Cabot Performance Materials
2002 Decommissioning Cost Estimate
for the Boyertown, Pennsylvania Site

Prepared by:

Weston Solutions, Inc.

Approved by:

________________________________ ________________________
Robert Schoenfelder Date
Project Manager

Prepared for:

Cabot Performance Materials, Inc.
County Line Road
Boyertown, PA 19512

September 6, 2002

EXECUTIVE SUMMARY

Weston Solutions, Inc. (WESTON®) is providing a cost estimate for decommissioning the Cabot Performance Materials, Inc. (CPM) Boyertown, Pennsylvania site. The cost estimate is based on a survey that was performed by the Scientific Ecology Group, Inc. (SEG) in 1993 (Reference 6.1); however, the estimate has been updated to reflect current decommissioning standards and unit costs. Conversations with CPM's Radiation Safety Officer indicate that no major spills or changes in configuration have occurred since 1993; therefore, the SEG information was used with certain minor modifications to estimate the radioactive materials presently on-site. WESTON then updated the cost estimate, following cessation of site operations, for site characterization; equipment, tank, concrete, and soil decontamination; radioactive waste volume reduction, packaging, shipping, and disposal; health physicist support; and final release surveys. The updated cost estimate is $5,886,000, which reflects typical 2002 costs and incorporates a 15% contingency. This estimate is for budgetary purposes only and is not a proposal or cost estimate for WESTON to perform work.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 PURPOSE

Weston Solutions, Inc. (WESTON®) prepared this document to provide an updated cost estimate for decommissioning the Cabot Performance Materials, Inc. (CPM) Boyertown, Pennsylvania site (Boyertown site). The cost estimate includes only those activities and cost factors, including a 15% contingency factor, required to remove residual radioactivity to levels that will allow release of the site for unrestricted use in accordance with the Nuclear Regulatory Commission (NRC) guidelines (See Reference 6.2, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material*, and Reference 6.3, *Draft Consolidated NMSS Decommissioning Guidance: Decommissioning Process*). Costs associated with the demolition and removal of non-contaminated equipment or structures are not included in this cost estimate. The date of actual decommissioning is not known or projected, as this facility is expected to continue operation for an extended period of time. The costs listed in this report are estimates based on typical 2002 costs. The cost estimate in this document should be used for budgetary purposes only and does not constitute a proposal or cost estimate for WESTON to perform the work.

1.2 SCOPE

The scope of this report is limited to the derivation of the cost required to remove residual radioactivity after cessation of operations at this site. Costs, in 2002 dollars, include the following:

- Costs of a detailed site characterization after site operations have ceased and all stores of licensed material have been removed from site.
- Costs of manpower and equipment to remove or reduce residual radioactivity to levels that will permit release for unrestricted use.
- Costs of radioactive waste packaging, volume reduction, shipping, and disposal.
- Costs of final site release survey.

1.3 DISCUSSION

This cost estimate represents an evaluation and study of the costs for the decommissioning and disposal of the radioactive portions of the CPM Boyertown site. The methodologies specified for decontamination and demolition were selected to minimize the decommissioning cost. This study is based on the physical condition of the Boyertown site as of 2002 and the decommissioning cost estimate prepared by the Scientific Ecology Group, Inc. (SEG) (Reference 6.1). The result of this study is a decommissioning cost estimate of $5,886,000. The bases of the cost estimate are clearly documented in a concise spreadsheet calculation that can be easily updated. The following list of assumptions and bases were utilized in developing the cost estimate.

1. All stored ore and ore filtercake will have been removed from the site, by CPM, prior to the start of decommissioning.
2. All operating areas will have been cleaned to remove loose ore dust and filtercake from equipment and structures.
3. The disassembly and decontamination of slightly contaminated equipment will be performed on-site utilizing labor supplied by CPM. (The internal cost to CPM for this labor was not included in this estimate.)
4. Contracted health physics and decommissioning project personnel will be used.
5. On-site decontamination of equipment will be used where possible.
6. Off-site volume reduction facilities will be used to minimize radioactive waste volume.
7. Contracted on-site soil washing equipment will be used to minimize radioactive soil waste volume.
8. Automatic data logging equipment will be used in the performance of site release surveys.
9. A Naturally Occurring Radioactive Material (NORM) disposal site will be used for disposal of unimportant quantity source material, as defined in 10 CFR 40.13. Currently, Waste Control Specialists, Inc. (WCS) is designated to accept such material from the site.
10. Residual source material that exceeds 0.05% uranium and thorium will be transferred to a uranium mill or transferred to another licensee for further processing.
11. There is the potential to generate mixed waste (chemical hazardous waste mixed with radioactive materials) during decommissioning. This cost estimate does not include any costs associated with mixed waste handling or disposal.

