-67, 3-41, 4-58, 4-93, 4-95, 4-102, 4-108, 4-133 through 4-135, 4-137, 4-140 through 4-142, 4-145, 5-2, 5-4

M (continued)

Mixed waste, 1-1, 1-3 through 1-4, 2-1 through 2-2, 2-6, 2-8 through 2-10, 2-12, 2-15, 2-27, 2-37, 2-42, 2-47, 2-48, 2-59, 2-65, 2-67, 3-1, 3-25, 3-62 through 3-63, 3-65, 3-67, 3-69 through 3-70, 4-2, 4-10, 4-21 through 4-24, 4-28, 4-50, 4-51, 4-58, 4-64, 4-66 through 4-68, 4-74, 4-76, 4-81 through 4-82, 4-87 through 4-89, 4-91, 4-97, 4-122 through 4-123, 4-127, 4-140, 4-142, 4-146, 5-5, 5-10, 5-12 through 5-13, 5-15, 5-17 through 5-18, 6-1, 6-6, 6-8 through 6-10
Monitoring, 1-2, 2-2, 2-20 through 2-21, 2-27, 2-47, 2-51, 2-59, 2-67, 2-68, 3-20, 3-23, 3-25 through 3-28, 3-30, 3-34 through 3-35, 3-54 through 3-56, 3-63 through 3-64, 3-66, 3-69, 3-73, 4-1 through 4-2, 4-7 through 4-8, 4-13, 4-35, 4-37, 4-58, 4-76, 4-81, 4-91, 4-99, 4-102, 4-125, 4-134, 5-1 through 5-15, 5-18, 6-2, 6-5, 6-7 through 6-9

N

NEPA, 2-1 through 2-2, 2-10 through 2-11, 2-42, 2-44, 4-1, 4-88, 4-146, 5-2, 6-1, 6-12
National Environmental Policy Act, 1-4, 2-1, 4-1, 4-146, 5-2, 6-1
National Register of Historic Places, 3-7, 4-33
Nonradiological releases, 4-133

O

Occupational exposures, 2-49

P

PATHRAE, 4-3, 4-13, 4-19, 4-31, 4-37, 4-41, 4-45 through 4-46, 4-49, 4-54, 4-61, 4-64, 4-132, 5-15 through 5-16
Par Pond, 3-41, 3-43 through 3-45, 3-65
Pen Branch, 3-32, 3-38, 3-40 through 3-41, 3-55, 4-13, 4-16, 4-20, 4-31 through 4-32
Port Wentworth, 3-43, 4-104, 5-10 through 5-11
Project specific actions, 1-4, 2-1, 2-15, 2-31, 2-59, 4-87
Public services, 3-6

R

RCRA, 1-1 through 1-4, 2-1 through 2-2, 2-8, 2-12, 2-31, 2-36, 2-37, 2-39, 2-40, 2-47, 2-65, 2-67, 3-17, 4-41, 4-89, 4-91, 4-95, 4-99, 4-120 through 4-122, 4-126, 4-130 through 4-131, 4-138 through 4-140, 4-142, 5-2, 5-8, 5-13, 6-3, 6-5 through 6-10
Radiation, 1-2, 2-36, 2-37, 2-65, 2-66, 3-51 through 3-52, 3-54 through 3-55, 3-69, 3-75, 4-3 through 4-4, 4-22, 4-104, 4-106 through 4-107, 4-109 through 4-110, 4-127, 4-136, 4-138, 5-8, 6-2, 6-4, 6-10
Radioactive waste burial ground, 2-17, 4-22 through 4-23, 4-36, 4-50, 4-51, 4-61, 4-66, 4-68, 4-74, 4-120, 5-9
Radiological releases, 4-22, 4-50, 4-85, 4-89 through 4-91, 4-93, 4-95 through 4-96, 4-98
Radionuclides, 1-2, 2-12, 2-40, 2-42, 2-49, 2-51, 3-51, 3-54 through 3-56, 4-5, 4-16, 4-20 through 4-21, 4-37, 4-41, 4-46, 4-64, 4-90 through 4-93, 4-97, 4-102, 4-103, 4-106 through 4-107, 4-109, 4-128, 4-147, 5-8 through 5-9, 5-14, 5-16, 6-4
Recreation, 3-43
Red-cockaded woodpecker, 3-48 through 3-49, 4-32, 4-92, 4-97
Resource Conservation and Recovery Act, 1-1, 2-1, 3-17, 4-91, 5-2, 6-3, 6-9 through 6-10
Retrievable storage, 2-8 through 2-9, 2-12, 2-36, 2-48, 2-59, 2-65, 2-67, 4-1, 4-132, 4-139 through 4-141, 5-14

