DEVELOPMENT OF AN INVENTORY REDUCTION PLAN FOR THE OAK RIDGE RESERVATION LOW LEVEL WASTE INVENTORIES

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ABSTRACT

An Inventory Reduction Plan (IRP) was developed at the Oak Ridge Reservation (ORR) to provide a management-level strategic plan and information document for the removal of legacy and newly generated low level and industrial waste. The first release of the document (Revision 0) provided the format, process, and strategy for inventory reduction. The IRP is also the baseline document for future updates to reflect changes in priorities, objectives, and strategies for low level waste (LLW) and industrial waste inventory reduction and disposition on the ORR. The IRP was developed at the work breakdown structure (WBS) Level 8 (waste stream level) and reported at WBS Level 7 (waste category level).

The IRP provides guidance on the scope of work needed to reduce the current inventory on a yearly basis. This IRP Revision 0 Report was developed using the methodical and logical approach outlined below:

1. Develop IRP Inventory
2. Develop Work Off Priorities
3. Develop Priority Ranking System
4. Apply Priority Ranking System to IRP Inventory
5. Input Priority Ranked IRP Inventory into P3 Scheduling Software
6. Input Work Off Metrics into the Schedule
7. Develop Final Inventory Reduction Schedule
8. Develop Final Inventory Reduction Cost Projection

Although the IRP was developed for LLW and Industrial Wastes, this paper will only present information on LLW.

INTRODUCTION

The Waste Disposition Project provides for the treatment, storage, and disposition of legacy waste consisting of low-level radioactive waste (LLW), mixed low level waste, hazardous waste, industrial waste, and transuranic waste. Oak Ridge Reservation's (ORR) inventory of legacy waste is the highest in the country for LLW (~40% of DOE's inventory) and is managed by waste types. Each waste type is implemented as a set of projects.

The LLW Disposition Project is divided into three subprojects: (1) Solid LLW Disposition, (2) LLW Process Residues Disposition, and (3) LLW Special Case Waste Disposition. These subprojects provide for the management and disposal of various types of low-level waste consisting of liquids, sludges, soils, debris, metal, remote-handled and classified wastes. The objective of each of the waste disposal subprojects is to characterize, treat (as required) and dispose of all legacy and newly generated low-level waste on the ORR. LLW Treatment will be conducted primarily at off-site commercial facilities or onsite

wastewater treatment facilities. The majority of LLW disposal from ORR will be sent to the Nevada Test Site, Hanford Site, on site landfills, or commercial facilities, such as Envirocare.

Waste treatment and disposal activities are prioritized based on the need to remove waste from areas to be re-industrialized, or that are on the critical path for environmental restoration or decommissioning activities. An initial inventory of approximately 46,325 m^3 of LLW and 848 m^3 of sanitary/industrial waste is stored in approximately 40 storage facilities on the Oak Ridge Reservation (1). As waste is removed from a storage facility, the storage facility will be closed or transferred to another program. It is planned that all inventory of legacy LLW will be disposed by the end of FY 2007, and at steady state the stored inventory will be less than 10 % of one year's worth of generation (i.e., 700 m^3 per year). Low level and industrial wastes generated from remedial actions and decontamination and decommissioning projects are dispositioned directly to treatment or disposal facilities.

Legacy wastes, as defined in the IRP, are materials that were containerized and in the WITS database as corrected by the December 31, 1999 inventory reconciliation and all waste generated until the end of Fiscal Year 2000. Inventory reduction is achieved when waste material is removed from storage and shipped for treatment and / or disposal. The IRP applies to legacy waste materials maintained within storage containers (i.e., cans, pails, drums, boxes, Sea/Land®, tanks, dumpsters, etc.); or scrap/bulk items maintained on skids, pallets, etc. Although the IRP was written to work off inventories of LLW and Sanitary Waste, this paper will only focus on LLW.

BACKGROUND

General Sites Description

The ORR consists of three major DOE facilities, the ETTP (formerly the K-25 Site), ORNL, and Y-12 Plant. Each of these facilities serves a distinct mission from the other with major funding provided by different DOE program offices.