2. GENERAL SITE DESCRIPTION

The CPM facility at Boyertown, Pennsylvania, prepares tantalum and columbium (niobium) products for use in several U.S. industries. The tantalum and columbium are recovered from ores and slags using chemical processes. Other operations in the Boyertown facility include fabrication of products, treatment of acidic wastewaters, and storage of filtercake containing the uranium and thorium contaminants. The concentrations of the uranium and thorium contaminants are such that they exceed the 0.05% by weight criterion of 10 CFR 40 and must be controlled in accordance with the requirements of the NRC.

The current operations involving source material are concentrated in two areas of the l60-acre site. The production area is located in the southeastern part of the site (on both sides of County Line Road), and the wastewater treatment plant, filtercake storage bins, and principal raw material storage areas are located northwest of the production area. The remainder of the site consists of approximately equal areas of deciduous trees (e.g., oak, hickory, maple, elm, and ash) and open field (grassland and corn).

3. DESCRIPTION OF THE DECOMMISSIONING METHOD

The decommissioning method presented in this section is taken primarily from Reference 6.1, *Decommissioning Cost Estimate for Boyertown, Pennsylvania Site*. This method requires that residual radioactive materials be removed after termination of operations at this site. For the purposes of this cost estimate, once structures and soils are decontaminated to releasable limits, no further decontamination or demolition is required.

When the site operations cease, it is assumed that no unprocessed ore will remain on-site and that the filtercake in the bulk storage bins has been removed. It is further assumed that all areas in which ore was stored or processed have been cleaned to remove residual material. Thoroughly cleaning equipment, external and internal areas, and all other building surfaces would most likely accomplish this.

The following areas are considered for decommissioning in this cost estimate because they contain radioactive material or have previously contained radioactive material.

3.1 BUILDING 73

Grinding equipment is operated in an enclosed system within Building 73. The fine ore and slag particles from the grinding process are collected and segregated according to particle size with an air classification system. The effluent is cleaned in a baghouse that operates at a pressure slightly lower than that of the building.

With the exception of the outdoor filtercake storage pad, surrounding outdoor areas, and underground drain pipes, all of the equipment and electrical boxes in Building 73 are assumed to contain ore dust. The ore dust is a loose material that is expected to be removable to release limits by conventional cleaning methods. The first step in the cleanup would be to perform a general cleaning of these areas, using appropriate equipment.

Electrical boxes, control panels, and other miscellaneous items from the walls of Building 73 will be compacted prior to disposal at a licensed facility. The Digester Area, Filter Area, Outdoor Scrubber Area, and Outdoor Feed Tank Area contain process piping and equipment that requires flushing and wipe down prior to survey and release (most of this piping is plastic or plastic-lined). The smaller pipe sizes may not be accessible for surveying and may be compacted for disposal.

The surfaces of metal ceilings and/or cinder-block walls will be vacuumed and wiped down prior to survey and release. In some areas the cinder-block walls have large open holes in the blocks. Additional holes will be made in these blocks to allow the dust to be vacuumed from within the blocks. For areas with corrugated fiberglass wall panels, the walls will be vacuumed, brushed, and wiped prior to survey and release. The concrete surfaces or floors and bases will be vacuumed and then scabbled to remove approximately 1/2 inch of concrete. The cracks will then be chipped out to remove contamination as necessary prior to surveying for release.

3.1.1 Grinding Area

Ore is ground in the Grinding Area in Building 73. The general cleaning outlined above would be followed by disassembly of the grinders, conveyors, hoppers, and support structures. This equipment would require further vacuum cleaning, brush cleaning, and wipe down prior to survey and release.

3.1.2 Repackaging/Screening Area

Materials are screened for appropriate size and repackaged in the repackaging/screening area, which is part of Building 73. The general cleaning outlined for Building 73 would be followed by disassembly of the drum handler/screener and support structures. This equipment would require further vacuum cleaning, brush cleaning, and wipe down prior to survey and release.

3.1.3 Digester Area

The finely ground ore is transferred, as needed, into the digester tanks containing hydrofluoric acid. The acid selectively dissolves tantalum and columbium to form fluorotantalic acid (H_2TaF_7) and f1uoroniobic acid (H_2NbF_7). The uranium and thorium contaminants react with the acid to form the insoluble compounds, UF_4 and ThF_4. Aluminum, calcium, magnesium, and potassium also react to form insoluble fluoride compounds. After a sufficient dissolution period, the mixture is passed through filter equipment where the insoluble compounds (containing the uranium and thorium) are removed from the solution and collected for disposal.

It is expected that equipment and floors may have the radioactive contamination strongly bonded as the result of the acid digestion process. Flushing and disconnection of the digester vessels would follow the general cleaning. The vessels have a rubber lining and a layer of graphite bricks inside to resist the hydrofluoric acid. These bricks will have absorbed activity and will need to be removed for disposal. It is expected that the tank lids will be removed and that the graphite bricks will be removed using a long-handled digging bar. The interior can then be flushed, surveyed, and released.

