Decommissioning Cost Estimate
For
Safety Light Corporation
Bloomsburg, PA

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Enclosure (2)

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1.0 Introduction

This independent cost estimate for decommissioning the Safety Light Corporation (SLC) Bloomsburg, PA facility has been prepared in accordance with guidance developed by the U.S. Nuclear Regulatory Commission (NRC) for the development of Decommissioning Funding Plans. The cost estimate prepared is for all areas within the SLC facility that are subject to licensing under two NRC radioactive material licenses: Number 37-0030-02 (herein referred to as the 02 license) and Number 37-0030-08 (herein referred to as the 08 license).

This decommissioning cost estimate includes:

- Overview of Scenarios Modeled and Results;
- Overview of Cost Estimating Methodology;
- Summary of Site Characterization;
- Key Assumptions for Unrestricted Release Scenarios;
- Key Assumptions for Restricted Release Scenarios;
- Derivation of Unit Costs; and
- Listing of Reference Documentation.

2.0 Overview of Scenario Modeled and Results

This cost estimate models costs for decommissioning associated with two unrestricted and three restricted release scenarios at the SLC site in Bloomsburg, PA:

- Scenario 1 models the unrestricted release scenario upper bound cost estimate. In this scenario, contamination is removed from buildings through scabbling or chemical cleaning, contaminated equipment is decontaminated and disposed as LLW, the buildings are demolished, vegetation is removed from the site, contaminated soil is removed and disposed as LLW, slurry walls are installed, and groundwater is treated (during remediation). The decommissioning activities are designed to remove all contamination above the site derived concentration guidance levels (DCGLs). These DCGLs correspond to a maximum exposure rate of 25 mrem per person-year.

- Scenario 2 models the unrestricted release scenario lower bound cost estimate. This scenario is similar to scenario 1 in the activities undertaken, but assumes a smaller amount of material is contaminated above the DCGLs.

- Scenario 3 models the minimal action restricted release scenario, under 10 CFR §20.1403 in which buildings are demolished "as is" and vegetation is cleared and buried on the site. The site is then covered with a six inch gravel layer and a two foot thick rip-rap cover to protect against flood damage to the site and prevent future use of the site.

- Scenario 4 represents a restricted release scenario designed to prevent exposure in excess of 100 mrem/person-year. This scenario assumes that contamination above four times the DCGLs is removed. Contamination is removed from buildings through scabbling or chemical cleaning. Soil contaminated above four times the DCGL is removed and disposed as LLW and contaminated equipment is decontaminated and disposed as LLW. The buildings are demolished and vegetation is removed and both are buried on the site, which is then covered with a six inch gravel layer and a two foot thick rip-rap cover to protect against flood damage to the site and prevent future use of the site.

- Scenario 5 represents a restricted release scenario utilizing a 500 mrem/person-year maximum exposure rate. This scenario is the same as scenario 4 except that instead of comparing contaminant levels with four times the DCGLs, the contaminant levels are compared with 20 times the DCGLs.

Because disposal of LLW is the major cost driver in most of these scenarios, this cost estimate used three LLW disposal rates to bound the cost ($\$5/ft^3$, $\$11/ft^3$, and $\$17/ft^3$), assuming the waste will be disposed at Envirocare as LLW. Mixed waste is considered to be approximately three times the cost of disposal of LLW. The range for LLW and the increase for mixed waste corresponds to data provided by a DOE web site that describes the range of disposal costs for DOE and commercial sites as well as direct input from NRC staff. Section 7.9 provides more information on the derivation of these unit costs. Exhibit 1 presents costs associated with these five scenarios, assuming a disposal cost estimate of $\$11/ft^3$ for LLW at Envirocare. Exhibit 2 presents costs associated with these scenarios, assuming a disposal cost estimate of $\$17/ft^3$ for LLW at Envirocare. Exhibit 3 presents costs, assuming a disposal cost estimate of $\$5/ft^3$ for LLW at Envirocare.

Exhibit 1. Cost Estimates for SLC Assuming Envirocare Disposal Charge of $11/ft^3

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	Unrestricted Release - Upper Bound	Unrestricted Release - Lower Bound	Restricted Release - Minimal Action	Restricted Release - 100 mrem	Restricted Release - 500 mrem
Slurry Walls	$ 182,667	$ 182,667			
Buildings					
Scabbling	$ 1,514,662	$ 1,058,275		$ 566,755	$ 237,047
Chemical Cleaning - Equipment	$ 2,868,913	$ 2,868,913	$2,868,913	$ 2,868,913	$ 2,868,913
Chemical Cleaning - Building Surfaces	$ 217,006	$ 64,393		$ 43,616	$ 19,281
Building Demolition	$ 124,728	$ 124,728	$124,728	$ 124,728	$ 124,728
Excavate Soil	$ 884,586	$ 775,644	$ 24,513	$ 580,889	$ 301,240
Clear Vegetation	$9,149	$9,149	$ 9,149	$9,149	$9,149
Groundwater	$ 59,958	$ 59,958			
RipRap			$1,955,907	$ 1,955,907	$ 1,955,907
Site Controls and Maintenance			$1,361,920	$ 1,361,920	$ 1,361,920
Shipping & Disposal					
Envirocare LLW	$43,514,928	$47,964,540	$1,438,015	$37,243,850	$21,892,417
Envirocare Mixed Waste	$29,107,432	$ 8,594,845		$ 6,633,381	$ 3,771,188
Subtotal	$78,484,031	$61,703,114	$7,783,146	$51,389,108	$32,541,790
Planning & Preparation	$11,772,605	$ 9,255,467	$1,167,472	$ 7,708,366	$ 4,881,269
Final Radiation Survey	$ 5,493,882	$ 4,319,218	$544,820	$ 3,597,238	$ 2,277,925
Contingency	$23,937,629	$18,819,450	$2,373,859	$15,673,678	$ 9,925,246
Total	**$119,688,147**	**$94,097,249**	**$11,869,297**	**$78,368,389**	**$49,626,230**

Monserco. Exhibit 4 identifies the most conservative isotope used in each building and the value of the DCGL for that isotope, based on a review of available literature documenting building histories. Exhibit 5 shows the percentages of wall, floor, and ceiling grids contaminated above the DCGLs and various multiples of these DCGLs.

4.2 Surface Soils

Surface soils at the SLC site are known to have been contaminated with a number of different isotopes as well as metals and possibly organic compounds. The primary radioactive isotopes of concern are Ra-226, Cs-137, Am-241, and Sr-90. Daughter isotopes of Ra-226, such as Pb-214 and Bi-214, have also been found in the surface soils. The use and disposal of solvents, acid etching wastes, plating wastes, and metal constituents at the site raises the strong possibility that soil at the site might contain significant quantities of mixed waste.

