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Plan and Schedule to Discontinue Disposal of Contaminated Liquids Into the Soil Column at the Hanford Site

Response to Congressional Request

March 16, 1987

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EXECUTIVE SUMMARY

Liquid wastes have been generated as a result of operations conducted at the Hanford Site for over 40 years. These wastes are discharged to soil column disposal units in accordance with U.S. Department of Energy (DOE) Orders that require protection of public health and safety and are intended to control and, to the extent possible, minimize adverse impacts on the environment. Current DOE policy on radioactive waste management states that disposal operations involving discharges of contaminated liquids directly to the environment or natural soil column shall be replaced by other techniques (DOE 1984). The DOE was directed by Congress to provide a plan and schedule to discontinue disposal of contaminated liquids into the soil at the Hanford Site. The purpose of this document is to provide the requested plan and an implementation schedule.

Within the Hanford Site, 32 active liquid waste discharges are currently released to soil column disposal units. These discharges consist of large quantities of cooling water and smaller quantities of other discharges, many of which contain low levels of radioactive contamination resulting from operations at the Hanford Site. All discharges from DOE-facilities are required to be as-low-as-reasonably-achievable. The principal radioactive contaminant in these wastes is tritium, which meets the DOE derived concentration guide at the site boundary without treatment.

Active liquid waste discharges are routinely monitored for radioactive constituents. Based on process evaluations and sampling done to date, none of the liquid waste streams that are routinely released to the soil column have been designated as hazardous waste. The radiation dose resulting to the hypothetical maximally exposed offsite individual from Hanford Site operations, including discharges to the soil column, was calculated to be 3 mrem in 1985, well under the offsite dose limits of 500 mrem for occasional exposure and 100 mrem for prolonged exposure. These numbers also compare favorably to the average annual natural background exposure for the United States of about 100 mrem.

In accordance with the policy to replace the practice of soil column disposal for contaminated effluents, DOE has been studying alternative effluent treatment and disposal methods, the results of which are presented in this plan. The criteria for effluent disposal used in this study are derived from review of regulations enacted pursuant to the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Clean Water Act (CWA), the State of Washington Water Pollution Control Act (WWPC), and the Atomic Energy Act. A liquid effluent is considered suitable for disposal to the environment, including the soil column, if it meets the established criteria derived from the aforementioned statutes.

Based on consideration of the CWA and WWPC, the best-available technology (BAT) economically achievable would be evaluated and applied to all discharges currently going to the soil column. The process of selecting and implementing alternative technology would include preparation of

required National Environmental Policy Act documentation. As appropriate, consultation and coordination with other State and Federal agencies would be maintained throughout the design process to ensure that all technical requirements are met. Technology for the removal and disposal of tritium is currently not available. The available alternatives for management of tritium contaminated waste water include direct discharge to the Columbia River, volatilization to the atmosphere, and discharge to the soil column. Of these alternatives, soil column disposal is preferred because it results in the lowest offsite dose and is also the lowest in cost. Evaluation of tritium waste technology will continue with future implementation dependent upon the successful development of technically feasible methods.

The implementation schedule presented in the plan is based on application of a two-phased prioritization system for liquid effluents. Of the 32 discharges, 16 would be designated as Phase I, and appropriate treatment technologies could be implemented by 1995. Preliminary cost estimates for the Phase I projects range from $120 to $160 million in capital funds and $28 million in support costs.

Within the higher priority actions grouped in Phase I, the implementation of the planned N Reactor effluent treatment scheduled for completion by 1989, followed by shutdown of N Reactor in 1995, results in the overall reduction of total radionuclide discharges (excluding tritium) to the soil column by approximately 98%. Similarly, implementation of effluent treatment for three Phase I waste streams would also result in approximately a 90% reduction in nitrate discharges, which is the principal chemical constituent of the wastes. Phase I implementation would also provide additional engineered controls to prevent the nonroutine discharge (spills) of chemical substances. The plan incorporates ongoing activities in support of waste treatment system upgrades and effluent treatments to reduce quantities and improve the quality of the wastes discharged. These activities address laboratory and chemical sewers, process condensates, and waste water streams.

The estimated costs for implementation of Phase II would range from $130 to $200 million in capital funds with an additional $23 million in development or support costs. The total estimated capital and support cost for implementation of Phase I and Phase II ranges from $300 to $410 million. The estimated annual operating cost following implementation of both Phase I and Phase II projects would be approximately $50 million per year.

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1.0 INTRODUCTION

1.1 OVERVIEW

This document has been prepared in response to the Congressional requirement to provide a plan and schedule to discontinue disposal of contaminated liquids into the soil at the Hanford Site. Congress requested this plan within 120 days of enactment of the 1987 Budget Appropriations Bill.

The U.S. Department of Energy (DOE) has established requirements for the disposal of liquid effluents on the Hanford Site and requires compliance with applicable U.S. Environmental Protection Agency (EPA) and State of Washington regulations. Although current liquid effluent disposal practices at the Hanford Site are conducted in accordance with DOE requirements, the continued use of the soil column for the disposal of liquid effluents and the protection of surface and groundwaters is a concern to the DOE. It is the policy of DOE to replace the use of soil column disposal practices for contaminated effluents with alternative waste treatment and disposal methods (DOE 1984).

1.2 BACKGROUND

Since 1944, when the first Hanford Site facilities were operated to produce plutonium for the Manhattan Project, large quantities of Columbia River water have been used for reactor and chemical separation operations. Disposal of this water, most of which is not routinely in contact with radioactive materials, is by direct discharge back to the environment via the soil column. Waste management programs at the Hanford Site have included a continuous and evolving program to evaluate the compliance status of all liquid effluent releases with DOE requirements and to ensure that releases are reduced to as-low-as-reasonably achievable (ALARA).

Dose limits established by DOE for individuals exposed to radionuclide releases from operations at the Hanford Site are derived from internationally accepted radiation protection standards. The whole body dose to the maximum exposed offsite individual has been limited to 500 mrem/yr since the 1950s. While dose limits have changed very little during the operation of the Hanford Site, increasingly restrictive management practices have been applied to liquid effluents to ensure that annual doses are ALARA. In 1985 DOE issued guidance limiting exposure to members of the public to 100 mrem/yr for prolonged periods of exposure, and 500 mrem/yr for maximum occasional exposure, which is calculated using current International Commission on Radiological Protection methodology.

During the peak period of Hanford Site operations (1956 to 1964), elevated concentrations of Hanford-related radionuclides were detected in the environment, including the Columbia River. As effluent disposal practices at the Hanford Site were improved and the number of operating facilities was reduced, the presence of Hanford-related radionuclides in the environment became increasingly difficult to detect and distinguish from

natural background and world-wide fallout from nuclear weapons tests. By the early 1970s, it was generally no longer possible to estimate offsite radiation doses from Hanford Site operations solely on the basis of samples and measurements of environmental media (i.e., vegetation, air, river water, etc.). Beginning in 1974, environmental transport and radiation dose models were used to calculate potential radiation doses using data on effluents released into the atmosphere and into the Columbia River. The estimated whole body dose to the hypothetical maximally exposed individual as a result of Hanford Site operations ranged from 50 to 100 mrem per year during the early 1960s. The calculated annual dose estimates during 1984 and 1985 have been reduced to 2 and 3 mrem/yr, respectively (Price 1986). Of this calculated 3-mrem dose, 99% is attributable to releases from the previous N Reactor soil column disposal unit. Use of a replacement soil column disposal unit, which started in 1985, has significantly reduced releases to the groundwater and should result in a declining calculated offsite dose. The offsite dose impact from past chemical separations and waste management area discharges resulted in a comparable calculated dose of 0.014 mrem in 1985.

Information on offsite doses has been reported in annual environmental reports published since 1957. A review of the reports issued from 1957 through 1984 was recently completed by Soldat et al. (1986) and the following conclusions were made:

- Radiation doses for the maximum individual did not exceed the applicable dose standards
- Environmental monitoring and dose calculations do not suggest a significant dose contribution from the buildup in the offsite environment of radioactive materials associated with Hanford Site operations.

The principal adverse environmental impact from effluent disposal practices, most of which occur in the 200 Areas of the Hanford Site, is the accumulation of radioactivity in the onsite subsurface soils and the unconfined aquifer. The unconfined aquifer under the Hanford Site discharges directly to the Columbia River after a 20-yr travel time (approximately) from the 200 Areas. Due to the relatively low volume of groundwater flow, the delay in discharge to the Columbia River, and the fact that the Hanford Site groundwater is not used as a community water supply, the impacts to humans are small. The principal potential pathway for dose to humans from 200 Area discharges results from an assumption that at some unspecified future time government control of the Hanford Site ceases and is followed by human habitation and extensive utilization of groundwater for irrigation and consumption.

During the early years of the Hanford Site, the allowable concentration level of nonradioactive contaminants in the liquid effluents was based on engineering practices and design criteria that were current during the period the facility was constructed. The allowable concentration levels have become significantly more restrictive pursuant to limitations

established by DOE to ensure compliance with current standards derived from the Resource Conservation and Recovery Act (RCRA) and other relevant legislation, resulting in implementation of administrative controls and engineered systems to control or prevent the release of nonradioactive contaminants in the liquid effluents.

1.3 OBJECTIVE

The objective of this document is to present a plan to replace the practice of using the soil column at the Hanford Site to dispose of contaminated liquid effluents. Alternative effluent treatment and disposal for contaminated effluents shall be implemented in accordance with liquid effluent disposal criteria derived from DOE Orders and relevant environmental regulations. In addition, current effluent disposal practices will continue to be managed in a responsible manner that protects public health and safety, and minimizes adverse effects on the environment.

1.4 SCOPE

This document includes all liquid effluents currently discharged to the soil on the Hanford Site that are routinely or potentially contaminated with radionuclide and/or chemical constituents. Sanitary wastes, direct discharges to the Columbia River, which are permitted under the National Pollutant Discharge Elimination System (NPDES), and small volume or intermittent discharges from heating, ventilation, and air conditioning systems, and floor drains and sumps from noncontaminated or nonchemical handling facilities are not included in the scope of this plan. Construction of replacement production facilities not already planned, which includes improved effluent treatment and disposal systems, are also not considered in the scope of this study.

1.5 KEY ASSUMPTIONS

The following key assumptions were used in the preparation of this document:

- The Hanford Site Production Reactor (N Reactor) will discontinue operation in 1995 and will be prepared for decommissioning
- The Plutonium-Uranium Extraction (PUREX) Facility and the UO_3 Plant will continue to operate beyond the year 2001
- The Process Facility Modification (PFM) plant construction will be completed in fiscal year (FY) 1994 and will be fully operational by 1996
- The Plutonium Finishing Plant (PFP) will continue to operate beyond the year 2001

- Capital and expense funding will be provided on the schedule included in this plan

- New facilities will meet the liquid effluent disposal requirements described in this plan.