3.1.4 Filter Area

After digestion, the processed mixture is passed through filtration equipment where the insoluble compounds (containing the uranium and thorium) are removed from the solution and collected for disposal. This filtering step includes a press to reduce the moisture content of these solids (filtercake) to about 40%. Filtrate is pumped to the metal-recovery process facility (Building 74).

It is expected that equipment and floors may have the radioactive contamination strongly bonded as the result of the acid digestion process. Flushing and disconnection of the filters would follow general cleaning. The disassembled filters can be further brushed and washed to remove contamination prior to being surveyed and released. The walls in the filter discharge area would receive an additional high-pressure wash to remove caked-on material.

3.1.5 Outdoor Scrubber Area

Air emissions are scrubbed in the outdoor scrubber area near Building 73. Flushing and disconnection of the scrubber vessels, piping, and fiberglass ductwork would follow the general cleaning. The disassembled vessels, process piping, and other process equipment would require flushing and wipe down prior to survey and release.

3.1.6 Outdoor Bag Filter Area

The bag filter plenums are located in the outdoor bag filter areas. The general cleaning would be followed by disassembly of the filter system. The disassembled filters, ductwork, and other equipment would require additional vacuum cleaning, brushing, and wipe down prior to survey and release.

3.1.7 Outdoor Compressor and Tank Area

The compressed air system is located in the outdoor compressor and tank area. The compressor is expected to have internal contamination that will not allow it to be surveyed for release. Disconnection and removal of the compressor would follow general cleaning. The pressure tank would be opened and all surfaces would be vacuumed and wiped down prior to surveying for release.

3.1.8 Outdoor Feed Tank Area

The tantalum and niobium-rich liquor that is produced during ore processing is initially transferred to a feed tank area outside Building 73. The cleanup of this area would involve a flush of all the tanks followed by a wipe down of the exterior of the fiberglass tanks. The tanks would then be disconnected and opened to allow brushing and flushing to remove solids caked in the bottoms of the tanks. The tanks would then be removed and surveyed for release.

3.1.9 Outdoor Filtercake Storage Area

The filtercake from the dissolution and filtering operations is a mixture of $CaAlF_5$, $KMgAlF_6$, CaF_2, $CaMg_2AlF_{12}$, SiO_2, and SnO_2. The filtercake also contains residual tantalum and niobium along with a combined uranium/thorium concentration of about 1%. The filtercake is temporarily stored in open, portable hoppers on the northwest end of Building 73 until a truckload of containers is filled. The filtercake containers are then transported to the bulk storage bins where they are emptied.

Filtercake has been in contact with the concrete and asphalt surfaces in this temporary storage area. About half the area is concrete (where the filtercake hoppers are staged) and half is asphalt.

The cleanup consists of a general high pressure washing of the pad, scabbling the rough concrete surface to remove about 1/2 inch of concrete followed by chipping out the cracks to remove contamination. The asphalt would then be removed for disposal at a licensed facility prior to surveying the area for release.

3.1.10 Roof Top Classifier and Bucket Elevators

Building 73 contains equipment that sorts and transfers ore feed material. A sealed, size-sorting device or classifier is located on the roof, and the bucket elevator transfers scoops of ore to the grinding circuit. These systems would receive a general cleaning that would be followed by disassembly of the classifier system, bucket elevators, and ancillary equipment. This equipment would require additional vacuum cleaning, brushing, and wipe down prior to survey and release.

3.1.11 Surrounding Outdoor Areas

Ore, ore dusts, and filtercake have been in contact with areas outside Building 73 due to ore handling operations, grinding operations, maintenance operations, and outdoor filtercake hopper storage. Asphalt was added around the building after the building was initially put into operation. The areas not covered by asphalt are covered with a soil composed of gravel and clay that is over one foot deep. Deep soil samples could not be obtained in this area, but it is expected that contamination has penetrated to a depth of about one foot.

The area will be excavated to a depth of one foot. Most of the gravel would be washed to remove contamination, then surveyed and released. The portion of the soil that cannot be decontaminated would be packaged for disposal at a licensed facility prior to surveying the area for release.

3.1.12 Underground Drain Pipes

Outside drains that collect rainwater from the roof gutter system are expected to be contaminated. Floor drains in the building will also be contaminated. These drains will need to be removed and the soil around the drains monitored for contamination. The extent of contamination was not determined for this cost estimate. It is expected that the drainpipes could be located and monitored along their length to determine the extent of contamination. For this cost evaluation, it is expected that 100 yards of contaminated piping buried 4 feet below grade will require removal. It is also expected that 10% of the fill around the pipe is contaminated. The pipe is expected to have absorbed contamination that cannot be removed. The pipe will be removed and disposed at a licensed facility before the area is surveyed for release.

