APPENDIX G

ASSESSMENT OF ALTERNATIVE STRATEGIES FOR NEW DISPOSAL/STORAGE FACILITIES

This environmental impact statement (EIS) furnishes an environmental basis for selecting a strategy to modify waste management activities at the Savannah River Plant (SRP). Appendix G provides the range of potential environmental impacts of the four strategies described in Chapter 2 (i.e., No Action, Dedication, Elimination, and Combination) relative to new disposal/storage facilities. Table G-1 lists the technologies the U.S. Department of Energy (DOE) could employ under each strategy. The implementation of each waste management strategy has been defined in terms of these technologies and facilities, which assume design and operation in compliance with all applicable regulations and requirements (see Appendix E). TE

This appendix discusses the range of potential environmental impacts associated with the implementation of each of the four alternative waste management strategies. The environmental evaluation is conservative; it analyzes impacts on groundwater, surface water, air, ecology, archaeological and historic resources, human health, socioeconomics, land dedication, institutions (DOE), and noise. Some analyses (i.e., groundwater modeling) were conducted relative to a specific site because of the need for site-related parameters. TE

Appendix E describes site selection. Site B was selected for hazardous waste and mixed waste RCRA facilities; Site L for mixed waste cement/fly ash matrix disposal; and Site G for low-level radioactive waste facilities (see Figure E-3). Some analyses (e.g., archaeological and historic resources) were conducted on the three or four highest ranked candidate sites. Other analyses (i.e., noise) were based on the nature of the potential impact relative to conditions present at any candidate site. Table G-2 shows the basis of impact evaluations in each environmental category. TE

The accuracy of numerical modeling results (i.e., groundwater concentrations and radiological doses) and qualitative results are affected by assumptions, potential ranges of significant parameters, and estimated site-specific details. The level of accuracy of these results is within an average factor of 5; therefore, they can be used only to determine the relative performance of a strategy. They are appropriately used in this EIS only for comparative evaluations and strategy selection. TE

G.1 NO-ACTION STRATEGY

G.1.1 SUMMARY AND OBJECTIVES

The No-Action strategy would continue the current management of hazardous, mixed, and low-level radioactive wastes with no new facilities. The existing interim storage buildings for hazardous and mixed waste would be used for storage until their capacity is reached in 1992. The existing low-level radioactive waste burial ground would be used for disposal of low-level waste

Table G-1. New Disposal/Storage Facility Technologies

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

[a]Vaults may be aboveground or belowground.
[b]Engineered low-level trench disposal.
[c]Above grade operation disposal.
[d]Greater confinement disposal.
[e]Cement/flyash matrix.

Table G-2. Basis for New Waste Management Facility Impact Evaluations

Environmental Category	Basis of Impact Evaluation
Groundwater	Environmental impacts analyzed using computer model or presumption of facility compliance with regulations; assumptions include (1) Candidate Site B (RCRA facilities for hazardous or mixed waste), Site L (DOE facilities for delisted mixed waste), or Site G (DOE facilities for low-level radioactive waste); (2) Waste stream consists of operations and interim storage wastes; and (3) Some pretreatment.
Surface water	Same as Groundwater.
Nonradiological air	Impacts based on the presumption that wastes are containerized at the treatment or generating facility prior to delivery for disposal or storage.
Ecology	Impacts based on a conservative estimate of the land area required for technologies assuming maximum potential waste volumes and various ecological features as determined at the candidate sites. TE
Radiological releases	Same as Groundwater.
Archaeological and historic	Impacts based on results of an archaeological and historic field survey of candidate sites.
Socioeconomics	Impacts assume a peak construction force for new waste management facilities not exceeding 200 persons.
Noise	Impacts based on attenuation features at all possible siting locations.
Site dedication	Impacts based on an estimate of the land area required for disposal assuming the most land intensive technologies and maximum potential waste volumes. TE
Institutional	Impacts assessed relative to applicable regulations.

until its capacity is reached in early 1989. Thereafter, containerized wastes would be stored indefinitely in other existing structures, on available concrete pads, or in other waste storage or disposal areas.

Under no action, noncompatible hazardous and mixed wastes would be segregated and stored to simplify periodic inspection. Inspections would be performed regularly, damaged or deteriorated containers would be replaced, and any spillage or leakage would receive immediate attention. Low-level radioactive and mixed wastes having radioactivity greater than 300 millirem per hour (i.e., intermediate-activity waste) would be placed in existing unused shielded structures such as the R-Reactor building.

The release of waste constituents and the associated health and environmental effects would be insignificant if no substantial leaks or spills occurred as a result of fire, explosion, container deterioration, or breach of containers by impact. Storage facilities of this type would not be designed and constructed to include the backup systems and safety equipment required of a regulated facility (e.g., liners and barriers, leachate collection, built-in fire protection, vapor detection, leakage recovery); thus, the risk of a serious accidental release of waste and the associated effects would be greater than any of the other strategies. A potential failure in performance of no action could result in releases ranging from zero (no releases under optimum circumstances) to the release and dispersion of all waste stored (under severe accidental or natural disaster circumstances). Because there would be no barriers, backup systems, and safety equipment, the risk of any waste constituent release, including a catastrophic release, would be higher than with other strategies. Although this higher risk cannot be quantified, it would be unacceptable under applicable regulations.

Details not considered in the environmental evaluation of no action include identification of specific unused structures, pads, or areas for storage; container design; specific handling and operational procedures; and specific characteristic of the waste generated. No action would not achieve regulatory compliance and poses higher environmental and health risks. The assessment of specific environmental categories assumes that the No-Action strategy would result in a high risk of sudden or long term accidental release of waste, adversely affecting the environment and potentially affecting human health.

G.1.2 GROUNDWATER AND SURFACE WATER EFFECTS

Waste management under no action could involve a greater risk of accidental release of waste constituents to surface and subsurface waters than other strategies. Potential impacts to the environment cannot be predicted accurately but over a 20-year period are assumed to exceed those of currently documented SRP existing waste sites.

G.1.3 NONRADIOACTIVE ATMOSPHERIC RELEASES

The preparation of existing structures, pads, and other areas for the storage of wastes under no action would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts and truck traffic, and suspended particulates and dust from ground-surface disturbances. All applicable emission standards would be met during this activity.

The EIS assumes that all wastes would be packaged in high-integrity containers and that, except for accidents, natural disasters, or neglect, there would be no releases. Because of the lack of backup containment systems, leak sensors, and protection systems (e.g., fire, freezing), and because of its vulnerability to natural forces and human error, the No-Action strategy would have an unquantified risk of release and atmospheric dispersion of the stored material ranging between zero and 100 percent, which could cause environmental and health effects both on- and offsite.

G.1.4 ECOLOGICAL EFFECTS

Under the No-Action strategy, releases could range between zero and 100 percent of the waste stored. The ecological impact would depend on the amount and type of material released, the proximity to sensitive areas, and on the effectiveness of cleanup actions. Wetlands and aquatic resources would be especially sensitive to uncontrolled releases. The exact nature and extent of impacts cannot be determined, but the risk of such damage is higher than with other strategies.

G.1.5 RADIOLOGICAL RELEASES

Structures, pads, and areas that could be used to store mixed and radioactive wastes after the existing facilities reached capacity would not be equipped with protective and backup systems to contain releases. Although storage operations would strive to prevent releases of radiological contaminants to the environment, the risk of such an occurrence would be much higher for no action than for any other strategy. The on- and off-site effects of such releases cannot be accurately determined but could involve significant impact on human health and the environment. TE

G.1.6 ARCHAEOLOGICAL AND HISTORIC RESOURCES

No new construction would be required, because existing facilities would be used. Additional pads for storage of wastes would be located at an existing facility where, because of past soil disturbances, there are no significant archaeological resources.

G.1.7 SOCIOECONOMICS

Under the No-Action strategy, the potential socioeconomic impacts of a large-scale, catastrophic, accidental release could be substantial due to the combined effects of three factors. First, cleanup specialists would be brought in as expediently as possible. This sudden demand for housing and other requirements could have adverse effects on real estate markets and government services. Second, with such a release, it is possible that specific SRP units would have to shut down because of either contamination or interference with the cleanup. A shutdown could potentially result in SRP layoffs. Finally, public perception of the incident's effect on human health and welfare could have severe adverse effects on property demand and property values near the SRP. TC

G.1.8 DEDICATION OF SITE

The No-Action strategy would not involve permanent placement of wastes at existing facilities, but rather a temporary storage arrangement in which the ability to retrieve the waste was preserved. Assuming an uneventful period of storage, the long term dedication of these storage facilities would not be required. However, site dedication could be required as a result of previous waste management practices or a serious accidental release of wastes during storage.

