APPLICATION OF PHASE IV LAND DISPOSAL RESTRICTIONS TO NEWLY IDENTIFIED MINERAL PROCESSING WASTES

REGULATORY IMPACT ANALYSIS

OFFICE OF SOLID WASTE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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MINERAL PROCESSING WASTES FORMERLY EXEMPT UNDER THE BEVILL AMENDMENT

This regulatory impact analysis (RIA) estimates the costs, economic impacts, and benefits of the supplemental proposed rule applying Phase IV Land Disposal Restrictions (LDRs) to newly identified hazardous mineral processing wastes. Today's proposal modifies potential waste management requirements that were originally proposed on January 25, 1996 (61 FR 2338).

In today's notice, EPA is proposing standards for mineral processing wastes no longer exempt from Subtitle C requirements under the Bevill exemption. Under the provisions of today's proposal, previously exempt Bevill mineral processing wastes destined for disposal would need to be treated to meet RCRA Universal Treatment Standards (UTS) before management or disposal in a land-based unit. At the same time, however, operators could reclaim hazardous mineral processing residues and store them in non-land based units prior to reclamation without complying with full Subtitle C requirements, under certain specified conditions.

Background

This component of the Phase IV Land Disposal Restrictions rule is one in a series of regulations that restricts the continued land disposal of hazardous wastes under the 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA). At the time HSWA was enacted, EPA was required to promulgate treatment and disposal standards by May 8, 1990 for wastes already identified or listed as hazardous. EPA completed development of treatment standards and waste management practices for these wastes in 1990. EPA also is required to develop treatment standards for wastes subsequently identified or listed as hazardous. EPA is addressing these "newly identified" wastes in several "phases." EPA has finalized rules for three phases and proposed the Phase IV rule in two parts in August 1995 and January 1996.

Under the provisions of the Mining Waste Exclusion of RCRA, solid waste from the extraction, beneficiation, and processing of ores and minerals is exempt from regulation as hazardous waste under Subtitle C of RCRA, as amended. The Mining Waste Exclusion was established in response to the so-called "Bevill Amendment," which was added in the 1980 Solid Waste Disposal Act Amendments. The Bevill Amendment precluded EPA from regulating these wastes until the Agency performed a study and submitted a Report to Congress. Following a process of litigation and rulemakings that took place over several years, the Agency promulgated final rules on September 1, 1989 (54 FR 36592) and January 23, 1990 (55 FR 2322) establishing that only 20 specific mineral processing wastes fulfilled the newly promulgated special wastes criteria; all other mineral processing wastes were removed from the Mining Waste Exclusion.

These newly identified non-exempt wastes have the same regulatory status as any other industrial solid waste. Thus, if they exhibit characteristics of hazardous waste or are listed as hazardous wastes, they must be managed in accordance with RCRA Subtitle C or equivalent state standards. Existing waste characterization data suggest that many of these wastes may exhibit the characteristic of toxicity for metals (waste codes D004-D011), corrosivity (D002), and/or reactivity (D003).

EPA considers these wastes to be "newly identified" because they were brought into the RCRA Subtitle C system after the date of enactment of the HSWA on November 8, 1984. EPA did not include the newly identified wastes within the scope of the LDRs for Subtitle C characteristic hazardous wastes published in June 1990, deciding instead to promulgate additional treatment standards (Best Demonstrated Available Technology, or BDAT) in several phases. At the time, EPA had not performed the technical analyses necessary to determine whether the treatment standards being promulgated for characteristic hazardous wastes were feasible for the newly non-exempt mineral processing wastes. In addition, the list of non-exempt wastes was not yet final, because the regulatory determination for the 20 wastes studied in the 1990 Report to Congress had not yet been promulgated. The boundaries of the Exclusion have now been firmly established, and the Agency is ready to characterize and establish treatment standards for all newly identified hazardous mineral processing wastes.

Today's rule contains elements that are related to non-HSWA provisions of the statute (e.g., the conditional exclusion from the definition of solid waste for storage of mineral processing residues) as well as elements that are related to HSWA provisions (the proposed universal treatment standards for land disposed mineral processing wastes). The definition of solid waste provisions of this rule are not being promulgated pursuant to HSWA. Thus, these federal requirements will take effect only in states that do not have final RCRA authorization. In contrast, the universal treatment standards for land disposed mineral processing wastes are being promulgated pursuant to HSWA. Therefore, these treatment standard provisions will take effect in all states upon the effective date of the rule regardless of final authorization status.

1. REGULATORY OPTIONS

This section presents the options that EPA is considering for applying LDR standards to newly identified hazardous mineral processing wastes. All of these options are examined in depth in this Regulatory Impact Analysis, and have been selected for analysis because they reflect the views of various interested parties and will enable EPA to effectively solicit public comment on appropriate management standards for the subject wastes. Section 1.1 summarizes the key features of each option. Section 1.2 discusses their implications for the RIA.

1.1 Specific Options

Summarized below are the four options that are the focus of analysis in this RIA. In addition to the option-specific details outlined below, several of the options share the following common features:

- In all four options, mineral processing wastes being disposed must be treated to UTS levels prior to disposal in Subtitle D disposal units;
- Operators of facilities that generate and manage hazardous mineral processing wastes must comply with simplified recordkeeping and reporting requirements under all four options;
- Secondary mineral processing materials destined for recycling may be stored for up to one year under all four options; and
- Recycling of non-mineral processing materials outside of RCRA Subtitle C jurisdiction is prohibited, i.e., the conditional exclusions for certain activities

provided in Options 2, 3, and 4 (as described below) are available only for mineral processing residues.

Option 1 -- Subtitle C Jurisdiction

Option 1 represents a comprehensive approach for ensuring that land storage of secondary materials destined for reprocessing does not contribute to the "waste management problem" and that recycling claims by the mineral processing industry are legitimate and not simply a mechanism for disposal of mineral processing wastes outside RCRA Subtitle C jurisdiction. This option is similar to the first option in the January 1996 supplemental proposal, though it now restricts reintroduction of mineral processing secondary materials into beneficiation or Bevill process units. The option consists of the following features:

1. Subtitle C jurisdiction would be extended to cover characteristic sludges and by-products, even when these materials are reclaimed; i.e., these materials would be considered solid wastes and thus subject to RCRA jurisdiction in the same manner that spent materials are currently classified.

2. Storage on land of secondary materials destined for recycling or reprocessing would not be permitted for materials generated a rates of less than 45,000 metric tons of solids or one million metric tons of liquids per year.

3. If materials are stored on land, the land-based storage units must not contribute to significant groundwater contamination through discard. This condition might be met in one of three ways:[1]

   - The facility operator demonstrates that he/she is not polluting groundwater at levels exceeding the Maximum Contaminant Level (MCL) for any hazardous constituent likely to be in the secondary materials stored (i.e., the toxic metals listed in Appendix VIII of Part 261 and cyanide). The demonstration would be made by means of groundwater monitoring. If a release were detected that exceeded MCLs, unit-specific corrective action would be required.

   - The unit storing the materials is designed in a manner that obviates the need for a demonstration that MCLs are not being exceeded. Specifically, surface impoundment units would need to be constructed to have the transmissivity equivalent of a 40 mil geomembrane liner on a surface of 12 inches of 10^{-5} cm/sec hydraulic conductivity soil. Storage of solids in piles located on concrete, asphalt, or soil with the

[1] Note that for the purposes of this RIA, EPA has modeled only the cost of complying with the second of the three alternative conditions (i.e., installation of liners). Throughout the RIA, the Agency has assumed that operators will choose the least-cost option for compliance, and upon consideration, has determined that installing liners in previously unlined land-based units is likely to be the least-cost means for most operators to continue storing secondary materials on land. Installing liners obviates the need to implement groundwater monitoring and allows the operator to avoid triggering corrective action requirements.

transmissivity equivalent of three feet of clay with 10^{-7} cm/sec hydraulic conductivity also would be permitted.

- The facility obtains a determination from an authorized state or (in unauthorized states) from the Regional Administrator, that a management practice or alternative design provides adequate assurance that the unit provides effective containment and will not become part of the waste disposal problem through discard.

4. All non-land based storage units (i.e., tanks, containers, and containment buildings (TCBs)) must meet applicable 40 CFR Part 265 standards (standards for interim status facilities).

5. Facility owners and operators would have to demonstrate that legitimate recycling is occurring at the facility in the following two ways:

   - Demonstrate that the recycled secondary material complies with a quantitative minimum material content standard; or

   - Demonstrate that hazardous constituents different from those normally found in customarily used raw materials are not present in secondary materials, thereby precluding the presence of "toxics along for the ride" or "TAR."

   Facilities that fail to meet conditions for legitimate recycling would be subject to Subtitle C treatment and storage permitting, along with associated financial responsibility and facility-wide corrective action requirements.

6. Hazardous mineral processing residues could not be recycled to primary beneficiation operations/units or Bevill process units without loss of the Bevill exempt status of any beneficiation or other special wastes generated by such units. That is, these operations would become regulated Subtitle C units and resulting wastes from these units would lose their Bevill status when mineral processing residues were mixed with ores, minerals, or beneficiated ores or minerals.

Option 2 -- Conditional Exemption from RCRA Jurisdiction (But Including Bevill Unit Recycling Prohibition)

Option 2 represents an attempt to both (1) stimulate greater resource recovery in the minerals industry by not classifying recoverable mineral processing residuals as wastes if they are recovered in process units, and (2) ensure that appropriate waste treatment standards and technologies are applied to hazardous mineral processing wastes destined for land disposal, thereby protecting human health and the environment. This option is new (i.e., it was not included in the January 1996 proposed rule). It differs from Option 1 in two ways: Option 2 does not include a legitimacy test for recycled materials, and it allows storage in tanks, containers, and buildings that do not meet RCRA part 265 subpart I, J, and DD standards. The option consists of the following features:

1. A conditional exclusion from the definition of solid waste would apply to non-exempt mineral processing residues stored in tanks, containers, or buildings

(TCBs) prior to reinsertion into a mineral processing production unit. TCBs would not be required to meet any additional design requirements to be eligible for the conditional exclusion.

2. Storage on land of secondary materials destined for recycling or reprocessing would not be permitted for materials generated at rates less than 45,000 metric tons of solids or one million metric tons of liquids per year.

3. If materials are stored on land, the land-based storage units must not contribute to significant groundwater contamination through discard. This condition might be met in one of three ways:[2]

   - The facility operator demonstrates that he/she is not polluting groundwater at levels exceeding the Maximum Contaminant Level (MCL) for any hazardous constituent likely to be in the secondary materials stored (i.e., the toxic metals listed in Appendix VIII of Part 261 and cyanide). The demonstration would be made by means of groundwater monitoring. If a release were detected that exceeded MCLs, unit-specific corrective action would be required.

   - The unit storing the materials is designed in a manner that obviates the need for a demonstration that MCLs are not being exceeded. Specifically, surface impoundment units would need to be constructed to have the transmissivity equivalent of a 40 mil geomembrane liner on a surface of 12 inches of 10^{-5} cm/sec hydraulic conductivity soil. Storage of solids in piles located on concrete, asphalt, or soil with the transmissivity equivalent of three feet of clay with 10^{-7} cm/sec hydraulic conductivity also would be permitted.

   - The facility obtains a determination from an authorized state or (in unauthorized states) from the Regional Administrator, that a management practice or alternative design provides adequate assurance that the unit provides effective containment and will not become part of the waste disposal problem through discard.

4. Hazardous mineral processing residues could not be recycled to primary beneficiation operations/units or Bevill process units without loss of the Bevill status of any beneficiation or other special wastes generated by such units. That is, these operations would become regulated Subtitle C units and resulting wastes from these units would lose their Bevill status when mineral processing residues were mixed with ores, minerals, or beneficiated ores or minerals.

[2] See previous footnote.

Option 3 -- Conditional Exclusion from RCRA Jurisdiction (Excluding Bevill Unit Recycling Prohibition)

Option 3 includes all of the Option 2 provisions, with one significant exception. The prohibition on recycling hazardous mineral processing residues through beneficiation or Bevill process units (the last feature listed in Option 2) would not apply. This option includes the following features:

1. A conditional exclusion from the definition of solid waste would apply to non-exempt mineral processing residues stored in tanks, containers, or buildings (TCBs) prior to reinsertion into a mineral processing production unit. TCBs would not be required to meet any additional design requirements to be eligible for the conditional exclusion.

2. Storage on land of secondary materials destined for recycling or reprocessing would not be permitted for materials generated at rates less than 45,000 metric tons of solids or one million metric tons of liquids per year.

3. If materials are stored on land, the land-based storage units must not contribute to significant groundwater contamination through discard. This condition might be met in one of three ways:[3]

    - The facility operator demonstrates that he/she is not polluting groundwater at levels exceeding the Maximum Contaminant Level (MCL) for any hazardous constituent likely to be in the secondary materials stored (i.e., the toxic metals listed in Appendix VIII of Part 261 and cyanide). The demonstration would be made by means of groundwater monitoring. If a release were detected that exceeded MCLs, unit-specific corrective action would be required.

    - The unit storing the materials is designed in a manner that obviates the need for a demonstration that MCLs are not being exceeded. Specifically, surface impoundment units would need to be constructed to have the transmissivity equivalent of a 40 mil geomembrane liner on a surface of 12 inches of 10^{-5} cm/sec hydraulic conductivity soil. Storage of solids in piles located on concrete, asphalt, or soil with the transmissivity equivalent of three feet of clay with 10^{-7} cm/sec hydraulic conductivity also would be permitted.

    - The facility obtains a determination from an authorized state or (in unauthorized states) from the Regional Administrator, that a management practice or alternative design provides adequate assurance that the unit provides effective containment and will not become part of the waste disposal problem through discard.

[3] See footnote 1.

Option 4 -- Unconditional Exclusion from RCRA Jurisdiction

This option is based on approaches advanced by the mineral processing industry and would maximize the ability of industry to recycle secondary materials without triggering *any* additional requirements. This option was included as Option 3 in the January 1996 proposal. This option includes the following features:

1. All outputs from mineral processing facilities would be unconditionally excluded from RCRA jurisdiction regardless of how the materials are stored. Consequently, there would be no special requirements for any type of unit storing secondary materials.

2. Facility operators would not be required to comply with a legitimacy test for mineral processing residues being recycled.

3. Hazardous mineral processing residues could be recycled to primary beneficiation operations/units without risk to the Bevill status of any beneficiation wastes generated by such units. These residues would not be required to meet a "significantly affected" test.

1.2 Discussion of Options and Implications for the Regulatory Impact Analysis

The Agency has performed a detailed analysis of each of the four options described above, assuming each of three alternative baselines. The baseline discussed in the remainder of this RIA is the one the Agency believes best reflects actual operator behavior. EPA refers to this baseline as the "modified prior treatment" baseline (because it is a variation on the “prior treatment baseline”, one of the two baselines modeled in the December 1995 RIA). A description of the assumptions underlying the alternative baselines (prior treatment and no prior treatment), and the resulting costs and impacts can be found in Appendix A.

The modified prior treatment baseline assumes that all generators of hazardous mineral processing wastes currently dispose those wastes in compliance with Subtitle C treatment standards (except for LDRs). The least-cost method for attaining compliance for most operators would be to lime neutralize and/or cement-stabilize their waste(s) to remove the hazardous characteristic(s).[4] Because this method also would be used to achieve UTS, there would be essentially no new treatment required upon promulgation of the LDRs, and hence, no costs or benefits associated with the LDR portion of the rule. The baseline also allows for consideration of apparent confusion within the regulated community as to requirements that currently apply to their mineral processing operations. Operators are assumed to temporarily store characteristic spent materials in unlined land-based units prior to reinsertion into a mineral processing production unit. This alternative reflects the Agency's belief that some operators do not clearly understand the Subtitle C regulations that apply to their secondary materials, i.e., that spent materials intended for recycling are not currently excluded from Subtitle C regulation.

[4] As discussed in Section 2 below, the vast majority of hazardous mineral processing wastes exhibit the characteristics of corrosivity and/or toxicity. EPA has shown that cement stabilization (in some cases preceded by neutralization), which is the basis for the UTS standards, is an effective treatment technology for removing these hazardous waste characteristics.

Generally, the Agency believes that the four options described above characterize the range of alternatives available for addressing storage of secondary materials intended for reinsertion into mineral production processes, in terms of the trade-offs among costs, economic impacts, and benefits. Costs to industry would be highest under Option 1, which would impose a number of additional requirements on facilities recycling secondary materials, while potential benefits in terms of environmental protection could be greater under Option 1 than under the other three options. At the same time, the restriction against recycling secondary material through beneficiation or Bevill units, legitimacy tests, and storage unit standards may serve as a disincentive to recycling, thus discouraging the reuse of these materials at mineral processing facilities.

Option 2 would impose costs similar to Option 1, driven primarily by the prohibition against recycling secondary materials to beneficiation or Bevill process units. Two factors make this option slightly less expensive than Option 1: the absence of a legitimacy test for recycling materials through mineral processing units; and the provision allowing storage of secondary materials in non-RCRA tanks, containers, and buildings prior to recycling. As a result of these two factors, Option 2 may be seen as slightly less protective of the environment (i.e., because the possibility of "sham recycling" exists and because storage units, though generally assumed to be sturdy, would not have secondary containment). This option would create a mild disincentive for recycling material through non-Bevill units.

One additional feature of Options 1 and 2 is worthy of more extensive discussion. Either of these options, if promulgated, would not only prohibit the reintroduction of hazardous mineral processing wastes into production units that generate Bevill wastes, they also would remove the special waste status of all extraction, beneficiation, and processing wastes that are generated by units that receive *any* other non-Bevill waste streams, irrespective of their hazard characteristics. EPA believes that the effect of this new, broad-spectrum regulatory control would be that facility operators would cease the practice of reinserting secondary materials, of any kind, into Bevill production units. Given the substantial degree of material recycling and resource recovery conducted within the primary minerals industry, adoption of Options 1 or 2 might therefore impose profound effects on the materials handling and production processes in use within this industry. Indeed, one result might be that resource recovery would decline in parallel with a significant increase in the quantities of solid and hazardous wastes generated at mineral production facilities.

In addition, several other industries that send secondary materials to Bevill production units could also be affected under Options 1 and 2. Prominent examples of non-mineral processing secondary materials that are recovered in Bevill units by mineral processors include F006 (wastewater treatment sludge from electroplating operations), foundry sands, cathode ray tubes, and circuit boards. EPA has not attempted to quantify the magnitude or distribution of any potential operational, financial, or environmental impacts associated with the prohibition against recycling *any* non-Bevill waste stream through Bevill production units, due to a lack of sufficient data. Nonetheless, the Agency believes that the logistical and financial impacts on the facility operator associated with enactment of either of these options might be severe in some cases.

Option 3 is the least expensive non-land based storage option considered. As stated earlier, the only difference between Option 3 and Option 2 is that Option 3 does not prohibit recycling through beneficiation or Bevill process units. As a result, although it may impose a slight disincentive to recycling, Option 3 is protective of the environment, without interfering excessively with resource recovery.

Option 4 would impose no additional requirements for management of secondary materials to be recycled, regardless of where they are stored. Consequently, this option represents the least cost approach for industry and may provide greater incentives for materials reuse than the other three options. At the same time, this option does little to ensure that recycling is legitimate and also does not impose any standard to ensure that land-based storage of materials prior to reinsertion into the process does not result in releases that contribute to the "waste management problem." This option, therefore, could be expected to result in greater releases of hazardous constituents to the environment and greater human exposure to those constituents.

2. DEFINING THE UNIVERSE AND ESTIMATING WASTE VOLUMES

EPA developed a step-wise methodology for both defining the universe of mineral processing sectors, facilities, and waste streams potentially affected by the Phase IV Land Disposal Restrictions and estimating the volumes of wastes potentially affected under the various implementation options being considered by the Agency. The Agency's methodology began with the broadest possible scope of inquiry in order to ensure that EPA captured all of the potentially affected mineral commodity sectors and waste streams.[5] The Agency then narrowed the focus of its data gathering and analysis as it completed each subsequent step. This six-step methodology is described in detail in the Appendix I.

The Agency's data sets and underlying mineral commodity sector reports were made available to the regulated community during the comment period following the January 1996 proposal. In some cases, reviewers supplied the Agency with additional or more current information about a particular commodity sector. Where appropriate, EPA has revised the sector reports and incorporated new information into its analysis. In addition, since the rule was proposed in January 1996, EPA has obtained other information that it has used to update some of the sector reports. This information also has been incorporated into the analysis presented in this RIA.

EPA has developed a bounded cost analysis, providing an expected cost (expected value case), as well as a lower bound cost (minimum value case), and an upper bound cost (maximum value case) for each of the options considered. EPA used two factors, uncertainty about generation rate and uncertainty about hazardous characteristics, to develop these three cost cases. All other steps in the cost modeling process are applied consistently across the three cost cases.

As in the December 1995 RIA, EPA began with the three estimates of generation rates potentially affected by this rulemaking for every waste stream: a minimum generation rate, an expected generation rate, and a maximum generation rate. In some cases, there is no variation in the three estimates because the generation rate of the stream was known (e.g., it was reported in literature). For a number of these waste streams EPA also lacked data about hazardous characteristics. To address these uncertainties, EPA weighted the volume estimates for each waste stream to account for the degree of certainty that the particular waste stream exhibited one or more of the RCRA hazardous waste characteristics. As shown in Exhibit 2-1, 100 percent of each waste stream known to be hazardous was included in the minimum, expected, and maximum value scenarios. For streams that were only suspected of being hazardous, however, none, 50 percent and 100 percent of the generation rate is included in the minimum, expected, and maximum value case. That is, the generation rate in each of the cost scenarios was multiplied by a percentage considered to be hazardous in this analysis, based on the certainty that the wastestream is hazardous. The remaining "nonhazardous" portion drops out of the analysis. Exhibit 2-2 presents the

[5] Appendix B lists the mineral processing facilities affected by this rulemaking.

average facility levels of waste assumed to be "hazardous" in each sector, for the minimum, expected, and maximum value cases.

Exhibit 2-1

Portion of Waste Stream Considered to Be Hazardous (in Percent)

Costing Scenario	Hazard Characteristic(s)	
	Y	**Y?**
Minimum	100	0
Expected	100	50
Maximum	100	100

Notes:

Y means that EPA has actual analytical data demonstrating that the waste exhibits one or more of the RCRA hazardous waste characteristics.

Y? means that EPA, based on professional judgment, believes that the waste may exhibit one or more of the RCRA hazardous waste characteristics.

3. COST AND ECONOMIC IMPACTS OF THE RULE

This section presents the methodology and results of EPA's analysis of the cost and economic impacts arising from today's proposed rule. Section 3.1 begins by describing the methods employed to determine the costs of complying with the four options described above and to compute the screening-level economic impact measures employed in this analysis. Section 3.2 presents and describes the results of the analysis.

3.1 Methods

This section describes the methodology used to calculate the costs and impacts of managing the affected mineral processing wastes under each of the four regulatory options. The basic analytical construct used throughout this analysis is that facility operators will choose the least-cost option that complies with the law. For today's proposal the Agency has conducted a *dynamic* analysis of shifts in recycling that models shifts in types or quantities of mineral processing residues between treatment/disposal and storage/recycling/reclamation.[6] For Options 1, 2, and 3 the analysis examines various shifts that may diminish recycling, while for Option 4 the analysis assumes no change in recycling.

