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7. Abstract

This study is an options study for the disposition of the water in the K-East Basin. Several options are discussed, along with the cost and schedule associated with each.

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OPTIONS FOR DISPOSITION OF KE-BASIN WATER
(WHC-SD-SNF-ES-005)

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OPTIONS FOR DISPOSITION OF KE-BASIN WATER

1.0 EXECUTIVE SUMMARY

Several *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) milestones (Section 3.4, below) have been established to ensure that the contaminated water within the Hanford Site's 105-K East Basin (KE Basin) is safely managed and dispositioned. Westinghouse Hanford Company's (WHC) Spent Nuclear Fuel Project (SNFP) is responsible for K Basins. This report provides planning options for selection of the process to treat and dispose of the KE Basin water to support completion of Tri-Party Agreement (TPA) Milestone, M-34-00-T04, "Submit a schedule describing activities for the final disposition of contaminated K-East Basin water for planning purposes to support the 100-KR-4 record of decision."

A related milestone, TPA M-34-01, requires that action begin in September of 1996 to lower the basin water's tritium concentration, unless project planning supports removal of all fuel and sludge from the basin early in 1999, which it doesn't. The goal of this action is to achieve a factor of ten reduction in the basin water's tritium concentration by removing (or otherwise processing) at least two basin volumes of tritium contaminated water per year. Once that goal has been achieved, reduced capacity operations will continue (as required) to maintain the concentration within acceptable limits.

Six options have been identified which encompass the range of alternatives for processing and/or disposing of KE Basin water.

0. Continue current basin water-treatment operations (as required) to store the fuel safely, support fuel and sludge removal activities, and prepare basin for turnover

1. Treat water at KE Basin, then dispose at 100 K Area via river discharge or evaporation pond

2. Treat at KE Basin, transport to the 200 Area C-018 Effluent Treatment Facility (ETF), and dispose in the 200 Area's State Approved Land Disposal Site (SALDS)

3. Transport to the 204-AR Unloading Facility, treat at the 242-A Evaporator, and at ETF, then dispose to SALDS

4. Option 2 or 3 above, followed by detritiation at ETF, prior to disposal in SALDS

5. Treat only that water behind the construction joint barrier (approximately 10 % of the basin volume) and dispose via options 1, 2, or 3

Option 0 would be the most cost-effective, because only one basin of water would require action to disposition tritium. Option 0 corresponds to an option provided by M-34-01 to defer tritium management/disposal actions until basin deactivation. However, the acceptability of that option is dependent on removal of all fuel and sludge from the KE Basin by early 1999. Because that schedule is not supported by WHC's M-34-00-T03 submittal (WHC-SD-SNF-ES-003), nor by current planning for expedited fuel and sludge removal, a no-interim-action option for tritium would be unresponsive to M-34-01.

Option 1 would eliminate the need for transportation away from K-Basin, which would result in a substantial cost savings over all other non-zero options. However, because that option requires either direct tritium discharge to the river or direct evaporation to the atmosphere, that option is judged highly vulnerable to permitting delays and stakeholder challenges. And based on an anticipated 36 month permitting cycle, Option 1 appears unable to meet the M-34-01 startup deadline (9/96).

Option 2, which is the baseline option provided by M-34-01, is the most cost-effective option that would keep the tritiated water out of the readily accessible environment. The at-basin treatment system would be very similar to the design proposed by Hunacek (September 1994) for Option 1, wherein approximately 15% (4% of average annual throughput) of the discharge stream from one of the basin water cleanup system's ion-exchange modules (IXM) would be diverted through additional ion-exchange and filtration equipment, prior to transporting it to the 200 Area's C-018 Effluent Treatment Facility (ETF).

In Option 3, the water would be treated at the 242-A Evaporator, prior to further treatment at ETF. That precludes the need for treatment at KE Basin, beyond that already afforded at the discharge of the IXM(s). However, any cost savings which accrue from the simplified treatment requirements could be nullified by higher transportation and 200 Area treatment costs. The worst case scenario used for the initial scoping estimate assumes that much of the fixed evaporator costs would have to be borne by this project.

Option 4 would use some future technology at ETF, whereby tritium would be concentrated into a small volume of water for long term storage and decay. Strictly speaking, this is not really a K Basins option at all, because any decision to separate tritium at ETF will be made by the Tank Waste Remediation System (TWRS), not by SNFP. It is included here because it is possible that TWRS might elect, or be forced, to separate tritium some time in the future. No separation costs are shown because there is no way to know what they might be. It should be noted that, although no option is included for at-basin separation of tritiated water from non-tritiated water, such a process could be adopted at any point in the project's life (including operations), depending on the economics and reliability of that process.

Option 5 would only address the water behind the construction joint barrier (approximately 10% of the total basin volume), thereby greatly reducing the cost. This option plainly does not meet the letter of the M-34-01 milestone's wording. It is included in this study because it was not

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available at the time M-34-01 was established, and because it might be viewed by stake holders as a highly cost effective option that is responsive to the milestone's overall intent.

While Options 0, 1, and 5 do not meet the technical and/or schedular requirements of M-34-01, they do provide options for management consideration and stake holder negotiation as the projects for K Basin fuel, sludge, and water remediation evolve. To facilitate selection of an option, this report also identifies logistics, critical path items, needed technologies, and approximate project costs and schedules.

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2.0 PURPOSE

The major thrust of this work is to present K-Basin water treatment options for planning purposes that support M-34-00-T04, in view of recent changes to the physical plant (e.g., the construction joint isolation barrier) and to project planning for removal of the fuel and sludge from the basins.

3.0 BACKGROUND

3.1 FACILITY DESCRIPTION

The KE Basin was constructed during the early 1950s, as an integral component of the 105-K East Reactor building. Similar basins were provided in all Hanford weapons production reactor buildings to receive fuel elements discharged from the reactors and stage them for rail transport to 200 Area fuel reprocessing plants. The 105-K East Reactor began operation in 1955, along with the 105-K West Reactor, its nearby twin. It was shut down in 1971. However, the KE Basin was reactivated several years later to store spent fuel from the N-Reactor and permit its continued operation during outages at the Plutonium Uranium Extraction (PUREX) plant.

The KE Basin is an unlined concrete pool, 38 meters long, by 20 meters wide, by 6 meters deep. The basin contains approximately 5,000 m^3 of water, and provides three fuel storage bays, along with a number of small service bays (typically referred to as "pits"). The basin is provided with an asphaltic membrane lined leakage collection sump under most of its footprint. However, there are several structures which extend past the collection sump, including the construction joint which connects the basin to the main reactor portion of the building. This joint is assumed to be the cause of two incidents during which water is known to have leaked from the basin. A water tight barrier is currently being fabricated to isolate the construction joint from approximately 90% of the water within the basin.

3.2 RELATED STUDIES

A study, initiated in 1993, has been completed that treats water locally (Hunacek, 1994). That study recommended that polishing filtration and additional ion-exchange be used at KE Basin to treat demineralized water drawn from the discharge of an existing basin water cleanup system, followed by disposal at 100 K Area via river discharge or evaporation pond. Several things have changed since then. Provisions are being made to more readily accommodate low level liquid effluents at ETF, and a construction joint isolation barrier is being installed to mitigate potential leaks from the basin pool.

3.3 100-KR-4 INTERIM RECORD OF DECISION

The 100-KR-4 Interim Record of Decision (IROD) Decisional Draft (*Proposed Plan for Interim Remedial Measure at the 100-KR-4 Operable Unit*, DOE/RL-94-113) describes a joint DOE, U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology) plan for interim action to address groundwater contamination at the 100-KR-4 Operable Unit.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) applies to the 100-KR-4 Operable Unit, which was placed on CERCLA's Superfund National Priorities List (NPL) on November 3, 1989 because of soil and groundwater contamination resulting from the past operation of nuclear facilities. [An Operable Unit (OU) is defined as a subset of a larger CERCLA site, which is typically the subject of OU-specific investigations and remedial actions.]

Operable Unit 100-KR-4 is one of four OUs associated with the 100 K Area. Operable Units 100-KR-1, 100-KR-2, and 100-KR-3 address contaminated soil and solid waste disposal sites, while 100-KR-4 addresses contamination in the underlying ground water for the entire 100 K Area. At some point in the future (following completion of requisite studies) 100-KR-4 will be combined with other 100 Area OUs under the 100 Area Aggregate Record of Decision (ROD).

The site history section of the Decisional Draft states that both tritium and carbon-14 were disposed into french drains adjacent to the KW and KE Reactors, and that "...these wastes are a concern because their radioactive emissions could be hazardous to humans and wildlife." The Decisional Draft proposes: (1) continued operation and evaluation of a pilot-scale groundwater treatability system (located at the 100-D/DR Area); (2) further study of groundwater/Columbia River interactions and chromium migration in groundwater; (3) further evaluation of ecological risks through the Columbia River Comprehensive Impact Assessment; (4) continued application of institutional controls; and (5) continued groundwater monitoring.

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3.3.1 Impact of Treatment Options on OU 100-KR-4

With respect to the K Basin water treatment/disposition options which are the subject of this report, none of the options addressed by this report (including Option 1) introduce contamination to the 100-KR-4 OU.

3.4 TRI-PARTY AGREEMENT MILESTONES

Applicable sections of the *Hanford Federal Facility Agreement and Consent Order* (89-10 Rev. 3) are reproduced below:

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TPA Milestone M-34-00-T03 **Due: September 30, 1994**

"Submit an engineering study to determine the feasibility of moving and temporarily storing K-East fuel and sludge (once encapsulated) to the K-West Basin."

TPA Milestone M-34-00-T04 **Due October 31, 1994**

"Submit a schedule describing activities for the final disposition of contaminated K-East Basin water for planning purposes to support the 100-KR-4 Record of Decision."

TPA Milestone M-34-00-T05 **Due: March 31, 1995**

"DOE shall provide a schedule for fuel and sludge encapsulation and contaminated water removal or replacement to ecology and EPA that supports the TPA milestone."

TPA Milestone M-34-01 **Due: TBD**

"Contaminated K-East Basin water will be removed, replaced, or treated. The timing of this action must be coordinated with encapsulation and the cleaning of the residual contamination in the basin and (as noted below) the alternative selection is dependant on the feasibility of moving encapsulated K-East Basin fuel and sludge to the K-West Basin. The contaminated water will be dispositioned in accordance with reasonable available Hanford Site treatment and/or disposal processes and methods, available at the time of this action. Unless a better option becomes available, the water will be trucked to C-018 [ETF] for disposal."

"If the K-East fuel and sludge, once encapsulated, can be moved to the K-West basin (determined through a September 1994 Engineering Study Target Date) the removal and disposal of the contaminated water shall be completed by September 2000. This date is an eighteen month action, starting in March 1999, three months after fuel and sludge encapsulation is completed. If the transfer of encapsulated K-East Basin fuel and sludge to K-West Basin is infeasible, contaminated K-East Basin water will be replaced by fresh water, starting in September, 1996 at a rate of two million gallons/year, and will continue until

such time that the tritium concentration in the basin is decreased and is maintained at or below 300,000 pCi/L (the goal is to reduce the tritium concentration in the basin such that resulting groundwater tritium concentration[sic] meet[sic] drinking water concentration standards, recognizing a lag between basin and groundwater concentrations."

4.0 CRITERIA AND ENABLING ASSUMPTIONS

4.1 TPA M-34-01 CRITERIA/GUIDANCE

- Contaminated KE-Basin water will be removed, replaced, or treated in accordance with reasonable site disposition methods.
- If a better method is not available, the water will be trucked to C-018 (ETF).
- Because current planning does not contemplate removal of fuel and sludge from KE Basin by early 1999, tritium mitigation via "feed and bleed" must begin in September 1996.
- The feed and bleed rate must be at least 7600 m^3/yr (2 million gallons/year) until a tritium concentration of 300,000 pCi/L is obtained, after which time it may be reduced to a maintenance rate.

4.2 OVERALL K BASIN WATER CLEANUP OBJECTIVES

The overall water cleanup objectives for the K Basins are summarized below:

- The water must be purified to the maximum practicable extent before release to the environment.
- The treatment/disposition processes and operations must be cost effective.
- The treatment/disposition processes and operations must minimize interim fixes or be configured to support ultimate disposal of all basin water.

4.3 WORKING ASSUMPTIONS

The following working assumptions have been made to facilitate this options study:

- Tritium in the water represents the major technical challenge. The other contaminants in the water can be filtered out or chemically removed.

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Presently, there are no proven, economic processes currently available for separation of tritiated water from non-tritiated water. Although a promising membrane technology is currently being developed, it is premature to speculate on its success (see Appendix B for details).

- Additional treatment of the water will be needed before it can be accepted at ETF. This will consist of post IXM polishing (filtration and ion-exchange) at KE Basin, prior to batch sampling and shipment.

- Permitting of new and existing facilities or additions to handle the basin water will be crucial to the ability of any given treatment option to support the required schedule.

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5.0 TREATMENT/DISPOSITION OPTIONS

5.1 GENERAL WATER TREATMENT UPGRADES (OPTION 0)

Near term tritium mitigation is not addressed by activities to optimize and/or augment existing water treatment equipment and operations. Nor is it addressed by planning for one-time removal and disposal of the entire basin water inventory, including the tritium, at facility deactivation (beyond 2000). Consequently, these necessary activities are included in this report's null-option (Option 0).

> Continue current basin water-treatment operations (as required) to store the fuel and safely, support fuel and sludge removal activities, and prepare basin for turnover.

The overall goals of the basin water treatment activities are to: (1) maintain radionuclide concentrations (both dissolved and suspended) at levels which present minimal risk to workers, to the public, and to the environment; (2) maintain dissolved ions (including loading from make-up water) at minimal levels to limit fuel corrosion rates and extend the life of ion-exchange media; (3) maintain suspended solids (turbidity) below concentrations which would hamper visibility and create air born contamination; (4) maintain water temperatures as low as possible to further limit fuel corrosion rates; (5) accommodate increased basin contamination during fuel removal activities.

To achieve these goals, various options will be examined during the next year to establish system upgrade designs. These may include the following:

- Addition of online conductivity, turbidity, and other instrumentation to optimize water treatment equipment operation;

- Improved make-up water quality to minimize additional ion loading on the ion-exchange systems;

- Additional filtration to maintain water clarity during fuel and sludge handling operations;

- Additional ion-exchange capacity to maintain water chemistry during fuel and sludge handling operations;

- Bench scale and pilot scale testing to optimize the ratio between anion and cation exchange materials.

5.2 TRITIUM MITIGATION OPTIONS

Despite the broad range of water treatment activities planned for the next several years, the scope of this report is focused primarily on the tritium mitigation activity required by M-34-01. Five tritium specific process options have been identified for near term mitigation and ultimate disposal of tritiated KE Basin water.