G.1.9 INSTITUTIONAL IMPACTS

Because no action would involve the use of existing structures and waste disposal facilities for an indefinite period, DOE would have to maintain full title and control of the land as long as the wastes were stored.

G.1.10 NOISE

The preparation of storage areas under no action could require heavy equipment. Noise from this equipment would not be detectable at the SRP boundary because of attenuation provided by distance, topography, and natural vegetation.

G.2 DEDICATION STRATEGY

G.2.1 SUMMARY AND OBJECTIVES

With the Dedication strategy for waste management, DOE would establish new disposal facilities to accommodate hazardous, low-level radioactive, and mixed
TE wastes generated from ongoing SRP operations, those in interim storage, and those generated from the closure of existing waste sites. Waste disposal
TC sites would be dedicated for waste management in perpetuity. Up to 400 acres would be required. For the service life of the facilities plus an institutional control period following cessation of active service, DOE would monitor and maintain the sites to ensure long term environmental and public health protection.

Table G-1 lists the technologies included in the Dedication strategy; they are described in Appendix E.

Under the hazardous waste category, both RCRA landfill and vault technologies are considered to be equivalent in their groundwater protection capabilities; therefore, both were evaluated. The RCRA landfill and vault technologies under mixed waste are equivalent as well; however, when the cement/flyash matrix (CFM) vaults are included in the alternative, they represent the least
TC protective of the technological options. Therefore, RCRA landfill or vault, with CFM vault, was selected to describe mixed waste impacts.

Under low-level waste, the vault and greater confinement disposal technologies for intermediate-activity waste are considered equivalent in groundwater protection capabilities, and no distinction is made in the evaluation. Among the technologies for low-activity waste disposal, the engineered low-level trench (ELLT) technology was selected to evaluate the impacts since it represents the least protective of the optional technologies available for the disposal of this waste type. TC

The assessment of environmental impacts for the Dedication strategy presumes that facilities would be constructed and operated in accordance with applicable regulations and would achieve regulatory and environmental compliance.

Modeling has been used to define the influence of specific protective design features and the need for potential future mitigation. Assuming that post-closure maintenance and monitoring will cease at the end of the institutional control period, model results show that exceedances of environmental or health standards caused by presumed structural failure of a facility may occur to substantially varying degrees depending on the technology used (i.e., landfill or vault), the closure design (i.e., low permeability cap or no cap), and the inclusion of waste pretreatment technologies (i.e., treated waste or no pretreatment). DOE is not proposing waste management technologies under the Dedication strategy which will knowingly fail. For those alternatives which modeling indicates will fail at some time beyond the 100-year institutional control period, this EIS assumes that such failure would be averted by modifications to design, operations and, if necessary, post-closure care activities up to and including future waste retrieval and remedial action. TC

G.2.2 GROUNDWATER AND SURFACE WATER EFFECTS

The base floodplain of the SRP region is confined to riparian wetlands and low terraces along the Savannah River and its primary tributaries. Siting criteria for new disposal facilities avoid such flood-prone areas; thus, no impacts due to potential flooding of the facilities are expected.

G.2.2.1 Hazardous Waste

Facilities for hazardous waste management would be designed to meet or exceed RCRA minimum technology requirements (i.e., a goal of zero release) and prevent contact of waste constituents with groundwater. The facilities would include interior and exterior leachate collection systems to recover and retain any waste releases that could occur. Accordingly, releases of contaminants to the subsurface environment are not expected to occur, and groundwater quality should not be significantly affected during the period of institutional control.

Modeling of hazardous and mixed waste streams combined predicts that, beyond the institutional control period, both RCRA landfill and vault technology will eventually fail to varying degrees, given certain conditions and sufficient time. The RCRA landfill without a low-permeability cap and no predisposal treatment resulted in exceedances at the boundary well of the acceptable daily intake (ADI) of several hazardous substances soon after the end of the institutional control period. Exceedances of surface water criteria were determined in wetlands and Upper Three Runs Creek. No exceedances were identified for the Savannah River because of its dilution capacity.

Vault technology, a low-permeability cap, and predisposal treatment (i.e., incineration) all resulted in improvements which were somewhat additive. Modeling showed no exceedances of the ADI or surface water criteria for vault technology with a low-permeability cap and predisposal treatment. Table G-3 summarizes all exceedances of the ADI and surface water criteria identified by the modeling effort. For potential impacts that are projected to occur beyond the 100-year institutional control period, future planning would determine the most cost-effective, cost-beneficial technological option.

G.2.2.2 Mixed Waste

Mixed waste management with RCRA landfills or vaults would meet or exceed RCRA minimum technology requirements. Releases of contaminants to the subsurface environment are not expected to occur. Groundwater quality should not be significantly affected during the period of institutional control (see G.2.2.1).

Modeling indicates that no hazardous substances are released in concentrations which exceed applicable groundwater or surface water standards during a period up to 10,000 years following closure.

Of the radiological constituents, only uranium-238 was shown to exceed the derived standard [i.e., ICRP Publication 30 (ICRP, 1979) methodology was used to determine the radionuclide concentration that individually yields an annual effective whole-body dose or organ dose of 4 millirem per year, the dose limit required by EPA Primary Drinking Water Standards (40 CFR 141)]. Table G-4 shows that the estimated peak concentration at the boundary well was 8.3 times the standard concentration and was predicted to occur at 10,000 years. All remaining boundary well nuclides, as well as all surface water nuclides including uranium, did not exceed their respective derived standard concentrations.

Modeling was conservatively conducted with no solubility limit inputs for uranium. Uranium chemistry in the natural environment is complex and is a function of many factors including soil pH, groundwater reduction-oxidation (redox) potential (Eh), cation exchange capacity, and the presence of chelating or complexing species. In a field situation, low uranium solubility limits compared to the release rate will act as a limit to the migration of uranium from the facility. Uranium and other radionuclides are not expected to exceed derived groundwater or surface water standards due to the presence of solubility limits.

G.2.2.3 Low-Level Radioactive Waste

Low-level radioactive waste management activities, which were selected to evaluate impacts to groundwater and surface water, included ELLTs for disposal of low-activity waste (less than 300 millirem per hour) and vaults or GCD for disposal of intermediate-activity waste. These facilities would be constructed in accordance with DOE Orders and would achieve releases which are as low as reasonably achievable (ALARA). Groundwater and surface water modeling predict the peak concentrations of radionuclides and the times at which they occur. Table G-5 compares the modeling results to the derived groundwater standard for each nuclide.

Table G-3. Ratio of Modeled Peak Concentration to ADI[a]/Surface Water Criteria[b]

Substance	RCRA landfill		Vault	
	No cap	With cap	No cap	With cap
	BOUNDARY WELL (No Pretreatment)			
2,4-D	3.1 (100)[c]	2.2 (140)	< 1	< 1
Lead	140 (7700)	14 (74000)	77 (8100)	< 1
Methylethyl Ketone	550 (110)	52 (260)	3.3 (330)	3.3 (760)
Nitrate	4.6 (110)	3.6 (130)	< 1	< 1
Phenol	50 (110)	40 (130)	< 1	< 1
Toluene	8.8 (210)	< 1	< 1	< 1
TBP[d]	1200 (160)	130 (810)	8.2 (1000)	8.3 (9600)
Xylene	3300 (100)	1800 (170)	17 (330)	17 (1100)
	BOUNDARY WELL (Treated Waste)			
Lead	170 (7500)	19 (74000)	75 (8500)	< 1
Nitrate	1.1 (170)	1.1 (200)	< 1	< 1
	WETLAND (No Pretreatment)			
Benzene	2000	190	520	16
2,4-D	9400	8100	80	79
Lead	1.3	1.1	1.3	< 1
Lindane	37000	3600	800	300
Phenol	210	190	1.8	1.8
Toluene	590	54	35	4.6
TBP[d]	5.9	4.9	< 1	< 1
111-TCE[e]	5900	4900	49	49
	WETLAND (Treated Waste)			
Lead	1.3	1.1	1.2	< 1
	UPPER THREE RUNS CREEK (No Pretreatment)			
Benzene	2.0	< 1	< 1	< 1
2,4-D	9.4	8.1	< 1	< 1
Lindane	37	3.6	< 1	< 1
111-TCE[e]	5.9	4.9	< 1	< 1
	Upper Three Runs Creek (Treated Waste) No Exceedances			
	Savannah River (No Pretreatment or Treated Waste) No Exceedances			

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[a]Acceptable Daily Intake.
[b]Source: Cook, Grant, and Towler, 1987a.
[c]Numbers in parentheses represent the number of years after closure when peak will occur.
[d]Tributyl phosphate.
[e]1,1,1-Trichloroethane.

