Draft Regulatory Analysis

Amendments to 10 CFR Part 20 on

Radiological Criteria for Controlling the Disposition of Solid Materials

March 2005

Table of Contents

1.0 Introduction

The Proposed Rule being considered in this Draft Regulatory Analysis (RA) is a Nuclear Regulatory Commission (NRC) regulation to control the disposition of solid materials. These solid materials originate in restricted or impacted areas[1] of NRC-licensed facilities, and have no, or very small amounts of, radioactivity resulting from licensed operations (collectively referred to in this RA as "solid materials"). The Proposed Rule would provide a clear and consistent regulatory basis for determining the disposition of solid materials. In conducting this rulemaking, the NRC is guided by the goals in its Strategic Plan (NRC 2004b) of which the primary goal is ensuring the protection of public health and safety and the environment. The NRC is also seeking to avoid unnecessary regulatory burden associated with disposal of solid materials when they are no longer needed or useful at licensed facilities.

The purpose of this RA is to evaluate the benefits and costs associated with the Proposed Rule. This document presents background material, describes the objectives of the rule, outlines the alternatives considered, and evaluates the benefits and costs of the alternatives for the Proposed Rule.

1.1 Background

NRC initially considered a proposed rulemaking in 1999. As part of the scoping process, NRC published an Issues Paper on the Release of Solid Materials from Licensed Facilities in June 1999 in the Federal Register (64 FR 35090) (NRC 1999) and requested public comments. NRC indicated that it was examining alternatives for controlling the disposition of solid materials. NRC held four public meetings during the fall of 1999 as part of the scoping process to receive comments. Over 800 public comment letters were received during the public comment period in 1999. Comments were diverse in the views expressed, and provided a number of alternatives for controlling the disposition of solid materials.

On March 23, 2000, the NRC staff provided the Commission with a paper (SECY-00-0070) on the diversity of views expressed in public comments received on the Issues Paper. Attachment 2 of SECY-00-0070 (NRC 2000a) provides a summary of views and comments received; summaries of the comments can also be viewed in NUREG/CR-6682, "Summary and Categorization of Public Comments on the Control of Solid Materials" (September 2000) (NRC 2000b). To solicit additional input, the Commission held a public meeting on May 9, 2000, at which stakeholder groups presented their views and discussed alternatives for controlling the disposition of solid materials.

On August 18, 2000, the Commission decided to defer a final decision on whether to proceed with a rulemaking and directed the staff to request that the National Academies conduct a study of alternatives for controlling the disposition of solid materials. The Commission also directed

[1] A restricted area is any area to which access is controlled for the protection of individuals from exposure to radiation and radioactive materials. An impacted area is an area with some reasonable potential for residual radioactivity in excess of natural background or fallout levels.

the staff to continue to develop technical information and to stay informed of international and U.S. agency activities in this area.

The National Academies study of alternatives for controlling the disposition of solid materials was initiated in August 2000. As part of the study, the National Academies held three information gathering meetings in January, March, and June of 2001, at which it obtained input from various stakeholder groups. The input received was similar to that presented to the NRC earlier. Based on these meetings, and on its deliberations on this topic, the National Academies submitted a report to the NRC in March 2002 titled *The Disposition Dilemma - Controlling the Release of Solid Materials from Nuclear Regulatory Commission-Licensed Facilities* (National Research Council, 2002). The report contains findings and nine recommendations related to the decision-making process, potential approaches for controlling the disposition of solid materials, and additional technical information needs. An important finding in the National Academies report was that NRC's current approach for controlling the disposition of solid materials protects public health and does not need immediate revamping. However, the National Academies report also states that NRC's current approach is incomplete and inconsistent and concludes that NRC should therefore undertake a process to evaluate a broad range of alternatives to provide clear risk-informed direction on controlling the disposition of solid materials. The report notes that broad stakeholder involvement and participation in the NRC's decision-making process on the alternatives is critical as the process moves forward. The report also recommends that an individual dose standard of 1 mrem/yr provides a reasonable starting point for the process of considering alternatives for a dose-based standard. A link to the National Academies report is contained in the Background section of the NRC's web page on controlling the disposition of solid materials.[2]

Following completion of the National Academies report, the NRC staff submitted a paper to the Commission on July 15, 2002 (SECY-02-0133) (NRC 2002) which contained a set of options for proceeding with a regulatory process for examining alternatives for controlling the disposition of solid materials. Based on its review of the National Academies report and of SECY-02-0133, the Commission, in a Staff Requirements Memorandum dated October 25, 2002, directed the staff to proceed with an enhanced participatory rulemaking to develop specific requirements for controlling the disposition of solid materials.

On February 28, 2003, NRC published a notice in the Federal Register (68 FR 9595) (NRC 2003a) requesting comments on the scope of the proposed rulemaking and announcing its intention to prepare a GEIS to analyze alternatives for establishing requirements for controlling the disposition of solid materials. On April 18, 2003, NRC published another notice in the Federal Register (68 FR 19232) (NRC 2003b) announcing the dates and location of a public workshop to discuss the proposed rulemaking and the scoping process.

[2] http://www.nrc.gov/materials.html. Click on "Controlling the Disposition of Solid Materials" under "Key Issues."

1.2 Objectives of the Proposed Rule (Purpose and Need)

The purpose of the Proposed Rule is to provide efficiency in regulation of the disposition of solid materials and to continue to provide control in a manner that protects public health and safety and the environment. To this end, the Commission's Proposed Rule should not impose unnecessary regulatory burdens beyond what is necessary and sufficient for providing reasonable assurance that public health and safety is protected.
The Proposed Rule is focused on controlling the disposition of solid materials from restricted or impacted areas in NRC-licensed facilities. Despite their location in these restricted or impacted areas, much of this solid material has no, or very small amounts of, radioactivity resulting from licensed operations either because the material was exposed to radioactivity in the facility to only a limited extent or because it has been cleaned. These solid materials can include furniture and ventilation ducts in buildings; metal equipment and pipes; wood, paper, and glass; laboratory materials (gloves, beakers, etc); routine trash; site fences; concrete; or soil.

Currently, radiation surveys are conducted on solid materials before they leave restricted or impacted areas of a site. Solid materials can currently be released for any unrestricted use using a set of existing guidelines that are based primarily on survey instrument capabilities. However, these levels are in NRC guidance and 10 CFR Part 20 does not currently specify the level below which the material can be released. The NRC agrees with the findings in the National Academies report regarding the need to consider modifying its current approach to provide specific direction on controlling the disposition of solid materials.

2.0 Identification and Analysis of Alternative Approaches

NRC has identified a number of alternatives for controlling the disposition of solid materials. A set of preliminary alternatives for controlling the disposition of solid materials was first described in an NRC Issues Paper published for public comment in the Federal Register on June 30, 1999 (64 FR 35090) (NRC 1999). This set of preliminary alternatives was narrowed down and finalized based on input from a public scoping process.

2.1 Comparison of Alternatives

NRC is studying five alternatives in detail for controlling the disposition of solid materials.

1. No Action: Retain current approach of allowing unrestricted use using measurement-based guidelines.

2. Unrestricted Release: Permit release of materials for unrestricted use if the potential dose to the public from the materials are less than a specified dose-based criterion determined during the rulemaking process.

3. EPA/State-Regulated Disposal: Dispose of all solid materials in EPA/State-regulated landfills.

4. Low-Level Waste (LLW) Disposal/Prohibition: Dispose of all solid materials in restricted or impacted areas in LLW disposal facilities. Prohibit solid material from general commerce or EPA/State-regulated landfill disposal.

5. Limited Dispositions: Permit release of materials from licensed control if the potential dose to the public from the material is less than a specified dose-based criterion determined during the rulemaking process. However, NRC would allow only certain authorized dispositions to limit the potential for public exposure.

2.2 No Action

NRC requires the analysis of a No Action Alternative to provide the decisionmaker with a basis for comparison to a Proposed Rule and other reasonable alternatives. In this case, under the No Action Alternative, NRC would continue to apply its current approach to determining the eligibility of solid material for unrestricted release in general commerce or disposal. The NRC's current approach is one that employs measurement-based guidelines to determine if solid materials can be released for any use or disposal. In implementation, the provisions of license conditions and facility-specific procedures require that solid materials that have been used in restricted areas be surveyed for the presence of radioactivity before being taken out of radiologically controlled areas. Solid materials can currently be released for any unrestricted use or disposal using a set of existing NRC guidelines that are based primarily on survey instrument capabilities. Although NRC does not track release quantities if the materials meet the criteria, NRC inspectors routinely inspect a licensee's radiation protection programs and implementing procedures, which includes survey records for compliance with Part 20 and license conditions.

However, 10 CFR Part 20 does not currently specify a numerical level (e.g. dose limit) below which the material can be released. Decisions on disposition of solid materials are currently made using levels contained in a set of existing guidelines that are based primarily on the ability of survey techniques to measure the radioactivity level on, or in, the solid material. Solid material releases have been evaluated at many sites during decommissioning. Under the current case-by-case approach, NRC considers the volumes of material, exposure pathways, doses to individuals, environmental impacts, stakeholder concerns, and ALARA[3] issues in evaluating licensee requests.

Under the No Action Alternative, solid material released for unrestricted use may be recycled and reused in a variety of end products, or it may be sent for disposal. Disposal may take place in an EPA/State-regulated landfill or LLW disposal facility. The potential exposures and the groups of individuals subject to exposures from released materials are dependent on their final dispositions.

Disadvantages of the current case-by-case approach are (1) the lack of a consistent criteria for controlling solid materials can result in inconsistent release levels, (2) there is no guidance for volumetrically contaminated materials, (3) there have been problems when new detectors with greater sensitivity are used and low levels of radioactivity are detected in previously released material, and (4) additional time and resources are required to evaluate and implement an approach that can vary with each case.

2.3 Unrestricted Release

The Unrestricted Release Alternative would allow solid materials to be released for any use in general commerce (recycling and/or reuse into consumer products and industrial and construction uses) or for disposal, if they are below a dose-based criterion. Under the Unrestricted Release Alternative, all materials to be released would undergo a radiation survey and the measured level of radiation would be compared against the criterion for unrestricted release.[4] Solid materials with measured radiation levels below the established criterion would be released from regulatory control for unrestricted release, while solid materials with radiation levels above the criterion would be sent to a LLW disposal site. The proposed rulemaking would include a table of radionuclide concentrations (clearance levels) corresponding to the selected dose-based criterion. In implementation, survey results would be compared to the clearance level of each radionuclide or mixture of radionuclides in demonstrating compliance with the rule. Compliance is demonstrated when the survey results are less than the applicable clearance levels. A supporting NRC document (NRC 2005a) presents the methodology by which licensees would demonstrate compliance.

Under the Unrestricted Release Alternative, solid material released for unrestricted use may follow any disposition path – it may be recycled and reused in a variety of end products, or it may be sent for disposal. Disposal may take place in an EPA/State-regulated landfill or LLW disposal

[3] As Low As Reasonably Achievable.

[4] The term clearance is used by various organizations and in various documents to mean removal from regulatory control of material that meets certain release criteria.

facility. The potential radionuclide exposures and the groups of individuals subject to exposures from released materials are dependent on their final dispositions.

This RA considers a range of potential options for allowable dose levels for allowing the release of solid materials. The allowable dose level that NRC selects would directly impact the amount of solid material released for use in general commerce, with the amount of material released decreasing as the allowable dose criterion decreases. These dose options are:

- 0.03 mrem/yr (A zero above background dose option was modeled at 0.03 mrem/yr.)
- 0.1 mrem/yr
- 1 mrem/yr
- 10 mrem/yr
- International Atomic Energy Agency (IAEA) Safety Guide No. RS-G-1.7, "Application of the Concepts of Exclusion, Exemption, and Clearance" (IAEA, 2004); based on 1 mrem/yr.

For the first four dose options, NRC has independently assessed potential doses to individuals that could result from release of solid materials (NUREG-1640 (NRC 2003c)). For the fifth dose option, IAEA Safety Guide No. RS-G-1.7 (IAEA, 2004) was assessed. Using RS-G-1.7 for clearance levels would provide more consistency with international numeric standards. An additional international standard is the European Commission's clearance levels. RS-G-1.7 was considered as part of this alternative because it was more recently adopted.

Under each dose option, solid materials to be released would have their level of radioactivity measured on-site by licensed facility workers (survey workers) prior to release. Those materials whose level of activity are found to be below the applicable clearance levels would be cleared for unrestricted release, including disposal in a landfill. Materials that do not meet clearance levels would be disposed of in a licensed LLW facility.

2.4 EPA/State-Regulated Disposal

Under this alternative, all solid material would be sent to EPA/State-regulated landfills and would be prohibited from general commerce (recycling into consumer products and industrial and construction uses). A base case and one variation of this alternative are being considered, specifically:

1. EPA/State-Regulated Landfill (base case) – All released solid materials would be disposed of in EPA/State-regulated Resource Conservation and Recovery Act (RCRA) Subtitle D landfills. Solid materials above the dose-based criterion would be sent to a LLW disposal facility.

2. EPA/State-Regulated Trash Incineration (variation) – Trash would be incinerated at EPA/State-regulated incinerators and the ash disposed of in EPA/State-Regulated landfills. All non-trash solid materials (concrete, ferrous metal, etc.) would not be incinerated, but would be disposed of in EPA/State-regulated landfills. Solid materials above the dose-based criterion would be sent to a LLW disposal facility.

Under both the base case and the incinerator variations of this alternative, the following five dose options are being considered.

- 0.03 mrem/yr
- 0.1 mrem/yr
- 1 mrem/yr
- 10 mrem/yr
- IAEA Safety Guide No. RS-G-1.7 (1 mrem/yr)

For the first four dose options, which are based on NRC's independent analysis in NUREG-1640 (NRC 2003c), a greater amount of activity could be released to landfills than the amount that would be released to general commerce under the Unrestricted Release Alternative.

EPA regulates municipal and industrial solid waste under RCRA. Under RCRA Subtitle D, the solid waste program encourages States to develop comprehensive plans for managing non-hazardous industrial solid waste and municipal solid waste and also sets criteria for municipal solid waste landfills and other solid waste disposal facilities.

Under RCRA Subtitle C, the hazardous waste program establishes a system for controlling chemically-hazardous waste from the time it is generated until its disposal. Because NRC's current rulemaking effort focuses on materials which are at a risk level well below the chemical hazard of materials typically disposed of in Subtitle C facilities, this alternative considers only RCRA Subtitle D facilities. However, it is useful to discuss the status of EPA efforts on RCRA Subtitle C facilities. EPA is considering a rulemaking that could permit disposal of certain NRC-regulated material in a RCRA Subtitle C facility subject to, if necessary, an appropriate NRC approval process (e.g., a site-specific or general license, or exemption). EPA published an Advanced Notice of Proposed Rulemaking in the Federal Register (68 FR 65119, November 18, 2003) (EPA 2003) to solicit stakeholder input on a potential regulatory framework to permit disposal of low-activity radioactive waste, including mixed waste and other low-level waste, in RCRA Subtitle C disposal facilities. EPA is considering a wide range of allowable dose limits for materials being disposed, most of which are higher than a 1 mrem/yr dose limit. EPA is coordinating with NRC on the ANPR effort. If EPA decides to move forward with a rulemaking for Subtitle C facilities, NRC would need to take conforming regulatory action in a separate rulemaking. That effort would be different from the Proposed Rule discussed in this RA and would take place at a later time once EPA decides if it is moving forward with a rulemaking.

2.5 LLW Disposal/Prohibition

Under the alternatives described in Sections 2.2-2.4, solid materials in excess of the release criteria would be sent to licensed LLW disposal facilities. However, under this alternative, also known as Prohibition, all potentially clearable solid material would be prohibited from general commerce and EPA/State-regulated landfill disposal. All solid material in restricted or impacted areas would be classified as LLW and required to be disposed of under NRC's existing regulations (10 CFR Part 61). The requirements of 10 CFR Part 61 address the siting, operation, and closure of LLW disposal facilities. Requirements in Appendix G to 10 CFR Part 20 focus on

licensees (as waste generators) and provide procedures to ship LLW wastes to such disposal sites.

There are currently three LLW disposal sites operating in the country that could accept solid material under this alternative. These facilities are:

- Envirocare - Clive, UT
- Barnwell Disposal Facility - Barnwell, SC
- Hanford Off-Site LLW Disposal Facility - Hanford, WA

The Barnwell Disposal Facility will only accept non-regional waste until 2008, at which time it will accept waste only from the Atlantic Compact States of South Carolina, New Jersey, and Connecticut, which is a relatively small subset of the total population of licensed facilities. The Hanford Off-Site LLW Disposal Facility accepts waste only from the Northwest and Rocky Mountain Compact States, which are: Washington, Oregon, Idaho, Montana, Utah, Wyoming, Nevada, Colorado, New Mexico, Alaska, and Hawaii. Because it is assumed that very little of the solid material would be eligible for disposal at the Barnwell and Hanford facilities, this alternative assumes that in the future all solid material would be sent to the Envirocare site for disposal.

2.6 Limited Dispositions

In this alternative, solid material would be released from further licensed control, but NRC would allow only certain authorized dispositions to limit the potential for public exposure. All materials to be released would undergo a radiation survey and the measured level of radiation would be compared against the dose criterion for release for limited dispositions. Solid materials with measured radiation levels below the established criterion would be released for pre-approved limited dispositions, while solid materials with radiation levels above the radionuclide levels associated with a dose-based criterion would be sent to a LLW disposal facility. NRC regulations in 10 CFR Part 20 would be amended to add a dose-based regulation on limited dispositions. Any requests to release material for other than these limited end uses or at higher radionuclide concentrations than those of the Proposed Rule would require case-specific approval from NRC.

For the pre-approved dispositions, the radionuclide criterion was chosen to be a dose limit of 1 mrem/yr using the IAEA Safety Guide No. RS-G-1.7 (IAEA, 2004). A dose limit of 1 mrem/yr was chosen based on various factors, including that it is a small fraction of the public dose limit established to ensure adequate protection of public health and safety. It is also consistent with dose criteria in Federal standards for other media and is consistent with the NCRP and the National Academies recommendations. The table of radionuclide concentrations accompanying the IAEA Safety Guide are based on unrestricted release. The materials that could be released under the IAEA standard are concrete, metal and trash. It is difficult to develop a generic set of radionuclide concentrations for soil, so disposition.of soil would be considered under the case-specific element of the proposed rule.

Solid material could be released if its further use would be restricted to only certain uses with limited potential for public exposure, such as use in a controlled environment. Examples include industrial uses such as metals in bridges or sewer lines, concrete use in road fill, and reuse of tools and equipment for its original purpose. Based on public comments during the scoping period, some of the possible recycling uses were not considered as pre-approved dispositions. Also, the marketplace is likely to limit the range of end-uses for the disposition of solid materials. For example, the recycling industry indicated it would be difficult to find scrap metal brokers and steels mills willing to accept and process the released materials. Although recycling of scrap metal was not considered as a pre-approved disposition, metal recycling could be considered as a case-specific application.

Based on public comments during the scoping period and on NRC's analyses of the Unrestricted Release and EPA/State-Regulated Disposal Alternatives, the only limited dispositions considered under this alternative are disposal in a RCRA Subtitle D landfill, concrete use in roadbeds, and reuse of tools and equipment for their original purpose. Licensees would need to demonstrate that doses for limited dispositions would be consistent with the dose criterion. Any requests to release material for other than these limited end uses would require case-specific approval (including the disposition of soils).

To help assure that the material releases are occurring to the pre-approved dispositions, there will be licensee recordkeeping and these activities would be evaluated periodically during routine staff inspections at licensed facilities. Also, enforcement action would be taken if necessary according to NRC regulations in 10 CFR Part 2.

The following are the components of this alternative.

Landfills. For landfill disposal under this alternative, the released solid materials (concrete, metal or trash) at or below the 1 mrem/yr criterion using the RS-G-1.7 standard could be disposed of in RCRA Subtitle D landfills. At this risk level, the controls associated with disposal of solid materials at RCRA Subtitle D landfills are sufficient to provide reasonable assurance of that the dose criterion of the Proposed Rule is maintained. Solid materials above the 1 mrem/yr criterion would be sent to a LLW disposal facility. As explained in Section 2.4.3 (EPA/State-Regulated Disposal Alternative), this proposed rulemaking considers only RCRA Subtitle D facilities because EPA is currently evaluating the possibility of higher dose limits at RCRA Subtitle C facilities.

Although NRC would authorize by rule disposal in a RCRA Subtitle D facility, the regulator of each RCRA facility would determine if an actual transfer to that facility will be allowed. If a specific RCRA facility is permitted by the EPA or a State agency to receive material at a projected dose greater than that in the proposed rule, disposition of such material could be considered under existing provisions of 10 CFR 20.2002.

Concrete in Roadbeds. Released concrete at or below the 1 mrem/yr criterion using the RS-G-1.7 standard could be recycled into roadbed material. Licensees who could demonstrate that concrete would be recycled into roadbed material could proceed with that release of material

without an initial approval of the NRC, but subject to NRC inspections in demonstrating compliance with the provisions of the rule.

Reuse of Tools and Equipment for their Original Purpose. A separate provision of the rule would address the reuse of tools and equipment for their original use. Tools and equipment that meet the 1 mrem/yr dose criterion using the IAEA standard could be reused. Equipment at a licensed facility includes scaffolds, cranes, trucks and office furniture. Smaller pieces of equipment and tools are used by workers and may be transported in and out of restricted/impacted areas as part of the routine conduct of work in those areas.