To analyze each option, EPA employed a number of steps and assumptions, some of which exert a major influence on the results obtained. The following sub-sections discuss these major analytical steps.

[6] In contrast, data limitations did not allow the Agency to conduct analysis of potential shifts in recycling for the RIA that accompanied the January 1996 proposal.

Exhibit 2-2
Average Facility Waste Type Input Data

Commodity	Minimum Cost Scenario				Expected Cost Scenario				Maximum Cost Scenario			
	Number of Facilities	Waste Water (mt/yr)	1 - 10% Solids (mt/yr)	Solids (mt/yr)	Number of Facilities	Waste Water (mt/yr)	1 - 10% Solids (mt/yr)	Solids (mt/yr)	Number of Facilities	Waste Water (mt/yr)	1 - 10% Solids (mt/yr)	Solids (mt/yr)
Alumina and Aluminum	23.0	-	-	3,330	23.0	-	-	3,330	23.0	-	-	3,330
Antimony	6.0	53	-	3,532	6.0	4,500	-	3,532	6.0	9,000	-	3,532
Beryllium	2.0	100	-	100	2.0	50,000	-	23,000	2.0	1,000,000	-	45,000
Bismuth	1.0	200	200	3,300	1.0	12,300	12,200	10,020	1.0	24,200	24,000	25,200
Cadmium	2.0	285	190	570	2.0	2,850	1,900	5,700	2.0	28,500	19,000	57,000
Calcium	1.0	-	-	40	1.0	-	-	40	1.0	-	-	40
Coal Gas	-	-	-	-	-	-	-	-	1.0	-	65,000	-
Copper	10.0	-	530,000	600	10.0	-	530,000	600	10.0	-	530,000	600
Elemental Phosphorus	2.0	560,000	2,000	230	2.0	560,000	2,000	230	2.0	560,000	2,000	230
Fluorspar and Hydrofluoric Acid	-	-	-	-	3.0	5,000	-	-	3.0	15,000	-	-
Germanium	4.0	200	-	10	4.0	1,100	-	161	4.0	2,000	-	302
Lead	4.0	880,000	-	100,770	4.0	880,000	-	123,345	4.0	880,000	-	153,095
Magnesium and Magnesia from Brines	2.0	-	-	13,038	2.0	-	-	13,380	2.0	-	-	16,800
Mercury	7.0	9,000	-	12	7.0	11,000	-	12	7.0	60,000	-	12
Molybdenum, Ferromolybdenum, and Ammonium Molybdate	11.0	91	-	100	11.0	91	-	23,000	11.0	91	-	45,000
Platinum Group Metals	3.0	200	-	2	3.0	1,140	-	15	3.0	2,000	-	150
Pyrobitumens, Mineral Waxes, and Natural Asphalts	2.0	1	-	1	2.0	5,000	-	23,000	2.0	10,000	-	45,000
Rare Earths	1.0	21,200	-	170	1.0	1,021,000	-	3,000	1.0	2,021,000	-	11,500
Rhenium	2.0	-	-	44,000	2.0	50	-	44,000	2.0	100	-	44,000
Scandium	7.0	200	-	-	7.0	1,120	-	-	7.0	2,000	-	-
Selenium	3.0	22,000	-	68	3.0	22,000	-	680	3.0	22,000	-	6,800
Synthetic Rutile	1.0	30,000	-	75,000	1.0	30,000	-	75,000	1.0	30,000	-	75,000
Tantalum, Columbium, and Ferrocolumbium	2.0	-	75,000	1,500	2.0	-	75,000	1,500	2.0	-	75,000	1,500
Tellurium	2.0	200	-	200	2.0	11,000	-	2,000	2.0	30,000	-	9,000
Titanium and Titanium Dioxide	7.0	55,289	-	65,114	7.0	75,876	-	68,243	7.0	96,289	-	71,671
Tungsten	6.0	370	-	-	6.0	730	-	-	6.0	5,000	-	-
Uranium	17.0	300	-	100	17.0	1,250	-	650	17.0	2,200	-	1,200
Zinc	3.0	3,243,417	-	16,600	3.0	3,243,417	-	16,600	3.0	3,243,417	-	16,600
Zirconium and Hafnium	2.0	17,100	-	-	2.0	521,000	-	-	2.0	2,256,000	-	-

3.1.1 Waste Management Assumptions

The costs imposed by a particular regulatory option are measured as the difference in cost between the current, or baseline, management practices and the lowest-cost alternative practice allowed under the option. In this analysis, therefore, EPA identified what it believes to be the current management practices that are applied to the waste streams of interest and then determined the costs of these practices. These baseline costs are then subtracted from the costs of complying with the least-cost management practice allowed under each of the four options. Exhibit 3-1 summarizes the pre- and post-rule behavior that is discussed in more detail below.

Exhibit 3-1

Assumed Management Practices

Baseline or Option	Wasted Portion	Secondary Materials Recycled through Bevill Units	Secondary Materials Recycled through Processing units
Baseline	Treated to TC levels, disposed	Stored in unlined land-based units	Stored in unlined land-based units
Option 1	Treated to UTS levels, disposed	No longer recycled, now treated to UTS levels and disposed	Stored in RCRA tanks, containers, and buildings (must pass legitimacy test)
Option 2	Treated to UTS levels, disposed	No longer recycled, now treated to UTS levels and disposed	Stored in tanks, containers, and buildings
Option 3	Treated to UTS levels, disposed	Stored in tanks, containers, and buildings	Stored in tanks, containers, and buildings
Option 4	Treated to UTS levels, disposed	Stored in unlined units	Stored in unlined units

Pre-LDR Behavior (Baseline)

In the baseline, operators are assumed to be in full compliance with RCRA Subtitle C requirements (but not LDRs) for managing waste materials. The baseline assumes that the operator has chosen the least-cost option for compliance with these requirements: corrosive and/or TC toxic wastewaters and slurries are treated (generally with lime) in tanks; and TC toxic solids, sludges, and other materials are cement stabilized within 90 days of being generated, and disposed (generally on site) in a Subtitle D unit.[7] Fundamentally, these assumptions are based upon the feasibility of mineral processing residue treatment by lime neutralization for wastewaters and slurries and cement stabilization for sludges and solids. These methods, along with high temperature metals recovery (HTMR), are part of the basis for the UTS standards.

[7] To comply with current regulations, facility operators also could dispose of these wastes in a Subtitle C permitted landfill. Appendix C presents a break-even analysis showing that treatment and Subtitle D disposal is less expensive than Subtitle C disposal without treatment, in most cases.

A point of further interest and critical importance to the analysis presented below is the fact that the very same technologies can be used to treat wastes to the point of removing the hazardous characteristic(s) and to meet the UTS standards; the difference between achieving removal of the hazardous characteristic and the UTS standards is simply one of degree. Since the January 1996 supplemental proposed rule, EPA received numerous comments on the use of existing UTS levels for mineral processing wastes. These comments suggested that some of the existing UTS levels were inappropriate for mineral processing wastes. In response to these comments, the Agency analyzed additional stabilization data provided by the commenters and, in light of this new information, is proposing revised UTS levels for mineral processing wastes. Exhibit 3-2 presents the TC levels, existing UTS levels, and revised UTS levels. Based on the revised levels, EPA believes that mineral processing facilities treating wastes using cement stabilization will not incur any additional costs in order to achieve UTS levels.

Exhibit 3-2
Existing and Revised UTS Levels
(Nonwastewater Metals)

Waste Code	Constituent	TC Level (mg/l)	Existing UTS level (mg/l TCLP)	Proposed UTS Level (Revised)
D004	Arsenic	5.0	5.0	5.0
D005	Barium	100.	7.6	21
D006	Cadmium	1.0	0.19	0.20
D007	Chromium	5.0	0.86	0.85
D008	Lead	5.0	0.37	0.75
D009	Mercury - Retort residue	0.20	0.20	0.20
D009	Mercury - all others	.2	0.025	.025
D010	Selenium	1.0	0.16	5.7
D011	Silver	5.0	0.30	0.11
------	Antimony	-----	2.1	0.07
------	Beryllium	-----	0.014	0.02
------	Nickel	-----	5.0	13.6
------	Thallium	-----	0.078	0.20
------	Vanadium	------	0.23	1.6
------	Zinc	------	5.3	4.3

In the baseline, all secondary materials destined for recycling, including spent materials, are assumed to be stored in unlined, land-based units for some period of time prior to reinsertion into the process. This assumption reflects apparent confusion in the regulated community concerning the status of spent materials, and the proper methods for storing them prior to disposal or reuse.[8] (Because sludges and by-products that are reclaimed are not solid wastes, and hence, not hazardous wastes, there are currently no standards regulating storage units for sludges and by-products.)

Post-Rule Compliance Behavior

To determine the incremental impact of the Phase IV LDR standards, EPA first predicted cost-minimizing behavior by affected facility operators that would be in compliance with the provisions of each option analyzed.

Under Option 1, facility operators are expected to move material destined for recycling from unlined land-based storage units to TCBs that meet Subtitle C standards,[9] provided these materials are not recycled through a beneficiation or other Bevill process unit. These materials could be stored in TCBs for up to one year in the absence of a RCRA Subtitle C permit.[10] EPA assumes facility operators will stop recycling materials through beneficiation or Bevill process units rather than lose the Bevill exempt or special waste status of the wastes generated by those beneficiation or Bevill process units. Material formerly recycled through beneficiation or Bevill process units would then be treated and disposed. Facility operators would continue treating the wasted portion using cement stabilization or neutralization and dewatering. In addition, facility operators might stop recycling other materials rather than risk failing a legitimacy test, because facilities that fail to meet conditions for legitimate recycling would be subject to Subtitle C treatment and storage permitting, along with associated financial responsibility and facility-wide corrective action requirements.

Under Option 2, facility operators are expected to move material destined for recycling from unlined land-based storage units to non-RCRA TCBs, provided these materials are not recycled through a beneficiation or Bevill process unit. These materials could be stored in TCBs for up to one year in the absence of a RCRA Subtitle C permit.[11] EPA assumes that facility operators would stop recycling materials through beneficiation or Bevill process units, rather than lose the Bevill exempt or special waste status of the wastes generated by those beneficiation or Bevill process units. Material formerly recycled through beneficiation or other Bevill process units would be treated and disposed. Facility operators would continue treating the wasted portion using cement stabilization or neutralization and dewatering.

Under Option 3, facility operators are expected to move material destined for recycling from unlined land-based storage units to non-RCRA TCBs. These materials could be stored in TCBs for up to

[8] Spent materials destined for recycling, if stored, must be stored in tanks, containers, or buildings for less than 90 days prior to recycling, unless they are stored at a RCRA permitted treatment, storage, or disposal facility.

[9] These standards can be found in 40 CFR 265 subparts I, J, and DD.

[10] Note that for purposes of the cost model, although storage for up to one year is possible under this option, the Agency assumed that facilities only have capacity to store solids for 90 days and liquids for 30 days.

[11] See footnote 10.

one year in the absence of a RCRA Subtitle C permit.[12] Facility operators would continue treating the wasted portion using cement stabilization or neutralization and dewatering.

Under Option 4, facility operators are expected to continue storing material destined for recycling in unlined land-based storage units. These materials could be stored for up to one year in the absence of a RCRA Subtitle C permit.[13] Facility operators would continue treating the wasted portion using cement stabilization or neutralization and dewatering.

Dynamic Shifts

As a refinement to the analysis originally prepared for the December 1995 RIA, the Agency has used a dynamic analysis to model changes in the management of newly-identified mineral processing wastes that might be induced by the new LDR requirements. Specifically, the dynamic analysis accounts for shifts in the amount of material that is recycled rather than being treated and disposed.

For Options 1 and 2, the analysis assumes that rather than lose the Bevill exclusion for wastes generated in beneficiation units and process units, facility operators would stop recycling all mineral processing secondary materials through these units. Option 1 also might create a moderate disincentive for recycling newly-identified mineral processing wastes through processing units, due to the imposition of a legitimacy test and more stringent storage unit standards. Option 2 might impose a mild disincentive for recycling newly-identified mineral processing wastes through processing units due to more stringent storage unit standards. Option 3 could cause a similar minor disincentive for all recycled wastes, regardless of the point of reintroduction to the manufacturing process because of the additional storage unit requirements. Option 4, which does not impose any new storage requirements, would neither increase nor decrease the amount of materials recycled (which are assumed to be stored in land based units without restriction in the baseline).

3.1.2 Cost Modeling Assumptions

EPA estimated the implementation costs of the options for hazardous waste streams from mineral processing by calculating the difference between the estimated pre- and post-LDR costs. Because of data limitations, EPA used sector-wide averages and totals for estimating the impacts of the rule. Sector-wide estimates were developed on an average facility basis, however, so as to correctly address facility-level economies of scale. Detailed cost model calculations and results are bound in a separate document.

Cost Functions

To calculate the costs of managing the affected wastes under the baseline and the four options, EPA developed and applied cost-estimating functions for treatment and disposal, as well as storage prior to recycling. Appendix D provides a detailed discussion of these cost functions. The cost functions address the capital and O&M costs associated with each technology, as well as decommissioning costs for on-site tank treatment and stabilization. These costing equations are expressed as a function of the waste generation rate (in metric tons/year). In addition, the costing functions provide a means of estimating the break-even point between off-site and on-site land disposal costs.

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[12] See Footnote 10.

[13] See Footnote 10.

The application of new technologies for treating wastes often involves the procurement and installation of new capital equipment, as well as changes in periodic operating costs. Because this new equipment is used over an extended period of time (i.e., not consumed), it is necessary to allocate its procurement and installation costs over its useful operating life. EPA addressed this issue by annualizing the initial capital costs over the operating life of the durable equipment, and then adding the discounted value of the annualized initial capital costs to the annual (recurring) capital, operating, and maintenance costs associated with the technology, in order to obtain a total annualized cost. This yields a measure of cost impact that can be compared directly with data reflecting the ability of the affected firms to bear this incremental cost (e.g., earnings, value of product shipments).

The costing functions incorporate the following general assumptions:

- *Operating Life*. The analysis assumes a 20-year operating life for waste management units and facilities. With a positive and even moderately significant discount rate, extending the operating life beyond this period adds complexity but little tangible difference in estimated costs.

- *Tax Rate*. Costs are estimated on a before-tax basis to facilitate comparisons with available data related to predicting ultimate economic impacts.

- *Discount Rate*. The analysis uses a discount rate of seven percent, in keeping with current Office of Management and Budget (OMB) guidance.[14]

- *Inflation Rate.* The analysis is conducted in real terms and, consequently, assumes an inflation rate of zero.

General Approach to Developing Waste Management Costs

Based on the assumed incentives and/or disincentives for increase recycling, as well as each stream's certainty of recycling, EPA estimated the percentage of hazardous material sent to treatment and disposed for each baseline and option. The remaining hazardous material is considered to be recycled.[15] The dynamic analysis results from the shifts in management in each baseline-option combination. Exhibit 3-3 presents the percentages of hazardous mineral processing waste streams that are sent to treatment and disposal, in both the baseline and post-rule options. Exhibit 3-4 presents the percentages of hazardous mineral processing wastes that are recycled. In response to public comment suggesting that several mineral processing facilities currently recycle material to beneficiation units, EPA attempted to determine the point in the production process where each recycled material is reintroduced. Appendix E lists this information.

EPA then aggregated the non-reclaimed hazardous streams by solids content, based on the assumption that a facility would not build a separate stabilization facility and on-site landfill for each

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[14] OMB, 1992. *Circular A-94*.

[15] EPA developed the recycling assumptions (percentages) using limited empirical data on the recycling of two listed wastes, K061 (emission control dust from electric arc steel furnaces) and F006 (wastewater treatment sludge from electroplating operations). More information on the derivation of the percentages in the tables can be found in Appendix A.

individual waste stream but would instead handle all wastes requiring neutralization, dewatering, stabilization, and disposal in common treatment and disposal units. That is, the facility operator would take advantage of scale economies and co-manage similar waste types. Therefore, EPA calculated the "model facility" generation rate by *mineral processing sector* (e.g., lead, copper) for hazardous waste streams containing 1 to 10 percent solids (i.e., slurries), hazardous waste streams having greater than 10 percent solids, and hazardous wastewaters.[16]

In contrast, quantities of residues destined for recycling were assumed to require segregation, so as to promote efficient resource recovery. EPA made the conservative assumption that each material to be recovered would require storage prior to reclamation and, therefore, that each would require its own storage unit. Consequently, for each recycled stream, EPA divided the total sector quantity stored prior to recycling by the number of facilities generating that waste stream to determine the "average facility" quantity recycled. The significant difference in the calculation of the "model facility" totals for treatment and disposal and "average facility" quantities of materials stored prior to recycling are due to the difference in management assumption, i.e., streams to be treated are co-mingled while streams to be recycled are not.

Exhibit 3-3

Proportions of Waste Streams Sent to Treatment and Disposal (in percent)

Baseline or Option	Affected Material	Percent Disposed				
		Certainty of Recycling				
		Y	Y?	YS	YS?	N
Baseline	All	0	15	25	80	100
Option 1	Bevill	100	100	100	100	100
	Non-Bevill	30	65	100	100	100
Option 2	Bevill	100	100	100	100	100
	Non-Bevill	0	25	35	85	100
Option 3	All	0	25	35	85	100
Option 4	All	0	15	25	80	100

[16] EPA added the total sector generation rate of each type of waste and divided these totals by the maximum number of facilities in the sector producing waste requiring treatment. More information on this totaling process can be found in Appendix F. An example of the cost model calculations for a single sector can be found in Appendix G.

Exhibit 3-4

Proportions of Waste Streams Stored Prior to Recycling (in percent)

Baseline or Option	Affected Material	Percent Recycled Certainty of Recycling Y	Y?	YS	YS?	N
Baseline	All	100	85	75	20	0
Option 1	Bevill	0	0	0	0	0
	Non-Bevill	70	35	0	0	0
Option 2	Bevill	0	0	0	0	0
	Non-Bevill	100	75	65	15	0
Option 3	All	100	75	65	15	0
Option 4	All	100	85	75	20	0

Notes for Exhibits 3-3 and 3-4:

Y means that EPA has information indicating that the waste stream is fully recycled.

Y? means that EPA, based on professional judgment, believes that the waste stream could be fully recycled.

YS means that EPA has information indicating that a portion of the waste stream is fully recycled.

YS? means that EPA, based on professional judgment, believes that a portion of the waste stream could be fully recycled.

Bevill means that secondary materials are recycled through beneficiation or Bevill process units.

Non-Bevill means that secondary materials are not recycled through beneficiation or Bevill process units.

Having derived the "model facility" quantity of each type of waste (wastewaters, 1-10 percent solids, and more than 10 percent solids) going to treatment and disposal, and the "average facility" quantities of individual streams going to storage prior to recycling in each sector, EPA calculated the cost associated with each of these activities.

Development of Treatment Costs

In the analysis, the Agency made the following assumptions about waste treatment and disposal practices:

- Management of hazardous mineral processing wastes containing more than 10 percent solids involves non-permitted treatment followed by disposal of the stabilized mass in a Subtitle D unit. Treatment consists of cement stabilization, which increases the mass of waste destined for disposal to 175 percent of the mass entering stabilization.

- Management of hazardous mineral processing wastewaters and wastes containing 1 to 10 percent solids involves non-permitted treatment followed by disposal of the stabilized mass in a Subtitle D unit. Treatment consists of neutralization, followed by dewatering of the precipitated solids, and cement stabilization of the dewatered sludge. The precipitated mass from neutralization is 15 percent of the original waste stream, while the dewatered mass is 15 percent of the precipitated mass (or 2.25 percent of the original waste stream). Stabilization increases the mass of the dewatered sludge by 55 percent (or 155 percent of the mass entering stabilization).

These assumptions and their factual basis are documented in Appendix D and Appendix F.

The Agency has assumed that both pre- and post-LDR management of treated residues would occur in (primarily) on-site Subtitle D waste disposal piles, because under the baseline, affected operators would have constructed such units to be in compliance with (i.e., avoid) pre-LDR Subtitle C waste management requirements. For low volume wastes (less than or equal to 879 metric tons solids/year or 350 metric tons liquids/year), EPA has assumed that the operator would send the waste to an off-site Subtitle C facility for treatment (stabilization) and ultimate disposal in a Subtitle D unit. The Agency did not include non-hazardous waste streams in the analysis because the treatment standards in the supplemental proposed Phase IV LDR rule will not affect those wastes.

The first step in determining the cost of treatment was to compute the quantity of waste requiring each *type* of treatment at a "model facility" in each sector, because each treatment technology generates a residue which must either be further treated or disposed. For example, both wastewaters and wastes with a 1 to 10 percent solids content are assumed to be neutralized and dewatered in the same units, while the sludge (residue) generated from dewatering is mixed with waste with more than 10 percent solids, stabilized in a single stabilization unit, and disposed in a single Subtitle D waste pile. Once EPA determined the quantities of waste going to each treatment unit (accounting for volume changes brought about by each treatment step), the Agency used costing equations (described in detail in Appendix D) to determine the capital, operating and maintenance, and closure costs of each of the treatment and disposal units. These costs were then annualized and totaled. In some sectors, there was not enough waste to justify on-site treatment and disposal, so the Agency used a unit cost to reflect shipping the waste off-site for treatment and disposal. The "model facility" treatment cost was multiplied by the number of facilities treating and disposing waste to get the total sector treatment cost.

Development of Storage Costs

To determine the costs associated with storing wastes prior to recycling, EPA assumed that wastes to be recycled are stored for 30 days or less in drums or tanks if they are liquid and for less than 90 days in drums, roll-off containers, or buildings if they have a solids content of more than 10 percent.[17] To estimate the impacts of the material reclamation practices outlined above, the Agency used unit cost functions (described in detail in Appendix D) to calculate the costs associated with storing wastes in piles, surface impoundments, RCRA TCBs, and non-RCRA TCBs. Again, and in contrast to waste treatment operations, EPA determined recycling costs on a per waste stream basis, rather than a per facility basis,

[17] Some of the options allow a longer period of storage: because, however, facility operators would have to build larger and more expensive storage units to take advantage of these longer periods of storage, EPA has assumed that they would attempt to minimize storage time.

because it is important in many cases that the wastes to be recycled not be commingled. To determine the total sector storage cost, EPA multiplied the cost of storage for each stream by the number of facilities generating that stream and summed these total sector stream costs.

Development of Total Costs

EPA then calculated incremental treatment and disposal costs by subtracting total sector pre-LDR treatment and disposal costs from total sector post-LDR treatment and disposal costs. EPA calculated total sector incremental storage costs in a similar manner. EPA calculated the total sector costs by adding the total sector incremental treatment costs to the total sector incremental storage costs. EPA divided this total sector cost by the number of facilities in the sector to determine the average facility costs.