Table G-4. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Dedication Strategy, Mixed Waste[a]

Radionuclide	Derived standard[b]	Estimated concentration[c]							
		Boundary well		Wetlands		Upper Three Runs Creek		Savannah River	
		Estimate	Ratio	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio
Tritium	8.7×10^{4}	1.1×10^{0} (114)	1.3×10^{-5}	2.2×10^{-2} (140)	2.5×10^{-7}	2.2×10^{-5} (140)	2.5×10^{-10}	4.1×10^{-7} (140)	4.7×10^{-12}
Strontium-90	4.2×10^{1}	2.5×10^{-4} (361)	6.0×10^{-6}	1.9×10^{-14} (914)	4.5×10^{-16}	1.9×10^{-17} (914)	4.5×10^{-19}	3.6×10^{-19} (914)	8.6×10^{-21}
Yttrium-90	5.5×10^{2}	2.5×10^{-4} (361)	4.5×10^{-7}	1.9×10^{-14} (914)	3.5×10^{-17}	1.9×10^{-17} (914)	3.5×10^{-20}	3.6×10^{-19} (914)	6.5×10^{-22}
Uranium-235	2.2×10^{1}	1.6×10^{-1} (10,000)	7.3×10^{-3}	7.7×10^{-3} (10,000)	3.5×10^{-4}	7.7×10^{-6} (10,000)	3.5×10^{-7}	1.4×10^{-7} (10,000)	6.4×10^{-9}
Uranium-238	2.4×10^{1}	2.0×10^{2} (10,000)	8.3×10^{0}	9.5×10^{0} (10,000)	4.0×10^{-1}	9.5×10^{-3} (10,000)	4.0×10^{-4}	1.8×10^{-4} (10,000)	7.5×10^{-6}
Ratio Total			8.3×10^{0}		4.0×10^{-1}		4.0×10^{-4}		7.5×10^{-6}

[a]Source: Cook and Grant, 1987.
[b]ICRP Publication 30 (ICRP, 1979) methodology was used to determine radionuclide concentrations that individually yield an annual effective whole-body or organ dose of 4 millirem. Four millirem dose limit required for drinking water by 40 CFR 141.
[c]Figures in parentheses represent number of years after closure.

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Table G-5. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Dedication Strategy, Low-Level Waste[a]

Radionuclide	Derived standard[b]	Estimated concentration[c]							
		Boundary well		Wetlands		Upper Three Runs Creek		Savannah River	
		Estimate	Ratio	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio
LOW-ACTIVITY WASTE									
Carbon-14	2.6×10^{3}	1.25×10^{-1} (30.1)	4.81×10^{-5}	1.62×10^{-2} (53.1)	6.23×10^{-6}	1.62×10^{-5} (53.1)	6.23×10^{-9}	3.03×10^{-7} (53.1)	1.17×10^{-10}
Tritium	8.7×10^{4}	4.20×10^{0} (24.4)	4.83×10^{-5}	1.92×10^{-1} (40.1)	2.21×10^{-6}	1.92×10^{-4} (40.1)	2.21×10^{-9}	3.58×10^{-6} (40.1)	4.11×10^{-11}
Iodine-129	2.0×10^{1}	3.36×10^{-3} (132)	1.68×10^{-4}	4.44×10^{-4} (179)	2.22×10^{-5}	4.44×10^{-7} (179)	2.22×10^{-8}	8.29×10^{-9} (179)	4.15×10^{-10}
Rubidium-87	1.1×10^{3}	2.35×10^{-7} (2730)	2.14×10^{-10}	3.24×10^{-8} (3350)	2.95×10^{-11}	3.24×10^{-11} (3350)	2.95×10^{-14}	6.06×10^{-13} (3350)	5.51×10^{-16}
Selenium-79	6.6×10^{2}	7.42×10^{-3} (1380)	1.12×10^{-5}	1.02×10^{-3} (1700)	1.55×10^{-6}	1.02×10^{-6} (1700)	1.55×10^{-9}	1.90×10^{-8} (1700)	2.88×10^{-11}
Technetium-99	4.2×10^{3}	4.13×10^{0} (24.4)	9.83×10^{-4}	5.62×10^{-1} (47.7)	1.34×10^{-4}	5.62×10^{-4} (47.7)	1.34×10^{-7}	1.05×10^{-5} (47.7)	2.50×10^{-9}
Neptunium-237	1.4×10^{-1}	1.15×10^{-4} (5430)	8.21×10^{-4}	1.59×10^{-5} (6640)	1.14×10^{-4}	1.59×10^{-8} (6640)	1.14×10^{-7}	2.97×10^{-10} (6640)	2.12×10^{-9}
Subtotal			2.08×10^{-3}		2.80×10^{-4}		2.80×10^{-7}		5.22×10^{-9}
INTERMEDIATE-ACTIVITY WASTE									
Carbon-14	2.6×10^{3}	3.63×10^{-1} (57.1)	1.40×10^{-4}	1.41×10^{-2} (91.8)	5.42×10^{-6}	1.41×10^{-5} (91.8)	5.42×10^{-9}	2.64×10^{-7} (91.8)	1.02×10^{-10}
Tritium	8.7×10^{4}	6.13×10^{6} (37.7)	7.05×10^{1}	6.58×10^{4} (55.4)	7.56×10^{-1}	6.58×10^{1} (55.4)	7.56×10^{-4}	1.23×10^{0} (55.4)	1.41×10^{-5}
Iodine-129	2.0×10^{1}	2.00×10^{-2} (171)	1.00×10^{-3}	7.82×10^{-4} (295)	3.91×10^{-5}	7.82×10^{-7} (295)	3.91×10^{-8}	1.46×10^{-8} (295)	7.30×10^{-10}

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Table G-5. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Dedication Strategy, Low-Level Waste[a] (continued)

		Estimated concentration[c]							
		Boundary well		Wetlands		Upper Three Runs Creek		Savannah River	
Radionuclide	Derived standard[b]	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio
Rubidium-87	1.1×10^{3}	2.17×10^{-5} (3020)	1.97×10^{-8}	8.51×10^{-7} (3490)	7.74×10^{-10}	8.51×10^{-10} (3490)	7.74×10^{-13}	1.59×10^{-11} (3490)	1.45×10^{-14}
Selenium-79	6.6×10^{2}	3.40×10^{-1} (709)	5.15×10^{-4}	1.32×10^{-2} (1410)	2.00×10^{-5}	1.32×10^{-5} (1410)	2.00×10^{-8}	2.46×10^{-7} (1410)	3.73×10^{-10}
Technetium-99	4.2×10^{3}	1.20×10^{1} (646)	2.86×10^{-3}	4.69×10^{-1} (102)	1.12×10^{-4}	4.69×10^{-4} (102)	1.12×10^{-7}	8.77×10^{-6} (102)	2.09×10^{-9}
Strontium-90	4.2×10^{1}	1.16×10^{-7} (1060)	2.76×10^{-9}	(d)	-	(d)	-	(d)	-
Yttrium-90	5.5×10^{2}	1.16×10^{-7} (1060)	2.11×10^{-10}	(d)	-	(d)	-	(d)	-
Uranium-234	2.1×10^{1}	2.47×10^{1} (7480)	1.18×10^{0}	(d)	-	(d)	-	(d)	-
Uranium-235	2.2×10^{1}	2.80×10^{-1} (7480)	1.27×10^{-2}	(d)	-	(d)	-	(d)	-
Uranium-236	2.2×10^{1}	2.02×10^{0} (7480)	9.18×10^{-2}	(d)	-	(d)	-	(d)	-
Uranium-238	2.4×10^{1}	1.23×10^{0} (7480)	5.13×10^{-2}	(d)	-	(d)	-	(d)	-
Neptunium-237	1.4×10^{-1}	2.05×10^{-2} (3270)	1.46×10^{-1}	7.87×10^{-4} (4750)	5.62×10^{-3}	7.87×10^{-7} (4750)	5.62×10^{-6}	1.47×10^{-8} (4750)	1.05×10^{-7}
Subtotal			7.20×10^{1}		7.62×10^{-1}		7.62×10^{-4}		1.42×10^{-5}
Ratio Totals			7.20×10^{1}		7.62×10^{-1}		7.62×10^{-4}		1.42×10^{-5}

[a] Source: Cook, Grant, and Towler, 1987b.
[b] ICRP Publication 30 (ICRP, 1979) methodology was used to determine radionuclide concentrations that individually yield an annual effective whole-body or organ dose of 4 millirem. Four millirem dose limit required for drinking water by 40 CFR 141.
[c] Figures in parentheses represent number of years after closure.
[d] No significant radionuclide concentration at this receptor location within 10,000 years after closure.