Case-specific approvals. Any request to release solid material for other than these limited dispositions or releases at higher radionuclide concentrations would require case-specific approval from NRC. For these requests, NRC would codify the process and the criteria for licensees to seek case-specific approvals under a license amendment request. The licensee would also be required to submit environmental information for the proposed action. The Proposed Rule would identify the requirements that licensees need to observe in preparing and submitting such requests. It is expected that such applications would address limited end-uses for types and amounts of materials. For example, some types of structural steel may be reused for the construction of a framework for warehouses. For soils, materials may be used as backfill or as bedding in pipe trenches. For soil-like materials with cementitious properties, materials may be used as an additive to concrete in industrial settings, such as building footings and foundations or equipment pedestals. A licensee seeking release of solid material for some limited end use would be required to request approval based on pathways, worker protection, future uses, etc. A licensee would have to provide reasonable assurance that such materials are kept out of disposition paths that are not allowed and would have to submit a dose assessment to NRC for a case-specific disposition application.

Recordkeeping. As part of its Proposed Rule, the NRC would include a requirement for records maintenance. These records would aid in allowing verification that the dose criterion has been met and provide reasonable assurance that the material was delivered to one of the allowed destinations. Licensees would be required to maintain records indicating the nature of the material released (i.e., type and quantity of solid material, and nuclides present and their concentrations) and its destination (i.e., the landfill or specific end use shipped to, etc.). For tools and equipment released from restricted/impacted areas as part of the routine conduct of business, records would be kept of the specific tool or equipment removed from the restricted/impacted area and the nuclide level of the item.

In summary, the limited dispositions for each material are as follows:

- Concrete could be disposed of in a RCRA Subtitle D landfill or recycled into roadbed material.
- Metals could be disposed of in a RCRA Subtitle D landfill.
- Tools and equipment could be disposed of in a RCRA Subtitle D landfill or could be reused.

- Trash could be disposed in a RCRA Subtitle D landfill.
- Disposition of soils would be case-specific.
- Any other disposition of these materials or disposition in landfills at higher radionuclide concentrations would require case-specific approval by NRC.

3.0 Analysis of Values and Impacts

This chapter examines the values (benefits) and impacts (costs) expected to result from NRC's Proposed Rule and its alternatives. The cost-benefit analysis sets forth the various economic benefits and costs of the alternatives under consideration, including environmental benefits. Benefits and costs are assessed at the national level. Section 3.1 presents the affected attributes. Section 3.2 presents the methodology for calculating the benefits and costs associated with each attribute, and Section 3.3 presents the results.

3.1 Identification of Affected Attributes

This section identifies the factors within the public and private sectors that the alternatives are expected to affect. These factors are classified as "attributes" using the list of potential attributes provided by NRC in Chapter 5 of its *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997).

- ***Environmental Considerations***. For each alternative, air emissions could be affected by the number of vehicle miles traveled and/or the relative production of new versus recycled materials (i.e., ferrous metal, copper, aluminum).

- ***Industry Operation***. Industry may incur operational costs or savings related to surveys, transportation of either LLW or released material, disposal as either LLW or released material, and recycling fees or revenues for released material.

- ***Public Health (Routine)***. The dose to the public associated with release levels or released materials may increase or decrease as a result of the alternatives. The dose is monetized using a value of $2,000 per person rem.

- ***Occupational Health (Routine)***. The dose to workers associated with release levels or released materials may increase or decrease as a result of the alternatives. The dose is monetized using a value of $2,000 per person rem.

- ***Public Health (Accidental)***. The number of driver fatalities associated with accidents may be affected by changes in the number of vehicle miles traveled. Fatalities are monetized using a value of $3 million per fatality.

- ***Industry Implementation***. One-time costs or savings may result from incremental activities such as reading the regulations and guidance documents; training employees on new procedures; capital outlays for equipment; increased recordkeeping if required; and researching markets and vendors for released material.

- ***NRC Implementation***. The NRC may incur an incremental staff burden to conduct the following implementation tasks: develop guidance, procedures, and aids for use by NRC; develop enforcement procedures; and develop guidance, procedures, and aids for use by licensees.

- ***NRC Operation***. The NRC may incur an annual incremental staff burden to conduct inspections, evaluate licensee compliance, and enforcement activities.

- ***Other Government***. Other government costs could include costs related to rulemakings in Agreement States. (This excludes facilities that are assumed to be covered under the industry operation and industry implementation attributes, such as DOE and DoD facilities.)

- ***Regulatory Efficiency***. The alternatives will result in benefits associated with the streamlining of procedures compared with baseline (current) procedures.

- ***Other Considerations***. Public confidence in NRC may be affected by the outcome of this action.

The following attributes are not expected to be affected:

- Occupational Health (Accidental),
- Offsite Property,
- Onsite Property,
- General Public,
- Improvements in Knowledge,
- Antitrust Considerations, and
- Safeguards and Security Considerations.

3.2 Analytical Methodology

This section presents the methodology for calculating the values (benefits) and impacts (costs) associated with each of the affected attributes. An in-house model was developed which draws upon input data including inventory quantities and dose estimates from SC&A 2003, survey costs from NRC 2004a, and various unit cost factors described in this appendix. SC&A 2003 presented data broken out by year. Consequently, the model calculates the costs in each year in which material is assumed to be released and then calculates the net present value for each alternative considered in 2003 dollars.

For a given alternative, the costs and benefits within each attribute are driven by the quantities of materials generated for release, the different types of licensees, the different types of materials, and the assumed life cycle of materials generated for release. The benefits include any desirable changes in affected attributes (e.g., improved safety, monetary savings) while the costs include any undesirable changes in affected attributes (e.g., increased radiological exposures, monetary costs). The net benefit for each alternative is the difference between the sum of the benefits of all attributes and the sum of the costs of all attributes.

With two exceptions (i.e., regulatory efficiency and other considerations), this analysis evaluates all attributes quantitatively.[5] Quantitative analysis requires a baseline characterization of factors such as the number of affected facilities, the quantities of material generated, the rate and time over which the materials are generated, cost information, and a range of other factors.

3.2.1 Scope of the Cost-Benefit Analysis

Ideally, the cost-benefit analysis should analyze each of the following:

- The five rule alternatives under consideration:

    1. No Action
    2. Unrestricted Release
        - < Material-specific limits
        - < Material-independent limits
    3. EPA/State-Regulated Disposal
        - < RCRA Subtitle D Landfill Disposal without Incineration
        - < Disposal with Trash Incineration
    4. LLW Disposal
    5. Limited Dispositions

- The five dose options (for the dose-specific alternatives):

    - 0.03 mrem/yr;
    - 0.1 mrem/yr;
    - 1.0 mrem/yr;
    - 10.0 mrem/yr; and
    - IAEA Safety Guide No. RS-G-1.7.

- All facility types:

    - Light water reactors (LWRs);
    - Independent spent fuel storage installations (ISFSIs);
    - Research reactors;
    - Facilities included in the site decommissioning management plan (SDMP);
    - Fuel cycle facilities; and
    - Other materials licensees including, but not limited to medical, academic, industrial, source, and special nuclear licensees.

- All affected materials:

    - Ferrous Metal;

[5] A third attribute, environmental considerations, is evaluated partly quantitatively and partly qualitatively.

- Concrete;
- Copper;
- Aluminum;
- Equipment, and
- Trash.

Due to the broad scope of this Draft RA and limited data availability, not all facility types and materials could be evaluated for all rule alternatives. Nevertheless, the analysis captures a substantial majority of material (i.e., items) and activity (i.e., radioactivity) that could be released, as well as the resulting dose.

Alternatives/Dose Options Considered

The cost-benefit analysis addresses all of the alternatives under consideration. For the dose-specific alternatives (i.e.,Unrestricted Release and EPA/State-Regulated Disposal), all five dose options are evaluated.

Materials/Facilities Covered

This analysis quantitatively addresses LWRs for ferrous metals, concrete, and trash. Inventory information on other metals, besides ferrous metal, indicated these were primarily copper or aluminum, and there is a small amount of these materials generated as compared to ferrous metal. The results of a screening analysis indicated that collective doses for copper and aluminum are about one to two orders of magnitude lower than that of ferrous metals. Consequently, these materials were not included in the cost-benefit analysis. Since data on the type and quantity of tools and equipment available for reuse and the frequency at which they are being released were not available, equipment reuse was not included in the cost-benefit analysis, but a scoping assessment of collective doses is presented in Appendix D, Section 12 of the Draft GEIS (NRC 2005b).

3.2.2 Data and Assumptions

This analysis draws on data regarding material quantities, doses, and survey costs that were developed in the *Collective Dose Assessment* (SC&A, 2003) and the *Clearance Survey Cost Report* (NRC 2004a), prepared under technical basis contracts for NRC. Some additional information was collected during the development of this RA.

The analysis measures the incremental impacts of each alternative relative to a baseline, which is how things would be if the alternative were not imposed (i.e., the No Action Alternative). The baseline used in this analysis assumes full licensee compliance with existing NRC requirements, including current regulations. This is consistent with the *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission* which states that, "...in evaluating a new requirement for existing plants, the staff should assume that all existing NRC and Agreement State requirements have been implemented" (NRC 2000c). Unless otherwise noted, all costs and savings estimates reflect this baseline.

Exhibit 1 depicts the life cycle of materials generated for disposal or release for the Unrestricted Release Alternative. In the other alternatives, one or more of the pathways may not be allowed. The analysis is driven by how materials flow through the different paths of the life cycle. The main decision points in the life cycle flow path determination are (1) whether the material potentially contains residual radioactivity; (2) whether the material is below the release level; (3) whether disposal is less costly than decontamination and release; and (4) whether cost effective recycling is available for the material. Exhibit 1 also shows the four possible endpoints for materials that have residual radioactively that have been released: reuse of equipment, on-site disposal, off-site disposal, and recycling for use in new products.[6]

For each of the alternatives and each of the materials, the analysis assumed that released materials will be recycled, reused, or sent to a municipal solid waste (MSW) landfill or incinerator, and that materials not meeting the clearance levels will be sent to a LLW facility for disposal. This analysis assumes economic rationality (i.e., least cost behavior) on the part of all entities affected by the rule. For example, under the Unrestricted Release Alternative, in which ferrous metal could be recycled, this analysis assumes that ferrous metal will only be recycled if it is more profitable (or less costly) to recycle ferrous metal than to dispose of it. Similarly, the costs associated with a MSW incinerator are greater than those associated with an MSW landfill due to transport and disposal costs. Therefore, this analysis assumes that facilities will not choose to send their trash to an MSW incinerator, even if allowed to do so, and instead will dispose of their trash in a MSW landfill. Consequently, the costs and benefits of EPA/State-regulated trash incineration are the same as the RCRA Subtitle D Landfill Alternative. Table 3-1 summarizes the assumptions made about how materials are managed in the baseline and in each alternative under consideration.

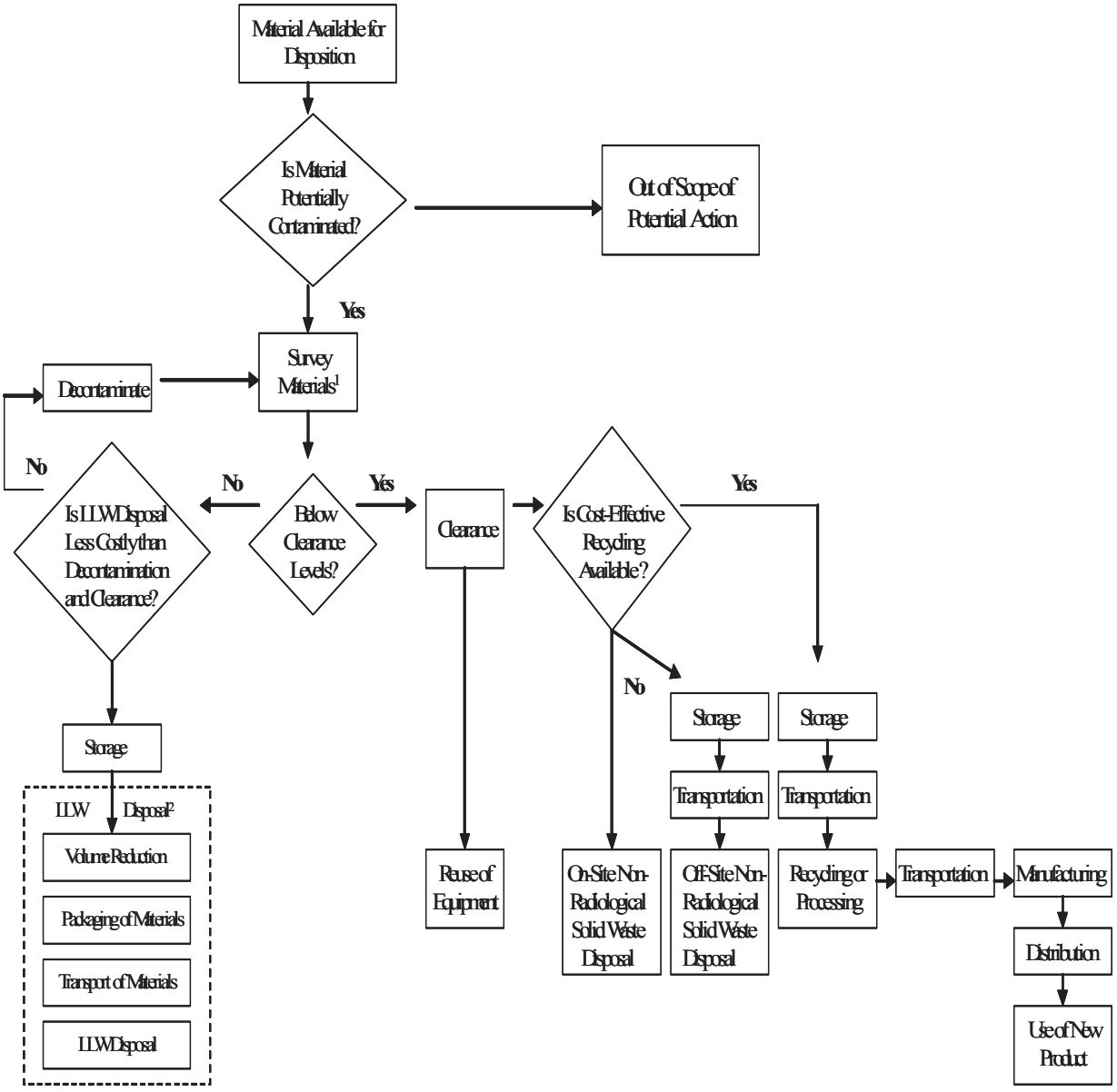
Table 3-1: Assumed Disposition of Material under Baseline and Alternatives

Alternative	Concrete	Ferrous metal	Trash
Baseline/ No Action	Recycled	Recycled	MSW Landfill
Unrestricted Release	Recycled	Recycled	MSW Landfill
EPA/State-Regulated Landfill Disposal	MSW Landfill	MSW Landfill	MSW Landfill
LLW Disposal	LLW	LLW	LLW
Limited Dispositions	Recycled*	MSW Landfill	MSW Landfill

MSW = municipal solid waste; LLW = low-level waste

* Concrete would be released at or below the 1 mrem/yr criterion and could be recycled into roadbed material.

[6] On-site disposal is not considered here. Doses from the on-site landfill would be included in the dose analysis conducted in a licensee's decommissioning analysis. Reuse of equipment is considered qualitatively because data on amount of equipment that would be available for reuse were not available.



1 Survey may include knowledge of where material was located and/or measurement of radioactivity levels.

2 Material can be disposed of under other NRC regulations, such as 10 CFR Subpart K § 20.2002.

Exhibit 1: Generalized Material Life Cycle for Potentially Cleared Materials

The analysis also assumes it will not be cost effective to decontaminate and resurvey any material that is not clearable based on the initial survey. Such material is assumed to be sent for disposal at a LLW facility. Additionally, recycling fees and/or revenues from recycling only are calculated for the first recipient of the material (e.g., a scrap yard) because after that point, the material has been "released." [7]

[7] In contrast, dose is calculated through end users.

The time frame for which costs are estimated differs based on the remaining operating life of the relevant LWRs. For the analysis as a whole, however, costs and savings are estimated over approximately 47 years, with each year's costs and savings discounted back to the present at both a seven- and a three-percent discount rate, in accordance with NUREG/BR-0184 (NRC 1997) and OMB Circular A-4. The 47-year period encompasses the planned shutdown dates and subsequent decommissioning of all LWRs. Dose is estimated for 300 years, because the dose will not cease at the end of 47 years. In fact, dose will continue after 300 years, however, after that point, dose becomes negligible in the cost-benefit analysis.

Further, the current and future cost of disposal and other disposal options are assumed to equal the current applicable disposal fee. It is possible that new disposal capacity will be required, or required earlier, as a result of some alternatives of this rule. If new disposal facilities are constructed, it is possible that disposal costs will change as a result. To address the uncertainty of LLW disposal costs, which are a major cost driver, this analysis conducts a sensitivity analysis that considers the effect of a 15 percent increase in disposal costs effective in the year 2020. A second sensitivity analysis was performed to assess the impact of transportation costs on the overall benefits and costs of the alternatives. In the main analysis all material was assumed to be shipped by truck. However, given the long distances that are involved in transporting material to LLW disposal facilities (1,544 miles on average), a sensitivity analysis was run in which all material being shipped to LLW facilities was shipped by rail. Section 3.3.7 presents the results of these sensitivity analyses.

3.2.3 Attribute Methodology Introduction

The methodology for analyzing the cost and benefits of the 11 affected attributes is discussed in the following subsections. Each subsection describes the attribute and presents the equations that were used to analyze the attribute. These subsections also present data on unit costs and major assumptions used in evaluating each attribute. The methodology for calculating the environmental considerations attribute has a detailed discussion because the calculations were complex. For the other attributes, one or more equations are included followed by a table that contains the definition of the equation's parameters. Some of the attributes are partitioned into "sub-attributes" where more detailed analysis is required.

These equations present the cost or benefit in a given year for material being cleared from light water reactors. While other types of facilities are affected by this rule, sufficient information was not available to calculate quantitative costs or benefits for these other types of facilities. The costs and benefits are calculated for each year in the analysis time horizon (2003-2049), converted to present value and summed to calculate the net present value (in $2003), as described in Section 3.2.15.

To determine the incremental benefit or cost relative to the baseline (No Action), the analysis subtracts the baseline benefits or costs from each alternative's benefits or cost. Negative results indicated net costs, while positive results indicate net benefits. The incremental costs associated with the No Action Alternative would be zero (because there is no change relative to the baseline). All unit costs are presented as negative numbers in the tables and assumptions following the equations, under the description where the numerical value of the cost is presented.

The unit costs for the analysis are given in the format of a negative number so that the result of the equations, when calculated using numbers, yield the appropriate value indicating whether the alternative results in a net benefit or cost for that attribute.

3.2.4 Attribute - Environmental Considerations

This section discusses the methodology for calculating the environmental benefits of the rule under each alternative. Most of the incremental environmental benefits are expected to result from air emissions avoided as a result of changes in transportation destinations and increases in recycling (i.e., reductions in manufacturing using virgin materials) due to clearance of additional materials. This section provides a detailed analysis of these benefits for structural ferrous metal, concrete, and trash. Due to data limitations and the small total volume of materials, the analysis presents discussions of the benefits associated with the reuse of aluminum and copper products in aggregate terms without the level of detail for the other materials.

The environmental benefits due to changes in transportation needs, which cause changes in air emissions, are calculated for the relevant solid materials by multiplying the changes in net miles (i.e., miles traveled under a specific alternative minus miles traveled under the baseline) by the appropriate emission factors for different pollutants and different transportation modes. These air emission changes are then monetized by multiplying by the price per ton for each pollutant. Aggregate environmental benefit estimates are then derived by summing over four pollutants (Sulfur Dioxide (SO_2), Nitrogen Oxides (NO_x), Particulate Matter (PM), and Carbon Dioxide (CO_2)).

Similarly, environmental benefits caused by changes in manufacturing needs for the relevant materials are calculated by multiplying the changes in the amount of recyclable material that are estimated to be released under this rule by the appropriate emission factors for relevant pollutants. Again, to monetize these benefits, total emission changes are multiplied by the price per ton for each pollutant. Finally, aggregate environmental benefits are derived by summing over the four pollutants.

Note that the overall methodology described above, while appropriate, has not been applied for all the different materials released under this rule. For example, environmental benefits due to recycling of released concrete are not expected to be significant and therefore, have been left out of the analysis. Sections 3.2.4.1 through 3.2.4.5 discuss the estimation of environmental benefits in detail for each material.

The quantities of materials released under this rule are not expected to be large enough to have a disruptive effect on the current market conditions, in terms of its impact on the recycling rates or the current demand/supply conditions. For example, the ferrous metal industry is likely to have the largest potential impact from recycling scrap ferrous metal as a result of this proposed rule. The net amount of scrap ferrous metal salvaged under the rulemaking alternatives (i.e., the amount salvaged relative to the No Action Alternative) would range between a maximum increase of 0.03 million tons and a maximum decrease of 0.13 million tons annually. According to the most recent data, annual U.S. production of ferrous metal is approximately 100 million tons. This means that the changes in ferrous metal scrap due to this rule would be approximately a tenth of a percent of the total U.S. ferrous metal market and therefore not expected to have any

significant disruptions. Section 3.2.4.1 presents a brief discussion of the market share analysis for ferrous metal.

3.2.4.1 Ferrous Metal

Under the Unrestricted Release Alternative, the most significant environmental benefit is the recycling of ferrous metal released under this rule, which means less virgin ferrous metal is produced.[8] Virgin ferrous metal is produced in integrated ferrous metal mills using a three-step process that involves cokemaking, ironmaking, and Basic Oxygen Furnace (BOF) technology. Cokemaking and ironmaking processes have the greatest impact on the environment because large quantities of SO_2, NO_x, PM, and CO_2 are emitted. Electric Arc Furnace (EAF) facilities, often referred to as minimills, use up to 100 percent of scrap metal to produce ferrous metal. EAF technology does not require cokemaking and ironmaking processes. As a result, minimills emit less SO_2, NO_x, PM, and CO_2 per unit of output relative to integrated mills.