The recent decision that N Reactor operations will be discontinued in 1995 may impact the operation of other Hanford Site process facilities. Evaluation of these impacts on other process facilities, in particular PUREX, UO_3 Plant, PFP, and the planned PFM facility are continuing. The actions delineated in this plan will be reviewed periodically and will require specific reexamination if process facility operating scenarios are revised. This reexamination will ensure that proposed upgrades are justified considering the useful life of the facility and are consistent with the overall Hanford Site mission.

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2.0 EFFLUENT IDENTIFICATION AND DESCRIPTION

Operations at the Hanford Site include the fabrication of nuclear fuels, operation of nuclear reactors, chemical processing of nuclear materials, management of chemical and nuclear wastes, surveillance and maintenance or decontamination and decommissioning of retired facilities, and a broad range of research and development activities. The location of the Hanford Site is illustrated in figure 1. Hanford Site facilities (DOE-RL 1986; ERDA 1975) currently discharging liquid effluents to the soil are located in the following areas:

- N Reactor (100 Area)
- Chemical separations and waste management operations (200 Area)
- Fuels fabrication and laboratory operations (300 Area)
- Fast Flux Test Facility (FFTF) (400 Area).

2.1 EFFLUENT IDENTIFICATION

Within these locations are 21 facilities that generate 32 liquid effluent streams. The effluent-generating facilities, specific effluents, and associated soil column disposal units are identified in table 1.

2.2 EFFLUENT DESCRIPTION

Based upon similarities in the generating facilities and waste constituents, the effluent streams have been grouped into six categories:

- N Reactor effluents
- Laboratory and chemical sewers
- Process condensates
- Laundry waste water
- Cooling water
- Steam condensates.

The category of the effluent and total volume of each discharge is shown in table 1. Several of the liquid waste streams have components from two or more waste categories. For example, the design of some facilities results in the combination of cooling water and steam condensates into a single stream. In other facilities, a discharge that could be considered a chemical sewer is combined with either cooling water, steam condensate, or both. In these cases, the primary category of the stream was determined by the component that contributed the greatest quantity of contamination.

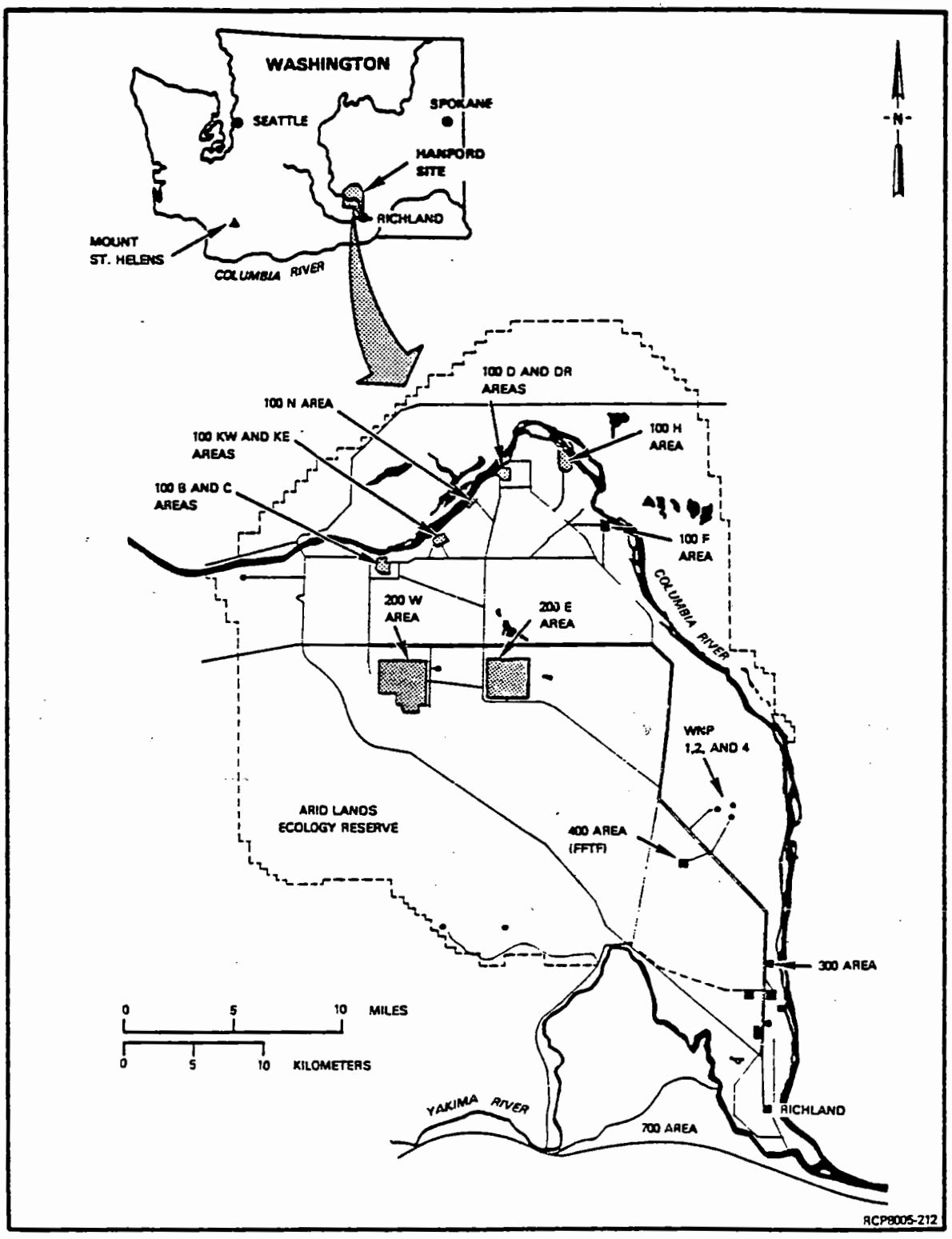

Figure 1. The Hanford Site.

Table 1. Effluent Generating Facilities, Effluents, and Effluent Disposal Units. (sheet 1 of 2)

Hanford Site area	Effluent generating facility	Effluent category	Disposal unit identification number	Disposal site type	Millions of gal/yr[a] (1985)
N Reactor (100 Area)	N Reactor	N Reactor effluent	1325-N	Crib	960
	100-D Laboratory[b]	Chemical sewer	100-D pond	Pond	17[c]
Chemical separations and waste management (200 Area)	PUREX (fuels reprocessing facility)	Chemical sewer Process condensate Cooling water Steam condensate Process condensate (ammonia scrubber)	216-B-3/A-29 216-A-10 216-B-3[d]/A-25 216-A-30/A-37-2 216-A-36B	Pond/ditch Crib Ponds Cribs Crib	460 27 3,250 233 20
	B Plant (waste fractionation plant)	Chemical sewer Process condensate Cooling water Steam condensate	216-B-63 216-B-62 216-B-3[d]/A-25 216-B-55	Ditch Crib Ponds Crib	82 1 950 2
	Laboratories	222-S Laboratory waste 2101-M Laboratory waste[b] 209-E Laboratory waste	216-S-26 2101-M pond 216-C-7	Crib Pond Crib	12 1[c] <0.1[c]
	UO_3 Plant (uranium recovery plant)	Process condensate Waste water[e] (cooling water, steam condensate and chemical sewer)	216-U-12 216-U-14	Crib Ditch	1 33
	Plutonium Finishing Plant	Waste water[e] (cooling water, steam condensate and chemical sewer)	216-Z-20	Crib	100
	Evaporator/ concentrators	242-A process condensate 242-A cooling water 242-A steam condensate 242-S steam condensate	216-A-37-1 216-B-3[d]/A-25 B-3/A-29 216-U-14	Crib Ponds Ponds Ditch	13 920 22 5

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Table 1. Effluent Generating Facilities, Effluents, and Disposal Units. (sheet 2 of 2)

Hanford Site area	Effluent generating facility	Effluent category	Disposal unit identification number	Disposal site type	Millions of gal/yr[a] (1985)
Chemical separations and waste management (200 Area) (cont.)	T Plant (decontamination facility)	Laboratory waste water Cooling water[b] (steam condensate)	216-T-1 216-T-4-2	Ditch Ditch	0.3[c] 21[c]
	Steam plants[b]	Cooling water (200 East Area Powerhouse) Cooling water (200 West Area Powerhouse)	216-B-3[d]/A-25 Powerhouse pond	Ponds Pond	4[c] 2[c]
	Waste storage tank facilities	A-Farm cooling water 244-AR Vault cooling water AY, AZ Farm steam condensates	216-B-3[d]/A-25 216-B-3[d]/A-25 216-A-8	Ponds Ponds Crib	105 23 0.06
	Laundry	Laundry effluent	216-W-LC	Crib	19
	S Plant	Cooling water[e]	216-S-10	Ditch/ pond	53
Fuels fabrications and laboratory operations (300 Area)	Fuels fabrication facility and laboratories	Chemical sewer[e]	300 Area process trenches	Trenches	58
400 Area	Air conditioning[b]	Cooling water[e]	400 Area pond	Pond	5[c]

[a]Total volume discharged is 7.4 billion gal in 1985.
[b]Nonradioactive generating facility.
[c]Estimated volume.
[d]Includes the 216-B-3-3 and 216-B-2-3 ditches.
[e]Includes two or more waste categories.

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The Hanford Site waste streams discharged a total of 7.4 billion gal of waste water during 1985. Figure 2 illustrates how this volume of waste water was distributed among the six waste stream categories. Cooling water accounted for over 74% of the waste water discharged on the Hanford Site. Based on process evaluations and sampling done to date, none of the liquid waste streams that are routinely released to the soil column have been designated as hazardous wastes.

The liquid effluents released to the soil column at the Hanford Site in 1985 contained 11,200 Ci of tritium, 6,260 Ci of beta/gamma activity with half-life greater than 48 hours and 3,060 Ci of beta/gamma activity with half-life greater than 45 days, and 6.3 Ci of alpha activity (Aldrich 1986; UNC 1986a). The N Reactor accounts for about 98% of the total activity (excluding tritium) released to the soil on the Hanford Site. The process condensates are the next largest contributor and account for about 2% (excluding tritium) of the activity released to the soil column. The remaining streams account for less than 0.1% (excluding tritium) of the activity released to the soil column. The PUREX Plant accounted for over 90% of the tritium discharged to the soil at the Hanford Site.

2.3 EFFLUENT CHARACTERIZATION

The effluent characterization data used in the evaluations in this report were collected from routine radiological environmental surveillance data and from continuing actions to extensively characterize the chemical constituents of the liquid effluents. Additional data are currently being collected to support several activities including increased routine radiological surveillance requirements, continuing chemical characterization, and engineering and design studies of effluent treatment technology.