1. Treat water at KE Basin, then dispose at 100 K Area via river discharge or evaporation pond

2. Treat at KE Basin, transport to the 200 Area C-018 Effluent Treatment Facility (ETF), and dispose in the 200 Area's State Approved Land Disposal Site (SALDS)

3. Transport to the 204-AR Unloading Facility, Treat at the 242-A Evaporator, and at ETF, then dispose to SALDS

4. Option 2 or 3 above, with additional processing via some future tritium separation technology at ETF. Strictly speaking, this particular tritium separation scenario is not really a K Basins option at all, because any decision to separate tritium at ETF will be made by TWRS, not by SNFP. It is included here because it is possible that TWRS might elect, or be forced, to separate tritium some time in the future. No separation costs are shown because there is no way to know what they might be.

5. Treat only that water behind the construction joint isolation barrier (approximately 10% of the basin volume) and dispose via options 1, 2, or 3

5.2.1 Option 1

Treatment of the water at KE Basin, followed by disposal to the river, or to an evaporator pond (see Figure A.1). This would consist of:

1. Diversion of a small fraction of the deionized water discharge from the recirculating basin water cleanup system Ion Exchange Module(s) (IXM) for treatment;

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2. Further removal of particulates via micro/ultra filtration;

3. Further removal of dissolved radionuclides using a polishing ion exchange system;

4. Disposal to a permitted river discharge or evaporator pond.

5.2.2 Option 2

Treatment at KE Basin and ETF, followed by disposal to SALDS (see Figure A.2). This would consist of:

1. The same KE Basin treatment as described for Option 1;

2. Transportation to ETF;

3. This process would remove the tritiated water from the environment for about a hundred years or more by discharge to SALDS. This would give sufficient time for the tritium to decay to insignificant levels (^{3}H has a 12.3 yr half life).

5.2.3 Option 3

Treatment at the 242-A Evaporator and further processing at ETF (see Figure A.3). This would consist of:

1. Diversion of a small fraction of the deionized water discharge from the recirculating basin water cleanup system IXM(s) for transportation to the 204-AR unloading facility, followed by transfer to the 242-A evaporator;

2. Evaporation, with condensation of the resulting steam;

3. Transfer of condensate to ETF (evaporator bottoms to tank farms);

4. Additional treatment at ETF;

5. Disposal to SALDS.

5.2.4 Option 4

Options 2 or 3, with the addition of some future technology for separation of tritiated water from non-tritiated water at ETF (see Figure A.4).

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5.2.5 Option 5

Treat only the water (roughly 10% of the basin total) behind the construction joint isolation barrier (see Figure A.5). This would consist of:

1. Provision of a small, dedicated, recirculating ion-exchange system to replace the deionized water purge that would otherwise be provided by the main basin water cleanup system (this tritium option precludes discharge of tritium from the main basin into the construction joint side of the insolation barrier);

2. Treat isolated water, using Options 1, 2, or 3.

The installation of the construction joint barrier should largely isolate the main basin water from the environment. Therefore, the environment can be protected by reducing the level of tritium in only the water behind the construction joint barrier. Thus, the tritium in the main basin water need not be addressed until the fuel and sludge are removed from the basin. This approach could reduce the near term volume of water that must be treated by a factor of ten. Assuming one-time removal and disposal of the entire basin inventory at facility deactivation, this option could reduce the total disposal volume by a factor of eight.

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6.0 PLAN FOR OPTION SELECTION

The process for selecting the tritium mitigation and final basin water disposition option begins with submittal of the options and their associated cost/schedule impacts by October 31, 1994 (TPA Milestone M-34-00-T04). Following this, three separate tasks will begin. These include a functions and requirements document, a permitting strategy, an engineering study of the options to support the decision, and a decision matrix. All of these tasks are scheduled for completion during December. An option recommendation letter will be submitted to DOE-RL by December 30, 1994.

7.0 SUPPORTING TECHNOLOGY

There are several activities that are common to many of the tritium mitigation process options:

<u>Removal and Replacement of Basin Water</u>

Water must be removed and replaced with high purity makeup water ("feed and bleed"), or otherwise treated, at the rate of 7600 m^3/year (2 million

gal/year) in accordance with M-34-01. This action would require approximately 2 years to reduce the tritium level by a factor of 10. While feed and bleed operations would still be necessary to accommodate the continued release of tritium to the basin, it should be possible to accomplish this at around 1/4 of the initial rate. However, for the present study, it is assumed that the treatment will continue for ~6 years at the full design rate.

Process Feed

Regardless of the treatment option selected, all basin water that is fed to the tritium mitigation process/operation will consist of deionized water, taken directly from the IXM discharge header of the basin's water cleanup system. This water easily meets the technical acceptance criteria of the 242-A Evaporator for Option 3. For Option 1, however, it will require treatment prior to disposal via river discharge or evaporator pond. Option 2 will also require at-basin treatment prior to transporting the water to the ETF. Table 7.1 compares the ETF's normal acceptance limits to recent, worst case radionuclide concentrations in samples taken from the IXM discharge header. A third column lists the decontamination factors (DF) that must be attained before the water could be accepted at the ETF.

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Support Activities and Facilities

Additional common activities for the options can be divided into two categories. These are on-site (at 100 K Area) activities, and off-site (away from 100 K Area) activities.

- On-site common activities include: makeup water treatment; secondary waste management; and transport on-loading.

- Off-site common activities include: transport to a 200 Area unloading/holding facility such as 204-AR; and treatment/disposal operations at the 242-A Evaporator and/or the C-108 Effluent Treatment Facility (ETF).

TABLE 7.1
ETF FEED REQUIREMENTS VERSUS K-EAST BASIN WATER (μCi/mL)

Isotope	ETF Feed Limit	IXM Outlet	Required DF
H-3	3.0E-02	3.4E-3	None
C-14	2.7E-06	--	
Mn-54	--	3.5E-8	
Co-60	6.4E-05	7.3E-7	None
Se-79	2.9E-05	--	
Sr-90	4.6E-06	2.7E-5	DF > 6
Nb-94	4.8E-05	--	
Tc-99	2.4E-04	--	
Ru-106	2.5E-05	--	
Sb-12	--	6.0E-6	
I-129	2.0E-04	--	
Cs-134	8.0E-05	1.5E-7	None
Cs-137	5.4E-07	3.1E-5	DF > 60
Ce-144	--	--	
Eu-154	--	--	
Eu-155	--	--	
Ra-226	--	--	
U-234	7.2E-08	3.4E-9***	None
U-235	3.5E-09	2.0E-10***	None
U-238	2.6E-08	3.1E-9***	None
Np-237	1.2E-07	--	
Pu-238	3.9E-10	6.5E-7	DF > 1700
Pu-239/240	8.0E-10	3.5E-6	DF > 4500
Pu-241	--	--	
Am-241	3.0E-09	9.0E-7	DF > 300
Cm-244	4.8E-07	--	

*From draft report WHC-SD-ETF-SAR-001.
**From draft report WHC-SD-SNF-ES-001 Table B-1.
***Calculated using isotopic composition from WHC-SD-CP-TI-175.

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8.0 COSTS

The costs for procurement, construction, installation, and operations associated with the K-Basin water treatment options have been estimated from a variety of sources. Most of these are internal Westinghouse Hanford reports and memoranda and were not intended for external release. Nevertheless, this information was used to provide an estimate of the relative costs of each of the options. Where informal information estimates were made. Sufficient information was not available to estimate decommissioning costs of new equipment and installations was not available so they are not included.

The zero option is to leave the water in the K-East Basin until all the fuel and sludge are removed. The remaining water will be used to clean up the walls and floor of the basin. This would mean no cost for water cleanup, and would result in disposal of the smallest volume of water.

Table 8.1 provides a summary of total project costs (less decommissioning) as a function of tritium mitigation process option.

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TABLE 8.1 - COST TO TREAT 7600 m^3 (2M GAL)/YEAR

OPTION	FUNCTIONS		COST FOR 6 YEARS ($M)	
OPTION 1	Treat	Local	Capital	4.01
	Trans	None	Operation	6.70
	Dispose	River	TOTAL	10.71
	Treat	Local	Capital	5.65
	Trans	None	Operation	9.70
	Dispose	Solar Pond	TOTAL	15.35
OPTION 2	Treat	Local	Capital	6.59
	Trans	Truck	Operation	11.34
	Dispose	SALDS	TOTAL	17.93
OPTION 3	Treat	Evaporator	Capital	5.37
	Trans	Truck	Operation	50.89
	Dispose	SALDS	TOTAL	56.26
OPTION 4	Treat	Evaporator or ETF	Same as 2 or 3 above, plus an indeterminate cost for tritium removal	
	Trans	Truck		
	Dispose	SALDS		
	Remove Tritium			
OPTION 5	1a		TOTAL	4.81
	1b		TOTAL	8.69
	2		TOTAL	7.91
	3		TOTAL	10.58

The costs do not include those items associated with current and continuous operation of the site. For example, the current treatment of the basin water to protect personnel and the environment is not included in the cost estimates.

On the other hand, the current cost estimate is grossly conservative because:

(1) The full design capacity throughput of 7600 m^3/year (2 million gal/year) is assumed for operating expenses beyond the second year of operation. Additional work must be performed to establish a realistic estimate of the rate at which tritium will continue to enter the pool from the fuel and sludge, once the concentration has been driven down to the M-34-T04 goal. The results of that study are expected to allow out-year operating cost estimates to be greatly reduced. If additional treatment costs are incurred as the result of tritium release from major fuel moving activities (assuming that tritium mitigation is even justified under those circumstances), those incremental operating costs should be borne by the fuel removal project.

(2) Processing charges are grossly overestimated for some facilities. Despite the fact that those facilities are currently staffed to process waste from other areas, the estimates of the costs provided in Appendix C reflect the total operating cost of the facility, as opposed to the incremental costs associated with the K-Basin water. Additional work must be performed to determine best-estimate, incremental facility charges for each process option before a final option can be selected.

A detailed cost breakdown is provided in Appendix C.

9.0 SCHEDULE

Table 9.1 summarizes the start-design, start-processing, and complete-processing dates for each of the options. A schedule is not included for Option 0, because it does not require tritium processing until facility deactivation. Appendix D provides further detail for the option schedules.

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TABLE 9.1 -- PROJECT SCHEDULE

OPTION	START DESIGN	START PROCESSING	COMPLETE PROCESSING
0	- - - -	- - - -	- - - -
1-a	1995	1998	2003
1-b	1995	1997	2002
2	1995	1996	2002
3	1995	1996	2003
4	1995	1996	2003
5-1a	1995	1998	2003
5-1b	1995	1997	2002
5-2	1995	1996	2002
5-3	1995	1996	2003

The "Start Processing" dates shown in Table 9.1 for some options are not consistent with the schedule required by M-34-01. This is due to the long lead time required to obtain permits. Options 1a, 1b, 5-1a, and 5-1b miss the "Start Processing" date by a year to almost two years.

10.0 PERMITTING

The lead time required to gain approval from the requisite federal, state, and local agencies must also be addressed. In many cases, gaining this approval is a critical path item for startup of water treatment operations.[1] Appendix E provides a detailed listing of the various permits required for discharge of the water to the environment.

[1] Tables 9.1 and 9.2 list the required permits by option, and show which permit is the driving permit.

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TABLE 9.1 - PERMITS REQUIRED BY OPTION

PERMIT	OPTION(S)	TIME NEEDED TO OBTAIN PERMIT (MONTHS)
Modify NPDES Permit	1	36
U.S. Army Dredge and Fill Permit	1	16
Washington Department of Natural Resources, Lease of River Bottom	1	13
Washington Department of Fisheries Hydraulic Project Permit	1	13
U.S. Park Service Review for Wild and Scenic River Act	1	6
EPA NOI and State Water Pollution Prevention Plan for Construction	1	6
Benton County Department Shoreline Development Permit	1	5
DOH, Modify Existing Notice of Construction	1, 2, 3, 4	8
NEPA for ETF to include 105KE Basin	2, 3, 4	18
Modify WAC 173-216 Permit	2, 3, 4	9
Additional SEPA for State Approval of Land Discharge Site	2, 3, 4	18
Delisting Petition for ETF/SALDS Modification	2, 3, 4	18
NEPA for Solar Evaporation	1	12
SEPA for Solar Evaporation	1	12
DOH Notice of Construction for Solar Evaporation	1	24
Groundwater Monitoring Plan (Ecology)	1	12

TABLE 9.2 - DRIVING PERMITS REQUIRED BY OPTION

PERMIT	OPTION	TIME NEEDED TO OBTAIN PERMIT (MONTHS)
Modify NPDES Permit	1	36
NEPA for ETF to include 105KE Basin/additional SEPA for SALDS	2	18
NEPA for ETF to include 105KE Basin/additional SEPA for SALDS	3	18
NEPA for ETF to include 105KE Basin/additional SEPA for SALDS	4	18

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11.0 REFERENCES

Hunacek, G. S. Jr, and S. S. Gahir, 1994, *KE Basin Water Dispositioning Engineering Study*, Draft, WHC-SD-SNF-ES-001, REV. 0, Westinghouse Hanford Company, Richland, Wa.

Krahn, D. E., 1994, *200 Area Effluent Treatment Facility Final Safety Analysis Report*, Draft, WHC-SD-ETF-SAR-001 REV. 0, Westinghouse Hanford Company, Richland, Wa.

Tritium Isotope Separation, Gheorghe Vasaru, CRC Press, 1993.

