Advanced Fuel Cycle Cost Basis Report: Module J Near Surface Disposal

Nuclear Fuel Cycle and Supply Chain

Prepared for

U.S. Department of Energy

Systems Analysis and Integration

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Revision 1

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
	2004	All	Version of AFC-CBR in which Module first appeared: 2004 as Module J. In 2004 and 2005 only rough capital and O&M data were presented. Unit cost ($/m3) data based on an actual design and cost estimate first appeared in the 2006 AFC-CBR.
	2006	All	Latest version of module in which new technical data was used to establish unit cost values: 2006
			New technical/cost data which has recently become available and will benefit next revision: • The US LLW disposal industry has been undergoing turbulence lately with possible buyouts, lawsuits, and bankruptcies complicating the business outlook. The major players are Energy Solutions (Utah) and Waste Control Services (Texas). It would also be useful to revisit the fees (or calculated unit costs) charged by USDOE sites for the disposal of materials originating at Government sites.
	2021	All	Re-formatted module consistent with revised approach to release of the AFC-CBR and escalated cost estimates from year of technical basis to escalated year 2020. Cost estimates are in US dollars ($) of year 2020.

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ACKNOWLEDGEMENT

This latest version of the Module J Near Surface Disposal is the result of the cumulative effort of many authors that have contributed to the Advanced Fuel Cycle Cost Basis Report (AFC-CBR). It is not possible to identify and acknowledge all those contributions to the AFC-CBR and this module. All the authors, including the four primary authors, fifteen contributing authors, the twelve contributors acknowledged, and the many other unacknowledged contributors in the 2017 version of the report may have contributed various amounts to the development and writing of this module prior to this current revision. Unfortunately, there is not a consolidated history that allows us to properly acknowledge those that built the foundation that was updated and revised in this latest revision.

This update reformats previous work to the current format for rerelease of the entire report as individual modules so there is no primary technical developer or lead author. J. Hansen (INL) and E. Hoffman (ANL) can be contacted with any questions regarding this document.

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TABLES

ACRONYMS

DOE	U.S. Department of Energy
GCD	Greater Confinement Disposal
GTCC	Greater Than Class C
LLW	Low-level waste
O&M	operations and maintenance
TRU	transuranic
WIT	What-It-Takes

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Module J
Near Surface Disposal

J-MD. SHORT DESCRIPTION OF METHODOLOGY USED FOR ESTABLISHMENT OF MOST RECENT COST BASIS AND UNDERLYING RATIONALE

- **Constant $ base year 2020 for this FY21 update.**
- **Nature of this 2017 Module update from previous AFC-CBRs:** Escalation only.
- **Estimating Methodology for latest (2006 AFC-CBR) technical update from which this FY21 update was escalated:** Bottom-up pre-conceptual design and cost estimate for a commercial Greenfield LLW disposal site. Pricing data from US Private Companies and fees charged by USDOE disposal sites were also used to establish the "What-it-takes" unit cost values for the final geologic disposal of Low Level Waste.

J-1. BASIC INFORMATION

Low-level waste (LLW) is disposed in shallow, or "near surface," disposal trenches. The trenches are lined, accessible by truck, and have an earthen cover. Currently, both U.S. Department of Energy (DOE) and commercial (Nuclear Regulatory Commission or state licensed) LLW disposal sites exist in several locations across the country. However, for the purposes of this module, costs were developed for a new or "greenfield" site, with a comparison to available cost data of existing disposal sites. LLW arrives prepackaged in 1.22 × 1.22 × 2.33-m (4 × 4 × 7-ft) containers and is buried in shallow (8-m) trenches for near surface disposal. Each trench or pit can hold approximately 146,000 m^3 of waste (46,000 containers).

J-2. FUNCTIONAL AND OPERATIONAL DESCRIPTION

Figure J-1 shows a simple diagram of the functional flow. Waste material arrives in trucks prepackaged in standard waste (4 × 4 × 7-ft) containers. Containers are unloaded in the pit and stacked along the long wall for burial. Figures J-2 and J-3 illustrate typical operations for near surface disposal facilities. Figure J-4 provides an example of a typical near surface disposal layout, for which cost estimates were developed.