3.2 BUILDING 74

The solutions from the Building 73 filtering equipment are pumped to the processing equipment in the metal-recovery facility, Building 74. The tantalum and columbium are continuously extracted from the solutions by reactions with methyl-isobutylketone (MIBK), followed by sulfuric acid and hydrofluoric acid treatment. This process separates the mixture into two product streams containing either H_2NbF_7 or H_2TaF_7 and a liquid waste (raffinate) stream. The liquid waste stream is an aqueous solution of sulfuric and hydrofluoric acids, with possible traces of MIBK.

The disassembled process piping from the tanks and vessels would require flushing and wipe down prior to survey and release (most of the process piping is plastic or plastic lined). The smaller pipe sizes may not be accessible for surveying and may be compacted for disposal at a licensed facility. As decontamination of the process pumps would not be practical, the pumps would be compacted and packaged for disposal at a licensed disposal facility. The concrete surfaces around the tanks and vessels will be scabbled to remove about 1/2 inch of concrete, cracks in the concrete will be chipped to remove contamination, and the area will be monitored for unrestricted release.

3.2.1 Feed Tank Area

Six fiberglass tanks along the northeast wall, labeled 8A, 8B, 9A, 9B, 10A, and 10B, contain radioactive material, as indicated by elevated radiation readings on the tank bottoms (in the mR/hr range). Because of these readings, it is expected that the floor under the tanks will be contaminated from leakage, but that the general floor area will not be contaminated. Although the floor has an epoxy coating, this coating can be damaged when a tank fails and direct contact with the concrete floor occurs. The first step in the cleanup of this area would be to flush all the tanks and then to wipe down the exterior of the fiberglass tanks. The tanks would then be disconnected and opened to allow brushing and flushing to remove solids caked in the bottoms of the tanks before they are surveyed for release.

3.2.2 Extraction Vessel Area

Two extraction tanks contain radioactive material, as indicated by elevated radiation readings on the tank bottoms (in the mR/hr range). It is expected that the floor under these vessels will be contaminated from leakage, but that the general floor area will not be contaminated. The cleanup of this area would begin with a flush of the vessels followed by a wipe down of the exterior. The vessels would then be disconnected and opened to allow brushing and flushing to remove solids caked in the vessels. The vessels would then be removed and surveyed for release.

3.2.3 Floor Drains

The floor drains for collecting process spills are contaminated and will need to be removed, and the soil around the drains will need to be monitored for contamination. The extent of contamination was not determined for this cost estimate. It is anticipated that the drainpipes could be located and monitored along their length to determine the extent of contamination. For this cost evaluation, it is expected that 50 yards of contaminated piping buried 4 feet below grade will require removal. Approximately 10% of the fill around the pipe may be contaminated. The pipe is expected to have absorbed contamination or have internal contamination that cannot be removed; therefore, the pipe will be disposed at a licensed facility before the area is surveyed for release.

3.2.4 Outdoor Acid Waste Tank Area

Two contaminated outdoor acid waste tanks are situated in an area with a high curb; one of them is abandoned. These tanks read about 500 μR/hr. The cleanup of these tanks would begin with a flush, after which they would be disconnected and opened to allow brushing and flushing to remove solids caked in the bottoms of the tanks. The tanks would then be removed and surveyed for release.

3.3 BUILDING 87

Building 87 is the original digestion and press building that continues to be used for handling radioactive materials. Monitoring activities and potential decontamination will be required in the area when the license is terminated.

3.3.1 Digestion and Feed Area

Ore digestion and liquor extraction originally occurred in the digestion and feed area. The only area of this building that demonstrated measurable contamination was the concrete floor under the digester on the southwest side of the building. The digester and filter press did not have elevated radiation levels. For the concrete floor under the digester vessel, the concrete surfaces will be scabbled to remove about 1/2 inch of concrete and cracks will be chipped out to remove contamination prior to surveying for release.

3.3.2 Warehouse and Digester Area

Materials were stored and the digester was located in the warehouse and digester area. The only area of this building that demonstrated measurable contamination was the concrete floor where drums of ore and a contaminated bucket conveyor belt have been stored. The surface of the concrete floor may require scabbling to remove about 1/2 inch of concrete, and the cracks will need chipping to remove contamination before the area is surveyed for release.

3.3.3 Surrounding Outdoor Area

There is evidence of contamination outside Building 87. The area surrounding the building is covered with a soil composed of a gravel and clay mixture more than one foot deep. Deep soil samples could not be obtained in this area, but contamination is assumed to have penetrated to a depth of about one foot due to the porous nature of the soil.

The soil would need to be removed to a one-foot depth. It is expected that the soil could be washed to remove contamination, surveyed, and released. The remaining soil would need to be packaged for disposal at a licensed facility. The area would then be surveyed for release.