Data for chemical constituents were collected as part of an ongoing activity to complete the characterization and designation of effluents disposed of to the soil column. SW-846, Test Methods for Evaluating Solid Waste-Physical/Chemical Methods (EPA 1982), is being used to plan and conduct the sampling and define the analytical and statistical procedures used to designate the discharge. At least four random samples will be collected from each effluent over a period of up to one year. In some cases, substreams of an effluent will be sampled to determine the impact of alternative process configurations on waste characteristics. Currently, sampling is scheduled to continue through calendar year 1987 with data reported in early 1988. Actual sampling is contingent on process facility operating schedules, and additional sampling will be scheduled in the event of process modifications that will significantly impact effluent characteristics.

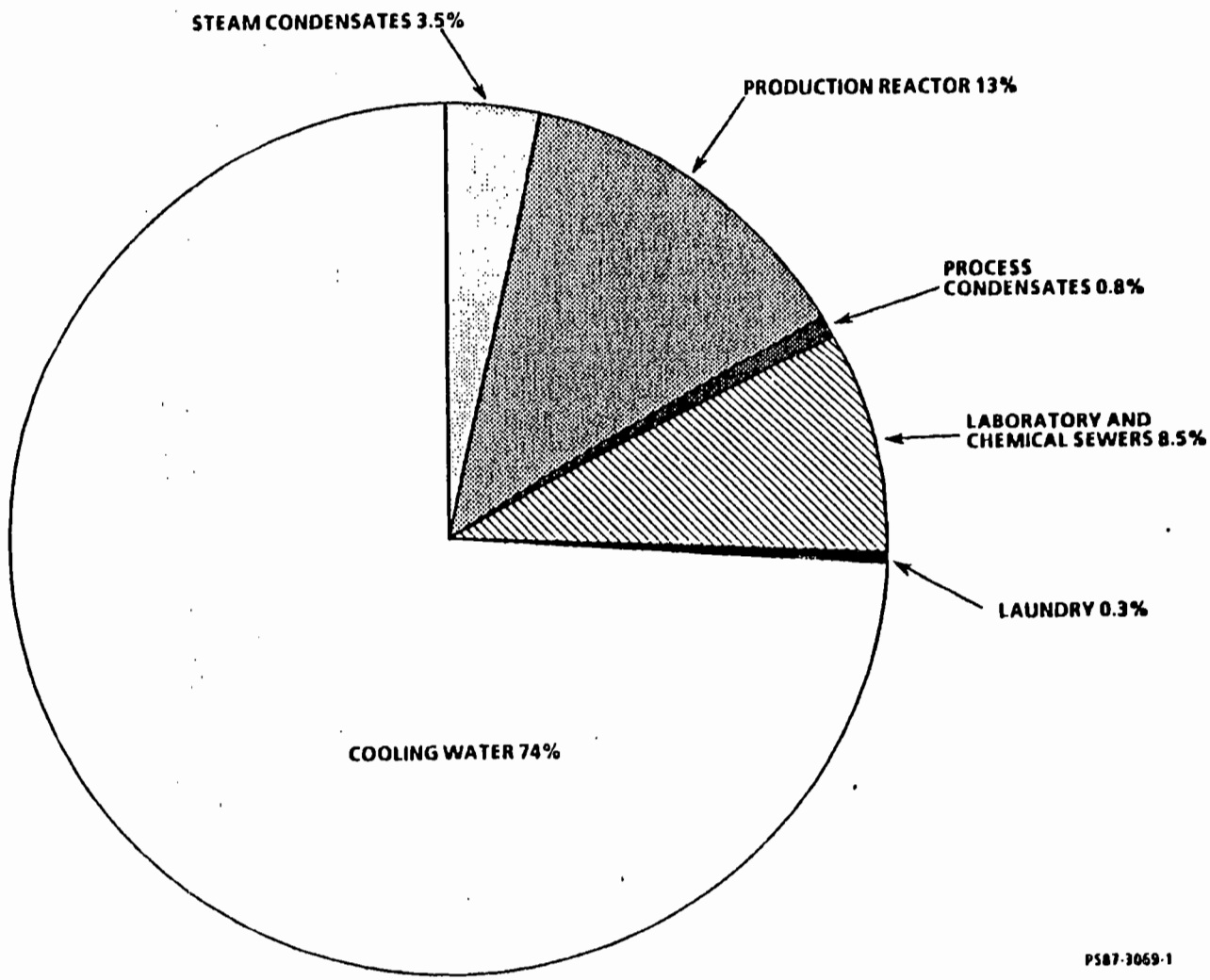

Figure 2. Total Volume Released (1985).

3.0 STRATEGY

3.1 LIQUID EFFLUENT DISPOSAL CRITERIA

It is the policy of DOE that operations are conducted in a safe, cost-effective, and environmentally sound manner, and that discharges of radioactive and nonradioactive materials released to the environment meet applicable regulatory requirements and are ALARA. It is also the policy of DOE that the disposal of contaminated effluents to the soil column be replaced by other techniques (DOE 1984). Implementation of this policy is based on criteria for soil column disposal derived from DOE orders and relevant environmental regulations. The environmental legislation used to develop the liquid effluent disposal criteria include the following:

- RCRA (PL-94-580, as amended, 42 USC 6501, et seq.) and WAC-173-303, "Dangerous Waste Regulations"
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (PL-96-510, 42 USC 9601, et seq.)
- Clean Water Act (CWA) (PL-92-500, 33 USC 1251, et seq.) and Washington Water Pollution Control Laws (90.48 Revised Code of Washington (RCW))
- National Environmental Policy Act (NEPA) (PL-91-190, 42 USC 4321, et seq.)
- Atomic Energy Act (AEA) (PL-83-703, 42 USC 2011, et seq.).

The aforementioned environmental statutes were enacted to protect public health and the environment, and preserve and protect present and future beneficial uses of the environment, including the groundwater. The following sections address how these environmental statutes and the implementing regulations are used to establish criteria for liquid effluent treatment and disposal. A liquid effluent is considered suitable for disposal to the environment, including the soil column if it meets the established criteria.

3.1.1 Resource Conservation and Recovery Act

The RCRA provides for protection of health and the environment from activities associated with the management and disposal of hazardous wastes. Subtitle C of RCRA sets forth requirements for generators and transporters of hazardous waste and also establishes a specific permit program for owners and operators of facilities for treatment, storage, and disposal of hazardous wastes. Contained within the implementing regulations are criteria for the designation of hazardous wastes. If a liquid effluent meets or exceeds these criteria, the effluent is considered a hazardous waste, which requires the generating facility to treat, store, or dispose of the waste according to the provisions of the RCRA.

States may obtain the authority to administer and enforce a hazardous waste program under the provisions of section 3006 of the RCRA. Washington State obtained final authority from the EPA to administer a hazardous waste program in January 1986. In July of 1986, the EPA published a notice in the Federal Register indicating that states must be authorized to regulate radioactive mixed wastes and that in order to obtain and maintain authorization to administer and enforce a mixed waste program, states must demonstrate the ability to regulate the hazardous components of radioactive mixed wastes. Washington State is developing the necessary documentation and is expected to gain authority for regulation of the hazardous components of mixed wastes during 1987.

Presently, the Washington State Department of Ecology administers the hazardous waste program under the regulations found in WAC 173-303. In order to gain authority to administer the hazardous waste program, state regulations must be at least as restrictive as federal regulations. The criteria for liquid effluent disposal at the Hanford Site are based on the present requirements of WAC 173-303 (until mixed waste regulations are promulgated), which require liquid discharges to the soil or environment be nonhazardous according to the designation criteria established in WAC 173-303.

3.1.2 Comprehensive Environmental Response, Compensation, and Liability Act

The CERCLA establishes reporting and remedial action requirements for other than federally permitted releases of chemical substances above minimum reportable quantities (e.g., spills). Federal agencies are subject to the reporting and remedial action requirements of CERCLA, but are not entitled to use the trust fund established by the CERCLA for cleanup.

The specific criteria derived from CERCLA require the use of control and containment systems to prevent the release of reportable quantities of chemical substances. Administrative controls are currently in place to prevent the release of reportable quantities of chemical substances. Engineered barriers are being added to provide additional protection against the release of chemical substances. Several years are required to complete the design, funding, and construction of these barriers.

3.1.3 Clean Water Act

The CWA was established to restore and maintain the chemical, physical, and biological integrity of the navigable waters in the United States. Effluent limitations are established and administered through the NPDES permit program and include technology-based limitations and established water quality standards. The Best Available Technology (BAT) economically achievable is a base-level treatment requirement established under the CWA.

Section 304(b)(2) of the CWA establishes factors to be considered in the assessment of BAT including age of equipment and facilities, process, engineering aspects of potential control technologies, process changes, cost, and nonwater quality environmental impacts.

Under the CWA, states are required to establish water quality standards that will protect the public health and welfare and to enhance the quality of the waters of the United States. Also pursuant to the CWA, states can gain authorization to administer the NPDES permit system. Washington State, under Chapter 90.48 of the RCW, "Washington Water Pollution Control Laws," has been authorized to adopt water quality standards under the CWA. The water quality standards are promulgated under WAC-173-201, "Water Quality Standards for Waters of the State of Washington." The NPDES permit program is applicable only to the discharge of liquid effluents to navigable waters, which does not include soil column disposal.

The effluent disposal criteria used in this plan are based on consideration of WAC-173-216, "State Waste Discharge Permit Program," which requires that all known, available, and reasonable methods of prevention, control and treatment for pollutants shall be provided; and conditions necessary to preserve or protect beneficial uses for groundwater will be utilized. The BAT economically achievable guidance established under the CWA, implementing regulations, guidance documentation, and the aforementioned WAC provision will be used as effluent disposal criteria in this plan.

3.1.4 National Environmental Policy Act

The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences. The Council on Environmental Quality (CEQ) regulations for compliance with NEPA (40 CFR Parts 1500-1508) require that federal agencies integrate the NEPA process with other planning at the earliest possible time and prepare required documentation. The DOE procedures for implementing the CEQ NEPA regulations are contained in the "DOE Guidelines for Compliance with the National Environmental Policy Act," Federal Register, March 28, 1980, as amended.

3.1.5 Atomic Energy Act of 1954

The AEA authorizes the Atomic Energy Commission and successor agencies to conduct nuclear materials production, research and development, and associated activities. The AEA authorizes and provides for the agency to regulate its research, development, and production activity and to adopt such orders and standards as may be necessary to protect health and safety consistent with other applicable laws.

The DOE has issued an extensive set of orders to regulate the operation of its facilities, including disposal of liquid effluents. The derived concentration guides (DCG) have been developed by DOE based on International Commission on Radiological Protection-26, -30 methodology and a 100-mrem/yr dose limit for all pathways. The DCG will be used in this plan as prioritization criteria for establishing implementation schedules based on radionuclide constituents. The effluent disposal criteria for radionuclide reduction will be based on a BAT economically achievable evaluation procedure similar to that described under the CWA for chemical constituents.

3.1.6 Effluent Disposal Criteria Summary

The specific criteria applied to liquid effluents discharged to the soil column are summarized below.