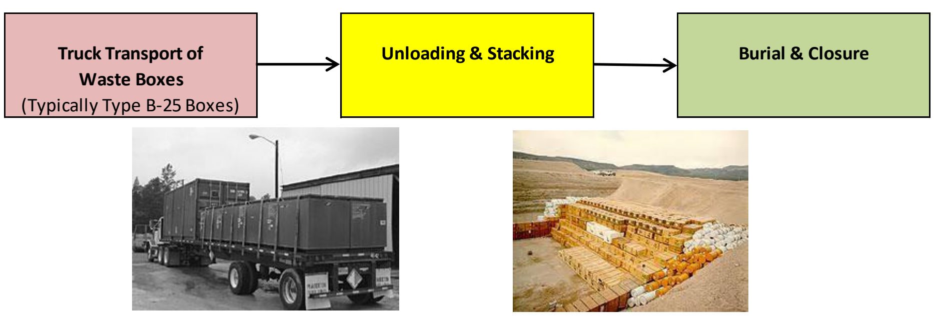


Figure J-1. Functional block diagram for near surface waste disposal.

J-3. PICTURES AND DIAGRAMS

Figure J-2. Low-Level Waste operations at Nevada Test Site (State of Nevada 2009). The NTS has been renamed by the Department of Energy to the Nevada National Security Site

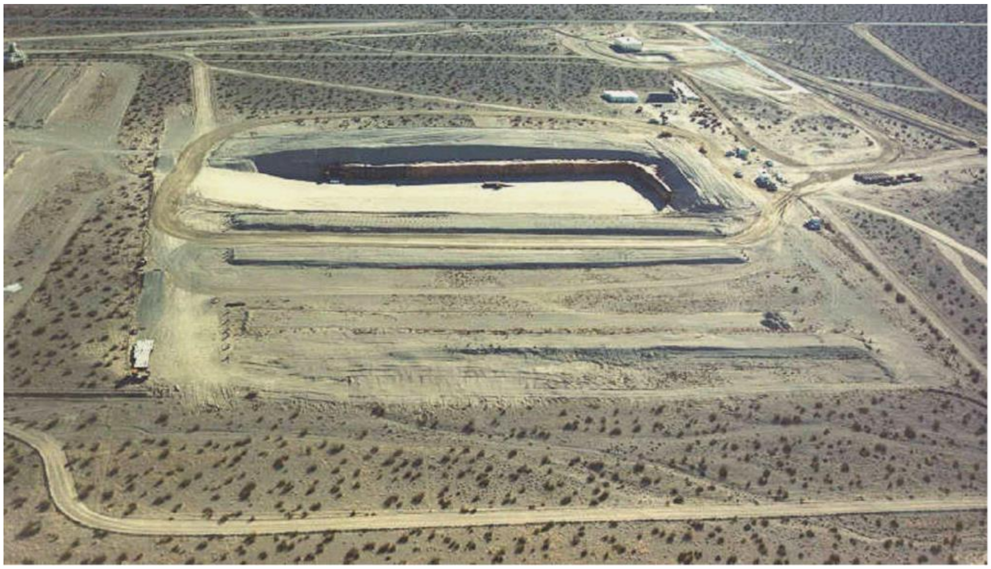


Figure J-3. Nevada Test Site (Nevada National Security Site) low-level waste disposal facility aerial view (State of Nevada 2009).