Exhibit 4. Building Evaluation Summary Information

Building	Most Conservative Isotope	DCGL ($dpm/100cm^2$)
Main Building	Ra-226	2170
Etching Building	Ra-226	2170
Personnel Office Building	Ra-226	2170
Machine Shop	H-3	1.10E+08
Pipe Shop	Ra-226	2170
Carpenter Shop	Ra-226	2170
Multi-Metals Waste Treatment Building	Ra-226	2170
Well House	Ra-226	2170
Lacquer Storage Building	None	Assumed 2170
Radium Vault	Ra-226	2170
Utility Building	Sr-90	43160
8 x 8 Building	Sr-90	43160
Liquid Waste Building	Am-241	112
Old House	Am-241	112
Solid Waste Building	Am-241	112
Metal Silo	Ra-226	2170
Tritium Building	H-3	1.10E+08
Old Garage Foundation	Ra-226	2170
Cesium Ion Exchange Unit	Cs-137	40,500

Exhibit 5. Average Percentage of Grids Contaminated

	Above DCGL	Above 4x DCGL	Above 20x DCGL	Above 1000x DCGL
Walls	36%	19%	7%	0%
Floor	40%	25%	10%	0%
Ceiling	9%	9%	3%	0%

Exhibit 2. Cost Estimates for SLC Assuming Envirocare Disposal Charge of S17/ft^3

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	Unrestricted Release - Upper Bound	Unrestricted Release - Lower Bound	Restricted Release - Minimal Action	Restricted Release - 100 mrem	Restricted Release - 500 mrem
Slurry Walls	$ 182,667	$ 182,667			
Buildings					
Scabbling	$ 1,514,662	$ 1,058,275		$ 566,755	$ 237,047
Chemical Cleaning - Equipment	$ 2,868,913	$ 2,868,913	$2,868,913	$ 2,868,913	$ 2,868,913
Chemical Cleaning - Building Surfaces	$ 217,006	$ 64,393		$ 43,616	$ 19,281
Building Demolition	$ 124,728	$ 124,728	$124,728	$ 124,728	$ 124,728
Excavate Soil	$ 884,586	$ 775,644	$ 24,513	$ 580,889	$ 301,240
Clear Vegetation	$9,149	$9,149	$ 9,149	$9,149	$9,149
Groundwater	$ 59,958	$ 59,958			
RipRap			$1,955,907	$ 1,955,907	$ 1,955,907
Site Controls and Maintenance			$1,361,920	$ 1,361,920	$ 1,361,920
Shipping & Disposal					
Envirocare LLW	$53,693,931	$59,184,982	$1,773,427	$45,956,336	$27,013,025
Envirocare Mixed Waste	$40,103,131	$11,840,233		$ 9,138,762	$ 5,194,781
Subtotal	$99,658,733	$76,168,943	$8,118,558	$62,606,975	$39,085,991
Planning & Preparation	$14,948,810	$11,425,341	$1,217,784	$ 9,391,046	$ 5,862,899
Final Radiation Survey	$ 6,976,111	$ 5,331,826	$568,299	$ 4,382,488	$ 2,736,019
Contingency	$30,395,914	$23,231,528	$2,476,160	$19,095,127	$11,921,227
Total	**$151,979,568**	**$116,157,639**	**$12,380,800**	**$95,475,637**	**$59,606,137**

Exhibit 3. Cost Estimates for SLC Assuming Envirocare Disposal Charge of $\$5/ft^3$

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	Unrestricted Release - Upper Bound	Unrestricted Release - Lower Bound	Restricted Release - Minimal Action	Restricted Release - 100 mrem	Restricted Release - 500 mrem
Slurry Walls	$ 182,667	$ 182,667			
Buildings					
Scabbling	$ 1,514,662	$ 1,058,275		$ 566,755	$ 237,047
Chemical Cleaning - Equipment	$ 2,868,913	$ 2,868,913	$2,868,913	$ 2,868,913	$ 2,868,913
Chemical Cleaning - Building Surfaces	$ 217,006	$ 64,393		$ 43,616	$ 19,281
Building Demolition	$ 124,728	$ 124,728	$124,728	$ 124,728	$ 124,728
Excavate Soil	$ 884,586	$ 775,644	$ 24,513	$ 580,889	$ 301,240
Clear Vegetation	$9,149	$9,149	$ 9,149	$9,149	$9,149
Groundwater	$ 59,958	$ 59,958			
RipRap			$1,955,907	$ 1,955,907	$ 1,955,907
Site Controls and Maintenance			$1,361,920	$ 1,361,920	$ 1,361,920
Shipping & Disposal					
Envirocare LLW	$33,335,926	$36,744,099	$1,102,603	$28,531,363	$16,771,808
Envirocare Mixed Waste	$18,111,732	$ 5,349,457		$ 4,128,000	$ 2,347,596
Subtotal	$57,309,329	$47,237,285	$7,447,734	$40,171,240	$25,997,590
Planning & Preparation	$ 8,596,399	$ 7,085,593	$1,117,160	$ 6,025,686	$ 3,899,638
Final Radiation Survey	$ 4,011,653	$ 3,306,610	$521,341	$ 2,811,987	$ 1,819,831
Contingency	$17,479,345	$14,407,372	$2,271,559	$12,252,228	$ 7,929,265
Total	**$87,396,727**	**$72,036,859**	**$11,357,794**	**$61,261,141**	**$39,646,324**

3.0 Overview of Cost Estimating Methodology

The process in developing the cost estimate for SLC involved the following five steps:

1) Review site documentation and conduct a site visit to become familiar with the site;

2) Evaluate the prior characterization of the site to date, to define the nature and extent of contamination;

3) Evaluate the existing cost estimates;
4) Develop assumptions for appropriate methods to adequately remediate the site;

5) Gather necessary unit cost estimates; and

6) Calculate cost results.

Steps one, two, and three were performed under other tasks within this work assignment. A summary of the results of the site characterization review is provided in section 4.0. The remainder of this document outlines the assumptions used (sections 5 and 6) and explains the derivation of unit costs (section 7).

4.0 Summary of Site Characterization

This section provides a summary of the major findings from the site characterization document prepared by ICF entitled *Review and Evaluation of Characterization Data Provided for Safety Light Corporation, Bloomsburg, PA*. A more complete description of characterization efforts conducted at the SLC facility can be found in that report.

4.1 Buildings

The Safety Light Corporation site includes nineteen buildings. Current operations are limited to approximately six of these buildings. The remaining buildings are used for storage or have been abandoned due to disrepair. Characterization activities were performed on eighteen of these buildings in 1995 by Monserco, Limited. The nineteenth building is the Tritium building, which was not surveyed during the 1995 characterization because the building was still used in active tritium operations.

Characterization surveys were performed by Monserco primarily for loose alpha, beta, or H-3 contamination and fixed alpha/beta or beta/gamma contamination. The results were presented in counts per area (e.g., dpm/100 cm^2) and were not isotope specific. Derived concentration guideline levels (DCGLs) used were calculated by SLC to evaluate building contamination. The DCGLs were also presented in counts per area, but were isotope specific. Consequently, the Monserco survey results could not be directly compared with the DCGLs.

In order to evaluate whether contamination was present above the DCGLs, ICF (1) identified the "most conservative isotope" for each building (i.e., the isotope known to have been used in that building with the lowest DCGL value) and (2) assumed this isotope was causing the counts recorded by

Monserco. Exhibit 4 identifies the most conservative isotope used in each building and the value of the DCGL for that isotope, based on a review of available literature documenting building histories. Exhibit 5 shows the percentages of wall, floor, and ceiling grids contaminated above the DCGLs and various multiples of these DCGLs.

4.2 Surface Soils

Surface soils at the SLC site are known to have been contaminated with a number of different isotopes as well as metals and possibly organic compounds. The primary radioactive isotopes of concern are Ra-226, Cs-137, Am-241, and Sr-90. Daughter isotopes of Ra-226, such as Pb-214 and Bi-214, have also been found in the surface soils. The use and disposal of solvents, acid etching wastes, plating wastes, and metal constituents at the site raises the strong possibility that soil at the site might contain significant quantities of mixed waste.