TC

Table G-5 shows that peak concentrations of low-activity waste constituents occur at the boundary well as soon as 24 years following closure during the institutional control period and up to 5400 years in the future. The ratio of TE each peak concentration to its respective standard is less than one, indicating that no exceedances are projected to occur. Peak concentrations occur at widely varying times, and the sum of the ratios is less than one. This indicates that even if the peak concentrations occurred at the same time, the total annual radiological dose received by an individual using boundary well water or surface water for his sole drinking water supply would still be less TE than 0.2 percent of the drinking water standard.

The peak concentrations of intermediate-activity waste occur as soon as 38 years and up to 7500 years after closure. With the exception of tritium and uranium-234, all ratios of concentrations to standards are less than 1. TE Modeling yielded estimates that uranium-234 exceeds its derived standard, peaking at 7480 years. Since the model used contains no solubility limits for uranium which would inhibit leaching and transport, this value is considered high, and the uranium-234 concentration is not expected to exceed its derived groundwater standard (see Section G.2.2.2).

Tritium in surface waters is not expected to exceed its derived standard. However, a peak tritium concentration of approximately 70 times the derived standard occurs 38 years following closure at the boundary well. This TE exceedance is based on a conservative assumption that the facilities would contain no liners or leachate collection system. The tritium peak at 38 years occurs during the institutional control period. Therefore, an exceedance of the derived standard for tritium is not expected to occur because: (1) the vault technology or the optional GCD technology used for intermediate-activity waste disposal contain liners and leachate collection systems that would intercept and recover any tritium released from the waste throughout the 100-year institutional control period, (2) by the end of the 100-year TC institutional control period, radiological decay would reduce the original radioactivity by 99 percent, (3) if leachate continued to exceed standards at the conclusion of the 100-year institutional control period, an extended control period would be implemented by DOE until groundwater standards would be achieved without leachate collection, and (4) as a mitigation measure, tritium waste could be segregated from the intermediate-activity waste stream and stored for decay in place.

Low-level radioactive waste constituent concentrations are not expected to exceed derived standards at the boundary well, wetlands, Upper Three Runs Creek, or the Savannah River with any combination of the low-level waste technologies in Table G-1.

G.2.3 NONRADIOACTIVE ATMOSPHERIC RELEASES

The construction of waste disposal facilities would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts and truck traffic, and suspended particulates and dust from ground surface disturbances. All applicable emission standards would be met during construction.

Because hazardous and mixed wastes would be delivered in sealed containers, releases would be unlikely. Thus, no significant impact on air quality is TE projected.

G.2.4 ECOLOGICAL EFFECTS

The candidate sites range as close as 300 meters to primary SRP streams (i.e., Upper Three Runs Creek, Tinker Creek) and even closer to associated wetlands and ephemeral feeder streams. The operation and dedication of facilities is not expected to involve releases which would exceed groundwater quality standards or surface water standards/criteria; therefore, no adverse impacts on aquatic or terrestrial ecology are expected.

Construction of waste disposal facilities may involve clearing as much as 400 acres for the waste facilities and roads. This clearing would destroy existing or potential wildlife habitat and foreclose any other future benefits that TC may be provided by a natural landscape at the candidate site (e.g., timber production). The available habitat on the SRP amounts to 184,200 acres; thus, the maximum loss of about 0.2 percent (i.e., 400 acres) would have an insignificant effect on the ecology of the Plant and the region.

TC Four endangered species (bald eagle, red-cockaded woodpecker, wood stork, and shortnose sturgeon) occur on or near the SRP; however, none are present on or in the immediate vicinity of any candidate sites. Therefore, construction of the disposal facilities under the Dedication strategy would not cause adverse impacts to any endangered species.

In addition to the habitat destruction, traffic, facility lighting, and human presence in the area would disturb wildlife in otherwise unaffected areas surrounding the facility and associated roadways. Traffic would also increase the risk of vehicle-wildlife collisions; however, because of slow vehicle speed such occurrences would be rare and would not have a significant impact on wildlife populations.

Construction of the facilities could result in soil erosion and subsequent sedimentation of nearby streams, distant wetlands, or creeks. Adequate erosion and sedimentation control measures should eliminate impacts on wetlands and water bodies.

With the belowground disposal options, the uptake of wastes by vegetation could occur if the roots of plants penetrated the clay cap and/or other barriers between the surface and the waste forms. Therefore, shallow-rooted species will be used to stabilize soils during closure and will be mowed during the postclosure institutional control period to prevent deeply-rooted plants TE (e.g., shrubs and trees) from becoming established.

G.2.5 RADIOLOGICAL RELEASES

G.2.5.1 Hazardous Waste

Since by definition hazardous wastes do not contain radioactive constituents, no radiological releases are expected from hazardous waste disposal facilities.

G.2.5.2 Mixed Waste

Mixed waste management with RCRA landfills or vaults would meet or exceed RCRA minimum technology requirements. Radiological releases from the facilities, as well as releases of other waste constituents, are not expected to occur during the institutional control period (see Section G.2.2.1). RCRA landfills and CFM vaults or RCRA vaults and CFM vaults and potential waste constituent releases are described in Section G.2.2.2. TE

Computer modeling was used to estimate the peak individual radiological doses from boundary well water, Savannah River water, and food grown onsite. Unlike ADIs for hazardous waste constituents, radiological doses expressed in millirem per year are additive and can be evaluated individually or collectively against a dose standard.

Table G-6 shows the peak radiological doses estimated by the model and the estimated times of occurrence for the three pathways. Conservative assumptions in the model were that the facility would not include a low-permeability cap, and that there were no solubility limits for uranium. As expected, only uranium-238 at the boundary is shown to be responsible for the exceedance of the 4 millirem per year drinking-water-dose standard. Doses from all other nuclides at the boundary well and all nuclides including uranium-238 from other pathways are below the standard. TE

The model assumption of no solubility limit for uranium is conservative and impossible in the environment of the SRP (see Section G.2.2.2). Consequently, the radiological dose from uranium-238 and all nuclides collectively, at the hypothetical boundary well and through other pathways, is expected to be significantly below the 4-millirem-per-year standard. TE

G.2.5.3 Low-Level Radioactive Waste

Computer modeling was used to predict peak individual radiological doses from ELLT disposal of low-activity waste and vault or GCD disposal for intermediate-activity waste. The two pathways analyzed were the boundary well and the Savannah River. Doses were calculated on the basis of an individual's diet of plant, meat, and dairy foods grown using well or river water, plus the direct annual ingestion of 370 liters of the same water.

Table G-7 shows the peak radiological doses estimated by the model and the estimated times of occurrence for the two pathways. Modeling has identified tritium from the intermediate-activity fraction as the dominant radionuclide relative to individual dose. However, when considering the inclusion of leachate collection and radiological decay during the period of institutional control, plus the ability to extend institutional control as necessary or segregate and store tritium for decay in-place, the total radiological doses from either pathway are within the applicable 4-millirem-per-year standard.

Doses from uranium-234, as well as the other uranium isotopes, would be substantially less than shown because of solubility limits in the environment not included in the modeling effort (see G.2.2.2). TE

G.2.6 ARCHAEOLOGICAL AND HISTORIC RESOURCES

Brooks, Hanson, and Brooks (1986) describe an intensive archaeological survey of the SRP candidate sites in compliance with Federal regulations. Within the five highest-rated candidate sites for waste disposal facilities under the Dedication strategy, five archaeological sites were located in Site G and two in Site L. Because of their limited extent, content, disturbed surface TC

Table G-6. Peak Radiological Dose and Times of Occurrence for Dedication Strategy, Mixed Waste[a]

Radionuclide	Boundary well		Savannah River		Food grown on site	
	Dose	Time	Dose	Time	Dose	Time
Tritium	6.1×10^{-5}	114	2.2×10^{-11}	140	(b)	-
Strontium-90	1.6×10^{-5}	361	3.3×10^{-20}	914	4.4×10^{-5}	100
Yttrium-90	(b)	-	2.5×10^{-21}	914	(b)	-
Uranium-235	1.9×10^{-2}	10,000	1.8×10^{-8}	10,000	(b)	-
Uranium-238	2.2×10^{1}	10,000	2.0×10^{-5}	10,000	2.6×10^{-4}	100
Cesium-137	(b)	-	(b)	-	2.8×10^{-5}	100
Total Dose	2.2×10^{1}		2.0×10^{-5}		3.3×10^{-4}	

[a]Source: Cook and Grant, 1987. Doses calculated using PATHRAE model incorporating a human diet of plant, meat, and dairy foods and 370 liters of contaminated water ingested per year. Doses expressed in millirem per year; time in number of years after closure. TC

[b]Dose contributed from this radionuclide is insignificant.