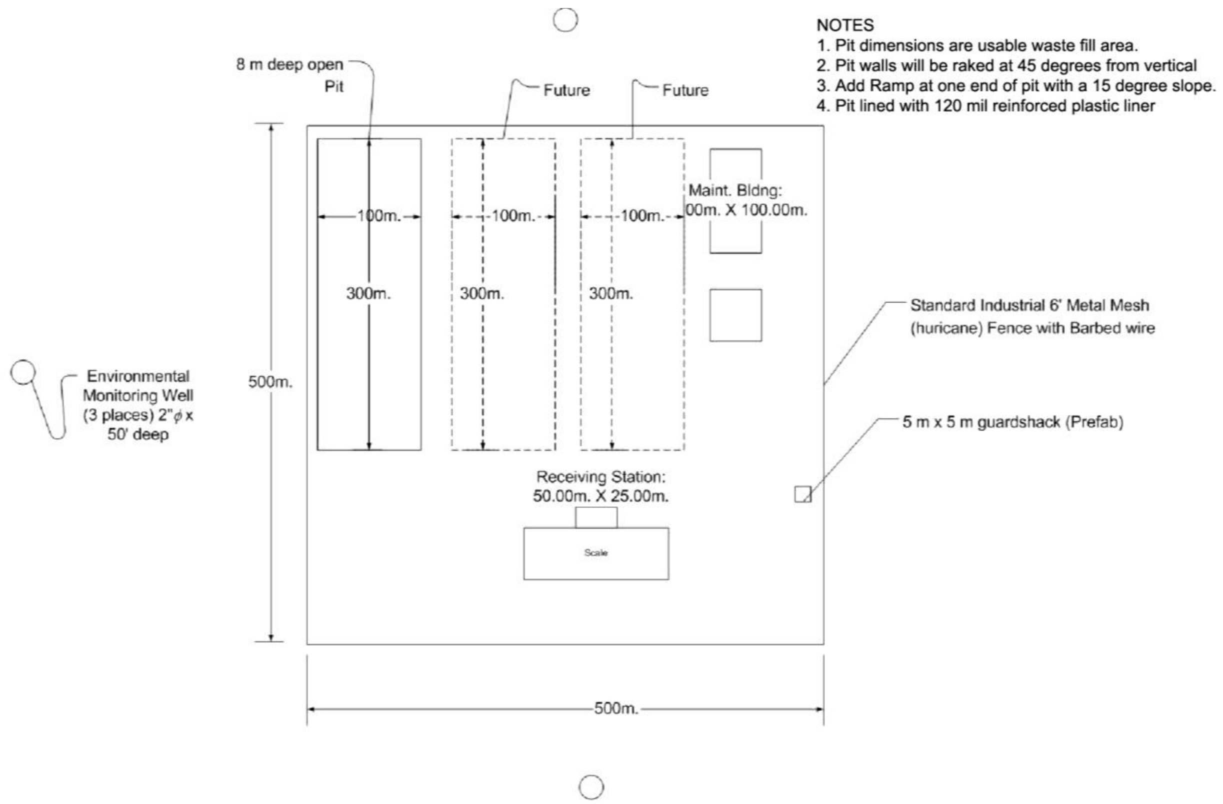


Figure J-4. Typical near surface disposal site dimensions.

J-4. MODULE INTERFACES

Low-level waste is material that has been slightly contaminated by radioactive material. It typically consists of clothing worn in contaminated (or potentially contaminated) areas, tools, cleaning supplies, and other contaminated disposable items. It can be generated at any nuclear facility, but the bulk will probably be generated at reprocessing plants (Module F), fuel fabrication plants (Module D), and reactors (Module R).

Module G-3 covers the cost of treating and packaging various types of contaminated materials (bulk solids/debris, liquids, and resins) for disposal as LLW. **So as not to be confused with the G3 Module the J Module covers only the capital and operating expense of the final LLW burial site.** Transportation (Module O2), LLW containers, and ancillary expenditures are excluded. Bulk depleted uranium from enrichment operations and clean REPU from reprocessing operations can also be disposed of as LLW, but the expectation is that it will be dispositioned in special areas of a LLW site due to its higher bulk density and slightly increasing specific activity.. Module K discusses these options in detail. Module J is a terminal module in that nothing leaves once it has been accepted. It should be noted that the majority of disposal containers, sometimes called “B-25 boxes” are relatively inexpensive compared to the disposal operation costs, and they are commercially available from multiple manufacturers.

Module J may also potentially be used to dispose of materials that exceed the general classification of LLW. In the United States, radioactive waste is generally categorized as one of three classes:

1. Spent nuclear fuel or the high-level waste resulting from the processing of spent nuclear fuel.
2. LLW, which is further subdivided into three successively stringent classes (Class A, Class B, and Class C) based on quantities and activities of the constituents.

3. Material that is in excess of the highest category of LLW (Class C), which is generally referred to as Greater Than Class C (GTCC) waste. The Code of Federal Regulations lacks clarity with regard to disposal of GTCC waste, which is commonly interpreted as being material destined for the mined geologic repository (Module L). However, it is possible to safely dispose of GTCC material without using valuable repository space by burying the waste at intermediate depths (~35 m), referred to as Greater Confinement Disposal (GCD). This document does not provide costs for GTCC disposal because such costs remain highly speculative until greater specificity is provided by the regulations or by licensing decisions.

The following historical summary regarding disposal of GTCC waste is provided for informational purposes. From 1984 until 1989, intermediate depth disposal operations were conducted by DOE at the Nevada Test Site (Now Nevada National Security Site). The operations emplaced high specific-activity low-level radioactive waste and limited quantities of transuranic (TRU) waste in GCD boreholes.

The GCD boreholes are about 3 m (10 ft) in diameter and 36 m (120 ft) deep, of which the bottom 15 m (50 ft) were used for waste emplacement and the upper 21 m (70 ft) were backfilled with native alluvium. The boreholes are situated in a thick sequence of arid alluvium of which the bottom is almost 200 m (650 ft) above the water table at the Nevada Test Site—one of the most arid regions of the U.S.