APPENDIX A

WATER DISPOSITION OPTIONS

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Basin Water Disposal Option 1

Treat and Dispose at 100 K

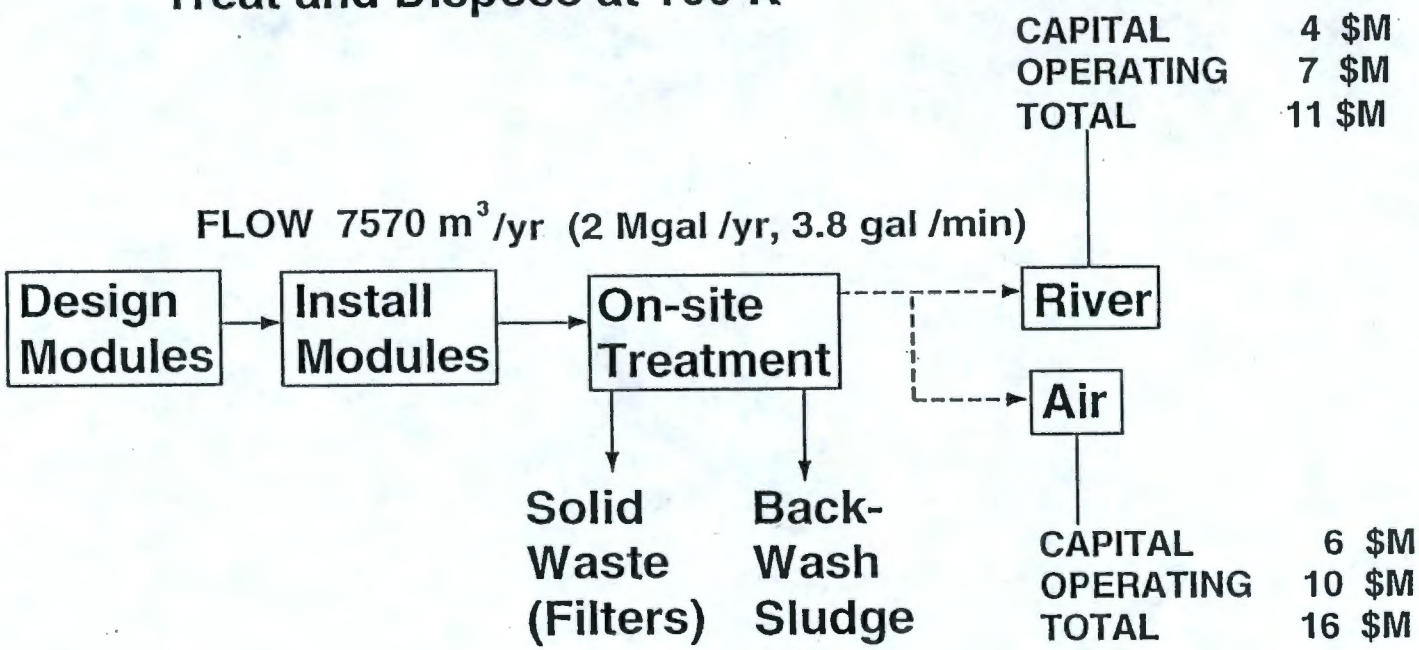

FIGURE A.1

Basin Water Disposal Option 2

Treat at 100 K and Dispose in SALDS

CAPITAL	7	$M
OPERATING	11	$M
TOTAL	18	$M

FIGURE A.2

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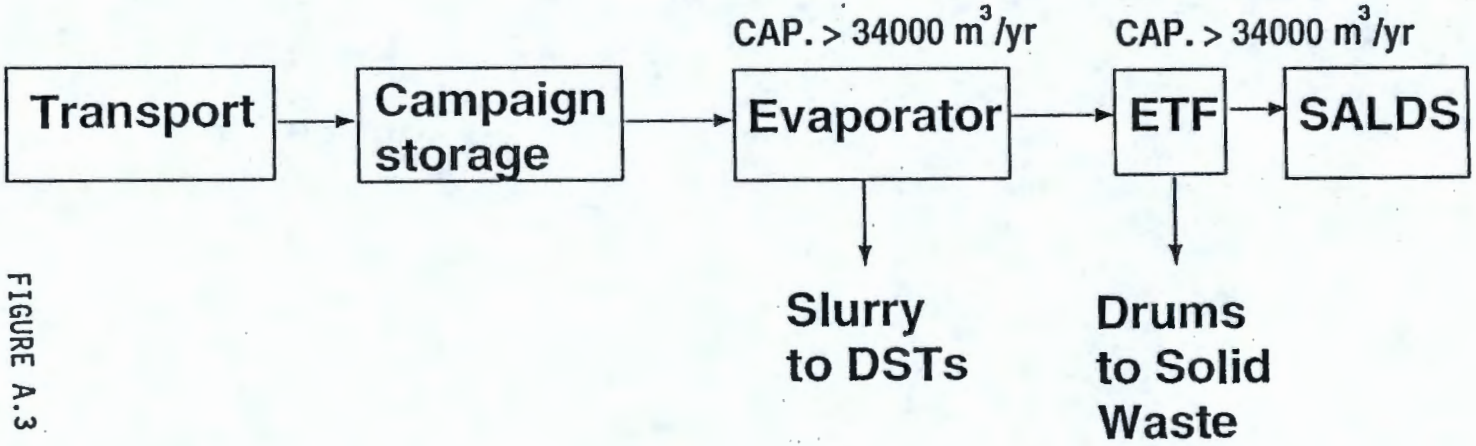
Basin Water Disposal Option 3

Treat at Evaporator and Dispose in SALDS

FLOW 7570 m^3/yr (2 Mgal /yr, 3.8 gal /min)



CAPITAL	5	$M
OPERATING	51	$M
TOTAL	56	$M

FIGURE A.3

Basin Water Disposal Option 4

Treat at Evaporator and De-tritiate

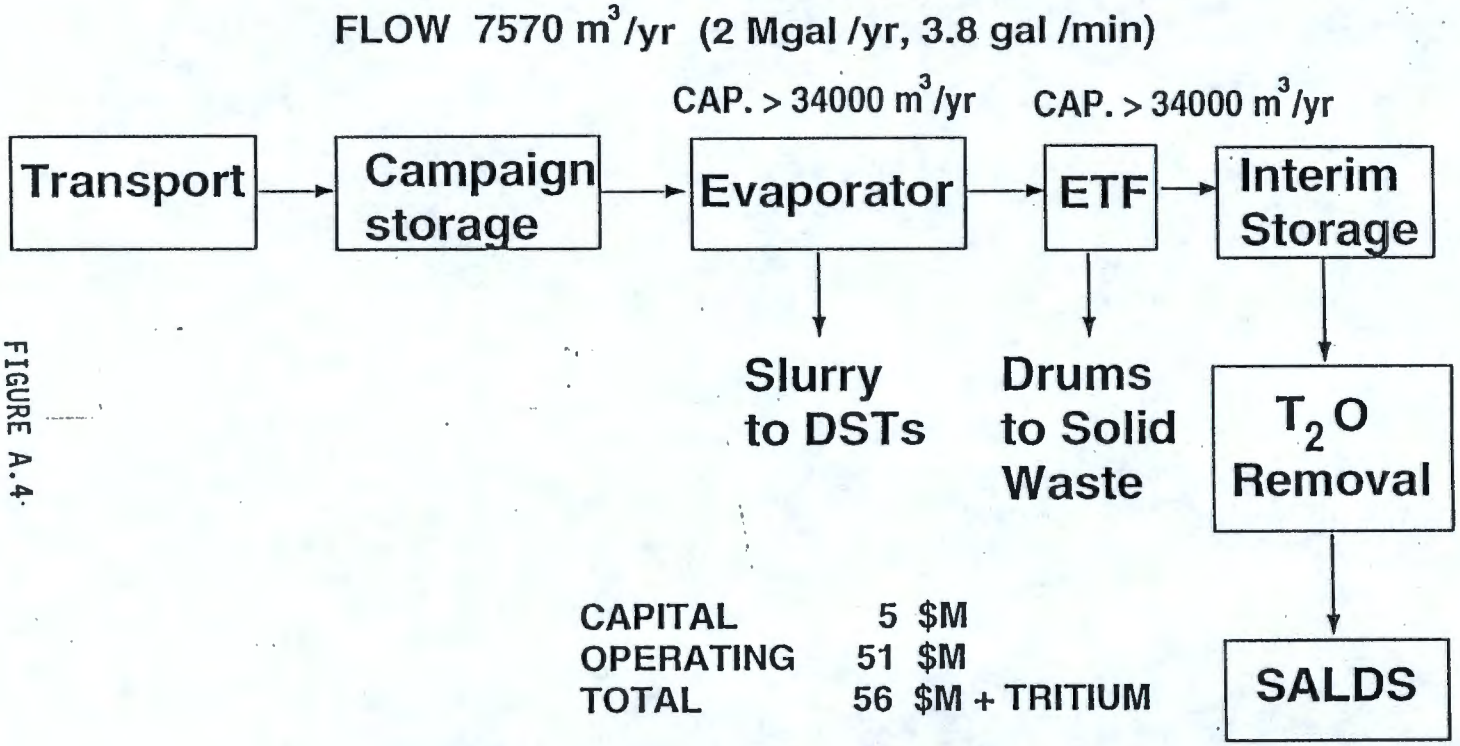


FIGURE A.4

Basin Water Disposal Option 5

Process Water Behind Cofferdam

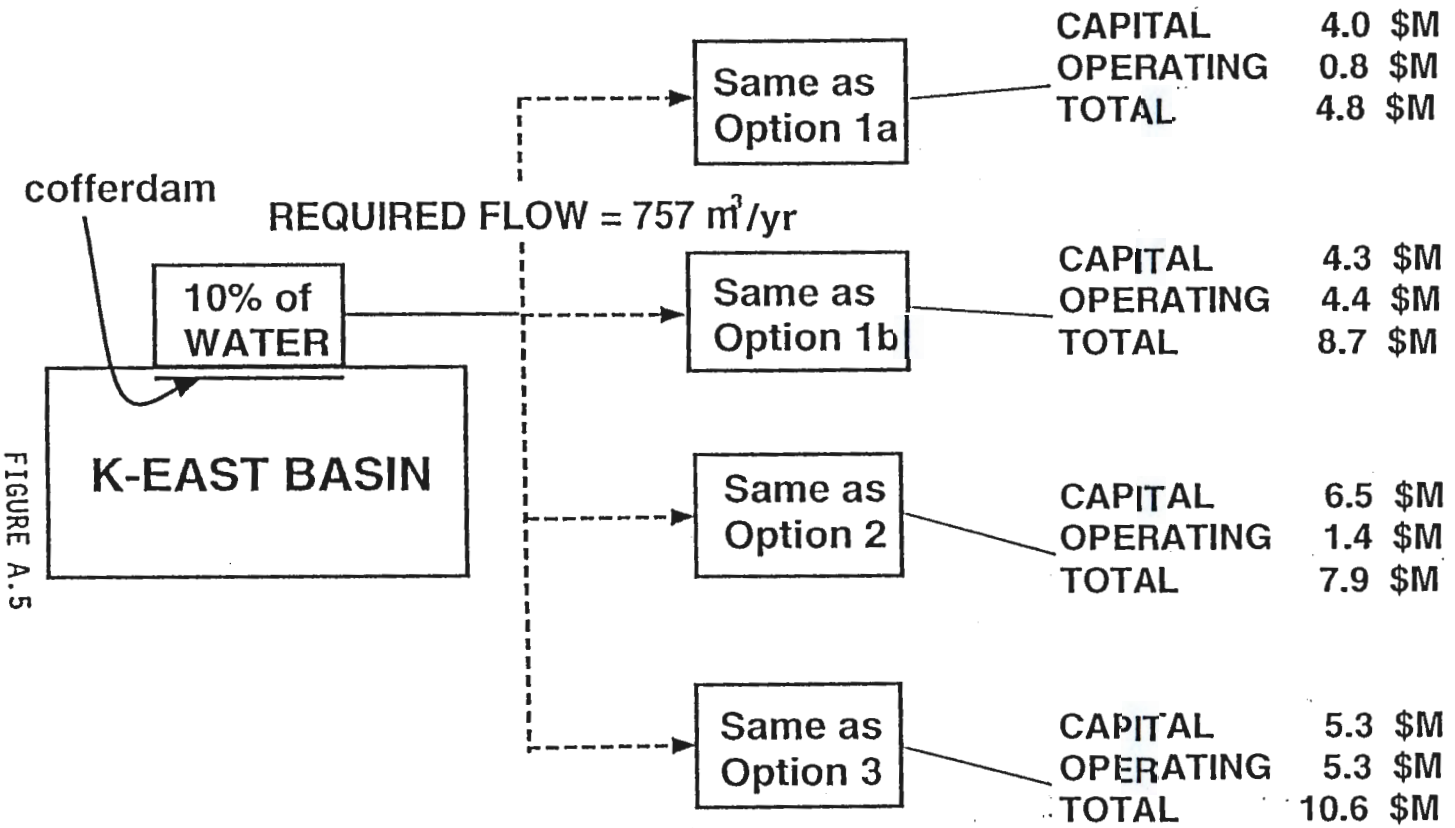


FIGURE A.5

APPENDIX B

SUPPORTING TECHNOLOGY

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B.1 ON-SITE (At KE Basin)

EXISTING BASIN WATER RECIRCULATION SYSTEMS

The basin is served by two separate water recirculation systems. The first system recirculates approximately 9 L/sec (150 gpm) of water through each of the basin's three bays via suction and discharge headers located approximately 2.5 m below the pool's surface. This system is currently operated to provide heat removal only.

A second system (the skimmer system) recirculates an additional 8 L/sec (130 gpm) through each of the three bays via near-surface suction and discharge headers. This system routes its full 25 L/sec (400 gpm) flow through a sand filter, after which a portion of the flow is diverted through IXM(s).

With both of the two available IXMs on line, the total basin ion exchange processing rate is around 20 L/sec (320 gpm). This represents the maximum rate at which basin water can be processed to remove dissolved contamination, irrespective of the overall 53 L/sec (850 gpm) rate afforded by the combined flow of the two basin recirculation systems.

The discharge stream from the existing basin IXM(s) should be more than adequate for Option 3 (treatment at Evaporator 242-A). Basin Operations and Transportation personnel exposure limits can be met with this water, and it should meet the requirements for Low Specific Activity (LSA), thus reducing the requirements for transportation. It would also be possible to remove the water directly from the Basin. The dose rate on the surface of a 5,000 gallon truck tank filled with water taken directly from the basin should be less than 2 mrem/hr. And the dose rate at 2 meters should be less than 0.6 mrem/hr. Therefore, transportation dose requirements could probably be met with untreated water. However, it is doubtful that transportation of water taken directly from the basin (versus transportation of water taken from the IXM discharge header) would result in any significant (or even noticeable) reduction in secondary wastes. Given an annual basin ion-exchange throughput somewhere in the neighborhood of 250,000 to over 600,000 m^3 (depending on the plant factor, and the number of IXMs on line), and an uncertain cutoff point for each spent IXM, the annual 7600 m^3 savings would be lost in the noise. On the other hand, ALARA considerations will argue strongly for taking the water from the basin's IXM discharge header.

PROCESS SPECIFIC TREATMENT EQUIPMENT

If the water is to be treated at the ETF (Option 2) or disposed of on-site (Option 1), it will be necessary to perform additional treatment on the water drawn from the basin's IXM discharge header. Additional micro-filters, polishing ion exchange columns, pumping equipment, and load-out staging/sampling tanks will be required. It is expected that the equipment identified by Hunacek and Gahir (1994) will cover both these options.

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However, it will be necessary to perform treatability testing prior to establishing the design.