The ETTP was originally constructed in the 1940's for production of highly enriched uranium for nuclear weapons (2). After military production of highly enriched uranium was concluded in 1964, the plant processed only slightly enriched uranium to be fabricated into fuel elements for commercial nuclear reactors. Other missions included development and testing of the gas centrifuge method of uranium enrichment and development of laser isotope separation. By 1985, the demand for enriched uranium had declined; the process was placed in standby mode and formally shut down in 1987. The site is currently managed under DOE-EM Program and future plans are to re-industrialize the site and reuse site assets through lease of vacated facilities (hence the name change to ETTP).

ORNL was built in 1943 with its original mission to produce and chemically separate the first gram quantities of plutonium (4, 6). Today, ORNL is a basic and applied research facility funded by DOE Energy Research and other programs. The main elements of ORNL's mission include activities in each of the following areas: energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education.

The Y-12 Plant was also constructed in the 1940's with its original mission to produce enriched uranium by electromagnetic processing (3, 5). The plant evolved to become a highly sophisticated weapon component manufacturing and development engineering facility. The current mission includes: production of complex components and assemblies; safe and secure storage of nuclear materials; dismantlement, disposition, evaluation, and assessment of weapon components; transition of the plant size

to meet DOE needs; transfer of technology to private industry; and support of other national priorities. The DOE Defense Program has operations and landlord responsibility for the Y-12 Plant.

Description of Waste Streams

The LLW generated on the ORR comes from a variety of activities and is often different in form and radionuclide content among the three sites (8, 9). Efforts were made to identify generating facilities and generating processes. Fig. 1 shows the different waste streams according to WBS levels (10).

- Low Level Wastes are materials that exhibit radionuclide concentrations that are not economically feasible to recover. The types of LLW generated on the ORR can be grouped into three broad categories: solid LLW, process residues, and special case waste.

- Solid LLW consist of six waste categories: construction debris, dry active waste, radioactive scrap metal, soils, non-regulated chemicals and lab packs, and uranium oxide.

- Process residues consist of six waste categories: wastewaters, organic liquids, sludges/treatment residues, monoliths, resins/trapping materials, and volume reduction residues.

- Special case waste consists of four waste categories: fissile, remote handled, classified, and contact handled alpha.

Description of Waste Generating Processes

The majority of LLW generated on the ORR are either a direct or indirect result of current operations conducted at the three sites as well as from remediation and D&D activities conducted as the result of former operations (7). No readily available historical documentation exists regarding generation processes including the radiological and chemical hazards associated with the waste. This would require an intensive records search and current / former personnel interviews, which are not within the scope of this document.

LLW generating processes at the ETTP includes building demolition/reuse, waste operations, legacy waste storage, and environmental restoration. Wastes generated as the result of these processes primarily contain depleted uranium, enriched uranium, and technetium.

ORNL LLW generating processes includes research laboratory operations, waste operations, legacy waste storage, and environmental restoration. These generating activities result in waste contaminated with multiple radionuclides including, but not limited to, Cesium-137, Cobalt-60, Strontium-90, Beryllium-7, Uranium-233, and Europium.