3.3.4 Outdoor Temporary Staging Area

There is evidence of contaminated material handling and equipment storage in the outdoor temporary storage area. The area is covered with a soil composed of a gravel and clay combination more than one foot in depth. Deep soil samples could not be obtained in this area, but contamination is expected to have penetrated to a depth of about one foot due to the porous nature of the soil.

The soil will be removed to a one-foot depth. It is expected that most of the soil could be washed to remove contamination, surveyed, and released. The portion of the soil that cannot be decontaminated would be packaged for disposal at a licensed facility before the area is surveyed for release.

3.4 BUILDING 18, STORAGE BUILDING

Building 18 is a former aluminum foundry building that was converted years ago into a warehouse. Most of the building is used to store drums and bags of ore, empty drums, and some chemicals. The rest of the building is used to store equipment and other operational supplies. The ore containers are sampled in this building.

3.4.1 Ore Storage Area

Ore was stored and sampled in the Ore Storage Area. Ore handling in the Ore Storage Building has resulted in some spillage of ore onto the floor. As a result, the floor of this building may be slightly contaminated and will need to be cleaned and monitored prior to release. The cinder-block walls and metal ceiling are expected to be clean. The first step in the cleanup of this area would be to perform a general vacuum cleaning of the area. If residual contamination were detected, the concrete surface would be scabbled to remove about 1/2 inch of concrete, and the cracks would be chipped out to remove contamination.

3.4.2 Surrounding Outdoor Area

There is no evidence of contamination outside Building 18. No decontamination is planned for the outside area, which is mostly asphalt. However, the final survey of the outdoor area should include deep soil samples taken through the asphalt to reveal any contaminated soil that needs to be removed prior to releasing the area.

3.5 BUILDING 10, STORAGE BUILDING

The Storage Building is used to store palletized bags and drums of chemicals and materials produced at the Boyertown site. Some palletized drums and bags of ore are also stored here. There is no evidence of contamination in Building 10. Although no decontamination of this building is planned, a final survey of the area should include deep soil samples taken through the asphalt floor to reveal any contaminated soil that needs to be removed before the area is surveyed for release.

3.6 BUILDING 23, LOADING DOCK

Building 23 has a concrete loading dock with a surface-mounted scale used for weighing ore when it is received. There is no evidence of contamination on this loading dock. No decontamination of the area is planned. The area will be surveyed and released.

3.7 BUILDING 11, DEVELOPMENT LABORATORY

This laboratory is used in developing new processes for recovering metals from the contaminated ores and for recovering useful materials from the waste filtercake processed in Building 73. There is no evidence of contamination in the laboratory. No decontamination is planned prior to surveying the area for release.

3.8 BUILDING 41, ANALYTICAL LABORATORY

The Analytical Laboratory includes a sample staging room as well as a wet chemical analysis room.

3.8.1 Sample Introduction Room

The sample introduction room is used to hold samples before and after analysis. It is anticipated that removal and wiping of all laboratory equipment will remove the contamination. No other decontamination of the area is planned prior to surveying the area for release.

3.8.2 General Laboratory Area

The general laboratory area is used for wet and dry chemical analysis. There is no evidence of contamination in this area. No decontamination is planned prior to surveying the area for release.

3.9 BUILDING 62, WASTE PROCESSING AND TRUCK BED WASH DOWN AREA

The filtercake from Building 73 processing is transported to the bulk storage bins in open hoppers on flatbed trucks. During transit, some of the filtercake may fall onto the truck bed. After unloading, the truck beds are washed off on an asphalt area attached to the wastewater filter house. The asphalt in this area, which was installed in 1993, exhibited no evidence of contamination at that time. No decontamination of the area is planned prior to surveying it for release.

3.10 BULK STORAGE BINS

The filtercake generated in Building 73 is temporarily stored in open, portable hoppers outside the building until a truckload of containers is filled. The filtercake containers are then transported to and emptied into the bulk storage bins.

The filtercake is currently being stored in the dedicated on-site bulk storage bin for further processing and/or disposal. This cost estimate includes removing, packaging, and transporting the filtercake for uranium recovery processing at a qualified, licensed facility, which is about half as expensive as disposal at a radioactive waste disposal site. The bulk storage bins will be monitored for unrestricted release. Approximately 3,000 tons of filtercake were stored at the time of this plan.

3.10.1 Buildings 99 and 102

Bulk storage bins 1 through 4 constitute Building 99, and bulk storage bins 5 through 7 constitute Building 102. Before each bin is used, it is refurbished with a seamless liner that wraps 6 feet up each wall and is topped by a sloped concrete floor. The filtercake is dumped onto the concrete floor of each bulk storage bin as a wet acidic sludge.