3.1.3 Economic Impact Analysis

To evaluate the significance of increased waste management costs on affected facilities and industry sectors, EPA employed simple ratio analyses to yield first-order economic impact estimates. The Agency compared sector-wide estimated regulatory compliance costs with three different measures of economic activity.[18]

First, EPA compared regulatory costs for each sector to the estimated *value of shipments* from the plants in that sector. This provides a rough measure of the extent to which gross margins would be reduced by the increased waste management costs, or alternatively, the amount by which the affected commodity price would need to increase to maintain existing margins. The Agency recognizes that this approach produces only a very crude and preliminary estimate of ultimate economic impact on affected facilities. Unfortunately, however, this is the only ratio analysis for which the needed data were available for all of the industry sectors. EPA calculated the ratio of annualized incremental cost to the value of shipments for all four options, has defined the screening level threshold for significant impact as three percent.

Second, for 16 industry sectors where data were available, EPA compared estimated regulatory costs for each sector to the estimated *value added* by that sector. A ratio of regulatory costs to value added may be more useful in assessing regulatory impacts than a ratio of regulatory costs to shipments. In particular, a mineral processing sector (such as the primary copper industry) generally incurs substantial costs to purchase or produce the raw materials (such as copper concentrate) used in mineral processing activities. The total dollar value of shipments for a mineral processing industry thus includes not only the costs of production and profit, but also the costs of raw materials. In contrast, the value added in manufacturing measures the sales revenue minus the cost of raw materials. Thus, it presents a clearer picture of the extent of economic activity at the regulated operation, and the basis on which the firm may make profits attributable to that operation. EPA obtained value added data for copper and aluminum from

[18] EPA did not consider the extent to which industry sectors may be able to pass on to their customers the costs of regulation. An industry sector's ability to pass on costs depends on two factors: (1) the elasticity of demand (if demand changes little with a change in price, industry has a greater opportunity to pass on most of the costs), and (2) the extent of the world market represented by U.S. suppliers (if U.S. suppliers represent a small portion of the world market, most of the market is unaffected by U.S. regulations and U.S. suppliers cannot pass through the costs).

a Census Bureau publication.[19] The Agency obtained value added data for 14 industry sectors categorized as "primary nonferrous metals, not elsewhere classified" from the same publication, and apportioned the total value added to each of the 14 sectors according to that sector's proportion of the total value of shipments for the 14 sectors.[20] For this analysis, EPA used a screening level of 10 percent for significant impact.

Third, for five industry sectors where data were available, EPA compared estimated regulatory costs for each sector to the estimated profits of that sector. This ratio analysis permits a direct comparison of regulatory costs to profits, and indicates the maximum extent to which the regulation will reduce industry profits if industry cannot pass on any of the regulatory costs to customers. To conduct this analysis, EPA obtained profits data for firms known to be engaged primarily or exclusively in processing a single type of mineral. The Agency obtained these data from the Disclosure on-line commercial database, for the most recent year available in the database. (The Disclosure database, in turn, contains data taken from 10K forms that publicly-held firms must file with the Securities and Exchange Commission.) EPA based its estimate of profitability for each of the five industry sectors on the weighted average profitability of the firms in each sector for which data were available.[21] For this analysis, EPA selected a screening level threshold for severe impacts of 100 percent.

3.2 Results

This section presents EPA's estimates of the cost and screening-level economic impacts of Options 1, 2, 3, and 4. These estimates are provided in-turn by option, followed by some brief comparisons between options. Please note that the detailed discussion of cost and economic results presented in Sections 3.2.1 and 3.2.2 focuses on the expected value case. Exhibit 3-5 highlights the differences between the minimum, expected, and maximum value cases.

Exhibit 3-5

Summary of Cost Results

	Minimum	Expected	Maximum
Option 1	$46,000,000	$58,000,000	$75,000,000
Option 2	$37,000,000	$45,000,000	$55,000,000
Option 3	$5,200,000	$8,400,000	$13,000,000
Option 4	$71,000	$190,000	$190,000

[19] Bureau of the Census, U.S. Department of Commerce, *1992 Census of Manufactures, Industry Series, Smelting and Refining of Nonferrous Metals and Alloys, Industries 3331, 3334, 3339, and 3341* (Washington, DC: U.S. Department of Commerce), p. 33C-9.

[20] The Agency's background calculations are provided in Appendix G of the *Regulatory Impact Analysis of the Supplemental Proposed Rule Applying Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes*, December 1995.

[21] See previous footnote.

EPA's use of the dynamic analysis contributes to some counter-intuitive results such as savings in some sectors where costs are expected. The unexpected consequences result from relative economies of scale and a low-volume wastewater treatment unit cost gap. Both are discussed further.

- *The dynamic shift and relative economies of scale*. The overall cost for an option will depend on the amount and type of material moving from treatment and disposal to recycling, the storage requirements, and the relative unit costs. For most options, at any given generation rate storage prior to recycling is less expensive than treatment and disposal. Because quantities to be treated and disposed are aggregated, while quantities to be recycled need to be stored in dedicated units, moving small quantities of materials from treatment and disposal to recycling may not produce a cost savings due to relative scale economies. For example, if a facility were treating and disposing two wastewater streams in the baseline, one generated at 100,000 mt/yr and one at 150 mt/yr, these two streams would be commingled and the unit cost of treatment in the baseline would be based on treating 100,150 mt/yr. If after the rule went into effect the smaller stream was then fully recycled, the *unit cost* of storing 150 mt/yr in a dedicated unit might be higher than the *unit cost* of treating those 150 mt/yr in the baseline (when the unit cost was based on treating 100,150 mt/yr).

- *Low-volume wastewater treatment unit cost gap.* In addition to the problem of relative scale economies, there is a low volume wastewater treatment unit cost gap. That is, using available information on pertinent treatment technologies, the smallest treatment system that can reasonably be built on-site has a capacity of 350 mt/yr, resulting in an annualized cost of about $100 per metric ton, while off-site treatment and disposal costs $175 per metric ton. Therefore, for facilities treating and disposing small quantities of wastewater in the baseline, a slight increase in the quantity treated and disposed (and, therefore, a slight decrease in the quantity recycled) may shift treatment from off-site to on-site. Because off-site treatment is significantly more expensive, the result of this shift is a decreased cost, rather than an increase (as would be expected).

3.2.1 Cost Analysis Results

Cost impact results are presented in Exhibits 3-6 through 3-9. The options are discussed in order from the most to the least costly.

Option 1

Under Option 1, EPA anticipates that the total expected incremental cost will be $58,000,000, as seen in Exhibit 3-6. Twenty-six of the 29 industry sectors (90 percent) are projected to experience increased costs, one (three percent) is expected to have no additional costs, and two (seven percent) are anticipated to have cost savings. On a sector basis, the cost changes range from an expected savings of $43,000 (tungsten) to a cost increase of $27,000,000 (lead). Note that the cost impacts of this option fall disproportionately on the lead sector; the cost impacts estimated for the lead sector account for more than 46 percent of the total cost impacts estimated under this option.[22] EPA expects five of the sectors (17 percent) to have total incremental costs greater than $1,000,000 (alumina and aluminum, copper, elemental phosphorus, lead, and zinc). Three sectors (10 percent) are expected to have total costs between $500,000 and $1,000,000 (mercury, synthetic rutile, and titanium and titanium dioxide). Only

[22] EPA is currently conducting additional analyses to determine whether costs to the lead sector may be overstated by the cost model.

Exhibit 3-6

Option 1 Incremental Costs

Commodity	Minimum Value Case		Expected Value Case		Maximum Value Case	
	Total Incremental Cost ($/yr)	Avg. Fac. Incremental Cost ($/yr)	Total Incremental Cost ($/yr)	Avg. Fac. Incremental Cost ($/yr)	Total Incremental Cost ($/yr)	Avg. Fac. Incremental Cost ($/yr)
Alumina and Aluminum	1,400,000	62,000	2,400,000	100,000	2,900,000	130,000
Antimony	-	-	55,000	9,200	81,000	14,000
Beryllium	-	-	40,000	20,000	800,000	400,000
Bismuth	-	-	39,000	39,000	72,000	72,000
Cadmium	-	-	63,000	31,000	2,500,000	1,200,000
Calcium	-	-	4,300	4,300	7,300	7,300
Coal Gas	-	-	-	-	220,000	220,000
Copper	10,000,000	1,000,000	10,000,000	1,000,000	10,000,000	1,000,000
Elemental Phosphorus	3,400,000	1,700,000	3,400,000	1,700,000	3,400,000	1,700,000
Fluorspar and Hydrofluoric Acid	-	-	190,000	63,000	330,000	110,000
Germanium	-	-	39,000	9,700	45,000	11,000
Lead	21,000,000	5,200,000	27,000,000	6,700,000	32,000,000	8,100,000
Magnesium and Magnesia from Brines	2,800	1,400	3,100	1,500	240,000	120,000
Mercury	-	-	680,000	97,000	1,800,000	260,000
Molybdenum, Ferromolybdenum, and Ammonium Molybdate	-	-	16,000	1,400	16,000	1,400
Platinum Group Metals	-	-	5,900	2,000	38,000	13,000
Pyrobitumens, Mineral Waxes, and Natural Asphalts	-	-	140,000	68,000	170,000	83,000
Rare Earths	9,800	9,800	200,000	200,000	1,100,000	1,100,000
Rhenium	-	-	9,500	4,700	31,000	15,000
Scandium	-	-	(22,000)	(3,100)	170,000	25,000
Selenium	81,000	40,000	140,000	46,000	300,000	100,000
Synthetic Rutile	-	-	560,000	560,000	1,000,000	1,000,000
Tantalum, Columbium, and Ferrocolumbium	540,000	270,000	390,000	200,000	390,000	200,000
Tellurium	-	-	150,000	75,000	180,000	90,000
Titanium and Titanium Dioxide	170,000	83,000	920,000	130,000	1,400,000	200,000
Tungsten	-	-	(43,000)	(7,200)	73,000	12,000
Uranium	-	-	220,000	13,000	1,100,000	63,000
Zinc	9,700,000	3,200,000	11,000,000	3,700,000	13,000,000	4,200,000
Zirconium and Hafnium	-	-	210,000	110,000	1,200,000	610,000
Total	46,000,000		58,000,000		75,000,000	

Exhibit 3-7

Option 2 Incremental Costs

	Minimum Value Case		Expected Value Case		Maximum Value Case	
Commodity	**Total Incremental Cost ($/yr)**	**Avg. Fac. Incremental Cost ($/yr)**	**Total Incremental Cost ($/yr)**	**Avg. Fac. Incremental Cost ($/yr)**	**Total Incremental Cost ($/yr)**	**Avg. Fac. Incremental Cost ($/yr)**
Alumina and Aluminum	310,000	14,000	810,000	35,000	1,500,000	64,000
Antimony	-	-	24,000	4,000	38,000	6,400
Beryllium	-	-	19,000	9,300	350,000	180,000
Bismuth	-	-	10,000	10,000	22,000	22,000
Cadmium	-	-	53,000	27,000	570,000	280,000
Calcium	-	-	4,300	4,300	7,300	7,300
Coal Gas	-	-	-	-	220,000	220,000
Copper	10,000,000	1,000,000	10,000,000	1,000,000	10,000,000	1,000,000
Elemental Phosphorus	3,400,000	1,700,000	3,400,000	1,700,000	3,400,000	1,700,000
Fluorspar and Hydrofluoric Acid	-	-	52,000	17,000	84,000	28,000
Germanium	-	-	15,000	3,800	17,000	4,300
Lead	21,000,000	5,200,000	27,000,000	6,700,000	32,000,000	8,100,000
Magnesium and Magnesia from Brines	2,800	1,400	3,900	2,000	49,000	25,000
Mercury	-	-	680,000	97,000	1,800,000	260,000
Molybdenum, Ferromolybdenum, and Ammonium Molybdate	-	-	16,000	1,400	16,000	1,400
Platinum Group Metals	-	-	4,600	1,500	11,000	3,700
Pyrobitumens, Mineral Waxes, and Natural Asphalts	-	-	46,000	23,000	57,000	28,000
Rare Earths	9,800	9,800	200,000	200,000	980,000	980,000
Rhenium	-	-	9,500	4,700	31,000	15,000
Scandium	-	-	(94,000)	(13,000)	44,000	6,300
Selenium	81,000	40,000	100,000	34,000	160,000	54,000
Synthetic Rutile	-	-	80,000	80,000	150,000	150,000
Tantalum, Columbium, and Ferrocolumbium	170,000	86,000	130,000	67,000	130,000	67,000
Tellurium	-	-	12,000	5,800	40,000	20,000
Titanium and Titanium Dioxide	76,000	38,000	240,000	34,000	380,000	55,000
Tungsten	-	-	(43,000)	(7,200)	73,000	12,000
Uranium	-	-	47,000	2,700	100,000	6,200
Zinc	1,500,000	490,000	2,400,000	790,000	2,700,000	890,000
Zirconium and Hafnium	-	-	100,000	50,000	320,000	160,000
Total	37,000,000		45,000,000		55,000,000	

Exhibit 3-8

Option 3 Incremental Costs

Commodity	Minimum Value Case Total Incremental Cost ($/yr)	Minimum Value Case Avg. Fac. Incremental Cost ($/yr)	Expected Value Case Total Incremental Cost ($/yr)	Expected Value Case Avg. Fac. Incremental Cost ($/yr)	Maximum Value Case Total Incremental Cost ($/yr)	Maximum Value Case Avg. Fac. Incremental Cost ($/yr)
Alumina and Aluminum	310,000	14,000	810,000	35,000	1,500,000	64,000
Antimony	-	-	24,000	4,000	38,000	6,400
Beryllium	-	-	19,000	9,300	350,000	180,000
Bismuth	-	-	10,000	10,000	22,000	22,000
Cadmium	-	-	24,000	12,000	490,000	250,000
Calcium	-	-	1,400	1,400	1,400	1,400
Coal Gas	-	-	-	-	68,000	68,000
Copper	2,600,000	260,000	2,500,000	250,000	2,600,000	260,000
Elemental Phosphorus	480,000	240,000	480,000	240,000	480,000	240,000
Fluorspar and Hydrofluoric Acid	-	-	52,000	17,000	84,000	28,000
Germanium	-	-	15,000	3,800	17,000	4,300
Lead	59,000	15,000	1,100,000	280,000	2,100,000	510,000
Magnesium and Magnesia from Brines	2,800	1,400	3,900	2,000	49,000	25,000
Mercury	-	-	190,000	27,000	520,000	74,000
Molybdenum, Ferromolybdenum, and Ammonium Molybdate	-	-	16,000	1,400	16,000	1,400
Platinum Group Metals	-	-	4,600	1,500	11,000	3,700
Pyrobitumens, Mineral Waxes, and Natural Asphalts	-	-	46,000	23,000	57,000	28,000
Rare Earths	5,200	5,200	94,000	94,000	320,000	320,000
Rhenium	-	-	3,700	1,800	6,200	3,100
Scandium	-	-	(94,000)	(13,000)	44,000	6,300
Selenium	30,000	15,000	44,000	15,000	130,000	44,000
Synthetic Rutile	-	-	80,000	80,000	150,000	150,000
Tantalum, Columbium, and Ferrocolumbium	170,000	86,000	130,000	67,000	130,000	67,000
Tellurium	-	-	12,000	5,800	40,000	20,000
Titanium and Titanium Dioxide	76,000	38,000	240,000	34,000	380,000	55,000
Tungsten	-	-	27,000	4,400	36,000	6,100
Uranium	-	-	47,000	2,700	100,000	6,200
Zinc	1,500,000	490,000	2,400,000	790,000	2,700,000	890,000
Zirconium and Hafnium	-	-	100,000	50,000	320,000	160,000
Total	5,200,000		8,400,000		13,000,000	

Exhibit 3-9

Option 4 Incremental Costs

	Minimum Value Case		Expected Value Case		Maximum Value Case	
Commodity	**Total Incremental Cost ($/yr)**	**Avg. Fac. Incremental Cost ($/yr)**	**Total Incremental Cost ($/yr)**	**Avg. Fac. Incremental Cost ($/yr)**	**Total Incremental Cost ($/yr)**	**Avg. Fac. Incremental Cost ($/yr)**
Alumina and Aluminum	32,000	1,400	32,000	1,400	32,000	1,400
Antimony	-	-	8,500	1,400	8,500	1,400
Beryllium	-	-	2,800	1,400	2,800	1,400
Bismuth	-	-	1,400	1,400	1,400	1,400
Cadmium	-	-	2,800	1,400	2,800	1,400
Calcium	-	-	1,400	1,400	1,400	1,400
Coal Gas	-	-	-	-	1,400	1,400
Copper	14,000	1,400	14,000	1,400	14,000	1,400
Elemental Phosphorus	2,800	1,400	2,800	1,400	2,800	1,400
Fluorspar and Hydrofluoric Acid	-	-	4,200	1,400	4,200	1,400
Germanium	-	-	5,600	1,400	5,600	1,400
Lead	5,600	1,400	5,600	1,400	5,600	1,400
Magnesium and Magnesia from Brines	2,800	1,400	2,800	1,400	2,800	1,400
Mercury	-	-	9,900	1,400	9,900	1,400
Molybdenum, Ferromolybdenum, and Ammonium Molybdate	-	-	16,000	1,400	16,000	1,400
Platinum Group Metals	-	-	4,200	1,400	4,200	1,400
Pyrobitumens, Mineral Waxes, and Natural Asphalts	-	-	2,800	1,400	2,800	1,400
Rare Earths	1,400	1,400	1,400	1,400	1,400	1,400
Rhenium	-	-	2,800	1,400	2,800	1,400
Scandium	-	-	9,900	1,400	9,900	1,400
Selenium	2,800	1,400	4,200	1,400	4,200	1,400
Synthetic Rutile	-	-	1,400	1,400	1,400	1,400
Tantalum, Columbium, and Ferrocolumbium	2,800	1,400	2,800	1,400	2,800	1,400
Tellurium	-	-	2,800	1,400	2,800	1,400
Titanium and Titanium Dioxide	2,800	1,400	9,900	1,400	9,900	1,400
Tungsten	-	-	8,500	1,400	8,500	1,400
Uranium	-	-	24,000	1,400	24,000	1,400
Zinc	4,200	1,400	4,200	1,400	4,200	1,400
Zirconium and Hafnium	-	-	2,800	1,400	2,800	1,400
Total	71,000		190,000		190,000	

one sector, coal gas, is expected to experience no cost changes. Finally, EPA projects that the scandium and tungsten sectors will experience cost savings of $22,000 and $43,000, respectively.

On a per facility basis, average expected incremental costs range from a savings of $7,300 (tungsten) to an increase of $6,700,000 (lead). EPA projects that facilities in four sectors (14 percent) will incur impacts in excess of $1,000,000 (copper, elemental phosphorus, lead, and zinc). Facilities in only one other sector (three percent) are expected to have average impacts between $500,000 and $600,000 (synthetic rutile), while facilities in another five sectors (17 percent) are projected to have average impacts between $100,000 and $200,000 (alumina and aluminum; rare earths; tantalum columbium and ferrocolumbium; titanium and titanium dioxide; tellurium, and zirconium and hafnium). The average expected savings for facilities in the scandium and tungsten sectors are $3,100 and $7,200, respectively.

Option 2

Under Option 2, EPA expects the total incremental cost to be $45,000,000, as shown in Exhibit 3-7. Twenty-six of the industry sectors (90 percent) are projected to experience increased costs, one (three percent) is expected to have no additional costs, and two (seven percent) are anticipated to see cost savings. On a sector basis, incremental costs range from an expected savings of $94,000 (scandium) to a cost increase of $27,000,000 (lead). Again, as was the case for Option 1, cost impacts fall disproportionately on the lead sector; lead sector cost impacts account for sixty percent of total industry impacts under this option.[23] EPA expects four sectors (14 percent) to have total incremental costs greater than $1,000,000 (copper, elemental phosphorus, lead, and zinc) and two (seven percent) to have total costs between $500,000 and $800,000 (alumina and aluminum, and mercury). As with Option 1, only one sector, coal gas, is expected to experience no cost changes. Finally, EPA expects that the scandium and tungsten sectors will incur cost savings of $94,000 and $43,000, respectively.

On a per facility basis, average incremental costs range from a savings of $13,000 (scandium) to a cost increase of $6,700,000 (lead). EPA expects facilities in three sectors (10 percent) to incur impacts in excess of $1,000,000 (copper, elemental phosphorus, and lead) and facilities in one other sector (three percent) to have cost increases of more than $700,000 (zinc). Facilities in one sector (rare earths) are expected to incur average impacts of $200,000. Facilities in the remainder of the sectors (83 percent) are expected to have average cost increases of less than $100,000, except for those in coal gas (no impacts), scandium (savings of $13,000), and tungsten (savings of $7,200).

Option 3

Under Option 3, the total expected incremental cost is $8,400,000; these impacts are shown in Exhibit 3-8. Twenty-seven of the industry sectors (93 percent) are projected to experience increased costs, one sector (three percent) is expected to have no additional costs, and one (three percent) is anticipated to realize cost savings. On a sector basis, incremental costs range from an expected savings of $94,000 (scandium) to an increase of $2,500,000 (copper). EPA expects three sectors (10 percent) to experience total incremental costs greater than $1,000,000 (copper, lead, and zinc) and one (three percent) to have total costs of more than $800,000 (alumina and aluminum). The one sector with no expected costs is coal gas. Finally, EPA expects that the only sector to experience cost savings will be the scandium sector ($94,000).

[23] See previous footnote.

On a per facility basis, average incremental expected costs range from a savings of $13,000 (scandium) to an increase of $790,000 (zinc). Facilities in three other industry sectors (10 percent) are expected to have cost increases between $100,000 and $500,000 (copper, elemental phosphorus, and lead). Facilities in the remainder of the sectors (83 percent) are expected to have cost increases of less than $100,000, except for coal gas (no impacts) and scandium (savings of $13,000).

Option 4

Under Option 4, the total expected incremental cost to industry is $190,000, significantly lower than for the other options. These impacts are shown in Exhibit 3-9. Twenty-eight sectors are projected to experience increased costs, with one sector experiencing no change in costs. Expected incremental costs range from zero (coal gas) to $32,000 (alumina and aluminum). Four sectors under this option are expected to experience costs of more than $10,000 (alumina and aluminum; copper; molybdenum, ferromolybdenum, and ammonium molybdate; and uranium).

On a per facility basis, average incremental expected costs range from zero (coal gas) to $1,400 for all other sectors. The reason for the uniformity in per facility costs is that the only costs that the Agency estimates will be incurred by industry under this option are recordkeeping and reporting requirements. No other cost impacts are estimated for any of the sectors because the Agency expects that under this option, management practices will not change, relative to the baseline. For example, facility operators will continue to store materials to be recycled in unlined land-based units, so no new costs attributable to storage are expected.

3.2.2 Economic Impact Analysis Results

As described above, EPA conducted three ratio analyses comparing regulatory costs to the following three financial indicators: (1) value of shipments, (2) value added, and (3) gross profits. Data were available to determine the ratio of regulatory costs to value of shipments for all 29 industry sectors affected. However, data were available for only 16 industry sectors to determine the ratio using value added and for only six industry sectors to determine the ratio using gross profits. This section presents the results of the three analyses.