S

SARA, 1-3, 2-1 through 2-2, 6-4
SRP, 1-1 through 1-4, 2-1 through 2-2, 2-6, 2-8 through 2-10, 2-12, 2-15, 2-31, 2-37, 2-42, 2-44, 2-47, 2-49, 2-51, 2-59, 2-65, 2-69, 2-72, 2-74, 3-1 through 3-2, 3-4 through 3-8, 3-10 through 3-14, 3-16 through 3-18, 3-20, 3-23, 3-25 through 3-30, 3-32, 3-34 through 3-35, 3-41, 3-43, 3-45 through 3-54, 3-56, 3-62, 3-64 through 3-67, 3-72 through 3-74, 4-1, 4-3 through 4-4, 4-7, 4-10, 4-16, 4-21, 4-23, 4-28, 4-31 through 4-33, 4-46, 4-49 through 4-50, 4-51, 4-57 through 4-58, 4-66 through 4-67, 4-75, 4-78 through 4-82, 4-85 through 4-88, 4-90, 4-92 through 4-99, 4-104, 4-109, 4-111 through 4-112, 4-114 through 4-115, 4-120 through 4-129, 4-131 through 4-133, 4-135 through 4-137, 4-140 through 4-141, 4-144, 5-1 through 5-2, 5-4 through 5-5, 5-8, 5-10 through 5-11, 5-13, 5-16 through 5-17, 6-1 through 6-3, 6-6 through 6-12
Savannah River Plant, 1-1, 1-3, 1-5, 2-1, 2-10, 2-51, 2-74, 3-1, 3-3 through 3-4, 3-7, 3-16, 3-23, 3-45 through 3-46, 3-49 through 3-50, 3-69 through 3-75, 4-1, 4-87, 4-120, 4-146 through 4-148, 5-1, 5-17 through 5-18, 6-1 through 6-2, 6-12
Savannah River swamp, 3-45 through 3-46, 4-41
Savannah River, 1-1, 1-3, 1-5, 2-1, 2-10, 2-51, 2-70, 2-74, 3-1, 3-3 through 3-4, 3-6 through 3-7, 3-14, 3-16, 3-20, 3-23 through 3-24, 3-29 through 3-30, 3-32 through 3-35, 3-38, 3-43, 3-45 through 3-46, 3-49 through 3-50, 3-56, 3-64, 3-66, 3-69 through 3-75, 4-1, 4-13, 4-19 through 4-20, 4-31 through 4-32, 4-41, 4-85, 4-87 through 4-88, 4-93, 4-95, 4-109, 4-111, 4-120, 4-126 through 4-129, 4-132 through 4-134, 4-137, 4-146 through 4-148, 5-1 through 5-2, 5-10, 5-13, 5-17 through 5-18, 6-1 through 6-2, 6-9, 6-12
Security, 2-36, 3-66, 4-94, 4-98, 6-12
Seepage basin, 2-12, 2-15, 2-27, 2-31, 2-49, 2-66, 2-68, 3-63, 3-65, 3-67, 3-70, 3-72, 4-8, 4-10, 4-13, 4-16, 4-21 through 4-24, 4-27, 4-31 through 4-33, 4-35 through 4-36, 4-41, 4-46, 4-49 through 4-50, 4-51, 4-57, 4-61, 4-64, 4-66, 4-68, 4-71, 4-76 through 4-80, 4-82, 4-102, 4-107, 4-130, 4-132, 4-136, 4-142, 4-146, 4-148, 5-8, 5-10, 5-13, 6-12
Seismology, 3-12, 3-16
Settling basin, 1-1, 3-63, 3-65, 3-67, 3-74, 4-8, 4-21 through 4-24, 4-31 through 4-33, 4-36, 4-50, 4-51, 4-54, 4-57 through 4-58, 4-66 through 4-68, 4-71, 4-74, 4-79, 4-121, 4-130 through 4-132, 4-136, 4-148, 5-2, 5-4, 5-10 through 5-11, 5-13, 6-7
Shortnose sturgeon, 3-48, 3-50, 4-32, 4-92, 4-97
Six-county area, 3-4, 3-6 through 3-7
Socioeconomics, 2-72, 4-89 through 4-90, 4-93, 4-96, 4-98 through 4-99
Soils, 2-8 through 2-9, 3-46, 3-56, 3-62, 3-65, 3-69, 4-34, 4-57, 4-79, 4-93, 4-974-113, 4-132
Steel Creek, 3-32, 3-34, 3-41 through 3-43, 3-46, 4-16, 4-20
Surface water, 1-3, 2-2, 2-12, 2-50, 2-70, 3-16, 3-23, 3-56, 3-62, 3-73, 4-2, 4-20, 4-26, 4-45, 4-69, 4-79, 4-85, 4-88 through 4-89, 4-91 through 4-92, 4-95, 4-97, 4-107, 4-126, 4-129 through 4-131, 4-142, 5-14