MAKEUP WATER DEMINERALIZE

The existing demineralized water system provides a nominal 3/4 L/sec (12 gpm) of makeup water to the basin. If 38 m^3/day (10,000 gal/day) are removed from the basin for treatment or disposal, and this removal takes place during one shift, ~1.3 L/sec (20 gal/min) of makeup water would be required. A new system, capable of supplying ~3.2 L/sec (50 gal/min) should be installed (Hunacek, 1994) to supply this water. This new equipment is required for all process and disposal options that treat the water without draining the basin.

SECONDARY WASTES

If the water is treated on-site, the secondary wastes generated are primarily in the form of used ion-exchange columns and filters. These may be TRU waste, particularly the filters. Consequently, the design must provide column and filters which can be placed directly into in appropriate TRU waste disposal packages. The material accumulating in the existing sand filter is back flushed and retained in the sand filter backwash pit (north load out pit) at the basins. This material contains significant TRUs and will be collected and disposed of with the rest of the sludge on the floor of the basin.

DISPOSAL FACILITIES

There are no known additional on-site facility or equipment requirements if the treated water is disposed of in the Columbia River. Existing piping and the 004 outfall are sufficient to transport the water from the discharge tanks to the river.

If the treated water is to be disposed of by evaporation to the atmosphere, two evaporation ponds and associated piping must be constructed.

TRANSPORTATION TRANSFER STATIONS

If the water is to be transported away from 100 K Area for treatment and/or disposal, facilities to transfer the water from the basin to a transportation system must be available.

If transportation is to be accomplished by tanker truck, a load-out facility must be constructed. This facility will involve concrete pads, piping, pumps, and connections to the basin water. These connections can be made at the end of the existing or new treatment equipment.

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Transportation by rail car will utilize the existing tracks that enter the building by the South Loadout Pit. This location is directly adjacent to the main basin, and only minimal piping need be installed to load the cars if untreated water is to be shipped. If treated water is to be shipped, piping to the existing or new treatment equipment, either directly across the basin or routed around the edges, must be installed.

If a pipeline is used to transport the water to the 200 Area, a terminal connecting to either the Basin or the treatment equipment must be constructed.

B.2 OFF SITE (Away from K-Area)

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B.2.1 TRANSPORTATION

TRANSPORTATION TO TREATMENT/DISPOSAL FACILITY

Several options were considered for transporting the Basin water to treatment or disposal facilities in the 200 Area. Each option can transport either treated or untreated water. The receiving terminal facilities are discussed under OFF-SITE.

Truck/Tank: The water can be transported to the 200 Area using either cargo tank trucks or cab/trailer equipment. No special shielding is required because the radiation levels of the water are low and meet LSA requirements. There will soon be twelve 14 m^3 (3,800 gal) tanks available that could be used. Two could be placed on a 12 m (40 ft) trailer.

Rail Car: There are currently four 76 m^3 (20,000 gal) tank cars on site. However, only one is being used because the other three have radiation problems from solids which remain on the tank bottoms. A new double containment car is currently being purchased for on-site use.

Rail lines exist from the KE Basin to the 242-A Evaporator's receiving facility (204-AR). If the material is to go to the ETF, additional track would be required.

TRANSPORTATION RECEIVING FACILITY

Rail Car: The 204-AR Receiving facility currently exists and can readily handle one rail car per day. The water can be transferred either to the new tank, or to another double shell tank for temporary or long term storage. Before the water can be pumped to a tank, it must be accurately characterized and the pH adjusted. The characterization measurements may be more easily performed at the K-East Basin. With no rail facilities at ETF, if rail cars are used to transport the water directly to the ETF, appropriate terminal facilities would be required.

Tanker Truck: The 204-AR facility can also receive trucks/tankers. Two trucks per day would cause some operational problems because of the requirements for characterization, inspection, certifying the containers for release, and possibly decontaminating the exterior of the containers. Some increase in staffing would be required to handle this number of shipments.

A receiving station for trucks at the ETF is currently being built and is expected to be available by June, 1995.

HOLDING FACILITIES

Water received at the 204-AR facility can be directed to any of the double shell tanks that have the available storage capacity.

The pH of the water will have been adjusted at 204-AR to be compatible with the requirements for the tanks. This storage can be either long term, awaiting tritium removal processing, or short term prior to being processed by Evaporator 242-A. Water destined for direct processing at the ETF will not be shipped to 204-AR. If the water has been characterized sufficiently it could be transferred into the 102-AW evaporator feed tank (~3800 m^3 - 1 million gal).

The reserve capacity in the double shell tanks will be significantly reduced in the late 1990s. ~7600m^3/yr (2 million gallons/year) from K Basins will certainly have an impact on available DST excess storage if the transfer of the water is not closely coordinated to allow it to be rapidly treated at the evaporator.

Water shipped directly to the ETF will probably be stored in the LERF which feeds the ETF directly. Efforts are currently underway to extend the life of the LERF beyond the June, 1995 target date to terminate operation. Extension of the LERF operations lifetime should ease ETF's operation by allowing accumulation of a large volume of material that can be processed using a single set of adjustments to the plant equipment.

B.2.2 Treatment Facilities

200 AREA EFFLUENT TREATMENT FACILITY (ETF)

The 200 Area ETF, in conjunction with the 242-A Evaporator, is planned to reduce the volume of liquid waste currently stored in the Hanford waste tanks. The ETF is a state-of-the-art waste water treatment facility that is designed to meet all current applicable federal and state regulations. It is presently scheduled to be operational by June 1995. A streamlined permitting process that will speed the approval for processing wastes through the ETF from other areas is being examined.

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The ETF is to contain systems that are designed to reduce the concentration of organic, inorganic and radioactive constituents (except tritium). The systems have been designated by Washington State Ecology to be consistent with all known, available and reasonable technology (AKART).

The ETF is located in the 200 East Area adjacent to the 242-A Evaporator and the Liquid Effluent Retention Facility (LERF). It is planned to be connected to the State Approved Land Disposal Site (SALDS). The ETF is scheduled to be able to treat 150-570 L/min (40 - 150 gpm) of waste water that comes directly from the 242-A Evaporator or from the LERF. The waste water is treated by having the inorganic and radioactive (excluding tritium) constituents removed and organic constituents destroyed by filtration, reverse osmosis, chemical/ion-exchange treatments and ultraviolet oxidation. The treated water will be analyzed to verify that discharge limits have been met and then discharged to an approved disposal site.

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The radionuclide concentrations in the raw and processed KE-Basin water (Hunacek 1994) is compared to that required for ETF operations (Krahn 1994) in Table 7.1. While most isotopes would not require any treatment beyond that already afforded at the basin's IXM discharge header, there are several exceptions, most notably Pu. ETF has stringent limits on PU, which are greatly exceeded by water from the basin's IXM discharge header. As shown in Table 7.1, decontamination factors in excess of 1000 will be required for Pu. The Pu is probably getting past the IXMs in a colloidal form. Therefore, an ultra (~0.01 microns) or nano filter will be needed prior final polishing ion-exchange and transport to ETF. Filtration of colloids offers some significant technical challenges. These particles are readily charged, and when combined, could bridge pores in membrane filters. Also, they may individually plug pores. This would require changing membranes frequently. Ultra filtration, supported by an aggressive development testing program will probably be required to meet the ETF feed limits for Pu.

The waste from K Basins is not regulated by RCRA, so it could not be mixed with the regulated waste to reduce radiation levels. ETF currently has no permitting in place to dump water with the K Basin tritium levels to soil column.

242-A EVAPORATOR

The 242-A Evaporator is the fourth evaporator to be built at Hanford and is the only facility that is still in service and processing tank waste. It is located in the 200 East Area. The 242-A was built in 1973, started operation in 1977, and was shut down in 1989 due to environmental concerns. It had evaporated ~212,000 m^3 (~56 million gallons) of condensate from highly radioactive waste stored in Hanford storage tanks. During the shutdown, the 242-A was extensively modified and updated for expected service through 2000.

Evaporator 242-A operates under a partial vacuum (~60 torr) and at a reduced temperature (~46 C° - 115°F). The system contains a boiler with a capacity of

~87 m^3 (~23,000 gallons) through which recirculating solution is pumped at a flow of ~947 L/sec (15,000 gpm). The system usually operates with a feed rate of tank waste to the boiler of ~6.3 L/sec (~100 gpm) supplied from the Evaporator Feed Tank (TK-102-AW). The feed is blended with the recirculating solution before reentering the boiler. Generally, ~3.2 L/sec - ~50 gpm (as water) of steam is directed from the boiler to the condenser coils. This condensate is processed through a filter and an ion exchange column, prior to its transfer to a retention facility. The balance of the process solution (~3.2 L/sec - ~50 gpm), is directed to the Slurry Receiving Tank (TK-106-AW), where it is routed to a settling tank or back to the Feed Tank for reprocessing. It is necessary that the slurry solution be recirculated several times through the Evaporator before the solution has reached a sufficient waste volume reduction (typically ~85%).

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The evaporator restarted operation with Campaign 94-2 on September 22, 1994, treating 101AP, 107AP, and 108AP. It will start treating 105AW, 104AW, 102AY, 103AW in 1995 (the next scheduled evaporator campaign). These are non-leaking tanks. They intend to fill these tanks soon (105AW with Purex supernate, 102AY with B-plant lab material). Their sampling is done by the 222-S laboratory. The analysis is done by 222-S and PNL (organics) personnel. Based on the latest operation, it can support about 2-3 campaigns per year, treating around 24,000 m^3 (6-9 million gallons). The present schedule shows that the 242-A evaporator could have sufficient capacity to process KE Basin water in the 1996 to 2000 time frame.

STATE APPROVED LAND DISPOSAL SITE (SALDS)

The SALDS is a gravel-filled drain field into which ETF treated water is discharged. The SALDS is located directly north of the 200W Area boundary. Its siting was to provide a location where the migration of tritium laden ETF treated water to the Columbia River was increased to an estimated 105 years. This would result in substantial decay in the concentration of the 12.3 year half-life hydrogen isotope.

After treatment in the ETF and verification that the treated water meets the requirements of the discharge permit, the water is discharged to the SALDS for disposal to the soil column. The treated water is pumped six (6) miles from the ETF to the SALDS in 8" NPS (8" NPS) PVC piping. SALDS contains no electrical, instrumentation, monitoring or control equipment. There are seven 4" NPS (NPS) PVC monitoring wells.

SALDS is 61 m (200 feet) long by 33.5 m (110 feet) wide by 1.8 m (6 feet) deep and filled with 2 - 4 cm diameter natural gravel. An 8" NPS (8" NPS) diameter distribution header runs the length of the SALDS with thirty-four 4" NPS (4"NPS) laterals attached to the header at 1.8 m (6') intervals. An impermeable barrier is laid on the top of the gravel bed to prevent soil migration into the void spaces between the gravel and to prevent tritium-laden water from migrating to the surface. The impermeable barrier is covered by 30.5 cm (12") of compacted soil.

The designed discharge flow rate to the SALDS is 19 L/sec (300 gpm). A design infiltration rate for 200 Area soil of 3.6 L/day (10 gallons per day) per square meter was used for the drain field design. The SALDS was sized to allow the contents of a verification tank 2536 m^3 (670,000 gallons) to be discharged at 19 L/sec (300 gpm) into an initially empty drain field without flooding. Once filled, the SALDS should theoretically take 36 hours to empty. This value to be verified when the system starts operation.

The tank farms have about 3300 Ci of ^3H. K-East has about 3-12 Ci.

B.2.3 TRITIUM REMOVAL

1. Combined Electrolysis and Catalytic Exchange (CECE)

The Combined Electrolysis and Catalytic Exchange (CECE) is the most used process for separating low concentrations of tritium from hydrogen for conditions of high feed volume. Current large applications of tritium separation are in use for heavy water moderated reactors. Here, the interest is in recovering both protium (the "normal" isotope of hydrogen containing only a proton in the nucleus) and tritium from the deuterium heavy water medium. Removal of protium enhances nuclear moderating properties, while tritium is separated to reduce occupational radiation doses to maintenance crews and to limit the environmental release of tritium. Estimates of hydrogen isotope separation facility and operating costs would be based on heavy-water systems that separate and dispose of unwanted hydrogen isotopes.

Nearly all schemes for separation of hydrogen have the heavier isotope remain in the feed, or upstream, processing stage. For tritium, this results in the physical separation system that have small separation factors of typically 1.05 to 1.8. The high number of physical separation stages that are required would result in high capital costs.

Chemical isotopic separation processes have a much larger separation factor, usually 3 to 10, than do physical separation processes. However, even with a combination chemical process, such as the Atomic Energy of Canada Limited's (AECL) developed CECE process, very high quantities of electrical power are required to implement this approach. For the CECE multistage process, a 100 L/minute tritiated waste stream flow rate would require more than 50 MW of electric power to reduce the tritium concentration to drinking water standards (<20,000 pCi/l).

Cost estimates for tritium separation systems are limited. The Canadian heavy water tritium separation plant at Darlington, Ontario, is operated by Ontario Hydro. This plant processes at 360 Kg/hr, the heavy-water coolant-moderator from all the twenty Canadian Deuterium-Uranium (CANDU) reactors operated by Ontario Hydro. Each reactor uses 500-700 tons of heavy water. The capital costs of the Darlington plant was ~$140 M, built in about 1980, using the regulatory policies in place in Canada at that time. An unsubstantiated operating cost of the facility is about $6/Kg of processed water.

More recently, ORNL and AECL jointly estimated the cost to develop a Heavy Water Upgrading and Detritiation Facility (HWUDF) as part of the ORNL deuterium heavy water cooled and moderated Advanced Neutron Source (ANS). The ANS is a proposed follow-on high-flux thermal test reactor to the ORNL High Flux Isotope Reactor (HFIR) that is light water cooled and beryllium moderated. The HWUDF, which is about ⅓ the size of the Darlington plant, was estimated (in the 1990s) to cost about $80 million for construction.

2. Tritium Separation with Membrane Technology

PNL/WHC employees are developing a membrane technology for the separation of tritiated water from normal water. The membrane is a polyphosphazene (PN_x) membrane. This material was selected because it has excellent radiological, thermal and chemical stability. The membrane is able to separate HTO from water. The process also is very energy efficient, which is a key feature for the large volumes of water involved in the K-basin cleanup.

The polyphosphazene membranes have been shown to produce 74% HTO depletion at 2-4 °C and a pressure of 330 KPa (48 psi) with tritium concentrations of 10,000 pCi/L.