Ratio of Regulatory Costs to Value of Shipments

Exhibits 3-10 through 3-13 present the results of the value of shipments analysis.

Economic impacts expressed as a ratio of regulatory costs to the value of shipments suggest that Options 1 and 2 impose the most significant impact on affected industries and Option 4 imposes the least impact. Option 1 imposes significant cost impacts (defined as 3 percent of the value of shipments for the sake of this analysis) on five of the 29 industrial sectors (seventeen percent of the affected sectors) in the expected value case. EPA projects significantly affected sectors to include cadmium (6 percent impact), lead (13 percent), mercury (176 percent), pyrobitumens, mineral waxes, and natural asphalt (56 percent), and selenium (5 percent). The remaining 24 sectors (83 percent of all affected sectors) are expected to experience economic impacts of three percent or less.

Option 2 would impose burdens very similar to those estimated for Option 1. Like Option 1, Option 2 imposes significant cost impacts on five of the 29 industrial sectors in the expected value case. As was the case for Option 1 as well, EPA expects significantly affected sectors to include cadmium (5 percent), lead (13 percent), mercury (176 percent), pyrobitumens, mineral waxes, and natural asphalt (18

Exhibit 3-10
Option 1 Impacts

Sector	Production MT	Price $/MT	Value of Shipments $	Incremental Sector Cost $			Economic Impact (percent of Value of Shipments)		
				Minimum	Expected	Maximum	Minimum	Expected	Maximum
Alumina and Aluminum	3,700,000	1,168	*4,321,600,000*	1,400,000	2,400,000	2,900,000	0.03	0.06	0.07
Antimony	18,000	1,764	*31,752,000*	-	55,000	81,000	0.00	0.17	0.26
Beryllium	159	352,640	*56,069,760*	-	40,000	800,000	0.00	0.07	1.43
Bismuth	1,100	7,824	*8,606,400*	-	39,000	72,000	0.00	0.45	0.84
Cadmium	1,050	992	*1,041,600*	-	63,000	2,500,000	0.00	6.05	240.02
Calcium	1,200	4,605	*5,526,000*	-	4,300	7,300	0.00	0.08	0.13
Coal Gas			*170,000,000*	-	-	220,000	0.00	0.00	0.13
Copper	1,770,000	2,029	*3,591,330,000*	10,000,000	10,000,000	10,000,000	0.28	0.28	0.28
Elemental Phosphorus	311,000	1,833	*570,063,000*	3,400,000	3,400,000	3,400,000	0.60	0.60	0.60
Fluorspar and Hydrofluoric Acid	60,000	193	*11,580,000*	-	190,000	330,000	0.00	1.64	2.85
Germanium	10	1,060,000	*10,600,000*	-	39,000	45,000	0.00	0.37	0.42
Lead	290,000	706	*204,740,000*	21,000,000	27,000,000	32,000,000	10.26	13.19	15.63
Magnesium and Magnesia from Brines	145,000	3,219	*466,755,000*	2,800	3,100	240,000	0.00	0.00	0.05
Mercury	70	5,512	*385,840*	-	680,000	1,800,000	0.00	176.24	466.51
Molybdenum, Ferromolybdenum and Ammonium Molybdate			239,864,579	-	16,000	16,000	0.00	0.01	0.01
Platinum Group Metals			53,203,971	-	5,900	38,000	0.00	0.01	0.07
Pyrobitumens, Mineral Waxes, and Natural Asphalt	10,000	25	250,000	-	140,000	170,000	0.00	56.00	68.00
Rare Earths			57,372,120	9,800	200,000	1,100,000	0.02	0.35	1.92
Rhenium	5	1,200,000	*6,000,000*	-	9,500	31,000	0.00	0.16	0.52
Scandium	25	1,500,000	*37,500,000*	-	(22,000)	170,000	0.00	-0.06	0.45
Selenium	250	11,246	2,811,500	81,000	140,000	300,000	2.88	4.98	10.67
Synthetic Rutile	140,000	345	48,300,000	-	560,000	1,000,000	0.00	1.16	2.07
Tantalum, Columbium, and Ferrocolumbium			60,897,400	540,000	390,000	390,000	0.89	0.64	0.64
Tellurium	60	59,508	*3,570,480*	-	150,000	180,000	0.00	4.20	5.04
Titanium and Titanium Dioxide			2,516,300,000	170,000	920,000	1,400,000	0.01	0.04	0.06
Tungsten	9,406	40	*376,240*	-	(43,000)	73,000	0.00	-11.43	19.40
Uranium			40,734,000	-	220,000	1,100,000	0.00	0.54	2.70
Zinc	505,000	1,014	*512,070,000*	9,700,000	11,000,000	13,000,000	1.89	2.15	2.54
Zirconium and Hafnium			379,899,000	-	210,000	1,200,000	0.00	0.06	0.32
Total				46,000,000	58,000,000	75,000,000			

Exhibit 3-11
Option 2 Impacts

Sector	Production	Price	Value of Shipments	Incremental Sector Cost $			Economic Impact (percent of Value of Shipments)		
	MT	$/MT	$	Minimum	Expected	Maximum	Minimum	Expected	Maximum
Alumina and Aluminum	3,700,000	1,168	*4,321,600,000*	310,000	810,000	1,500,000	0.01	0.02	0.03
Antimony	18,000	1,764	*31,752,000*	-	24,000	38,000	0.00	0.08	0.12
Beryllium	159	352,640	*56,069,760*	-	19,000	350,000	0.00	0.03	0.62
Bismuth	1,100	7,824	*8,606,400*	-	10,000	22,000	0.00	0.12	0.26
Cadmium	1,050	992	*1,041,600*	-	53,000	570,000	0.00	5.09	54.72
Calcium	1,200	4,605	*5,526,000*	-	4,300	7,300	0.00	0.08	0.13
Coal Gas			*170,000,000*	-	-	220,000	0.00	0.00	0.13
Copper	1,770,000	2,029	*3,591,330,000*	10,000,000	10,000,000	10,000,000	0.28	0.28	0.28
Elemental Phosphorus	311,000	1,833	*570,063,000*	3,400,000	3,400,000	3,400,000	0.60	0.60	0.60
Fluorspar and Hydrofluoric Acid	60,000	193	*11,580,000*	-	52,000	84,000	0.00	0.45	0.73
Germanium	10	1,060,000	*10,600,000*	-	15,000	17,000	0.00	0.14	0.16
Lead	290,000	706	*204,740,000*	21,000,000	27,000,000	32,000,000	10.26	13.19	15.63
Magnesium and Magnesia from Brines	145,000	3,219	*466,755,000*	2,800	3,900	49,000	0.00	0.00	0.01
Mercury	70	5,512	*385,840*	-	680,000	1,800,000	0.00	176.24	466.51
Molybdenum, Ferromolybdenum and Ammonium Molybdate			239,864,579	-	16,000	16,000	0.00	0.01	0.01
Platinum Group Metals			53,203,971	-	4,600	11,000	0.00	0.01	0.02
Pyrobitumens, Mineral Waxes, and Natural Asphalt	10,000	25	250,000	-	46,000	57,000	0.00	18.40	22.80
Rare Earths			57,372,120	9,800	200,000	980,000	0.02	0.35	1.71
Rhenium	5	1,200,000	*6,000,000*	-	9,500	31,000	0.00	0.16	0.52
Scandium	25	1,500,000	*37,500,000*	-	(94,000)	44,000	0.00	-0.25	0.12
Selenium	250	11,246	2,811,500	81,000	100,000	160,000	2.88	3.56	5.69
Synthetic Rutile	140,000	345	48,300,000	-	80,000	150,000	0.00	0.17	0.31
Tantalum, Columbium, and Ferrocolumbium			60,897,400	170,000	130,000	130,000	0.28	0.21	0.21
Tellurium	60	59,508	*3,570,480*	-	12,000	40,000	0.00	0.34	1.12
Titanium and Titanium Dioxide			2,516,300,000	76,000	240,000	380,000	0.00	0.01	0.02
Tungsten	9,406	40	*376,240*	-	(43,000)	73,000	0.00	-11.43	19.40
Uranium			40,734,000	-	47,000	100,000	0.00	0.12	0.25
Zinc	505,000	1,014	*512,070,000*	1,500,000	2,400,000	2,700,000	0.29	0.47	0.53
Zirconium and Hafnium			379,899,000	-	100,000	320,000	0.00	0.03	0.08
Total				37,000,000	45,000,000	55,000,000			

Exhibit 3-12
Option 3 Impacts

Sector	Production MT	Price $/MT	Value of Shipments $	Incremental Sector Cost $			Economic Impact (percent of Value of Shipments)		
				Minimum	Expected	Maximum	Minimum	Expected	Maximum
Alumina and Aluminum	3,700,000	1,168	*4,321,600,000*	310,000	810,000	1,500,000	0.01	0.02	0.03
Antimony	18,000	1,764	*31,752,000*	-	24,000	38,000	0.00	0.08	0.12
Beryllium	159	352,640	*56,069,760*	-	19,000	350,000	0.00	0.03	0.62
Bismuth	1,100	7,824	*8,606,400*	-	10,000	22,000	0.00	0.12	0.26
Cadmium	1,050	992	*1,041,600*	-	24,000	490,000	0.00	2.30	47.04
Calcium	1,200	4,605	*5,526,000*	-	1,400	1,400	0.00	0.03	0.03
Coal Gas			*170,000,000*	-	-	68,000	0.00	0.00	0.04
Copper	1,770,000	2,029	*3,591,330,000*	2,600,000	2,500,000	2,600,000	0.07	0.07	0.07
Elemental Phosphorus	311,000	1,833	*570,063,000*	480,000	480,000	480,000	0.08	0.08	0.08
Fluorspar and Hydrofluoric Acid	60,000	193	*11,580,000*	-	52,000	84,000	0.00	0.45	0.73
Germanium	10	1,060,000	*10,600,000*	-	15,000	17,000	0.00	0.14	0.16
Lead	290,000	706	*204,740,000*	59,000	1,100,000	2,100,000	0.03	0.54	1.03
Magnesium and Magnesia from Brines	145,000	3,219	*466,755,000*	2,800	3,900	49,000	0.00	0.00	0.01
Mercury	70	5,512	*385,840*	-	190,000	520,000	0.00	49.24	134.77
Molybdenum, Ferromolybdenum and Ammonium Molybdate			239,864,579	-	16,000	16,000	0.00	0.01	0.01
Platinum Group Metals			53,203,971	-	4,600	11,000	0.00	0.01	0.02
Pyrobitumens, Mineral Waxes, and Natural Asphalt	10,000	25	250,000	-	46,000	57,000	0.00	18.40	22.80
Rare Earths			57,372,120	5,200	94,000	320,000	0.01	0.16	0.56
Rhenium	5	1,200,000	*6,000,000*	-	3,700	6,200	0.00	0.06	0.10
Scandium	25	1,500,000	*37,500,000*	-	(94,000)	44,000	0.00	-0.25	0.12
Selenium	250	11,246	2,811,500	30,000	44,000	130,000	1.07	1.57	4.62
Synthetic Rutile	140,000	345	48,300,000	-	80,000	150,000	0.00	0.17	0.31
Tantalum, Columbium, and Ferrocolumbium			60,897,400	170,000	130,000	130,000	0.28	0.21	0.21
Tellurium	60	59,508	*3,570,480*	-	12,000	40,000	0.00	0.34	1.12
Titanium and Titanium Dioxide			2,516,300,000	76,000	240,000	380,000	0.00	0.01	0.02
Tungsten	9,406	40	*376,240*	-	27,000	36,000	0.00	7.18	9.57
Uranium			40,734,000	-	47,000	100,000	0.00	0.12	0.25
Zinc	505,000	1,014	*512,070,000*	1,500,000	2,400,000	2,700,000	0.29	0.47	0.53
Zirconium and Hafnium			379,899,000	-	100,000	320,000	0.00	0.03	0.08
Total				5,200,000	8,400,000	13,000,000			

Exhibit 3-13
Option 4 Impacts

Sector	Production MT	Price $/MT	Value of Shipments $	Incremental Sector Cost $			Economic Impact (percent of Value of Shipments)		
				Minimum	Expected	Maximum	Minimum	Expected	Maximum
Alumina and Aluminum	3,700,000	1,168	*4,321,600,000*	32,000	32,000	32,000	0.00	0.00	0.00
Antimony	18,000	1,764	*31,752,000*	-	8,500	8,500	0.00	0.03	0.03
Beryllium	159	352,640	*56,069,760*	-	2,800	2,800	0.00	0.00	0.00
Bismuth	1,100	7,824	*8,606,400*	-	1,400	1,400	0.00	0.02	0.02
Cadmium	1,050	992	*1,041,600*	-	2,800	2,800	0.00	0.27	0.27
Calcium	1,200	4,605	*5,526,000*	-	1,400	1,400	0.00	0.03	0.03
Coal Gas			*170,000,000*	-	-	1,400	0.00	0.00	0.00
Copper	1,770,000	2,029	*3,591,330,000*	14,000	14,000	14,000	0.00	0.00	0.00
Elemental Phosphorus	311,000	1,833	*570,063,000*	2,800	2,800	2,800	0.00	0.00	0.00
Fluorspar and Hydrofluoric Acid	60,000	193	*11,580,000*	-	4,200	4,200	0.00	0.04	0.04
Germanium	10	1,060,000	*10,600,000*	-	5,600	5,600	0.00	0.05	0.05
Lead	290,000	706	*204,740,000*	5,600	5,600	5,600	0.00	0.00	0.00
Magnesium and Magnesia from Brines	145,000	3,219	*466,755,000*	2,800	2,800	2,800	0.00	0.00	0.00
Mercury	70	5,512	*385,840*	-	9,900	9,900	0.00	2.57	2.57
Molybdenum, Ferromolybdenum and Ammonium Molybdate			239,864,579	-	16,000	16,000	0.00	0.01	0.01
Platinum Group Metals			53,203,971	-	4,200	4,200	0.00	0.01	0.01
Pyrobitumens, Mineral Waxes, and Natural Asphalt	10,000	25	250,000	-	2,800	2,800	0.00	1.12	1.12
Rare Earths			57,372,120	1,400	1,400	1,400	0.00	0.00	0.00
Rhenium	5	1,200,000	*6,000,000*	-	2,800	2,800	0.00	0.05	0.05
Scandium	25	1,500,000	*37,500,000*	-	9,900	9,900	0.00	0.03	0.03
Selenium	250	11,246	2,811,500	2,800	4,200	4,200	0.10	0.15	0.15
Synthetic Rutile	140,000	345	48,300,000	-	1,400	1,400	0.00	0.00	0.00
Tantalum, Columbium, and Ferrocolumbium			60,897,400	2,800	2,800	2,800	0.00	0.00	0.00
Tellurium	60	59,508	*3,570,480*	-	2,800	2,800	0.00	0.08	0.08
Titanium and Titanium Dioxide			2,516,300,000	2,800	9,900	9,900	0.00	0.00	0.00
Tungsten	9,406	40	*376,240*	-	8,500	8,500	0.00	2.26	2.26
Uranium			40,734,000	-	24,000	24,000	0.00	0.06	0.06
Zinc	505,000	1,014	*512,070,000*	4,200	4,200	4,200	0.00	0.00	0.00
Zirconium and Hafnium			379,899,000	-	2,800	2,800	0.00	0.00	0.00
Total				71,000	190,000	190,000			

percent), and selenium (3.5 percent). The remaining 24 sectors (83 percent) are expected to experience economic impacts between zero and three percent. Note that the impact of Option 2, expressed as a percentage of the value of shipments, is nearly the same under Options 1 and 2.

Option 3 imposes significantly smaller impacts across all sectors. Significant impacts are expected for only three sectors (ten percent of the affected sectors) in the expected value case. These sectors are: mercury (49 percent), pyrobitumens, mineral waxes, and natural asphalt (18 percent), and tungsten (7 percent). In addition, fourteen sectors are expected to realize negative impacts of less than one tenth of a percent under this option. The remaining 12 sectors (41 percent of the affected sectors) are expected to experience economic impacts between one tenth of a percent and three percent.

Finally, Option 4 is projected to impose the lowest cost burden on affected industrial sectors of any of the options. EPA estimates that no sectors would experience significant impacts under Option 4. The most heavily affected sector under this option would be the mercury sector (approximately 2.5 percent), and the second most affected sector would be the tungsten sector (approximately 2 percent). Impacts would be negligible for most other sectors; 24 of the 29 sectors would experience an impact of less than one tenth of a percent.

The severity of predicted economic impacts does not in all cases reflect the magnitude of increased waste treatment costs estimated in this analysis. Facilities in several sectors are projected to experience significant cost increases but are not expected to suffer serious economic impact, because of high production rates and/or because the commodities that they produce have a high unit market price. Examples include alumina and aluminum, copper, magnesium, molybdenum, titanium, and zinc. Plants in other sectors (e.g., calcium, platinum group metals) are projected to experience low impacts because estimated incremental waste treatment costs are relatively modest.

In contrast, the sectors that are projected to experience the most significant impacts have both moderate to high incremental waste management costs and low commodity production rates, a low commodity price, or both. Prominent examples in this category include cadmium, selenium, and particularly, pyrobitumens, mineral waxes, and natural asphalt. It is worthy of note, however, that several of these commodities are co-products. That is, their principal or sole source of production is another, generally much larger mineral production operation. Consequently, while new waste management controls (and their costs) might threaten the economic viability of production of these commodities, they would generally not threaten the viability of the larger operation. This phenomenon is critically important to evaluating potential impacts on a number of sectors projected to experience significant cost/economic impacts in this analysis. Exhibit 3-14 displays the relationships between some of these sectors and their larger associated commodity production operation(s).

Ratio of Regulatory Costs to Value Added

Because value added is less than value of shipments, the ratio of regulatory costs to value added will be higher than the ratio of regulatory costs to shipments. EPA obtained data on value added for 16 mineral industry sectors. Detailed results of the value-added impact analysis are presented in Exhibits 3-15 through 3-18.

Exhibit 3-14

Relationships Among Mineral Commodity Production Operations

Affected Commodity Sector	Primary Associated Commodity
Cadmium	Zinc
Mercury	Gold
Selenium	Copper
Antimony	Lead, silver/copper
Bismuth	Lead, copper/lead
Rhenium	Molybdenum
Tellurium	Copper

Analysis of costs as a percentage of value added indicates that as with cost impacts and other economic impacts, Option 1 is the most burdensome and Option 4 is the least burdensome. For the sake of this analysis, EPA defined significant economic impacts as greater than 10 percent. For Option 1, EPA anticipates that five of the 16 industry sectors (31 percent of the sectors included in this analysis) will be significantly affected (lead, cadmium, selenium, tellurium, and zinc). Under Option 2, three of the 16 sectors (19 percent of the sectors analyzed) are expected to be significantly affected (lead, cadmium and selenium). EPA estimates that Option 3 will significantly impact the cadmium and selenium sectors (13 percent of the sectors analyzed). Finally, EPA expects Option 4 would result in no economic impacts for any of the 16 sectors examined.

Ratio of Regulatory Costs to Profits

Comparing regulatory costs to profits allows one to estimate how the costs of regulations will affect an industry's bottom line. Incremental costs that exceed a company's or industry's profits over an extended period generally will result in facility closures and exit from the industry in question. EPA obtained limited data on profits for five industry sectors.

Results of the screening level economic impact analysis using profits data are presented in Exhibits 3-19 through 3-22. None of the five industry sectors for which data were available are projected to have severe cost impacts (defined as costs that were greater than estimated industry profits) under any option. In fact, impacts exceed one percent in the expected value case only for the copper sector and only under Options 1 and 2. Even under the maximum value case, impacts exceed five percent only for the beryllium sector under Option 1. The Agency recognizes the limitations inherent in this approach, principally the likelihood that the reported gross income (before tax) for the companies comprising the five sector sample includes earnings from activities that may be unaffected by today's proposal, and therefore, may be overestimated for purposes of analyzing economic impacts.