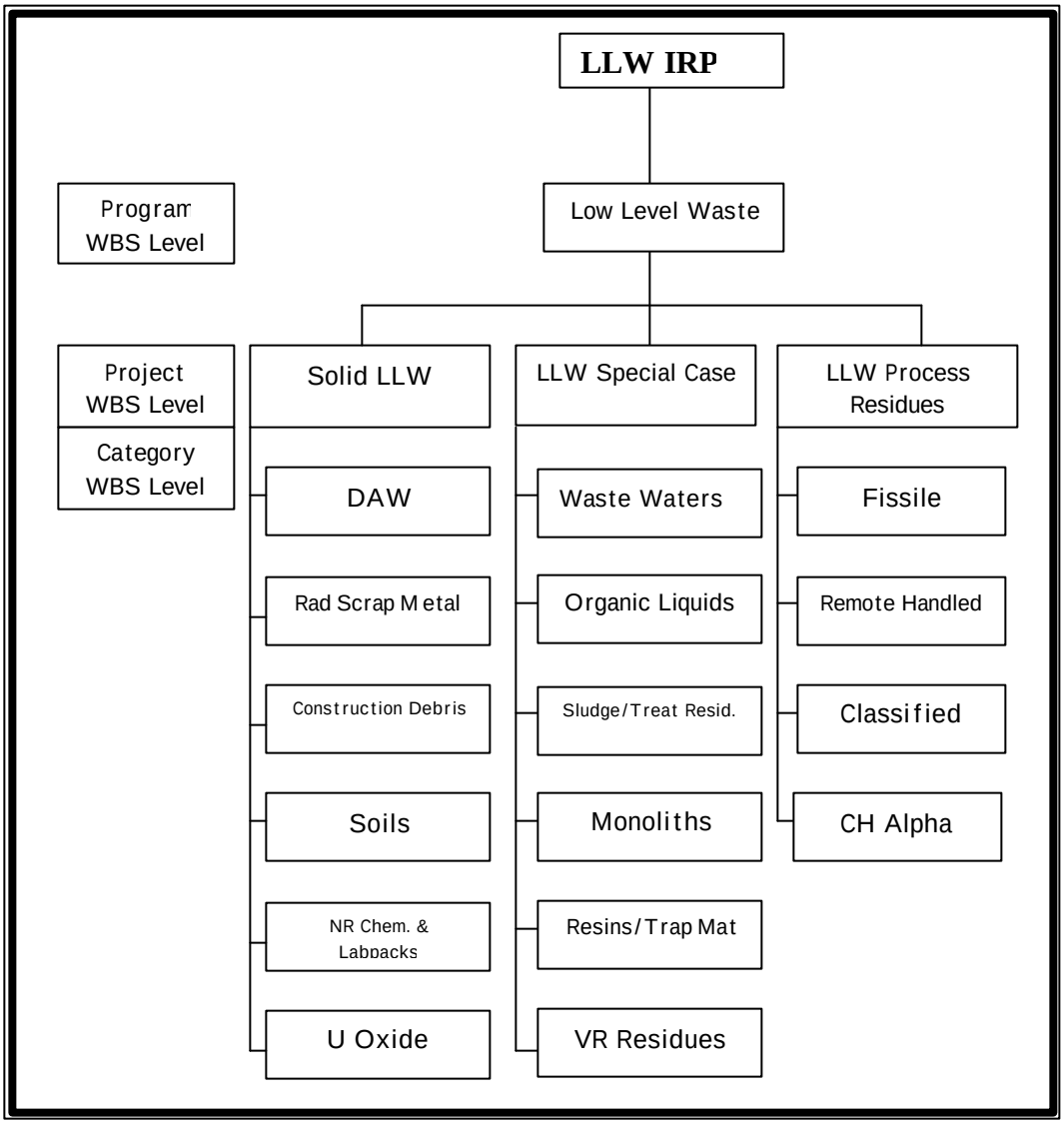

Fig. 1. WBS Layout of LLW Projects

The Y-12 Plant LLW generating processes includes nuclear defense machining and manufacturing work, waste operations, legacy waste storage, and environmental restoration. LLW generated at the Y-12 Plant may contain depleted uranium, enriched uranium, and thorium.

Overview of LLW Disposal Practices (11, 12, 13)

Historically, Oak Ridge had disposal facilities at all three plant sites. Between the mid-1980's and 1992, all disposals except for the tumulus disposal facilities at ORNL were phased out due to performance

assessment restrictions. The limited capacity and high cost associated with the tumulus disposal technology have resulted in OR aggressively pursuing offsite disposal capability since 1992.

In 1992, DOE-HQ designated OR as an NTS generator. The initial waste stream identified to be sent to Nevada was the monoliths from ORNL. As a result, the ORNL LLW Certification Program was developed and approved by NTS in 1994. In 1995, a lawsuit was filed against the DOE by the State of Nevada that resulted in the NTS EIS ROD allowing only current generators to ship waste. ORR had not yet shipped any waste and was therefore banned from shipping until the PEIS RODs were issued. The PEIS ROD was issued in February 2000 giving ORR access to NTS for approved wastestreams. Shipment of the monoliths commenced in April 2000. It is anticipated that during 2001, waste shipments targeted for commercial disposal will be phased into NTS as the profiles are approved.

In the interim, OR has volume reduced waste at GTS Duratek using metal melt, incineration, and compaction technology. Commercial disposal was also pursued. Since the resolution of the Waste Control Specialists (WCS) lawsuit in 1998, some wastes have been disposed of at Envirocare of Utah through both the U.S. Army Corps of Engineers and the DOE Ohio contracts. To date, the ORR has five LLW profiles approved for disposal at Envirocare (Portsmouth soil, soils, debris, PWTP filtercake, and uranium oxide). Several additional profiles are in various stages of development.