The buildings are constructed of poured concrete, except the upper areas, which are cinder block. The cinder blocks have been added on most of the walls to reduce the size of the opening between the tops of the walls and the bottoms of the roofs. Windblown rainwater is prevented from entering the bins by louvered vents and plastic weather strips above the gates to each bin. In addition, the entryway to each bin has been pitched such that rainwater is directed away from the entrance. Radioactive material is expected to be strongly bonded to the walls and floors. It is assumed that the filtercake will be removed from the bulk storage bins before the decommissioning process begins. The cleanup of the facility would start with a high-pressure wash of the interior ceilings, walls, and floors to remove caked on filtercake. The ceiling and wall areas, including the cinder blocks, would be grit blasted to remove activity and then vacuumed before they are surveyed for release. Prior to surveying the area for release, the concrete surface would be scabbled in two separate passes to remove a total of 1/2 inch of material; then the cracks would be chipped out to remove contamination.

3.10.2 Surrounding Outdoor Area

There is evidence of contaminated filtercake from the bulk storage bins in the soil outside the buildings. The soil is a clay type, and there are graveled roadways around the buildings. Composite surface and deep soil samples obtained in this area indicate that contamination has penetrated to a depth of about 6 inches. The soil will be removed to a 6-inch depth. It is expected that most of the soil could be washed to remove contamination, and then surveyed and released. The portion of the soil that cannot be decontaminated would be packaged for disposal at a licensed facility prior to surveying the area for release.

3.11 FORMER TIN SLAG STORAGE AREAS

Tin slag is a black silicate glass with a wide range of particle sizes and irregular particle shapes. This material is the water-quenched waste from the tin smelting process in Malaysian countries and was delivered in 55-gallon drums and stored in a large field north and east of Lagoon 6 and also along the roadway to the bulk storage bins. Some of this slag was seen lying on the surface of the ground, and radiation levels are elevated throughout the area. The soil is a clay type, and there is a graveled roadway passing through the area to the bulk storage bins. Composite surface and deep soil samples were obtained in this areas. Because contamination has penetrated to a 6-inch depth, the soil would be removed to a 6-inch depth. It is expected that most of the soil would be washed to remove contamination, surveyed, and released. The portion of the soil that cannot be decontaminated would be packaged for disposal at a licensed facility before the area is surveyed for release.

3.12 WINTER STORAGE SLAG PILE

The tin slag in 55-gallon drums was initially stored in an area north and east of Lagoon 6. To avoid problems with obtaining frozen slag from the drums during the winter season, a pile of slag was formerly maintained in an area between Buildings 73 and 74. This area is a concrete pad with ore dust on it and no barriers to keep material from being washed off the pad onto the surrounding soil. Although the concrete pad was decontaminated, monitored, and released for unrestricted use, about 3600 cubic feet of contaminated soil would be removed from the winter storage slag pile area, as stated in the original SEG cost estimate (Reference 6.1). The cost for disposal of that volume of material remains in this cost estimate although the area will not require further monitoring, excavation, or disposal.

4. SITE PRELIMINARY CHARACTERIZATION

The CPM Boyertown site was surveyed by SEG in July of 1993 to gather physical facility and nuclear data. In order to gather sufficient data to allow the development of a decommissioning cost estimate, SEG performed direct beta monitoring of surfaces and direct monitoring of general areas with a μR meter, sampled soil areas that demonstrated elevated dose rate readings, and obtained smears to determine the levels of removable activity. The results of this preliminary characterization work were provided to CPM (1993). The results of that characterization are considered valid today because there have been no significant changes in the site operations and no unplanned releases of radioactive material since 1993, and because routine radiological surveys conducted by CPM have indicated no significant increases in radiation levels around the site and in work areas.

The typical raw ore processed at the Boyertown site contains uranium and thorium as a contaminant. Table 4-1 shows actual average and maximum concentrations of uranium and thorium in the various ores received at the site during 2001.

Table 4-1. Average Concentration of Uranium and Thorium in Ore Materials Received by CPM During 2001 (Weight Percent).

	%Th	%U
Average	0.057	0.165
Maximum	1.128	0.647

Thorium-232 has much lower surface activity release limits than natural uranium. As a consequence, the site decommissioning will need to meet the lower release limits. Total alpha activity levels of 1,000 disintegrations per minute per 100 cubic centimeters (dpm/l00 cm^2) and removable activity levels of 200 dpm/100 cm^2 alpha are acceptable for unrestricted release of equipment and material from the site. Structures are assumed to meet the dose-based license termination criteria once total alpha contamination levels are reduced to approximately 50dpm/100 cm^2. In addition, soil sample activities that exceed background by about 2.5 pCi/g of thorium-232 were considered potentially significant under the 25-mrem/y dose-based standard. These areas were included in the remediation cost estimate. The total and removable activity limits for equipment and materials are based upon the NRC guidelines in Reference 6.2. Total activity limits for residual surface contamination on structures are based on the DandD Version 2.1.0[1] computer program (Reference 6.4) occupancy scenario simulations. The preliminary soil activity limits also are based on simulations using DandD Version 2.1.0. A thorough characterization should be performed to establish with certainty the areas requiring remediation. This would occur prior to the projected decommissioning and after all radioactive ore has been removed from the site.