Under the EPA-Regulated Disposal Alternative, which prohibits recycling, environmental benefits result primarily from a reduction in the amount of fuel burned compared to the LLW Disposal Alternative. Less fuel is used because fewer vehicle miles are traveled (MSW landfills are located closer to NRC-licensed facilities than LLW facilities).

The following two sections explain the methodology for estimating environmental benefits in transportation and ferrous metal manufacturing sectors.

Benefits Due to Transportation Changes

The analysis calculates the change in air emissions by multiplying the net miles traveled by the corresponding emission factors for different pollutants. The following section explains how the emission factors are derived.

Based on the geographic location of NRC-licensed facilities relative to rail and highway infrastructure, the analysis assumes that ferrous metal scrap is transported by trucks. Depending on the alternative, one-way haul distances range from approximately 60 miles to over 1,500 miles. Given the range of haul distances, the analysis assumes that both short- and long-haul trucks transport ferrous metal scrap from NRC-licensed facilities. For the purpose of this analysis, long-haul trucks are characterized as: (1) class 8b heavy-duty diesel trucks; (2) trucks traveling long distances (greater than 200 miles from their home base); and (3) trucks traveling at higher speeds over longer distances. Short-haul trucks are characterized as: (1) class 8b heavy-duty diesel trucks; (2) trucks traveling less than 200 miles from their home base; and (3) trucks operating mostly in urban areas.

[8] The ferrous metal industry has stated that it will not reprocess scrap ferrous metal with residual radioactivity. If true, this would substantially reduce the rule's environmental benefits. This analysis, however, assumes that recyclable ferrous metal will be recycled because it is not clear from available information how the steel industry views released steel. It is possible that it is currently being released and disposed, rather than released and recycled.

The air emissions standards for short- and long-haul trucks are expected to change over the period covered by this analysis. Therefore, the study models emission factors assuming that, on average, every five years a new standard for on-road vehicle emissions would be established. Thus, the standard established in 2003 would stay in effect until 2009 and a new standard would be established in 2010. This new standard would be applicable in 2010 and would stay in effect until 2014. The emission factors are not modeled past 2030 to avoid excessive speculation. Therefore, the standard established in 2030 is assumed to stay in effect until 2049. Fleet age and replacement also influence these factors, accounting for the increases seen in the CO_2 emission factors. The emission factors by pollutant for long-haul and short-haul trucks are presented in Tables 3-2 and 3-3, respectively.

Table 3-2 Emission Factors (in grams/mile) for Long-Haul Trucks

Year	SO_2	NO_x	PM_{10}	CO_2
2003	0.3440	27.919	0.3096	1615.2
2010	0.0110	9.720	0.1471	1611.6
2015	0.0110	2.612	0.0910	1613.0
2020	0.0110	1.235	0.0779	1613.4
2025	0.0110	0.997	0.0770	1613.5
2030	0.0110	0.960	0.0767	1613.5

Table 3-3 Emission Factors (in grams/mile) for Short-Haul Trucks

Year	SO_2	NO_x	PM_{10}	CO_2
2003	0.3557	25.779	0.6184	1665.2
2010	0.0111	13.765	0.2599	1617.6
2015	0.0110	6.394	0.1591	1612.1
2020	0.0110	2.737	0.0989	1612.6
2025	0.0110	1.143	0.0836	1613.2
2030	0.0110	0.702	0.0781	1613.4

Source: ICF Analyses using EPA MOBILE 6.2 emissions factor model and 1997 Vehicle Inventory and Use Survey (VIUS).

Benefits Due to Manufacturing Changes

Although this analysis assumes no significant disruptions to the ferrous metal market as a result of the rule (see market share analysis presented below), the slight change in the market price of ferrous metal is important to the analysis of virgin ferrous metal displacement. The ferrous metal market consists of ferrous metal products made from iron ore (i.e., using BOF technology) and those made from scrap (i.e., using EAF technology). Under the Unrestricted Release Alternative, the supply of ferrous metal products made from scrap would increase. The increase in the supply of ferrous metal made from scrap would ultimately lead to an overall increase in the supply of all ferrous metal. Based on the economic principles of supply and demand, this would cause the price of ferrous metal to decrease slightly.[9] The slight drop in the price of ferrous metal is

[9] Assuming that the demand for ferrous metal is downward sloping and the supply of ferrous metal is upward sloping, the magnitude of the price change would depend on the elasticities of the supply and

expected to lead to a slight increase in quantity demanded for ferrous metal. In addition, the quantity supplied of virgin ferrous metal is expected to decrease slightly as a result of the decrease in the market price of ferrous metal.

The general approach used in this analysis is to estimate the quantity of ferrous metal scrap that would be recycled under each regulatory alternative relative to the baseline, determine the quantity of domestic virgin ferrous metal that would be displaced, derive emission factors for each pollutant emitted in the production of virgin ferrous metal, and then multiply emission factors by quantity of virgin ferrous metal displaced.

The industry data indicate that minimills use, on average, 1.07 kilograms of scrap to produce 1 kilogram of ferrous metal (IISI 2002). The study uses this ratio of scrap to ferrous metal to estimate the amount of ferrous metal that would be produced from licensees' scrap. As previously explained, the increase in the supply of ferrous metal made from NRC scrap would cause a slight decrease in the price of ferrous metal and, in turn, increase the quantity of ferrous metal demanded. In order to estimate how much of the ferrous metal would be replaced by the ferrous metal made from scrap generated by this rule, the study makes a simplifying assumption that the elasticities of supply and demand are equal. Under this assumption, an increase of one million ton in the supply of ferrous metal products made from ferrous metal scrap (released by licensees) generated by this rule would result in 0.5 million ton increase in quantity demanded of ferrous metal, and 0.5 million ton decrease in the quantity supplied of ferrous metal (both virgin ferrous metal and ferrous metal made from scrap). The assumed decreased supply of scrap metal would not be limited to material not generated by this rule. It is assumed that the decrease in supply could be from scrap generated by this rule or scrap not generated by this rule. This assumption is based on the idea that once the scrap metal enters the market, it becomes part of the total scrap market and no differentiation is made as to whether it was generated as a result of the rule or not.

The quantity of virgin ferrous metal consumed domestically is supplied by both domestic and foreign producers. The analysis, however, focuses only on air emissions avoided through the displacement of domestic virgin ferrous metal. In reality, CO_2 does have trans-boundary implications. Estimating the increase in ambient concentration of CO_2 in the US resulting from foreign production of virgin ferrous metal is, however, beyond the scope of this analysis.

To understand how much of domestic virgin ferrous metal can be replaced with the scrap generated by this rule under various alternatives, the study first estimates the share of virgin ferrous metal in the total domestic consumption of ferrous metal, and then calculates the share of US virgin ferrous metal consumed domestically.

The average annual US production of ferrous metal is 98 million tons (for the period 1997-2001), with 53 million tons of ferrous metal products produced using iron ore (i.e, virgin ferrous metal using BOF technology). In order to account properly for air emissions in manufacturing of virgin ferrous metal, the study assumes that all of the U.S. virgin ferrous metal is consumed

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demand of ferrous metal. Although the price change estimation is beyond the scope of this analysis, the change in price is not expected to be significant as the increase in supply is relatively small.

domestically. Therefore, for the purpose of this analysis, the U.S. consumption of virgin ferrous metal is equal to the U.S. production of virgin ferrous metal plus the U.S. imports of virgin ferrous metal. Based on the estimated amount of foreign virgin ferrous metal imported annually, the estimated total amount of virgin ferrous metal available for domestic consumption is 77 million tons per year.[10]

The next step in the analysis is to estimate the share of domestic virgin ferrous metal in the U.S. consumption of ferrous metal. The U.S. Geological Survey (USGS) data for 1997-2001 (USGS 2004c; USGS 2004d) indicate that the average annual U.S. consumption of ferrous metal is approximately 117 million tons. Based on the study estimates presented above, virgin ferrous metal products account for 66 percent of the total ferrous metal consumption in the U.S. (77 million tons / 117 million tons = 66 percent). Out of 77 million tons of virgin ferrous metal products consumed domestically, 53 million tons, or 69 percent, is produced domestically. Therefore, to derive the amount of domestic virgin ferrous metal displaced, the study first multiplies the total quantity of ferrous metal displaced by 0.66 to derive the amount of virgin ferrous metal displaced in the domestic consumption, and then by 0.69 to calculate the amount of domestic virgin ferrous metal displaced.

As stated previously, virgin ferrous metal production includes cokemaking and ironmaking processes. These two processes are not required when using EAF technology (i.e., when making ferrous metal products from ferrous metal scrap). The industry data indicate that the production of ferrous metal by BOF technology requires about 0.7 tons of pig iron and between 0.35 and 0.65 tons of coke (DOE 2000; IISI 2002). The study uses these factors to estimate the amount of pig iron and coke required to produce the amount of domestic virgin ferrous metal that would be displaced by the NRC ferrous metal scrap.[11]

The next step in the analysis is to estimate the total amount of emissions avoided through the displacement of domestic virgin ferrous metal. The analysis uses the emission factors for the iron and ferrous metal industry derived by DOE (DOE 2000). The emission factors are presented in Table 3-4.

To estimate the total amount of emissions avoided, the study multiplies the emission factors by the amount of coke and pig iron saved through recycling of NRC ferrous metal scrap.

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[10] Using the USGS data for 1997-2001, the study estimates that approximately 75 percent of the world production of ferrous metal is produced from virgin ferrous metal (i.e., using BOF technology). The study then assumes that 75 percent of the ferrous metal products imported by the U.S. are made from virgin ferrous metal. The analysis estimates that out of 32 million tons of ferrous metal imported annually, approximately 24 million tons are virgin ferrous metal products (32 million tons * 75 percent = 24 million tons). Based on the estimated amount of imported virgin ferrous metal, the total amount of virgin ferrous metal available for domestic consumption is 77 million tons per year (53 million tons + 24 million tons = 77 million tons).

[11] Using the mid point of the 0.36-0.65 range yields an average ratio of coke to ferrous metal of 0.5.

Table 3-4 Emission Factors for Criteria Pollutants by Ferrous Metalmaking Process

Process	Units	SO_2	NO_x	PM	CO_2
Integrated Mills					
Cokemaking	lbs/ton of coke	4.1	0.98	1.374	389.17
Ironmaking	lbs/ton of ferrous metal	26.47	10.27	7.624	2,000.0

Source: DOE.

Data on Pollutant Prices

The study estimates the monetary value of environmental benefits by multiplying the estimated net emissions by the estimated allowance price for each pollutant. Under competitive market conditions, allowance prices are expected to provide the estimated monetary value for reducing a unit of the relevant pollutant. For SO_2 and NO_x, allowance prices used are based on EPA's projections for 2006 to 2020 for the proposed multi-pollutant scenario, known as the Clear Skies Act found in ICF Consulting's Integrated Planning Model (an analytical model designed to evaluate various aspects of electric power production, including air pollution). Allowance prices for SO_2 and NO_x used in this analysis are as shown in Table 3-5.

Table 3-5 Allowance Prices for SO_2 and NO_x

Year	SO_2 ($/ton)	NO_x ($/ton)
2006	493	1844
2010	605	1,063
2015	785	1,081
2020	1,018	1,402

Note that the prices were not estimated past 2020 to avoid speculation. For the years past 2020, the estimated allowance price for 2020 is used.

For particulate matter and CO_2, this study uses the 1990 Pace University Study (Ottinger et al. 1990)[12] estimate of $3,516 per ton of particulate matter and $20 per ton of CO_2. The Pace study, prepared for the New York State Energy Research and Development Authority and DOE examines the environmental costs associated with a variety of energy sources and environmental effects (e.g., air pollution, global warming, land use).

[12] Reproduced from U.S. Congress, Office of Technology Assessment, Studies of the Environmental Costs of Electricity, OTA–ETI–134 (Washington, DC: U.S. Government Printing Office, September 1994, page 24).

3.2.4.2 Concrete

Benefits Due to Transportation Changes

Most of the incremental environmental benefits would be provided through reduction in fuel burned by decreasing haul distances. The study used the same methodology for estimating environmental benefits from the change in air emissions as presented above for ferrous metal.

Benefits Due to Manufacturing Changes

Recycled concrete is used in place of virgin aggregate primarily as road base material. The analysis assumes that concrete cleared from NRC-licensed facilities would be used in the same capacity. The available publications on concrete recycling, however, do not indicate that there are considerable environmental benefits in terms of emissions avoided from using recycled concrete, instead of virgin aggregate, in road construction (DOT 2003). Therefore, the study does not estimate environmental benefits from recycling of concrete.

3.2.4.3 Trash

Benefits Due to Transportation Changes

Under both the Unrestricted Release and EPA-Regulated Disposal Alternatives, trash from NRC-licensed facilities would be disposed in MSW landfills or low-level waste facilities. Trash would not be recycled or used for any purpose that would yield environmental benefits. The type and location of permitted landfills, however, would vary depending on the alternative. Thus, some environmental benefits would be provided through reduction in fuel burned by decreasing the distances that material is hauled. The study uses the same methodology for estimating environmental benefits from the change in air emissions as presented above for ferrous metal. For the EPA-Regulated Disposal Alternative, no incineration of trash is expected because it is less expensive to send material to an MSW landfill for disposal.

3.2.4.4 Copper

This analysis presents a brief discussion of the environmental benefits from recycling copper. The analysis is constrained by the lack of detailed data on the quantity of copper expected to be recycled due to this rule. SC&A 2003 estimates there are about 6,584 tons of potentially clearable copper; this is about one-quarter percent of the total mass of ferrous metals (which is about 2.4 million tons). Also, lack of detailed annual estimates of potentially clearable copper for different alternatives precludes estimating incremental environmental benefits due to this rule (i.e., benefits over a No Action "baseline"). However, copper is a valuable material and any quantity generated by this rule can be expected to be recycled with tangible environmental benefits, since recycling copper is generally considered less energy-intensive than producing

copper from ore.[13] Given the limitations of the data, this analysis does not quantify this environmental benefit.

3.2.4.5 Aluminum

SC&A 2003 estimates there are about 212 tons of potentially clearable aluminum from decommissioning all licensed facilities; this is about a tenth of a percent of the total mass of ferrous metals.[14] Again, because of data limitations, this analysis does not attempt to quantify the incremental environmental benefits from this amount, but notes that the environmental benefit from this small amount of aluminum can be expected to be finite but less than that for copper.

3.2.4.6 Market Share Analysis

This section provides a market share analysis for ferrous metal, copper, and aluminum. The analysis provides a description of the effects that the proposed action could have on the market for these metals, if any.

Ferrous metal

In the period 1997-2001, U.S. production of ferrous metal was, on average, almost 100 million metric tons. Approximately 54 percent of ferrous metal products were produced from virgin materials such as iron ore and coal using BOF technology. The remainder, 46 percent, was produced from ferrous metal scrap in EAF facilities. These data show that the U.S. ferrous metal industry already has a high recycling rate. The rate is expected to increase under the Unrestricted Release Alternative. Although most of the U.S. demand is satisfied through domestic production, ferrous metal imports account for 25 to 30 percent of annual consumption of ferrous metal. The summary statistics for the U.S. iron and ferrous metal industry are presented in Table 3-6 (USGS 2004c; USGS 2004d).

The net amount of scrap salvaged under the alternatives (i.e., the amount salvaged relative to the base case) would range between a maximum increase of 0.03 million tons to a maximum decrease of 0.13 million tons annually, or between 0.03 percent and 0.13 percent of the annual consumption, respectively. These quantities are relatively small compared to the total amount of ferrous metal products consumed annually. Therefore, the rule is not expected to cause any significant disruptions to the U.S. market for ferrous metal.

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[13] See for example, "The Life Cycle of Copper, its Co-Products and By-Products," International Institute for Environment and Development (IIED), 2002.

[14] *Ibid.*

Table 3-6 U.S. Iron and Ferrous Metal Industry Summary Statistics from USGS (in million metric tons of metal)

	1997	1998	1999	2000	2001[1]
Pig Iron Production	49.6	48.2	46.3	47.9	44.2
Ferrous Metal Production	98.5	98.6	97.4	102	92.9
Basic Oxygen Furnaces	55.4	54.1	52.3	54.1	49.4
Electric Arc Furnaces	43.1	44.5	45.1	47.9	43.5
Imports of Ferrous Metal Mill Products	28.3	37.7	32.4	34.4	26.2
Exports of Ferrous Metal Mill Products	5.5	5.0	4.9	5.9	5.6
Apparent Ferrous Metal Consumption[2]	114	118	116	119	118

[1] Estimated values.

[2] Apparent consumption = production + imports – exports + adjustment for industry stock changes + adjustment for imports of semi-finished ferrous metal products.

Source: USGS 2004c, USGS 2004d

Copper

In the period 1997-2001, average annual U.S. production of copper was almost 3 million metric tons. Approximately 63 percent of copper products were produced from virgin materials such as ore, concentrate, or precipitate. The remaining 37 percent was produced from old scrap (secondary production), new scrap, or refinery scrap. Old scrap refers to obsolete or discarded end-use items that are recycled. New scrap represents the copper that is recovered from scrap generated during manufacturing (e.g., stampings, defective parts, etc.), and returned to smelters, refineries, or mills for reprocessing. Refinery scrap may have been processed through smelting and electrolytic refining or directly processed at a fire refinery. Although most of the U.S. demand is satisfied through domestic production, copper imports account for around 30 percent of annual consumption of copper. The summary statistics for the U.S. copper industry are presented in Table 3-7 (USGS 2004a).

The net amount of scrap salvaged under the rulemaking alternatives (i.e., the amount salvaged relative to the base case) would total 6,584 tons. This quantity is relatively small compared to the total amount of copper consumed annually. Even if all of this copper was generated in the same year, it would only represent 0.22 percent of the average U.S. annual copper consumption. Therefore, the rule is not expected to cause any significant disruptions to the U.S. market for copper.

Table 3-7 U.S. Copper Industry Summary Statistics from USGS (in million metric tons of metal)

	1997	1998	1999	2000	2001
Primary Production	2.07	2.14	1.89	1.59	1.63
Secondary Production	0.498	0.466	0.381	0.357	0.316
New Scrap	0.967	0.956	0.949	0.955	0.833
Refinery Scrap	0.396	0.349	0.23	0.208	0.172
Imports	0.632	0.683	0.837	1.06	0.991
Exports	0.0929	0.0862	0.0252	0.0936	0.0225
Apparent Copper Consumption[1]	2.94	3.03	3.13	3.13	2.5

[1] Apparent consumption = primary production + secondary production + imports – exports ± adjustment for industry stock changes.

Source: USGS 2004a.

Aluminum

In the period 1996-2000, average annual U.S. production of aluminum was just over 7 million metric tons. Approximately 51 percent of aluminum products were produced from virgin materials. The remaining 49 percent was produced from secondary sources. Secondary production includes metal recovered from post-consumer aluminum scrap and fabrication aluminum scrap. Although the majority of the U.S. demand is satisfied through domestic production, aluminum imports account for about 48 percent of annual consumption of aluminum. The summary statistics for the U.S. aluminum industry are presented in Table 3-8 (USGS 2004b).

The net amount of scrap salvaged under the rulemaking alternatives (i.e., the amount salvaged relative to the base case) would total 212 tons. This quantity is relatively small compared to the total amount of aluminum consumed annually. Even if all of this aluminum was generated in the same year, this amount would only represent 0.003 percent of the average U.S. annual aluminum consumption. Therefore, the rule is not expected to cause any significant disruptions to the U.S. market for aluminum.

Table 3-8 U.S. Aluminum Industry Summary Statistics from USGS (in million metric tons of metal)

	1996	1997	1998	1999	2000
Primary Production	3.577	3.603	3.713	3.779	3.668
Secondary Production	3.31	3.55	3.44	3.69	3.45
Imports	2.81	3.08	3.55	4	3.91
Exports	1.5	1.57	1.59	1.64	1.76
Apparent Aluminum Consumption[1]	6.61	6.72	7.09	7.77	7.53

[1] Apparent consumption = primary production + secondary production + imports – exports ± adjustment for industry stock changes.

Source: USGS 2004b

3.2.5 Attribute – Industry Operation

Attribute Definition and Identification of Driving Factors

Industry Operation measures yearly net incremental cost and benefits (e.g., relevant capital, operating, and maintenance costs) due to changes in industry operations, including incremental costs and savings for each of the following four sub-attributes:[15] (1) ongoing decision making/paperwork, (2) survey of materials, (3) solid waste disposal, recycling, or reuse, and (4) transportation.

1. *Sub-Attribute - Decision Making/Paperwork.* This sub-attribute captures the costs associated with preparing any required documents for the clearance of materials.

2. *Sub-Attribute - Survey of Materials.* Unit cost estimates for surveying materials reflect variations in the type of material to be surveyed, the physical shape of the material, contamination potential of the material, dose option that must be met, the initial activity level of the material, and whether materials are surveyed on or off site.

3. *Sub-Attribute - Solid Waste Disposal or Recycling.* This sub-attribute includes cost or revenue information for the following three elements: (1) Low-Level Waste Disposal, (2) Off-Site Solid Waste Disposal, and (3) Recycling. Unit costs include tipping fees and revenue from recycling materials.

4. *Sub-Attribute - Transportation*. Unit cost estimates for transportation reflect: (1) the average distances between licensees and the nearest LLW disposal facilities, EPA-regulated landfills, recycling facilities, or reuse facilities; (2) the average

[15] If decontamination were conducted, it also would be counted as a cost under industry operation. However, this analysis assumes that it is not cost-effective to decontaminate and re-survey materials in order to clear them.

capacity of trucks used, and (3) the cost per ton-mile to ship cleared material versus controlled material.