IRP DEVELOPMENT METHODOLOGY (15)

Inventory Reduction Plans have been developed for both the Idaho National Engineering Laboratory and the Fernald Environmental Management Project. These IRPs provided a basic model for development of the ORR IRP. The IRP provides guidance on the scope of work and resources needed to reduce the current inventory on a yearly basis. This Inventory Reduction Plan report was developed using the methodical and logical approach outlined below:

a) Develop IRP Inventory
b) Develop Work Off Priorities
c) Develop Priority Ranking System
d) Apply Priority Ranking System to IRP Inventory
e) Input Priority Ranked IRP Inventory into P3 Scheduling Software
f) Input Work Off Metrics into the Schedule
g) Develop Final Inventory Reduction Schedule
h) Develop Final Inventory Reduction Cost Projection

Develop The IRP Inventory

This IRP segregates the legacy and newly generated LLW inventories into waste categories that were developed from existing databases used on the ORR for tracking and reporting the waste inventory. The databases used to develop the IRP database were:

- Waste Information Tracking System (WITS), and
- Environmental Management & Waste Inventory Reporting (EMWIR)

Table I shows the resultant IRP inventory by Waste Category (WBS Level 7) with total number of containers in each category, volume, anticipated treatment that may be required for final disposal, and the anticipated disposal sites. Data was based on information compiled for the 12/31/99 inventory.

Table I. LLW Categories, Containers and Final Disposition				
Waste Category	**# of Containers**	**Volume m^3**	**Planned Treatment**	**Planned Disposal**
Solid LLW				
- Construction Debris	2,008	3,067	None	Envirocare
- Dry Active Waste	5,906	10,079	Onsite/Offsite	Envirocare & NTS
- Rad Scrap Metal	6,686	20,725	Onsite/Offsite or None	NTS
- Soils	2,927	1,891	None	Envirocare
- NR Chemicals & Lab Packs	1,227	1,607	Onsite or None	Envirocare & NTS
- Uranium Oxide	168	1,036	Onsite or None	Envirocare & NTS
Process Residue				
- Wastewaters	235	57	Onsite	Waste Ops Dispose
- Organic Liquids	360	66	Onsite/Offsite	Burned
- Sludge/Treat Residues	2,497	1,348	Onsite or None	Envirocare & NTS
- Monoliths	254	2,607	Onsite or None	NTS
- Resins/Trap Materials	439	203	None	NTS
- Vol Reduc Residues	1,480	3,316	None	NTS
Special Case Waste				
- Fissile	505	13	Onsite or None	NTS
- RH Waste	49	65	None	Hanford & NTS
- Classified Waste	52	170	None	NTS
- CH Alpha	21	75	None	NTS
TOTALS	24,814	46,325		

The following steps were then taken to develop the priority system and apply it to the inventory database.

- ***Develop Priority Ranking System:*** The ranking system used qualitative measurement scales developed for each of the primary priorities developed and applied to the individual waste streams. Table II lists the scoring areas, the possible and impossible combinations (i.e., waste identified to be characterized in FY 2000 C=1 and waste currently being shipped S=0 is not possible so the storage location score is irrelevant and is designated as L=X) for LLW.

- ***Apply Priority Ranking System to IRP Inventory:*** Once the priority ranking system was developed, it was applied to each of the 161 LLW streams.

Develop Work Off Priorities (14)

Priorities were developed at two levels for the IRP; Primary and Secondary as shown in Table III. The first priority in developing the IRP was to consider the health and safety of the workers and the environment. The other primary priority was the critical path established using the D&D Schedule and the strategy for reducing the storage footprint and includes the following inventory reduction objectives:

a) Continued removal of scheduled FY 2000 legacy waste (i.e., Monoliths, Soils)
b) Removal of newly generated waste with approved waste profiles to NTS or Envirocare
c) Removal of waste from K-25 Building by end of FY 2001
d) Removal of waste from K-27 Building by end of FY 2001
e) Removal of Y-12 salvage yard scrap metal by end of FY 2004
f) Removal of waste from SWSA 6 in FY 2005