4.1 DOSE RATE READINGS USING A μR METER

Dose rate readings were taken using a μR survey instrument in all areas with the potential for residual activity. These results are summarized in Appendix 1 of the 1993 SEG report (Reference 6.1). Appendix 1 of that report contains survey maps for the various locations and the associated instrument readings. The μR instrument was used in determining if elevated dose readings extended into the soil areas surrounding the process and storage buildings. The lower dose rate readings on-site and away from processing were in the range of 5 to 20 μR/hr. A value of 20 μR/hr was established as the background level for the purpose of this report.

4.2 DIRECT COUNT RATE RESULTS

Beta activity levels were measured by SEG (1993) in all structures and outdoor pads with the potential for residual radioactivity. The results are summarized in Appendix 2 of the SEG document (Reference 6.1), which contains the instrument readings and survey map locations for the various readings. SEG used a count rate meter with a shielded GM detector that was primarily sensitive to alpha and beta activity. In 1993, readings in all areas still being actively used for ore processing exceeded 3,000 dpm/l00 cm^2. Such areas would require decontamination.

---

[1] In these simulations, it was assumed that people rinse heavily soiled food items with water, therefore DandD Version 2.1.0 parameters MLV (1), MLV (2), MLV (3) and MLV (4) were reduced by a factor of 10 (e.g., to 0.01).

4.3 REMOVABLE ACTIVITY RESULTS

SEG took smears in all structures and outdoor pads with the potential for residual radioactivity. These results are summarized in Appendix 3 of Reference 6.1, which presents the counting results for these smears. Most portions of the ore processing facilities had activity levels exceeding 200 dpm/l00 cm^2. They are assumed to require decontamination.

4.4 SOIL SAMPLE RESULTS

During the 1993 survey, SEG took soil samples in areas that they judged were likely to exhibit residual activity. The sample locations were based on historical records and preliminary measurement results. These results are summarized in Appendix 4 of Reference 6.1, which contains the instrument readings and the maps showing the survey locations. Most of the samples were surface composite samples taken within a couple of inches of the surface from within the sample areas. Soil activity levels of greater than the preliminary criteria of ~2.5 pCi/g of thorium-232 were considered significant. Most (31 of 46) of the surface samples were collected from active areas that exceeded the 2.5 pCi/g level. Deep soil samples were taken in areas where the activity level was expected to be well over this criteria. Four out of nine of the subsurface samples did not exceed 2.5 pCi/g of thorium-232. Deep soil samples were not obtained from near Buildings 73 and 74, as the soil was mostly gravel to a depth greater than 6 inches. It is important to note that the high quantities of gravel in some of these areas would allow ore products to penetrate deeper than could occur in the clay soil found in other areas.

5. COST ESTIMATE

The estimated cost for this project is $5,886,000 with the limitations and assumptions discussed previously. This estimate includes decontamination of equipment, concrete, and material (where feasible), radioactive waste disposal, radioactive waste volume reduction, health physics support, and final release survey. Details of the cost elements and methodologies are discussed below.

5.1 ESTIMATING APPROACH

This cost estimate is based on a detailed survey performed in 1993 by SEG (Reference 6.1). The 1993 evaluation has been updated to reflect present day (2002) decommissioning standards and unit costs.

The Radiation Safety Officer at CPM indicates that the licensed activities are continuing in the same locations at the CPM facility as they were in 1993. In addition, no major spills or releases of radioactive materials have occurred since 1993. Therefore surface and soil contamination levels are assumed to be unchanged from 1993.

The release criteria for standing structures and soil has changed from numerical concentrations to a dose-based standard of 25 mrem/y. This made it necessary for WESTON to modify certain assumptions that SEG made concerning the extent of contamination that would have to be removed from standing structures and soil. Those assumptions were that more extensive decontamination would be required for standing structures and additional contaminated soil would require off-site disposal.

5.2 ESTIMATING METHODOLOGY

WESTON's cost estimate is provided in Table 5-1. WESTON began its estimation process with a review of the SEG data and estimates (1993) and applied appropriate updates. The rationale for the changes is explained in the following sections.