Exhibit 3-15
Option 1 Impacts (Value Added Analysis)

Sector	Estimated Value Added	Incremental Sector Cost $ Minimum	Incremental Sector Cost $ Expected	Incremental Sector Cost $ Maximum	Economic Impact (Percent of Value Added) Minimum	Economic Impact (Percent of Value Added) Expected	Economic Impact (Percent of Value Added) Maximum
Alumina and Aluminum	1,609,800,000	1,400,000	2,400,000	2,900,000	0.1%	0.1%	0.2%
Antimony	3,381,146	-	55,000	81,000	0.0%	1.6%	2.4%
Beryllium	5,970,650	-	40,000	800,000	0.0%	0.7%	13.4%
Bismuth	916,462	-	39,000	72,000	0.0%	4.3%	7.9%
Cadmium	110,916	-	63,000	2,500,000	0.0%	56.8%	2254.0%
Copper	947,900,000	10,000,000	10,000,000	10,000,000	1.1%	1.1%	1.1%
Germanium	1,128,753	-	39,000	45,000	0.0%	3.5%	4.0%
Lead	21,801,962	21,000,000	27,000,000	32,000,000	96.3%	123.8%	146.8%
Magnesium and Magnesia from Brines	49,702,916	2,800	3,100	240,000	0.0%	0.0%	0.5%
Platinum Group Metals	5,665,483	-	5,900	38,000	0.0%	0.1%	0.7%
Rhenium	638,917	-	9,500	31,000	0.0%	1.5%	4.9%
Selenium	299,386	81,000	140,000	300,000	27.1%	46.8%	100.2%
Tellurium	380,206	-	150,000	180,000	0.0%	39.5%	47.3%
Titanium and Titanium Dioxide	267,950,952	170,000	920,000	1,400,000	0.1%	0.3%	0.5%
Zinc	54,528,333	9,700,000	11,000,000	13,000,000	17.8%	20.2%	23.8%
Zirconium and Hafnium	40,453,960	-	210,000	1,200,000	0.0%	0.5%	3.0%

Exhibit 3-16
Option 2 Impacts (Value Added Analysis)

		Incremental Sector Cost $			Economic Impact (Percent of Value Added)		
Sector	**Estimated Value Added**	**Minimum**	**Expected**	**Maximum**	**Minimum**	**Expected**	**Maximum**
Alumina and Aluminum	1,609,800,000	310,000	810,000	1,500,000	0.0%	0.1%	0.1%
Antimony	3,381,146	-	24,000	38,000	0.0%	0.7%	1.1%
Beryllium	5,970,650	-	19,000	350,000	0.0%	0.3%	5.9%
Bismuth	916,462	-	10,000	22,000	0.0%	1.1%	2.4%
Cadmium	110,916	-	53,000	570,000	0.0%	47.8%	513.9%
Copper	947,900,000	10,000,000	10,000,000	10,000,000	1.1%	1.1%	1.1%
Germanium	1,128,753	-	15,000	17,000	0.0%	1.3%	1.5%
Lead	21,801,962	21,000,000	27,000,000	32,000,000	96.3%	123.8%	146.8%
Magnesium and Magnesia from Brines	49,702,916	2,800	3,900	49,000	0.0%	0.0%	0.1%
Platinum Group Metals	5,665,483	-	4,600	11,000	0.0%	0.1%	0.2%
Rhenium	638,917	-	9,500	31,000	0.0%	1.5%	4.9%
Selenium	299,386	81,000	100,000	160,000	27.1%	33.4%	53.4%
Tellurium	380,206	-	12,000	40,000	0.0%	3.2%	10.5%
Titanium and Titanium Dioxide	267,950,952	76,000	240,000	380,000	0.0%	0.1%	0.1%
Zinc	54,528,333	1,500,000	2,400,000	2,700,000	2.8%	4.4%	5.0%
Zirconium and Hafnium	40,453,960	-	100,000	320,000	0.0%	0.2%	0.8%

Exhibit 3-17
Option 3 Impacts (Value Added Analysis)

		Incremental Sector Cost $			Economic Impact (Percent of Value Added)		
Sector	**Estimated Value Added**	**Minimum**	**Expected**	**Maximum**	**Minimum**	**Expected**	**Maximum**
Alumina and Aluminum	1,609,800,000	310,000	810,000	1,500,000	0.0%	0.1%	0.1%
Antimony	3,381,146	-	24,000	38,000	0.0%	0.7%	1.1%
Beryllium	5,970,650	-	19,000	350,000	0.0%	0.3%	5.9%
Bismuth	916,462	-	10,000	22,000	0.0%	1.1%	2.4%
Cadmium	110,916	-	24,000	490,000	0.0%	21.6%	441.8%
Copper	947,900,000	2,600,000	2,500,000	2,600,000	0.3%	0.3%	0.3%
Germanium	1,128,753	-	15,000	17,000	0.0%	1.3%	1.5%
Lead	21,801,962	59,000	1,100,000	2,100,000	0.3%	5.0%	9.6%
Magnesium and Magnesia from Brines	49,702,916	2,800	3,900	49,000	0.0%	0.0%	0.1%
Platinum Group Metals	5,665,483	-	4,600	11,000	0.0%	0.1%	0.2%
Rhenium	638,917	-	3,700	6,200	0.0%	0.6%	1.0%
Selenium	299,386	30,000	44,000	130,000	10.0%	14.7%	43.4%
Tellurium	380,206	-	12,000	40,000	0.0%	3.2%	10.5%
Titanium and Titanium Dioxide	267,950,952	76,000	240,000	380,000	0.0%	0.1%	0.1%
Zinc	54,528,333	1,500,000	2,400,000	2,700,000	2.8%	4.4%	5.0%
Zirconium and Hafnium	40,453,960	-	100,000	320,000	0.0%	0.2%	0.8%

Exhibit 3-18
Option 4 Impacts (Value Added Analysis)

		Incremental Sector Cost $			Economic Impact (Percent of Value Added)		
Sector	**Estimated Value Added**	**Minimum**	**Expected**	**Maximum**	**Minimum**	**Expected**	**Maximum**
Alumina and Aluminum	1,609,800,000	32,000	32,000	32,000	0.0%	0.0%	0.0%
Antimony	3,381,146	-	8,500	8,500	0.0%	0.3%	0.3%
Beryllium	5,970,650	-	2,800	2,800	0.0%	0.0%	0.0%
Bismuth	916,462	-	1,400	1,400	0.0%	0.2%	0.2%
Cadmium	110,916	-	2,800	2,800	0.0%	2.5%	2.5%
Copper	947,900,000	14,000	14,000	14,000	0.0%	0.0%	0.0%
Germanium	1,128,753	-	5,600	5,600	0.0%	0.5%	0.5%
Lead	21,801,962	5,600	5,600	5,600	0.0%	0.0%	0.0%
Magnesium and Magnesia from Brines	49,702,916	2,800	2,800	2,800	0.0%	0.0%	0.0%
Platinum Group Metals	5,665,483	-	4,200	4,200	0.0%	0.1%	0.1%
Rhenium	638,917	-	2,800	2,800	0.0%	0.4%	0.4%
Selenium	299,386	2,800	4,200	4,200	0.9%	1.4%	1.4%
Tellurium	380,206	-	2,800	2,800	0.0%	0.7%	0.7%
Titanium and Titanium Dioxide	267,950,952	2,800	9,900	9,900	0.0%	0.0%	0.0%
Zinc	54,528,333	4,200	4,200	4,200	0.0%	0.0%	0.0%
Zirconium and Hafnium	40,453,960	-	2,800	2,800	0.0%	0.0%	0.0%

Exhibit 3-19
Option 1 Impacts (Profits Analysis)

Sector	Estimated Profits $	Incremental Sector Cost $			Economic Impact (Percent of Profits)		
		Minimum	Expected	Maximum	Minimum	Expected	Maximu
Alumina and Aluminum	*720,221,231*	1,400,000	2,400,000	2,900,000	0.19	0.33	0.40
Beryllium	*14,904,254*	0	40,000	800,000	0.00	0.27	5.37
Copper	*956,454,882*	10,000,000	10,000,000	10,000,000	1.05	1.05	1.05
Platinum Group Metals	*8,229,711*	-	5,900	38,000	0.00	0.07	0.46
Titanium and Titanium Dioxide	*1,480,901,274*	*170,000*	*920,000*	*1,400,000*	*0.01*	*0.06*	*0.09*

Exhibit 3-20
Option 2 Impacts (Profits Analysis)

Sector	Estimated Profits $	Incremental Sector Cost $			Economic Impact (Percent of Profits)		
		Minimum	Expected	Maximum	Minimum	Expected	Maximu
Alumina and Aluminum	*720,221,231*	310,000	810,000	1,500,000	0.04	0.11	0.21
Beryllium	14,904,254	0	19,000	350,000	0.00	0.13	2.35
Copper	*956,454,882*	10,000,000	10,000,000	10,000,000	1.05	1.05	1.05
Platinum Group Metals	*8,229,711*	-	4,600	11,000	0.00	0.06	0.13
Titanium and Titanium Dioxide	*1,480,901,274*	76,000	240,000	380,000	0.01	0.02	0.03

Exhibit 3-21
Option 3 Impacts (Profits Analysis)

Sector	Estimated Profits $	Sector Cost $			Economic Impact (Percent of Profits)		
		Minimum	Expected	Maximum	Minimum	Expected	Maximum
Alumina and Aluminum	*720,221,231*	310,000	810,000	1,500,000	0.04	0.11	0.21
Beryllium	14,904,254	0	19,000	350,000	0.00	0.13	2.35
Copper	*956,454,882*	2,600,000	2,500,000	2,600,000	0.27	0.26	0.27
Platinum Group Metals	*8,229,711*	-	4,600	11,000	0.00	0.06	0.13
Titanium and Titanium Dioxide	*1,480,901,274*	76,000	240,000	380,000	0.01	0.02	0.03

3.3 Regulatory Flexibility Analysis

This section describes EPA's initial assessment of the small business impacts expected to be incurred by mineral processing firms as a result of the Phase IV Land Disposal Restrictions (LDRs). Approximately 22 small businesses owning approximately 24 facilities may be affected by the rule. The first subsection describes the methodology EPA used in conducting the analysis. The second subsection presents the results of the analysis. In brief, the analysis concludes that no significant small business

Exhibit 3-22
Option 4 Impacts (Profits Analysis)

Sector	Estimated Profits $	Sector Cost $			Economic Impact (Percent of Profits)		
		Minimum	Expected	Maximum	Minimum	Expected	Maximum
Alumina and Aluminum	*720,221,231*	32,000	32,000	32,000	0.00	0.00	0.00
Beryllium	*14,904,254*	0	2,800	2,800	0.00	0.02	0.02
Copper	*956,454,882*	14,000	14,000	14,000	0.00	0.00	0.00
Platinum Group Metals	*8,229,711*	-	4,200	4,200	0.00	0.05	0.05
Titanium and Titanium Dioxide	*1,480,901,274*	2,800	9,900	9,900	0.00	0.00	0.00

impacts are anticipated as a result of the rule and, therefore, preparation of a formal Regulatory Flexibility Analysis is unnecessary.

3.3.1 Methodology

An initial assessment of small business impacts involves four major tasks: (1) defining "small entities" for the rule being analyzed, (2) determining what number constitutes a "substantial number" of these entities, (3) determining how "significant impacts" will be measured, and (4) completing a screening analysis. If the initial assessment determines that a substantial number of small entities may face significant impacts as a result of the rule being analyzed, then a formal Regulatory Flexibility Analysis may be required.

Defining "Small Entities" Affected by the Rule

The Phase IV LDRs will affect those mineral processing entities that currently (i.e., prior to the rule) generate hazardous waste. For purposes of this analysis, "small entity" refers to any such mineral processing business concern that has 750 or fewer employees including itself and all of its domestic and foreign affiliates (1000 or fewer employees for entities in the copper and aluminum sectors). This definition is consistent with the size standards established by the Small Business Administration (SBA) in 13 CFR Sections 121.103 and 121.201 on January 31, 1996. EPA does not believe that other types of small entities, such as non-profit organizations or local governments, will be affected by the application of Phase IV LDRs to mineral processing activities.

Determining What Number Constitutes a Substantial Number

This initial assessment applies a figure corresponding to 20 percent of small entities in determining whether a "substantial number" of small entities are likely to be impacted by the rule. For sensitivity analysis purposes, EPA has also applied an alternate figure corresponding to five percent of small entities.

Measuring "Significant Impacts"

To evaluate the impact that a small entity is expected to incur as a result of the rule, this analysis calculates the entity's ratio of annualized compliance costs as a percentage of sales. Entities are classified as facing potentially "significant" impacts if this ratio exceeds three percent. For sensitivity analysis purposes, EPA has also applied an alternate figure of one percent.

Conducting the Screening Analysis

The final task of the initial assessment is to conduct the screening analysis and determine whether, using the criteria established above, the rule is expected to result in significant impacts on a substantial number of small entities. The screening analysis involves four steps:

(1) Identify Facilities Generating Hazardous Mineral Processing Waste. EPA compiled a list of the facilities generating hazardous mineral processing waste based on information contained in the technical background document Identification and Description of Mineral Processing Sectors and Waste Streams, U.S. EPA Office of Solid Waste, December 1995, and on information obtained from public comments on the proposed rule. Where uncertainty existed regarding whether certain facilities currently generate hazardous mineral processing waste, EPA included the facility in this analysis to avoid understating impacts (even if doing so meant exceeding the number of facilities estimated in the cost model). Approximately 22 small businesses owning approximately 24 facilities may be affected by the rulemaking.

(2) Obtain Employee And Sales Data For The Business Concerns Owning Each Facility. Using the list of facilities developed in the preceding step, EPA researched the number of employees and total sales for each business concern owning one or more facility. (As noted earlier, a "business concern" includes not only the company owning a given facility, but all of its domestic and foreign affiliates.) EPA obtained data from a variety of public and commercial sources.

(3) Obtain Compliance Cost Data For Each Small Business Concern. For each facility owned by a small business concern, EPA applied its most current estimate for the "average" sector-specific facility cost, in the expected value case, of complying with Option 2 under the assumed baseline. In the few cases where a small business concern owns multiple facilities, EPA added the compliance costs for the individual facilities to obtain a total compliance cost for the small business owner. For example, if one company owns two facilities, the costs of these facilities are added together to determine the total compliance cost to the company.

(4) Compute Small Business Impacts. Finally, using the data obtained in the preceding steps, EPA calculated each small business concern's ratio of total annualized compliance costs as a percentage of sales. EPA then compared the ratios to the threshold value for significant impacts of three percent, and to the sensitivity threshold of one percent.

3.3.2 Results

As described above, EPA examined the potential for small business impacts by comparing, for each small business, the total annualized compliance costs as a percentage of sales and comparing the ratio to a threshold of three percent. Approximately 22 small businesses owning approximately 24 facilities may be affected by the rule. These facilities fall into the following sectors: alumina/aluminum, antimony, cadmium, coal gas, germanium, fluorspar/hydrofluoric acid, molybdenum/ferromolybdenum/ammonium molybdate, platinum group metals, pyrobitumens/mineral waxes/natural asphalts, scandium, tungsten, and/or zinc. EPA's analysis finds that the proposed rule would not result in a significant impact on a substantial number of small mineral processing entities.[24] In fact the proposed rule is unlikely to result in a significant impact on *any* small mineral processing entities, and some small business owners would incur cost savings under the option. Two possible - but unlikely - exceptions to this finding arise as a result of data limitations. Because this analysis was unable to obtain sales data for certain small businesses, the analysis could not directly estimate impacts on these companies. Nevertheless, significant impacts on these businesses are unlikely, as discussed below:

- One company processing hydrofluoric acid is expected to incur annual costs of only $17,000. Therefore, this company will not incur significant impacts unless it has sales of less than $566,667 (i.e., $17,000/0.03) or, using the alternate threshold of one percent, less than $1,700,000 (i.e., $17,000/0.01). Because higher sales can be expected for a sustained business venture conducting mineral processing,[25] EPA believes that this small business will not incur significant impacts.

- Similarly, the analysis does not address small business concerns that may own one or more of the 17 facilities in the uranium sector. The average annual cost to such facilities is $2,700. Thus, if any of the 17 facilities are owned by small business concerns, significant small business impacts would arise only for those concerns with sales of less than $90,000 (i.e., $2,700/0.03) or, using the alternate threshold of one percent, less than $270,000 (i.e., $2,700/0.01).[26] Assuming the total sales of a small business owning a uranium processing facility are at least as great as the lowest confirmed sales figure ($2,100,000) among all other small businesses in the analysis, then no impacts arise in the uranium sector under either threshold.

Even in the unlikely event that any company incurs significant impacts under the scenarios described above, the rule would not generate significant impacts on a *substantial number* of small businesses unless 20 percent or more of small mineral processing firms (five percent or more under the alternative threshold for "substantial number") incur significant impacts. This corresponds to five entities (two under the alternative threshold), and seems highly unlikely.[27]

It is worth noting that actual impacts may be even less than estimated above because the facilities owned by small business concerns may incur smaller than average compliance costs. This could reasonably occur if small business concerns tend to own smaller than average facilities.

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[24] This analysis was conducted based on the average costs to facilities in a given sector under Option 2. The findings, however, also apply to the less costly options (option 3 and option 4).

[25] For example, the lowest confirmed sales figure among all other small businesses in the analysis exceeds $2 million

[26] This assumes that only one uranium processing facility is owned per small business concern.

[27] Even if this had occurred, however, it would not necessarily constitute a substantial number of entities. Such a determination might also require consideration of other factors, such as the sectors in which the entities operate and the absolute number of facilities affected.

4. BENEFITS ASSESSMENT

The potential human health and ecological benefits of the proposed LDRs for mineral processing arise from reduced releases of toxic waste constituents to the environment as a result of regulatory controls. These reductions in release translate into reduced human exposures and reduced risks to human health. This section describes the approaches that have been taken to evaluating risks to human health associated with waste disposal and with storage of recycled materials. Risks have been assessed under the modified prior treatment baseline, and reductions in risks that may be associated with the various regulatory options are also identified.

4.1 Risk and Benefits Assessments Methodologies

4.1.1 Overview of Risk and Benefits Assessment Activities

In developing this RIA, a number of efforts have been undertaken to evaluate the risks associated with mineral processing wastes disposal and storage and to assess the health benefits associated with changes in management practices under the proposed LDRs. These efforts have evolved in parallel with changes in the definitions of the baseline assumptions and with changes in the regulatory options that have occurred during the regulatory development process. Much of the work done early in the development of the rule analyzes baseline assumptions and regulatory options that are to some degree different from those currently being considered. Most significantly, the modified prior treatment baseline has only quite recently become the focus of risk assessment efforts while the initial focus of the risk and benefit assessment was the no prior treatment baseline.

In evaluating the results of these analyses, it is important to understand that all of the risk assessment activities described below employ screening methodologies, and do not provide definitive information about health risks or risk reduction benefits for actual exposed populations. The screening level methodologies are not site-specific, and they employ generic assumptions about facility characteristics, exposure pathways, receptors, and receptor behavior. Exposed populations living near actual mineral processing facilities have not been identified or enumerated, and the applicability of the various exposure pathways that are evaluated to these populations has not been verified. Cancer risks and noncancer hazards are calculated for hypothetical individuals under the generic exposure conditions. The assumptions used in the risk assessment have been derived by EPA in the course of numerous regulatory analyses under RCRA, and they are generally considered to provide conservative, but plausible estimates of individual exposures and risks.

A brief summary of the risk and benefits assessment efforts is provided below to show the relationships between the risk assessments for the various activities, baselines, and regulatory options. The major risk assessment efforts have included (in chronological order):

Risk and Benefits Assessment for the Waste Disposal Using Non-Constituent Specific DAFs

This effort involved the development of risk and risk reduction estimates for the wasted (unrecycled) portions of the mineral processing waste streams. Data regarding constituent concentrations were available for 38 waste streams, and the risk and benefits assessment were limited to those streams. The 28 streams comprised approximately 80 percent, by volume, of the total wastes generated by the mineral processing industry. The assessment was also limited only to health risks arising from groundwater exposures. Risks were estimated for the no prior treatment baseline (which was then considered to be a prudently conservative assumption, reasonable representative of current practice), and risk reductions were estimated for all three of the regulatory options that were then being considered. Since under all three options (and under all four current options), treatment to UTS levels would be required prior to disposal of any of the waste streams, the benefit calculations for all three options were the same.

In this initial analysis, groundwater exposure concentrations were calculated using dilution-attenuation factor values (DAFs) derived by EPA for use in previous regulatory analyses. The DAFs were based solely on unit characteristics, and did not take into account the geochemical properties of the waste constituents. Risks were calculated using mean constituent concentrations estimated for each waste stream, and benefits were estimated in terms of "facility-waste stream combinations," which are the estimated numbers of facilities at which given risk reduction would be achieved. Through imposition of the LDRs. *The results of this assessment are summarized in the October 1995 Draft Mineral Processing LDRs RIA.*

Waste Disposal Risk and Benefits Assessment Using Sample-Specific Concentration Estimates

Subsequent to the October 1995 RIA, EPA conducted sensitivity analyses to better evaluate potential sources of uncertainty in the risk and benefits assessment for the RIA. These analyses indicated the use of mean constituent concentration values obscured important variations in constituent concentrations within some of the waste streams, as well as variations in the risks that might be associated with the management of these streams. As a result of this finding, the risk and benefits assessment were revised, using constituent concentrations from individual waste samples, instead of mean values, to calculate risks. As in the previous effort, the benefits were calculated relative to the no prior treatment baseline. Thus, risk reduction benefits were again the same under all three options, except that one option would have excluded two spent materials streams from regulation under the no prior treatment baseline. *This analysis was presented in the December 1995 RIA.*

Waste Disposal Risk and Benefits Assessment Using Constituent-Specific DAFs

For this analysis, EPA employed DAF values that were derived specifically for waste management units from the mineral processing industry and which took into account differences in geochemical properties of the waste constituents. Except for this, this assessment was identical to that described in the previous paragraph, and evaluated benefits from changes in waste disposal relative to the no prior treatment baseline. *The methods used and results are also described in more detail in Appendix A of this RIA.*

Risk Assessment for the Storage of Recycled Streams

The latest risk assessment effort, discussed in this document, is the first which has focused on the recycled streams, and on the risks associated with storage, rather than only with the disposal of the wasted portions of the streams. In this effort, EPA has assessed health risks both for groundwater exposure, as in the previous analysis, and for non-groundwater direct and indirect exposure pathways.

Risks are assessed for 14 waste streams that EPA has identified as being recycled and for which constituent concentration data were available. These 14 streams account for 40 percent of the total mineral processing waste generation, and for about 65 percent of the recycled volume. Analogous to the methods used in the August RIA, EPA derived groundwater DAF values specifically for land-based recycling units, and specifically for each waste constituent. EPA assessed non-groundwater risks associated with the storage of recycled materials using methods generally similar to those used to derive the proposed Exit Concentrations under the Hazardous Waste Identification Rule. These methods are described in detail in Appendix H.

No quantitative benefits assessment has been performed for the stored materials. This is because, under three of the four regulatory options currently being considered, recycled materials would be stored in tanks, containers, or buildings (TCBs), and no data or satisfactory models are available which would allow the estimation of risks associated with these management units. Under Option 4, it is again assumed that recycled materials would be stored in land-based units, and no health benefits from improved storage would be realized relative to the baseline.

Thus, for recycled materials management, EPA has estimated only baseline risks. These risks represent upper-bound estimates of the achievable health benefits if releases to the environment are completely abolished under the regulatory options under the modified prior treatment baseline. The degree of potential risk reduction associated with the various options differs only in that recycling of secondary materials through Bevill units would not be allowed under Options 1 and 2.

In the discussion that follows, the primary focus will be an risks relative to the modified prior treatment baseline, but the risk and benefits assessment for waste disposal, relative to no prior treatment is also discussed, as it provides information useful in the estimation of disposal risks and risk reductions under the modified prior treatment baseline.

4.1.2 Risk and Benefits Assessment Methods for Nonrecycled Materials

As noted in the previous section, all of the quantitative risk and benefits assessment work performed by EPA for the non-recycled portion of the mineral processing waste streams has focused on the management of these wastes under the no prior treatment baseline. Thus, the baseline risks have been assessed for final disposal of untreated materials in unlined units, and regulatory benefits have been evaluated in terms of the risk reduction achievable by initial treatment of all streams to UTS levels prior to disposal.

Under the modified prior treatment baseline, however, which EPA has recently identified as being most representative of current practice, it is assumed that all wastes would be stabilized to comply with TC regulatory levels prior to disposal, even in the absence of LDRs. Thus, potential baseline risks would be lower than when no prior treatment is assume. Also, the regulatory benefits, which under this baseline would represent the difference between waste treatment to TC levels and waste treated to UTS levels, would be considerably lower than the benefits estimated relative to the no prior treatment baseline.

EPA has not quantitatively evaluated the risks associated with the disposal of waste at the TC levels, and thus has not developed quantitative estimates of benefits associated with changes in waste disposal practices in relation to the modified prior treatment baseline. The baseline health risks and risk reduction benefits calculated for the alternative baselines (no prior treatment, prior treatment) are discussed in detail in Appendix A.2. However, as will be discussed in Section 4.2.1, these estimates provide a useful basis for evaluating the modified prior treatment baseline.

4.1.3 Risk and Benefits Assessment Methods for the Storage of Recycled Materials

As discussed in Section 4.1.1, a quantitative risk assessment has been performed for the storage of recycled materials under the modified prior treatment baseline. Under this baseline, (as under the no prior treatment baseline), all recycled streams are assumed to be stored in unlined land storage units prior to recycling. Streams were included in the analysis if EPA identified them as having non-zero recycled volumes under the "expected" cost scenario. Waste streams were also eliminated from the risk assessment if the estimated annual recycled volume was so low (less than 500 tons per year) that storage in land units would not be cost-effective. Based on these criteria, 14 streams were included in the risk assessment for stored materials, as shown in Exhibit 4-1.