Further development is planned in the following areas:

- Increase tritium concentrations to $1x10^6$ pCi/L
- Pilot plant testing needed
- Commercialize membrane construction
- Determine if laminar or turbulent flow is best
- Try speeding the process by addition of salts
- Determine optimum membrane thickness

The current schedule for development of the membrane technology is:

Complete bench scale test at 100 area basin with test cells	1-30-95
Report to TPA managers	5-30-95
Delivery and installation of membrane module in 100 area	7-15-95
Complete pilot scale installation at 100 area basin	9-30-95

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3. Laser Separation of Tritium Isotopes

Ontario Hydro has generated a conceptual design for laser induced tritium separation that could be used in tritium production at a future fusion reactor facility (Vasaru, 1993). The design is for feed water containing tritium in concentrations of from 1 to 10 Ci/kg and a processing rate of 500 kg/h. The following is a brief description of the way the plant would work:

- Water containing HTO would be subjected to a chemical exchange process in which NaOH would act as a catalyst and dimethyl sulfoxide (DMSO) would be used as a rate enhancing solvent. The product of the exchange process would be both CTF_3 and CHF_3.

- Then the gases would be subjected to infrared CO_2 laser radiation at a wave length of about 9.4 μm. The laser output will be from about 12 to 60 J/cm^2 and have a pulse length of from 2 to 1000 nsec. Laser operation at this wave length will selectively break the CTF_3 bonds to form C_2F_4 and TF.

- The CTF_3, CHF_3 C_2F_4, TF, and HF gas stream will feed into a separator. The TF and HF will be absorbed by NaF pellets, but the TF is absorbed more strongly. The TF concentration will be about 3% of the HF in the NaF pellets. The NaF pellets will then be heated to drive off the TF and HF. The TF and HF will be passed over a reducing metal to produce hydrogen and tritium gas.

- The hydrogen and tritium gases will then be cryogenically distilled to separate the hydrogen and tritium gases.

The capital cost of this laser separation plant was estimated to be about ½ that of a Combined Electrolysis and Catalytic Exchange (CECE) process with equivalent capacity. Operating costs would be about the same for these high levels of tritium concentrations. But, the energy required for laser separation of K-basin water would be much less than with a CECE process because the energy required for the laser separation goes down with reduced tritium concentrations.

APPENDIX C

COSTS

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The purpose of the cost estimates was to provide relative cost information for each of the options to aid in selecting one or a limited number for further study. Attempts were made to use uniform assumptions for all of the costs so that they would be consistent. The multiplicative factors derived in Hunacek (1994) to determine present values were used throughout. These are:

- Present value of operating costs for six years.
  - Current annual operating cost times 4.7665
- Annual amortized value of capital equipment (and installation).
  - Capital and installation costs times 0.2098
- Installation cost of capital equipment.
  - Capital cost times 6.636

The following sections describe the preliminary costs for each part of the water treatment options. The costs are summarized as:

annual, current annual operating and amortization costs, $M.year

and

6 year, present value of costs for six years of operation.

DEMINERALIZED MAKEUP WATER

Upgrades to the demineralization system are assumed to have little additional cost. Operation of the system (personnel and consumables) is estimated to cost $0.2M/year

	Annual $M/year	6 year $M
Capital		
Operation	0.20	0.95
Total	0.20	0.95

TREATMENT EQUIPMENT

The on-site treatment equipment upgrades are described in Hunacek (1994A). They include the additional filtration equipment needed to reduce the level of contaminants in the basin water after it has passed through the existing filtration system. Holding tanks to permit verifying the purity of the water before it is disposed of or shipped off site are included in these estimates.

	Annual $M/year	6 year $M
Capital	0.84	4.01
Operation	0.77	3.66
Total	1.61	7.67

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DISPOSAL FACILITIES

Dispose in Columbia River

No additional capital equipment is required for this option (Hunacek 1994A). Additional testing of the water and other operations are required, however.

	Annual $M/year	6 year $M
Capital		
Operation	0.44	2.08
Total	0.44	2.08

Dispose through solar evaporation

Solar evaporation ponds must be constructed (Hunacek 1994A). Costs are included for special testing of the water to be evaporated and the environment surrounding the ponds, and disposing of the residue settling in the ponds.

	Annual $M/year	6 year $M
Capital	0.34	1.64
Operation	1.07	5.09
Total	1.41	6.73

TRANSPORTATION TRANSFER STATIONS

The costs for construction, installation of equipment, and operation of a transfer station for truck transfer are given in Hunacek (1994A). Most of these costs are associated with the pumping, connections, and operation of the station. The costs for rail and pipe transfer will be somewhat smaller because of the existing facilities and the direct transfer of the water to the piping system, respectively. However, these reductions will be minor. Therefore, one cost estimate is provided for all modes of transportation.

	Annual $M/year	6 year $M
Capital	0.25	1.21
Operation	0.24	1.16
Total	0.49	2.35

TRANSPORTATION TO TREATMENT/DISPOSAL FACILITY

Truck/tank to Evaporator or ETF

Transportation by truck or trailer to either the evaporator or the ETF requires the purchase of two truck or trailer rigs. Two operating crews are also required.

	Annual $M/year	6 year $M
Capital	0.03	0.15
Operation	0.93	4.41
Total	0.96	4.56

Rail car to Evaporator

One tank car must be purchased and operated. Rail lines currently exist to this facility.

	Annual $M/year	6 year $M
Capital	0.20	0.95
Operation	1.62	7.73
Total	1.82	8.68

Rail car to ETF

An additional two miles of track must be provided to extend the existing rail lines to the ETF.

	Annual $M/year	6 year $M
Capital	0.49	2.31
Operation	1.62	7.73
Total	2.11	10.04

Piping transfer

The costs for transfer by pipe are based on nine miles of piping (at $1.5M/mile) and the associated pumping and operating expenses.

	Annual $M/year	6 year $M
Capital	2.83	13.50
Operation	0.26	1.25
Total	3.09	14.75

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TRANSPORTATION RECEIVING FACILITY

Transfer to the evaporator, either by truck or rail, would go to the existing 204-AR facility. Operating expenses of that facility are included in the evaporator costs given below.

Transportation to the ETF by either truck or rail will require a receiving station. The costs for this station, both capital and operating, are assumed to be the same as for the on-site transfer station.

	Annual $M/year	6 year $M
Capital	0.25	1.21
Operation	0.24	1.16
Total	0.49	2.35

The receiving station for piping transfer to either the evaporator or the ETF is assumed to cost the same as the on-site transfer station.

	Annual $M/year	6 year $M
Capital	0.25	1.21
Operation	0.24	1.16
Total	0.49	2.35

HOLDING FACILITIES

The costs for storing, transferring, and monitoring the water in double shell tanks prior to and during the process of treating it at the evaporator are included in the treatment costs given below.

It is assumed that treatment at the ETF will not require additional costs for storing of the water.

No estimate has been made for the storage of water awaiting removal of the tritium. However, if that option is selected, such storage would be covered by the normal operating costs of the tank farms.

TREATMENT FACILITIES

ETF

The costs for operation of the ETF facility and disposal at SALDS have been estimated to be $0.44/gal of liquid treated. These costs assume that the liquid is ready for treatment (staged at the evaporator and characterized) and that the facility will be operating near full capacity. They also include the

amortized costs of recent improvements and therefore are higher than the actual incremental costs of processing the K-East basin water.

	Annual $M/year	6 year $M
Capital	0.00	0.00
Operation	0.88	4.19
Total	0.88	4.19

242A Evaporator

Cost estimates for the operation of the evaporator have been made that include the sampling and analysis of the water required when received, prior to treatment, and while stored in the double-shell tanks. These estimates also included the materials (resins and chemicals) required for the treatment. It was assumed that the water would be processed twice and the final residue would be sent to grout (95%) and HWVP (5%). These latter waste streams make up 26% of the total cost and may be overestimated. These costs account for all of the costs of the facility and do not reflect that it is already funded and staffed to operated.

Annual	6 year $M/year	$M
Capital	0.00	0.00
Operation	7.66	36.51
Total	7.66	35.51

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DISPOSAL FACILITIES

SALDS

The costs for disposal at SALDS is included in the ETF costs.

DECOMMISSIONING OF NEW FACILITIES

No estimates are currently available for the decommissioning of the facilities and equipment installed for the treatment and disposal options. Those costs would be especially large for the piping transfer option and therefore the costs for that option are probably quite optimistic. It should be noted that these costs would be mitigated somewhat if that piping system was modified to transport N Reactor water to the 200 Area.

APPENDIX D

SCHEDULES

9413295.0323

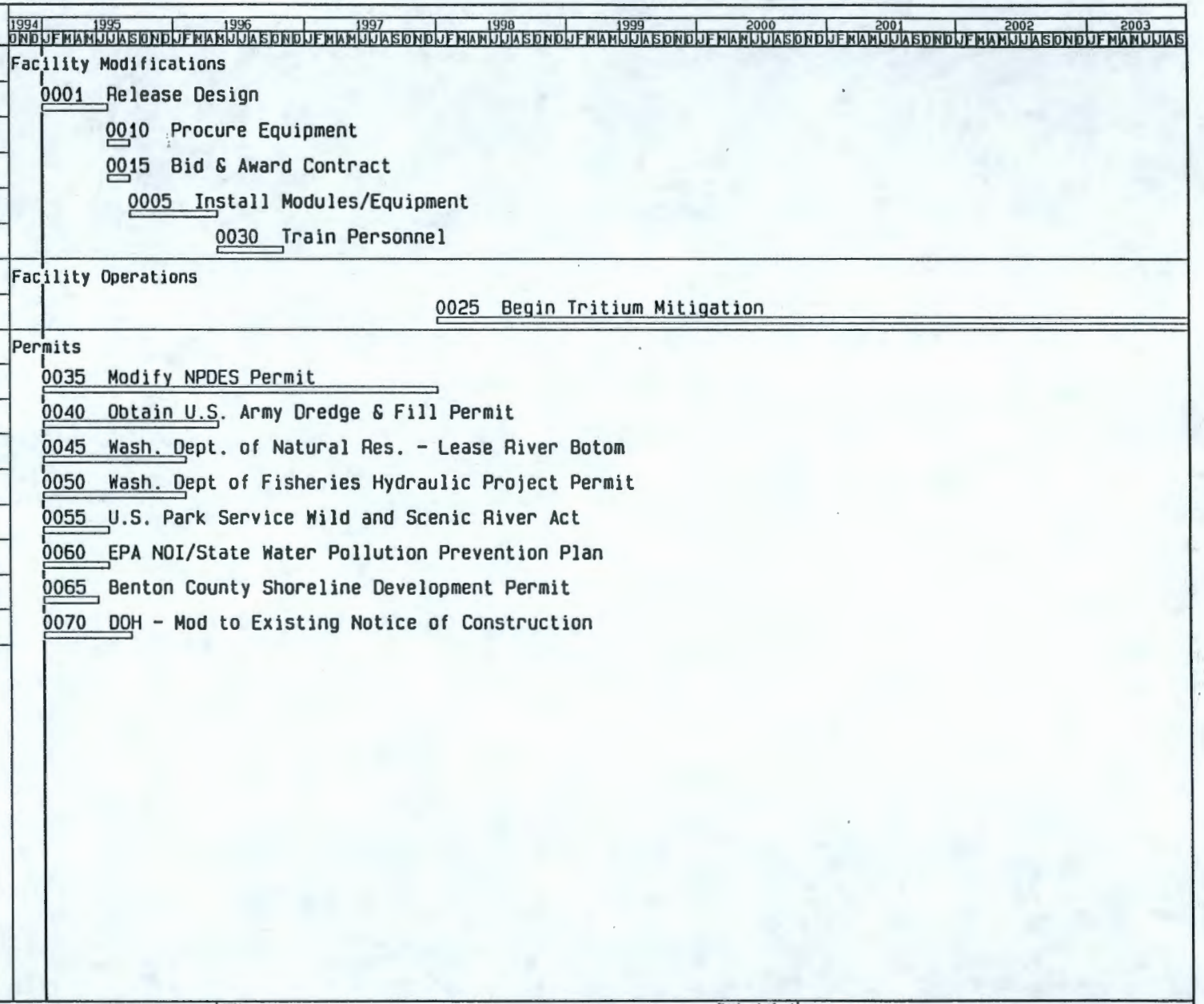
D.0 SCHEDULE

There is no schedule given for the zero option, because it would not require water processing as a separate item. The only water processed would be that used to clean the floor and walls of the basin. That would be part of the decommissioning and decontamination.

The following schedules give an estimate of time required to complete the specified options:

9413295.0324

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	30JUN95	6	0001 Release Design
1JUL95	31AUG95	2	0010 Procure Equipment
1JUL95	31AUG95	2	0015 Bid & Award Contract
1SEP95	30APR96	8	0005 Install Modules/Equipment
1MAY96	31OCT96	6	0030 Train Personnel
			Facility Operations
1JAN98	31DEC03	72	0025 Begin Tritium Mitigation
			Permits
1JAN95	31DEC97	36	0035 Modify NPDES Permit
1JAN95	30APR96	16	0040 Obtain U.S. Army Dredge & Fill Permit
1JAN95	31JAN96	13	0045 Wash. Dept. of Natural Res. - Lease River Botom
1JAN95	31JAN96	13	0050 Wash. Dept of Fisheries Hydraulic Project Permit
1JAN95	30JUN95	6	0055 U.S. Park Service Wild and Scenic River Act
1JAN95	30JUN95	6	0060 EPA NOI/State Water Pollution Prevention Plan
1JAN95	31MAY95	5	0065 Benton County Shoreline Development Permit
1JAN95	31AUG95	8	0070 DOH - Mod to Existing Notice of Construction