Following emplacement, a performance assessment was completed to determine whether the TRU waste posed a danger to human health, the requirements of which are defined under the U.S. Environmental Protection Agency (EPA) Code of Federal Regulations, Title 40, Part 191 Subpart B promulgated in 1985. The primary conclusions of the performance assessment were that disposal of TRU waste in intermediate depth GCD boreholes in the Nevada Test Site setting easily provides isolation under the 10,000-year Containment Requirement, and potential doses under the Individual Protection Requirements in the 1,000-year regulatory timeframe are almost insignificant.

Although there are currently no dedicated federal or commercially licensed facilities to dispose of GTCC materials, it is anticipated such facilities will become available in the near future, particularly for the eventual very large volumes expected from the decontamination and decommissioning of aged nuclear plants, including conversion, enrichment, reactors, reprocessing, and fuel fabrication facilities.

J-5. SCALING CONSIDERATIONS

The traditional exponential scaling factor is not applicable to this type of facility. Capacity increases are generally accomplished by increasing the number of pits, rather than by increasing the size of a single pit. Consequently, the capital cost of the facility is better expressed as a cost for a one-pit facility plus an incremental cost for each pit after the first one. For example, the capital cost for the facility estimated here is $52.19M + $29.79M • (N – 1), where N is the number of pits.

J-6. COST BASES, ASSUMPTIONS, AND DATA SOURCES

Credible partitioned costs for near-surface disposal facilities are not readily available in the literature, so an estimate was developed from the bottom up based on the Nevada Test Site facility diagrammed in Figure J-4. The following assumptions apply:

1. Facilities will be located on existing nuclear facility sites, remote federal lands, or remote private lands. In all cases, land cost is an insignificant factor and is ignored.

2. All waste arrives in 1.22 × 1.22 × 2.33-m (4 × 4 × 7-ft) rectangular standard waste boxes known as "B-25 Crates of B-25 Boxes" (Figure J-2), the cost of which is covered under LLW transportation.

3. All material is transported by truck to the site.

4. The estimate includes groundwater-monitoring wells, which may or may not be required.

Each pit can contain approximately 146,000 m^3 of waste based on standard B-25 boxes stacked four high and covered with a 2.4-m-thick cap.

Table J-1 shows the estimated operating costs for a near surface disposal facility. The estimated operating cost is $2,500,000 per year in 2006 dollars, with a discounted cost of $171.5/m^3 for a 460,000 m^3 capacity facility having a life of 30 years. Staffing and cost are based on interviews with Sandia National Laboratories personnel who are involved with storage facilities operations.

Table J-1. Estimated operating costs (2007 dollars/year).

Cost Description	Rate	Units	Quantity	Extension
Direct labor				
Manager	$86,500	$/year	2	$173,000
Waste Acceptance	$65,200	$/year	8	$521,760
Heavy Equipment	$27.00	$/hour	4,160	$112,320
Miscellaneous Support	$13.50	$/hour	4,160	$56,160
Subtotal				$863,240
Overhead and Support @ 1.25				$1,079,050
Total Labor				$1,942,290
Fuel	$3.00	$/gallon	25,000	$75,000
Repair to Operating Equipment				$25,500
				$2,042,790
Allowance Unforeseen Expenses @ 25%				$510,700
				$2,553,490
Regulatory @ 135%				$3,447,200
Total (rounded)				$6,000,000

In addition to the costs shown in Table J-1, it is likely that costs for security, regulatory compliance, etc. will be incurred as part of a “facility charge” imposed by the federal or state site upon which the facility is located. As an example, the Hanford LLBG has annual operating costs of $3.1M and “regulatory” costs of $4.2M, or 135% of the operating cost. When this factor is applied, the annual costs are $6M.

Table J-2, on the next page, provides a cost estimate provided to Sandia by F. Wingate. The basic estimate is for three pits. The estimate was then adjusted, as shown in the last two columns, for just one pit. It was assumed that the surface facilities occupy approximately the same area as one pit. Thus, the area of a one-pit facility will be half that of a three-pit facility. By the same token, the fencing required for a one-pit facility will be 75% that of a three-pit facility. Table J-3 takes the results from Table J-2 and completes the cost estimate to include contingency and some “administrative” items. By taking the difference between the cost for three pits and the cost for one and dividing the result in half, the incremental cost for additional pits can be determined to be approximately $34.2M.

The amount of waste generation per year is an estimate. As described at their Web site (DOE 2005), the Nevada National Security Site facility accepts approximately 35,000 m^3 per year (actually, less than 1 million ft^3) with two pit systems operational. Hence, each trench is accepting about 17,000 m^3 per year. This was taken to be a “reasonable” receipt rate and reduced slightly in the present analysis to 14,600 m^3/year to accommodate a 10-year fill time for a single pit.