- Liquid discharges to the soil or environment shall be nonhazardous according to the designation criteria established in WAC-173-303.
- All known, available, and reasonable methods of prevention, control, and treatment for pollutants shall be provided and conditions necessary to preserve or protect beneficial uses for groundwater will be utilized. The BAT economically achievable guidance established in the CWA and subsequent implementing regulations will be used in the development of design standards to ensure that the effluent streams at the Hanford Site which are discharged to the soil or environment meet the requirements of WAC 173-216.
- Control and containment systems shall be used to prevent spills of chemical and radioactive substances.
- Radionuclides in liquid discharges shall be reduced using BAT economically achievable guidance.
- Design criteria will, as a minimum, be applied at the point of discharge (end of pipe) to the environment.

3.2 DECISION PROCESS

The decision process used to prioritize and plan the implementation of alternative treatment and disposal systems to replace the soil column disposal of contaminated effluents is shown in figure 3. This decision process involves two general activities: (1) establishing an implementation plan including priorities and preliminary cost and schedule, which is addressed in this document, and (2) addressing the individual effluents for specific project implementation.

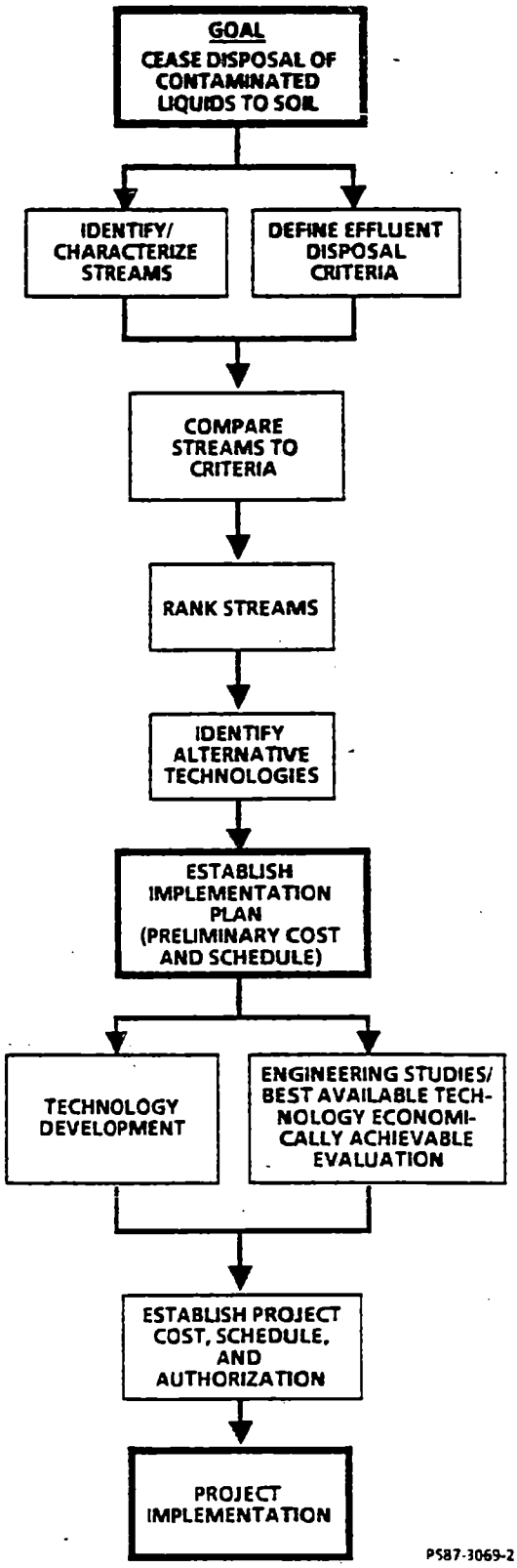

Figure 3. Implementation Plan.

Establishment of the implementation plan requires several steps. Criteria are determined for alternative treatment and disposal systems for contaminated liquids currently disposed to the soil. Specific streams are identified and characterization data collected and compiled. The streams are then compared to the effluent disposal criteria from which the streams can be prioritized and alternative technologies identified. The stream priorities and alternative technologies provide the basis for the preliminary cost and schedule described in this plan. Based on these priorities and schedule, detailed engineering and design studies will be conducted to establish the BAT economically achievable for each specific effluent. Throughout the decision-making process, consultation and coordination with State and Federal agencies will be maintained. The results of the studies and consultation with regulatory agencies will be considered in the development of the detailed project justification including cost, scheduling, and NEPA documentation, which is required for project authorization and implementation.

3.3 IMPLEMENTATION STRATEGY

The strategy to be used for implementation of alternative treatment and disposal systems involves prioritization of the planned actions into Phase I and Phase II. Phase I actions include the following:

- Complete detailed characterization of liquid effluents
- Complete BAT evaluations for all contaminated or potentially contaminated effluents
- Implement alternative treatment and disposal systems for those streams identified as Phase I priority. (The prioritization of streams into Phase I and Phase II is discussed in section 5.0.).

Stream-specific schedules have been developed (see section 6.0) for the Phase I actions including each Phase I stream with the exception of the laboratory and chemical sewers, which are grouped as a single schedule element. All remaining streams will be addressed in Phase II. Periodic evaluations will be conducted to update the implementation plan and to provide detailed schedules for Phase II implementation.

Capital projects required to replace soil column disposal of contaminated effluents will be implemented according to the requirements of DOE-RL Order 5700.2A, Project Management System. Detailed engineering studies will be completed to evaluate alternatives and select the BAT economically achievable for each stream. Throughout completion of these studies, consultation and coordination with other agencies, including the Washington State Department of Ecology and the EPA, will be maintained. Conceptual design and NEPA documentation will be completed and will provide the detailed cost and schedule needed for project authorization. The successful implementation of these projects on the schedule developed in this plan requires that the expense and capital funding is available in the identified year.

3.4 TRITIUM REMOVAL

Tritium removal is not proposed for immediate implementation for the streams that contain tritium. The streams that contain significant tritium concentrations (the percentage of total site tritium discharge in each stream is denoted by parentheses) are the PUREX process condensate (90%), PUREX ammonia scrubber discharge (2%), and N Reactor effluent (2%). Tritium removal is not proposed for immediate implementation due to the current lack of plant-scale, feasible (technically and economically) treatment systems. In addition, the PUREX ammonia scrubber discharge will be eliminated in 1996 when PFM becomes operational.

Current DOE policy requires that tritium discharges be ALARA (DOE 1981). The DOE policy imposes a tritium concentration guide in water released to the offsite environment; this DOE concentration guide is met at the Hanford Site boundary without treatment.

The most conceivable method for control of tritium from the Hanford Site facilities would require the following steps:

- Improvement of fuel handling technology to reduce any tritium release due to breakage of fuel
- Extensive modification of PUREX to recycle all tritiated effluents
- Application of isotopic separation technologies.

If technically feasible, these steps would reduce the tritiated waste water to a volume that could practicably be stored or disposed. The required technologies have not been demonstrated out of the laboratory and, therefore, are not considered currently available or feasible for the PUREX process.

The cost for this tritium control technology, if found to be feasible, is expected to exceed $100 million for the PUREX recycle and isotopic separation steps alone. The total cost of tritium removal is expected to be far in excess of $100 million; no costs are currently available for the N Reactor modifications, support facilities (buildings and utilities), or storage or disposal of the concentrated tritium-contaminated waste.

Given that if tritium removal through treatment is not economically or technically feasible, three alternatives, all of which would meet offsite dose limits, remain for the management of tritiated waste water:

- Discharge to the soil column with subsequent release to the onsite aquifer
- Volatilization of tritium with subsequent airborne release
- Direct discharge to the Columbia River.

Discharge to the soil column is preferred to volatilization and direct discharge to the Columbia River because groundwater travel time under the Hanford Site is slow and allows time for decay before any groundwater enters the Columbia River. Because of tritium's relatively short half-life (approximately 12 yr), soil discharge offers an advantage to air discharge. For instance, groundwater travel time from PUREX to the Columbia River has been measured at ~ 23 yr, or two half-lives of tritium. This represents a reduction in tritium concentration by a factor of 4. Once in the river, tritium is quickly diluted.

Volatilization and airborne release of tritium could result in a dose to an offsite individual of up to 1 mrem/yr. Soil discharge results in a much lower dose because the unconfined aquifer beneath the Hanford Site is not used for community water supply and because of the dilution provided by the Columbia River. The necessary facilities for volatilization (evaporation) could cost several hundred million dollars.

The strategy for tritium entails further technology evaluation to investigate plant-process-scale tritium removal techniques. This effort is planned to take place through 1995. Tritium removal facilities would be planned for implementation beyond 1995 if the development effort results in an economically and technically feasible treatment system for Hanford Site effluents.

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4.0 ALTERNATIVE TREATMENT AND DISPOSAL TECHNOLOGIES

The replacement of soil column disposal practices for contaminated effluents on the Hanford Site requires the selection and implementation of treatment and disposal technologies (fig. 4). The application of treatment and recycle technologies will result in the generation of a treated stream that is suitable for recycle back to the process or discharge to the environment. The separated contaminants will undergo additional concentration and solidification prior to disposal.

The following sections discuss the alternative technologies available for the treatment and disposal of contaminated effluents. Also presented is a discussion of the reference technologies that were selected for the preliminary cost estimates presented in this plan.

4.1 TREATMENT AND RECYCLE METHODS

The following general approaches were considered for the treatment of the liquid discharges:

- Facility and process modifications to prevent or minimize the introduction of contaminants into the effluent
- Closed-loop recycle systems to return water and process chemicals back to the process
- End-of-pipe treatment systems to separate and concentrate the contaminants from the effluent prior to reuse or discharge.

In many applications, these approaches will be used in various combinations to produce an optimal system. The implementation of a disposal system requires a thorough evaluation of technologies used in each approach and design of an integrated system.

4.1.1 Facility and Process Modifications

Facility and process modifications to upgrade older plant systems prevent or minimize the introduction of radioactive and chemical contaminants to the stream. All Hanford Site reactor and chemical processing facilities were built using design standards and technologies that were in effect at the time of construction. These standards and technologies were different than would be applied today to the design of a new facility. In many cases, existing facilities may not easily accommodate the upgrades.