Exhibit 4. Building Evaluation Summary Information

Building	Most Conservative Isotope	DCGL (pCi/g)
Main Building	Ra-226	2170
Etching Building	Ra-226	2170
Personnel Office Building	Ra-226	2170
Machine Shop	H-3	1.10E+08
Pipe Shop	Ra-226	2170
Carpenter Shop	Ra-226	2170
Multi-Metals Waste Treatment Building	Ra-226	2170
Well House	Ra-226	2170
Lacquer Storage Building	None	Assumed 2170
Radium Vault	Ra-226	2170
Utility Building	Sr-90	43160
8 x 8 Building	Sr-90	43160
Liquid Waste Building	Am-241	112
Old House	Am-241	112
Solid Waste Building	Am-241	112
Metal Silo	Ra-226	2170
Tritium Building	H-3	1.10E+08
Old Garage Foundation	Ra-226	2170
Cesium Ion Exchange Unit	Cs-137	40,500

Exhibit 5. Average Percentage of Grids Contaminated

	Above DCGL	Above 4x DCGL	Above 20x DCGL	Above 1000x DCGL
Walls	36%	19%	7%	0%
Floor	40%	25%	10%	0%
Ceiling	9%	9%	3%	0%

The abandoned canal, which once ran from Sunbury to Scranton, was the primary area of concern during the 1995 Monserco Site Characterization. The canal is known to have been used for the disposal of Ra-226 contaminated ductwork as well as liquid waste from radiological production activities. The East and West Lagoons were built in portions of the old canal and were used to dispose of process waste waters and silver plating wastes, respectively. The East and West Plant Dumps are also located in portions of the old canal and were used to dispose of Ra-226 contaminated ductwork, Ra-226 dials, and Sr-90 deck markers.

Monserco used a grid system to divide the outdoor survey area. The property was divided into 307 grids. Grids expected to be unaffected measured 25 meters by 25 meters and areas expected to be affected measured 10 meters by 10 meters. Surface soils were both field surveyed and sampled for analysis. A portable gamma spectrometer was used to survey the site grounds south of the Main Building. Most of the grids in the area of the old canal had four surface soil samples collected although some had less. A number of grids around the site had one, two, or three samples collected. Forty grids had no surface soil samples collected. A total of 502 soil samples reported by Monserco were analyzed for gross beta and 504 soil samples were analyzed using gamma spectroscopy. A total of 124 samples had beta readings above the Minimum Detectable Activity (MDA) of 7.0 pCi/g. Gamma spectroscopy indicated the presence of Cs-137, Bi-214, Pb-214, Ra-226, and Am-241.

Exhibit 6 provides the percentage of grids contaminated for three areas of the site. This analysis divided the site into thirds, with grids 1-39 comprising Area 1 or "Road to Nurses Station;" grids 40-150 comprising the Area 2 or "Buildings Area;" and grids 151-310 representing Area 3 or "Back of Buildings to River." To calculate these percentages a sum of fractions was utilized. Additionally, although a DCGL was not provided for beta contamination, it was included with an assumed DCGL of 5 pCi/g.

Exhibit 6. Percentage of Surface Soils Contaminated

Grid Area	Unsampled	>DCGL	>4 X DCGL	>20 X DCGL
Area 1 (grids 1-39)	2%	36%	28%	13%
Area 2 (grids 40-150)	27%	33%	21%	15%
Area 3 (grids 151-310)	5%	45%	32%	8%

4.3 Sub-Surface Soils

Sub-surface soils at the SLC site are known to have been contaminated with a number of different isotopes as well as metals and possibly organic compounds. The primary radioactive isotopes of concern are Ra-226, Cs-137, Am-241, and Sr-90. Daughter isotopes of Ra-226, such as Pb-214 and Bi-214, have also been found in the sub-surface soils. The use and disposal of solvents, acid etching wastes, plating wastes, and metal constituents at the site raises the strong possibility that subsurface soils at the site are likely to contain significant quantities of mixed waste.

The abandoned canal was the primary area of concern for subsurface soils as well as surface soils during the 1995 Monserco Site Characterization. Additional concerns in evaluating sub-surface soils included underground piping/utilities/drain lines, a sewer grate located behind the Main Building, an underground storage tank detected during an electromagnetic survey, buried metallic objects detected south of the Liquid Waste Building during a ground penetrating radar survey, and the underground silo area.

The Monserco investigation of sub-surface soils included both the electromagnetic survey and the ground penetrating radar survey. The electromagnetic survey revealed uniform distributions of soil conductivity across the property with conductivities increasing in the southern portion of the property. The ground penetrating radar revealed metallic objects in the area of the West Dump and in the soils on the south side of the Liquid Waste Building. Thirteen boreholes were drilled at various locations across the site concentrating on the southern portion of the property south of suspected affected areas. Boreholes were cored to a minimum depth of 20 feet or to the water table and samples were collected for every 2 to 2.5 feet drilled. The highest gross beta result was obtained south of the East Silo, the highest Cs-137 result was obtained south of the Lacquer Storage Building, the highest Ra-226 result was obtained south of the East Lagoon.

Exhibit 7 provides the percentage of boreholes contaminated for three different depths and the percentage of clean boreholes under each scenario. As with surface soils, a sum of fractions approach was used that included beta with an assumed DCGL of 5 pCi/g.

Exhibit 7. Percentage of Sub-Surface Soils Contaminated

Depth (m)	Above DCGL	Above 4 X DCGL	Above 20 X DCGL
0-2	23%	31%	31%
2-3	23%	8%	0%
>3	38%	31%	15%
Clean	16%	30%	54%

5.0 Key Assumptions for Unrestricted Release Scenarios

The assumptions used in the unrestricted release scenarios (scenarios 1 and 2) are presented below. In preparing these assumptions, this analysis sought to utilize assumed values that are reasonable, but conservative - and not worst-case.

5.1 Buildings

As mentioned in Section 4.1, the Monserco report contained sampling data for each building or grids within buildings reported as activity in dpm/100 cm^2. The isotope causing this activity was not identified. However, the surface DCGLs were presented by isotope, and varied significantly. Consequently, this analysis reviewed the documentation and identified the isotopes used in each building, identified the most conservative DCGL associated with the isotopes used in each building, and compared the analytical results with the most conservative DCGL for each building. Concrete and wood buildings were assumed to be scabbled and metal buildings were assumed to be chemically cleaned. Floors, walls and ceilings were considered separately, as floors were considered to be scabbled to 1/4 inch, while walls and ceilings were scabbled to 1/8 inch. Both chemical cleaning and scabbling are assumed to be repeated on 25 percent of the surface areas requiring decontamination, resulting in a maximum reduction in contamination levels of three orders of magnitude. After decontamination, all buildings were demolished, and all "clean" material was used on-site as backfill.

- If the radiation levels in a building (or portion of a building) were below the most conservative DCGL for the isotopes used in that building, that building was considered "Clean."

- If the radiation levels in a building (or portion of a building) were greater than the most conservative DCGL for the isotopes used in that building, but less than 1,000 times the most conservative DCGL, that building (or portion of a building) required treatment (chemical cleaning or scabbling).

- If the radiation levels in a building (or portion of a building) were greater than 1,000 times the most conservative DCGL for the isotopes used in that building, that building (or portion of a building) was assumed to be demolished, sorted, and disposed of as LLW (because repeated scabbling and/or chemical cleaning is assumed to remove no more than a total of three orders of magnitude of contamination).