In addition to the capitalized costs to open the facility, it will be necessary to fund its closure and any long-term stewardship costs that might be imposed. The Hanford LLBG estimated $317,000/acre to close, INL estimated $400,000/acre, and SRS estimated $430,000/acre (DOE 2002). Based on Figure J-3, this facility encompasses 61.75 acres, so its cost to close will be $24.7M at $400,000/acre. Various sites have estimated long-term stewardship costs at $0.5M/acre for 100 year ($50M) while Tennessee imposes a cost of $1M for 10 years ($10M) (DOE 2002). This study uses $50M.

It is now possible to combine the operating costs from Table J-1 and the capital costs from Table J-3 to estimate the life cycle costs presented in Table J-4. Table J-4 contains a present value analysis showing each capital cost outlay and the operations and maintenance (O&M) expenditures per year with inflation, taxes, and discount factors included. Inflation is assumed to be 2% per year and the discount factor used in the analysis is 15%, which should be sufficient to allow a reasonable return on investment and some profit. The unit cost (which also escalates annually) is approximately $1,245/m^3. This compares well with Table J-5, providing a sort of “mid-range” estimate as compared to the many examples in the table.

The bottoms-up estimate shown in Table J-3 is accurate for the scope presented to within a range of 30% high or low.

Table J-2. Detailed capital cost estimate in 2003 dollars for near-surface disposal facility.

File Name: Detail Worksheet								
Code	Description	Quantity	Unit	Matl/Equip Unit Cost	Material/ Equipment	Labor	One Only Mat/Equip	One Only Labor
1	Clear Site w/dozer. Medium clearing.	61.82	AC	110.00	$6,800	$3,555	$6,800	$3,555
2	Grade Site, 200-ft haul	299,209.00	SY	0.67	$200,470	$80,786	$100,235	$40,393
3	Excavate 3/ea 100 × 300 × 30-m pits.	4,594,287.00	CY	3.28	$15,057,776	$9,351,671	$5,019,259	$3,117,224
4	Haul Excavated Material (1 mile RT w/12 CY dump truck)	4,594,287.00	CY	2.14	$9,831,774	$5,177,761	$3,277,258	$1,725,920
5	Spread fill, w/dozer 300 HP, 300-ft haul	4,594,287.00	CY	1.88	$8,637,260	$2,756,572	$2,879,087	$918,857
6	Fence, Chain Link, Sch.40, 3 Strands of Barbed wire, 6 ft H	6,500	LF	19.53	$126,926	$26,761	$95,195	$20,070
7	Gates, allowance	2	EA	7,000.00	$14,000	$6,000	$14,000	$6,000
8	Truck scale	1	EA	35,000.00	$35,000	$15,000	$35,000	$15,000
9	Concrete foundation for above	1	EA	4,700.00	$4,700	$8,900	$4,700	$8,900
10	Receiving station, all in cost	13,500	SF	106.00	$1,431,000		$1,431,000	
11	Maintenance building	32,400	SF	83.00	$2,689,200		$2,689,200	
12	Guard shack, all in cost, allowance	1	EA	100,000.00	$100,000		$100,000	
					$38,128,106	$17, 423,452	$15,651,733	$5,852,365
	FREIGHT ALLOWANCE @ 0%							
	DESIGN DEVELOPMENT @ 10%				$3,812,810	$1,742,350	$1,565,173	$585,237
	CONTRACTOR INDIRECT @ 35% LABOR/10% OF MATERIAL				$4,194,092	$6,708,031	$6,025,917	$2,253,161
	TOTAL				**$46,135,008**	**$25,873,833**	**$23,242,823**	**$8,690,762**

Table J-3. Summary capital cost estimate for near-surface disposal facility.

Description	Factor	Labor Hours	Three $ × 1,000s Cost	One Only $ × 1,000s Cost
Equipment			$46,135	$23,243
Material			w/above	w/above
Labor	60.00	431,230/144,850	$25,874	$8,691
Total Field Cost		351,445	$72,009	$31,934
Construction Mgmt/Procurement @ % of Field	3%		$2,160	$958
D.E./P.M. @ % of Field Cost	12%	100,840	$8,641	$3,832
Total Directs			$82,810	$36,724
Owners Field (5% Craft Hours) @ $/hour	80.00	21,561/7,243	$1,725	$0
Owners Home Office (5% Direct Cost)			$4,141	$1,836
Total Owners Cost			$5,866	$2,415
Total Dir. + Owners			$88,676	$39,139
Environmental Permitting@ % of Above	3.00		$2,660	$1,174
Licensing @ % of Above	0.00		$0	$0
Total Allowances			$2,660	$1,174
Total Dir.+Owners+Allow			$91,336	$40,313
Startup & Testing @ % Above	0.00		$0	$0
Total in 2003 Dollars			$91,336	$40,313
Escalation/Rounding	11.6%		$10,595	$4,676
Total in 2007 Dollars			$101,931	$44,989
Contingency	20.0%		$20,386	$8,998
Grand Total			$122,317	$53,987

Table J-4. Present value analysis (escalation at 2%/yr, and a 15% discount factor).