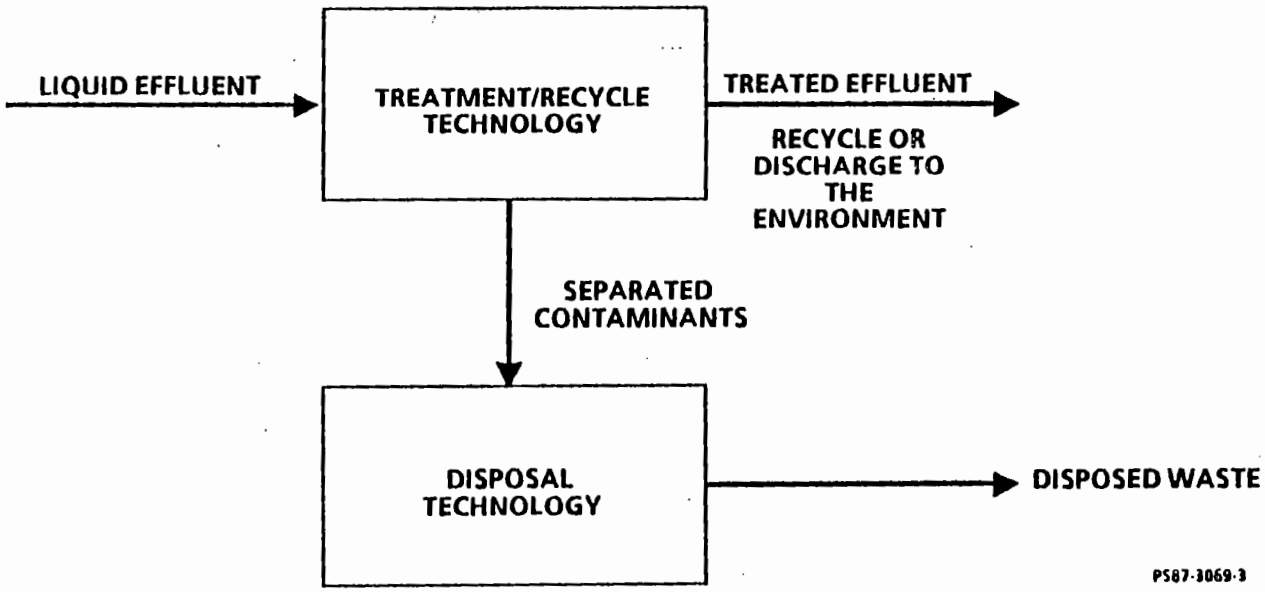

Figure 4. Alternate Disposal System.

The following is a list of process and facility modifications that are available and being considered for application at the Hanford Site:

- Waste minimization and chemical substitutions
- Process control improvements
- Process equipment upgrades
- Process flow sheet modifications
- Process operation administrative controls and procedural modifications
- Process upset and spill control and containment upgrades.

It is possible, in some instances in Hanford Site facilities, that much of the contamination present in a given stream results from a specific unit operation or piece of process equipment that contributes a relatively small amount of the total volume of the effluent. In these cases, upgrades or segregation of the specific unit operation or piece of equipment may result in a very significant overall contaminant reduction. This type of upgrade may not achieve the full contaminant reduction achievable with closed-loop or end-of-pipe treatment systems; however, a large fraction of the total reduction may be achieved at a small fraction of the cost. While these types of upgrades have not been thoroughly evaluated at this time, they will be considered in the engineering and conceptual design studies leading to project implementation.

4.1.2 Closed-Loop Systems

Closed-loop systems are designed to recycle water and chemicals back into the process. Closed-loop systems greatly reduce the quantity of liquid discharged and prevent the release of small quantities of contaminants that occasionally enter the steam or cooling water systems. Waste water treatment systems are used to remove contaminants which may accumulate in the closed loop. While this type of system may be applicable to Hanford Site facilities that were designed with single-pass or once-through cooling water and steam systems, the design of many of these facilities will not easily accommodate recycle systems without significant process equipment and facility upgrades and some increase in operating personnel exposure to ionizing radiation.

4.1.3 End-of-Pipe Treatment Systems

End-of-pipe treatment systems are designed to collect, separate, and concentrate radioactive and chemical contaminants once they have been introduced into the waste stream. This approach will be required for any Hanford Site facility in which the process flow sheets or facility designs will not

readily accommodate additional in-plant controls and recycle systems. Although these types of treatment systems are typically expensive and increase operating personnel exposure, these systems are operated at the Hanford Site and other DOE sites. Experience gained from current operation of these types of facilities will be used in evaluating further applications.

The treatment operations currently being considered include the following:

- Pretreatment (e.g., flow equalization, filtration, neutralization)
- Evaporation
- Chemical treatment (e.g., precipitation, flocculation)
- Ion exchange and adsorption
- Membrane processes (e.g., reverse osmosis, ultrafiltration).

Additional technologies may be identified during the detailed engineering and design studies required for final technology selection.

4.2 DISPOSAL OF CONCENTRATES SEPARATED FROM LIQUID EFFLUENTS

Work is currently underway at the Hanford Site to develop and implement a waste disposal technology for low-level radioactive and chemical wastes. This technology utilizes solidification of contaminated waste with cement and other additives to produce a physically and chemically stable waste form that is suitable for near-surface disposal in high-integrity vaults. Vault design includes double liners and leachate collection, groundwater monitoring, and an engineered surface barrier as required under RCRA. Application of this technology is the most viable approach to disposal of the contaminants that are separated from the effluent streams. Two approaches are available for application of this technology: a decentralized solidification system for individual treatment systems, and a centralized solidification system to collect wastes from several treatment systems.

4.3 DISPOSAL OF TREATED LIQUID EFFLUENTS

Alternatives considered for the disposal of the treated effluents following application of alternative treatment and disposal systems include complete recycle and reuse (i.e., zero discharge), discharge to the soil column, and discharge to the Columbia River. The implementation of the alternative systems described in the previous sections will significantly reduce the volume of liquid effluents; however, they will not result in zero discharge. While the total recycle and reuse or zero discharge alternative is a goal of the CWA, it is not a BAT economically achievable requirement nor is it a practice commonly achieved by industry in general or at other DOE sites.

The discharge of treated liquid effluents directly to the Columbia River, as permitted under NPDES, is not considered practical or desirable for most Hanford discharges for two reasons. Most Hanford effluents are generated in the 200 Areas, which are located approximately 7 to 12 mi from the Columbia River. Discharge to the unconfined aquifer via the soil column allows additional time for radioactive decay prior to offsite release. As a result, direct discharge to the Columbia River would increase calculated dose to the offsite population. In addition, a significant cost would be incurred in transporting these effluents for discharge directly to the river. Therefore, discharge to the soil column is preferred for disposal of minimized volumes of treated effluents following application of BAT alternative systems.

4.4 SELECTED ALTERNATIVE TREATMENT AND DISPOSAL TECHNOLOGIES

A preliminary technology selection has been completed for each of the six effluent categories to provide a basis for the cost estimates and schedules presented in this plan. The selected technologies are state of the art, expected to meet or exceed BAT guidance, and are appropriate for site planning purposes. The selected technologies, however, are not necessarily the most cost-effective technology for a given stream nor has a BAT analysis been performed to determine whether the effluent reduction achieved justifies the cost involved or whether further treatment may be required. Stream-specific engineering and conceptual design studies, consultation with regulatory agencies, and the NEPA process will be required to make final technology selections, prepare project cost estimates, and determine cost effectiveness of the selected technology.

The selected technologies for each of the six Hanford effluent categories and the final disposal system include:

- An end-of-pipe treatment system for the N Reactor effluent. Beginning in 1984, engineering studies were initiated for stream characterization and an evaluation of alternative technologies for treatment. Following these studies (1985 to 1986), an extensive conceptual design for full treatment was performed using available technologies including flow reduction, source-term reduction, filtration, and ion exchange (UNC 1986b). With the determination that the N Reactor will discontinue operation in 1995, a reduced scope that excludes the ion exchange portion was determined to be economically viable and design of this project is underway (Bechtel 1986).

- In-plant and process modifications for the laboratory and chemical sewers. Modifications will be stream-specific and are expected to include process control improvements, flow sheet modifications, waste minimization, and spill control and containment systems. Administrative systems are in place to prevent and control chemical spills and other discharges. These upgrades provide

additional engineered controls to prevent the nonroutine discharge (e.g., spills) of regulated or reportable quantities of chemical and radioactive substances

- An end-of-pipe treatment system for the process condensates. This system includes filtration to remove suspended solids, and reverse osmosis and ion exchange to remove dissolved chemicals and radioactivity

- An end-of-pipe treatment system for the laundry waste water. This system is based on the design of a new laundry facility. The treatment system includes filtration to remove suspended solids and ion exchange to remove radioactivity

- A closed-loop system for the cooling water effluents. This system includes use of two loops: the primary loop supplies the cooling water to the facility and dissipates the heat to the secondary loop via a heat exchanger, and the secondary loop releases the heat to the environment via a cooling tower. A portion of the primary loop is continually treated with filtration and ion exchange to control the buildup of chemicals and radioactivity

- A closed-loop system for the steam condensates. This system uses a reboiler to recycle the condensates back to the facility. Blowdown from the reboiler is routed to the process condensate treatment systems to control chemicals or radioactivity that may contaminate the steam system

- A waste solidification and land disposal system for separated contaminants. This system uses Hanford Site waste grouting and land disposal technology currently being developed.

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5.0 PRIORITIZATION

A two-phased prioritization system is used to determine stream priority and establish the implementation schedule. Phase I streams are considered higher priority and are scheduled first. The criteria used in this prioritization system are based on the effluent disposal criteria previously discussed in section 3.1. The following specific criteria are used to identify Phase I streams:

- The liquid effluent exhibits hazardous waste characteristics or receives RCRA-listed hazardous wastes
- A significant potential exists for the liquid effluent to receive CERCLA-reportable quantities of chemical or radioactive substances
- Best currently available data indicate that the liquid effluent contains radioactive substances in excess of the DCG. The DCG are based on a 100-mrem effective dose equivalent.

Each stream is evaluated with respect to each of the prioritization criteria and assigned a Phase I ranking if currently available data indicate that chemical or radioactive substances in the effluent exceed or potentially exceed the specific quantitative levels. Assignment of a Phase I for any of the criteria results in the stream being given a Phase I priority ranking. The remaining streams are considered lower priority and are scheduled for implementation during Phase II.

The concentrations and quantities of radioactive and chemical substances contained in the prioritization criteria are derived by the DOE or EPA from consideration of health, safety, and environmental risks. Use of these criteria, therefore, results in a risk-based prioritization and an implementation schedule that maximizes the near-term benefit from use of limited resources.

The results of the stream prioritization are summarized in table 2. The prioritization process has identified 16 Phase I streams and 16 Phase II streams. The prioritization of these streams is based on the best currently available information and may be revised as additional information is collected. All effluents discharged in close proximity to the Columbia River are assigned to Phase I from consideration of effluent characteristics and, therefore, the location of the discharge will have no additional impact upon the stream priority.

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Table 2. Prioritization Summary.