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 31DEC03

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

OP11

Sheet 1 of 1

K Basin Water Removal - Option 1a
Treat at K-Basin/Release to River

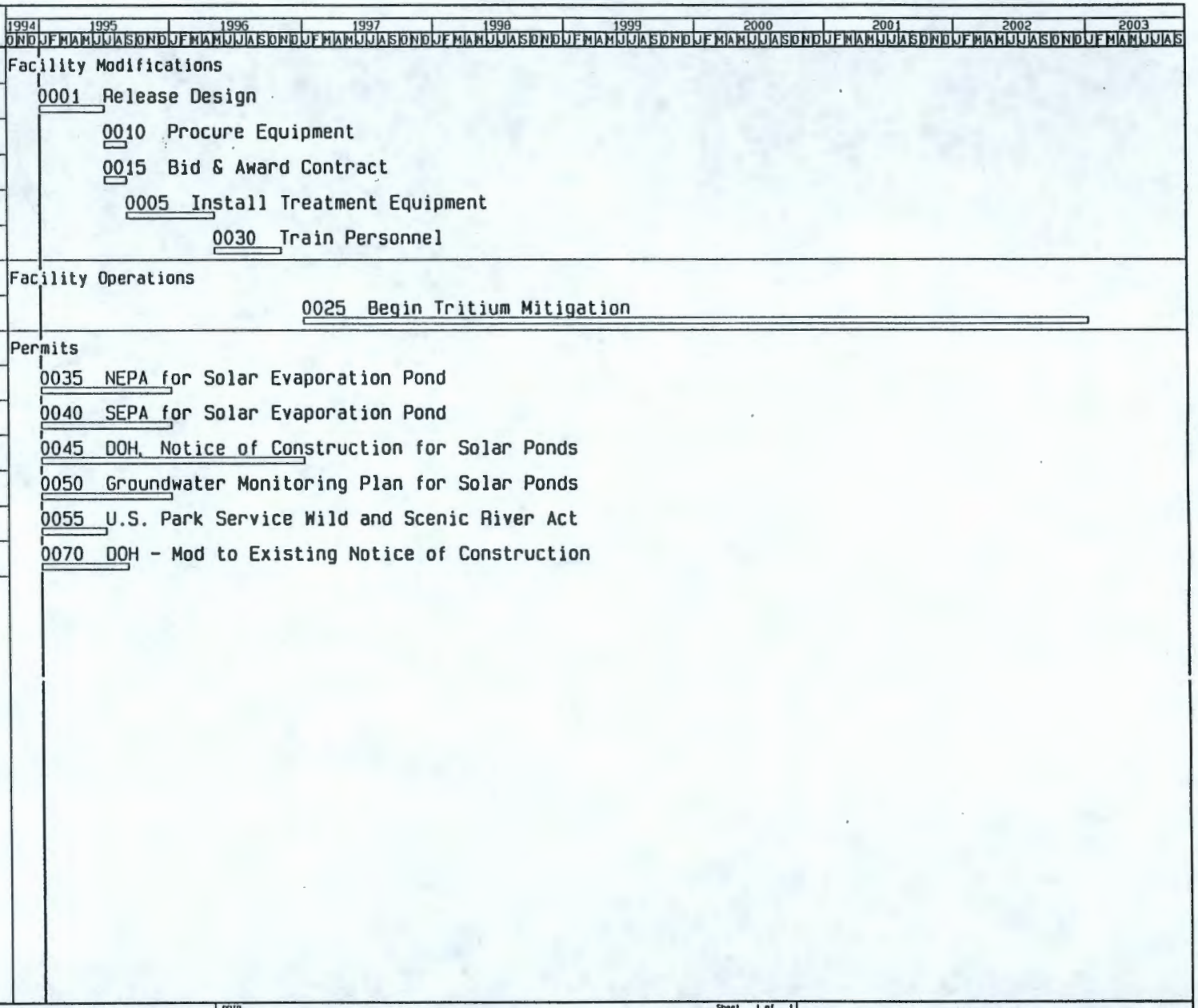
10-25-94

Date	Revision	Checked	Approved

FIGURE D.0-1a

K-Basin Water Removal Option 1b

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	30JUN95	6	0001 Release Design
1JUL95	31AUG95	2	0010 Procure Equipment
1JUL95	31AUG95	2	0015 Bid & Award Contract
1SEP95	30APR96	8	0005 Install Treatment Equipment
1MAY96	31OCT96	6	0030 Train Personnel
			Facility Operations
1JAN97	31DEC02	72	0025 Begin Tritium Mitigation
			Permits
1JAN95	31DEC95	12	0035 NEPA for Solar Evaporation Pond
1JAN95	31DEC95	12	0040 SEPA for Solar Evaporation Pond
1JAN95	31DEC96	24	0045 DOH, Notice of Construction for Solar Ponds
1JAN95	31DEC95	12	0050 Groundwater Monitoring Plan for Solar Ponds
1JAN95	30JUN95	6	0055 U.S. Park Service Wild and Scenic River Act
1JAN95	31AUG95	8	0070 DOH - Mod to Existing Notice of Construction



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 31DEC02

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Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

OPTB

Sheet 1 of 1

K Basin Water Removal - Option 1b
Treat at K-Basin/Transfer to Ponds

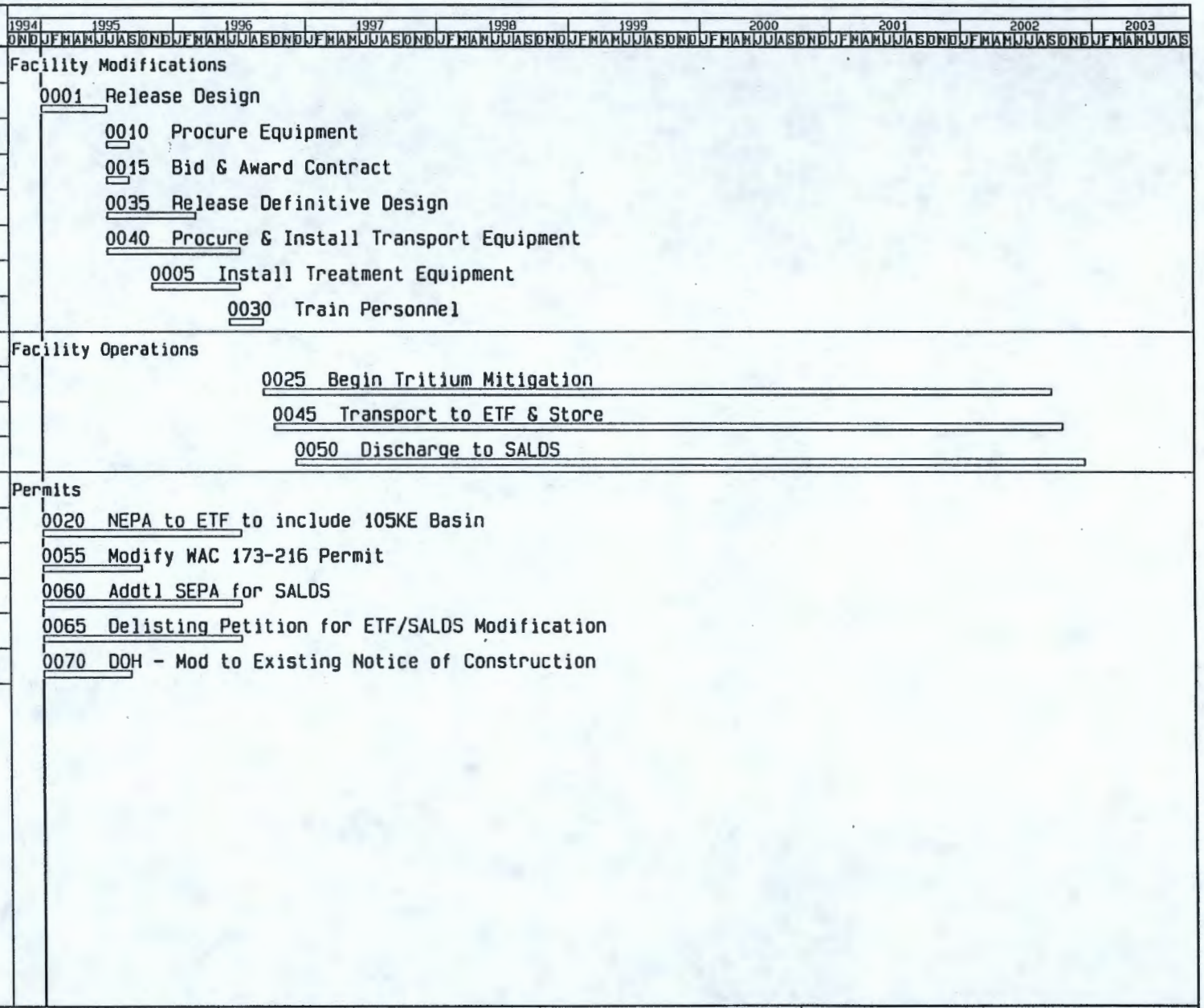
10-25-94

Date	Revision	Checked	Approved

FIGURE D.0.1b

K-Basin Water Removal Option 2

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	30JUN95	6	0001 Release Design
1JUL95	31AUG95	2	0010 Procure Equipment
1JUL95	31AUG95	2	0015 Bid & Award Contract
1JUL95	29FEB96	8	0035 Release Definitive Design
1JUL95	30JUN96	12	0040 Procure & Install Transport Equipment
1NOV95	30JUN96	8	0005 Install Treatment Equipment
1JUN96	31AUG96	3	0030 Train Personnel
			Facility Operations
1SEP96	31AUG02	72	0025 Begin Tritium Mitigation
1OCT96	30SEP02	72	0045 Transport to ETF & Store
1DEC96	30NOV02	72	0050 Discharge to SALDS
			Permits
1JAN95	30JUN96	18	0020 NEPA to ETF to include 105KE Basin
1JAN95	30SEP95	9	0055 Modify WAC 173-216 Permit
1JAN95	30JUN96	18	0060 Addtl SEPA for SALDS
1JAN95	30JUN96	18	0065 Delisting Petition for ETF/SALDS Modification
1JAN95	31AUG95	8	0070 DOH - Mod to Existing Notice of Construction



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 30NOV02

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Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

OP12

Sheet 1 of 1

K Basin Water Removal - Option 2
Treat at K-Basin/Dispose in SALDS

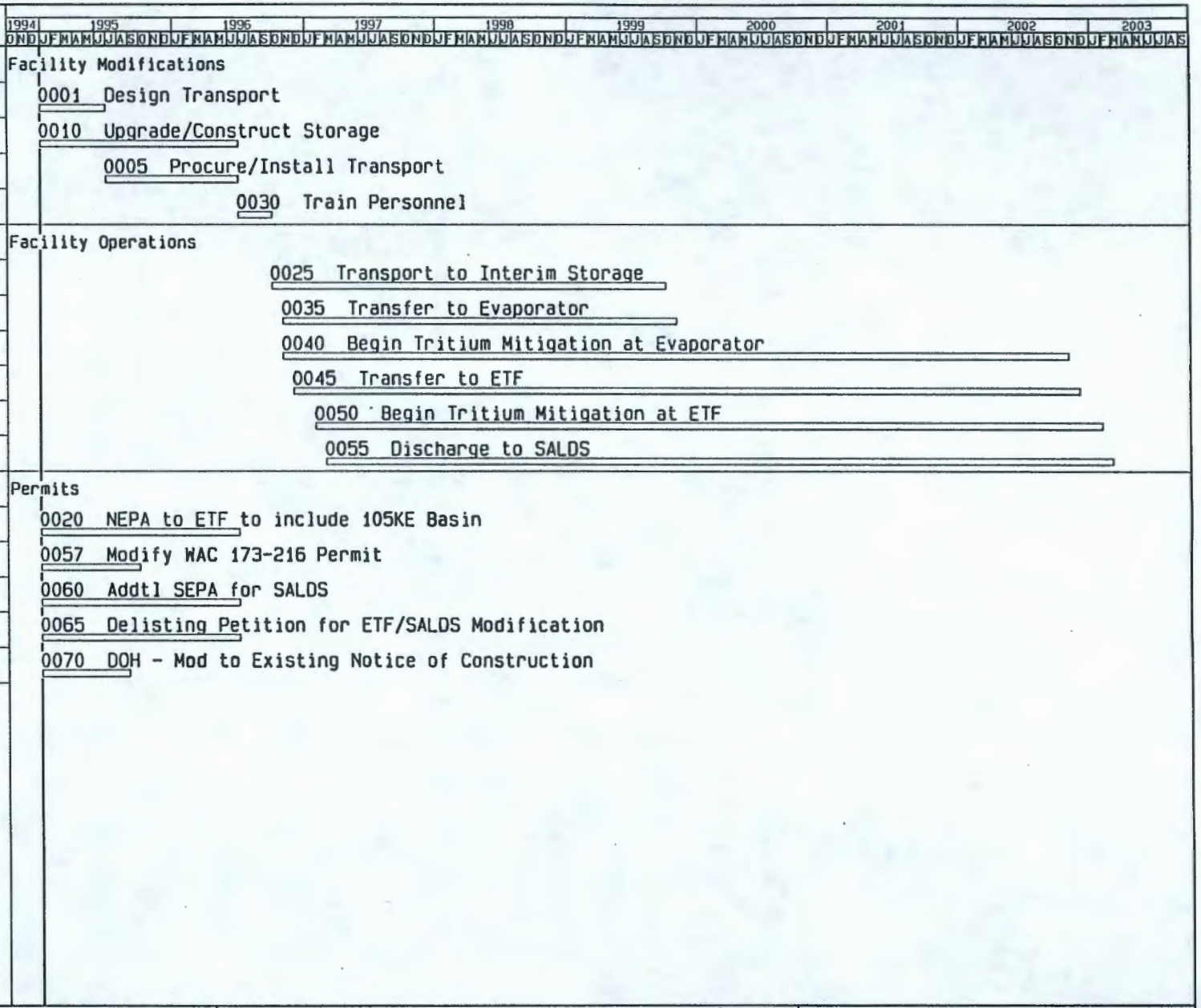
10-25-94

Date	Revision	Checked	Approved

FIGURE D.0-2

K-Basin Water Removal Option 3

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	30JUN95	6	0001 Design Transport
1JAN95	30JUN96	18	0010 Upgrade/Construct Storage
1JUL95	30JUN96	12	0005 Procure/Install Transport
1JUL96	30SEP96	3	0030 Train Personnel
			Facility Operations
1OCT96	30SEP99	36	0025 Transport to Interim Storage
1NOV96	31OCT99	36	0035 Transfer to Evaporator
1NOV96	31OCT02	72	0040 Begin Tritium Mitigation at Evaporator
1DEC96	30NOV02	72	0045 Transfer to ETF
1FEB97	31JAN03	72	0050 Begin Tritium Mitigation at ETF
1MAR97	28FEB03	72	0055 Discharge to SALDS
			Permits
1JAN95	30JUN96	18	0020 NEPA to ETF to include 105KE Basin
1JAN95	30SEP95	9	0057 Modify WAC 173-216 Permit
1JAN95	30JUN96	18	0060 Addtl SEPA for SALDS
1JAN95	30JUN96	18	0065 Delisting Petition for ETF/SALDS Modification
1JAN95	31AUG95	8	0070 DOH - Mod to Existing Notice of Construction



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 28FEB03

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Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