Year	Capital Cost	O&M	Boxes/year	Annual Volume	Revenue	Pretax Income	Depreciation	Tax	Cash Flow	Present Value
0	-$53,987								-$53,987	-$53,987
1		-$6,120	4,600	14,600	$18,615	$12,495	-$5,399	-$2,839	$9,656	$8,397
2		-$6,242	4,600	14,600	$18,987	$12,745	-$5,399	-$2,938	$9,806	$7,415
3		-$6,367	4,600	14,600	$19,367	$13,000	-$5,399	-$3,040	$9,959	$6,548
4		-$6,495	4,600	14,600	$19,754	$13,260	-$5,399	-$3,144	$10,115	$5,783
5		-$6,624	4,600	14,600	$20,149	$13,525	-$5,399	-$3,251	$10,274	$5,108
6		-$6,757	4,600	14,600	$20,552	$13,795	-$5,399	-$3,359	$10,437	$4,512
7		-$6,892	4,600	14,600	$20,964	$14,071	-$5,399	-$3,469	$10,602	$3,986
8		-$7,030	4,,600	14,600	$21,383	$14,353	-$5,399	-$3,582	$10,771	$3,521
9		-$7,171	4,600	14,600	$21,810	$14,640	-$5,399	-$3,696	$10,943	$3,111
10	-$41,647	-$7,314	4,600	14,600	$22,247	$14,933	-$5,399	-$3,814	-$30,528	-$7,546
11		-$7,460	4,600	14,600	$22,692	$15,231	-$4,165	-$4,427	$10,805	$2,322
12		-$7,609	4,600	14,600	$23,145	$15,536	-$4,165	-$4,549	$10,987	$2,054
13		-$7,762	4,600	14,600	$23,608	$15,847	-$4,165	-$4,673	$11,174	$1,816
14		-$7,917	4,600	14,600	$24,080	$16,164	-$4,165	-$4,800	$11,364	$1,606
15		-$8,075	4,600	14,600	$24,562	$16,487	-$4,165	-$4,929	$11,558	$1,420
16		-$8,237	4,600	14,600	$25,053	$16,817	-$4,165	-$5,061	$11,756	$1,256
17		-$8,401	4,600	14,600	$25,554	$17,153	-$4,165	-$5,195	$11,958	$1,111
18		-$8,569	4,600	14,600	$26,065	$17,496	-$4,165	-$5,333	$12,163	$983
19		-$8,741	4,600	14,600	$26,587	$17,846	-$4,165	-$5,472	$12,373	$869
20	-$50,767	-$8,916	4,600	14,600	$27,119	$18,203	-$4,165	-$5,615	-$38,180	-$2,333
21		-$9,094	4,600	14,600	$27,661	$18,567	-$5,077	-$5,396	$13,171	$700
22		-$9,276	4,600	14,600	$28,214	$18,938	-$5,077	-$5,545	$13,394	$619
23		-$9,461	4,600	14,600	$28,778	$19,317	-$5,077	-$5,696	$13,621	$547
24		-$9,651	4,600	14,600	$29,354	$19,703	-$5,077	-$5,851	$13,853	$484
25		-$9,844	4,600	14,600	$29,941	$20,097	-$5,077	-$6,008	$14,089	$428
26		-$10,041	4,600	14,600	$30,540	$20,499	-$5,077	-$6,169	$14,330	$379
27		-$10,241	4,600	14,600	$31,151	$20,909	-$5,077	-$6,333	$14,576	$335
28		-$10,446	4,600	14,600	$31,774	$21,328	-$5,077	-$6,500	$14,827	$296
29		-$10,655	4,600	14,600	$32,409	$21,754	-$5,077	-$6,671	$15,083	$262
30		-$10,868	4,600	14,600	$33,057	$22,189	-$5,077	-$6,845	$15,344	$232
31	-$136,722	-$11,086	0	0					-$147,807	-$1,941
Total				**Rate/m^3**	1.25					
	-$283,123	-$259,362	13,8000	43,8000	$755,175	$506,898	-$146,401	-$144,199	$68,491	$294