The quantities of materials (ferrous metal, concrete, and trash) that are released in the baseline and for each alternative are taken from the collective dose assessment report, as described in Table 3-9. For the alternatives with dose options (Unrestricted Release and EPA-Regulated Disposal), quantity information was provided for the 0.03 mrem/yr, 0.1 mrem/yr, 1 mrem/yr, and 10 mrem/yr options. For the IAEA Safety Guide No. RS-G-1.7 dose option, the quantities were assumed to be equal to the 1 mrem/yr dose option.

Table 3-9 Quantity Sources in SC&A 2003

Description in Cost-Benefit Analysis	Description in SC&A 2003
Baseline/No Action	No Action (Case A)[16]
Unrestricted Release: Material-Specific Limits	Case A
Unrestricted Release: Material-Independent Limits	Case B
EPA-Regulated Disposal without Incineration	Case C
EPA-Regulated Disposal with Trash Incineration	Case C2
LLW Disposal	No Action (Case A)
Limited Disposition	Case B (Concrete); Case C (Ferrous metal and Trash)

Table 3-10 presents the total quantities of material released under the baseline (No Action Alternative) and each alternative. As can be seen, different amounts of material are released under each alternative and dose option. That is, not only could a different amount of material be released between the 0.03 mrem/yr dose option and the 0.1 mrem/yr dose option, but within the 0.03 mrem dose options, different amounts are released depending on the alternative. In the 0.03 mrem/yr dose option in any alternative, less material clears and is available for release than in the baseline (or No Action Alternative). Positive values in the change in quantity released column indicate that more material meets release levels under the alternative than in the baseline. This "newly releasable" material is assumed to be sent to disposal in a LLW facility in the baseline. Often this change in the quantity that can be released drives the results of the cost modeling. Table 3-11 presents the quantities of each type of material (ferrous metals, concrete, and trash) that could be released under each alternative and dose option.

[16] The collective dose report (SC&A 2003) presents different values for the dose associated with the No Action Alternative. This cost-benefit analysis assumes the most appropriate version of the quantities and dose associated with the No Action Alternative (and hence the baseline) is in fact the No Action Alternative in the collective dose report (SC&A 2003) associated with the Unrestricted Release Alternative.

Table 3-10 Material Quantities Released by Alternative

Alternative	Dose	Baseline Tons Released	Alternative Quantity Released	Change in Quantity Released
No Action	NA	17,954,742	17,954,742	0
Unrestricted Release Material Specific Limits	0.03	17,954,742	15,735,586	(2,219,156)
	0.1	17,954,742	18,768,310	813,568
	1	17,954,742	21,525,814	3,571,072
	10	17,954,742	21,909,149	3,954,407
Unrestricted Release Material Independent Limits	0.03	17,954,742	15,247,765	(2,706,977)
	0.1	17,954,742	18,080,580	125,838
	1	17,954,742	21,044,465	3,089,723
	10	17,954,742	21,709,582	3,754,840
	RS-G-1.7	17,954,742	21,044,465	3,089,723
EPA/State-Regulated Disposal (Landfill)	0.03	17,954,742	16,888,904	(1,065,838)
	0.1	17,954,742	19,570,465	1,615,723
	1	17,954,742	21,790,651	3,835,909
	10	17,954,742	21,928,420	3,973,678
	RS-G-1.7	17,954,742	21,790,651	3,835,909
LLW Disposal/ Prohibition	NA	17,954,742	17,954,742	-
Limited Disposition	RS-G-1.7	17,954,742	21,694,631	3,739,890

Table 3-11 Quantities Released Under Baseline and Alternatives by Dose Option and Material

Alternative	Dose	Baseline Tons Released			Alternative Tons Released			Change in Quantity Released		
		Ferrous metal	Concrete	Trash	Ferrous metal	Concrete	Trash	Ferrous metal	Concrete	Trash
No Action	NA	1,803,602	16,130,738	20,402	1,803,602	16,130,738	20,402	0	0	0
Unrestricted Release Material Specific Limits	0.03	1,803,602	16,130,738	20,402	759,254	14,962,692	13,640	(1,044,347)	(1,168,047)	(6,762)
	0.1	1,803,602	16,130,738	20,402	1,256,607	17,490,696	21,007	(546,995)	1,359,958	605
	1	1,803,602	16,130,738	20,402	1,940,589	19,544,245	40,979	136,987	3,413,507	20,577
	10	1,803,602	16,130,738	20,402	2,171,232	19,671,833	66,084	367,630	3,541,094	45,682
Unrestricted Release Material Independent Limits	0.03	1,803,602	16,130,738	20,402	284,888	14,962,692	186	(1,518,714)	(1,168,047)	(20,216)
	0.1	1,803,602	16,130,738	20,402	589,452	17,490,696	432	(1,214,150)	1359958	(19,970)
	1	1,803,602	16,130,738	20,402	1,498,424	19,544,245	1,796	(305,178)	3,413,507	(18,606)
	10	1,803,602	16,130,738	20,402	2,031,852	19,671,833	5,897	228,250	3541094	(14,505)
	RS-G-1.7	1,803,602	16,130,738	20,402	1,498,424	19,544,245	1,796	(305,178)	3,413,507	(18,606)
EPA/State-Regulated Disposal (Landfill)	0.03	1,803,602	16,130,738	20,402	1,332,548	15,542,717	13,640	(471,054)	(588,021)	(6,762)
	0.1	1,803,602	16,130,738	20,402	1,742,296	17,807,161	21,007	(61,306)	1,676,423	605
	1	1,803,602	16,130,738	20,402	2,109,407	19,640,265	40,979	305,805	3,509,527	20,577
	10	1,803602	16,130,738	20,402	2,190,503	19,671,833	66,084	386,901	3,541,094	45,682
	RS-G-1.7	1,803602	16,130,738	20,402	2,109,407	19,640,265	40,979	305,805	3,509,527	20,577
LLW Disposal/ Prohibition	NA	1,803602	16,130,738	20,402	1,803,602	16,130,738	20,402	-	-	-
Limited Disposition	RS-G-1.7	1,803,602	16,130,738	20,402	2,109,407	19,544,245	40,979	305,805	3,413,507	20,577

Attribute Equations

The following four equations are used to calculate the net change in costs and benefits due to the Industry Operation attribute.

Equation 1 - Decision Making/Paperwork

The administrative costs associated with decision making and paperwork of the *Industry Operation* attribute are estimated as follows:

$$Decision\ Making/Paperwork = (HOURS_{Technical} \times WAGE_{Technical})$$

Parameter	Description
$HOURS_{Technical}$	The number of additional hours required for administrative tasks by technical workers (see assumptions below)
$WAGE_{Technical}$	The loaded hourly wage per technical labor (see assumptions below)

Assumptions

- The number of administrative hours per licensee undergoing their first year of decommissioning required by technical staff ($HOURS_{Technical}$) is equal to 200 hours.[17]
- The hourly wage rates used throughout the equations in this appendix for each labor category are as follows:[18]
    - Technical labor ($WAGE_{Technical}$) = -$33.84 per hour per person (OPM, 2004)[19]
    - Managerial labor ($WAGE_{Managerial}$) = -$48.22 per hour per person (OPM, 2004)[20]
    - Attorney or lawyer labor ($WAGE_{Legal}$) = -$67.04 per hour per person (OPM, 2004)[21]
    - Clerical labor ($WAGE_{Clerical}$) = -$20.58 per hour per person (OPM, 2004)[22]

[17] Based on Best Professional Judgment and guidance in NUREG-6477 (NRC 1998).

[18] As discussed in Section 3.2.3, the unit costs are presented as negative in order to provide results that correctly identify benefits as positive and costs as negative.

[19] GS-11, Step 1 with a standard overhead factor of 1.6.

[20] GS-13, Step 1 with a standard overhead factor of 1.6.

[21] GS-15, Step 1 with a standard overhead factor of 1.6.

[22] GS-6, Step 1 with a standard overhead factor of 1.6.

Equation 2 - Survey costs

The net survey costs associated with the *Industry Operation* attribute are estimated as follows:

$$Survey = [(COST_{ferrous\ metal\ dose\ survey} \times QUANTITY_{ferrous\ metal\ dose}) + (COST_{concrete\ dose\ survey} \times QUANTITY_{concrete\ dose}) + (COST_{trash\ dose\ survey} \times QUANTITY_{trash\ dose})] - [(COST_{ferrous\ metal\ baseline\ survey} \times QUANTITY_{ferrous\ metal\ baseline}) + (COST_{baseline\ concrete\ survey} \times QUANTITY_{concrete\ baseline}) + (COST_{trash\ baseline\ survey} \times QUANTITY_{trash\ baseline})]$$

Parameter	Description
$COST_{baseline\ concrete\ survey}$	Baseline survey costs per ton of concrete (see table 3-12 below)
$COST_{ferrous\ metal\ baseline\ survey}$	Baseline survey costs per ton of ferrous metal (see table 3-12 below)
$COST_{trash\ baseline\ survey}$	Baseline survey costs per ton of trash (see table 3-12 below)
$QUANTITY_{concrete\ baseline}$	Baseline total tons of concrete
$QUANTITY_{ferrous\ metal\ baseline}$	Baseline total tons of ferrous metal
$QUANTITY_{trash\ baseline}$	Baseline total tons of trash
$COST_{concrete\ dose\ survey}$	Survey costs per ton of concrete under dose option (see table 3-12 below)
$COST_{ferrous\ metal\ dose\ survey}$	Survey costs per ton of ferrous metal under dose option (see table 3-12 below)
$COST_{trash\ dose\ survey}$	Survey costs per ton of trash under dose option (see table 3-12 below)
$QUANTITY_{concrete\ dose}$	Total tons of concrete to be released under dose option
$QUANTITY_{ferrous\ metal\ dose}$	Total tons of ferrous metal to be released under dose option
$QUANTITY_{trash\ dose}$	Total tons of trash to be released under dose option

Assumptions

- The available survey costs from the Clearance Survey Cost Report (NRC 2004a) are summarized in Table 3-12.

- Because survey costs are dependent on MARSSIM classification (NRC 2001), the survey costs were weighted to reflect the relative proportion of MARSSIM Class 2 and Class 3 material. The percentages for ferrous metal were taken from SC&A 2003. Based on data in tables on pages 3-10, 3-20, and the scaling factors from page 3-23, the relative proportion of Class 2 material was 27 percent and Class 3 material was 73 percent. Similar information was not available for concrete and trash in SC&A 2003. Attachment 1 of Appendix K of the draft GEIS (NRC 2005b) describes the relative proportion of Class 1, 2, and 3 material for ferrous metal, concrete, and trash. Assuming that only Class 2 and Class 3 material would be surveyed to be released, this analysis calculates that 11 percent of concrete would be Class 2 and 89 percent would be Class 3. For trash, 50 percent is assumed to be Class 2 and 50 percent is assumed to be Class 3.

Table 3-12: Survey Costs by Dose Option

Dose Option Level and MARSSIM Classification	Cost	Units	Source in Feb 2004 Clearance Survey Cost Report
Concrete Rubble			
baseline/no action	-26	$/ton	p. 7-9
0.03 mrem/yr - Class 2	Not Feasible		
0.1 mrem/yr- Class 2	-314	$/ton	p. 7-10
1 mrem/yr - Class 2	-84	$/ton	p. 7-10
10 mrem/yr - Class 2	-84	$/ton	p. 7-10
IAEA Standard - Class 2	-84	$/ton	Assumed to be equal to 1 mrem/yr
0.03 mrem/yr - Class 3	Not Feasible		
0.1 mrem/yr- Class 3	-85	$/ton	p. 7-10
1 mrem/yr - Class 3	-30	$/ton	p. 7-10
10 mrem/yr - Class 3	-30	$/ton	p. 7-10
IAEA Standard - Class 3	-30	$/ton	Assumed to be equal to 1 mrem/yr
Structural Ferrous Metal			
baseline/no action	-176	$/ton	p. 7-26
0.03 mrem/yr - Class 2	Not Feasible		
0.1 mrem/yr- Class 2	-89	$/ton	p. 7-28
1 mrem/yr - Class 2	-82	$/ton	p. 7-28
10 mrem/yr - Class 2	-82	$/ton	p. 7-28
IAEA Standard - Class 2	-82	$/ton	Assumed to be equal to 1 mrem/yr
0.03 mrem/yr - Class 3	Not Feasible		
0.1 mrem/yr- Class 3	-30	$/ton	p. 7-28
1 mrem/yr - Class 3	-27	$/ton	p. 7-28
10 mrem/yr - Class 3	-27	$/ton	p. 7-28
IAEA Standard - Class 3	-27	$/ton	Assumed to be equal to 1 mrem/yr
Trash			
baseline/no action	-50	$/ton	Assumed to be twice 0.1 mrem/yr (for class 3)
0.03 mrem/yr - Class 2	-246	$/ton	Assumed to be twice 0.1 mrem/yr
0.1 mrem/yr- Class 2	-123	$/ton	p. 7-53
1 mrem/yr - Class 2	-123	$/ton	p. 7-53
10 mrem/yr - Class 2	-123	$/ton	p. 7-53
IAEA Standard - Class 2	-123	$/ton	Assumed to be equal to 1 mrem/yr
0.03 mrem/yr - Class 3	-50	$/ton	Assumed to be twice 0.1 mrem/yr
0.1 mrem/yr- Class 3	-25	$/ton	p. 7-53
1 mrem/yr - Class 3	-25	$/ton	p. 7-53
10 mrem/yr - Class 3	-25	$/ton	p. 7-53
IAEA Standard - Class 3	-25	$/ton	Assumed to be equal to 1 mrem/yr

- It is not feasible to survey concrete and ferrous metal at the 0.03 mrem/yr dose option level, because the data quality objectives for the survey demand a very large number of samples (ORISE 2004). As a result, in the 0.03 mrem/yr dose options of the Unrestricted Release and EPA-Regulated Disposal Alternatives, ferrous metal and concrete are assumed to be sent for LLW disposal rather than surveyed and released.

Assumptions

- Survey costs for LLW disposal are not required by the proposed action. However, disposal facilities will not accept waste that has not been surveyed. Consequently, survey costs were included for all material being sent to LLW disposal. The survey costs for the 10 mrem/yr dose option were used as a proxy for the survey costs for LLW disposal.

Equation 3 - Disposal and recycling costs

The net disposal and recycling costs associated with the *Industry Operation* attribute are estimated as follows:

$$Disposal/Recycling = [(COST_{LLW\ Disposal} \times QUANTITY_{LLW\ Dose}) + (COST_{Landfill\ Disposal} \times QUANTITY_{Landfill\ Dose}) + (REVENUE_{ferrous\ metal\ recycyled} \times QUANTITY_{ferrous\ metal\ recycled\ dose}) + (COST_{concrete\ recycled} \times QUANTITY_{concrete\ recycled\ dose}) + (COST_{LLW\ Disposal} \times QUANTITY_{baseline\text{-}dose})] - [(COST_{LLW\ Disposal} \times QUANTITY_{LLW\ baseline}) + (COST_{Landfill\ Disposal} \times QUANTITY_{Landfill\ baseline}) + (REVENUE_{ferrous\ metal\ recycyled} \times QUANTITY_{ferrous\ metal\ recycled\ baseline}) + (COST_{concrete\ recycled} \times QUANTITY_{concrete\ recycled\ baseline})]$$

Parameter	Description
$QUANTITY_{LLW\ baseline}$	Baseline total tons of material disposed of offsite as LLW
$QUANTITY_{Landfill\ baseline}$	Baseline total tons of material disposed of offsite as MSW
$QUANTITY_{ferrous\ metal\ recycled\ baseline}$	Baseline total tons of ferrous metal recycled
$QUANTITY_{concrete\ recycled\ baseline}$	Baseline total tons of concrete recycled
$QUANTITY_{LLW\ Dose}$	Total tons of material disposed of offsite as LLW under dose option
$QUANTITY_{Landfill\ Dose}$	Total tons of material disposed of offsite as MSW under dose option
$QUANTITY_{ferrous\ metal\ recycled\ dose}$	Total tons of ferrous metal recycled under dose option
$QUANTITY_{concrete\ recycled\ dose}$	Total tons of concrete recycled under dose option
$QUANTITY_{baseline\text{-}dose}$	Net difference in tons cleared in baseline - tons cleared under dose option
$COST_{LLW\ Disposal}$	Offsite disposal costs per ton of material at a LLW facility (see assumptions below)
$COST_{Landfill\ Disposal}$	Offsite disposal costs per ton of material at a solid waste landfill (see assumptions below)
$REVENUE_{ferrous\ metal\ recycyled}$	Revenue generated from the average market price of recycling scrap ferrous metal (see assumptions below)
$COST_{concrete\ recycled}$	Recycling cost per ton of concrete (see assumptions below)

Assumptions

- The cost for disposal at a LLW facility (Envirocare) is equal to -$14.72 per cubic foot (DOE 2002). This cost reflects disposal of DOE waste, because prices for disposal of non-DOE wastes were not publicly available.

- The cost for disposal at a municipal or industrial solid waste landfill is equal to -$32.19 per ton (REPA 2001).

- The revenue associated with the average market price of scrap ferrous metal is equal to $85 per ton (Recycler's World 2003).[23]

- The cost of recycling concrete is equal to -$5 per ton.[24]

Equation 4 - Transportation costs

The net transportation cost associated with the *Industry Operation* attribute is estimated as follows:

$$Transportation = COST_{LLW\ transport\ truck} \times DISTANCE_{LLW\ facility} \times (QUANTITY_{LLW\ dose} + QUANTITY_{baseline\text{-}dose} - QUANTITY_{LLW\ baseline}) + COST_{Cleared\ transport\ truck} [(DISTANCE_{MSW\ Landfill} \times (QUANTITY_{Landfiill\ dose} - QUANTITY_{Landfiill\ baseline})) + (DISTANCE_{Recycling\ Facility\text{-}Ferrous\ metal} \times (QUANTITY_{ferrous\ metal\ recycled\ dose} - QUANTITY_{ferrous\ metal\ recycled\ baseline})) + (DISTANCE_{Recycling\ Facility\text{-}Concrete} \times (QUANTITY_{concrete\ recycled\ dose} - QUANTITY_{concrete\ recycled\ baseline}))]$$

Parameter	Description
$QUANTITY_{LLW\ baseline}$	Total baseline tons of material transported to a LLW facility
$QUANTITY_{Landfiill\ baseline}$	Total baseline tons of material transported to a municipal landfill
$QUANTITY_{ferrous\ metal\ recycled\ baseline}$	Total baseline tons of ferrous metal transported to a recycling facility
$QUANTITY_{concrete\ recycled\ baseline}$	Total baseline tons of concrete transported for recycling
$COST_{LLW\ transport\ truck}$	Cost per ton-mile for transport of LLW using a truck (see assumptions below)
$COST_{Cleared\ transport\ truck}$	Cost per ton-mile for transport of cleared material using a truck (see assumptions below)
$DISTANCE_{LLW\ facility}$	Distance to a LLW facility (see assumptions below)
$DISTANCE_{MSW\ Landfill}$	Distance to a MSW landfill (see assumptions below)
$DISTANCE_{Recycling\ Facility\text{-}Ferrous\ metal}$	Distance to a ferrous metal recycling facility (see assumptions below)
$DISTANCE_{Recycling\ Facility\text{-}Concrete}$	Distance to a concrete recycling facility (see assumptions below)

[23] Because the industry will pay licensees for the ferrous metal, this is considered a negative cost (actualized benefit).://www.recycle.net/price/metals.html

[24] Agretech. Phone Interview. November 25, 2003.

Parameter	Description
$QUANTITY_{baseline\text{-}dose}$	Net difference in tons cleared in baseline minus tons cleared under dose option
$QUANTITY_{LLW\ dose}$	Total tons of material transported under dose option to a LLW facility
$QUANTITY_{Landfiill\ dose}$	Total tons of material transported under dose option to a MSW landfill
$QUANTITY_{ferrous\ metal\ recycled\ dose}$	Total tons of ferrous metal transported under dose option to a recycling facility
$QUANTITY_{concrete\ recycled\ dose}$	Total tons of concrete transported under dose option to a recycling facility

Assumptions

The following transportation costs apply:

- LLW material using a truck: -$0.12/ton-mile (DOE 1999).
- Cleared material using a truck: -$0.06/ton-mile.[25]
- LLW ferrous metal using rail: -$0.016/ton-mile (DOE 2002).
- LLW concrete using rail: -$0.044/ton-mile.[26]

The following average distances apply:

- LLW facility: 1,544 miles.[27]
- MSW Landfill: 58 miles.[28]
- Ferrous metal recycling facility: 269 miles (SC&A 2003).[29]
- Concrete recycling facility: 198 miles.[30]

Trucks are assumed to be able to transport 25 tons per truckload of ferrous metals, concrete, or mixed materials destined for a LLW disposal facility. Trucks are assumed to transport 10 tons per truckload of trash.

3.2.6 Attribute - Public Health (Routine)

Attribute Definition and Identification of Driving Factors

Public Health (Routine) measures the yearly incremental cost or benefit due to changes in radiation exposures to the public associated with routine NRC licensee activities. The public is defined as any person not working in the nuclear industry. Exposures may occur from the

[25] Best professional judgment

[26] *Ibid.*

[27] Estimate based on average distance from existing LWRs to Clive, Utah, derived from GIS analysis.

[28] Best professional judgment.

[29] Table 9.62, page 9-97.

[30] *Ibid.*

following activities: material handling activities, storage, transportation, processing or recycling, disposal in solid waste landfills, manufacturing, and distribution and use of new products.

Attribute Equation

The following equation can be used to calculate the net change in costs and benefits due to the Public Health (Routine) attribute.