Table G-7. Peak Radiological Dose and Times of Occurrence for Dedication Strategy, Low-Level Waste[a]

Radionuclide	Boundary well Dose	Boundary well Time	Savannah River Dose	Savannah River Time
		LOW-ACTIVITY WASTE		
Carbon-14	1.58×10^{-4}	30.1	2.06×10^{-8}	53.1
Tritium	2.24×10^{-4}	24.4	1.93×10^{-10}	40.1
Iodine-129	6.67×10^{-4}	132	1.89×10^{-9}	179
Rubidium-87	8.93×10^{-10}	2730	4.24×10^{-14}	3350
Selenium-79	4.37×10^{-5}	1380	2.97×10^{-10}	1700
Technetium-99	3.93×10^{-3}	24.4	1.14×10^{-8}	47.7
Neptunium-237	2.09×10^{-5}	5430	6.19×10^{-11}	6640
Subtotal	5.04×10^{-3}		3.44×10^{-8}	
		INTERMEDIATE-ACTIVITY WASTE		
Carbon-14	4.59×10^{-4}	57.1	1.79×10^{-8}	91.8
Tritium	3.28×10^{2}	37.7	6.62×10^{-5}	55.4
Iodine-129	3.97×10^{-3}	171	3.32×10^{-9}	295
Rubidium-87	8.24×10^{-8}	3020	1.11×10^{-12}	3490
Selenium-79	2.00×10^{-3}	709	3.84×10^{-9}	1410
Technetium-99	1.14×10^{-2}	64.6	9.52×10^{-9}	102
Strontium-90	7.43×10^{-9}	1060	b	-
Yttrium-90	5.72×10^{-10}	1060	b	-
Uranium-234	3.06×10^{0}	7480	b	-

Footnotes on last page of table.

Table G-7. Peak Radiological Dose and Times of Occurrence for Dedication Strategy, Low-Level Waste[a] (continued)

Radionuclide	Boundary well		Savannah River	
	Dose	Time	Dose	Time
Uranium-235	3.34×10^{-2}	7480	b	-
Uranium-236	2.41×10^{-1}	7480	b	-
Uranium-238	1.35×10^{-1}	7480	b	-
Neptunium-237	3.72×10^{-3}	3270	3.06×10^{-9}	4750
Subtotal	3.31×10^{2}		6.62×10^{-5}	
Total Dose (all wastes)	3.31×10^{2}		6.62×10^{-5}	

TC [a]Source: Cook, Grant, and Towler, 1987b. Doses calculated using PATHRAE model scenarios incorporating a human diet of plant, meat, and dairy foods, and 370 liters of contaminated water ingested per year. Doses expressed in millirem per year; time in number of years after closure.
[b]No significant dose at this receptor location within 10,000 years after closure.

TC context, or the presence of similar preserved sites nearby, none of these sites is considered eligible for listing in the National Register of Historic Places. No further archaeological testing within these areas is warranted. Should a site for construction, other than those which have been evaluated, be considered for implementation during future planning, a similar field TE evaluation will be conducted to minimize potential impacts on archaeological resources.

G.2.7 SOCIOECONOMICS

The projected peak construction workforce is not expected to exceed 200 persons and would be from the existing SRP workforce. Workers are assigned to SRP projects based on availability. The construction workers required for this project reside in the SRP area and represent a maximum of only 2.6 percent of the Fiscal Year 1988 construction workforce projected by DOE. No impacts on the local communities and services because of immigrating workers are expected.

G.2.8 DEDICATION OF SITE

The original land acquisition efforts for the SRP were authorized by the Atomic Energy Act of 1946 (P.L. 77-585). This Act created the Atomic Energy Commission (AEC) and gave broad authority for land acquisition. These actions were not subject to discretionary Congressional review on such line items as specific parcel purchases.

The purchase of SRP properties was through fee-simple titles, which provide absolute ownership without limitations or conditions on their disposition. Land titles currently owned by DOE show no evidence of a remainder or reversion clause suggesting limited-ownership status (i.e., interest in an estate that passes on at a specified time or on the occurrence of a specific event). Moreover, a review of the AEC's official files and minutes yielded no evidence that a discussion of such actions took place during the land acquisition process at the SRP.

As a result of this ownership in perpetuity, DOE is responsible for ensuring long term dedication of the area to solid, hazardous, and nuclear waste disposal. Each disposal option identified in this EIS would require permanent dedication, defined as the retention of full title coupled with the implementation of security measures to prevent intentional or inadvertent human intrusion. Security measures include the enclosure of the actual site, the establishment of a land-use buffer zone around the waste facility within which only limited activities could occur (e.g., ecological research and forest management), the compliance with contingency plans and spill prevention and control measures, the erection of permanent markers to warn against future intrusion, and an extended period of institutional control as required.

New disposal facilities would require site dedication of up to an estimated 400 acres plus a buffer zone to ensure full compliance with the RCRA and South Carolina Hazardous Waste Management Regulations, and/or consistency with DOE Orders on environmental and public health protection.

G.2.9 INSTITUTIONAL IMPACTS

For DOE to ensure institutional control for the estimated 20-year service life of the waste disposal facilities and the monitoring period to follow, it must maintain full title to the land on which the disposal facilities are located. DOE must maintain organizational authority over the security and management of the site. Site dedication and security control require long-term control by a consistently cognizant organization.

In addition to the 30 years specified by RCRA for hazardous waste facilities, DOE intends to provide a minimum additional 70 years of institutional control, totaling 100 years. However, if necessary, these sites will be maintained in perpetuity to ensure long-term environmental and public health protection.

Institutional control requirements were imposed on DOE pursuant to RCRA and DOE Orders (see Table G-8).

Table G-8. Institutional Control Requirements

Requirement	Citation	Implementing agency	Summary
Financial requirements	R.61-79. 264, Subpart H[a]	South Carolina Department of Health and Environmental Control	Requires financial assurance of fiscal viability in the form of a trust fund, surety bond, or closure letter of credit. Although the Federal Government is exempt from this requirement, it recognizes the necessity for long term viability to ensure adequate closure and postclosure care.
Closure and postclosure performance standards	R.61-79. 264, Subpart G[a]	South Carolina Department of Health and Environmental Control	Requires that the need for maintenance be minimized and the potential for runoff and leaching be curtailed. Requires a postclosure monitoring period of 30 years.
Radioactive waste management	DOE 5820.2, Chapter III[b]	DOE	Requires security systems and permanent markers to prevent intrusion.

[a]South Carolina Hazardous Waste Management Regulations.
[b]DOE Administrative Order.

G.2.10 NOISE

Construction and operation of disposal facilities under the Dedication strategy would require heavy equipment. Noise from the equipment would not be detectable at the SRP boundary from any site and most other locations not less than 1 kilometer from the Plant boundary because of attenuation provided by distance, topography, and natural vegetation.

G.3 ELIMINATION STRATEGY

G.3.1 SUMMARY AND OBJECTIVES

Waste management under the Elimination strategy would use retrievable storage facilities to manage the hazardous, mixed, and low-level radioactive wastes generated for 20 years. A major objective of this strategy is to delay permanent deposition of wastes in anticipation of future, advanced methods of treatment, recycling, or disposal. Land is used on a temporary basis for waste management rather than being dedicated in perpetuity. When wastes are retrieved, the land may be used for other purposes or restored to a natural condition.

The technology included in the Elimination strategy is retrievable storage buildings as listed in Table G-1 and described in Appendix E.

The assessment of environmental impacts for the Elimination strategy presumes that retrievable storage facilities would be permitted, constructed, and operated for 20 years, in accordance with applicable regulations including periodic inspections and maintenance. Retrievable storage would achieve the goal of zero releases at hazardous and mixed waste facilities and ALARA releases, assumed to be zero, at low-level waste facilities. By the end of the operational period, advanced technologies for treatment, recycling, or disposal would be available presumably, such that the stored waste could be retrieved from the facilities.