Table II. LLW Prioritization Scoring

Characterization Scores = (C)				**Priority Ranking**	**Possible Score Combinations**		
0	Ready to Ship				**C**	**S**	**L**
1	Characterization in FY2000 Funded			1	0	0	0
2	Requires Review of Data for Adequacy			2	0	0	3
3	Limited Characterization Data Available			3	0	1	0
Shipping Scores = (S)				4	0	2	0
0	Currently Being Shipped			5	1	2	0
1	Ready to Ship (No Funding)			6	2	2	0
2	Not Ready to Ship			7	3	2	0
Storage Location Scores = (L)				8	0	0	1
0	K-25 Building			9	0	1	1
1	SWSA 6			10	0	2	1
2	Y-12 Scrap Yard			11	1	2	1
3	Stored Outside			12	2	2	1
4	Other			13	3	2	1
"Can't Have" Combinations				14	3	2	2
C	**S**	**L**		15	0	1	3
0	0	2		16	0	2	3
0	1	2		17	1	2	3
0	2	2		18	2	2	3
1	0	X		19	3	2	3
1	1	X		20	0	0	4
1	2	2		21	0	1	4
2	0	X		22	0	2	4
2	1	X		23	1	2	4
2	2	2		24	2	2	4
3	0	X		25	3	2	4
3	1	X					

Table III. IRP Priorities

Priority Rank	**Priority**	**Driver(s)**
Primary	- Health and Safety of Workers - Critical Path	Health & Safety, D&D schedule
Secondary	- Liquids - Waste with residual moisture - Storage facility maintenance costs	Container integrity concerns, Storage footprint reduction

- ***Develop Disposition Pathways:*** Seven strategic waste disposition pathways (Fig. 2) were also created that showed what activities (such as characterization, treatment, disposal) were required to disposition the waste stream to final disposal. Waste streams with similar rankings were grouped together with a total of 25 priority groups for low level waste.

The pathways provide an integrated set of functions necessary to move the waste from storage to final disposal. The main functions for disposal of LLW are characterization, preparation for shipment, shipment, treatment, and disposal. (Table IV).