- If a contaminated building or portion of a building was structurally unsound, the building would be demolished and sorted. The amount of the building considered to be contaminated was assumed to be the same as the percentages of grids above the DCGL. The contaminated portion would be sent to LLW disposal.

- If a building (or portion of a building) was not surveyed, in the upper bound scenario (scenario 1) 100 percent of floors, walls, and/or ceilings were assumed to be contaminated above the DCGL. In the lower bound scenario (scenario 2), 36 percent of walls, 40 percent of floors, and 9 percent of floors were assumed to be contaminated, based on the overall percentages of these surfaces that were found to be above the DCGL.

Because the sampling was performed by grid, and separated by floor, wall, and ceiling, this analysis might indicate a need to scabble one portion of building, do nothing to another, and send a third portion to disposal as LLW. For example, if five out of six wall grids were contaminated above the most conservative DCGL, but none were contaminated above 1,000 times the most conservative DCGL, this analysis assumed that 83 percent of the walls would be scabbled or chemically cleaned. If in that same room all floor grid samples were contaminated above 1,000 times the most conservative DCGL, this analysis assumed the entire floor was disposed as LLW without scabbling. Finally, if in this same building the ceiling did not have any contamination above the most conservative DCGL, this analysis would assumed the ceiling would be demolished and disposed on-site as backfill.

If the wall described above had been in a structurally unsound building, this analysis assumed the wall would be demolished and sorted, and 83 percent of the wall's volume would be sent off as LLW. Ultimately, all buildings would be demolished, and the clean portions would be buried on-site as backfill.

When estimates of equipment in the buildings were not provided, this analysis assigned each building to be empty or full, based on observations made during the site visit. Empty rooms were considered to contain an amount of equipment equivalent to 5 percent of the room's volume, and full rooms were considered to contain an amount of equipment equivalent to 30 percent of the room's volume. One third of equipment in buildings was assumed to be clean, one third assumed to require disposal as LLW, and one third was assumed to require cleaning in order to be disposed as LLW.

Exhibit 8 summarizes the management of walls, floors and ceilings for most buildings on the site. The Main building and Acid etching building are not included in exhibit 8 because 1) management was assigned by room and 2) the large number of rooms (over 160 rooms between the two buildings) would make a summary prohibitively long. In both the Main building and the Acid Etching building, some surfaces do not require remediation, some require scabbling, and some need to be sent offsite as LLW.

Exhibit 8. Assumed Remediation Methods by Building

Building	Scenario 1 Management			Scenario 2 Management		
	Wall	Floor	Ceiling	Wall	Floor	Ceiling
Personnel Office Building	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW
Machine Shop	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Pipe Shop	Scabble	Scabble	Not Required	Scabble	Scabble	Not Required
Carpenter Shop	Send Offsite as LLW	Send Offsite as LLW	Not Required	Send Offsite as LLW	Send Offsite as LLW	Not Required
Multi-Metals Waste Treatment Building	Scabble	Scabble	Not Required	Scabble	Scabble	Not Required
Well House	Scabble	Not Required	Not Required	Scabble	Not Required	Not Required
Lacquer Storage Building	Not Required	Send Offsite as LLW	Not Required	Not Required	Send Offsite as LLW	Not Required
Radium Vault	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW
Utility Building	Send Offsite as LLW	Send Offsite as LLW	Not Required	Send Offsite as LLW	Send Offsite as LLW	Not Required
8 x 8 Building	Scabble	Scabble	Not Required	Scabble	Scabble	Not Required
Liquid Waste Building	Not Required	Chemically Clean	Not Required	Not Required	Chemically Clean	Not Required
Old House	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW
Solid Waste Building	Send Offsite as LLW	Send Offsite as LLW	Scabble	Send Offsite as LLW	Send Offsite as LLW	Scabble
Metal Silo	Chemically Clean	Chemically Clean	Not Required	Chemically Clean	Chemically Clean	Not Required
Tritium Building	Chemically Clean	Chemically Clean	Chemically Clean	Chemically Clean	Chemically Clean	Chemically Clean
Old Garage Foundation	Scabble	Scabble	Scabble	Scabble	Scabble	Scabble
Cesium Ion Exchange Unit	Scabble	Scabble	Scabble	Scabble	Scabble	Scabble

5.2 Surface Soil

The amount of surface soil to be excavated and disposed of depends on where on the site the soil is located, and the analytical results presented in the Monserco report. In scenario 1, a grid was considered "contaminated" if: 1) the sum of fractions of each isotope divided by the DCGL added to more than one or 2) the grid was not sampled. In scenario 2, a grid was considered "contaminated" only if the sum of fractions of each isotope divided by the DCGL added to more than one. The percentages of contamination in each area corresponding to these assumptions can be found in Exhibit 6.Below each building, we assumed 25 percent of the soil would need to be excavated to 0.5 meter. Exhibit 9 describes the management of the remaining soil in each of the three areas of the site, and Exhibit 10 describes the percentage of soil in each area of the site assumed to be contaminated.

In scenario 1, "clean" soil is assumed to require remediation because of the potential for additional contamination. As noted in the characterization document (*Review and Evaluation of Characterization Data Provided for Safety Light Corporation. Bloomsburg, PA*), detection limits for some constituents were higher than the DCGL for those constituents, raising the possibility that the constituent could have been present above the DCGL but not detected. Figure 10 in the characterization document, which shows grids that are either known to be contaminated above the DCGL or for which the detection limit was higher than the DCGL, indicates that almost any grid on the site that is not known to be contaminated above the DCGL potentially may be contaminated above the DCGL. Thus, because scenario 1 is the upper bound cost estimate, at least 15 cm of surface soil is removed from the entire site.

Finally, area 3 is the only area where in subsurface soil is assumed to be contaminated. It is not clear whether surface soil contamination would be in the same area as the subsurface soil contamination or in different areas. It could be in the same area if contamination from the surface seeps down and becomes subsurface contamination. Alternatively, it could be in other places if the mechanism for surface contamination is different (e.g., windblown contamination from the buildings). Because it is more expensive to clean if contaminated surface soil is not assumed to overlay contaminated subsurface soil, scenario 1 assumes contaminated surface soil in Area 3 is independent of the location of contaminated subsurface soil. In scenario 2, contaminated surface soil is assumed to overlay subsurface soil, and thus is remediated when subsurface soils are remediated.

Exhibit 9. Management of Soil by Area of Site

	Scenario 1				Scenario 2			
	Percent of Contaminated Soil Requiring Remediation	At Depth (m)	Percent of Clean Soil Requiring Remediation	At Depth (m)	Percent of Contaminated Soil Requiring Remediation	At Depth (m)	Percent of Clean Soil Requiring Remediation	At Depth (m)
Area 1	75%	0.5	75%	0.15	75%	0.5	0%	-
	25%	1	25%	0.3	25%	0.65	0%	-
Area 2	90%	1	75%	0.15	90%	1	0%	-
	10%	2	25%	0.3	10%	1.15	0%	-
Area 3	75%	0.5	75%	0.15	NA	-	NA	-
	25%	1	25%	0.3	NA	-	NA	-

Exhibit 10. Assumed Amount of Mixed Waste by Area

	Scenario 1	Scenario 2
Amount of Mixed Waste	Area 1:0 percent Area 2: 10 percent Area 3: 33 percent	Area 1:0 percent Area 2:5 percent Area 3: 10 percent

5.3 Subsurface Soils

No subsurface soil contamination is anticipated in Areas 1 and 2 of the site. In Area 3, bounded by the river and the back of the buildings, contamination comes from both production activities and direct emplacement of wastes. All thirteen boreholes used in the Monserco study are located in Area 3. Based on the data in Exhibit 7, 23 percent of all soil in Area 3 is assumed to be removed to 2 m, 23 percent of all soil in Area 3 is assumed to be removed to 3.5 m, and 38 percent of all soil in Area 3 is assumed to be removed to 5 m. In scenario 1, the remaining 16 percent of Area 3 is not contaminated at depth, but may have surface contamination. Thus, this 16 percent of Area 3 is the input to surface contamination calculations. In scenario 2, this 16 percent of Area 3 is considered clean for both surface contamination and subsurface contamination.