Exhibit 4-1

Recycled Streams Included in the Storage Risk Analysis

Commodity	**Recycled Stream**
Aluminum and Alumina	Cast House Dust
Beryllium	Chip Treatment Wastewater
Copper	Acid Plant Blowdown
Elemental Phosphorus	AFM Rinsate
Elemental Phosphorus	Furnace Scrubber Blowdown
Rare Earths	Process Wastewater
Selenium	Plant Process Wastewater
Tantalum, Columbium, and Ferrocolumbium	Process Wastewater
Titanium and Titanium Oxide	Leach Liquor and Sponge Wastewater
Titanium and Titanium Oxide	Scrap Milling Scrubber Water
Zinc	Waste Ferrosilicon
Zinc	Spent Surface Impoundment Liquids
Zinc	Waste Water Treatment Plant Liquid Effluent
Zinc	Process Wastewater

All but two of these streams are wastewaters (WW) or liquid nonwastewaters (LNWW), for which the least-cost management unit is a surface impoundment. The remaining two streams (aluminum cast house dust and zinc waste ferrosilicon) are nonwastewaters (NWW), for which the least-cost management unit is a waste pile.

Constituent concentration data were available from a total of 187 samples from the recycled materials, only three of which are of the two NWW streams, with the remainder representing WW and LNWW streams. Among these, 145 were bulk analytical results, and 42 were EP extraction analysis. Of the available samples, 135 had concentration data for constituents having toxicity criteria values that could be used in quantitative risk assessment. Again, three of the samples were from NWW streams. The data used to derive DAFs are summarized in Appendix J.

Although storage risks were calculated for only 14 of the 118 total mineral processing waste streams, these streams represent substantial proportions of the total generated wastes and an even higher proportion of the recycled wastes. Depending on which estimate of waste generation is used (minimum, expected, or maximum), the 14 recycled streams included in the risk analysis represent between 32 and 42 percent of the total waste generation, and account for between 57 and 68 percent of the total recycled volume. This is because constituent concentration data are available for a substantial proportion of the high-volume waste streams. The extent of coverage of the storage risk assessment for the various commodity sectors is discussed in Appendix H.

To estimate groundwater exposure concentrations, bulk concentrations or adjusted EP constituent concentrations from each waste sample were divided by central tendency (CT) and high-end (HE) DAF values. The DAF values were derived specifically for the size and configuration of units (waste piles and surface impoundments) estimated in the cost and economic analysis as being necessary to contain recycled materials at representative size facilities in each commodity sector. DAF derivations were performed employing regionally representative ground-water transport parameters and climatological data for those facilities where these data were not available, or whose location was not known.

In evaluating risks, the 75th percentile constituent-specific DAFs were used to estimate central tendency (CT) groundwater concentrations. The rationale for using the 75th percentile DAFs rather than, for example, the 50th percentile value was that the EPACMTP model used to derive DAFs does not consider fractured or channeled flow or other facilitated transport mechanisms which may occur at some sites, resulting in higher groundwater concentrations than those predicted for homogeneous flow processes modeled by EPACMTP. The 95th percentile constituent-specific DAF values were used to estimate high-end (HE) groundwater concentrations, in keeping with the definition of a high-end receptor as someone exposed at levels between the 90th and 99th percentiles of all exposed individuals.

Risks for groundwater exposures were calculated assuming groundwater would be used as a drinking water supply by residents living near the management units for substantial proportions of their lives. Cancer risks were calculated for exposures to inorganic arsenic[28] using the Cancer Slope Factor (CSF) value from EPA's IRIS data base. For all other constituents, noncancer hazard quotients were calculated using EPA's ingestion pathway Reference Doses (RfDs). The DAF values derived for mineral processing storage units, along with the exposure factor values and equations used to estimate groundwater pathway risks, are provided in Appendix H.1.

Non-groundwater pathway risks for land storage of recycled materials were estimated using a variety of models, most of which generally follow the methods described in EPA's Technical Support Document for the proposed "HWIR-Waste" exit level derivation.[29] Exhibit 4-2 identifies the non-groundwater release events and exposure pathways for which risks were evaluated, and provides brief descriptions of the methods used to estimate exposures and risks. The release events that were evaluated for waste piles include air particulate generation by wind disturbance and materials handling, and surface

[28] Consistent with previous risk assessment efforts for mineral processing wastes, EPA chose not to model the potential ingestion pathway cancer risks associated with exposure to beryllium because, although beryllium has an approved Cancer Slope Factor in the IRIS data base, the value is currently under review, and there is a substantial degree of uncertainty surrounding the activity of beryllium as an ingestion pathway carcinogen.

[29] U.S. EPA, *Technical Support Document for the Hazardous Waste Identification Rule: Risk Assessment for Human and Ecological Receptors,* Office of Solid Waste, August 1995.

EXHIBIT 4-2. RELEASE AND EXPOSURE PATHWAY MODELING SUMMARY FOR MINERAL PROCESSING STORAGE RISK ASSESSMENT

UNIT TYPE	RELEASE EVENT/ MEDIUM	TRANSPORT MEDIUM I	TRANSPORT MEDIUM II	TRANSPORT MEDIUM III	EXPOSURE PATHWAY	RECEPTORS	MODELING APPROACHES
Waste Pile	Particulate Generation by Wind, Materials Handling	Air	--	--	Inhalation	Adult Resident	SCREEN3 (Emissions) ISCST3 (Deposition) HWIR (Exposure/Risk)
		Air	Soil (deposition)	--	Ingestion	Child/Adult Resident	HWIR-Waste (Exposure/Risk)
					Dermal	Child Resident	HWIR-Waste
		Air	Soil (deposition)	Crops	Ingestion	Subsistence Farmer	HWIR-Waste, modified for non-steady-state conditions (concentration in crops, vegetable intake, risk)
		Air	Soil/Water	Surface Water/Fish	Ingestion	Subsistence Fisher	Bounding analysis (100 percent deposition in water body)
Waste Pile	Runoff	Soil	--	--	Ingestion	Child Resident	Bounding analysis; 100 percent runoff to adjacent garden/yard, HWIR-Waste (exposure and risk)
		Soil	--	--	Dermal	Child Resident	Bounding analysis; 100 percent runoff to adjacent garden/yard, HWIR-Waste (exposure and risk)
		Soil	Crops	--	Ingestion	Subsistence Farmer	Bounding Analysis; HWIR-Waste
		Soil	--	Surface Water/Fish	Ingestion	Subsistence Fisher	Bounding analysis (100 percent deposition in water body)
Surface Impoundment	Control/Berm Failure	Surface Water	--	--	Ingestion	Adult Resident	HWIR-Waste (Release algorithms, exposure, drinking water ingestion)
		Surface Water	Fish	--	Ingestion	Subsistence Fisher	HWIR-Waste (Releases, dilution, fish ingestion, risk)

run-off caused by rainfall. For surface impoundments, releases due to run-on and inlet/outlet control failure events were evaluated. Owing to the nature of the constituents being evaluated (all inorganics), volatilization release events were not considered.

The transport and exposure media which were evaluated included air, soils, home-grown vegetables, surface water, and game fish. Exposure pathways and exposure factor values were generally consistent with the child/adult resident, subsistence farmer, and subsistence fisher receptors used in the HWIR Waste exit level determination. Cancer risks and noncancer hazard quotients were calculated for all pathways using standard pathway models and ingestion and inhalation pathway toxicological parameters from IRIS. The methods used to estimate exposures and to evaluate risks from the storage of recycled materials through non-groundwater pathways are described in detail in Appendix H.2.

4.2 Risk and Benefits Assessment Results

4.2.1 Risks and Benefits Associated With the Disposal of Mineral Processing Wastes

As noted previously, the estimated benefits associated with the proposed LDRs under the no prior treatment baseline are substantial, in terms of the numbers of facility-waste stream combinations that move from high-risk categories under baseline assumptions to lower risk categories under that requirement wastes be treated to UTS levels prior to disposal. These benefits, which would be realized under all four regulatory options, are summarized in Exhibits 4-3 and 4-4, and are discussed in detail in Appendix A.2. It can be seen from these exhibits that there are substantial numbers of waste stream-facility combinations for which estimated individual cancer risks through groundwater exposures exceed 10^{-5} and for which the estimated noncancer hazard quotient values exceed 1.0 under the no prior treatment baseline. This is true both under central tendency (CT) and high-end (HE) exposure assumptions. In contrast, post-LDR (where treatment to UTS levels would be required for all wastes), there are no waste stream-facility combinations for which these risk or hazard quotient levels are exceeded under either CT or HE assumptions.

Under the modified prior treatment baseline (and under the prior treatment baseline), the baseline risks and risk reduction associated with the first three regulatory options would be considerably lower than those derived assuming no treatment. This is because treatment to the TC regulatory levels prior to disposal, as assumed for modified prior treatment, in and of itself is sufficient to reduce the risks for most of the risk-driving constituents to below levels of concern for groundwater ingestion. In addition, the TC regulatory level and the UTS leachate level for arsenic, the sole ingestion pathway carcinogen among the constituents and a frequent risk driver, are the same. Thus, going from treatment to TC levels under modified prior treatment to UTS levels under the regulatory Options 1 through 4, will yield few benefits, in terms of reduced groundwater risks.

This is illustrated in Exhibit 4-3 where, post-LDR, cancer risks for all waste stream-facility combinations (which are all due to arsenic exposures) are below 10^{-5}. Thus, there are no baseline cancer risks above levels of concern under the modified prior treatment baseline even without LDRs. This, along with the equality of the TC and UTS treatment levels, means that no reduction in cancer risks would occur through the LDRs under the assumptions used to define the modified prior treatment baseline and the regulatory options.

EXHIBIT 4-3 RISK AND BENEFITS SUMMARY FOR MINERAL PROCESSING WASTE DISPOSAL

Distribution of Waste Stream-Facility Combinations by Groundwater Risk Category: Cancer Risks

Commodity	Waste Stream	Number of Waste Stream-Facility Combinations* #		Central Tendency												High End											
				Pre-LDR						Post-LDR						Pre-LDR						Post-LDR					
		Central Tendency	High End	<10-5	10-5 to 10-4	10-4 to 10-3	10-3 to 10-2	10-2 to 10-1	>10-1	<10-5	10-5 to 10-4	10-4 to 10-3	10-3 to 10-2	10-2 to 10-1	>10-1	<10-5	10-5 to 10-4	10-4 to 10-3	10-3 to 10-2	10-2 to 10-1	>10-1	<10-5	10-5 to 10-4	10-4 to 10-3	10-3 to 10-2	10-2 to 10-1	>10-1
Al and Alumina	Cast house dust	23	23	23	0	0	0	0	0	23	0	0	0	0	0	23	0	0	0	0	0	23	0	0	0	0	0
Sb	Autoclave filtrate	4	7	0	0	0	2	2	0	4	0	0	0	0	0	0	0	0	0	4	4	7	0	0	0	0	0
Be	Spent barren filtrate streams	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0
Be	Chip treatment WW	1	2	1	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
Cu	Acid plant blowdown	7	7	2	0	2	1	0	1	7	0	0	0	0	0	0	1	0	2	1	1	7	0	0	0	0	0
Cu	Scrubber blowdown	10	10	3	0	7	0	0	0	10	0	0	0	0	0	0	3	0	7	0	0	10	0	0	0	0	0
Elemental Phosphorus	AFM rinsate	2	2	1	1	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0
Elemental Phosphorus	Furnace offgas solids	2	2	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
Elemental Phosphorus	Furnace scrubber blowdown	2	2	1	1	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0
Elemental Phosphorus	Slag quenchwater	2	2	0	2	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0
Ge	Waste acid wash/rinse water	2	4	2	0	0	0	0	0	2	0	0	0	0	0	0	4	0	0	0	0	4	0	0	0	0	0
Ge	Chlorinator wet air poll. ctrl. sludge	2	4	2	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0
Ge	Hydrolysis filtrate	2	4	2	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0
Ge	Waste still liquor	2	4	2	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0
Mg and Magnesia (brine)	Smut	2	2	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
Mo, FeMo, Amm. Mo	Liquid residues	1	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0
Rare Earths	Spent ammon. nitrate proc. sol.	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Rare Earths	PWW	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Se	Plant PWW	2	2	0	2	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0
Ta, Columbium, and FeCol.	PWW	2	2	1	0	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	2	0	0	0	0	0
Titanium and TiO2	Pickle liquor & wash water	2	3	1	1	0	0	0	0	2	0	0	0	0	0	0	2	2	0	0	0	3	0	0	0	0	0
Titanium and TiO2	Leach liquor & sponge wash water	1	2	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0
Titanium and TiO2	Scrap milling scrubber water	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Titanium and TiO2	Spent s.i. liquids	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium and TiO2	Spent s.i. solids	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium and TiO2	Waste acids (Sulfate process)	1	2	0	1	0	0	0	0	1	0	0	0	0	0	1	0	2	0	0	0	2	0	0	0	0	0
Titanium and TiO2	WWTP sludge/solids	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W	Spent acid & rinse water	3	6	2	0	2	0	0	0	3	0	0	0	0	0	0	3	0	3	0	0	6	0	0	0	0	0
Zn	Waste ferrosilicon	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	Spent s.i. liquids	3	3	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0
Zn	WWTP solids	3	3	3	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0
Zn	Spent synthetic gypsum	3	3	3	0	0	0	0	0	3	0	0	0	0	0	2	0	2	0	0	0	3	0	0	0	0	0
Zn	WWTP liquid effluent	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	Zinc lean slag	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
TOTALS*		108	133	56	11	11	8	2	1	89	0	0	0	0	0	46	20	14	13	10	5	108	0	0	0	0	0

* Sums by risk category may not add to the number of central or high-end waste stream/facility combinations due to rounding.

EXHIBIT 4-4 RISK AND BENEFITS SUMMARY FOR MINERAL PROCESSING WASTE DISPOSAL

Distribution of Waste Stream-Facility Combinations by Groundwater Hazard Category: Non-Cancer Hazards

Commodity	Waste Stream	Number of Waste Stream-Facility Combinations*		Central Tendency												High End											
				Pre-LDR						Post-LDR						Pre-LDR						Post-LDR					
		Central Tendency	High End	<1	1 to 10	10 to 100	100 to 1k	1k to 10k	>10k	<1	1 to 10	10 to 100	100 to 1k	1k to 10k	>10k	<1	1 to 10	10 to 100	100 to 1k	1k to 10k	>10k	<1	1 to 10	10 to 100	100 to 1k	1k to 10k	>10k
Al and Alumina	Cast house dust	23	23	23	0	0	0	0	0	23	0	0	0	0	0	23	0	0	0	0	0	23	0	0	0	0	0
Sb	Autoclave filtrate	4	7	0	0	0	3	1	0	4	0	0	0	0	0	0	0	0	2	2	2	7	0	0	0	0	0
Be	Spent barren filtrate streams	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Be	Chip treatment WW	1	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
Cu	Acid plant blowdown	7	7	1	2	2	1	1	0	7	0	0	0	0	0	0	1	1	2	1	1	7	0	0	0	0	0
Cu	Scrubber blowdown	10	10	0	3	7	0	0	0	10	0	0	0	0	0	0	0	0	10	0	0	10	0	0	0	0	0
Elemental Phosphorus	AFM rinsate	2	2	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0
Elemental Phosphorus	Furnace offgas solids	2	2	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
Elemental Phosphorus	Furnace scrubber blowdown	2	2	1	1	0	0	0	0	2	0	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0
Elemental Phosphorus	Slag quenchwater	2	2	2	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0
Ge	Waste acid wash/rinse water	2	4	2	0	0	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0
Ge	Chlorinator wet air poll. ctrl. sludge	2	4	2	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0
Ge	Hydrolysis filtrate	2	4	2	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0
Ge	Waste still liquor	2	4	2	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0
Mg and Magnesia (brine)	Smut	2	2	2	0	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	2	0	0	0	0	0
Mo, FeMo, Amm. Mo	Liquid residues	1	2	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0
Rare Earths	Spent ammon. nitrate proc. sol.	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Rare Earths	PWW	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Se	Plant PWW	2	2	1	1	0	0	0	0	2	0	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0
Ta, Columbium, and FeCol.	PWW	2	2	1	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
Titanium and TiO2	Pickle liquor & wash water	2	3	0	2	0	0	0	0	2	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0
Titanium and TiO2	Leach liquor & sponge wash water	1	2	0	1	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0
Titanium and TiO2	Scrap milling scrubber water	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Titanium and TiO2	Spent s.i. liquids	4	7	4	0	0	0	0	0	4	0	0	0	0	0	7	0	0	0	0	0	7	0	0	0	0	0
Titanium and TiO2	Spent s.i. solids	4	7	4	0	0	0	0	0	4	0	0	0	0	0	5	2	0	0	0	0	7	0	0	0	0	0
Titanium and TiO2	Waste acids (Sulfate process)	1	2	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0
Titanium and TiO2	WWTP sludge/solids	7	7	7	0	0	0	0	0	7	0	0	0	0	0	4	4	0	0	0	0	7	0	0	0	0	0
W	Spent acid & rinse water	3	6	2	1	0	0	0	0	3	0	0	0	0	0	3	2	0	2	0	0	6	0	0	0	0	0
Zn	Waste ferrosilicon	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Zn	Spent s.i. liquids	3	3	0	1	1	0	1	0	3	0	0	0	0	0	0	1	0	1	0	1	3	0	0	0	0	0
Zn	WWTP solids	3	3	3	0	0	0	0	0	3	0	0	0	0	0	1	1	1	0	0	0	3	0	0	0	0	0
Zn	Spent synthetic gypsum	3	3	3	0	0	0	0	0	3	0	0	0	0	0	2	2	0	0	0	0	3	0	0	0	0	0
Zn	WWTP liquid effluent	3	3	0	1	1	0	0	1	3	0	0	0	0	0	0	0	2	0	0	1	3	0	0	0	0	0
Zn	Zinc lean slag	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
TOTALS*		108	133	68	16	14	4	4	1	108	0	0	0	0	0	63	15	19	24	4	8	133	0	0	0	0	0

* Sums by hazard category may not add to the number of central or high-end waste stream/facility combinations due to rounding.

In the case of noncarcinogenic constituents, the situation is very similar. Again (see Exhibit 4-4), treatment of all of the waste streams to UTS levels prior to disposal (post-LDR) results in all waste stream-facility combinations having noncancer hazard quotients less than 1.0. Unlike the case for arsenic, however, the UTS concentrations for many of the constituents are lower than the TC concentrations. Even in these cases, however, screening calculations indicate that, with one possible exception, treatment to the TC level, as required under the modified prior treatment baseline, would results in hazard quotient values less than 1.0 for all of the waste samples. The basis for this argument is shown in Exhibit 4-5.

It can be seen from this exhibit that the estimated exposure concentrations in groundwater, calculated using HE constituent-specific DAF values for surface impoundments[30], are all below levels corresponding to noncancer hazard quotient values of 1.0, with the exception of barium, for which the exposure concentration corresponding to the TC leachate regulatory level just exceeds the health-based level. Barium is rarely a risk-driving constituent in the waste disposal risk assessment, and review of the data base of constituent concentrations indicates that no EP leachate sample from any waste stream has a barium concentration exceeding the TC level, even prior to treatment, and most of the EP extraction analytical results are many orders of magnitude below the TC level. Further, only five bulk samples from any of the waste streams have barium concentrations exceeding 100 mg/kg, and four of these samples are from nonwastewater streams that would be managed in waste piles rather than in surface impoundments. The HE DAF for barium release from waste piles is many orders of magnitude lower than the value for surface impoundments, and thus the calculated groundwater exposure concentrations would also be much lower for these samples.

The findings presented above provide a high degree of assurance that the groundwater pathway risks associated with the presence of TC analytes in the disposed mineral processing wastes would pose low risks under the modified prior treatment baseline. Consequently, the health benefits of the regulatory options relative to this baseline from reduced groundwater exposures would be minimal for most constituents, and would be zero for arsenic, for which the TC and the UTS levels are the same.

Exhibit 4-5

Groundwater Concentrations Resulting from Releases of Noncarcinogenic Constituents at TC Concentrations Compared to Health-Based Levels

Constituent	Health-Based Level (Groundwater Concentration corresponding to HQ = 1) (mg/l)	TC Regulatory Level (mg/l)	HE Groundwater Concentration Corresponding to Release at TC Regulatory Level (mg/l) 2
Barium	2.5	100	6.8
Cadmium	0.035	1	0.00031
Chromium (VI)	0.18	5	0.031
Lead	0.015[1]	5	$6X10^{-9}$
Mercury	0.011	0.025	$6X10^{-6}$
Selenium	0.18	1	0.0023
Silver	0.18	5	0.010

[1] The HBL for lead is the Safe Drinking Water Act MCL.
[2] Calculates using the constituent-specific HE DAF value for surface impoundments

[30] This is the lowest DAF value used in the analysis, and gives the highest risks.

A similar blanket statement cannot be made for the other constituents (antimony, beryllium, cyanide, nickel, thallium, vanadium, and zinc) for which TC regulatory levels have not been set, but which have UTS levels. In these cases, the benefits associated with going from the modified prior treatment baseline to regulatory options 1-4 could be higher. In the extreme case, (where treatment to reduce the mobility of the TC analytes does not reduce the mobility of the other UTS constituents), the baseline risks and regulatory benefits could be almost as high as those shown in Exhibit 4-4. It is likely, however, that under the modified prior treatment baseline, treatment to reduce leaching of the TC analytes would also reduce the mobility of the other UTS analytes to a substantial degree. Thus, the baseline groundwater pathway risks, and the risk reduction benefits under this baseline are likely to be much lower than those indicated in Exhibit 4-4.

Finally, the risk assessment for mineral processing waste disposal has not addressed non-groundwater pathway risks. It is not known to what extent these risks would be reduced by LDRs compared to the modified prior treatment baseline.

4.2.2 Risk Assessment Results for Recycled Materials Storage: Groundwater Pathway

Exhibit 4-6 summarizes the carcinogenic groundwater risk results for the 75 samples identified as containing arsenic, the sole ingestion pathway carcinogen among the waste constituents. Using the CT DAF values, the calculated cancer risks for 49 of these samples were less than 10^{-5}, the level of regulatory concern, and the risks for 26 of the samples exceeded this value. Cancer risks exceeded 10^{-5} for one or more samples from only four waste streams; copper acid plant blowdown, elemental phosphorus furnace scrubber blowdown, tantalum, columbium, and ferrocolumbium process wastewater, and zinc spent surface impoundment liquids. The highest cancer risks were associated with three samples of copper acid plant blowdown (10^{-3} to 10^{-2}). This waste stream accounted for 14 of the 16 samples with the highest CT cancer risks. The next highest risks (in the 10^{-4} to 10^{-3} range) were associated with one sample each from tantalum process wastewater and zinc spent surface impoundment liquids.

Using the high-end (HE) DAF values, cancer risks calculated for the groundwater pathway exceeded 10^{-5} for 50 of the 75 samples. Under this set of assumptions, risks for at least one sample exceeded 10^{-5} for 10 of the 14 waste streams evaluated. The highest risks (25 of 30 samples > 10^{-5}, highest risk category >10^{-1}) were again associated with copper acid plant blowdown, with the next highest risk (10^{-2} to 10^{-1}) being associated with the single sample of zinc spent surface impoundment liquids. Of the wastes whose CT cancer risks were below 10^{-5} for all samples, six (elemental phosphorus AFM rinsate, rare earths process wastewater, selenium plant wastewater, titanium/TiO_2 leach liquor and sponge wash water and scrap milling scrubber water, and zinc process wastewaters), had at least one sample with HE cancer risks above this level.