Table J-5. Life cycle costs for disposal of DOE low-level waste at various facilities (DOE 2002). [2017 note: Some of these facilities are now closed. Prices from the commercial facility are not current, and a new survey would be required to update this Table]

Disposal Site	Life-Cycle Cost ($/m^3)
DOE CERCLA Disposal Facilities	
Hanford ERDF	$29
Oak Ridge EMWMF	$140
INL ICDF	$160
Fernald OSDF	$190
DOE Non-CERCLA Disposal Facilities	
Savannah River Site Trenches	$130
Nevada Test Site	$320
INL RWMC	$700
Hanford LLBG	$2,000
Savannah River Site Vaults	$2,100
Commercial Disposal Facilities	
Envirocare (soil)	$180
Envirocare (debris)	$520
Barnwell	$14,000
U.S. Ecology	$2,500

Notes:

(1) To gain a true cost comparison of disposal sites, generator costs including waste preparation, packaging, and transportation must also be considered, which vary depending on the disposal site.

(2) These costs do not include surcharges for remote handling, shielding, mixed low-level waste, etc.

(3) The values shown for Barnwell and U.S. Ecology are their nominal average prices for low-level waste and do not include curie or dose rate surcharges.

(4) Cost estimates for DOE facilities include all future closure and long-term stewardship costs. Even though for many of the facilities, these are partially sunk costs that DOE must pay regardless of whether any future waste is emplaced in the facility.

J-7. DATA LIMITATIONS

- Estimate is plus or minus 30% as standard factored cost on scope presented
- Scope is well established based on existing facilities
- Technology is well proven on a large scale commercially.

The technology readiness is commercially viable. Disposal of LLW is existing technology. The data quality is categorized as a scoping assessment with a common basis/approach.

J-8. COST SUMMARIES

Given the variable nature of LLW, it is not possible to estimate the amount of uranium present in material from a possible reprocessing facility. Therefore, no attempt was made to relate these costs to uranium consumption based on a 2,000 MTHM/year spent nuclear fuel processing capacity. Instead, costs were normalized to the volume of contaminated material delivered to the site, which is based roughly on a volume rate similar to the current Nevada Test Site (Nevada National Security Site) system and a 30-year life. The waste receipt rate and related volume of delivered material could possibly double. Table J-6 is a code-of-accounts breakdown of disposal cost.

Table J-6. Code-of-accounts information.

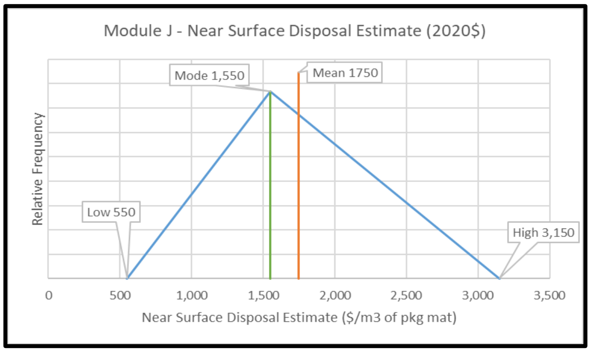
AFCI Code of Accounts No.	Code of Accounts Description	Cost (Million 2007 $)	Comments
0	Early Life-Cycle Costs	—	
1	Capitalized Preconstruction Costs	—	
2	Capitalized Direct Costs	122	
	Closure Costs (Sinking Fund)*	24	
	Stewardship Costs (Sinking Fund)*	50	
	Total Directs	196	
3	Capitalized Support Services	—	Included above
	Base Construction Cost (BCC)	196	
4	Capitalized Operations	—	Included above
5	Capitalized Supplementary Costs	—	Included above
	Total Overnight Cost (TOC)	196	
6	Capitalized Financial Costs	—	
	Total Capital Investment Cost (TCIC)	196	
7	Annualized O&M Cost	6.0	
9	Annualized Financial Costs, Taxes & Profit	5.7	
	Total Operating Costs	351	30-year life
	Total Project Life-Cycle Cost	547	Inflation not included
* Note that end-of-life costs for closure and stewardship have been included with capital costs.			

The module cost information is summarized in the What-It-Takes (WIT) cost summary in Table J-7. The summary shows the reference cost basis (constant year U.S. dollars), the reference basis cost contingency (if known), the cost analyst's judgment of the potential upsides (low end of cost range) and downsides (high end of cost range) based on references and qualitative factors, and selected nominal costs (judgment of the expected costs based on the references, contingency factors, upsides, and downsides). These costs are subject to change and are updated as additional reference information is collected and evaluated and because of sensitivity and uncertainty analysis. Refer to Section 2.6 in the main section of this report for additional details on the cost estimation approach used to construct the WIT table. The triangular distribution based on the costs in the WIT Table is shown in Figure J-5.