5.4 Vegetation

All vegetation will be removed, surveyed and disposed of as either radioactive or non-radioactive (a 10:90 split for radioactive/non-radioactive vegetation is assumed). Non-radioactive vegetation will be used on-site for backfill.

5.5 Groundwater

Assuming that the soil removal described above removes all of the potential source materials, this analysis assumes long term groundwater remediation will not be necessary. However, short term groundwater remediation will be necessary during the period when the site is being remediated. Once the buildings are removed and prior to soil removal, a slurry wall will be built on the SLC perimeter to divert groundwater flow around the site. Groundwater will be pumped from a "production" well and will be treated by onsite air stripping and carbon adsorption to remove volatile organic constituents and radionuclides.

5.6 Off-Site Releases

This analysis assumes that there have been no off-site releases as determined by soil sampling conducted to verify no off-site migration of releases.

5.7 General Decommissioning Estimate Process

Based on guidance provided by the NRC in NUREG/CR-1754, NUREG/CR-1754 Addendum 1, and NUREG/CR-6477, this cost estimate considered the six major cost categories required by NRC in decommissioning funding plans:

- Planning and preparation;
- Decontamination and/or dismantlement of radioactive facility components;
- Packaging, shipping, and disposal of radioactive wastes;
- Restoration of contaminated areas on facility grounds;
- Final radiation survey; and
- Site stabilization and long-term surveillance.

This cost estimate also makes the following assumptions:

- Within each room/area cost estimate this analysis includes the labor, materials and equipment, and waste handling and management necessary to meet decontamination objectives. The individual room/areas are then added to provide a total cost estimate.

- An independent third party contractor will perform all work.

- The cost estimate includes a contingency factor of at least 25 percent to the sum of all estimated costs.

- The cost estimate does not take credit for (1) any salvage value that might be realized from the sale of potential assets during or after decommissioning, or (2) reduced taxes that might result from payment of decommissioning costs or site control and maintenance costs.

- The cost estimate for site control and maintenance assumes that all activities will be carried out to a level sufficient to prevent the annual dose to the average member of the critical group from exceeding 25 mrem (0.25 mSv). Thus, long-term surveillance measures are not needed.

- A single decontamination step such as HEPA vacuuming and chemical cleaning is assumed to reduce the level of surface contamination on a component by one or two orders of magnitude.[1]

- Planning, preparation, and final radiation survey costs are based upon estimates provided in NUREG/CR-1754, Addendum 1.

- Planning and preparation activities include the preparation of a detailed decommissioning plan, preparing other state and/or local documentation, developing work plans, performing staff training, and procuring special equipment. Planning and preparation costs will be assumed to account for approximately 15 percent of the total decommissioning costs. Based upon the potential for high radiation exposures possible during removal of materials and wastes, this planning estimate is reasonable.

- The final radiation survey will be performed to ensure that the materials license can be terminated and the premises released. Final radiation survey costs will include the cost of performing measurements to verify compliance with NRC guidelines on acceptable surface contamination levels, and the cost for preparing the survey report. The cost for the final

[1] E.S. Murphy, 1981. *Technology, Safety and Costs of Decommissioning Reference Non-Fuel-Cycle Nuclear Facilities.* NUREG/CR-1754. U.S. Nuclear Regulatory Commission Report by Pacific Northwest Laboratory, Richland, Washington.

radiation survey will be assumed to be 7 percent of the total decommissioning costs based upon previous experience with the NRC.

6.0 Key Assumptions for Restricted Releases Scenarios

6.1 General Assumptions

- These assumptions address only the NRC requirements under 10 CFR §20.1403 pertaining to criteria for license termination under restricted conditions, and do not address any other State or Federal regulatory requirements or approvals.

- Because of the high degree of intermingling of radium contamination with other radiological contaminants, radium is being addressed, even though it is not a radionuclide regulated by the NRC.

- The former Vance-Walton property is being included because of evidence that groundwater contamination extends under the property, and also because the property is owned by SLC.

- Based on a review of Federal Emergency Management Agency, Federal Insurance Administration Flood Insurance Rate Map, Township of South Centre, Pennsylvania, Columbia County, Community-Panel Number 421137 0005 B, November 18, 1980, approximately 50 percent of the site is within the 500-year flood boundary and approximately 30 percent of the site is within the 100-year flood boundary. These areas are assumed to correspond approximately to a E/W line from grid 150 to grid 171 for the 100- year flood boundary and an E/W line running through approximately the middle of grids 84 and 93 for the 500 year flood boundary. Although a Probable Maximum Flood (PMF) boundary is not indicated on the FEMA map, based on USGS topographical quadrangle maps and observations during the site visit that the slope of the remaining portion of the site is very moderate (no more that approximately 3 to 5 feet between the 500-year flood boundary and the Berwick Road boundary of the site), the PMF is assumed to cover the entire site.

- If additional characterization is undertaken prior to the adoption of a restricted release scenario, identification of subsoil contamination in hot spots affecting a significantly increased area of the site could lead to a conclusion that the restricted release scenario should not be undertaken because excavation and removal of the hotspots would affect a large proportion of the site area. Additional characterization might be considered for the following: (1) soil and subsurface soils outlined in *Review and Evaluation of Characterization Data Provided for Safety Light Corporation, Bloomsburg, PA*; (2) groundwater, through a comprehensive program of sampling down to the shale bedrock over at least a 12 month period that includes sampling for radium; (3) modeling of the interaction between groundwater underlying the site and the Susquehanna River, and (4) following removal of buildings, sampling underneath former building sites, including particularly the etching building site and the main building site.

6.2 Buildings

- With respect to buildings, all buildings are considered to be within the PMF boundary. With respect to building contamination, it is assumed that there is no basis for excluding the presence of the most restrictive isotope identified by sampling or historical records as being associated with a particular building. This analysis assumes all buildings will be demolished. Building removal will allow additional sampling underneath their sites and will allow for placement of rip-rap throughout the site. Scenario 3 does not model any prior decontamination, whereas in Scenarios 4 and 5 contamination above 4 times the DCGL and 20 times the DCGL is removed as outlined in section 5.1. Four times the DCGL and 20 times the DCGL are assumed to correspond to exposure rates of 100 mrem per person per year and 500 mrem per person per year respectively.

- Building debris will be sorted onsite and contaminated debris containerized and disposed at a radioactive waste disposal facility. All building demolition debris in Scenario 3 and clean portions of buildings (below 4 or 20 times the DCGL) in Scenarios 4 and 5 are buried on site as backfill.