Cancer risks for most of the samples increased about two orders of magnitude from the CT to HE case. This is consistent with the difference between the CT and HE DAF values for arsenic managed in surface impoundments. In the case of the NWW waste streams managed in piles, both the CT and HE cancer risks for all samples were below 10^{-5}. For aluminum/alumina cast house dust, this reflected the much higher CT and HE DAF values for arsenic managed in waste piles, compared to surface impoundments. Arsenic was not detected in the single sample of waste ferrosilicon from zinc production. Thus, no carcinogenic risks were calculated for this waste. The two other streams for which all HE sample-specific cancer risks were below 10^{-5} were beryllium chip treatment wastewater and zinc wastewater treatment plant liquid effluent.

EXHIBIT 4-6 RISK SUMMARY FOR STORAGE OF RECYCLED MATERIALS
Distribution of Samples by Groundwater Risk Category: Cancer Risks

Commodity	Waste Stream	Number of Samples with Cancer Risk	Central Tendency						High End					
			<10-5	10-5 to 10-4	10-4 to 10-3	10-3 to 10-2	10-2 to 10-1	>10-1	<10-5	10-5 to 10-4	10-4 to 10-3	10-3 to 10-2	10-2 to 10-1	>10-1
Aluminum, Alumina	Cast house dust	2	2	0	0	0	0	0	2	0	0	0	0	0
Beryllium	Chip treatment WW	1	1	0	0	0	0	0	1	0	0	0	0	0
Copper	Acid plant blowdown	30	9	7	8	3	3	0	5	3	5	8	5	4
Elemental Phosphorus	AFM rinsate	2	2	0	0	0	0	0	0	1	1	0	0	0
Elemental Phosphorus	Furnace scrubber blowdown	8	7	1	0	0	0	0	3	3	2	0	0	0
Rare Earths	PWW	2	2	0	0	0	0	0	0	2	0	0	0	0
Selenium	Plant PWW	2	2	0	0	0	0	0	0	1	1	0	0	0
Tantalum, etc. [1]	PWW	13	10	2	1	0	0	0	7	3	0	3	0	0
Titanium and TiO2	Leach liquor & sponge wash water	2	2	0	0	0	0	0	0	1	1	0	0	0
Titanium and TiO2	Scrap milling scrubber water	1	1	0	0	0	0	0	0	1	0	0	0	0
Zinc	Waste ferrosilicon	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc	Spent s.i. liquids	1	0	0	1	0	0	0	0	0	0	0	1	0
Zinc	WWTP liquid effluent	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc	Process wastewater	11	11	0	0	0	0	0	7	1	3	0	0	0
Total		75	49	10	10	3	3	0	25	16	13	11	6	4

1. Tantalum, Columbium, and Ferrocolumbium

Noncancer hazard quotient values for the groundwater pathway for the individual samples of recycled materials are summarized in Exhibit 4-7. Using the CT DAF values, hazard quotients exceeding 1.0 were calculated for 43 of 135 total samples from the 14 waste streams. As was the case for cancer risks, copper acid plant blowdown had the highest number of samples with noncancer hazard quotients above 1.0 (18 of 35 samples), and had the highest number of samples (4) in the highest-risk category (HQ = 100 to 1000). Samples from zinc production (11 of 22 for spent surface impoundment liquids and 8 of 16 for process wastewater) account for the bulk of the remaining hazard quotients above 1.0. The only other waste streams with CT hazard quotients above 1.0 included beryllium chip treatment wastewater (one sample), elemental phosphorus furnace scrubber blowdown (one sample), tantalum, process waste water (three samples), and zinc wastewater treatment plant liquid effluent (one sample).

When the HE DAF values are used to calculate exposures, hazard quotients exceed 1.0 for 100 of the 135 samples. As was the case for cancer risks, most of the hazard quotient values for individual samples are increased one to two orders of magnitude in the HE case compared to the CT case, reflecting the higher HE DAF values for the risk-driving constituents managed in surface impoundments. As for cancer risks, both the CT and HE DAF values for waste piles for all of the constituents are so high that no samples of either of the two streams stored in waste piles have hazard quotients exceeding 1.0 in either the CT or HE case. Hazard quotient values for one or more samples from five waste streams (elemental phosphorus AFM rinsate, rare earths process wastewater, selenium process wastewater, and titanium/TiO2 leach liquor and sponge wash water and scrap milling scrubber sludge) which were all below 1.0 in the CT case exceeded 1.0 in the HE case.

4.2.3 Potential Benefits From Control of Stored Materials: Groundwater Pathway

The cancer risk results for the individual samples, distributed across the numbers of facilities generating and storing the wastes, are summarized in Exhibit 4-8. Using the methods described in Section 1.1.2, EPA has estimated that CT groundwater pathway cancer risks would exceed 10^{-5} at approximately 10 of the 57 facility-waste stream facilities.[31] All of these facility-waste stream combinations were managing either copper acid plant blowdown (7 facility-waste stream combinations) or zinc spent surface impoundment liquids (3 combinations). These results, of course generally reflect the pattern of sample-specific risk results for the various commodity sectors. It should be noted, however, that for two waste streams, findings of one or more sample with greater than 10^{-5} risks did not translate into any facility-waste combinations above 10^{-5} risks. In the case of elemental phosphorus furnace scrubber blowdown, only one of seven samples had a cancer risk of just above 10^{-5}. Distributed across only two facilities estimated to be storing this waste, this result (one-seventh of the samples having risks above 10^{-5}) was rounded down to zero. Similarly, in the case of tantalum process wastewater, three of thirteen samples with risks above 10^{-5} were again rounded downward to zero of two facility-waste stream combinations. This occurrence is the almost inevitable result of having so few facilities in some of the commodity sectors, and the fact that non-integral numbers of waste-stream facility combinations are meaningless as risk or benefit indicators. It would be reasonable to interpret these results as indicating that either zero or one facility in these industries might have a CT cancer risk above 10^{-5}.

[31] Note that the totals in the risk categories do not sum exactly due to rounding. This is true for the following exhibit as well.

EXHIBIT 4-7 RISK SUMMARY FOR STORAGE OF RECYCLED MATERIALS
Distribution of Samples by Groundwater Hazard Category: Non-Cancer Hazards

Commodity	Waste Stream	Number of Samples with Non-cancer Hazard	Central Tendency						High End					
			<1	1 to 10	10 to 100	100 to 1k	1k to 10k	>10k	<1	1 to 10	10 to 100	100 to 1k	1k to 10k	>10k
Aluminum, Alumina	Cast house dust	2	2	0	0	0	0	0	2	0	0	0	0	0
Beryllium	Chip treatment WW	1	0	0	1	0	0	0	0	0	0	0	1	0
Copper	Acid plant blowdown	35	17	10	4	4	0	0	3	7	12	7	4	2
Elemental Phosphorus	AFM rinsate	2	2	0	0	0	0	0	0	0	2	0	0	0
Elemental Phosphorus	Furnace scrubber blowdown	14	13	1	0	0	0	0	4	4	5	1	0	0
Rare Earths	PWW	4	4	0	0	0	0	0	2	2	0	0	0	0
Selenium	Plant PWW	2	2	0	0	0	0	0	0	2	0	0	0	0
Tantalum, etc. [1]	PWW	21	18	3	0	0	0	0	13	3	0	5	0	0
Titanium and TiO2	Leach liquor & sponge wash water	2	2	0	0	0	0	0	0	1	1	0	0	0
Titanium and TiO2	Scrap milling scrubber water	1	1	0	0	0	0	0	0	1	0	0	0	0
Zinc	Waste ferrosilicon	1	1	0	0	0	0	0	1	0	0	0	0	0
Zinc	Spent s.i. liquids	22	11	5	4	2	0	0	4	3	2	7	2	4
Zinc	WWTP liquid effluent	3	2	0	0	1	0	0	0	1	1	0	0	1
Zinc	Process wastewater	24	16	7	1	0	0	0	5	4	5	8	2	0
Totals		134	91	26	10	7	0	0	34	28	28	28	9	7

1. Tantalum, Columbium, and Ferrocolumbium

EXHIBIT 4-8 RISK SUMMARY FOR STORAGE OF RECYCLED MATERIALS
Distribution of Waste Stream/Facility Combinations by Groundwater Risk Category: Cancer Risks

Commodity	Waste Stream	Number of Waste Stream-Facility Combinations		Central Tendency						High End					
		Central Tendency	High End	<10-5	10-5 to 10-4	10-4 to 10-3	10-3 to 10-2	10-2 to 10-1	>10-1	<10-5	10-5 to 10-4	10-4 to 10-3	10-3 to 10-2	10-2 to 10-1	>10-1
Aluminum, Alumina	Cast house dust	23	23	23	0	0	0	0	0	23	0	0	0	0	0
Beryllium	Chip treatment WW	2	2	2	0	0	0	0	0	2	0	0	0	0	0
Copper	Acid plant blowdown	10	10	3	2	3	1	1	0	2	1	2	2	2	2
Elemental Phosphorus	AFM rinsate	2	2	2	0	0	0	0	0	0	1	1	0	0	0
Elemental Phosphorus	Furnace scrubber blowdown	2	2	2	0	0	0	0	0	1	1	1	0	0	0
Rare Earths	PWW	1	1	1	0	0	0	0	0	0	1	0	0	0	0
Selenium	Plant PWW	2	2	2	0	0	0	0	0	0	1	1	0	0	0
Tantalum, etc. [1]	PWW	2	2	2	0	0	0	0	0	1	1	0	0	0	0
Titanium and TiO2	Leach liquor & sponge wash water	2	2	2	0	0	0	0	0	0	1	1	0	0	0
Titanium and TiO2	Scrap milling scrubber water	1	1	1	0	0	0	0	0	0	1	0	0	0	0
Zinc	Waste ferrosilicon	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Zinc	Spent s.i. liquids	3	3	0	0	3	0	0	0	0	0	0	0	3	0
Zinc	WWTP liquid effluent	3	3	0	0	0	0	0	0	0	0	0	0	0	0
Zinc	Process wastewater	3	3	3	0	0	0	0	0	2	0	1	0	0	0
TOTAL 2		57	57	42	3	6	1	1	0	30	8	6	3	5	2

1. Tantalum, Columbium, and Ferrocolumbium
2. Sums by risk category may not add to the number of central or high-end waste stream/facility combinations due to rounding.

When HE DAF values are used, the number of facility-waste stream combinations with cancer risks above 10^{-5} increases to 24 of 57 facilities. Under HE assumptions, most of the waste streams show one or more facilities at risk levels above 10^{-5}. The exceptions include both the two NWW streams that would be stored in waste piles, as well as beryllium chip treatment wastewater and zinc wastewater treatment plant liquid effluent. As noted previously, arsenic is not reported as a constituent of the latter waste.

The distribution of facility-waste stream combinations by noncancer risk category is summarized in Exhibit 4-9. Using the CT DAF values, 12 facility-waste stream combinations are identified as having noncancer hazard quotients greater than 1.0. Five of these facilities are managing copper acid plant blowdown, two are managing beryllium chip treatment wastewater, and two of the facility-waste stream combinations are associated with the management of zinc spent surface impoundment liquids.

Using HE DAF values, 28 facility-waste stream combinations are identified as being associated with noncancer hazard quotients above 1.0. Again, four waste streams have no facility- waste stream combinations with hazard quotients above levels of concern: aluminum/alumina cast house dust, rare earth chip treatment wastewater, tantalum process wastewater, and zinc spent waste ferrosilicon.

As discussed previously, if regulatory options completely abolish releases from the mineral processing storage units, post-LDR risks for all of the waste stream-facility combinations would drop below levels of concern. Thus, the numbers of facilities above levels of concern in Exhibits 4-7 and 4-8 provide an upper-bound estimate of the regulatory benefits, in terms of groundwater risk reduction, that might be achieved by Option 3, under which all recycled materials would be stored in tanks, containers, and buildings. Under Options 1 and 2, the recycling of secondary materials in Bevill units would be prohibited. The risks associated with the storage of these wastes (copper acid plant blowdown, and elemental phosphorus AFM rinsate and furnace scrubber blowdown) would definitely be reduced to below levels of concern, since these streams would need to be managed in Subtitle C units.

The extent to which these benefits might actually be realized is difficult to predict without explicit modeling of releases from the tanks, containers, and buildings. These technologies would probably provide substantial risk reduction for most wastes, but EPA does not have sufficient data to estimate the level of risk reduction. Probably those streams with storage risks which just exceed levels of concern would be more likely to fall below levels of concern if managed in TCBs than those streams for which risks exceed levels of concern by many orders of magnitude, because a lower degree of control would be necessary to control these risks. EPA also believes that it will be easier to manage the low-volume recycled streams to achieve high levels of control than it will be to manage the higher volume streams.

EXHIBIT 4-9 RISK SUMMARY FOR STORAGE OF RECYCLED MATERIALS
Distribution of Waste Stream/Facility Combinations by Groundwater Hazard Category: Non-Cancer Hazards

Commodity	Waste Stream	Number of Waste Stream-Facility Combinations: Central Tendency	Number of Waste Stream-Facility Combinations: High End	Central Tendency <1	1 to 10	10 to 100	100 to 1k	1k to 10k	>10k	High End <1	1 to 10	10 to 100	100 to 1k	1k to 10k	>10k
Aluminum, Alumina	Cast house dust	23	23	23	0	0	0	0	0	23	0	0	0	0	0
Beryllium	Chip treatment WW	2	2	0	0	2	0	0	0	0	0	0	0	2	0
Copper	Acid plant blowdown	10	10	4	3	1	1	0	0	1	2	3	2	1	1
Elemental Phosphorus	AFM rinsate	2	2	2	0	0	0	0	0	0	0	2	0	0	0
Elemental Phosphorus	Furnace scrubber blowdown	2	2	2	0	0	0	0	0	1	1	1	0	0	0
Rare Earths	PWW	1	1	1	0	0	0	0	0	1	0	0	0	0	0
Selenium	Plant PWW	2	2	2	0	0	0	0	0	0	2	0	0	0	0
Tantalum, etc. [1]	PWW	2	2	2	0	0	0	0	0	1	0	0	0	0	0
Titanium and TiO2	Leach liquor & sponge wash water	2	2	2	0	0	0	0	0	0	1	1	0	0	0
Titanium and TiO2	Scrap milling scrubber water	1	1	1	0	0	0	0	0	0	1	0	0	0	0
Zinc	Waste ferrosilicon	1	1	1	0	0	0	0	0	1	0	0	0	0	0
Zinc	Spent s.i. liquids	3	3	2	0	1	1	0	0	0	0	0	1	0	1
Zinc	WWTP liquid effluent	3	3	2	0	0	1	0	0	0	1	1	0	0	1
Zinc	Process wastewater	3	3	2	1	0	0	0	0	1	1	1	1	0	0
TOTAL 2		57	57	45	5	4	3	0	0	29	9	9	4	4	2

1. Tantalum, Columbium, and Ferrocolumbium
2. Sums by hazard category may not add to the number of central or high-end waste stream/facility combinations due to rounding.

4.2.4 Risk Assessment Results for Storage of Recycled Materials: Non-Groundwater Pathways

The health risks associated with recycled materials storage that were calculated for most of the non-groundwater release events and exposure pathways under the modified prior treatment baseline were below levels of concern (lifetime cancer risk less than 10^{-5}, hazard quotients less than 1.0). All risks under HE and CT assumptions were below these levels for the following release events/exposure pathway combinations:

- Inhalation of airborne particulate;
- Ingestion and dermal contact with soil contaminated by airborne particulate;
- Ingestion of crops grown in soil contaminated by airborne particulate;
- Ingestion and dermal contact with soil contaminated by surface run-off;
- Ingestion of crops grown on soil contaminated by surface run-off;
- Ingestion of surface water contaminated by airborne particulate and surface run-off and;
- Ingestion of game fish harvested from surface water contaminated by airborne particulate and surface run-off.

All of the pathways identified are complete only for waste piles. Thus, these findings indicate, as was the case for the groundwater pathway, that all non-groundwater risks for the two recycled streams stored in waste piles are less than levels of concern. In almost all cases, estimated cancer risks and noncancer hazard quotients were far (greater than one order of magnitude, and sometimes many more) below the defined levels of concern. The only exception among all of these pathways was the HE inhalation pathway hazard quotient for barium inhalation from aluminum cast house dust, which was 0.19, or five times below the level of concern. Detailed risk results for these pathways are given in Appendix H.2.

The only pathways for which some risks exceeded levels of concern were ingestion of surface water contaminated by surface impoundment failure, and ingestion of fish harvested from waters contaminated by surface impoundment failures. Exhibit 4-10 summarizes the results of the comparison of surface water concentrations from impoundment releases to HBLs for the water ingestion pathway.

Because there are multiple samples available for most of the waste streams managed in surface impoundments, the results of the comparison to HBLs are reported in terms of the numbers of samples and recycled streams for which the HE and CT surface water concentrations from impoundment releases exceed the HBLs, presented in order-of-magnitude categories.

EXHIBIT 4-10 RISK SUMMARY FOR STORAGE OF RECYCLED MATERIALS

COMPARISON OF SURFACE WATER CONCENTRATIONS DUE TO SURFACE IMPOUNDMENT RELEASES TO HEALTH-BASED LEVELS [1]
DRINKING WATER PATHWAY

				High-End Surface Water Concentration from Bulk Samples		High-End Surface Water Concentration from EP Extraction Samples			Central Tendency Surface Water Concentration from Bulk Samples		Central Tendency Surface Water Concentration from EP Extraction Samples	
				Samples Exceeding HBL by:		Samples Exceeding HBL by:			Samples Exceeding HBL by:		Samples Exceeding HBL by:	
Constituent	**Commodity**	**Wastestream**	**Total Samples**	**1-10x**	**10-100x**	**1-10x**	**10-100x**	**100-1000x**	**1-10x**	**10-100x**	**1-10x**	**10-100x**
Arsenic	Copper	Acid Plant blowdown	40	3	1			1			1	
Cadmium	Zinc	Spent Surface Impoundment Liquids	24	1								
Lead	Copper	Acid Plant Blowdown	40	1								
	Zinc	Spent Surface Impoundment Liquids	24	1	1							

1. The HBL for Arsenic corresponds to a 10-5 lifetime cancer risk.. The HBL for cadmium corresponds to a noncancer hazard quotient of 1.0, and the HBL for lead is the MCL.

Releases from surface impoundment failures were modeled as resulting in potential exceedances of HBLs for water ingestion for three constituents: arsenic, cadmium, and lead. Under high-end dilution assumptions, the arsenic concentrations in five samples (four bulk samples, one EP extraction) would exceed the drinking water HBL by up to one thousand-fold. (This is equivalent, in this case, to saying that the estimated cancer risks under HE assumptions would exceed the 10^{-5} level of concern by up to a factor of 1000.) All of these samples came from the copper acid plant blowdown stream, and under CT dilution assumptions the surface water concentration for arsenic exceeds the HBL for only one of the 40 total samples of this stream.

The concentration of cadmium in one of 24 samples from the zinc spent surface impoundment liquid stream results in surface water concentrations exceeding the drinking water HBL under HE assumptions. The HBL is exceeded by a factor of ten or less. Under CT assumptions, there are no surface water exceedances for cadmium. For cadmium, an HBL excedence corresponds to a hazard quotient value exceeding 1.0 for its critical toxic effect on kidney function. The lead concentrations in bulk samples from two waste streams result in estimated surface water concentrations exceeding the drinking water HBL. One sample of copper acid plant blowdown shows a concentration of lead such that the HE concentrations exceeds the HBL by a factor of less than ten. Under CT assumptions, this sample no longer exceeds the HBL. Two bulk samples of zinc spent surface impoundment liquids result in HE lead concentrations in surface water that exceed the HBL by a factor of up to 100. Again, under the CT dilution assumptions, the predicted lead concentrations in surface water are reduced to below the drinking water HBL. As noted previously, the HBL for lead is simply the Drinking Water MCL of 15 ug/l.

As shown in Exhibit 4-11, the predicted surface water concentrations of six contaminants released from surface impoundments also were such that HBLs derived for the ingestion of fish by subsistence fishers were exceeded. Six arsenic samples (again all from copper acid plant blowdown) resulted HE surface water concentrations exceeding the fish consumption HBLs by up to a factor of 1000. Four of these were bulk samples, and the remainder were EP extraction samples. Under CT assumptions, only one sample exceeded the arsenic fish ingestion HBL.

A total of 20 samples (one EP extraction, the rest bulk) contained cadmium concentrations which resulted in HE surface water concentrations exceeding the fish ingestion HBL by up to 1000-fold. These samples came from zinc spent surface impoundment liquids (10), zinc process wastewater (6), copper acid plant blowdown (2 samples), and one sample each from rare earths process wastewater and zinc wastewater treatment plant liquid effluent. Under CT dilution assumptions, the number of samples exceeding the HBL is reduced to 3 samples, and the maximum level of exceedance is reduce to less than 100-fold.

Under HE assumptions, five samples give mercury concentrations in surface water exceeding the fish ingestion HBL. These samples come from copper acid plant blowdown (3) and zinc spent surface impoundment liquids (2), and under CT assumptions, none of these samples exceeds the fish HBL. In the case of mercury, an HBL exceedance is equivalent to a hazard quotient greater than 1.0 for reproductive effects.

A single sample result for selenium in copper acid plant blowdown results in surface water concentrations above the HBL, as do two thallium results (one each from titanium/TiO_2 leach liquor and sponge wash water and from copper acid plant blowdown). For all of these samples, no excedences occur under CT dilution assumptions. The same is true for the six analytical results for zinc (all from zinc commodity streams). All six of the samples exceed the fish ingestion HBL under HE but not under CT dilution assumptions.

EXHIBIT 4-11 RISK SUMMARY FOR STORAGE OF RECYCLED MATERIALS

COMPARISON OF SURFACE WATER CONCENTRATIONS FROM SURFACE IMPOUNDMENT RELEASES TO HEALTH-BASED LEVELS 1
FISH INGESTION PATHWAY

				High-End Surface Water Concentration from Bulk Samples			High-End Surface Water Concentration from EP Extraction Samples			Central Tendency Surface Water Concentration from Bulk Samples		Central Tendency Surface Water Concentration from EP Extraction Samples	
				Samples Exceeding HBL by:			Samples Exceeding HBL by:			Samples Exceeding HBL by:		Samples Exceeding HBL by:	
Constituent	**Commodity**	**Wastestream**	**Total No. Samples**	**1-10x**	**10-100x**	**100-1000x**	**1-10x**	**10-100x**	**100-1000x**	**1-10x**	**10-100x**	**1-10x**	**10-100x**
Arsenic	Copper	Acid Plant Blowdown	40	2	2		1		1			1	
Cadmium	Copper	Acid Plant Blowdown	40	2									
	Rare Earths	Process Wastewater	8				1						
	Zinc	Process Wastewater	40	6									
	Zinc	Spent Surface Impoundment Liquids	24	6	3	1				1	1		
	Zinc	WWTP Liquid Effluent	5			1					1		
Mercury	Copper	Acid Plant Blowdown	40	2			1						
	Zinc	Spent Surface Impoundment Liquids	24	1	1								
Selenium	Copper	Acid Plant Blowdown	40	1									
Thallium	Titanium and TiO_2	Leach liquid & sponge wash water	8	1									
	Copper	Acid Plant Blowdown	40				1						
Zinc	Zinc	Spent Surface Impoundment Liquids	24	5									
	Zinc	WWTP Liquid Effluent	5	1									

1. The HBL for Arsenic corresponds to a 10-5 lifetime cancer risk.. The HBL for the other constituents correspond to a noncancer hazard quotient of 1.0.