Table 5-1. Cabot Boyertown Site Decommissioning Cost Estimate

	Total Quantities (ft^3 or T)	Total Cost ($)	Comments
Volume of Equipment for Decon (ft^3)	20,298 ft^3	$30,447	200% of SEG cost estimate
Concrete Decontamination (Removal)	7,196 ft^3	$122,000	166% of SEG estimate, 33% labor hour increase, 25% consumer price index (CPI) increase for labor rate
Soil Decontamination (Volume for Sorting)	184,458 ft^3	$130,000	50% Volume Reduction estimated. 103% of SEG estimate
Soil and Removed Concrete Disposal	99,425 ft^3	$3,082,175	Disposal at WCS; cost reduced from SEG estimate due to cheaper disposal site
Equipment Radwaste Disposal	1,015 ft^3	$406,000	Disposal at Barnwell, 2002 rates
Radwaste Volume Reduction	1,015 ft^3	$358,683	150% of SEG cost estimate
Uranium Recovery Processing of Filtercake	3,000 T	$1,035,000	Disposal at uranium mill
Release Survey		$635,000	166% of SEG estimate, 33% labor hour increase, 25% CPI increase for labor rates
Additional HP Support for Decon Work		$87,000	166% of SEG estimate, 33% labor hour increase, 25% CPI increase for labor rates
Grand Total		$5,886,305	149% of the SEG cost estimate (Reference 6.1)

5.3 UNIT COSTS

Unit costs and explanations are provided in the following text for each of the major categories of work that would need to be performed. CPM will provide labor and contracted health physics personnel will provide support for this effort.

5.3.1 Equipment and Tank Decontamination

SEG assumed that equipment decontamination would generate a compacted waste volume equivalent to 5% of the volume of the equipment being decontaminated. Since the standards for unrestricted radiological release of equipment have not changed since 1993, the SEG volume estimates for equipment that is easily decontaminated are still reasonable. The volume estimate for equipment and tank decontamination includes both protective clothing and cleaning supplies.

5.3.2 Concrete Decontamination

Concrete processing costs were estimated from SEG experience with scabbling concrete surfaces. Labor costs are assumed to have doubled since 1993 due to inflation. A greater percentage of the areas in the structures will have to be decontaminated than previously defined by SEG due to recent changes in regulatory release limits, and scabbling to a greater depth may be required to meet the current decommissioning criteria.

5.3.3 Soil Decontamination

Soil processing costs were estimated based on contracting for commercially available soil sorting services at a fully loaded cost of $0.695 per cubic foot of soil processed. It was assumed that the volume reduction realized would be 50%. The effectiveness of soil sorting will depend on how uniformly the radioactive materials are distributed in the soil. Depending on the uranium and thorium contents of the concentrate, the residual material would either be transferred to WCS for land disposal or to a licensed uranium mill.

5.3.4 Radioactive Waste Disposal Cost

It was assumed that waste containing less than 0.05% uranium/thorium could be disposed of at a NORM disposal site such as WCS. The NRC and Texas Department of Health allow WCS to receive unimportant quantities of source material from licensees. The current (2002) fully loaded cost for shipment and disposal at WCS is $31 per cubic foot. Higher activity soil or concrete chips would be transferred to a licensed uranium mill in the western United States at a similar fully loaded cost.

Contaminated piping and objects that cannot be properly surveyed for surface contamination are assumed to be radioactive waste. These materials would be disposed of at the Duratek facility in Barnwell, South Carolina. The fully loaded disposal cost is assumed to be $350 per cubic foot.

Transportation costs and fees associated with uranium recovery processing at a uranium mill are estimated at $345 per ton.

5.3.5 Radioactive Waste Volume Reduction Cost

The fully loaded volume reduction unit cost was increased by 50% from the values provided by SEG in Reference 6.1. SEG's volume estimates were accepted as reasonable.

5.3.6 Survey and Release

It is assumed that the final status survey will cost 66% more than SEG estimated in 1993. This takes into account a 25% increase in labor rates. It also assumes a 33% increase in the area to be surveyed due to the more restrictive decommissioning standards that are currently in effect.

5.3.7 Health Physics Support Cost

The health physics support cost was 66% more than the amount estimated by SEG (Reference 6.1) to take into account increases in labor rates and the greater scope of decontamination work.

5.3.8 The Total Cost of Decommissioning the Boyertown Site

The grand total estimated for decommissioning is $5,886,000. In general, the increase in decommissioning costs resulted from the restrictive cleanup levels that are implied by the current dose-based license termination standard. There were also inflation related increases. These increased costs were offset to a degree by our success in locating facilities that will accept contaminated soil as feed material or as solid waste for land disposal. The 2002 decommissioning cost estimate represents a 49% increase over the SEG decommissioning cost estimates given in Reference 6.1.

6. REFERENCES

6.1 Scientific Ecology Group, Inc. (SEG), *Decommissioning Cost Estimate for Boyertown, Pennsylvania Site*, 1993.

6.2 NRC, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material,* 1984.

6.3 NRC, *Consolidated NMSS Decommissioning Guidance: Decommissioning Process,* Draft NUREG-1757, Volume 1, 2002.

6.4 NRC, *Residual Radioactive Contamination From Decommissioning, User's Manual* DandD Version 2.1, NUREG/CR-5512, Vol. 2, 2001.