Exhibit 11 presents summarizes the management of walls, floors and ceilings for most buildings on the site in scenarios 4 and 5. As mentioned above, no remediation is expected to be required in scenario 3. The Main building and Acid Etching building are not included in exhibit 11 because 1) management was assigned by room and 2) the large number of rooms (over 160 rooms between the two buildings) would make a summary prohibitively long. In both the Main building and the Acid Etching building, some surfaces do not require remediation, some require scabbling, and some need to be sent offsite as LLW.

Exhibit 11. Assumed Remediation Methods by Building

Building	Scenario 4 Management			Scenario 5 Management		
	Wall	Floor	Ceiling	Wall	Floor	Ceiling
Personnel Office Building	Not Required	Not Required	Send Offsite as LLW	Not Required	Not Required	Send Offsite as LLW
Machine Shop	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Pipe Shop	Scabble	Not Required	Not Required	Not Required	Not Required	Not Required
Carpenter Shop	Send Offsite as LLW	Send Offsite as LLW	Not Required	Send Offsite as LLW	Send Offsite as LLW	Not Required
Multi-Metals Waste Treatment Building	Scabble	Scabble	Not Required	Scabble	Not Required	Not Required
Well House	Scabble	Not Required	Not Required	Not Required	Not Required	Not Required
Lacquer Storage Building	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Radium Vault	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Not Required	Send Offsite as LLW	Send Offsite as LLW
Utility Building	Send Offsite as LLW	Send Offsite as LLW	Not Required	Not Required	Send Offsite as LLW	Not Required
8 x 8 Building	Not Required	Scabble	Not Required	Not Required	Scabble	Not Required
Liquid Waste Building	Not Required	Chemically Clean	Not Required	Not Required	Not Required	Not Required
Old House	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW	Send Offsite as LLW
Solid Waste Building	Send Offsite as LLW	Send Offsite as LLW	Scabble	Send Offsite as LLW	Send Offsite as LLW	Scabble
Metal Silo	Chemically Clean	Chemically Clean	Not Required	Chemically Clean	Chemically Clean	Not Required
Tritium Building	Chemically Clean	Chemically Clean	Chemically Clean	Chemically Clean	Chemically Clean	Chemically Clean
Old Garage Foundation	Scabble	Scabble	Scabble	Scabble	Scabble	Scabble
Cesium Ion Exchange Unit	Scabble	Scabble	Scabble	Scabble	Scabble	Not Required

6.3 Surface and subsurface soil

- Because of the potential for flooding of the site, which lies completely within the PMF area, it is not considered reasonable to cap the site with readily erodible materials such as clay. A radon barrier cap is not considered necessary.

- In scenario 3, no soil or subsurface soil will be removed, although a pit will be excavated to bury building debris and vegetation. This pit will be backfilled with the excavated soil.

- In scenario 4, areas of surface and subsurface soil contamination exceeding the activity level that would result in a dose to the average member of the critical group of 100 mrem/year will be excavated and disposed at an offsite radioactive waste disposal facility. Potentially affected grids were considered to be grids that exceeded four times the DCGLs for 25 mrem/year, considering also data for beta radiation and the sum of fractions rule. As shown in Exhibit 6, 28 percent of surface soils in Area 1 and 21 percent of surface soils in Area 2 exceed four times the DCGLs. Although contamination above four times the DCGLs exists in Area 3, this contamination is expected to overlay subsurface contamination.

- In scenario 5, areas of surface and subsurface soil contamination exceeding the activity level that would result in a dose to the average member of the critical group of 500 mrem/year will be excavated and disposed at an offsite radioactive waste disposal facility. Potentially affected grids were considered to be grids that exceeded 20 times the DCGLs for 25 mrem/year, considering also data for beta radiation and the sum of fractions rule. As shown in Exhibit 6, 13 percent of surface soils in Area 1 and 15 percent of surface soils in Area 2 exceed 20 times the DCGLs. Although contamination above 20 times the DCGLs exists in Area 3, this contamination is expected to overlay subsurface contamination.

- In scenarios 4 and 5, 25 percent of areas beneath the concrete pads of buildings are assumed to require remediation to a depth of 0.5 meter.

- In scenario 4, subsurface soils in Area 3 with contamination above four times the DCGLs will be removed. In Scenario 4, 31 percent will be removed to a depth of 2 meters, 8 percent will be removed to a depth of 3.5 meters, and 31 percent will be removed to a depth of 5 meters.

- In scenario 5, subsurface soils in Area 3 with contamination above 20 times the DCGLs will be removed. In Scenario 5, 31 percent will be removed to a depth of 2 meters and 15 percent will be removed to a depth of 5 meters.

- In scenarios 3, 4, and 5, stone rip rap will be placed on the entire area to serve as a barrier to erosion of the site surface by flood waters and to prevent future use of the site. The area to be covered will include the Vance Walton property. The area will first be covered with a 6" gravel layer to promote drainage and then covered with rip-rap (18" granite 24" in depth).

6.4 Vegetation

Major vegetation (trees and large plants) will be removed and disposed onsite as common waste (90%) or offsite as radioactive waste (10%). Vegetation removal will facilitate removal of hot spots and placement of rip-rap.

6.5 Groundwater

This analysis does not assume active remediation of groundwater will be necessary. Monitored natural attenuation will be relied upon. High rates of flow onto the site (the rate of groundwater flow is 100 to 300 gallons per day according to the study performed in 1999-2000), coupled with the presence of contamination left on the site, is assumed to make groundwater treatment (e.g., with pumping and carbon filtration) ineffective. Groundwater is closely interconnected with the Susquehanna river, which has a relatively high flow rate. Contaminated groundwater that reaches the Susquehanna River is being heavily diluted before any human contact can occur. The groundwater underlying the site or down gradient is not serving as a current or potential source of potable water. There are no drinking water wells on site or down gradient. Removal of hot spots will remove major sources of groundwater contamination.

Boundary monitoring wells indicate that levels of contaminants are below EPA drinking water standards. Prior to other activities under scenarios 3, 4, and 5, onsite and offsite groundwater monitoring should be conducted over the course of a 12 month period to ensure a full range of climatic conditions and precipitation events are included that demonstrates that (a) no offsite users of the groundwater are affected and (b) there is no demonstrated effect on the Susquehanna River.

6.6 Institutional Controls

Institutional controls will include:

1) New security fencing and warning signs surrounding the site on all sides will be installed. The fenced area will include the Vance Walton property.

2) Transfer of site ownership and control to US DOE, under section 151(b) of NWPA, where DOE would be responsible for protection of public health and safety, through appropriate controls and maintenance.

3) Annual inspection and maintenance of the security fencing and warning signs by a third party responsible for the site.

4) One time payment to U.S. Treasury to comply with no cost transfer to DOE under 151(b) of NWPA at time of license termination.

7.0 Derivation of Unit Costs

7.1 Building Decontamination

The unit costs for scabbling 1/8" from floors ($14.68/ft^2$), walls ($17.12/ft^2$), and ceilings ($20.53/ft^2$) are found on page B-5 of the *Cost Estimate for Decommissioning the Advanced Medical Systems Facility in Cleveland, Ohio*, prepared for US NRC, Office of Nuclear Materials Safety and Safeguards, by ICF Incorporated, April 1998. Because it is common to scabble 1/4" from floors, the cost to scabble floors was doubled ($29.36/ft^2$).