Waste stream[a]	Prioritization criteria			
	Hazardous waste characteristic	Potential to receive reportable substance discharge	Radionuclide concentration	Overall priority
B Plant process condensate	—	—	Phase I	Phase I
PUREX ammonia scrubber discharge	—	—	Phase I	Phase I
AY, AZ steam condensate	—	—	Phase I	Phase I
N Reactor effluent	—	Phase I	Phase I	Phase I
PUREX process condensate	—[b]	Phase I	Phase I	Phase I
UO_3 Plant process condensate	—[b]	Phase I	Phase I	Phase I
PFP waste water	—	Phase I	Phase I	Phase I
PUREX chemical sewer	—	Phase I	—	Phase I
UO_3 Plant waste water[c]	—	Phase I	—	Phase I
B Plant chemical sewer	—	Phase I	—	Phase I
222-S Laboratory sewer	—	Phase I	—	Phase I
2101-M Laboratory sewer	—	Phase I	—	Phase I
300 Area process sewer	—	Phase I	—	Phase I
T Plant waste water	—	Phase I	—	Phase I
100-D Laboratory waste water	—	Phase I	—	Phase I
209-E Laboratory sewer	—	Phase I	—	Phase I
B Plant steam condensate	—	—	—	Phase II
PUREX steam condensate	—	—	—	Phase II
242-A process condensate	—	—	—	Phase II
Laundry waste water	—	—	—	Phase II
PUREX cooling water	—	—	—	Phase II
242-A steam condensate	—	—	—	Phase II
A Tank Farm cooling water	—	—	—	Phase II
S Plant waste water	—	—	—	Phase II
B Plant cooling water	—	—	—	Phase II
242-S steam condensate	—	—	—	Phase II
242-A cooling water	—	—	—	Phase II
244-AR Vault cooling water	—	—	—	Phase II
T Plant cooling water	—	—	—	Phase II
200 East Area Powerhouse cooling water	—	—	—	Phase II
200 West Area Powerhouse cooling water	—	—	—	Phase II
400 Area cooling water	—	—	—	Phase II

[a]Waste streams listed by decreasing radionuclide concentration.

[b]Stream exhibited low pH during 1986. Neutralization systems have been implemented and are being upgraded.

[c]UO_3 Plant waste water chemical sewer upgrades are Phase I priority. The cooling water and steam recycle projects are Phase II.

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6.0 COST AND SCHEDULE SUMMARY

This section presents a summary of the rough-order-of-magnitude (ROM) cost estimates for the selected treatment and disposal systems. Also contained in this section are the proposed implementation schedules for the alternative disposal systems.

6.1 COST ESTIMATES

A range of capital costs is presented for each project associated with the alternative technologies. This range is provided to account for uncertainties in the criteria used to develop the estimates, and undefined facility modifications that may be required to support the projects. Most of these cost estimates are not based on formal engineering studies and must be considered as preliminary. The estimates are considered to be sufficiently accurate for long-term planning. Specific project authorization, however, will require completion of engineering and conceptual design studies. An estimate of the required expense support is also presented for each project. This funding is required to support stream-specific and facility-specific engineering studies that will define the technical bases and capital funding requirements. Estimated costs are in FY 1989 dollars except for those expenditures planned for 1987 and 1988, which are in 1987 and 1988 dollars (schedule is discussed in section 6.2).

6.1.1 Phase I

Phase I implementation includes effluent treatment for Phase I priority streams and the final disposal system. The total estimated capital cost for Phase I implementation ranges from $120 to $160 million with $28 million in expense support.

6.1.1.1 Effluent Treatment. The ROM cost estimates for treatment of the 16 Phase I effluents are contained in table 3. The total estimated capital cost for all Phase I streams ranges from $73 to $102 million with an additional $21 million in e pense support. Eight of the effluents are laboratory and chemical sewers. The remaining eight streams include:

- N Reactor effluent
- PUREX process condensate
- PUREX ammonia scrubber discharge
- B Plant process condensate
- UO_3 Plant process condensate
- AY, AZ Tank Farm steam condensate

Table 3. Rough-Order-of-Magnitude Cost Estimates for Phase I Effluents.

Waste stream	Estimate range (millions of dollars) capital		Expense support
	Low	High	
Process condensates			
B Plant process condensate	12	18	2.0
PUREX ammonia scrubber discharge	a	a	a
PUREX process condensate			
Neutralization	0.7	0.7	0.2
Treatment system	13	19	2
UO_3 Plant process condensate			
Neutralization	0.5	0.5	0
Treatment system	13	19	2
Subtotal	39	57	6.2
N Reactor effluent			
Treatment System	15	15	3.3[b]
Subtotal	15	15	3.3
Other waste streams			
AY, AZ steam condensate	0.5	1	0.2
PFP waste water	7	11	0.66
Subtotal	8	12	0.9
Laboratory and chemical sewers			
PUREX chemical sewer	1.0	4.0	3.4
UO_3 Plant waste water (chemical sewer)[c]	0.7	0.7	0.4
B Plant chemical sewer	4.6	6.9	4.2
222-S Laboratory sewer	0.4	0.6	0.2
2101-M Laboratory sewer	0.1	0.2	0.1
300 Area process sewer	3.5	3.5	0.1
T Plant waste water	0.9	1.4	0.1
100-D Laboratory waste water	0.1	0.2	0.1
209-E Laboratory sewer	0.1	0.2	0.1
Subtotal	11	18	8.7
Miscellaneous expense tasks subtotal	--	--	2
Total	73	102	21

[a]PFM will eliminate this effluent in FY 1996. A treatment system for this effluent is estimated to cost between $12 and $18 million.

[b]Partial support, $2.2 million spent in prior years.

[c]UO_3 Plant waste water effluent chemical sewer upgrades are Phase I priority; the cooling water and steam recycle project is a Phase II upgrade.

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- UO_3 Plant waste water
- PFP waste water.

The estimated capital costs for the N Reactor effluent treatment ($15 million) represent a project, which will achieve significant contaminant reduction, can be implemented more rapidly, and are based upon the plan to discontinue N Reactor operation in 1995.

The estimated capital costs for the sum of the three process condensate treatment systems range from $39 to $57 million (including neutralization). Expense support costs for those projects are estimated at $6.2 million.

The PFM project is scheduled to be completed in January 1994 and become operational in FY 1996. This project will enable fuel to be prepared for processing by use of a shear-leach process in lieu of the PUREX zirflex chemical fuel dissolution process and would eliminate the PUREX ammonia scrubber effluent. In the event the PFM project is significantly delayed, not funded, or does not process N Reactor fuel, the capital cost for implementing Phase I would be increased by $12 to $18 million to accommodate treatment of the ammonia scrubber discharge.

The estimated capital cost for the PFP waste water stream is $7 to $11 million with $0.66 million in expense support. The estimated cost for the AY, AZ steam condensate is $0.5 to $1 million with $0.2 million in expense support. A facility modification is planned for 1987 that may reduce or eliminate the need for this project. The UO_3 Plant waste water stream is an effluent that consists of a combination of several types of waste, including chemical sewer, cooling water, and steam condensate components. The chemical sewer related upgrades involving spill control and containment to prevent the release of CERCLA-reportable quantities of hazardous substances are considered Phase I upgrades with an estimated capital cost of $0.7 million and $0.4 million in expense support. Upgrades to address the cooling water and steam condensate discharges are considered Phase II and are included in section 6.1.2 and table 4.

The estimated capital cost for the laboratory and chemical sewer streams ranges from $11 to $18 million with $8.7 million in expense support. This estimate consists of a large number of smaller individual projects including capital work orders, capital equipment, and general plant projects.

6.1.1.2 Final Disposal System. Table 5 lists the estimated costs for a system to dispose of the waste streams produced by the treatment systems. This system is predicated on the lack of capacity in existing double-shell tank storage, evaporation, and grout solidification facilities to handle the additional wastes. The need for this system will be periodically evaluated based upon review of the demand placed upon existing storage and disposal facilities by DOE mission requirements. The components of this system

Table 4. Rough-Order-of-Magnitude Cost Estimates for Phase II Streams.

Waste stream[a]	Estimate range (millions of dollars) capital		Expense support
	Low	High	
B Plant steam condensate	5.8	8.7	1
PUREX steam condensate	9.2	14	1.6
242-A process condensate	12	18	2
Laundry waste water	2.4	6	1
UO_3 Plant waste water[b]	22	33	2.7
PUREX cooling water	38	57	6.7
242-A steam condensate	2.2	3.3	0.4
A Tank Farm cooling water	1.4	2.1	0.2
S Plant waste water	c	c	c
B Plant cooling water	17	26	3
242-S steam condensate	d	d	d
242-A cooling water	22	33	3.9
244-AR Vault cooling water	0.9	0.9	0.1
T Plant cooling water	e	e	e
200 East Area Powerhouse cooling water	c	c	c
200 West Area Powerhouse cooling water	c	c	c
400 Area cooling water	c	c	c
Total	130	200	23

[a]Waste streams listed by decreasing radionuclide concentration.
[b]UO_3 Plant waste water chemical sewer upgrades are Phase I priority; the cooling water and steam recycle projects are Phase II upgrades.
[c]No estimates were prepared for these nonradioactive, nonhazardous effluents.
[d]No estimate was prepared for the inactive 242-S evaporator.
[e]Project costs not identified at this time.

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Table 5. Rough-Order-of-Magnitude Cost Estimates for Final Disposal System.

Waste stream	Estimate range (millions of dollars) capital		Expense support
	Low	High	
Final disposal system			
Storage facilities	4.0	6.0	0.7
Waste evaporator	26	26	3.3
Staging facility	4.0	6.0	0.7
Grout facility	13	20	2.3
Total	47	58	7

NOTE: Total system included in Phase I.

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include facilities for the storage of the wastes, a new evaporator, facilities for staging the wastes prior to solidification, and a grout facility for the solidification of the wastes. The capital cost for this system ranges from $47 to $58 million. Expense support costs for this system are estimated at $7 million.

6.1.2 Phase II

The estimated costs for treatment systems for the Phase II effluents are contained in table 4. The estimated capital costs for the Phase II streams range from $130 to $200 million. The expense support costs for those streams are estimated at $23 million.

6.1.3 Cost Summary

Total expense and capital costs for treating all effluents and the final disposal system are summarized in table 6 and range from approximately $300 to $410 million. Annual operating costs following implementation of Phase I and Phase II are estimated at $50 million. The overall level of funding identified in this plan has not been fully included in previous budget planning.

6.2 IMPLEMENTATION SCHEDULE

The proposed implementation schedule for elimination of soil column disposal practices on the Hanford Site is illustrated in figure 5. This schedule includes the following elements:

- Alternative systems to replace soil disposal practices for the Phase I priority effluents will be implemented by the year 1995
- PFM will be operational in FY 1996
- Capital and expense funding will be available and will not delay the projects
- Projects will follow the normal line-item schedule as outlined in DOE-RL Order 5700.2A, Project Management System.

The proposed implementation schedule shows an effluent characterization action during 1987 and 1988 (see section 2.3), which will collect additional radionuclide and chemical constituent data to supplement the existing data base, and may result in changes in stream prioritization. Beyond 1988, routine effluent monitoring data will continue to be collected and supplemental data will also be collected to support specific stream project implementation and to evaluate major changes in process configuration.

Table 6. Phase I and Phase II Rough-Order-of-Magnitude Cost Summary.