The evaluation of the Elimination strategy is more limited than the Dedication strategy because it involves only the 20-year operational period (i.e., no post-operational impacts are considered) and it focuses only on the storage facilities (i.e., no consideration of impacts associated with construction or operation of the needed advanced treatment/disposal facilities during the 20-year operational period). TE

G.3.2 GROUNDWATER AND SURFACE WATER EFFECTS

The retrievable storage facilities of the Elimination strategy would achieve zero releases of waste constituents. Therefore, groundwater and surface water would not be contaminated with waste constituents.

The base floodplain of the region is confined primarily to wetlands and low terraces along the Savannah River and its primary tributaries. Siting criteria avoid such flood prone areas; thus, no impacts due to potential flooding of storage facilities are expected.

G.3.3 NONRADIOACTIVE ATMOSPHERIC RELEASES

The construction of the waste retrievable-storage facilities would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts and truck traffic, and suspended particulates and dust from ground surface disturbances. All applicable emission standards would be met during construction.

Because hazardous, mixed, and low-level radioactive wastes would be delivered in high-integrity sealed containers, releases would be unlikely. No significant impact on air quality is projected.

G.3.4 ECOLOGICAL EFFECTS

No releases of waste constituents would result from operation of storage facilities. No contaminant-related impacts on aquatic or terrestrial resources are expected.

Construction of waste storage facilities may involve clearing up to 400 acres of land for facilities and roads. Clearing would destroy existing or potential wildlife habitat and foreclose other benefits (e.g., timber production) for the 20-year period of operations. Thereafter, the area could be restored to a natural condition or put to other nonrestricted uses.

The available habitat on the SRP amounts to 184,200 acres. The maximum loss of habitat, totaling about 0.2 percent (i.e., 400 acres), would have an insignificant effect on the ecology of the plant and the region.

TC Four endangered species (bald eagle, red-cockaded woodpecker, wood stork, and shortnose sturgeon) are on or near the SRP; however, none are present on or in the immediate vicinity of candidate sites. Therefore, construction of the retrievable storage facilities would not cause adverse impacts to endangered species.

In addition to destroying habitat; traffic, facility lighting, and human presence in the area would disturb wildlife in otherwise unaffected areas surrounding the facility and associated roadways. Traffic would increase the risk of vehicle-wildlife collisions; however, because of slow vehicle speed, such occurrences would be rare and would not have a significant impact on wildlife populations.

Construction of the facilities could result in soil erosion and subsequent sedimentation of the nearby streams, the more distant wetlands, or the creeks. Adequate erosion and sedimentation control measures should eliminate impacts on wetlands and water bodies.

G.3.5 RADIOLOGICAL RELEASES

The retrievable storage facilities would be designed to achieve a goal of zero releases of waste constituents. The release of radiological contaminants to the environment is not anticipated.

G.3.6 ARCHAEOLOGICAL AND HISTORIC RESOURCES

No effect on any significant archaeological resources through the development of selected candidate sites for waste storage facilities is anticipated. A request will be made to the South Carolina State Historic Preservation Officer for concurrence with this conclusion (see Section G.2.6.).

G.3.7 SOCIOECONOMICS

No socioeconomic impacts are expected from the construction of retrievable storage facilities (see Section G.2.7).

G.3.8 DEDICATION OF SITE

The Elimination strategy (i.e., retrievable-storage facilities) would require a site for a finite period of time. During this period, methods of waste recycling or disposal presumably would be developed and implemented at the SRP, such that at some future date the stored wastes could be retrieved. Facilities could then be decommissioned and removed, making these areas available for restoration or redevelopment. The Elimination strategy would not require the dedication of land for waste management purposes in perpetuity. TC

G.3.9 INSTITUTIONAL IMPACTS

Because the Elimination strategy would involve only temporary use (i.e., 20 years) of a site, after which use would not be restricted, DOE would not have to maintain full title and control of the land in perpetuity to ensure long-term protection of public health and the environment. However, since the basis of this strategy presumes that technologies for treatment, recycling, or disposal will be available before the end of the 20-year operational period, DOE would expect to undertake the research and development, planning, engineering, and construction to ensure that facilities are available. TC

G.3.10 NOISE

Noise associated with the construction and operation of storage facilities under the Elimination strategy would not be detectable at the SRP boundary from any candidate site because of attenuation provided by distance, topography, and natural vegetation.

G.4 <u>COMBINATION STRATEGY</u>

G.4.1 SUMMARY AND OBJECTIVES

The Dedication or Elimination strategies would provide adequate waste management of all SRP wastes as described in Appendix E (see Sections G.2 and G.3). However, the management of specific wastes could be more economical, more technologically feasible, or more environmentally reliable under one or the other strategy. TC A prime objective of the Combination strategy is to provide the optimum mix of disposal (i.e., Dedication) and storage (i.e., Elimination) technologies to accommodate specific hazardous, mixed, and low-level radioactive waste characteristics and volumes. TE

Technologies included in the Combination strategy for hazardous, mixed, and low-level radioactive waste are listed in Table G-1 and are described in Appendix E.

The technologies under each waste category are storage buildings and RCRA landfills or vaults for hazardous waste; storage buildings and RCRA landfills or vaults with CFM vaults for mixed waste; and for low-level radioactive waste, storage buildings, and ELLTs for the low-activity fraction, and vaults or GCD for intermediate-activity fraction (see Section G.2.1).

TC The assessment of environmental impacts for the Combination strategy presumes that facilities would be permitted, constructed, and operated in accordance with applicable regulations. Storage facilities would operate (with a variance) for 20 years; nonradioactive wastes would be retrieved for application of waste management technologies while radioactive wastes would remain in storage for decay-in-place up to 120 years. Disposal facilities would be operated for 20 years, ending with closure of the final unit. Thereafter, postclosure monitoring and maintenance would be carried out for a minimum of 100 years.

TC The storage actions of the strategy are assumed to result in no releases of waste constituents to the environment during their 20-year operational period or thereafter, for radioactive wastes. No post-operational impacts are considered. No consideration has been given to impacts associated with the construction or operation of future waste management facilities to treat or dispose of stored wastes.

G.4.2 GROUNDWATER AND SURFACE WATER EFFECTS

TE The base floodplain of the SRP region is confined to riparian wetlands and low terraces along the Savannah River and its primary tributaries. Siting criteria for new waste management facilities avoid such flood-prone areas; therefore, no impacts involving potential flooding of the facilities are expected.

G.4.2.1 Hazardous Waste

There are no releases expected from storage facilities during the 20-year operational period, and releases of contaminants to the subsurface from disposal facilities are not expected to occur as long as monitoring and leachate collection continues (see Sections G.2.2.1 and G.3.2). Groundwater quality would not be significantly affected through the 100-year institutional control period. Potential impacts beyond the institutional control period are described in Section G.2.2.1.

G.4.2.2 Mixed Waste

TC No releases of waste constituents will occur for storage facilities during the 20-year operational period or thereafter, and releases of contaminants from the RCRA disposal facilities are not expected to occur during the period of institutional control.

Modeling results indicate that hazardous constituents would not be released from the CFM vaults in concentrations which exceed applicable standards for up to 10,000 years. Likewise, radiological constituents including uranium are not expected to exceed their respective derived standards.

G.4.2.3 Low-Level Radioactive Waste

Low-level radioactive waste management facilities, selected to evaluate impacts on groundwater and surface water, were storage buildings, ELLTs for disposal of low-activity waste, and vaults or GCD for intermediate-activity waste. Retrievable storage assumably would be employed for the majority of intermediate-activity tritium wastes, carbon-14, and iodine-129. No releases of these stored wastes are expected, and no impact on groundwater or surface water is anticipated.

Modeling was used to predict the times of occurrence and the peak concentrations of radionuclides in ground and surface water. Table G-9 compares the modeling results to the derived groundwater standard for each nuclide. Peak concentrations of radionuclides are below their respective derived standard with the exception of uranium-234, which is just slightly above standard, 7500 years in the future. The uranium-234 concentration is not expected to exceed the derived groundwater standard as shown by the modeling (see Section G.2.2.2). Therefore, low-level radioactive waste constituent concentrations are not expected to exceed derived standards at the boundary well, wetlands, Upper Three Runs Creek, or the Savannah River with any mix of low-level waste technologies for the Combination strategy.