OPI3

Sheet 1 of 1

K Basin Water Removal - Option 3
Treat at Evap/ETF Transfer to SALDS

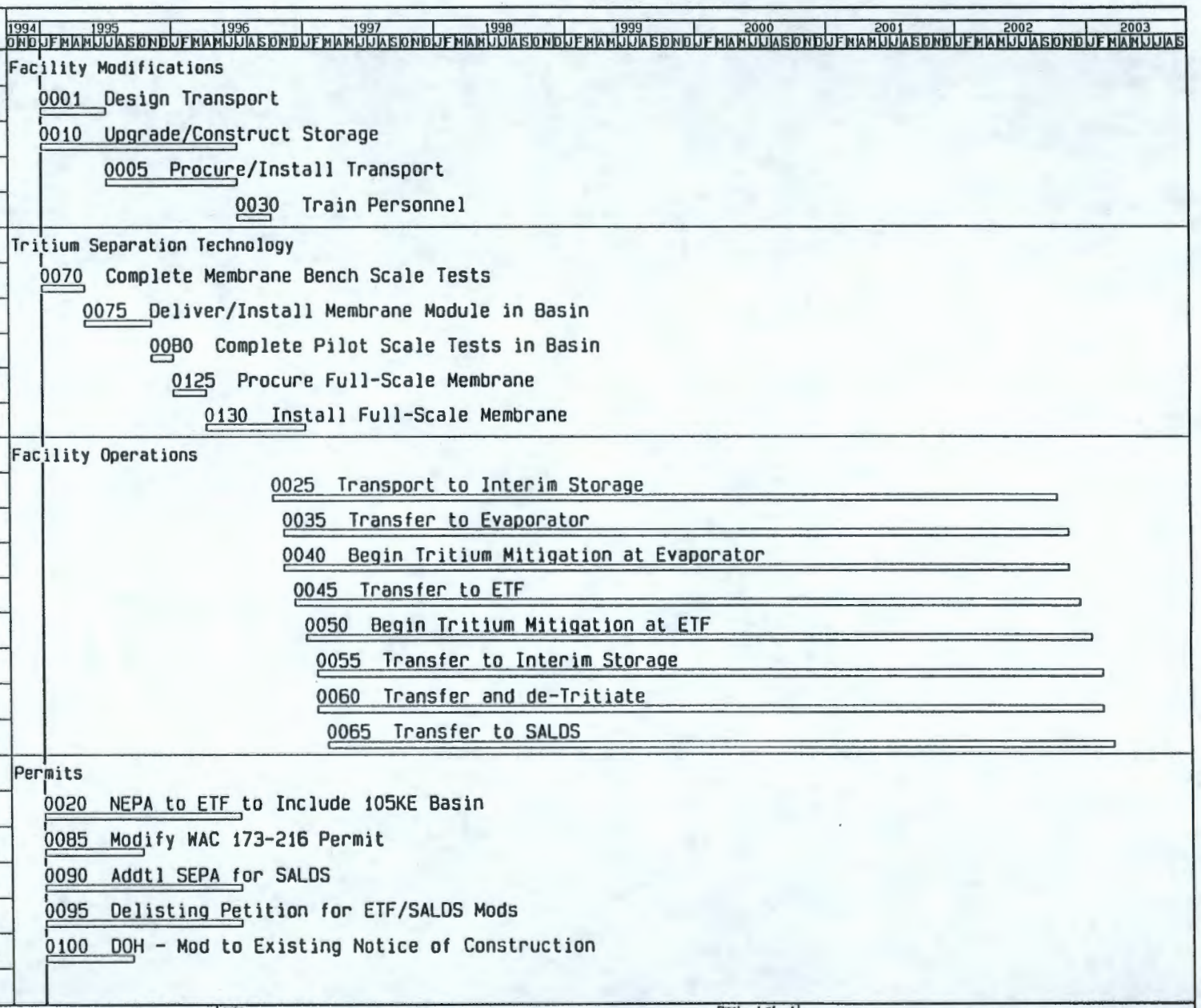
10-25-94

Date	Revision	Checked	Approved

FIGURE D.0-3

K-Basin Water Removal Option 4

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	30JUN95	6	0001 Design Transport
1JAN95	30JUN96	18	0010 Upgrade/Construct Storage
1JUL95	30JUN96	12	0005 Procure/Install Transport
1JUL96	30SEP96	3	0030 Train Personnel
			Tritium Separation Technology
1JAN95	30APR95	4	0070 Complete Membrane Bench Scale Tests
1MAY95	31OCT95	6	0075 Deliver/Install Membrane Module in Basin
1NOV95	31DEC95	2	0080 Complete Pilot Scale Tests in Basin
1JAN96	31MAR96	3	0125 Procure Full-Scale Membrane
1APR96	31DEC96	9	0130 Install Full-Scale Membrane
			Facility Operations
1OCT96	30SEP02	72	0025 Transport to Interim Storage
1NOV96	31OCT02	72	0035 Transfer to Evaporator
1NOV96	31OCT02	72	0040 Begin Tritium Mitigation at Evaporator
1DEC96	30NOV02	72	0045 Transfer to ETF
1JAN97	31DEC02	72	0050 Begin Tritium Mitigation at ETF
1FEB97	31JAN03	72	0055 Transfer to Interim Storage
1FEB97	31JAN03	72	0060 Transfer and de-Tritiate
1MAR97	28FEB03	72	0065 Transfer to SALDS
			Permits
1JAN95	30JUN96	18	0020 NEPA to ETF to Include 105KE Basin
1JAN95	30SEP95	9	0085 Modify WAC 173-216 Permit
1JAN95	30JUN96	18	0090 Addtl SEPA for SALDS
1JAN95	30JUN96	18	0095 Delisting Petition for ETF/SALDS Mods
1JAN95	31AUG95	8	0100 DOH - Mod to Existing Notice of Construction



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 28FEB03

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

DP14

Sheet 1 of 1

K Basin Water Removal - Option 4
Treat at Evap/ETF/de-Tritiate

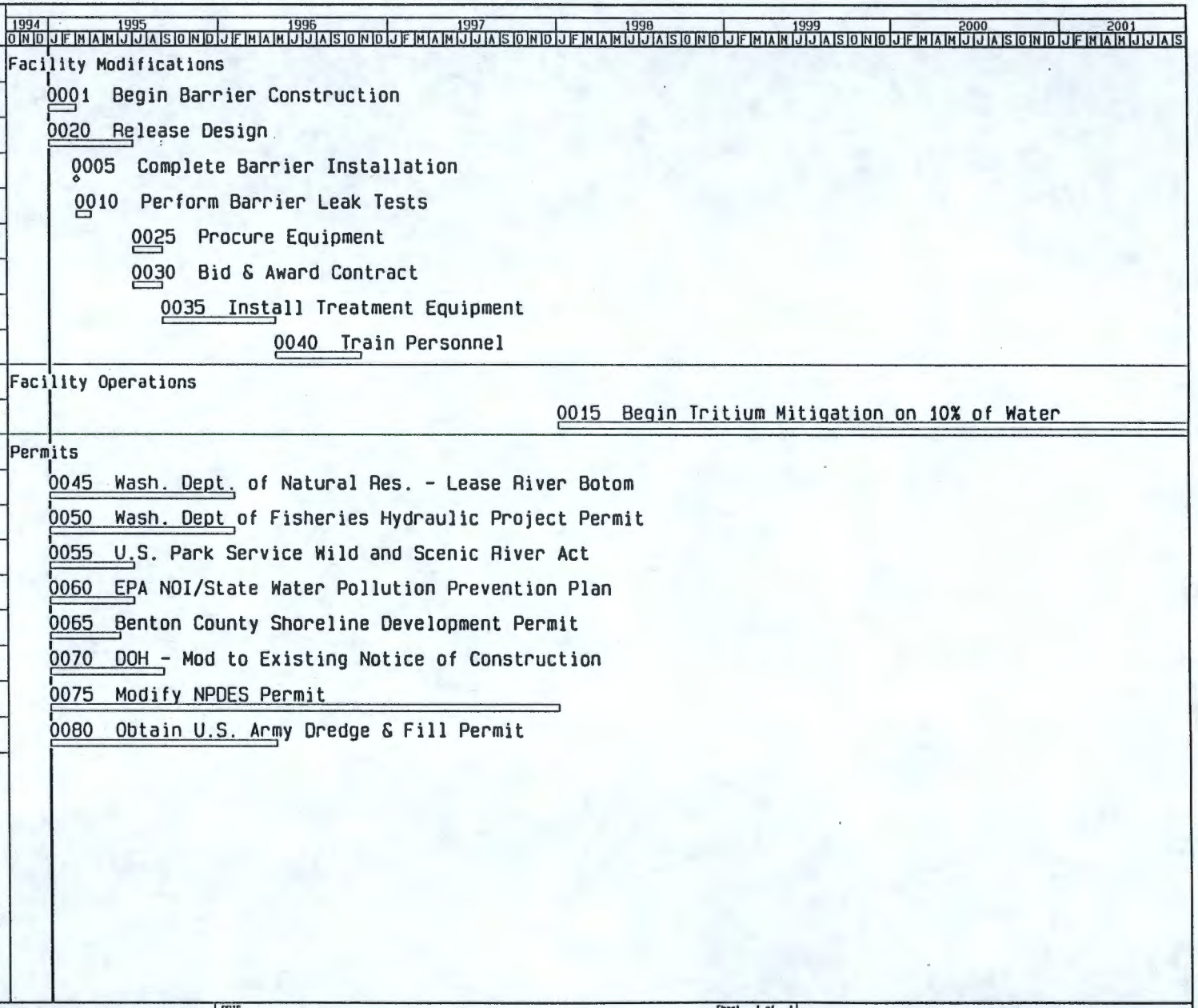
10-25-94

Date	Revision	Checked	Approved

FIGURE D.0-4

K-Basin Water Removal Option 5-1a

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	28FEB95	2	0001 Begin Barrier Construction
1JAN95	30JUN95	6	0020 Release Design
	28FEB95	0	0005 Complete Barrier Installation
1MAR95	31MAR95	1	0010 Perform Barrier Leak Tests
1JUL95	31AUG95	2	0025 Procure Equipment
1JUL95	31AUG95	2	0030 Bid & Award Contract
1SEP95	30APR96	8	0035 Install Treatment Equipment
1MAY96	31OCT96	6	0040 Train Personnel
			Facility Operations
1JAN98	31DEC03	72	0015 Begin Tritium Mitigation on 10% of Water
			Permits
1JAN95	31JAN96	13	0045 Wash. Dept. of Natural Res. - Lease River Botom
1JAN95	31JAN96	13	0050 Wash. Dept of Fisheries Hydraulic Project Permit
1JAN95	30JUN95	6	0055 U.S. Park Service Wild and Scenic River Act
1JAN95	30JUN95	6	0060 EPA NOI/State Water Pollution Prevention Plan
1JAN95	31MAY95	5	0065 Benton County Shoreline Development Permit
1JAN95	31AUG95	8	0070 DOH - Mod to Existing Notice of Construction
1JAN95	31DEC97	36	0075 Modify NPDES Permit
1JAN95	30APR96	16	0080 Obtain U.S. Army Dredge & Fill Permit



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 31DEC03

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

OP15

Sheet 1 of 1

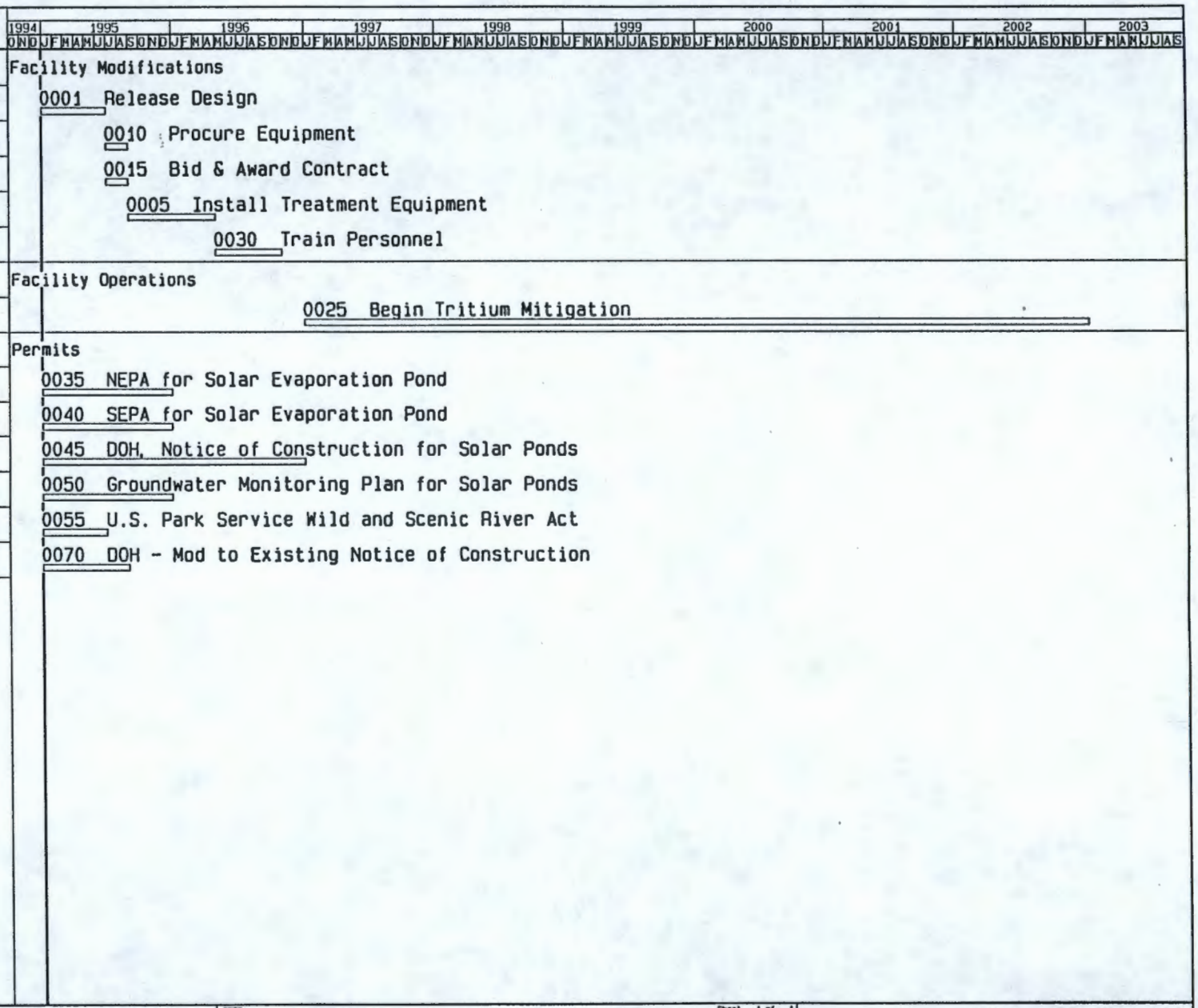
K Basin Water Removal - Option 5-1a
Install Barrier/River Discharge