Equation 5 - Routine radiologic exposure

The routine radiologic exposure cost associated with the *Public Health (Routine)* attribute is estimated as follows:

$$Radiological\ Exposure = (DOSE_{baseline\ public} - DOSE_{dose\ alternative\ public}) \times COST_{exposure}$$

Parameter	Description
$DOSE_{baseline\ public}$	The baseline dose to the public due to routine exposures in person rem for clearance of materials
$DOSE_{dose\ alternative\ public}$	The dose to the public due to routine exposures in person rem for clearance of materials under the alternative
$COST_{exposure}$	Cost of exposure per person-rem (see assumptions below)

Assumptions

- The cost of exposure per person is assumed to be -$2,000 per person-rem (NRC 2003e).

- The dose to the public was taken from SC&A 2003. Table 3-13 describes how the alternatives in this cost-benefit analysis relate to the naming conventions used in SC&A 2003. For the dose-specific alternatives (Unrestricted Release and EPA-Regulated Disposal), dose information was provided for the 0.03, 0.1, 1, and 10 mrem/yr options. For the IAEA Safety Guide No. RS-G-1.7 dose option, the quantities were assumed to be twice the dose associated with the 1 mrem/yr dose option based on NUREG-1640 (Appendix D, (NRC 2005b)).

- SC&A 2003 presents the collective dose to workers, such as truck drivers and recyclers, as well as members of the general public. Dose to members of the public and workers at non-licensed facilities normally would be captured in the attribute public health-routine, and dose to workers at licensed facilities normally would be captured in the attribute occupational health-routine. Because this analysis could not separate the collective doses into these two categories on a year-by-year basis for each alternative and dose-option considered, the public health-routine and occupational health routine attributes are combined in a single attribute described as public and occupational health-routine.

- The dose associated with equipment reuse was taken from the Draft GEIS, Appendix D, Section 12 (NRC 2005b).

Table 3-13 Description of Alternatives and Naming Conventions

Description in Cost-Benefit Analysis	Description in SC&A 2003
Baseline	No Action (Case A)[31]
Unrestricted Release: Material-Specific Limits	Case A
Unrestricted Release: Material-Independent Limits	Case B
EPA-Regulated Disposal without Incineration	Case C
EPA-Regulated Disposal with Trash Incineration	Case C2
Limited Disposition	Case B (concrete), Case C (ferrous metal and trash)
LLW Disposal	Not provided in Report. Assumed to be 0 person-rem.

3.2.7 Attribute - Occupational Health (Routine)

Attribute Definition and Identification of Driving Factors

Occupational Health (Routine) measures the yearly incremental cost or benefit due to changes in radiation exposures to occupational workers at licensed facilities associated with routine activities. Exposures may occur from the following material handling activities: storage, surveying, decontamination, volume reduction, packaging for disposal or recycling, and disposal.

Attribute Equation

The following equation can be used to calculate the net change in costs and benefits due to the Occupational Health (Routine) attribute.

Equation 6 - Routine occupational radiologic exposures

The routine radiological exposure cost associated with the *Occupational Health (Routine)* attribute is estimated as follows:

$$Radiologic\ Exposure = (DOSE_{baseline\ worker} - DOSE_{dose\ alternative\ worker}) \times COST_{exposure}$$

Parameter	Description
$DOSE_{baseline\ worker}$	The baseline dose to occupational workers due to exposure in person-rem for clearance of materials.
$DOSE_{dose\ alternative\ worker}$	The dose to occupational workers due to exposure in person-rem for clearance of materials, under the alternative.
$COST_{exposure}$	Cost of exposure per person-rem (see assumptions below)

[31] SC&A 2003 presents different values for the dose associated with the No Action Alternative. This cost-benefit analysis assumes the most appropriate version of the quantities and dose associated with the No Action Alternative (and hence the baseline) is in fact the No Action Alternative in SC&A 2003 associated with the Unrestricted Release Alternative.

Assumptions

- The cost of exposure per person is assumed to be -$2,000 per person-rem (NRC 2003e).

- SC&A 2003 presents the collective dose to workers, such as truck drivers and recyclers, as well as members of the general public. Dose to members of the public and workers at non-licensed facilities normally would be captured in the attribute public health-routine, and dose to workers at licensed facilities normally would be captured in the attribute occupational health-routine. Because this analysis could not separate the collective doses into these two categories on a year-by-year basis for each alternative and dose-option considered, the public health-routine and occupational health routine attributes are combined in a single attribute described as public and occupational health-routine.

3.2.8 Attribute - Public Health (Accident)

Attribute Definition and Identification of Driving Factors

Public Health (Accident) measures the yearly net incremental cost or benefit due to changes in radiation exposures to occupational workers in non-licensed facilities and the general public associated with any sort of accidents involving the potentially clearable material. Exposures may occur from accidents related to storage, transportation, surveying, decontamination, volume reduction, packaging of materials, and random acts, such as fires, however, no such exposures are quantified in this analysis because the amount of radiation in any given quantity of material being considered for clearance would not result in a significant dose in the event of these types of accidents (Section 3.3).

Another dimension of the Public Health (Accident) attribute is yearly net incremental cost or benefit due to changes in non-radiologically induced fatalities and disabilities related to transportation, decontamination, volume reduction, and packaging of materials.

Attribute Equation

The following equation can be used to calculate the net change in costs and benefits due to the Public Health (Accident) attribute. For this analysis, accidents are due to truck transport.

Equation 7 - Fatalities and disabilities due to accidents

The cost of accidental fatalities and disabilities associated with the *Public Health (Accident)* attribute is estimated as follows:

$$Accidental\ Fatalities\ and\ Disabilities = [(DISTANCE_{alternative\ total} - DISTANCE_{baseline\ total}) \times NUM_{accident\ fatalities} \times COST_{lost\ life}] + [(DISTANCE_{alternative\ total} - DISTANCE_{baseline\ total}) \times NUM_{accident\ disabilities} \times COST_{lifetime\ disability}]$$

Parameter	Description
$DISTANCE_{baseline\ total}$	Total vehicle miles traveled in baseline
$DISTANCE_{alternative\ total}$	Total vehicle miles traveled in alternative
$NUM_{accident\ fatalities}$	Number of fatalities due to accidents per vehicle mile traveled
$COST_{lost\ life}$	Average cost of a lost life (see assumptions below)
$NUM_{accident\ disabilities}$	Number of disabilities due to accidents per vehicle mile traveled
$COST_{lifetime\ disability}$	Lifetime cost of disability

Assumptions

- The average cost of a life is assumed to be -$3,000,000 (NRC 2003e).
- This analysis does not calculate any lifetime disabilities.
- The number of accidents is based on vehicle miles traveled multiplied by the accident fatality rate. As discussed in Chapter 3 of the Draft GEIS (NRC 2005b), the fatal accident rate for a truck is 2.409 E-08 per vehicle mile traveled (NRC 1994). This fatality rate includes both fatalities to members of the public and to drivers.

3.2.9 Attribute - Industry Implementation

Attribute Definition and Identification of Driving Factors

Industry Implementation measures the initial incremental cost or benefit to licensees due to changes in industry implementation, including incremental costs and savings of the following: reading regulations and guidance documents; training employees on new procedures; capital outlay for new equipment (e.g., trucks, survey equipment); and researching markets and vendors for cleared material. No capital outlay is expected to be required under this rulemaking. Fees paid to NRC are not included in the analysis as they represent a transfer payment. Thus fees paid are a cost to industry and a benefit to NRC, with a net balance of zero.

Attribute Equation

The following equation can be used to calculate the net change in costs and benefits due to the Industry Implementation attribute.

Equation 8 - Implementation costs

The implementation costs associated with the *Industry Implementation* attribute are estimated as follows:

$$Implementation = (HOURS_{industry\ implementation\ managers} \times WAGE_{Managerial}) + (HOURS_{industry\ implementation\ legal} \times WAGE_{Legal}) + (HOURS_{industry\ implementation\ clerical} \times WAGE_{Clerical})$$

Parameter	Description
$HOURS_{industry\ implementation\ managers}$	The number of additional hours required for administrative implementation tasks by managers (see assumptions below)
$WAGE_{Managerial}$	The loaded hourly wage per managerial labor (see Equation 1 assumptions in Section 3.2.5)
$HOURS_{industry\ implementation\ legal}$	The number of additional hours required for administrative implementation tasks by attorneys (see assumptions below)
$WAGE_{Legal}$	The loaded hourly wage per attorney (see Equation 1 assumptions in Section 3.2.5)
$HOURS_{industry\ implementation\ clerical}$	The number of additional hours required for administrative implementation tasks by clerical workers (see assumptions below)
$WAGE_{Clerical}$	The loaded hourly wage per clerical labor (see Equation 1 assumptions in Section 3.2.5)

Assumptions

The following are the number of hours assumed, using best professional judgment:

- Number of Managerial hours: 60.
- Number of Legal hours: 10.
- Number of Clerical hours: 10.

3.2.10 Attribute - NRC Implementation

Attribute Definition and Identification of Driving Factors

NRC Implementation involves, among other considerations, NRC staff time to complete the following implementation tasks:

- Develop guidance, procedures, and aids for use by NRC and Agreement States
- Develop enforcement procedures
- Develop guidance, procedures, and aids for use by licensees

Attribute Equation

The following equation calculates the costs and benefits due to NRC Implementation of new control criteria.

Equation 9 - Develop guidance

The administrative costs associated with developing guidance under the *NRC Implementation* attribute are estimated as follows:

$$Develop\ Guidance = (HOURS_{NRC\ implementation\ managerial} \times WAGE_{Managerial}) + (HOURS_{NRC\ implementation\ technical} \times WAGE_{Technical}) + (HOURS_{NRC\ implementation\ clerical} \times WAGE_{Clerical})$$

Parameter	Description
$HOURS_{NRC\ implementation\ managerial}$	The number of additional hours required for NRC managerial staff (see assumptions below)
$HOURS_{NRC\ implementation\ technical}$	The number of additional hours required for NRC technical staff (see assumptions below)
$HOURS_{NRC\ implementation\ clerical}$	The number of additional hours required for NRC clerical staff (see assumptions below)
$WAGE_{Managerial}$	The loaded hourly wage per managerial labor (see Equation 1 assumptions in Section 3.2.5)
$WAGE_{Technical}$	The loaded hourly wage per technical labor (see Equation 1 assumptions in Section 3.2.5)
$WAGE_{Clerical}$	The loaded hourly wage per clerical labor (see Equation 1 assumptions in Section 3.2.5)

Assumptions

The following are the number of hours necessary to develop guidance for the clearance of material, for the first year only, using best professional judgment:

- Number of Managerial hours: 10.
- Number of Technical hours: 80.
- Number of Clerical hours: 10.

3.2.11 Attribute - NRC Operation

Attribute Definition and Identification of Driving Factors

NRC operation involves NRC staff time to conduct the following operational tasks on an annual basis:

- Conduct inspections;
- Conduct evaluations of licensee compliance; and
- Enforcement.

Attribute Equations

The following equations calculate the costs due to NRC Operations related to new control criteria.

Equation 10 - Paperwork

The administrative costs associated with the paperwork of the *NRC Operations* attribute are estimated as follows:

$$NRC\ Paperwork = (HOURS_{NRC\ Ops\ Managerial} \times WAGE_{Managerial}) + (HOURS_{NRC\ Ops\ Legal} \times WAGE_{Legal}) + (HOURS_{NRC\ Ops\ Technical} \times WAGE_{Technical}) + (HOURS_{NRC\ Ops\ Clerical} \times WAGE_{Clerical})$$

Parameter	Description
$HOURS_{NRC\ Ops\ Managerial}$	The number of additional hours required for NRC managerial staff, to review paperwork for the clearance of material
$HOURS_{NRC\ Ops\ Legal}$	The number of additional hours required for NRC legal staff, to review paperwork for the clearance of material
$HOURS_{NRC\ Ops\ Technical}$	The number of additional hours required for NRC technical staff, to review paperwork for the clearance of material
$HOURS_{NRC\ Ops\ Clerical}$	The number of additional hours required for NRC clerical staff, to review paperwork for the clearance of material
$WAGE_{Managerial}$	The loaded hourly wage per managerial labor (see Equation 1 assumptions in Section 3.2.5)
$WAGE_{Legal}$	The loaded hourly wage per attorney (see Equation 1 assumptions in Section 3.2.5)
$WAGE_{Technical}$	The loaded hourly wage per technical labor (see Equation 1 assumptions in Section 3.2.5)
$WAGE_{Clerical}$	The loaded hourly wage per clerical labor (see Equation 1 assumptions in Section 3.2.5)

Assumptions

The analysis assumes that no hours will be required for NRC because no additional paperwork will be submitted by licensees, and therefore Equation 10 is equal to zero.

Equation 11 - Enforcement activities

The administrative costs associated with enforcement activities of the *NRC Operations* attribute are estimated as follows:

$$NRC\ Enforcement = (HOURS_{Enforcement\ Managerial} \times WAGE_{Managerial}) + (HOURS_{Enforcement\ Legal} \times WAGE_{Legal}) + (HOURS_{Enforcement\ Technical} \times WAGE_{Technical}) + (HOURS_{Enforcement\ Clerical} \times WAGE_{Clerical}) + COST_{Inspection\ Travel}$$

Parameter	Description
$HOURS_{Enforcement\ Managerial}$	The number of additional hours required for NRC managerial staff to conduct inspections for the clearance of material
$HOURS_{Enforcement\ Legal}$	The number of additional hours required for NRC legal staff to conduct inspections for the clearance of material
$HOURS_{Enforcement\ Technical}$	The number of additional hours required for NRC technical staff to conduct inspections for the clearance of material
$HOURS_{Enforcement\ Clerical}$	The number of additional hours required for NRC clerical staff to conduct inspections for the clearance of material
$WAGE_{Managerial}$	The loaded hourly wage per managerial labor (see Equation 1 assumptions in Section 3.2.5)

Parameter	Description
$WAGE_{Legal}$	The loaded hourly wage per attorney (see Equation 1 assumptions in Section 3.2.5)
$WAGE_{Techical}$	The loaded hourly wage per technical labor (see Equation 1 assumptions in Section 3.2.5)
$WAGE_{Clerical}$	The loaded hourly wage per clerical labor (see Equation 1 assumptions in Section 3.2.5)
$COST_{Inspection\ Travel}$	The travel-related costs associated with inspection of cleared material

Assumptions

The analysis assumes that no hours will be required because no additional enforcement activities will be necessary for NRC; therefore, Equation 11 is equal to zero.

3.2.12 Attribute - Other Government

Attribute Definition and Identification of Driving Factors

This analysis estimates Other Government costs, excluding facilities that are assumed to be covered under the attributes Industry Implementation and Industry Operation, such as DOE and Department of Defense (DoD) facilities. Since regulation of LWRs is not delegated to Agreement States, they will not incur costs related to these facilities. The administrative tasks for other government agencies that have been identified are rulemakings in the Agreement States.

Attribute Equation

The following equation calculates the Other Government costs due to the implementation of new control criteria.

Equation 12 - Burden to Agreement States

The administrative costs associated with State environmental agencies under the *Other Government* attribute are estimated as follows:

$$Environmental\ Agencies = 3(HOURS_{State\ Employees} \times WAGE_x)$$

Parameter	Description
$HOURS_{State\ Employees}$	The number of additional hours required for State employees for rulemakings
$WAGE_x$	The loaded hourly wage per worker type x.

Assumptions

- 33 Agreement States will need to adapt their regulations to this rulemaking.
- 25 of these States are assumed to require 520 hours of managerial labor (NRC 2003d).
- 8 of these States are assumed to require 208 hours of managerial labor (NRC 2003d).

3.2.13 Attribute - Regulatory Efficiency

This attribute is considered qualitatively in Section 3.3, regarding the significant benefits associated with the streamlining of procedures in the post regulatory environment compared with baseline procedures.

3.2.14 Attribute - Other Considerations

This attribute is considered qualitatively in Section 3.3, regarding public confidence in NRC.

3.2.15 Calculating Net Present Value

Present value is a future cash flow, or stream of cash flows, recalculated as an equivalent current amount of money. Net Present Value (NPV) is the present value of all cash flows, *positive and negative*, connected to a project. To calculate NPV, the amount and timing of the cash flows must be determined. Additionally, a discount rate must be used to find the present value. Solving for the present value of a future cash flow is also known as discounting. The following formula shows how NPV is calculated by summing the discounted cash flows that occur in each year:

$$Net\ \ Present\ Value\ = \sum_{t=1}^{n} \left[\frac{CF_t}{(1+r)^t} \right]$$

Parameter	Description
CF	cash flow in year t
t	year in which the cash flow takes place
n	life span (years) of the project
r	discount rate in year t

Assumptions

- For this analysis, discount rates of both seven percent and three percent are used in accordance with NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997).

3.3 Values and Impacts of Regulatory Alternatives Considered

Table 3-14 presents a summary of the benefits and costs associated with each affected attribute for each alternative (and dose option, if applicable) relative to the No Action Alternative, which

is the baseline. Negative benefits (shown in parentheses) reflect net costs, rather than benefits. These benefits and costs are discussed for each alternative below.

For the 0.03 mrem/yr dose options (regardless of the Alternative) it is economically infeasible to survey concrete and ferrous metal. Consequently, these materials are sent to LLW disposal, resulting in costs similar to the LLW Disposal Alternative. Because trash can still be surveyed at this dose level, some trash is sent to EPA landfills, resulting in a slightly lower cost than the LLW disposal alternative.

Note that OMB considers a rule "economically significant" under Executive Order 12866 if annual effects are greater than $100 million. The $1.4 billion cost associated with the LLW Disposal Alternative and the 0.03 dose options of the Unrestricted Release and EPA/State-Regulated Disposal Alternatives are discounted. When these costs are spread over the 47 year time frame of the analysis using a 7 percent discount rate, the annual cost exceeds the $100 million threshold and thus would qualify as "economically significant."

3.3.1 No Action Alternative

By definition, there are no values or impacts associated with the No Action alternative.

3.3.2 Unrestricted Release

The Unrestricted Release Alternative is expected to result in net incremental benefits under the 1 mem/yr, 10 mrem/yr, and IAEA Safety Guide No. RS-G-1.7 dose options. As shown in Table 3-14, most of the benefits result from changes in industry operations (i.e., costs and benefits associated with survey, transportation, and recycling or disposal of material). Public health benefits arise as there are fewer vehicular accidents. Environmental benefits arise as there are fewer air emissions due to a decrease in vehicle miles traveled and as a result of favorable manufacturing tradeoffs as recycled ferrous metal replaces virgin ferrous metal. Sometimes these benefits are offset slightly by a cost resulting from a slight increase in dose to the public.

Conversely, under the Unrestricted Release Alternative, at the 0.1 mrem/yr or 0.03 mrem/yr dose option levels, the analysis projects net costs, because more material fails to meet clear and, therefore, must be transported across the country for disposal as low-level waste.

Tables A-1 through A-9 in Attachment A provide year by year results for each of the dose options under the Unrestricted Release Alternative by attribute. Note that costs appear in some years and not in others; this is a result of the distribution of plants shutting down in different years. For the periods where there are no net costs or benefits for Industry Implementation, these are years during which no active D&D is occurring at any decommissioning plant. The cost summary tables follow the information contained in SC&A 2003, Chapter 3.

Table 3-14 Net Incremental Benefit (Cost) Associated with Attributes by Alternative and Dose Level (2003$)

Alternative	Dose Option	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations	Total
No Action	NA	$0	$0	$0	$0	$0	$0	$0	$0	$0
Unrestricted Release	0.03	$1,174,216	($13,514,350)	($219,720)	($1,376,897,891)	($3,395)	$0	($451,377)	($12,878,667)	($1,402,791,183)
Material Specific	0.1	$960,746	$0	($219,720)	($226,113,873)	($3,395)	$0	($451,377)	($618,308)	($226,445,926)
Limits	1	($787,022)	$0	($219,720)	$293,675,372	($3,395)	$0	($451,377)	$2,125,995	$294,339,854
	10	($8,167,397)	$0	($219,720)	$329,263,365	($3,395)	$0	($451,377)	$2,801,081	$323,222,558
Unrestricted Release	0.03	$1,233,593	($13,514,350)	($219,720)	($1,378,418,237)	($3,395)	$0	($451,377)	($12,902,162)	($1,404,275,647)
Material	0.1	$1,205,052	$0	($219,720)	($291,974,108)	($3,395)	$0	($451,377)	($2,278,274)	($293,721,822)
Independent	1	$713,415	$0	($219,720)	$246,021,542	($3,395)	$0	($451,377)	$987,754	$247,048,219
Limits	10	($1,851,424)	$0	($219,720)	$306,935,439	($3,395)	$0	($451,377)	$2,352,109	$306,761,633
	RS-G-1.7	$186,142	$0	($219,720)	$246,021,542	($3,395)	$0	($451,377)	$987,754	$246,520,945
EPA/State-	0.03	$1,240,634	($13,514,350)	($219,720)	($1,376,897,891)	($3,395)	$0	($451,377)	($12,878,667)	($1,402,724,765)
Regulated	0.1	$1,240,530	$0	($219,720)	($281,093,000)	($3,395)	$0	($451,377)	($2,259,193)	($282,786,154)
Disposal (Landfill)	1	$1,239,881	$0	($219,720)	$181,462,308	($3,395)	$0	($451,377)	($1,033,674)	$180,994,024
	10	$1,237,267	$0	($219,720)	$193,637,557	($3,395)	$0	($451,377)	($922,985)	$193,277,348
	RS-G-1.7	$1,239,074	$0	($219,720)	$181,462,308	($3,395)	$0	($451,377)	($1,033,674)	$180,993,217
LLW Disposal/ Prohibition	NA	$1,240,689	($13,514,350)	$0	($1,378,439,254)	($3,395)	$0	($451,377)	($12,902,486)	($1,404,070,173)
Limited Dispositions	RS-G-1.7	$1,227,219	$0	($219,720)	$258,149,485	($3,395)	$0	($451,377)	($1,500,316)	$257,201,896

1.Results are present value of all quantitatively analyzed attributes calculated over 47 years and discounted at 7 percent.
2. Excludes attributes described qualitatively in Section 3.3 (**regulatory efficiency** and other considerations).
3. Environmental benefits are limited to those described in Section 3.2.4.