G.4.3 NONRADIOACTIVE ATMOSPHERIC RELEASES

The construction of waste disposal and retrievable storage facilities would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts and truck traffic, and suspended particulates and dust from ground surface disturbances. All applicable emission standards would be met during construction.

Because hazardous wastes would be delivered in sealed containers, releases would be unlikely. No significant impact on air quality from the Combination strategy is projected.

G.4.4 ECOLOGICAL EFFECTS

The candidate sites are as close as 300 meters to primary SRP streams (i.e., Upper Three Runs Creek, Tinker Creek) and closer to wetlands and ephemeral feeder streams. Since the operation and dedication of facilities is not expected to involve releases which would exceed groundwater quality standards or surface water standards/criteria, no adverse impacts on aquatic or terrestrial ecology are expected.

Construction of waste disposal facilities may involve clearing up to 400 acres for the waste facilities, roads, and appurtenances. Clearing would destroy existing or potential wildlife habitat and foreclose any other future benefits that may be provided by a natural landscape in the SRP region (e.g., timber

Table G-9. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Combination Strategy, Low-Level Waste[a]

Radionuclide	Derived standard[b]	Estimated concentration[c]							
		Boundary well		Wetlands		Upper Three Runs Creek		Savannah River	
		Estimate	Ratio	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio
LOW-ACTIVITY WASTE									
Carbon-14	2.6×10^{3}	1.25×10^{-1} (30.1)	4.81×10^{-5}	1.62×10^{-2} (53.1)	6.23×10^{-6}	1.62×10^{-5} (53.1)	6.23×10^{-9}	3.03×10^{-7} (53.1)	1.17×10^{-10}
Tritium	8.7×10^{4}	4.20×10^{0} (24.4)	4.83×10^{-5}	1.92×10^{-1} (40.1)	2.21×10^{-6}	1.92×10^{-4} (40.1)	2.21×10^{-9}	3.58×10^{-6} (40.1)	4.11×10^{-11}
Iodine-129	2.0×10^{1}	3.36×10^{-3} (132)	1.68×10^{-4}	4.44×10^{-4} (179)	2.22×10^{-5}	4.44×10^{-7} (179)	2.22×10^{-8}	8.29×10^{-9} (179)	4.15×10^{-10}
Rubidium-87	1.1×10^{3}	2.35×10^{-7} (2730)	2.14×10^{-10}	3.24×10^{-8} (3350)	2.95×10^{-11}	3.24×10^{-11} (3350)	2.95×10^{-14}	6.06×10^{-13} (3350)	5.51×10^{-16}
Selenium-79	6.6×10^{2}	7.42×10^{-3} (1380)	1.12×10^{-5}	1.02×10^{-3} (1700)	1.55×10^{-6}	1.02×10^{-6} (1700)	1.55×10^{-9}	1.90×10^{-8} (1700)	2.88×10^{-11}
Technetium-99	4.2×10^{3}	4.13×10^{0} (24.4)	9.83×10^{-4}	5.62×10^{-1} (47.7)	1.34×10^{-4}	5.62×10^{-4} (47.7)	1.34×10^{-7}	1.05×10^{-5} (47.7)	2.50×10^{-9}
Neptunium-237	1.4×10^{-1}	1.15×10^{-4} (5430)	8.21×10^{-4}	1.59×10^{-5} (6640)	1.14×10^{-4}	1.59×10^{-8} (6640)	1.14×10^{-7}	2.97×10^{-10} (6640)	2.12×10^{-9}
Subtotal			2.08×10^{-3}		2.80×10^{-4}		2.80×10^{-7}		5.22×10^{-9}
INTERMEDIATE-ACTIVITY WASTE									
Carbon-14	2.6×10^{3}	7.56×10^{-2} (304)	2.91×10^{-5}	1.86×10^{-3} (333)	7.15×10^{-7}	1.86×10^{-6} (333)	7.15×10^{-10}	3.48×10^{-8} (333)	1.34×10^{-11}
Tritium	8.7×10^{4}	2.67×10^{-5} (223)	3.07×10^{-10}	1.99×10^{-7} (241)	2.29×10^{-12}	1.99×10^{-10} (241)	2.29×10^{-15}	3.71×10^{-12} (241)	4.26×10^{-17}
Iodine-129	2.0×10^{1}	4.30×10^{-3} (975)	2.15×10^{-4}	1.06×10^{-4} (1040)	5.30×10^{-6}	1.06×10^{-7} (1040)	5.30×10^{-9}	1.98×10^{-9} (1040)	9.90×10^{-11}

*Footnotes on last page of table.

Table G-9. Estimated Peak Concentrations of Radionuclides (pCi/L) and Times of Occurrence for Combination Strategy, Low-Level Waste[a] (continued)

		Estimated concentration[c]							
		Boundary well		Wetlands		Upper Three Runs Creek		Savannah River	
Radionuclide	Derived standard[b]	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio	Estimate	Ratio
Rubidium-87	1.1×10^{3}	2.17×10^{-5} (3020)	1.97×10^{-8}	8.51×10^{-7} (3490)	7.74×10^{-10}	8.51×10^{-10} (3490)	7.74×10^{-13}	1.59×10^{-11} (3490)	1.45×10^{-14}
Selenium-79	6.6×10^{2}	3.40×10^{-1} (709)	5.15×10^{-4}	1.32×10^{-2} (1410)	2.00×10^{-5}	1.32×10^{-5} (1410)	2.00×10^{-8}	2.46×10^{-7} (1410)	3.73×10^{-10}
Technetium-99	4.2×10^{3}	1.20×10^{1} (646)	2.86×10^{-3}	4.69×10^{-1} (102)	1.12×10^{-4}	4.69×10^{-4} (102)	1.12×10^{-7}	8.77×10^{-6} (102)	2.09×10^{-9}
Strontium-90	4.2×10^{1}	1.16×10^{-7} (1060)	2.76×10^{-9}	(d)	-	(d)	-	(d)	-
Yttrium-90	5.5×10^{2}	1.16×10^{-7} (1060)	2.11×10^{-10}	(d)	-	(d)	-	(d)	-
Uranium-234	2.1×10^{1}	2.47×10^{1} (7480)	1.18×10^{0}	(d)	-	(d)	-	(d)	-
Uranium-235	2.2×10^{1}	2.80×10^{-1} (7480)	1.27×10^{-2}	(d)	-	(d)	-	(d)	-
Uranium-236	2.2×10^{1}	2.02×10^{0} (7480)	9.18×10^{-2}	(d)	-	(d)	-	(d)	-
Uranium-238	2.4×10^{1}	1.23×10^{0} (7480)	5.13×10^{-2}	(d)	-	(d)	-	(d)	-
Neptunium-237	1.4×10^{-1}	2.05×10^{-2} (3270)	1.46×10^{-1}	7.87×10^{-4} (4750)	5.62×10^{-3}	7.87×10^{-7} (4750)	5.62×10^{-6}	1.47×10^{-8} (4750)	1.05×10^{-7}
Subtotal			1.49×10^{0}		5.76×10^{-3}		5.76×10^{-6}		1.08×10^{-7}
Ratio Totals			1.49×10^{0}		6.04×10^{-3}		6.04×10^{-6}		1.13×10^{-7}

[a]Source: Cook, Grant, and Towler, 1987b.
[b]ICRP Publication 30 (ICRP, 1979) methodology was used to determine radionuclide concentrations that individually yield an annual effective whole-body or organ dose of 4 millirem. Four millirem dose limit required for drinking water by 40 CFR 141. TC
[c]Figures in parentheses represent number of years after closure.
[d]No significant radionuclide concentration at this receptor location within 10,000 years after closure.

production). The available habitat on the SRP amounts to 184,200 acres; thus, the maximum loss of about 0.2 percent (i.e., 400 acres) would have an insignificant effect on the ecology of the Plant and the region.

TC Four endangered species (i.e., bald eagle, red-cockaded woodpecker, wood stork, and shortnose sturgeon) occur on or near the SRP; however, none are present on or in the immediate vicinity of any candidate sites. Therefore, construction of the disposal facilities under the Combination strategy would not cause adverse impacts to any endangered species.

In addition to the habitat destruction, traffic, facility lighting, and human presence in the area would disturb wildlife in otherwise unaffected areas surrounding the facility and associated roadways. Traffic would also increase the risk of vehicle-wildlife collisions; however, because of the slow vehicle speed, such occurrences would be rare and would not have a significant impact on wildlife populations.