Table J-7. Cost summary What-It-Takes WIT table (2006 $/MTU with escalation to 2020$ using a factor of 1.26).

2006 $					
Reference Cost(s) Based on Reference Capacity	Reference Cost Contingency (+/- %)	Low Cost	Mode Cost	Mean Cost	High Cost
$1,250/m^3$	(± 30%) $875–$1,560/m^3$	$450/m^3$ • Comparable to Envirocare • Lower capital costs; lower stewardship costs (i.e.,	$1,250/m^3$		$2,500/m^3$ • Comparable to US Ecology • More stringent requirements for security, environmental

		Tennessee at $10M)			protection and long-term stewardship
2020 $					
$1550	$1085 – $2015	$550	$1550	$1750	$3150



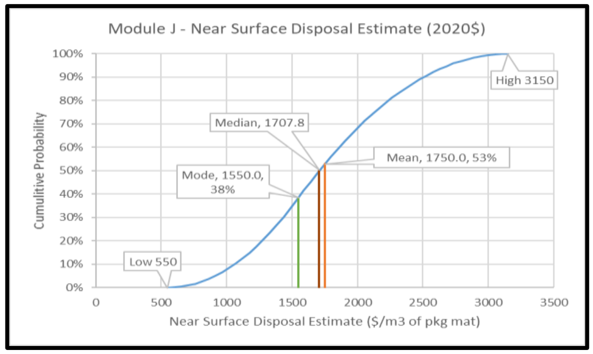


Figure J-5. Module J near surface disposal estimated cost frequency distribution.

J-9. SENSITIVITY AND UNCERTAINTY ANALYSIS

No sensitivity analyses were performed for this module.

J-10. REFERENCES

DOE, 2002, *Report to Congress; The Cost of Waste Disposal: Life Cycle Cost Analysis of Disposal of Department of Energy Low-Level Radioactive Waste at Federal and Commercial Facilities*, U.S. Department of Energy, Office of Environmental Management, Washington, DC, July 2002, http://ndep.nv.gov/boff/doehqllwreport7-08-02.pdf, Web page accessed September 2, 2009.

DOE, 2005, “Nevada Test Site”, http://www.nv.doe.gov/nts/default.htm, U.S. DOE/NNSA – Nevada Site Office, Web page accessed September 2, 2009.

State of Nevada, 2009, “Nevada Test Site (NTS),” http://ndep.nv.gov/BOFF/photo03.htm, Nevada Division of Environmental Protection, Web page accessed September 2, 2009.

J-11. BIBLIOGRAPHY

Bunn, M., et al., 2003, *The Economics of Reprocessing vs. Direct Disposal of Spent Nuclear Fuel*, Cambridge, Mass, Project on Managing the Atom, Harvard University, DE-FG26-99FT4028, December 2003, pp. 19, 55–57.

Platt, 2005a, “DOE to Transfer Depleted Uranium to BPA,” *Platts Nuclear News Flashes*, July 6, 2005.

Platt, 2005b, “LES News,” *Platt’s Nuclear News Flashes*, May 27, 2005.

Makhijani, A. and B. Smith, 2005, “Costs and Risks of Depleted Uranium from a Proposed Enrichment Facility,” Science for Democratic Action, Vol. 13, No. 2, June 2005, http://www.ieer.org/sdafiles/13-2.pdf, Web page accessed September 2, 2009.

Michaels, G. E and T. D. Welch, 1993, *Evaluation of Disposition Options for Reprocessed Uranium*, ORNL/TM-12326, February 1993, pp. 27–47, 89–109.

Neary, Ben, 2005, “NM Leaders Strike Deal on Uranium Waste Plant,” *The New Mexican*, June 4, 2005, http://www.freenewmexican.comlnews/14465.html, Web page accessed June 6, 2005.

OECD Nuclear Energy Agency and International Atomic Energy Agency, 1994, *The Economics of the Nuclear Fuel Cycle*, 1994, pp. 11, 27, 37–38, 50, 77–80, http://www.nea.fr/html/ndd/reports/efc/, Web page accessed January 24, 2006.

TRU TeamWorks, 2003, Transportation News (weekly e-newsletter of the Waste Isolation Pilot Plant team), RH-72B - Ready When the Time Comes, August 25, 2003, http://www.wipp.energy.gov/TeamWorks/TRUTeamWorksArchives/08-25-03ext.pdf, Web page accessed September 2, 2009.

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