At the 1 mrem/yr dose option, the Unrestricted Release Alternative results in a benefits of $247 million, which is approximately the same as, but slightly lower than the benefit of $257 million associated with the Limited Dispositions Alternative for the IAEA RS-G-1.7 dose option. This may appear counter intuitive because in the Limited Dispositions Alternative ferrous metals cannot be recycled, resulting in the loss of a revenue stream and the addition of a disposal fee. However, a larger quantity of material can be released in the Limited Disposition Alternative than in the Unrestricted Release Alternative, resulting in a net benefit that offsets those costs..

Qualitative Results

- Regulatory Efficiency - By developing standardized procedures for disposition of solid materials, there will be increased regulatory efficiency for both NRC and facilities that are undergoing decommissioning. By having clearly defined procedures for disposition of solid materials, facilities will be more certain of the options open to them at decommissioning. At the same time, NRC will have guidance in place that addresses disposition of material.

- Other Considerations. Public confidence in NRC likely will be affected by this action, regardless of which one of the alternatives NRC adopts. Early public comment indicated the public is concerned about the safety issues related to radioactive materials in consumer products. NRC will need to consider public confidence as it proceeds in the decision making process.

3.3.3 EPA/State-Regulated Disposal

The EPA/State-Regulated Disposal Alternative, while less beneficial than the Unrestricted Release Alternative, also is expected to result in net incremental benefits at the 1 mrem/yr, 10 mrem/yr, and IAEA Safety Guide No. RS-G-1.7 dose options. In this alternative, benefits result from changes in industry operation. This net benefit arises because under this Alternative a larger quantity of material can be released than in the No Action Alternative. Thus the avoided transport and disposal costs for LLW create a benefit relative to the No Action Alternative, which is offset slightly by the loss of recycling revenues and the cost of EPA/State-regulated disposal. A small additional benefit results from changes in public health (routine) because the dose to the public is less than in the baseline. Additionally, some benefit is offset by environmental costs related to a decrease in recycling.

Conversely, under the EPA/State-Regulated Disposal Alternative, at the 0.1 mrem/yr or 0.03 mrem/yr dose option levels, the analysis projects net costs, because more material fails to meet clear and, therefore, must be transported across the country for disposal as low-level waste.

Tables A-10 through A-14 in Attachment A provide year by year results for each of the dose options under the EPA/State-Regulated Disposal Alternative by attribute.

Qualitative Results

- Regulatory Efficiency - By developing standardized procedures for disposition of solid materials, there will be increased regulatory efficiency for both NRC and facilities that

are undergoing decommissioning. By having clearly defined procedures for disposition of solid materials, facilities will be more certain of the options open to them at decommissioning. At the same time, NRC will have guidance in place that addresses disposition of solid materials.

- Other Considerations. Public confidence in NRC likely will be affected by this action, regardless of which one of the alternatives NRC adopts. Early public comment indicated the public is concerned about the safety issues related to radioactive materials. NRC will need to consider public confidence as it proceeds in the decision making process.

3.3.4 Limited Dispositions

The Limited Disposition Alternative is expected to result in the highest net incremental benefit of about $257 million. Most of the benefits result from changes in industry operations (i.e., benefits associated with survey, transportation, and recycling or disposal of material). Public health benefits arise from both lower radiological doses and fewer vehicular accidents. There is a slight environmental cost associated with the loss of otherwise recyclable ferrous metals being disposed in landfills. Because this material is not recycled, recycled ferrous metal cannot replace virgin ferrous metal production.

Table A-15 in Attachment A provides year by year results for the Limited Dispositions Alternative by attribute.

Qualitative Results

- Regulatory Efficiency - By developing standardized procedures for disposition of solid materials, there will be increased regulatory efficiency for both NRC and facilities that are undergoing decommissioning. By having clearly defined procedures for disposition of solid materials, facilities will be more certain of the options open to them at decommissioning. At the same time, NRC will have guidance in place that addresses disposition of solid material.

- Other Considerations. Public confidence in NRC likely will be affected by this action, regardless of which one of the alternatives NRC adopts. Early public comment indicated the public is concerned about the safety issues related to radioactive materials. NRC will need to consider public confidence as it proceeds in the decision making process.

3.3.5 LLW Disposal

The LLW Disposal Alternative is projected to result in a net cost of approximately $1.4 billion. Most of this cost results from changes in industry operation, including transportation and disposal of materials as LLW. Other substantial costs result from change in public health - accidental, as a result of more fatalities from the increased transportation distances. A lower collective dose to the public is the only benefit of this alternative. All of the other quantifiable attributes contribute to a net cost.

Table A-16 in Attachment A provides year by year results for the LLW Disposal Alternative by attribute.

Qualitative Results

- Regulatory Efficiency - By developing standardized procedures for disposition of solid materials, there will be increased regulatory efficiency for both NRC and facilities that are undergoing decommissioning. By having clearly defined procedures for disposition of solid materials, facilities will be more certain of the options open to them at decommissioning. At the same time, NRC will have guidance in place that addresses disposition of solid materials.

- Other Considerations. Public confidence in NRC likely will be affected by this action, regardless of which one of the alternatives NRC adopts. Early public comment indicated the public is concerned about the safety issues related to radioactive materials. NRC will need to consider public confidence as it proceeds in the decision making process.

3.3.6 Summary of Results

The quantifiable net benefits associated with each of the various alternatives are presented in Table 3-15 using a seven percent discount rate and in Table 3-16 using a three percent discount rate. Negative benefits (shown in parentheses) reflect net impacts, rather than values. Compared to the seven percent discount rate, all net benefits and costs shown in Table 3-16 are roughly twice as high when calculated using the three percent discount rate. This reflects the relatively long timeframe (i.e., about 47 years) in which materials will be affected.

Table 3-15 Net Incremental Benefit (Cost) Associated with Rule Alternatives by Dose Level using Seven Percent Discount Rate ($2003)

Dose	No Action	Unrestricted Release Material Specific Limits	Unrestricted Release Material Independent Limits	EPA Landfill	LLW Disposal/ Prohibition	Limited Dispositions
0.03 mrem/yr		($1,402,791,183)	($1,404,275,647)	($1,402,724,765)		
0.1 mrem/yr		($226,445,926)	($293,721,822)	($282,786,154)		
1 mrem/yr		$294,339,854	$247,048,219	$180,994,024		
10 mrem/yr		$323,222,558	$306,761,633	$193,277,348		
IAEA RS-G-1.7			$246,520,945	$180,993,217		$257,201,896
No Action	-					
LLW Disposal					($1,404,070,173)	

Notes: Results are calculated as the present value of all quantitatively analyzed attributes calculated over 50 years and discounted at 7 percent. This excludes attributes described qualitatively in Section 3.3 (regulatory efficiency and other considerations).

Table 3-16 Net Incremental Benefit (Cost) Associated with Rule Alternatives by Dose Level using Three Percent Discount Rate ($2003)

Dose	No Action	Unrestricted Release Material Specific Limits	Unrestricted Release Material Independent Limits	EPA Landfill	LLW Disposal/ Prohibition	Limited Dispositions
0.03 mrem/yr		($3,096,851,438)	($3,098,955,560)	($3,096,677,677)		
0.1 mrem/yr		($503,025,207)	($648,746,117)	($625,205,528)		
1 mrem/yr		$646,271,345	$546,801,706	$398,563,623		
10 mrem/yr		$704,293,966	$677,063,566	$422,314,544		
IAEA RS-G-1.7			$545,402,481	$398,561,911		$567,379,193
No Action	-					
LLW Disposal					($3,098,503,318)	

Notes: Results are calculated as the present value of all quantitatively analyzed attributes calculated over 50 years and discounted at 3 percent. This excludes attributes described qualitatively in Section 3.3 (regulatory efficiency and other considerations).

`3.3.7 Discussion of Sensitivity Analysis Results

This analysis utilizes many assumptions to estimate the net costs and benefits of the alternatives. This section presents two sensitivity analyses to determine the impact of several key assumptions.

As described in Section 3.2.2, there is uncertainty about future LLW disposal costs. Table 3-17 presents the results of a sensitivity analysis in which LLW disposal costs increase by 15 percent in 2020 to address increases in cost associated with the need for additional LLW disposal capacity. These results are not significantly different from the results of the main analysis. For example, for the Limited Disposition Alternative, the change in disposal costs results in about a five percent *increase* in the overall benefit. The benefits increase because more material is sent to LLW Disposal in the baseline than in the alternative. In the LLW Disposal alternative, the change results in about a four percent *increase* in overall cost. The costs increase because more material is sent to LLW disposal in this alternative than in the baseline.

Table 3-17 Sensitivity Analysis in Net Incremental Benefit Assuming a 15 Percent Increase in LLW Disposal Costs in 2020 ($2003)

Dose	No Action	Unrestricted Release Material Specific Limits	Unrestricted Release Material Independent Limits	EPA Landfill	LLW Disposal/ Prohibition	Limited Dispositions
0.03 mrem/yr		($1,467,655,460)	($1,469,165,029)	($1,467,589,042)		
0.1 mrem/yr		($223,501,643)	($293,222,556)	($276,935,787)		
1 mrem/yr		$307,248,543	$258,283,611	$194,858,206		
10 mrem/yr		$337,467,478	$320,393,318	$207,587,058		
IAEA RS-G-1.7			$257,756,338	$194,857,399		$270,719,576
No Action	-					
LLW Disposal					($1,468,959,903)	

Notes:
1. Results are calculated as the present value of all quantitatively analyzed attributes calculated over 47 years and discounted at 7 percent.
2. LLW disposal costs assumed to increase by 15 percent beginning in 2020.
3. This excludes attributes described qualitatively in Section 3.3 (regulatory efficiency and other considerations).
4. Environmental benefits are limited to those described in Section 3.2.4.

A second sensitivity analysis was performed to assess the impact of transportation costs on the overall benefits and costs of each alternative. In the main analysis all material was assumed to be shipped by truck. However, given the long distances that are involved in transporting material to LLW disposal facilities (1,544 miles on average), a sensitivity analysis was run in which all material being shipped to LLW facilities was shipped by rail. Table 3-18 presents the results of this analysis. Use of rail lowers the cost of this rule by about 40 percent for the LLW Disposal Alternative as well as the 0.03 mrem/yr dose option in the Unrestricted Release and EPA/State-Regulated Disposal Alternatives. The benefit of this rule for the Limited Dispositions Alternative, and the 1 mrem/yr and and 10 mrem/yr dose options for the Unrestricted Release and EPA/State- Regulated Disposal Alternatives is reduced, because the more expensive truck transport of material to LLW disposal is avoided, reducing overall baseline costs.

Table 3-18 Sensitivity Analysis in Net Incremental Benefit (Cost) Assuming Transport of Material Destined for LLW Disposal by Rail ($2003)

Dose	No Action	Unrestricted Release Material Specific Limits	Unrestricted Release Material Independent Limits	EPA Landfill	LLW Disposal/ Prohibition	Limited Dispositions
0.03 mrem/yr		($883,613,800)	($884,334,260)	($883,547,382)		
0.1 mrem/yr		($242,967,381)	($284,430,964)	($325,705,793)		
1 mrem/yr		$195,798,319	$166,990,577	$73,595,507		
10 mrem/yr		$211,169,015	$203,341,050	$80,396,722		
IAEA RS-G-1.7			$166,463,304	$73,594,700		$152,405,179
No Action	-					
LLW Disposal					($884,118,225)	

Notes:
1. Results are calculated as the present value of all quantitatively analyzed attributes calculated over 47 years and discounted at 7 percent.
2. All materials sent to LLW disposal assumed to be transported by rail in baseline and all alternatives.
3. This excludes attributes described qualitatively in Section 3.3 (regulatory efficiency and other considerations).
4. Environmental benefits are limited to those described in Section 3.2.4.

3.4 Initial Regulatory Flexibility Analysis

As required by the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the NRC has considered the rule's likely impacts on small entities. Based on its initial analysis of this matter, the NRC believes that it would be useful to have additional information on small entities to complete its analysis. Therefore, the NRC has specifically requested public comment on the potential impact of the proposed rule on small entities. to reduce the rule's impacts on small entities as part of this rulemaking.

3.4.1 Reason Action is Being Considered

The principal reason for this rulemaking is to improve efficiency and effectiveness of the NRC regulatory process by establishing criteria for disposition of solid materials in the regulations. Section 1 of this Regulatory Analysis describes in more detail the reason the proposed rule is being considered.

3.4.2 Objective of the Proposed Rule

Section 1 of this Regulatory Analysis describes the objectives of the proposed rule.

3.4.3 Description and Estimate of the Number of Small Entities

There are six major categories of facility types that might be affected by this rule:

- Light water reactors,
- Independent spent fuel storage installations,
- Research reactors

- Facilities included in the site decommissioning management plan (SDMP);
- Fuel cycle facilities; and
- Other material licensees including, but not limited to medical, academic, industrial, source and special nuclear licensees.

Of these facility types, only some SDMP sites and some of the other materials licensees are likely to be owned by entities that meet the definition of small businesses used in the Regulatory Flexibility Act. While there are less than 50 sites on the SDMP list, there are more than 20,000 NRC and Agreement State material licensees . At present, it is unknown how many of these sites would qualify as small businesses, what North American Industry Classification System codes they fall into, or their revenues. Further, not all entities in these categories that qualify as small businesses will be affected by this rule.

3.4.4 Estimating Compliance Requirements

As part of gathering information for this rulemaking, the NRC has had a continuing effort to obtain stakeholder input on major issues associated with this rulemaking and has interacted with a diversity of stakeholders (including representatives from university laboratories, hospitals, manufacturers, etc.) on alternatives and possible impacts. Based on this input, the NRC has developed this proposed rule which would establish requirements that to a large extent formalize existing practices regarding decisions on disposition of solid material. Furthermore, as part of the rulemaking, the NRC is considering ways to minimize unnecessary impacts; for example, Section IV.C of FRN issuing the proposed rule specifically requests comment on the scope of material that should be covered by this proposed rule, namely whether it is more appropriate for the scope of the proposed rule to include material only from impacted areas, rather than both restricted areas and impacted areas. Limiting the scope to impacted areas only could mean that for smaller licensees like medical facilities , who may define restricted areas broadly based on facility design, the NRC could better focus its disposition and recordkeeping requirements on solid materials from those areas where a reasonable potential for the presence of residual radioactivity exists. Licensees could either designate the entire restricted area as an impacted area or could focus more on those areas they were designating as impacted areas, whichever was more cost-effective.

In addition, it can also be noted that many small entities would have only sealed sources or devices containing sealed sources and hence there would not be significant effort involved in disposition of solid materials.

Based on the above, the NRC believes that this proposed rule would not have a significant impact on small entities.

However, most of the data available for this regulatory analysis is for large entities, which account for the vast majority of materials covered by the proposed rule, and limited data has been available for analysis of small entities. It is unclear how many material licensees or SDMP sites currently release materials NRC's current approach (i.e., the No Action Alternative). Thus, as indicated in Section XIII of the FRN issuing this proposed rule, the NRC is seeking public comment on the potential impact of the proposed rule on small entities.

3.4.5 Significant Alternatives Considered

Because the rule is not expected to have negative or significant impacts on small entities, no other significant alternatives were considered.

3.4.6 Duplicative, Overlapping, and Conflicting Rules

NRC is not aware of any duplicative, overlapping, or conflicting federal rules.

4.0 Backfit Analysis

The regulatory options examined in this RA do not involve any provisions that would require backfits. Consequently, a backfit analysis is not necessary.

5.0 Decision Rationale

After considering the costs, benefits, and impacts of all the alternatives, NRC has preliminarily concluded that the Limited Dispositions Alternative can provide a risk-informed consistent dose criterion for disposition of solid materials that is at a level well below levels established to provide adequate protection of the public and the environment and can allow for a predictable regulatory process that is efficient and effective in not imposing undue burdens for implementation. The No Action Alternative (NRC's current approach) is sufficient to satisfy NRC's strategic goal of ensuring protection of public health, but there is a need for a risk-informed regulation. While some public commenters supported use of the Unrestricted Release Alternative because it was dose criterion was below NRC's public dose limit and consistent with NCRP and ICRP suggestions, others were concerned about this alternative because of the increased potential for solid material being present in general commerce and consumer products. The EPA/State-Regulated Disposal Alternative would limit the potential for radiation dose to the general public, but the radionuclide concentration limits for only landfill disposal are higher than for unrestricted release. For the LLW Disposal Alternative, there are higher estimated transportation accidents, a large impact on LLW disposal capacity, and a large cost. Thus the Limited Dispositions Alternative is the staff's preliminary recommendation.

NRC chose the Limited Dispositions Alternative based on the various reports and other standards relevant to decision making in this area, on stakeholder input, and on the results of the draft GEIS (NRC 2005b). The Limited Dispositions Alternative is comprised of four elements:

1. A set of limited allowed disposition paths for released solid material;
2. A dose criterion set at 1 mrem/yr;
3. Tables of nuclide concentrations associated with the dose criterion of 1 mrem/yr; and
4. A recordkeeping system.

The following sections provide a brief explanation of the rationale that supports each specific element.

5.1 Limited Disposition Paths

The decision to allow material to follow a set of limited disposition paths is consistent with NCRP Report No. 141, the National Academies' report, and a diverse range of stakeholder comments. In order to determine the allowed disposition paths, NRC considered the following: the feasibility of the disposition paths proposed; the ability of the disposition paths to limit where material goes while maintaining exposures below the dose criterion; and the costs of implementing the disposition paths.

5.2 Dose Criterion of 1 mrem/yr

The 1 mrem/yr dose criterion is well below the NRC's public dose limit established to ensure adequate protection of public health and safety. It is also consistent with other NRC and EPA standards for disposition of other media, such as air and liquid effluents and groundwater protection. Further, the 1 mrem/yr dose is consistent with the recommendations received from national and international scientific bodies regarding dose criteria. When compared to the low

doses of radiation from natural and other existing sources, the proposed dose criterion of 1 mrem/yr is a minute fraction (less than 0.003) of the background levels of radiation received from routine activities.

5.3 Tables of nuclide concentrations

The 1 mrem/yr dose criterion is less than 1/300th of what a person is routinely receiving from natural background; therefore, the dose level is difficult to measure directly. Tables of measurable volumetric and surficial nuclide concentrations will facilitate confirmation that the dose criterion has been met (i.e., if a licensee can demonstrate for a solid material being considered for release, that the nuclide concentrations are less than the table values, this will provide assurance that the 1 mrem/yr dose criterion has been met). Use of these tables provides a conservative approach that provides assurance that, despite uncertainties in assumptions or possible scenario modeling, a 1 mrem/yr dose criterion will be met.

5.4 Recordkeeping

Records would indicate the nature of the material released (e.g., type and quantity of solid material, and nuclides present and their concentrations) and its destination (e.g., the landfill or specific end use shipped to, etc.). The records required by the proposed rulemaking will aid in allowing verification that the dose criterion has been met and provide reasonable assurance that the material was delivered to one of the authorized destinations.

6.0 Implementation

A draft regulatory guidance document (draft NUREG-1813) is being prepared to provide implementation approaches for the proposed rule in areas of survey methods, disposition approaches, and records maintenance. Draft NUREG-1813 is being issued for public comment at the same time as the proposed rule. In addition, an information base is being developed for decisions for case-specific situations.

6.1 Schedule

Licensees will need adequate time to implement changes in their radiation protection programs as a result of the proposed rule amendment when it becomes final. At this time, the NRC is not proposing an implementation schedule for when licensee would need to comply with the rule when it becomes final. However, NRC is inviting comments on the time period for implementing these changes, including specific information on timing and economic considerations.