10-25-94

Date	Revision	Checked	Approved

FIGURE D.0-5a

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	30JUN95	6	0001 Release Design
1JUL95	31AUG95	2	0010 Procure Equipment
1JUL95	31AUG95	2	0015 Bid & Award Contract
1SEP95	30APR96	8	0005 Install Treatment Equipment
1MAY96	31OCT96	6	0030 Train Personnel
			Facility Operations
1JAN97	31DEC02	72	0025 Begin Tritium Mitigation
			Permits
1JAN95	31DEC95	12	0035 NEPA for Solar Evaporation Pond
1JAN95	31DEC95	12	0040 SEPA for Solar Evaporation Pond
1JAN95	31DEC96	24	0045 DOH, Notice of Construction for Solar Ponds
1JAN95	31DEC95	12	0050 Groundwater Monitoring Plan for Solar Ponds
1JAN95	30JUN95	6	0055 U.S. Park Service Wild and Scenic River Act
1JAN95	31AUG95	8	0070 DOH - Mod to Existing Notice of Construction



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 31DEC02

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

DP58

Sheet 1 of 1

K Basin Water Removal - Option 5-1b
Install Cofferdam/Transfer to Ponds

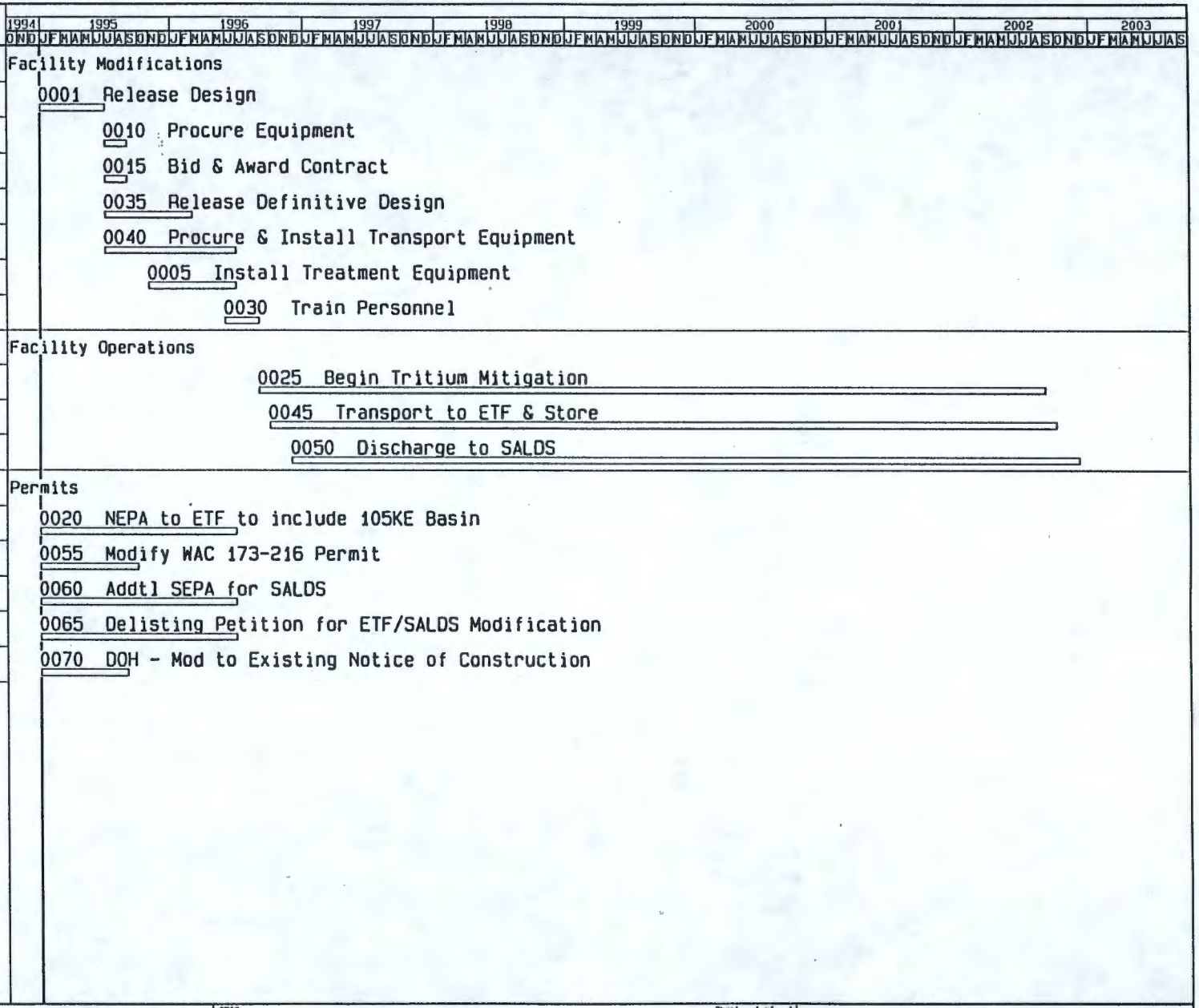
10-25-94

Date	Revision	Checked	Approved

FIGURE D.0-5b

K-Basin Water Removal Option 5-2

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	30JUN95	6	0001 Release Design
1JUL95	31AUG95	2	0010 Procure Equipment
1JUL95	31AUG95	2	0015 Bid & Award Contract
1JUL95	29FEB96	8	0035 Release Definitive Design
1JUL95	30JUN96	12	0040 Procure & Install Transport Equipment
1NOV95	30JUN96	8	0005 Install Treatment Equipment
1JUN96	31AUG96	3	0030 Train Personnel
			Facility Operations
1SEP96	31AUG02	72	0025 Begin Tritium Mitigation
1OCT96	30SEP02	72	0045 Transport to ETF & Store
1DEC96	30NOV02	72	0050 Discharge to SALDS
			Permits
1JAN95	30JUN96	18	0020 NEPA to ETF to include 105KE Basin
1JAN95	30SEP95	9	0055 Modify WAC 173-216 Permit
1JAN95	30JUN96	18	0060 Addtl SEPA for SALDS
1JAN95	30JUN96	18	0065 Delisting Petition for ETF/SALDS Modification
1JAN95	31AUG95	8	0070 DOH - Mod to Existing Notice of Construction



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 30NOV02

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Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

GP12

Sheet 1 of 1

K Basin Water Removal - Option 5-2
Install Barrier/Treat at KE & ETF

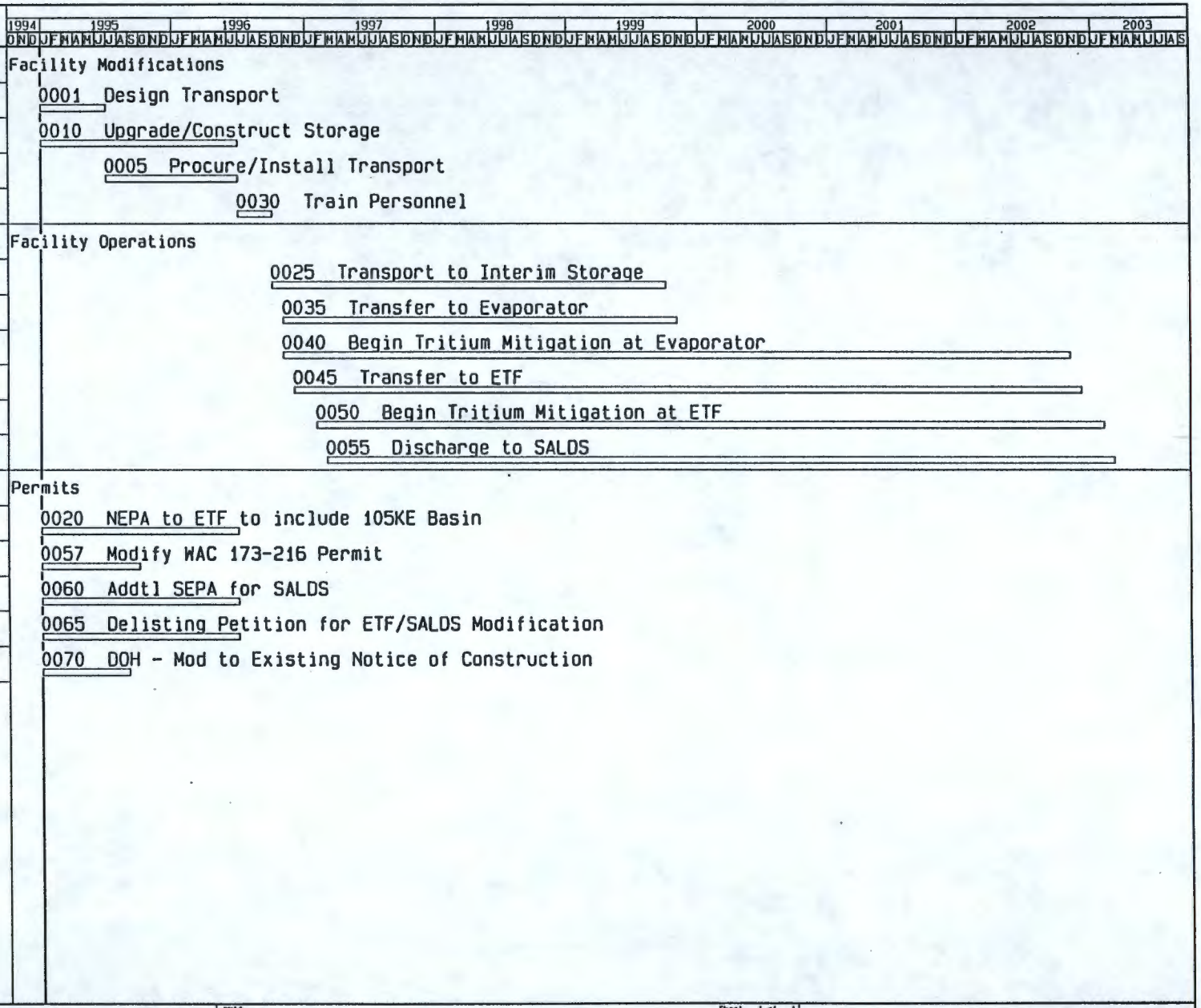
10-25-94

Date	Revision	Checked	Approved

FIGURE D.0-6

K-Basin Water Removal Option 5-3

EARLY START	EARLY FINISH	ORIG DUR	
			Facility Modifications
1JAN95	30JUN95	6	0001 Design Transport
1JAN95	30JUN96	18	0010 Upgrade/Construct Storage
1JUL95	30JUN96	12	0005 Procure/Install Transport
1JUL96	30SEP96	3	0030 Train Personnel
			Facility Operations
10CT96	30SEP99	36	0025 Transport to Interim Storage
1NOV96	31OCT99	36	0035 Transfer to Evaporator
1NOV96	31OCT02	72	0040 Begin Tritium Mitigation at Evaporator
1DEC96	30NOV02	72	0045 Transfer to ETF
1FEB97	31JAN03	72	0050 Begin Tritium Mitigation at ETF
1MAR97	28FEB03	72	0055 Discharge to SALDS
			Permits
1JAN95	30JUN96	18	0020 NEPA to ETF to include 105KE Basin
1JAN95	30SEP95	9	0057 Modify WAC 173-216 Permit
1JAN95	30JUN96	18	0060 Addtl SEPA for SALDS
1JAN95	30JUN96	18	0065 Delisting Petition for ETF/SALDS Modification
1JAN95	31AUG95	8	0070 DOH - Mod to Existing Notice of Construction



Plot Date 26OCT94
Data Date 1JAN95
Project Start 1JAN95
Project Finish 28FEB03

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

OP13

Sheet 1 of 1

K Basin Water Removal - Option 5-3
Install Barrier/Treat at ETF

10-25-94

Date	Revision	Checked	Approved

FIGURE D.0-7

APPENDIX E

PERMITTING

9413295.0334

Additional effort which will need to be completed includes gaining approval or obtaining permits from various federal, state, and local agencies. The following is a list of the various permits required for the discharge of the 105KE Basin effluent to the environment and a following explanation as to what the permit covers and why it is required.

Modification of NPDES Permit

Used to obtain regulatory approval for the discharge of pollutants from any point source into waters of the United States. The current NPDES would need to be modified to include discharge from the 105KE Basin.

U.S. Army Corps of Engineers Dredge & Fill Permit

Required for activities involving dredging or filling of the Columbia River below the normal high water mark. EPA could require a mixing zone for discharge to the river in a revised NPDES permit, which would require modifications to the existing outfall or a new outfall.

Washington Department of Fisheries Hydraulic Project Permit

Required from the State of Washington Department of Fisheries for activities which alter the flow or bed of river, even on a temporary basis. Modifications to the current outfall or construction of a new outfall would require this permit.

Benton County Department Shoreline Development Permit

Required for activities taking place on the shoreline of the river in areas where the land is not owned in fee by the federal government.

U.S. Park Service Review of Project for Wild and Scenic River Act

The Hanford Reach has been designated for inclusion in the National Wild and Scenic Rivers System. This requires documentation for any activity performed within one quarter mile of the high water line on the Columbia River.

Delisting Petition

This is prepared to exclude waste produced at a particular facility from regulation under 40 CFR 261. It must demonstrate that the waste does not meet any of the criteria under which the waste was or could be designated as hazardous.

9413295.0335

9413295.0336

Modify WAC 173-216

Chapter 173-216 WAC requires that all known, available, and reasonable methods of treatment (AKART) be employed for the discharge of waste water to the land surface/subsurface. This would need to be modified to include 105KE Basin.

Washington Department of Natural Resources Lease of River Bottom

If the siting and construction of a waste water outfall occurs on lands of the state, a State Land Lease must be secured. The new or modified outfall would fall under this.

NEPA for ETF to include 105KE Basin

NEPA is required to determine the potential for environmental impacts. ETF's current NEPA documentation would need to be modified to account for the 105KE Basin.

Additional SEPA for SALDs

SEPA requires an evaluation of potential environmental impacts for projects in which WHC and RL seek approval (e.g., license, permit) from a state (i.e., Ecology, DOH) or local agency. ETF discharge of the 105KE Basin would require this.

DOH, Modification to Existing Notice of Construction

The DOH regulates radioactive air emissions from all sources to ensure compliance with federal and state CAA and chapter 246-247 WAC. For new sources a NOC must be submitted to DOH. Modification of the existing NOC would be required to account for the 105KE Basin.

DISTRIBUTION SHEET

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DISTRIBUTION	RADIATION PHYSICS & SHIELDING	Date 10/27/94
Project Title/Work Order		EDT No. 603207
SNF/K BASINS		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
RJ MORFORD	H0-35	X			
J GREENBORG	H0-35	X			
GC MOOERS	R3-85	X			
JR FREDERICKSON	R3-86	X			
MJ WIEMERS	R3-86	X			
EW GERBER	R3-86	X			
DL SHERRELL	R3-86	X			
OM HOLGADO	R3-81	X			
SNF PROJECT FILE	N1-31	X			
CENTRAL FILES (ORIG. +2)	L8-04	X			
OSTI (2)	L8-07	X			

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