7.2 Equipment Decontamination

The following unit cost estimates for the chemical cleaning of floors, walls and ceilings, in buildings contaminated principally with tritium, presented in Exhibit 12, and in buildings with a mixture of significant contaminants, presented in Exhibit 13, were gathered from the *Revised Analyses of Decommissioning Reference Non-Fuel-Cycle Facilities* (NUREG/CR-6477), completed in July 1998. Each unit cost estimate includes the full cost of handling waste generated by its chemical cleaning process (packaging, supercompaction, transportation, and disposal) in addition to manpower and equipment.

Exhibit 12. Costs Associated with Chemically Cleaning Tritium Contaminated Equipment

	Costs ($ thousands/ 60 m^2)						
	Manpower	Equipment	Packaging	Supercompaction	Transportation	Disposal	Total
Floors	5.25	1.85	0.07	0.15	0.02	0.74	8.08
Walls	3.65	1.29	0.19	0.36	0.06	2.46	8.01
Ceilings	4.00	1.41	0.28	0.60	0.09	3.03	9.41

Exhibit 13. Costs Associated with Chemically Cleaning Equipment Contaminated with Mixed Isotopes

	Cost ($ thousands/ 60 m^2)						
	Manpower	Equipment	Packaging	Supercompaction	Transportation	Disposal	Total
Floors	5.87	1.86	0.10	0.23	0.03	1.14	9.23
Walls	6.54	2.07	0.23	0.44	0.07	3.12	12.47
Ceilings	4.68	1.48	0.55	1.18	0.17	5.98	14.04

To estimate the cost of chemically cleaning a volume of miscellaneous equipment, this analysis generated a new unit cost per piece of equipment based on a weighted average of the total unit costs for cleaning individual pieces of equipment listed in NUREG/CR-6477 and a weighted average of these items' respective volumes, as shown in Exhibits 14-16. Volumes were calculated from component dimensions found in NUREG/CR-6477 Appendix D. The list of items used to calculate average volume and cost for tritium and mixed contamination vary slightly as NUREG/CR-6477 did not contain the unit cost of chemically cleaning each item for each contamination scenario. For example, the cost of chemically cleaning cabinets was available for tritium but not mixed contamination, whereas the cost of cleaning sinks and drains was available for mixed but not tritium contamination. The weights of each item in the calculation were chosen to reflect that item's expected prevalence in chemically cleaned buildings.

Exhibit 14. Weighted average to calculate cost of Chemical Cleaning Tritium Contaminated Equipment

	Cost ($ thousands/component)							
	Manpower	Equip.	Packaging	Supercomp.	Transport.	Disposal	Weight	Total
Fumehood	3.13	1.10	0.13	0.27	0.04	1.36	1.0	6.03
Workbench	1.28	0.45	0.03	0.06	0.01	0.28	2.0	4.22
Refrigerator	1.24	0.44	0.21	0.46	0.07	2.30	1.0	4.72
Cabinets	0.97	0.34	0.04	0.09	0.01	0.46	4.0	7.64
Ventilation	7.16	2.51	0.06	0.13	0.02	0.64	0.5	5.26
Glove Box	0.97	0.34	0.09	0.20	0.03	1.02	1.0	2.65
						Total	**9.5**	**30.52**

Exhibit 15. Weighted average to calculate cost of Chemical Cleaning for Misc. Equipment with Mixed Decontamination

	Cost ($ thousands/component)							
	Manpower	Equip.	Packaging	Supercomp.	Transport.	Disposal	Weight	Total
Fumehood	3.17	1.00	0.13	0.29	0.04	1.44	1.0	6.07
Workbench	3.57	1.13	0.19	0.42	0.06	2.10	2.0	14.94
Refrigerator	1.25	0.39	0.21	0.46	0.07	2.31	1.0	4.69
Sink and Drain	0.57	0.18	0.07	0.15	0.02	0.77	4.0	7.04
Ventilation	7.90	2.49	0.07	0.15	0.02	0.75	0.5	5.69
Glove Box	1.10	0.35	0.10	0.21	0.03	1.04	1.0	2.83
Total							9.5	41.26

Exhibit 16. Weighted Average to Calculate Average Component Size

	Weight	Component Dimensions (m3)	Weighted Component Dimensions (m3)	Included in H-3 Contamination	Included in Mixed Contamination
Fumehood	1.0	2.84	2.84	1	1
Workbench	2.0	0.37	0.74	1	1
Refrigerator	1.0	0.56	0.56	1	1
Cabinets	4.0	0.52	2.08	1	
Sink and Drain	1.0	0.47	0.47		1
Ventilation	0.5	3.09	1.55	1	1
Glove Box	1.0	0.32	0.32	1	1
Total	10.5	8.17	8.55	6	6

7.3 Building Demolition

This analysis referenced RS Means Environmental Remediation Cost Data-Unit Price for 2001 to find unit costs for non-explosive building demolition. Unit costs depend on building material and number of stories, and include labor, equipment, and material for the demolition. The costs found in Exhibit 17 appear in RS Means section 17 02 01, page 4-5.

Exhibit 17. Nonexplosive Building Demolition Costs ($/ft^3)

	Labor	Equipment	Material	Total
Multilevel Concrete	$0.05	$0.04	$0.00	$0.09
Single-level Concrete	$0.07	$0.09	$0.00	$0.16
Single-level Steel	$0.05	$0.07	$0.00	$0.12
Single-level Wood	$0.05	$0.07	$0.00	$0.12

7.4 Vegetation

This analysis referenced RS Means Environmental Remediation Cost Data-Unit Price for 2000 to estimate the costs involved in clearing vegetation and disposing of the proportion that is not radioactive. The unit costs presented in Exhibit 18 are found in RS Means section 17 01 0108, page 4-1.

Exhibit 18. Costs to Clear Vegetation

	Unit	Labor	Equipment	Materials	Total
Clear and Grub, Heavy Trees to 16" Diameter, Cut and Chip	ACRE	$2,211.00	$2,303.00	$0.00	$4,514.00
Clearing - Light Brush without Grub	ACRE	$35.88	$24.75	$0.00	$60.63
Nonradioactive–Machine Load Spoils, 2 Mile Haul, Haul to Dump	Cubic Yards	$18.16	$13.15		$31.31

7.5 Slurry Wall

Exhibit 19 presents costs associated with constructing a slurry wall from RS Means Environmental Remediation Cost Data-Unit Price for 2001, section 33 06 03, pages 9-75 and 9-76.

Exhibit 19. Costs Associated with Constructing a Slurry Wall

	Unit	Labor	Equip.	Material	Total
Construct Dike for Mixing Basin	CY	$1.55	$4.28	$0.00	$5.83
Excavation of Clay/Sand w/ Boulders 26'-75'	CY	$2.28	$5.04	$0.00	$7.32
Bentonite Material Purchase	Ton	$0.00	$0.00	$55.00	$55.00
Slurry Mixing, Hydration, and Placement	Gal	$0.04	$0.00	$0.00	$0.04
Soil-Bentonite Backfill Mixing	CY	$0.70	$1.80	$0.00	$2.50
Demolish Mixing Basins and Regrade Working Surface	SF	$0.03	$0.03	$0.00	$0.06

7.5 Excavation

This analysis referenced RS Means Environmental Remediation Cost Data-Unit Price for 2001 to find unit cost estimates for different depths of trench excavation. The unit costs presented in Exhibit 20 for shallow excavation (this analysis assumed shallow excavation appropriate for depths less than 10 feet) and deep excavation (RS Means suggests for depths between 10 feet and 20 feet) were found under section 17 03 0202, page 4-10 and section 17 03 0260, page 4-13 respectively. (Neither cost includes transportation or disposal costs associated with the spoil.)