	Estimate range (millions of dollars) capital		Expense
	Low	High	
Phase I	120	160	28
Phase II	130	200	23
Total	250	360	50
Annual operating cost (Phase I and II)	–	–	50

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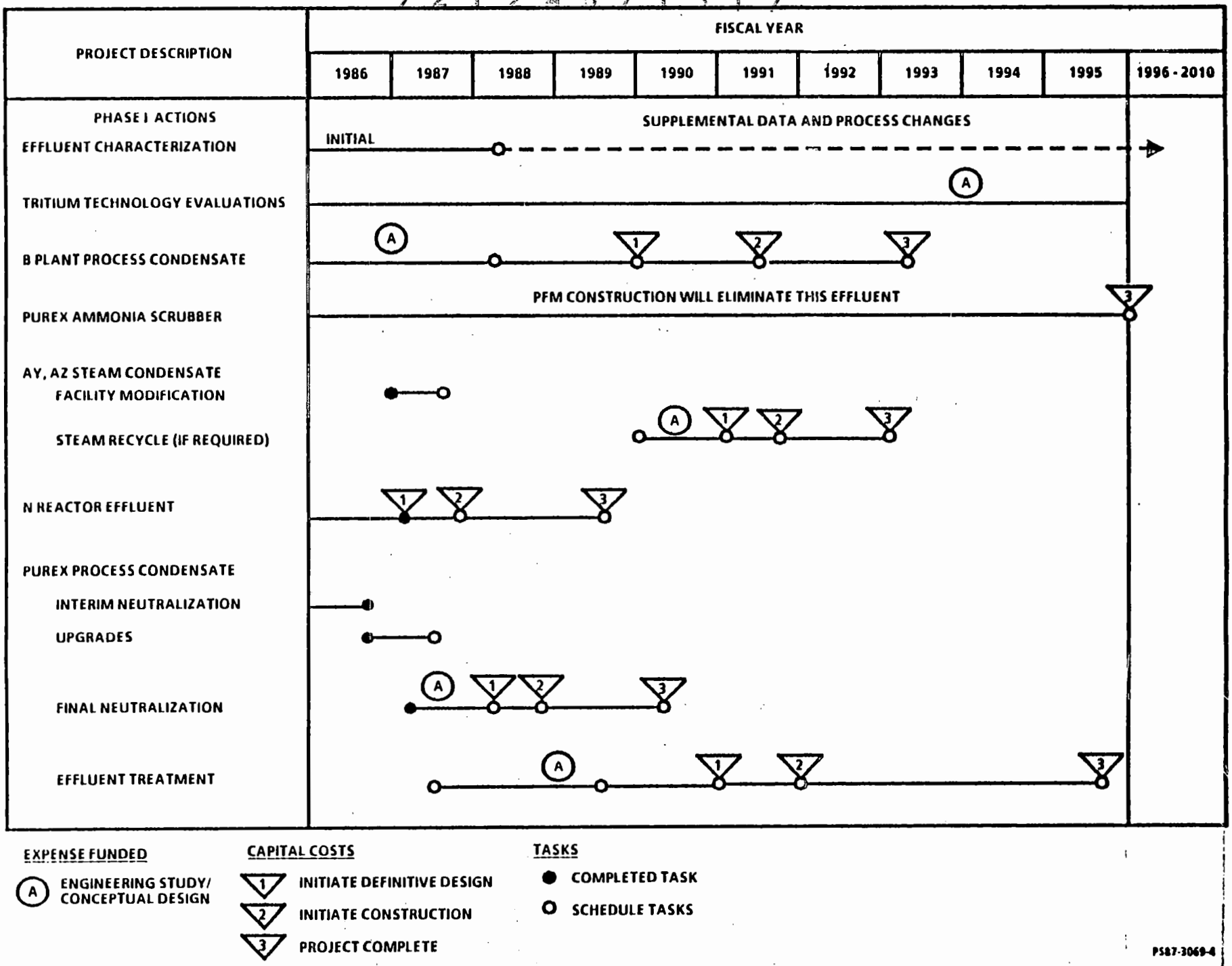


Figure 5. Proposed Implementation Schedule. (sheet 1 of 2)

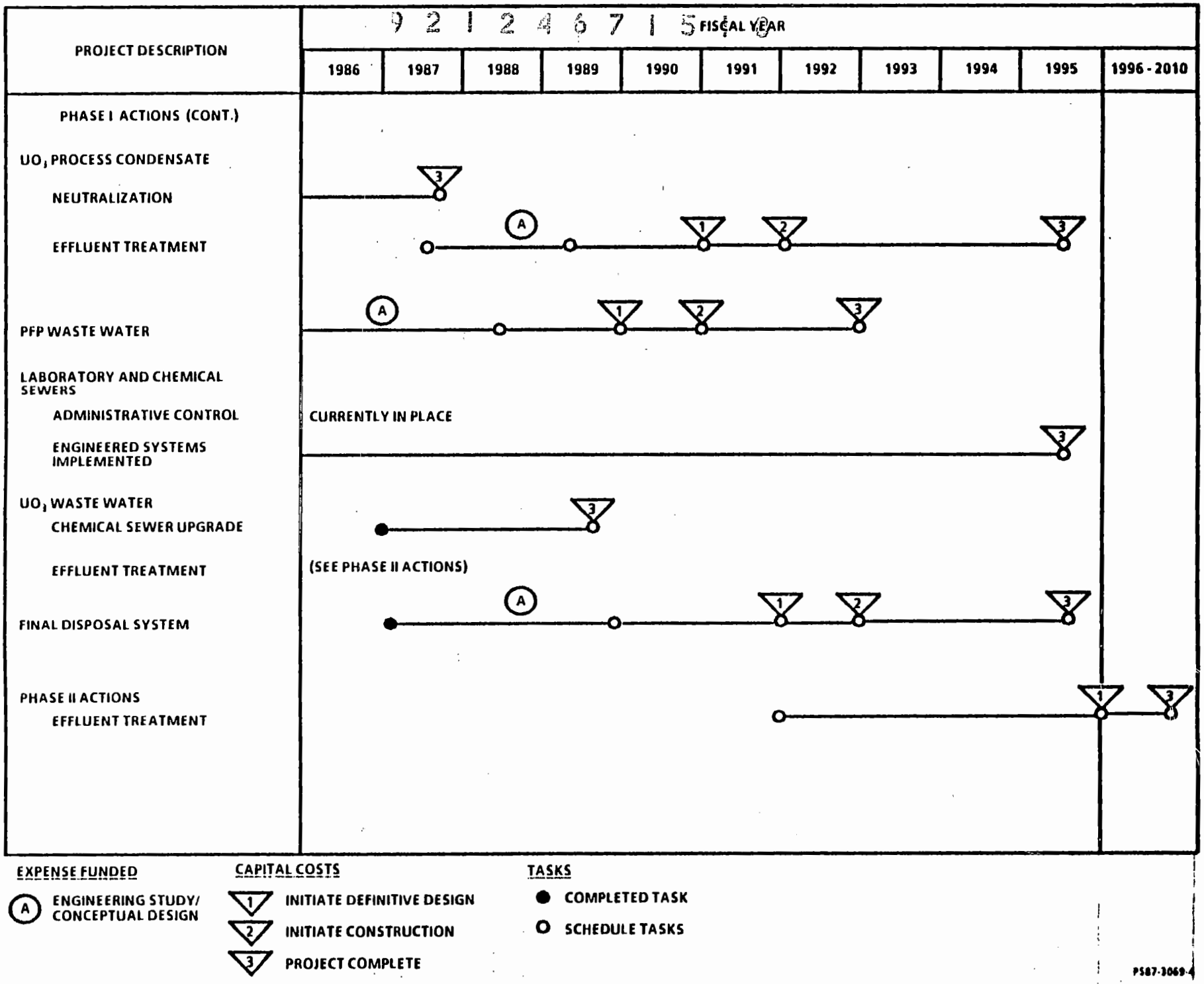


Figure 5. Proposed Implementation Schedule. (sheet 2 of 2)

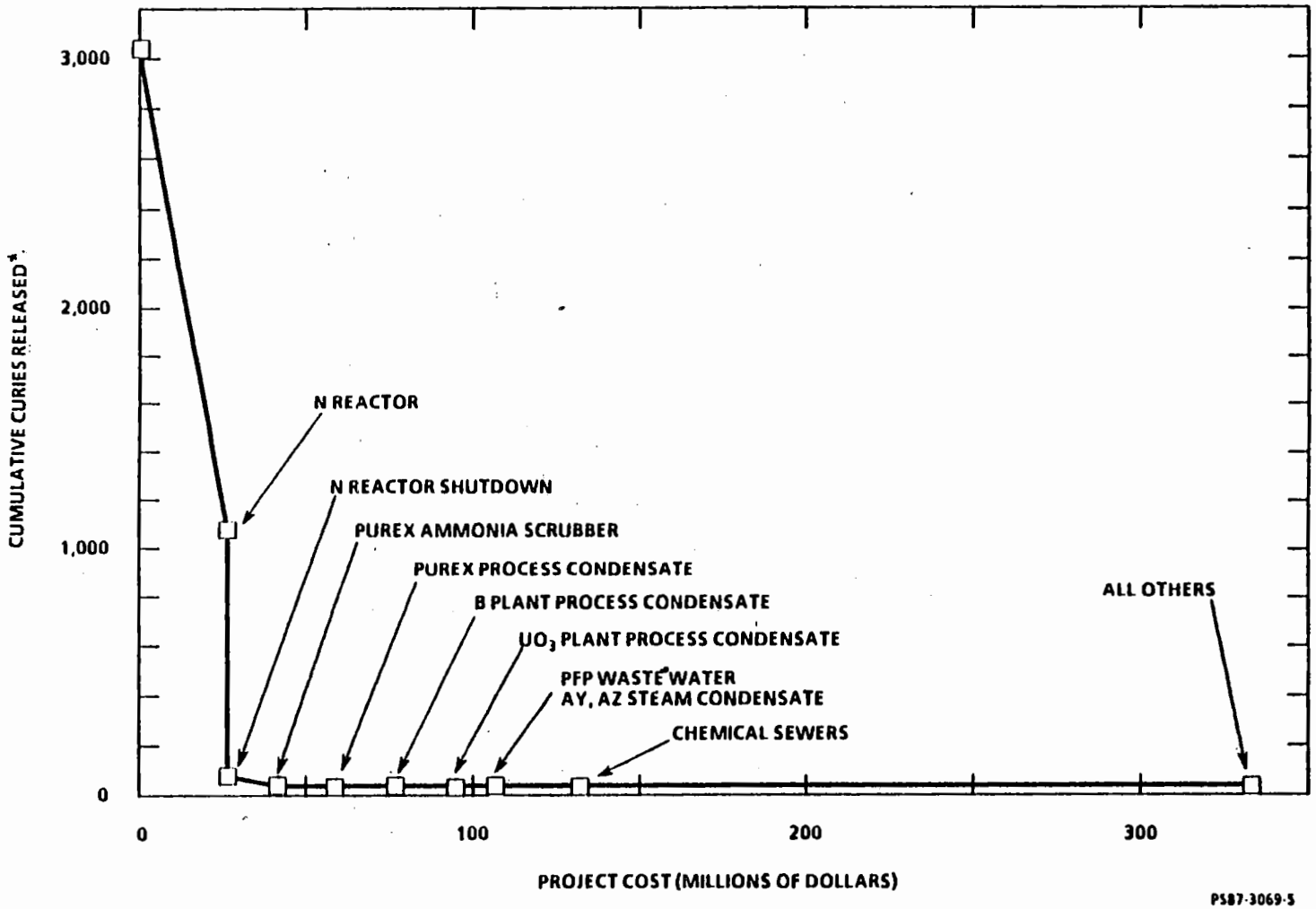
The implementation of various Phase I and Phase II projects will result in different magnitudes of radionuclide and chemical contaminant reduction. The reduction in total curies released as alternative disposal systems are implemented for Phase I streams, assuming a 90% reduction efficiency, is illustrated in figure 6. Total curies discharged, estimated releases after treatment, and estimated costs are summarized in table 7 for individual Phase I projects. N Reactor effluent treatment (costing an estimated $15 million) followed by discontinued operation in 1995 results in the greatest reduction: about 98% of the total curies discharged to the soil column. Effluent treatment or elimination of the four process condensate streams (including ammonia scrubber discharge) located in the 200 Areas account for most of the remaining 2% at a cost of an additional $39 to $57 million. The total curies released in the remaining 11 Phase I streams and the 16 Phase II streams account for less than 0.1% of the current total curies released. Treatment of these streams is estimated at $150 to $220 million. The expected pattern for the reduction in chemical substances contained in the discharges to soil is illustrated in figure 7, and is based on the expected reduction in nitrate released. Nitrate is the most significant chemical constituent in terms of total quantity of material discharged. The reductions plotted on figure 7 assume a 90% treatment system nitrate reduction efficiency. A similar reduction can be expected for the other chemical species contained in the effluents.