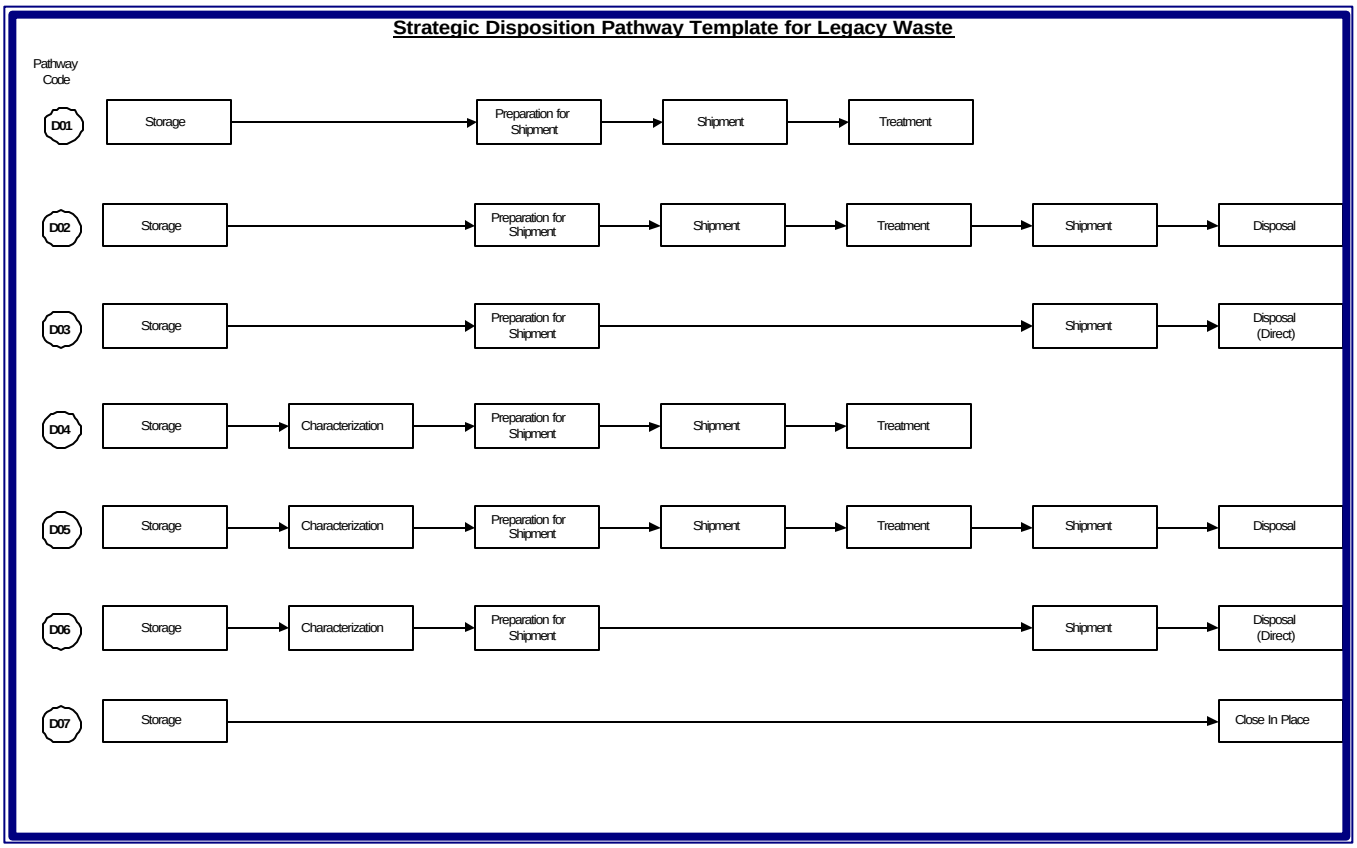

Fig. 2. Strategic Disposition Pathways

- ***Input Priority Ranked IRP Inventory into P3 Scheduling Software:*** Once the waste streams were ranked according to priority, and disposition pathways integrated, the information was input into Primavera Project Planning (P3) software. The waste streams were then 'scheduled' according to ranking and the disposition pathways.

- ***Input Work Off Metrics into the Schedule:*** Once the schedule was completed in P3, work off metrics (Table V) were developed and incorporated. Work off metrics assigned a time frame for each disposition pathway element. The metrics allowed assignment of cost, time, and resources and provided an overall review of the inventory reduction at a waste stream level (WBS level 8).

- ***Develop final Inventory Reduction Schedule:*** The final inventory reduction schedule was developed with all data entered into the scheduling program. A review of the schedule as dictated by the logic and methodology used, was completed to provide a final cut of the reduction plan.

Table IV. Disposition Pathway Descriptions		
Pathway	**Description**	**Steps**
Storage	The objective of this function is the collection and containment of the waste for the purpose of awaiting treatment or disposal capacity, in a manner as not to constitute disposal of the waste.	
Characterization	The objective of this function is to define the physical, chemical, radiological, and other characteristics of the waste and the process for collecting the data as defined by the waste acceptance criteria of the treatment or disposal facility. Activities included in the characterization function are as follows:	Review of process knowledge
		Develop Sampling and Analysis Plan
		Stage containers for sampling
		Evaluation of containers
		Sampling containers
		Analysis of waste samples
		QA/QC of analytical data
		Prepare Waste Analysis Report
		Evaluate characterization data against TSDF WAC
Preparation for Shipment	The objective of this function is to prepare the waste inventory to be ready for transfer to the treatment and disposal facility. Activities necessary to qualify the waste inventory as ready for shipment include:	Staging containers
		Overpacking (if needed)
		Certification of waste container against TSDF WAC
		Prepare shipment paperwork
Shipment	The objective of this function is to load and transport the waste containers to the destination treatment or disposal facility.	
Treatment	The objective of this function is to change the physical or chemical characteristics of the waste to render it less hazardous, safe for transport, storage, or disposal, or to reduce the volume. Treatment methods for LLW include:	Sorting and segregation
		Shredding
		Compaction
		Incineration
		Decontamination
		Physical-chemical methods for the treatment of wastewater.
Disposal	The objective of this function is for the emplacement of the waste in a manner that ensures protection of the human health and the environment within prescribed limits for the foreseeable future with no intention of retrieval and that requires deliberate action to gain access. Direct disposal is used when the waste inventory is disposed without treatment.	
Closure In Place	This disposition pathway function applies to the Y-12 uranium oxide vault. This may involve capping the top of the waste form inside, then sealing the vault for closure.	