T

Tertiary aquifers, 2-69
Tornado, 3-10 through 3-11, 3-72, 3-74, 4-111, 4-114
Tritium, 2-8, 2-49, 2-51, 2-59, 2-70, 2-72, 2-74, 3-28, 3-52, 3-54 through 3-57, 4-5, 4-10, 4-13, 4-16, 4-20 through 4-21, 4-31, 4-37, 4-41, 4-45, 4-61, 4-64, 4-82, 4-85, 4-92 through 4-93, 4-97 through 4-98, 4-102, 4-103

T (continued)

through 4-110, 4-122, 4-124, 4-132, 4-135, 4-141 through 4-142, 4-146, 5-8 through 5-11, 5-13
Tuscaloosa, 3-14, 3-20, 3-29 through 3-31, 3-56, 3-69, 4-10, 4-125, 4-146, 5-14, 5-17

U

Upper Three Runs Creek, 3-14, 3-17, 3-29, 3-32, 3-34 through 3-36, 3-38, 3-41, 3-49, 4-8, 4-10, 4-20, 4-31 through 4-32, 4-41, 4-85, 4-122

V

Vaults, 2-6, 2-10, 2-37, 2-39, 2-40, 2-47, 2-48, 2-59, 2-65, 4-91 through 4-92, 4-123, 4-140,
Vegetation, 2-41, 3-46 through 3-47, 4-32, 4-34, 4-57, 4-93, 4-97, 4-132, 4-137 through 4-138, 5-1, 5-8 through 5-10
Vogtle Nuclear Power Plant, 3-43, 3-51 through 3-52

W

Waste disposal, 1-3 through 1-4, 2-10, 2-37, 2-43, 2-47, 2-49, 2-59, 3-25, 3-62 through 3-64, 4-87, 4-92, 4-97, 4-123, 4-129, 4-137 through 4-138, 4-141, 5-5, 5-13 through 5-14, 5-16, 6-3 through 6-4
Waste management, 1-1 through 1-5, 2-1 through 2-2, 2-6 through 2-10, 2-12 through 2-15, 2-27, 2-31, 2-36, 2-43, 2-44, 2-47, 2-51, 2-59, 2-65, 2-72, 2-74, 3-4, 3-17, 3-56, 3-67, 3-70, 4-1 through 4-2, 4-4, 4-22, 4-24, 4-34, 4-36, 4-41, 4-46, 4-54, 4-61, 4-68, 4-74, 4-80 through 4-82, 4-87 through 4-89, 4-91, 4-94, 4-96, 4-99 through 4-101, 4-120, 4-139 through 4-141, 4-144, 4-146 through 4-147, 5-2 through 5-3, 5-5, 5-12 through 5-13, 5-17, 6-1 through 6-4, 6-7 through 6-11
Waste sites, 1-2 through 1-4, 2-1 through 2-2, 2-6, 2-8 through 2-9, 2-12, 2-15, 2-27, 2-31, 2-42, 2-43, 2-48, 2-49, 2-51, 2-59, 2-65, 2-72, 3-1, 3-7, 3-25, 3-55, 3-62 through 3-63, 3-65 through 3-67, 3-69, 3-73, 4-1 through 4-4, 4-7 through 4-8, 4-10, 4-13, 4-16, 4-21 through 4-23, 4-31 through 4-34, 4-36, 4-41, 4-46, 4-49 through 4-50, 4-51, 4-57 through 4-58, 4-61, 4-64, 4-67 through 4-68, 4-71, 4-74 through 4-76, 4-79 through 4-82, 4-85 through 4-86, 4-88, 4-110 through 4-113, 4-125 through 4-129, 4-131 through 4-135, 4-137, 4-139 through 4-144, 4-146 through 4-148, 5-4 through 5-7, 5-10 through 5-11, 5-13, 5-15, 5-17, 6-9
Waste storage, 1-1, 2-10, 2-59, 2-69, 2-74, 4-96, 4-120, 4-123, 4-128, 5-9 through 5-10, 5-17, 6-6, 6-8
Water quality, 2-70, 3-20, 3-32, 3-35, 4-31 through 4-33, 4-64, 4-76, 4-102, 4-126 through 4-127, 4-142
Water use, 3-43, 4-126, 5-4
Wetlands, 2-71, 2-72, 3-6, 3-45, 4-16, 4-33, 4-57, 4-71, 4-79, 4-95, 4-97, 4-121, 4-132, 4-144, 4-147, 6-11
Wildlife, 2-65, 3-46 through 3-47, 3-49, 4-31 through 4-32, 4-57, 4-71, 4-79, 4-92, 4-95, 4-97, 4-121, 4-132, 4-136 through 4-137, 4-139, 6-12
Wood stork, 3-48 through 3-49, 4-32, 4-92, 4-97