The proposed implementation schedule (see fig. 4) shows the final disposal system complete in 1995. This completion date is later than the completion date for several of the proposed treatment systems. Studies are currently underway to determine the best method to handle the wastes generated by the treatment systems during the period prior to full implementation of the final disposal system. Options that are being reviewed include:

- Commercial waste disposal systems
- Storage until final disposal
- Additional waste minimization technologies
- Mission changes that will reduce waste volumes.

The proposed implementation schedule shows a tritium technology evaluation effort through 1995. Tritium removal and control facilities would be implemented after 1995 if the development effort results in the identification of technically feasible systems.

Table 8 shows the costs by fiscal year for the Phase I actions. The successful completion of these projects requires that the expense and capital funding is available in the identified fiscal year. Should funding delays or reductions occur, it is unlikely that the projects can be completed in accordance with the proposed schedule.



*EXCLUDING TRITIUM AND RADIONUCLIDES WITH HALF-LIVES LESS THAN 45 DAYS.

Figure 6. Curies Released Versus Capital Cost (Estimated From 1985 Release Data).

Table 7. Total Curies Discharged, Estimated Releases After Treatment, and Estimated Costs.

Project	Transuranic and mixed fission products[a] (Ci) (1985)	Estimated release after treatment[a] (Ci)	Estimated capital cost (in millions of dollars)	
			Low	High
Phase I Projects				
B Plant process condensate	6	<0.6	12	18
PUREX ammonia scrubber	47	0	e	e
AY, AZ steam condensate	0.04	<0.004	0.5	1
N Reactor[b]			15	15
Total fission products	26,000	TBD		
Fission products with half-life >48 hours	6,200	2,100[c]		
Fission products with half-life >45 days	3,000	1,000[c]		
N Reactor shutdown		d		
PUREX process condensate	5	<0.5	13	19
UO_3 process condensate	0.007	<0.0007	13	19
PFP waste water	0.06	<0.006	7	11
Chemical sewers	2.1	<2.1	11	18
Final disposal	–	–	47	58
Phase I Totals[f]	3,060	<3.2[b]	120	160
Phase II Projects	6	<0.6	130	200

[a]Half-lives greater than 45 days and excludes tritium.

[b]Curies released following N Reactor project will be eliminated following N Reactor shutdown in 1995, and are not included in total.

[c]Based on preliminary design estimates (engineering analysis and pilot plant data) not included in total.

[d]The estimated 1,000 Ci/yr, released following N Reactor reduced-scope project, will be gradually eliminated following N Reactor shutdown in 1995 and removal of fuel from the N fuel storage basin. Estimated release should approximate zero.

[e]PFM will eliminate this stream.

[f]Totals based on radionuclides with a half-life greater than 45 days.

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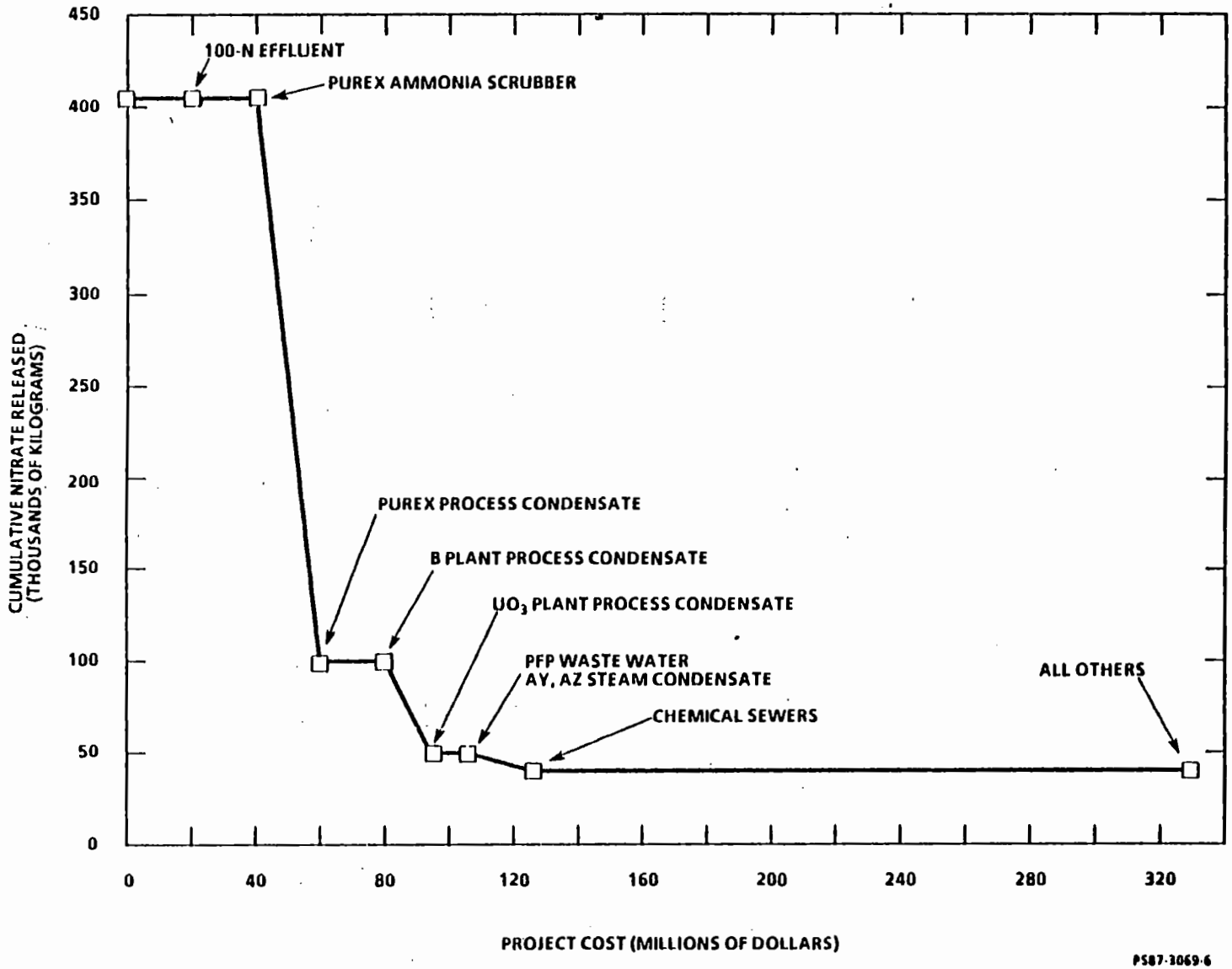

Figure 7. Nitrate Released Versus Capital Cost (Based on 1985 to 1986 Data).

Table 8. Costs by Fiscal Year for Phase I Actions. (sheet 1 of 2)

Project description	Cost (in millions of dollars)				Total
	FY 1987	FY 1988	FY 1989	FY 1990 - 1995	
Effluent characterization					
Expense	0.4	0.2	0.05	0.3	0.95
Capital					
Develop BAT evaluation guidance					
Expense	0.1				0.1
Capital					
B Plant process condensate					
Expense	0.7	0.3	0.2	0.8	2.0
Capital				12 - 18	12 - 18
AY, AZ steam condensate					
Expense	0.01			0.2	0.2
Capital				0.5 - 1.0	0.5 - 1.0
N Reactor effluent					
Expense	2.8	0.2	0.3		3.3
Capital	4.0	5.0	6.0		15
PUREX process condensate					
Neutralization					
Expense	0.1	0.1			0.2
Capital		0.7			0.7
Treatment system					
Expense	0.2	0.4	0.4	1.0	2
Capital				13 - 19	13-19
UO_3 Plant process condensate					
Neutralization					
Expense					
Capital	0.5				0.5
Treatment system					
Expense	0.2	0.4	0.4	1.0	2
Capital				13 - 19	13-19

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Table 8. Costs by Fiscal Year for Phase I Actions. (sheet 2 of 2)

Project description	Cost (in millions of dollars)				Total
	FY 1987	FY 1988	FY 1989	FY 1990 - 1995	
PFP waste water					
Expense	0.1	0.15	0.01	0.4	0.66
Capital				7 - 11	7 - 11
Laboratory and chemical sewers[a]					
Expense	2.3	1.8	0.6	3.6	8.3
Capital	4.8	0.7	1.9	3.3 - 9.3	11 - 17
UO_3 Plant waste water (chemical sewer upgrades)					
Expense	0.09	0.1	0.2		0.4
Capital	0.09	0.0	0.6		0.7
Tritium technology evaluation					
Expense	0.01	0.01	0.01	0.9	0.9
Capital					
Final disposal system					
Expense	0.05	0.1	0.5	6.35	7
Capital				47 - 58	47 - 58
Total					
Expense	7.06	3.76	2.67	14.55	28
Capital	9.39	6.4	8.5	96 - 135	120 - 160

NOTE: Costs in FY 1987 and FY 1988 are in 1987 and 1988 dollars. Costs in FY 1989 and beyond are in FY 1989 dollars.

[a]Additional review in process to identify work being covered.

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