Construction of the facilities could result in soil erosion and subsequent sedimentation of nearby steams, the more distant wetlands, or the creeks. Adequate erosion and sedimentation control measures should eliminate impacts on wetlands and water bodies from this source.

With the belowground disposal options, the uptake of wastes by vegetation could occur if the roots of plants penetrated the clay cap and/or other barriers between the surface and the waste forms. Therefore, shallow rooted species would be used to stabilize soils during closure and would be maintained by mowing during the postclosure institutional control period to prevent more TE deeply rooted plants (e.g., shrubs and trees) from becoming established.

G.4.5 RADIOLOGICAL RELEASES

G.4.5.1 Hazardous Waste

Because hazardous wastes do not contain radioactive constituents by definition, no radiological releases are expected from hazardous waste disposal/storage facilities.

G.4.5.2 Mixed Waste

The major radiological releases of the Combination strategy are associated with the CFM vault technology (see Section G.2.5.2). It is concluded that individual doses during the peak year, for all radionuclides including uranium-234, would not exceed the 4-millirem-per-year drinking water standard through all modeled pathways.

G.4.5.3 Low-Level Radioactive Waste

Under the Combination strategy, retrievable storage would be expressly designated for the intermediate-activity carbon-14, tritium, and iodine-129. Currently, storage of other wastes remains optional. Table G-10 shows the peak radiological doses estimated by the model and their estimated times of occurrence for the boundary well and Savannah River pathways. The sum of doses from all radionuclides is below the 4-millirem-per-year drinking-water standard for both the boundary well and Savannah River pathways. The modeling

Table G-10. Peak Radiological Dose and Times of Occurrence for Combination Strategy, Low-Level Waste[a, b]

Radionuclide	Boundary well		Savannah River	
	Dose	Time	Dose	Time
		LOW-ACTIVITY WASTE		
Carbon-14	1.58×10^{-4}	30.1	2.06×10^{-8}	53.1
Tritium	2.24×10^{-4}	24.4	1.93×10^{-10}	40.1
Iodine-129	6.67×10^{-4}	132	1.89×10^{-9}	179
Rubidium-87	8.93×10^{-10}	2730	4.24×10^{-14}	3350
Selenium-79	4.37×10^{-5}	1380	2.97×10^{-10}	1700
Technetium-99	3.93×10^{-3}	24.4	1.14×10^{-8}	47.7
Neptunium-237	2.09×10^{-5}	5430	6.19×10^{-11}	6640
Subtotal	5.04×10^{-3}		3.44×10^{-8}	
		INTERMEDIATE-ACTIVITY WASTE		
Carbon-14	9.57×10^{-5}	304	2.36×10^{-9}	333
Tritium	1.43×10^{-9}	223	2.00×10^{-16}	241
Iodine-129	8.54×10^{-4}	975	4.51×10^{-10}	1040
Rubidium-87	8.24×10^{-8}	3020	1.11×10^{-12}	3490
Selenium-79	2.00×10^{-3}	709	3.84×10^{-9}	1410
Technetium-99	1.14×10^{-2}	64.6	9.52×10^{-9}	102
Strontium-90	7.43×10^{-9}	1060	b	-
Yttrium-90	5.72×10^{-10}	1060	b	-
Uranium-234	3.06×10^{0}	7480	b	-
Uranium-235	3.34×10^{-2}	7480	b	-

Footnote on last page of table.

Table G-10. Peak Radiological Dose and Times of Occurrence for Combination Strategy, Low-Level Waste[a, b] (continued)

	Boundary well		Savannah River	
Radionuclide	Dose	Time	Dose	Time
Uranium-236	2.41×10^{-1}	7480	b	-
Uranium-238	1.35×10^{-1}	7480	b	-
Neptunium-237	3.72×10^{-3}	3270	3.06×10^{-9}	4750
Subtotal	3.49×10^{0}		1.92×10^{-8}	
Total Dose	3.50×10^{0}		5.36×10^{-8}	

TC [a]Source: Cook, Grant, and Towler, 1987b.
[b]Doses calculated using PATHRAE model incorporating a human diet of plant, meat, and dairy foods, and 370 liters of contaminated water ingested per year. Doses expressed in millirem per year; time in number of years after closure.

result of a 3.5-millirem-per-year peak is a conservative sum. It assumes that all nuclide doses peak at the same time, that no solubility limits exist for uranium, and that there is no leachate collection during the 100-year institutional control period. The nuclide doses would peak at various times from 24 to 7500 years beyond closure; environmental factors [e.g., soil pH, groundwater reduction-oxidation (redox) potential (Eh), cation exchange capacity, and the presence of chelating or complexing species in the soil] would limit the solubility of uranium; and leachate collection would occur as required during the institutional control period. Consequently, radiological doses from low-level radioactive waste facilities would be below the 4-millirem-per-year standard (see Section G.2.5.3). TC

G.4.6 ARCHAEOLOGICAL AND HISTORIC RESOURCES

No effect on any significant archaeological resources through the development of selected candidate sites for waste storage and disposal facilities is anticipated. A request will be made to the South Carolina State Historic Preservation Officer for concurrence with this conclusion (see Section G.2.6.).

G.4.7 SOCIOECONOMICS

No socioeconomic impacts are expected from the construction of storage and disposal facilities under the Combination strategy (see Section G.2.7).

G.4.8 DEDICATION OF SITE

The disposal portion of the Combination strategy, involving up to 400 acres plus a buffer zone, would require site dedication in perpetuity to ensure full compliance with RCRA and South Carolina Hazardous Waste Management Regulations and consistency with DOE Orders regarding environmental and public health protection.

The storage portion of the strategy, however, would require the use of a site for a finite period of time. Then the facilities could be removed and the site restored to a natural condition or redeveloped for other land uses with no restrictions (see Sections G.2.8 and G.3.8).

G.4.9 INSTITUTIONAL IMPACTS

Institutional impacts associated with the disposal portion of the Combination strategy would be the same as those in Section G.2.9.

Because the retrievable-storage portion of the Combination strategy would involve temporary use of a site (i.e., 20 or 120 years), DOE would not have to maintain full title and control of that portion of the site in perpetuity to ensure long-term protection of public health and the environment. Thus, institutional impacts associated with the storage facilities would be insignificant. TC

G.4.10 NOISE

Noise associated with the construction and operation of storage and disposal facilities under the Combination strategy would not be detectable at the SRP boundary from any candidate site because of attenuation provided by distance, topography, and natural vegetation.

G.5 SUMMARY

Table G-11 provides a summary of the four alternative waste management strategies.

Table G-11. Summary of New Waste Management Facility Impacts for Each Waste Management Strategy

Environmental category	No action	Dedication	Elimination	Combination
Groundwater/surface water	Potentially more damaging than all current existing waste sites	No significant impact through period of institutional control. Potential hazardous and radioactive releases, thereafter	No significant impact through 20-year period of operation	No significant impact through period of institutional control. Potential hazardous and radioactive releases, thereafter
Nonradioactive atmospheric	Potential dispersion of large quantities of waste due to disaster (e.g., fire)	No significant impact	No significant impact	No significant impact
Ecology	Potential substantial impacts both onsite and offsite and downstream	No significant waste-related impacts. No significant loss of habitat. No impact to rare/endangered species	Same as Dedication	Same as Dedication (TE)
Radiological releases	Potentially very damaging to the environment and public health	No significant impact through the period of institutional control. Potential impacts thereafter from tritium unless mitigated	No significant impact through 20-year period of operation	No significant impact through the period of institutional control. No significant impact from tritium thereafter
Archaeological/ historic	No impact	No impact	No impact	No impact
Socioeconomics	Potential substantial impacts due to temporary cleanup workforce, SRP unit shut-downs and layoffs, and public perception of offsite property values	No impact	No impact	No impact (TC)
Noise	No impact	No impact	No impact	No impact
Site dedication	Potential site dedication of land contaminated by accidental releases	Dedication of up to 400 acres of land for waste management in-perpetuity	No dedication of land in-perpetuity	Dedication of up to 400 acres of land for waste management in-perpetuity
Institutional	Would result in DOE's non-compliance with environmental laws and regulations	Possible site maintenance and monitoring indefinitely beyond institutional control period	Commitment to carry out research and development, planning, engineering, and construction of advanced waste management technologies.	Possible site maintenance and monitoring indefinitely beyond institutional control period. Commitment to carry out research and development, planning, engineering, and construction of advanced waste management technologies

REFERENCES

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

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

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

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, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Grants and Contract Division, Archaeological Research Program, Savannah River Plant, Aiken, South Carolina. TC