4.2.5 Potential Health Benefits from Regulation of Storage of Recycled Materials: Non-Groundwater Pathways

Exhibit 4-12 summarizes the estimated numbers of facility-waste stream combinations which exceed HBLs for both surface water pathways under the modified prior treatment baseline. Under the ingestion pathway, the three facilities with HBL exceedances under HE assumptions drops to zero under CT assumptions, as do the two facilities storing zinc spent surface impoundment liquids. Similarly, when the fish ingestion pathway is considered, a large number of facilities storing six different waste streams show exceedances of the HBLs under HE assumptions, but only one facility (storing zinc spent surface impoundment liquids) exceeds an HBL under CT assumptions.

As was the case with the groundwater pathway, effective management of the recycled materials could reduce all of the estimated risks to below levels of concern. Again, however, there is no way to estimate how much risk reduction would be achieved without explicit modeling of the non-groundwater pathway releases from TCBs. Under Options 1 and 2, copper acid plant blowdown could no longer be recycled through a Bevill unit, and treatment of this stream as a Subtitle C waste would undoubtedly result in a high degree of risk reduction. Under Option 3, all of the streams could be managed in TCBs, and the degree of risk reduction and the magnitude of health benefits for storage are harder to estimate. Since the magnitude of exceedances of the HBLs for most waste stream-facility combinations are rather low for the surface water pathways, it is possible that most of these risks would, in fact, be reduced below levels of concern under Option 3. In terms of reduced risks from the storage of recycled materials, Option 4 provides no benefits over the modified prior treatment baseline.

4.3 Uncertainties and Limitations in the Risk and Benefits Assessment for the Modified Prior Treatment Baseline

As noted in section4.1.1, the multipathway risk assessment for the storage of mineral processing recycled materials relies on relatively simple, generic models of contaminant releases, transport, exposures, and risks. Therefore, the risk assessment results cannot be used to estimate risk reduction benefits for actual exposed populations residing near the mineral processing facilities. Instead, they only provide plausible estimates of the potential health risks faced by hypothetical individuals under the defined exposure conditions.

The screening level analysis also shares the general limitations of all generic analyses in that high levels of uncertainty and variability may not be adequately treated, since only a limited number of generally applicable models and generally representative data are used to model risks from a wide range of units, wastes, and constituents. Many of these generic sources of uncertainty have been addressed in our previous work on mineral processing wastes, and the following discussion is focused on limitations specific to the multipathway analysis.

As noted previously, constituent concentration data are available for only 14 recycled waste streams, and for some wastes only small numbers of samples are available. It is interesting to note that two of the wastes for which estimated risks are the highest (copper acid plant blowdown and zinc spent surface impoundment liquids) also are those for which the largest number of samples are available. It is not possible to estimate which of the other wastes might also show risks above levels of concern if more data were available. As noted previously, the storage risk assessment covers waste streams representing about 40 percent of the total waste generated and about 65 percent of the recycled volume.

EXHIBIT 4-12 RISK SUMMARY FOR STORAGE OF RECYCLED MATERIALS

DISTRIBUTION OF WASTE-STREAM FACILITY COMBINATIONS BY DEGREE OF HBL EXCEEDENCE UNDER THE MODIFIED PRIOR TREATMENT BASELINE

			Number of Waste Stream-Facility Combinations with High-End Exceedences of HBLs by:			Waste Stream-Facilty Combinations with Central Tendency Exceedences of HBLs by:	
Commodity	**Waste Stream**	**Sector Total Waste Stream-Facility Combinations**	**1-10X**	**10-100X**	**100-1000X**	**1-10X**	**10-100X**
1. Drinking Water							
Copper	Acid Blowdown	10	1				
Zinc	Spent Surface Impoundment Liquids	3					
2. Fish Ingestion							
Copper	Acid Blowdown	10	2	1			
Rare Earths	Process Wastewater	1					
Titanium, TiO_2	Leach Liquor and Sponge Wash Water	2					
Zinc	Process Wastewater	3					
Zinc	Spent Surface Impoundment Liquids	3	1	1			
Zinc	WWTP Liquid Effluent	3			1		1

Limited data also are available concerning waste characteristics, including constituent speciation, solubility, and bioavailability. Throughout this analysis, we have assumed that all constituents would behave in such a manner as to maximize exposure potential. For example, we have assumed that none of the constituents would leach from soils after their initial deposition, and that all of the constituents would be bioavailable in the water column. Generally these assumptions increase the level of conservatism of the risk assessment.

In evaluating potential risks to human health, exposure through multiple release pathways (leaching to groundwater, particulate suspension, surface runoff, inlet/outlet failure for surface impoundments) were considered. In this analysis, it was assumed that all of the constituent mass placed in the management units was available for release through all release pathways. This assumption may have resulted in the overestimation of risks for some pathways due to double counting of constituent mass. For example, if constituent mass is depleted over time due to leaching, then the mass of constituent available for release through other pathways (e.g. particulate suspension) is reduced.

Mass balance calculations were performed for the non-groundwater release pathways (see Appendix H.2.2.1), and it was found that the proportion of constituent mass released by all of these pathways was below one percent of the total mass present in the management units. Thus, the neglect of mass balance considerations for these pathways resulted in negligible bias in the risk assessment results. The mass balance calculations did not include the groundwater pathway, however, because the methodology used did not allow release masses (only release concentrations) to be calculated. It is therefore possible that substantial depletion of some soluble and mobile constituents could occur through groundwater leaching, and these constituents would not be available for release by other pathways. This possibility has little or no impact on the findings of the risk assessment for waste piles, since, even if it is assumed that all of the constituents are released through every pathway, all calculated risks are below levels of concern. While it is not possible to estimate the magnitude of the potential bias in the risk results for surface impoundments, it is likely to be low, because of the relatively high through-put which is assumed for the impoundments, relative to plausible leachate release volumes.

Releases to groundwater and groundwater fate and transport were evaluated using EPA's EPACMTP model. Leachate concentrations and constituent- and facility-specific DAFs were derived using the best available data, which, although limited, provided a reasonable basis for generic modeling of the representative facilities. High-end (95th percentile) and central tendency (75th percentile) DAFs were used to explore the levels of uncertainty and variability in groundwater fate and transport processes. Comparison of the HE and CT DAFs indicates that the probability distribution of the DAF values is quite broad, and that the level of uncertainty is quite high. As for the other pathways, exposure assumptions were used that provide a moderate degree of conservatism for the groundwater pathway risk estimates.

Release events and amounts for non-groundwater pathways were simulated mostly using the general methods adopted in HWIR-Waste. The one exception is air particulate generation, which was estimated using the SCREEN3 model, rather than the model recommended in HWIR-Waste. SCREEN3 is a widely-accepted screening level EPA model. We believe that it is appropriate for the types of release events that were modeled. The use of SCREEN3 is unlikely to have biased the results of the risk assessment significantly compared to other methods. However, no data were available concerning the particle size characteristics of the two wastes streams that were modeled, so EPA relied on data from an earlier study of mineral processing wastes stored in waste piles. Based on limited information, the Agency believes, for example, that the particle size distribution which was used may overstate the potential for particulate release of the more coarse-grained, high-density zinc waste ferrosilicon, while more accurately describing the potential for particulate releases of aluminum cast house dust.

Run-off releases were evaluated using the same model the Universal Soil Loss Equation, USLE, applied in HWIR-Waste, with input parameters varied slightly to reflect the operating characteristics of the waste piles being simulated and the likely geographic distribution of the recycling facilities. We also assumed that no runoff controls would be used. The risk results are not particularly sensitive to these assumptions, as exposure concentrations in soil and surface water due to run-off events are very far below the levels of concern for all exposure pathways.

The ISCST3 model used to predict particulate air concentrations and deposition rates is a state-of-the-art model that has been used in many regulatory proceedings by EPA. The input data that were used, the "worst-case" meteorological conditions, were somewhat more conservative than the meteorological data used in HWIR-Waste with a similar model. Thus, our estimates of air impacts are likely to be higher than those that would have been achieved had we replicated the HWIR-Waste approach. Again, however, all the estimated risks and exposure concentrations for air releases are far below levels of concern, despite this conservatism.

The modeling of releases from surface impoundments reproduced exactly the approach used in HWIR-Waste. This release model and its input parameters were derived based on data from management units in the pulp and paper industry, and just how reliably they predict releases from surface impoundments in the mineral processing industries is not known. This is clearly a major source of uncertainty in the risk assessment, as these release events are the only ones for which health risks are predicted to be above levels of concern.

Because of resource limitations and the specific characteristics of the facilities that we were evaluating, we developed simplified approaches to modeling the concentrations of waste constituents in surface soils and surface water to substitute for the much more elaborate methods used in HWIR-Waste. In the case of surface run-off, in the absence of site-specific data, we conservatively assumed that soil contamination would be limited to relatively small distances (50 or 100 meters) from the piles in arbitrarily defined circular plumes. This is only intended as a bounding analysis, and the finding that this pathway is not a major concern can be supported by the fact that, even with these relatively small exposure areas (and the resultant high soil concentrations), constituent concentrations due to run-off events were two or more orders of magnitude below levels of health concern.

Similarly, to be conservative, we assumed that all of the run-off and all of the particulate generated by the waste piles would be deposited on the watershed in such a way that all of these materials would rapidly find their way into surface water. This approach, while it resulted in surface water concentrations far below levels of health concern, may be less conservative than the approach taken for surface soils, because the CT and HE streams are both rather large, and the model does not take into account possible run-off or deposition into smaller streams, lakes, or ponds where constituents may accumulate in surface water or sediment.

The approach taken in evaluating fish tissue concentrations was also somewhat more conservative than that taken in HWIR-Waste, in that the highest available BCF or BAF values were used, rather than representative values, in our calculations. For some constituents (arsenic, cadmium, mercury, thallium), this approach resulted in considerably higher tissue concentrations than would have been calculated had we used the HWIR-Waste values. This may be a major source of uncertainty in this analysis, since the fish ingestion pathway resulted in the highest risks predicted for several of the constituents and waste streams.

5. Other Administrative Requirements

This section describes the Agency's response to other rulemaking requirements established by statute and executive order, within the context of today's proposed rule.

Environmental Justice

EPA is committed to addressing environmental justice concerns and is assuming a leadership role in environmental justice initiatives to enhance environmental quality for all residents of the United States. The Agency's goals are to ensure that no segment of the population, regardless of race, color, national origin, or income bears disproportionately high and adverse human health and environmental impacts as a result of EPA's policies, programs, and activities, and that all people live in clean and sustainable communities. In response to Executive Order 12898 and to concerns voiced by many groups outside the Agency, EPA's Office of Solid Waste and Emergency Response formed an Environmental Justice Task Force to analyze the array of environmental justice issues specific to waste programs and to develop an overall strategy to identify and address these issues (OSWER Directive No. 9200.3-17).

Today's proposal covers wastes from mineral processing operations. The environmental problems addressed by this proposed rulemaking could disproportionately affect minority or low income communities, due to the location of some mineral processing and waste disposal facilities. Mineral processing sites are distributed throughout the country and many are located within highly populated areas. Mineral processing wastes have been disposed of in various states throughout the U.S., representing all geographic and climatic regions. In some cases, mineral processing waste is generated in one state and disposed of in another. In addition, mineral processing wastes are occasionally disposed of in municipal solid waste landfills.

Today's proposed rule is intended to reduce risks from mineral processing wastes, and to benefit all populations. It is, therefore, not expected to result in any disproportionately negative impacts on minority or low income communities relative to affluent or non-minority communities.

Unfunded Mandates Reform Act

Under Section 202 of the Unfunded Mandates Reform Act of 1995, signed into law on March 22, 1995, EPA must prepare a statement to accompany any rule where the estimated costs to state, local, or tribal governments in the aggregate, or to the private sector, will be $100 million or more in any one year. Under Section 205, EPA must select the most cost-effective and least burdensome alternative that achieves the objective of the rule and is consistent with statutory requirements. Section 203 requires EPA to establish a plan for informing and advising any small governments that may be significantly impacted by the rule.

EPA has completed an analysis of the costs and benefits from today's proposed rule and has determined that this proposed rule does not include a federal mandate that may result in estimated costs of $100 million or more to either state, local or tribal governments in the aggregate. The private sector also will not incur costs exceeding $100 million per year under any of the three costing scenarios described in Section 4.4, Cost and Economic Impacts of the Rule, above.

6. Conclusions

This section presents the Agency's preliminary conclusions regarding the regulatory impacts of implementing the options presented in today's notice. The chapter is organized around the central elements of the analyses provided in previous sections, namely characterizing the affected population of waste streams, facilities, and mineral industry sectors, analyzing the cost and economic impacts of implementing the options, and assessing the human health benefits of adopting these regulatory alternatives.

6.1 The Affected Universe

As described in depth in the RIA prepared in support of the January 1996 proposed rule, EPA conducted intensive research in an attempt to identify and characterize all of the waste streams that might be affected by imposition of LDR requirements on non-exempt hazardous mineral processing wastes. This research has yielded a group of 118 potentially hazardous mineral processing residues that may be subject to Subtitle C controls and accordingly, to new LDR treatment standards.

This number is far smaller than the total population of mineral industry wastes, and reflects EPA's step-wise process of eliminating from the analysis wastes that are: 1) generated by extraction and beneficiation operations (these are Bevill-exempt), 2) the 20 exempt special mineral processing wastes, and 3) wastes that are known or expected to be non-hazardous. The remaining waste streams have been included in the Agency's analyses, though in many cases substantial uncertainties regarding their generation rates, hazardous characteristics, and management practices have led EPA to develop several different estimates of these parameters, which in turn produce highly variable estimates of costs and benefits arising from new regulatory controls.

The Agency recognizes the limitations that these data gaps and simplifying assumptions impose on the accuracy of the analyses presented above. EPA has provided detailed analyses of the potential cost and benefit impacts of the LDR options in the interests of providing interested parties with as much pertinent information as possible.

EPA recognizes the limitations that these data gaps and simplifying assumptions impose on the accuracy of the analyses presented above. EPA has provided detailed analyses of the potential cost and benefit impacts of the LDR options in the interests of providing interested parties with as much pertinent information as possible.

6.2 Cost and Economic Impacts of the Rule

A summary of the projected costs of implementing the four options analyzed in this RIA is provided in Exhibit 4-13, below.

As can be seen in Exhibit 4-13, cost impacts are highest for Options 1 and 2, ranging between $46 million and $75 million annually for Option 1 and $37 million and $55 million annually for Option 2. Option 3 results in significantly lower cost impacts, with costs ranging only from $5.2 million to $13 million annually. Option 4 results in significantly lower cost impacts than the other three options, with impacts ranging only from $71,000 to 190,000 annually.

Exhibit 6-1

Summary of Cost Analysis Results
(Results in $ Thousands per Year)

Option[a]	Costing Scenario	Modified Prior Treatment
Option 1	Minimum	46,000
	Expected	58,000
	Maximum	75,000
Option 2	Minimum	37,000
	Expected	45,000
	Maximum	55,000
Option 3	Minimum	5,200
	Expected	8,400
	Maximum	13,000
Option 4	Minimum	71
	Expected	190
	Maximum	190

[a] Options are described in detail in Section 4.1.

The high costs associated with Option 1 are the result of additional requirements the option would impose on facility operator recycling secondary materials. Option 2 costs are slightly lower than Option 1 costs, and are driven primarily by the option's prohibition against recycling secondary materials to beneficiation or Bevill process units. The absence of a legitimacy test for recycling and the option's provisions that allow for storage of secondary materials in non-RCRA tanks, containers, and buildings prior to recycling account for Option 2's lower costs relative to Option 1.

Option 3 has the lowest costs of the non-land based storage options. The significantly lower costs associated with Option 3 result from the option's lack of prohibition in the recycling of secondary materials through beneficiation or Bevill process units. Option 4 results in relatively low net costs to industry because the option essentially allows facilities to continue operating as they currently operate. The Agency assumes that in some cases, facility owners and operators, out of misunderstanding of current requirements, handle spent materials improperly. Option 4 would allow these owners and operators to continue to handle spent materials in this manner. The only costs incurred by facility owners under this option are relatively insignificant recordkeeping and reporting requirements.

A brief summary of the projected economic impacts of the rule, assuming the modified prior treatment baseline, is summarized in Exhibit 4-14. Again, impact ratios are the annualized costs of compliance divided by annual value of shipments.

Exhibit 6-2

Summary of Economic Impact Screening Results: Modified Prior Treatment Baseline

Option	Costing Scenario	Sectors with Impacts
Option 1	Minimum	1
	Expected	5
	Maximum	7
Option 2	Minimum	1
	Expected	5
	Maximum	6
Option 3	Minimum	0
	Expected	3
	Maximum	5
Option 4	Minimum	0
	Expected	0
	Maximum	0

Analysis of costs as a percentage of value added indicates that only Option 4 results in no significant impacts (defined as greater than 10 percent) to industry. Option 3 will significantly impact the cadmium and selenium sectors (13 percent of the sectors analyzed). Greater impacts are expected to result from Options 1 and 2. For Option 1, EPA anticipates that five of the 16 industry sectors (31 percent of the sectors included in this analysis) will be significantly affected (lead, cadmium, selenium, tellurium, and zinc). Under Option 2, three of the 16 sectors (19 percent of the sectors analyzed) are expected to be significantly affected (lead, cadmium and selenium).

None of the five industry sectors for which profits data were available are projected to have severe cost impacts (defined as costs greater than estimated industry profits) under any option. In fact, impacts exceed one percent in the expected value case only for the copper sector and only under Options 1 and 2.

6.3 Health Benefits of the Proposed LDRs

The benefits of the proposed LDRs for mineral processing wastes take the form of reduced risks to human health and the environment from improved management of the subject wastes. EPA has conducted analyses of the potential health risks associated with the disposal of mineral processing wastes and the storage of recycled streams under different sets of baseline assumptions, and of the potential reductions in health risks that may be achieved under the proposed regulatory options. Potential risks and benefits have been evaluated for potential groundwater exposures to toxic waste constituents arising from waste disposal, and for groundwater and non-groundwater pathway exposures to constituents released during the storage of recycled streams. Detailed descriptions of the methods used to evaluate risks and benefits for waste disposal are found in Appendix A, and descriptions of the methods used for the risk assessment for waste storage are found in Appendix H of this RIA.

Under the modified prior treatment baseline, which EPA believes is the most realistic and representative characterization of current industry practice, it is assumed that the wasted (unrecycled) portion of all waste streams would be treated by stabilization to achieve compliance with the TC regulatory leachate levels prior to land disposal. Under this set of assumptions, the baseline groundwater pathway risks associated with the disposal of the wastes have been estimated to be quite low. As discussed in Section 4.2.1, disposal of the waste streams in compliance with the TC regulatory levels would result groundwater risks below levels of concern (10^{-5} cancer risk or noncancer hazard quotient of 1.0) for all of the TC analytes except arsenic. For arsenic, disposal at the TC concentration would result in estimated cancer risks that just exceed 10^{-5}. EPA believes (although the issue has not been evaluated quantitatively) that stabilization to comply with the TC regulatory levels also will control the mobility of most toxic non-TC inorganic constituents to the extent that baseline groundwater risks for these constituents also will be below levels of concern.

For these reasons, EPA estimates that the health benefits from improved waste disposal practices under all of the regulatory options would be quite low compared to the modified prior treatment baseline, considering only groundwater pathway exposures. For arsenic, which is a major risk-driving constituent for many wastes, risk reduction would not occur, since the TC regulatory level and UTS leachate concentration are identical. For other constituents, some exposure reduction could occur under these options, since the UTS levels are lower than the TC leachate concentrations, and because some non-TC analytes may not be effectively immobilized by treatments designed to comply with the TC.

EPA's evaluation of the potential groundwater risks associated with the storage of recycled streams under the modified prior treatment baseline is described in Section 4.2.3. Estimated groundwater pathway cancer risks under high-end (HE) baseline assumptions exceeded 10^{-5} at 24 of 57 facilities storing recycled streams, while under central tendency (CT) assumptions, only 11 facilities exceed this level (Exhibit 4-8). The HE noncancer hazard quotients for groundwater exposures exceed 1.0 at 28 facilities storing recycled materials, and under CT assumptions baseline hazard quotients exceed 1.0 at 12 facilities (Exhibit 4-9). All of the facilities for which baseline cancer risks or noncancer hazard quotients exceed levels of concern manage wastewater and liquid nonwastewater streams in impoundments. Owing primarily to the low recycled volumes and small facility sizes, the baseline groundwater risks for the two nonwastewater streams managed in waste piles are below levels of concern under both CT and HE assumptions.

The analysis of non-groundwater pathway risks associated with waste storage under the modified prior treatment baseline indicated that, for the majority of the pathways evaluated, estimated risks were far below levels of concern. As was the case for the groundwater pathway risk assessment, risks from the storage of the two nonwastewater streams in waste piles were less than levels of concern for all release events and exposure pathways.

Baseline risks greater than levels of concern were found for exposures to surface water contaminated by releases from surface impoundment failures of some waste streams, however. In the case of the direct ingestion pathway, one facility storing copper acid plant blowdown had an HE cancer risk exceeding 10^{-5}. Under CT assumptions, the estimated cancer risk for this facility was below the level of concern. When exposure through fish consumption is considered, six facilities from three commodity sectors had HE risks from waste storage exceeding cancer or noncancer levels of concern. Under CT assumptions, risks from only two storage facilities exceeded levels of concern for the fish ingestion pathway. These results are summarized in Exhibit 4-12.

EPA did not quantitatively estimate the extent of risk reduction or the level of health benefits that could be brought about by the proposed LDRs' effects on recycled materials storage. This is because the available data and models do not allow the development of risk reduction estimates for tanks, containers, and buildings, which would be the required management units for most of the recycled streams under regulatory Options 1-3. If these options completely or substantially eliminate the release of recycled streams to groundwater and other media, the baseline risks discussed in the previous paragraphs could all be reduced to below levels of concern. Lesser degrees of control would result in less risk reduction and lower health benefits. Under Options 1 and 2, the risks for three of the streams managed through Bevill units (copper acid plant blowdown, and the two streams from elemental phosphorus production) would be greatly reduced by the requirement to manage them in Subtitle C units. Copper acid plant blowdown figures prominently as a contributor to storage risks through both the groundwater and non-groundwater pathways. Under Option 4, no health benefits associated with the storage of recycled materials would be realized, as there is no requirement for improved management of these streams.