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ATTACHMENT A

Net Incremental Benefit or Cost Associated with Attributes for Alternatives Studied

Table A-1 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Specific Limits - 0.03 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$14,362	$0	($18,848)	($73,792,689)	($3,395)	$0	($451,377)	($1,348,379)
2004	$20,530	$0	($11,309)	($40,532,801)	$0	$0	$0	($745,860)
2005	$19,384	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2006	$18,192	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2007	$17,212	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2008	$16,348	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2009	$15,600	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2010	$14,928	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2011	$14,352	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2012	$13,854	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2013	$13,392	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2014	$13,236	$0	($3,770)	($3,662,425)	$0	$0	$0	($57,614)
2015	$24,478	$0	($18,848)	($110,212,760)	$0	$0	$0	($868,326)
2016	$43,140	($3,000,000)	($26,387)	($166,548,785)	$0	$0	$0	($1,342,084)
2017	$54,720	$0	($18,848)	($113,032,649)	$0	$0	$0	($952,889)
2018	$75,220	($3,000,000)	($33,926)	($221,381,781)	$0	$0	$0	($1,765,758)
2019	$116,760	($3,000,000)	($60,314)	($370,432,493)	$0	$0	$0	($3,044,680)
2020	$165,600	($6,000,000)	($67,853)	($476,413,898)	$0	$0	$0	($3,882,032)
2021	$185,960	($3,000,000)	($41,466)	($316,584,440)	$0	$0	$0	($2,556,884)
2022	$195,360	($3,000,000)	($30,157)	($203,730,363)	$0	$0	$0	($1,775,903)
2023	$208,580	($3,000,000)	($37,696)	($230,909,345)	$0	$0	$0	($2,016,965)
2024	$204,720	$0	($22,618)	($111,286,568)	$0	$0	$0	($1,047,434)
2025	$189,280	$0	($15,078)	($53,367,953)	$0	$0	$0	($506,990)
2026	$181,220	$0	($18,848)	($81,613,878)	$0	$0	$0	($769,510)
2027	$191,200	($3,000,000)	($30,157)	($168,001,997)	$0	$0	$0	($1,572,635)
2028	$208,280	($3,000,000)	($37,696)	($253,776,649)	$0	$0	$0	($2,204,502)
2029	$221,580	($3,000,000)	($37,696)	($301,038,895)	$0	$0	$0	($2,457,628)
2030	$253,960	($6,000,000)	($52,774)	($423,645,204)	$0	$0	$0	($3,506,365)
2031	$290,020	($6,000,000)	($56,544)	($454,470,162)	$0	$0	$0	($3,841,311)
2032	$320,440	($6,000,000)	($56,544)	($465,170,953)	$0	$0	$0	($3,869,190)
2033	$343,160	($6,000,000)	($52,774)	($409,017,991)	$0	$0	$0	($3,494,670)
2034	$327,820	($3,000,000)	($22,618)	($146,593,443)	$0	$0	$0	($1,375,334)
2035	$303,260	$0	($11,309)	($95,796,042)	$0	$0	$0	($811,410)
2036	$278,580	$0	($11,309)	($94,261,732)	$0	$0	$0	($797,075)
2037	$248,200	$0	($3,770)	($24,769,000)	$0	$0	$0	($234,464)
2038	$219,860	$0	($3,770)	($5,746,314)	$0	$0	$0	($45,140)
2039	$204,620	$0	($15,078)	($70,650,437)	$0	$0	$0	($651,218)
2040	$208,460	($3,000,000)	($26,387)	($160,753,698)	$0	$0	$0	($1,434,603)
2041	$202,760	$0	($18,848)	($119,968,404)	$0	$0	$0	($1,053,780)
2042	$185,840	$0	($7,539)	($44,134,092)	$0	$0	$0	($413,940)
2043	$166,880	$0	($3,770)	($19,968,177)	$0	$0	$0	($187,148)
2044	$149,680	$0	($3,770)	($35,919,945)	$0	$0	$0	($265,184)
2045	$134,540	$0	($3,770)	($35,919,945)	$0	$0	$0	($265,184)
2046	$117,860	$0	$0	$0	$0	$0	$0	$0
2047	$107,620	$0	($3,770)	($22,049,890)	$0	$0	$0	($207,017)
2048	$103,040	$0	($7,539)	($44,154,494)	$0	$0	$0	($414,420)
2049	$97,780	$0	($7,539)	($51,774,275)	$0	$0	$0	($426,393)

Table A-2 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Specific Limits - 0.1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$11,560	$0	($18,848)	($11,184,825)	($3,395)	$0	($451,377)	($19,826)
2004	$16,520	$0	($11,309)	($6,068,223)	$0	$0	$0	($11,345)
2005	$15,660	$0	$0	$341,960	$0	$0	$0	($3,104)
2006	$14,720	$0	$0	$341,960	$0	$0	$0	($3,104)
2007	$13,960	$0	$0	$341,960	$0	$0	$0	($3,104)
2008	$13,300	$0	$0	$341,960	$0	$0	$0	($3,104)
2009	$12,720	$0	$0	$341,960	$0	$0	$0	($3,104)
2010	$12,180	$0	$0	$341,960	$0	$0	$0	($2,467)
2011	$11,740	$0	$0	$341,960	$0	$0	$0	($2,467)
2012	$11,360	$0	$0	$341,960	$0	$0	$0	($2,467)
2013	$11,000	$0	$0	$341,960	$0	$0	$0	($2,467)
2014	$10,880	$0	($3,770)	($112,632)	$0	$0	$0	($2,468)
2015	$20,220	$0	($18,848)	($19,148,387)	$0	$0	$0	($24,671)
2016	$35,700	$0	($26,387)	($28,569,167)	$0	$0	$0	($48,994)
2017	$45,240	$0	($18,848)	($18,794,514)	$0	$0	$0	($44,321)
2018	$62,200	$0	($33,926)	($38,362,185)	$0	$0	$0	($62,318)
2019	$96,200	$0	($60,314)	($62,893,590)	$0	$0	$0	($135,006)
2020	$136,200	$0	($67,853)	($82,557,664)	$0	$0	$0	($197,561)
2021	$153,200	$0	($41,466)	($55,393,885)	$0	$0	$0	($125,416)
2022	$160,600	$0	($30,157)	($32,965,874)	$0	$0	$0	($110,930)
2023	$171,200	$0	($37,696)	($37,258,254)	$0	$0	$0	($126,882)
2024	$168,000	$0	($22,618)	($16,869,877)	$0	$0	$0	($81,219)
2025	$155,200	$0	($15,078)	($7,943,692)	$0	$0	$0	($38,385)
2026	$148,200	$0	($18,848)	($12,629,780)	$0	$0	$0	($61,374)
2027	$156,200	$0	($30,157)	($26,127,824)	$0	$0	$0	($126,524)
2028	$170,000	$0	($37,696)	($41,668,898)	$0	$0	$0	($142,292)
2029	$180,800	$0	($37,696)	($51,534,325)	$0	$0	$0	($121,991)
2030	$207,600	$0	($52,774)	($72,180,246)	$0	$0	$0	($188,050)
2031	$237,000	$0	($56,544)	($76,405,003)	$0	$0	$0	($227,927)
2032	$262,000	$0	($56,544)	($78,791,904)	$0	$0	$0	($214,203)
2033	$280,400	$0	($52,774)	($68,172,897)	$0	$0	$0	($216,099)
2034	$267,600	$0	($22,618)	($23,032,927)	$0	$0	$0	($115,351)
2035	$247,800	$0	($11,309)	($16,117,932)	$0	$0	$0	($49,027)
2036	$227,400	$0	($11,309)	($15,806,209)	$0	$0	$0	($47,115)
2037	$202,400	$0	($3,770)	($3,839,024)	$0	$0	$0	($19,525)
2038	$179,600	$0	($3,770)	($1,006,356)	$0	$0	$0	($1,323)
2039	$166,800	$0	($15,078)	($11,101,342)	$0	$0	$0	($50,654)
2040	$170,000	$0	($26,387)	($25,732,687)	$0	$0	$0	($101,016)
2041	$165,200	$0	($18,848)	($19,426,231)	$0	$0	$0	($70,901)
2042	$151,400	$0	($7,539)	($6,812,504)	$0	$0	$0	($34,285)
2043	$136,000	$0	($3,770)	($3,035,259)	$0	$0	$0	($14,935)
2044	$122,000	$0	($3,770)	($6,546,047)	$0	$0	$0	($6,713)
2045	$109,800	$0	($3,770)	($6,546,047)	$0	$0	$0	($6,713)
2046	$96,000	$0	$0	$0	$0	$0	$0	$0
2047	$87,600	$0	($3,770)	($3,438,472)	$0	$0	$0	($17,603)
2048	$83,800	$0	($7,539)	($6,904,404)	$0	$0	$0	($35,381)
2049	$79,600	$0	($7,539)	($8,857,740)	$0	$0	$0	($23,068)

Table A-3 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Specific Limits - 1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	($10,560)	$0	($18,848)	$16,743,605	($3,395)	$0	($451,377)	$237,554
2004	($15,000)	$0	($11,309)	$9,249,725	$0	$0	$0	$129,903
2005	($14,200)	$0	$0	$732,608	$0	$0	$0	$5,136
2006	($13,640)	$0	$0	$732,608	$0	$0	$0	$5,136
2007	($13,060)	$0	$0	$732,608	$0	$0	$0	$5,136
2008	($12,760)	$0	$0	$732,608	$0	$0	$0	$5,136
2009	($12,340)	$0	$0	$732,608	$0	$0	$0	$5,136
2010	($12,040)	$0	$0	$732,608	$0	$0	$0	$2,859
2011	($11,640)	$0	$0	$732,608	$0	$0	$0	$2,859
2012	($11,360)	$0	$0	$732,608	$0	$0	$0	$2,859
2013	($11,240)	$0	$0	$732,608	$0	$0	$0	$2,859
2014	($11,200)	$0	($3,770)	$1,214,413	$0	$0	$0	$6,848
2015	($17,800)	$0	($18,848)	$22,359,758	$0	$0	$0	$149,095
2016	($28,800)	$0	($26,387)	$34,175,733	$0	$0	$0	$227,935
2017	($36,800)	$0	($18,848)	$23,776,945	$0	$0	$0	$156,869
2018	($50,000)	$0	($33,926)	$45,149,318	$0	$0	$0	$301,877
2019	($76,800)	$0	($60,314)	$76,800,837	$0	$0	$0	$512,193
2020	($105,400)	$0	($67,853)	$97,322,953	$0	$0	$0	$644,834
2021	($116,000)	$0	($41,466)	$64,387,344	$0	$0	$0	$426,412
2022	($124,000)	$0	($30,157)	$44,310,196	$0	$0	$0	$289,831
2023	($134,000)	$0	($37,696)	$50,279,371	$0	$0	$0	$328,589
2024	($132,000)	$0	($22,618)	$25,376,779	$0	$0	$0	$163,806
2025	($124,200)	$0	($15,078)	$12,220,040	$0	$0	$0	$78,488
2026	($120,600)	$0	($18,848)	$18,356,316	$0	$0	$0	$119,223
2027	($130,000)	$0	($30,157)	$37,756,101	$0	$0	$0	$246,062
2028	($138,000)	$0	($37,696)	$54,101,628	$0	$0	$0	$354,459
2029	($148,000)	$0	($37,696)	$61,800,707	$0	$0	$0	$408,465
2030	($166,000)	$0	($52,774)	$87,201,747	$0	$0	$0	$577,084
2031	($190,000)	$0	($56,544)	$94,607,147	$0	$0	$0	$622,616
2032	($208,000)	$0	($56,544)	$96,936,105	$0	$0	$0	$638,232
2033	($224,000)	$0	($52,774)	$86,923,790	$0	$0	$0	$571,652
2034	($218,000)	$0	($22,618)	$32,928,364	$0	$0	$0	$214,516
2035	($200,000)	$0	($11,309)	$19,796,783	$0	$0	$0	$130,304
2036	($186,000)	$0	($11,309)	$19,555,954	$0	$0	$0	$128,407
2037	($166,000)	$0	($3,770)	$5,595,958	$0	$0	$0	$36,004
2038	($144,000)	$0	($3,770)	$1,148,336	$0	$0	$0	$7,604
2039	($138,000)	$0	($15,078)	$15,594,693	$0	$0	$0	$101,832
2040	($138,000)	$0	($26,387)	$34,848,628	$0	$0	$0	$228,383
2041	($134,000)	$0	($18,848)	$25,840,903	$0	$0	$0	$169,283
2042	($125,800)	$0	($7,539)	$10,001,286	$0	$0	$0	$65,004
2043	($111,800)	$0	($3,770)	$4,533,931	$0	$0	$0	$29,785
2044	($100,000)	$0	($3,770)	$6,893,933	$0	$0	$0	$46,325
2045	($90,000)	$0	($3,770)	$6,893,933	$0	$0	$0	$46,325
2046	($79,600)	$0	$0	$0	$0	$0	$0	$0
2047	($72,400)	$0	($3,770)	$4,991,783	$0	$0	$0	$31,973
2048	($70,000)	$0	($7,539)	$9,923,992	$0	$0	$0	$63,460
2049	($66,200)	$0	($7,539)	$10,478,626	$0	$0	$0	$68,865

Table A-4 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Specific Limits - 10 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	($105,560)	$0	($18,848)	$18,975,651	($3,395)	$0	($451,377)	$295,470
2004	($155,200)	$0	($11,309)	$10,624,203	$0	$0	$0	$164,154
2005	($156,200)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2006	($157,440)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2007	($158,460)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2008	($159,360)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2009	($160,140)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2010	($160,840)	$0	$0	$1,127,062	$0	$0	$0	$7,646
2011	($161,440)	$0	$0	$1,127,062	$0	$0	$0	$7,646
2012	($161,960)	$0	$0	$1,127,062	$0	$0	$0	$7,646
2013	($162,440)	$0	$0	$1,127,062	$0	$0	$0	$7,646
2014	($164,000)	$0	($3,770)	$1,659,095	$0	$0	$0	$12,429
2015	($238,000)	$0	($18,848)	$24,946,800	$0	$0	$0	$188,170
2016	($352,400)	$0	($26,387)	$38,036,241	$0	$0	$0	$290,582
2017	($420,200)	$0	($18,848)	$26,618,558	$0	$0	$0	$205,058
2018	($550,600)	$0	($33,926)	$50,134,101	$0	$0	$0	$382,867
2019	($810,800)	$0	($60,314)	$85,221,386	$0	$0	$0	$658,094
2020	($1,105,400)	$0	($67,853)	$107,887,663	$0	$0	$0	$836,424
2021	($1,228,000)	$0	($41,466)	$71,376,167	$0	$0	$0	$550,662
2022	($1,290,000)	$0	($30,157)	$49,315,056	$0	$0	$0	$386,193
2023	($1,374,000)	$0	($37,696)	$55,979,397	$0	$0	$0	$439,957
2024	($1,342,000)	$0	($22,618)	$28,445,874	$0	$0	$0	$227,831
2025	($1,246,200)	$0	($15,078)	$13,791,563	$0	$0	$0	$109,745
2026	($1,208,600)	$0	($18,848)	$20,622,590	$0	$0	$0	$165,456
2027	($1,276,000)	$0	($30,157)	$42,196,128	$0	$0	$0	$339,505
2028	($1,374,000)	$0	($37,696)	$60,225,271	$0	$0	$0	$474,312
2029	($1,458,000)	$0	($37,696)	$68,575,749	$0	$0	$0	$531,340
2030	($1,644,000)	$0	($52,774)	$96,815,447	$0	$0	$0	$756,609
2031	($1,854,000)	$0	($56,544)	$105,165,132	$0	$0	$0	$825,706
2032	($2,042,000)	$0	($56,544)	$107,453,319	$0	$0	$0	$837,002
2033	($2,178,000)	$0	($52,774)	$96,443,459	$0	$0	$0	$757,652
2034	($2,114,000)	$0	($22,618)	$36,721,286	$0	$0	$0	$296,432
2035	($1,940,000)	$0	($11,309)	$22,012,568	$0	$0	$0	$172,593
2036	($1,786,000)	$0	($11,309)	$21,746,406	$0	$0	$0	$170,186
2037	($1,596,000)	$0	($3,770)	$6,275,605	$0	$0	$0	$50,322
2038	($1,404,000)	$0	($3,770)	$1,289,270	$0	$0	$0	$9,665
2039	($1,322,000)	$0	($15,078)	$17,414,991	$0	$0	$0	$140,288
2040	($1,340,000)	$0	($26,387)	$38,764,819	$0	$0	$0	$308,980
2041	($1,302,000)	$0	($18,848)	$28,682,859	$0	$0	$0	$226,773
2042	($1,195,800)	$0	($7,539)	$11,123,450	$0	$0	$0	$89,203
2043	($1,071,800)	$0	($3,770)	$5,037,197	$0	$0	$0	$40,533
2044	($960,000)	$0	($3,770)	$7,611,559	$0	$0	$0	$57,429
2045	($862,000)	$0	($3,770)	$7,611,559	$0	$0	$0	$57,429
2046	($755,600)	$0	$0	$0	$0	$0	$0	$0
2047	($688,400)	$0	($3,770)	$5,556,406	$0	$0	$0	$44,270
2048	($655,200)	$0	($7,539)	$11,065,139	$0	$0	$0	$88,317
2049	($618,800)	$0	($7,539)	$11,659,353	$0	$0	$0	$90,704

Table A-5 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - 0.03 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,145	$0	($18,848)	($73,918,704)	($3,395)	$0	($451,377)	($1,351,148)
2004	$21,659	$0	($11,309)	($40,656,978)	$0	$0	$0	($748,588)
2005	$20,457	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2006	$19,216	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2007	$18,194	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2008	$17,293	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2009	$16,511	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2010	$15,810	$0	$0	($1,256,768)	$0	$0	$0	($37,086)
2011	$15,209	$0	$0	($1,256,768)	$0	$0	$0	($37,086)
2012	$14,689	$0	$0	($1,256,768)	$0	$0	$0	($37,086)
2013	$14,208	$0	$0	($1,256,768)	$0	$0	$0	($37,086)
2014	$14,046	$0	($3,770)	($3,784,630)	$0	$0	$0	($58,955)
2015	$25,790	$0	($18,848)	($110,334,964)	$0	$0	$0	($869,427)
2016	$45,298	($3,000,000)	($26,387)	($166,670,917)	$0	$0	$0	($1,343,184)
2017	$57,442	$0	($18,848)	($113,151,384)	$0	$0	$0	($953,959)
2018	$78,932	($3,000,000)	($33,926)	($221,498,041)	$0	$0	$0	($1,766,805)
2019	$122,504	($3,000,000)	($60,314)	($370,546,753)	$0	$0	$0	($3,045,709)
2020	$173,658	($6,000,000)	($67,853)	($476,522,308)	$0	$0	$0	($3,882,983)
2021	$194,958	($3,000,000)	($41,466)	($316,683,843)	$0	$0	$0	($2,557,756)
2022	$204,904	($3,000,000)	($30,157)	($203,820,426)	$0	$0	$0	($1,776,693)
2023	$218,834	($3,000,000)	($37,696)	($230,997,130)	$0	$0	$0	($2,017,735)
2024	$214,848	$0	($22,618)	($111,367,514)	$0	$0	$0	($1,048,144)
2025	$198,718	$0	($15,078)	($53,445,682)	$0	$0	$0	($507,669)
2026	$190,354	$0	($18,848)	($81,689,214)	$0	$0	$0	($770,169)
2027	$200,896	($3,000,000)	($30,157)	($168,076,981)	$0	$0	$0	($1,573,291)
2028	$218,814	($3,000,000)	($37,696)	($253,847,702)	$0	$0	$0	($2,205,122)
2029	$232,756	($3,000,000)	($37,696)	($301,105,132)	$0	$0	$0	($2,458,206)
2030	$266,602	($6,000,000)	($52,774)	($423,706,158)	$0	$0	$0	($3,506,898)
2031	$304,404	($6,000,000)	($56,544)	($454,525,519)	$0	$0	$0	($3,841,795)
2032	$336,242	($6,000,000)	($56,544)	($465,214,150)	$0	$0	$0	($3,869,568)
2033	$360,124	($6,000,000)	($52,774)	($409,053,376)	$0	$0	$0	($3,494,979)
2034	$344,194	($3,000,000)	($22,618)	($146,617,220)	$0	$0	$0	($1,375,542)
2035	$318,342	$0	($11,309)	($95,813,031)	$0	$0	$0	($811,558)
2036	$292,474	$0	($11,309)	($94,277,207)	$0	$0	$0	($797,210)
2037	$260,634	$0	($3,770)	($24,781,927)	$0	$0	$0	($234,577)
2038	$230,794	$0	($3,770)	($5,758,047)	$0	$0	$0	($45,242)
2039	$214,872	$0	($15,078)	($70,662,169)	$0	$0	$0	($651,321)
2040	$218,862	($3,000,000)	($26,387)	($160,765,263)	$0	$0	$0	($1,434,704)
2041	$212,890	$0	($18,848)	($119,976,328)	$0	$0	$0	($1,053,850)
2042	$195,172	$0	($7,539)	($44,137,577)	$0	$0	$0	($413,970)
2043	$175,272	$0	($3,770)	($19,970,346)	$0	$0	$0	($187,167)
2044	$157,168	$0	($3,770)	($35,920,962)	$0	$0	$0	($265,193)
2045	$141,252	$0	($3,770)	($35,920,962)	$0	$0	$0	($265,193)
2046	$123,740	$0	$0	$0	$0	$0	$0	$0
2047	$112,996	$0	($3,770)	($22,051,117)	$0	$0	$0	($207,028)
2048	$108,222	$0	($7,539)	($44,156,969)	$0	$0	$0	($414,442)
2049	$102,658	$0	($7,539)	($51,776,375)	$0	$0	$0	($426,412)