Table V. Disposition Pathway Metrics						
Pathway Code	Storage	Characterization Days/population	Preparation for Shipment	Shipment	Treatment	Disposal
D01	On going	--	5 days/ship	2 days/ship	5 days/ship	--
D02	On going	--	5 days/ship	2 days/ship	5 days/ship	5 days/ship
D03	On going	--	5 days/ship	2 days/ship	--	5 days/ship
D04	On going	60 or 20 days	5 days/ship	2 days/ship	5 days/ship	--
D05	On going	60 or 20 days	5 days/ship	2 days/ship	5 days/ship	5 days/ship
D06	On going	60 or 20 days	5 days/ship	2 days/ship	--	5 days/ship
D07	On going	--	--	0 days	--	Closure in Place
Assumptions:	1. One shipment contains 30 m^3					
	2. Characterization is 60 days for sampling and analysis or 20 days for document review.					

- ***Develop final Inventory Reduction Cost Projection:*** Using the results of the Life Cycle Baseline process, unit costs were developed for characterization, preparation for shipment, shipment to treatment, treatment, shipment to disposal, and disposal functions within the waste disposition process. These unit values were used with the planned waste disposition volumes to develop cost projections for the disposition of each waste category and waste stream. The final Inventory Reduction Plan is presented in Table VI showing work-off by storage location and fiscal year, and Table VII showing work-off by waste category and fiscal year.

Table VI. Legacy LLW Inventory Reduction by Storage Location

			Waste Inventory Reduction (m^3)					
Waste Removal Objective	**Baseline Inventory (12/31/99)**	**FY2000 Projected Ending Inventory**	**FY2000**	**FY2001**	**FY2002**	**FY2003**	**FY2004**	**FY2005**
Continue FY2000 Schedule			2,540					
From K-25 Bldg	4,123	2,671	1,452	2,671	-	-	-	-
From K-27 Bldg by	92	92	-	92	-	-	-	-
From Y-12 Scrap Yard	12,543	12,543	-	-	-	6,271	6,272	-
SWSA 6	3,784	3,784	449	259	681	1,157	801	437
Total Legacy LLW	46,325	51,521	2,540	4,219	1,672	10,021	10,539	7,093
Newly Generated Waste with Approved Waste Profiles	-	-	-	6,947	7,709	7,713	7,713	7,704

CONCLUSION

In the past, because of limited available disposal capacity, very little LLW that was sent to storage was characterized for purposes of disposal, but rather, was characterized for storage purposes. Substandard waste characterization and documentation provide additional obstacles when formulating a work-off plan for final waste disposition. For example, waste documents do not necessarily reflect the process, facility, or point of generation. Low level and industrial wastes generated from remedial actions and decontamination and decommissioning projects are dispositioned directly to treatment or disposal facilities.

Table VII. Legacy LLW Inventory Reduction by Waste Category							
	Waste Inventory Reduction (m^3)						
Waste Category	**Inventory (12/31/99)**	**FY2000**	**FY2001**	**FY2002**	**FY2003**	**FY2004**	**FY2005**
Solid LLW							
Dry Active Waste	10,079	-	791	-	1,627	1,627	2,634
Rad Scrap Metal	20,725	1,285	240	-	6,271	6,272	2,321
Construction Debris	3,067	-	153	163	721	721	721
Soils	1,892	749	453	224	237	237	345
NR Chem & Lab Packs	1,607	-	264	262	287	289	287
U Oxide	1,036	26	5	-	3	5	10
Process Residues							
Wastewaters	57	-	25	-	33	-	-
Organic Liquids	66	-	35	-	-	132	-
Sludges/Trtmnt Residues	1,348	378	293	208	285	-	374
Monoliths	2,607	102	245	245	525	1,115	375
Resins/Trping Materials	203	-	89	13	-	99	-
Vol Reduction Residues	3,316	-	1,535	556	-	-	-
Special Case Waste							
Fissile	13	-	16	-	-	-	-
RH Waste	65	-	-	-	30	30	15
Classified	170	-	1	1	3	11	11
CH Alpha	75	-	75	-	-	-	-
TOTAL LLW IRP	46,325	2,540	5,098	1,672	10,021	10,539	7,093

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