Exhibit 20. Costs Associated with Excavation

Excavation	Unit	Labor	Equipment	Material	Total
Trenching, 1 CY Gradall, Light Soil, 95 CY/hr, Continuous Footing Excavation	Cubic Yards	$1.54	$2.73	$0.00	$4.27
Cat 225, 1.5 CY, Soil/Sand, 10'-20' Deep Trench Box	Cubic Yards	$1.07	$1.46	$0.92	$3.45

7.6 Load and Haul Spoil

The unit costs presented in Exhibit 21 to load and haul 12 cubic yards of spoil 5 miles are found in RS Means Environmental Remediation Cost Data-Unit Price for 2001 under section 17 03 0203, page 4-10. This analysis converted this unit cost into dollars per cubic foot.

Exhibit 21. Costs Associated with Load and Haul

	Labor	Equipment	Material	Total
Load & Haul Soil, 12 Cubic Yards, 5 miles	$1.32	2.32	0	$3.64

7.7 Backfill

The costs presented in Exhibit 22 associated with backfilling were gathered from RS Means Environmental Remediation Cost Data-Unit Price for 2001, section 17 03 04, page 4-23.

Exhibit 22. Costs Associated with Backfill

Backfill ($/CY)	Labor	Equipment	Material	Total
Trench Backfill, 3 cubic yards, 950	$0.41	$0.69	$0.00	$1.10
Excavate & Load, 3-1/2 CY Wheel Loader, Medium Material, 103 CY/Hour	$0.32	$0.50	$0.00	$0.82
Haul, 12 CY Truck, 6 Miles, 40 MPH, 2.1 Cycles/Hour	$0.98	$1.72	$0.00	$2.70
Borrow Material, Unclassified Fill	$0.00	$0.00	$5.00	$5.00

7.8 Packaging Debris

This analysis used Safety Light Corporation's unit cost of $460.00 to obtain each used B-25 box, found in Table A-3 of appendix A of the *Decommissioning Cost Estimate for Safety Light Corporation,* prepared for SLC by GTS Duratek Radioactive Solutions, October 2000. This analysis then assumed a unit cost of $1.25 per cubic foot for containerizing debris.

7.9 Shipping and Disposal

This analysis used SLC's estimate of a distance of 2109 miles to the Envirocare facility located in Clive, Utah. This analysis also used SLC's estimates for a mileage rate of $1.95 per mile per shipment. Transportation costs do not vary by disposal rates.

This cost estimate used three disposal rates to bound the cost ($\$5/ft^3$, $\$11/ft^3$, and $\$17/ft^3$), assuming the waste will be disposed at Envirocare as LLW. Mixed waste is considered to be approximately three times the cost of disposal of LLW. The range for LLW and the increase for mixed waste corresponds to data provided by a DOE web site that describes the range of disposal costs for DOE and commercial sites (http://emi-web.inel.gov/contracts/range.html). Additionally, this range of costs corresponds directly with input from NRC staff. As part of this project NRC staff researched disposal costs by contacting the U.S. Corps of Engineers (USACE) and reviewing rates in their current Envirocare contract, and reviewing licensee decommissioning funding plan proposals and other available documents. NRC confirmed that approximately $\$11/ft^3$ is an "average" LLW disposal rate at Envirocare and that $\$5/ft^3$ and $\$17/ft^3$ adequately describe the range of anticipated LLW disposal costs. Furthermore, NRC confirmed with USACE that mixed waste disposal at Envirocare should be assumed to be three times the cost of LLW disposal.

7.10 Analytical Sampling

This analysis referenced RS Means Environmental Remediation Cost Data-Unit Price for 2001 section 33 02 2342, page 9-59 to obtain the unit cost estimate of $103 per sample for isotopic gamma spectroscopy of vegetation, soil, or sediment.

7.11 Ground Water Treatment

Exhibit 23 presents costs associated with air stripping from RS Means Environmental Remediation Cost Data-Unit Price for 2001, section 33 13 07, pages 9-123 through 9-125.

Exhibit 23. Costs Associated with Air Stripping

Air Stripping	Unit	Labor	Equipment	Material	Total
Packing Reconditioning	Each	$910.40	$1,678.00	$0.00	$2,588.40
Install Air Stripper Tower (12')	Each	$2,769.00	$475.26	$0.00	$3,244.26
Daily Inspection of Air Stripper	Hour	$19.50	$0.00	$0.00	$19.50
General Maintenance of Air Stripper	Hour	$61.90	$0.00	$0.00	$61.90
Internal Parts for Air Stripper (<20')	ft	$0.00	$0.00	$3,107.00	$3,107.00
Packing for Air Stripper Tower	ft3	$0.00	$0.00	$15.63	$15.63

Exhibit 24 presents costs associated with carbon adsorption were gathered from RS Means Environmental Remediation Cost Data-Unit Price for 2001, section 33 13 20, pages 9-148 through 9-151.

Exhibit 24. Costs Associated with Carbon Adsorption

Carbon Adsorption	Unit	Labor	Equipment	Material	Total
5 GPM, 85 Lb Fill, DOT 5B Drum, Disposable	Each	$60.66	$0.00	$470.00	$530.66
Coal-based General Purpose, 8 x 30 Sleve, 900 Iodine, <2,000 Lb	lb	$0.00	$0.00	$1.23	$1.23
Activated aluminas for highly oxidized contaminants	lb	$0.00	$0.00	$0.65	$0.65
Reactivation or thermal regeneration of carbon	lb	$0.00	$0.00	$0.05	$0.05
Remove carbon from vessels 10-20K minimum	lb	$0.00	$0.00	$0.02	$0.02
Removal, transportation, regeneration spent carbon	lb	$0.00	$0.00	$0.58	$0.58
4MM Pellet for solvent recovery, <2,000 Lb disposable	lb	$0.00	$0.00	$1.79	$1.79

7.12 Erosion Control Measures

The cost to cover the site with a six inch thick layer of gravel of $26.69/yd^3 was taken from RS Means Environmental Remediation Cost Data-Unit Price for 2001, page 5-18. The cost of $39/yd^3 to cover the site with Rip-rap was taken from RS Means Heavy Construction Cost Data, 2000, section 02370.

7.13 Site Control and Maintenance

Exhibit 25 presents unit costs for security fencing and warning signs from RS Means Environmental Remediation Cost Data-Unit Price for 2001, section 18 04 0101, page 5-13 and section 18 04 0501, page 5-15 respectively.

Exhibit 25. Cost Associated with Fencing and Signs

	Unit	Labor	Equipment	Material	Total
Security Fence, 10' Galvanized with 3 Strands Barbed Wire	Linear Feet	$8.30	$10.55	$13.26	$32.11
Directional Sign, 12" x 18" with Post Reflectorized, OSHA Standard, to mark Hazardous Waste	Each	$29.06	$0.00	$15.76	$44.82

To calculate the necessary amount of financial assurance for ongoing institutional control maintenance tasks, this analysis used the following equation from *Draft Regulatory Guide DG-4006, Demonstrating Compliance with the Radiological Criteria for License Termination, p. 33.*

$$\text{Funding Required} = C_o \times 50 \text{ yrs}$$

where:

C_o is the first year annual costs, (assumed to be $25,000/yr assumed for typical Title II UMTRCA site disposal cells) and

Hence, the funding required = $1,250,000.

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