Table A-6 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - 0.1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$14,754	$0	($18,848)	($15,859,375)	($3,395)	$0	($451,377)	($159,941)
2004	$21,092	$0	($11,309)	($8,699,774)	$0	$0	$0	($88,736)
2005	$19,916	$0	$0	($109,642)	$0	$0	$0	($13,569)
2006	$18,694	$0	$0	($109,642)	$0	$0	$0	($13,569)
2007	$17,690	$0	$0	($109,642)	$0	$0	$0	($13,569)
2008	$16,804	$0	$0	($109,642)	$0	$0	$0	($13,569)
2009	$16,038	$0	$0	($109,642)	$0	$0	$0	($13,569)
2010	$15,348	$0	$0	($109,642)	$0	$0	$0	($9,505)
2011	$14,758	$0	$0	($109,642)	$0	$0	$0	($9,505)
2012	$14,248	$0	$0	($109,642)	$0	$0	$0	($9,505)
2013	$13,774	$0	$0	($109,642)	$0	$0	$0	($9,505)
2014	$13,616	$0	($3,770)	($631,696)	$0	$0	$0	($11,129)
2015	$25,124	$0	($18,848)	($23,006,590)	$0	$0	$0	($113,097)
2016	$44,226	$0	($26,387)	($35,019,321)	$0	$0	$0	($199,643)
2017	$56,104	$0	($18,848)	($23,964,935)	$0	$0	$0	($164,367)
2018	$77,140	$0	($33,926)	($46,636,165)	$0	$0	$0	($256,952)
2019	$119,700	$0	($60,314)	($78,452,965)	$0	$0	$0	($504,598)
2020	$169,740	$0	($67,853)	($101,477,497)	$0	$0	$0	($678,976)
2021	$190,600	$0	($41,466)	($67,533,324)	$0	$0	$0	($433,171)
2022	$200,300	$0	($30,157)	($43,072,339)	$0	$0	$0	($366,869)
2023	$213,880	$0	($37,696)	($48,789,185)	$0	$0	$0	($419,463)
2024	$209,940	$0	($22,618)	($23,703,776)	$0	$0	$0	($253,521)
2025	$194,120	$0	($15,078)	($11,274,456)	$0	$0	$0	($120,761)
2026	$185,900	$0	($18,848)	($17,705,374)	$0	$0	$0	($188,539)
2027	$196,160	$0	($30,157)	($36,418,806)	$0	$0	$0	($387,304)
2028	$213,660	$0	($37,696)	($54,228,478)	$0	$0	$0	($461,336)
2029	$227,300	$0	($37,696)	($63,730,261)	$0	$0	$0	($431,902)
2030	$260,440	$0	($52,774)	($90,168,567)	$0	$0	$0	($646,417)
2031	$297,360	$0	($56,544)	($97,011,487)	$0	$0	$0	($753,557)
2032	$328,520	$0	($56,544)	($98,759,123)	$0	$0	$0	($723,923)
2033	$351,860	$0	($52,774)	($87,405,235)	$0	$0	$0	($707,295)
2034	$336,220	$0	($22,618)	($32,064,015)	$0	$0	$0	($345,735)
2035	$311,020	$0	($11,309)	($20,466,917)	$0	$0	$0	($159,760)
2036	$285,720	$0	($11,309)	($20,084,861)	$0	$0	$0	($156,104)
2037	$254,580	$0	($3,770)	($5,401,096)	$0	$0	$0	($59,040)
2038	$225,460	$0	($3,770)	($1,199,716)	$0	$0	$0	($5,831)
2039	$209,860	$0	($15,078)	($15,263,308)	$0	$0	$0	($156,797)
2040	$213,780	$0	($26,387)	($34,387,521)	$0	$0	$0	($322,227)
2041	$207,920	$0	($18,848)	($25,570,643)	$0	$0	$0	($227,958)
2042	$190,600	$0	($7,539)	($9,514,335)	$0	$0	$0	($103,346)
2043	$171,160	$0	($3,770)	($4,260,362)	$0	$0	$0	($46,228)
2044	$153,500	$0	($3,770)	($7,499,693)	$0	$0	$0	($31,096)
2045	$137,960	$0	($3,770)	($7,499,693)	$0	$0	$0	($31,096)
2046	$120,840	$0	$0	$0	$0	$0	$0	$0
2047	$110,340	$0	($3,770)	($4,793,703)	$0	$0	$0	($52,264)
2048	$105,660	$0	($7,539)	($9,610,936)	$0	$0	$0	($104,602)
2049	$100,260	$0	($7,539)	($11,006,085)	$0	$0	$0	($78,007)

Table A-7 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - 1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$8,340	$0	($18,848)	$13,418,392	($3,395)	$0	($451,377)	$142,936
2004	$12,020	$0	($11,309)	$7,255,578	$0	$0	$0	$75,691
2005	$11,480	$0	$0	$168,496	$0	$0	$0	($5,669)
2006	$10,820	$0	$0	$168,496	$0	$0	$0	($5,669)
2007	$10,300	$0	$0	$168,496	$0	$0	$0	($5,669)
2008	$9,860	$0	$0	$168,496	$0	$0	$0	($5,669)
2009	$9,460	$0	$0	$168,496	$0	$0	$0	($5,669)
2010	$9,100	$0	$0	$168,496	$0	$0	$0	($3,387)
2011	$8,800	$0	$0	$168,496	$0	$0	$0	($3,387)
2012	$8,540	$0	$0	$168,496	$0	$0	$0	($3,387)
2013	$8,300	$0	$0	$168,496	$0	$0	$0	($3,387)
2014	$8,240	$0	($3,770)	$600,554	$0	$0	$0	($581)
2015	$15,460	$0	($18,848)	$19,380,272	$0	$0	$0	$86,144
2016	$27,260	$0	($26,387)	$29,461,816	$0	$0	$0	$123,749
2017	$34,200	$0	($18,848)	$20,039,265	$0	$0	$0	$75,669
2018	$47,000	$0	($33,926)	$39,178,995	$0	$0	$0	$167,442
2019	$72,200	$0	($60,314)	$65,971,458	$0	$0	$0	$262,120
2020	$102,800	$0	($67,853)	$84,066,938	$0	$0	$0	$315,696
2021	$115,800	$0	($41,466)	$55,758,237	$0	$0	$0	$214,214
2022	$120,800	$0	($30,157)	$37,375,753	$0	$0	$0	$120,028
2023	$128,200	$0	($37,696)	$42,389,042	$0	$0	$0	$134,332
2024	$125,400	$0	($22,618)	$20,717,459	$0	$0	$0	$51,169
2025	$115,200	$0	($15,078)	$9,852,682	$0	$0	$0	$23,970
2026	$109,600	$0	($18,848)	$14,885,463	$0	$0	$0	$36,542
2027	$114,800	$0	($30,157)	$30,890,787	$0	$0	$0	$77,247
2028	$125,200	$0	($37,696)	$45,583,568	$0	$0	$0	$143,438
2029	$133,600	$0	($37,696)	$53,336,462	$0	$0	$0	$198,469
2030	$153,800	$0	($52,774)	$74,869,268	$0	$0	$0	$268,667
2031	$175,400	$0	($56,544)	$80,592,498	$0	$0	$0	$271,138
2032	$194,200	$0	($56,544)	$83,268,822	$0	$0	$0	$294,697
2033	$207,800	$0	($52,774)	$73,956,030	$0	$0	$0	$245,300
2034	$196,800	$0	($22,618)	$26,997,098	$0	$0	$0	$65,784
2035	$182,600	$0	($11,309)	$16,820,600	$0	$0	$0	$56,034
2036	$167,400	$0	($11,309)	$16,642,459	$0	$0	$0	$55,620
2037	$148,800	$0	($3,770)	$4,554,848	$0	$0	$0	$10,519
2038	$132,400	$0	($3,770)	$983,419	$0	$0	$0	$4,256
2039	$122,400	$0	($15,078)	$12,851,053	$0	$0	$0	$33,086
2040	$124,800	$0	($26,387)	$29,130,525	$0	$0	$0	$84,190
2041	$121,400	$0	($18,848)	$21,756,129	$0	$0	$0	$66,255
2042	$110,600	$0	($7,539)	$8,231,138	$0	$0	$0	$20,360
2043	$99,200	$0	($3,770)	$3,732,438	$0	$0	$0	$9,614
2044	$89,200	$0	($3,770)	$6,187,055	$0	$0	$0	$28,472
2045	$80,400	$0	($3,770)	$6,187,055	$0	$0	$0	$28,472
2046	$70,400	$0	$0	$0	$0	$0	$0	$0
2047	$64,200	$0	($3,770)	$4,107,966	$0	$0	$0	$9,645
2048	$61,200	$0	($7,539)	$8,153,607	$0	$0	$0	$18,737
2049	$58,200	$0	($7,539)	$9,008,663	$0	$0	$0	$31,735

Table A-8 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - 10 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	($24,560)	$0	($18,848)	$17,313,589	($3,395)	$0	($451,377)	$254,977
2004	($35,000)	$0	($11,309)	$9,381,712	$0	$0	$0	$136,282
2005	($33,800)	$0	$0	$343,833	$0	$0	$0	($999)
2006	($32,840)	$0	$0	$343,833	$0	$0	$0	($999)
2007	($31,860)	$0	$0	$343,833	$0	$0	$0	($999)
2008	($31,160)	$0	$0	$343,833	$0	$0	$0	($999)
2009	($30,340)	$0	$0	$343,833	$0	$0	$0	($999)
2010	($29,840)	$0	$0	$343,833	$0	$0	$0	$42
2011	($29,240)	$0	$0	$343,833	$0	$0	$0	$42
2012	($28,760)	$0	$0	$343,833	$0	$0	$0	$42
2013	($28,440)	$0	$0	$343,833	$0	$0	$0	$42
2014	($28,400)	$0	($3,770)	$860,222	$0	$0	$0	$4,459
2015	($44,800)	$0	($18,848)	$23,411,217	$0	$0	$0	$163,770
2016	($71,200)	$0	($26,387)	$35,976,200	$0	$0	$0	$253,707
2017	($87,400)	$0	($18,848)	$24,891,088	$0	$0	$0	$175,747
2018	($117,200)	$0	($33,926)	$47,724,349	$0	$0	$0	$337,092
2019	($180,800)	$0	($60,314)	$81,344,324	$0	$0	$0	$577,239
2020	($249,400)	$0	($67,853)	$103,249,196	$0	$0	$0	$730,426
2021	($278,000)	$0	($41,466)	$68,184,587	$0	$0	$0	$480,447
2022	($294,000)	$0	($30,157)	$46,701,157	$0	$0	$0	$329,620
2023	($314,000)	$0	($37,696)	$53,072,560	$0	$0	$0	$375,694
2024	($310,000)	$0	($22,618)	$26,602,875	$0	$0	$0	$189,853
2025	($288,200)	$0	($15,078)	$12,681,057	$0	$0	$0	$90,074
2026	($280,600)	$0	($18,848)	$19,181,885	$0	$0	$0	$137,149
2027	($300,000)	$0	($30,157)	$39,744,030	$0	$0	$0	$285,504
2028	($326,000)	$0	($37,696)	$57,265,437	$0	$0	$0	$407,005
2029	($346,000)	$0	($37,696)	$65,602,724	$0	$0	$0	$463,177
2030	($388,000)	$0	($52,774)	$92,688,108	$0	$0	$0	$658,608
2031	($442,000)	$0	($56,544)	$100,544,873	$0	$0	$0	$714,586
2032	($486,000)	$0	($56,544)	$102,944,105	$0	$0	$0	$727,365
2033	($522,000)	$0	($52,774)	$92,221,838	$0	$0	$0	$654,454
2034	($506,000)	$0	($22,618)	$34,777,896	$0	$0	$0	$249,735
2035	($462,000)	$0	($11,309)	$20,992,713	$0	$0	$0	$148,582
2036	($428,000)	$0	($11,309)	$20,751,891	$0	$0	$0	$146,653
2037	($384,000)	$0	($3,770)	$5,881,302	$0	$0	$0	$41,730
2038	($336,000)	$0	($3,770)	$1,180,040	$0	$0	$0	$8,174
2039	($318,000)	$0	($15,078)	$16,499,508	$0	$0	$0	$118,350
2040	($322,000)	$0	($26,387)	$36,925,771	$0	$0	$0	$263,602
2041	($314,000)	$0	($18,848)	$27,384,292	$0	$0	$0	$194,707
2042	($289,800)	$0	($7,539)	$10,569,439	$0	$0	$0	$75,535
2043	($259,800)	$0	($3,770)	$4,779,947	$0	$0	$0	$34,248
2044	($232,000)	$0	($3,770)	$7,385,450	$0	$0	$0	$51,809
2045	($208,000)	$0	($3,770)	$7,385,450	$0	$0	$0	$51,809
2046	($181,600)	$0	$0	$0	$0	$0	$0	$0
2047	($166,400)	$0	($3,770)	$5,274,950	$0	$0	$0	$37,265
2048	($159,200)	$0	($7,539)	$10,498,179	$0	$0	$0	$74,207
2049	($148,800)	$0	($7,539)	$11,189,626	$0	$0	$0	$79,022

Table A-9 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - RS-G-1.7 ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$1,440	$0	($18,848)	$13,418,392	($3,395)	$0	($451,377)	$142,936
2004	$2,240	$0	($11,309)	$7,255,578	$0	$0	$0	$75,691
2005	$2,360	$0	$0	$168,496	$0	$0	$0	($5,669)
2006	$2,280	$0	$0	$168,496	$0	$0	$0	($5,669)
2007	$2,260	$0	$0	$168,496	$0	$0	$0	($5,669)
2008	$2,280	$0	$0	$168,496	$0	$0	$0	($5,669)
2009	$2,260	$0	$0	$168,496	$0	$0	$0	($5,669)
2010	$2,240	$0	$0	$168,496	$0	$0	$0	($3,387)
2011	$2,240	$0	$0	$168,496	$0	$0	$0	($3,387)
2012	$2,240	$0	$0	$168,496	$0	$0	$0	($3,387)
2013	$2,240	$0	$0	$168,496	$0	$0	$0	($3,387)
2014	$2,280	$0	($3,770)	$600,554	$0	$0	$0	($581)
2015	$4,920	$0	($18,848)	$19,380,272	$0	$0	$0	$86,144
2016	$8,920	$0	($26,387)	$29,461,816	$0	$0	$0	$123,749
2017	$10,600	$0	($18,848)	$20,039,265	$0	$0	$0	$75,669
2018	$14,600	$0	($33,926)	$39,178,995	$0	$0	$0	$167,442
2019	$21,200	$0	($60,314)	$65,971,458	$0	$0	$0	$262,120
2020	$31,000	$0	($67,853)	$84,066,938	$0	$0	$0	$315,696
2021	$35,600	$0	($41,466)	$55,758,237	$0	$0	$0	$214,214
2022	$35,600	$0	($30,157)	$37,375,753	$0	$0	$0	$120,028
2023	$36,400	$0	($37,696)	$42,389,042	$0	$0	$0	$134,332
2024	$34,800	$0	($22,618)	$20,717,459	$0	$0	$0	$51,169
2025	$30,600	$0	($15,078)	$9,852,682	$0	$0	$0	$23,970
2026	$27,800	$0	($18,848)	$14,885,463	$0	$0	$0	$36,542
2027	$27,600	$0	($30,157)	$30,890,787	$0	$0	$0	$77,247
2028	$30,400	$0	($37,696)	$45,583,568	$0	$0	$0	$143,438
2029	$33,200	$0	($37,696)	$53,336,462	$0	$0	$0	$198,469
2030	$39,600	$0	($52,774)	$74,869,268	$0	$0	$0	$268,667
2031	$44,800	$0	($56,544)	$80,592,498	$0	$0	$0	$271,138
2032	$50,400	$0	($56,544)	$83,268,822	$0	$0	$0	$294,697
2033	$53,600	$0	($52,774)	$73,956,030	$0	$0	$0	$245,300
2034	$47,600	$0	($22,618)	$26,997,098	$0	$0	$0	$65,784
2035	$45,200	$0	($11,309)	$16,820,600	$0	$0	$0	$56,034
2036	$40,800	$0	($11,309)	$16,642,459	$0	$0	$0	$55,620
2037	$35,600	$0	($3,770)	$4,554,848	$0	$0	$0	$10,519
2038	$32,800	$0	($3,770)	$983,419	$0	$0	$0	$4,256
2039	$28,800	$0	($15,078)	$12,851,053	$0	$0	$0	$33,086
2040	$29,600	$0	($26,387)	$29,130,525	$0	$0	$0	$84,190
2041	$28,800	$0	($18,848)	$21,756,129	$0	$0	$0	$66,255
2042	$25,000	$0	($7,539)	$8,231,138	$0	$0	$0	$20,360
2043	$22,200	$0	($3,770)	$3,732,438	$0	$0	$0	$9,614
2044	$20,400	$0	($3,770)	$6,187,055	$0	$0	$0	$28,472
2045	$18,800	$0	($3,770)	$6,187,055	$0	$0	$0	$28,472
2046	$16,400	$0	$0	$0	$0	$0	$0	$0
2047	$14,800	$0	($3,770)	$4,107,966	$0	$0	$0	$9,645
2048	$13,600	$0	($7,539)	$8,153,607	$0	$0	$0	$18,737
2049	$13,200	$0	($7,539)	$9,008,663	$0	$0	$0	$31,735

Table A-10 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - 0.03 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,236	$0	($18,848)	($73,792,689)	($3,395)	$0	($451,377)	($1,348,379)
2004	$21,798	$0	($11,309)	($40,532,801)	$0	$0	$0	($745,860)
2005	$20,600	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2006	$19,360	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2007	$18,340	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2008	$17,440	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2009	$16,660	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2010	$15,960	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2011	$15,360	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2012	$14,840	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2013	$14,360	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2014	$14,200	$0	($3,770)	($3,662,425)	$0	$0	$0	($57,614)
2015	$25,997	$0	($18,848)	($110,212,760)	$0	$0	$0	($868,326)
2016	$45,595	($3,000,000)	($26,387)	($166,548,785)	$0	$0	$0	($1,342,084)
2017	$57,796	$0	($18,848)	($113,032,649)	$0	$0	$0	($952,889)
2018	$79,393	($3,000,000)	($33,926)	($221,381,781)	$0	$0	$0	($1,765,758)
2019	$123,187	($3,000,000)	($60,314)	($370,432,493)	$0	$0	$0	($3,044,680)
2020	$174,584	($6,000,000)	($67,853)	($476,413,898)	$0	$0	$0	($3,882,032)
2021	$195,990	($3,000,000)	($41,466)	($316,584,440)	$0	$0	$0	($2,556,884)
2022	$205,991	($3,000,000)	($30,157)	($203,730,363)	$0	$0	$0	($1,775,903)
2023	$219,990	($3,000,000)	($37,696)	($230,909,345)	$0	$0	$0	($2,016,965)
2024	$215,994	$0	($22,618)	($111,286,568)	$0	$0	$0	($1,047,434)
2025	$199,797	$0	($15,078)	($53,367,953)	$0	$0	$0	($506,990)
2026	$191,396	$0	($18,848)	($81,613,878)	$0	$0	$0	($769,510)
2027	$201,992	($3,000,000)	($30,157)	($168,001,997)	$0	$0	$0	($1,572,635)
2028	$219,990	($3,000,000)	($37,696)	($253,776,649)	$0	$0	$0	($2,204,502)
2029	$233,990	($3,000,000)	($37,696)	($301,038,895)	$0	$0	$0	($2,457,628)
2030	$267,985	($6,000,000)	($52,774)	($423,645,204)	$0	$0	$0	($3,506,365)
2031	$305,983	($6,000,000)	($56,544)	($454,470,162)	$0	$0	$0	($3,841,311)
2032	$337,983	($6,000,000)	($56,544)	($465,170,953)	$0	$0	$0	($3,869,190)
2033	$361,984	($6,000,000)	($52,774)	($409,017,991)	$0	$0	$0	($3,494,670)
2034	$345,992	($3,000,000)	($22,618)	($146,593,443)	$0	$0	$0	($1,375,334)
2035	$319,996	$0	($11,309)	($95,796,042)	$0	$0	$0	($811,410)
2036	$293,996	$0	($11,309)	($94,261,732)	$0	$0	$0	($797,075)
2037	$261,999	$0	($3,770)	($24,769,000)	$0	$0	$0	($234,464)
2038	$232,000	$0	($3,770)	($5,746,314)	$0	$0	$0	($45,140)
2039	$215,997	$0	($15,078)	($70,650,437)	$0	$0	$0	($651,218)
2040	$219,993	($3,000,000)	($26,387)	($160,753,698)	$0	$0	$0	($1,434,603)
2041	$213,995	$0	($18,848)	($119,968,404)	$0	$0	$0	($1,053,780)
2042	$196,198	$0	($7,539)	($44,134,092)	$0	$0	$0	($413,940)
2043	$176,199	$0	($3,770)	($19,968,177)	$0	$0	$0	($187,148)
2044	$157,999	$0	($3,770)	($35,919,945)	$0	$0	$0	($265,184)
2045	$141,999	$0	($3,770)	($35,919,945)	$0	$0	$0	($265,184)
2046	$124,400	$0	$0	$0	$0	$0	$0	$0
2047	$113,599	$0	($3,770)	($22,049,890)	$0	$0	$0	($207,017)
2048	$108,798	$0	($7,539)	($44,154,494)	$0	$0	$0	($414,420)
2049	$103,198	$0	($7,539)	($51,774,275)	$0	$0	$0	($426,393)

Table A-11 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - 0.1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,229	$0	($18,848)	($14,151,766)	($3,395)	$0	($451,377)	($83,417)
2004	$21,794	$0	($11,309)	($7,800,722)	$0	$0	$0	($53,266)
2005	$20,599	$0	$0	$71,845	$0	$0	$0	($26,236)
2006	$19,359	$0	$0	$71,845	$0	$0	$0	($26,236)
2007	$18,339	$0	$0	$71,845	$0	$0	$0	($26,236)
2008	$17,439	$0	$0	$71,845	$0	$0	$0	($26,236)
2009	$16,659	$0	$0	$71,845	$0	$0	$0	($26,236)
2010	$15,959	$0	$0	$71,845	$0	$0	$0	($25,837)
2011	$15,359	$0	$0	$71,845	$0	$0	$0	($25,837)
2012	$14,839	$0	$0	$71,845	$0	$0	$0	($25,837)
2013	$14,359	$0	$0	$71,845	$0	$0	$0	($25,837)
2014	$14,199	$0	($3,770)	($482,717)	$0	$0	$0	($26,339)
2015	$25,990	$0	($18,848)	($23,629,392)	$0	$0	$0	($103,257)
2016	$45,584	$0	($26,387)	($35,182,862)	$0	$0	$0	($183,249)
2017	$57,788	$0	($18,848)	($23,309,568)	$0	$0	$0	($164,729)
2018	$79,380	$0	($33,926)	($47,062,983)	$0	$0	$0	($226,471)
2019	$123,162	$0	($60,314)	($77,247,910)	$0	$0	$0	($461,968)
2020	$174,554	$0	($67,853)	($100,888,590)	$0	$0	$0	($655,713)
2021	$195,971	$0	($41,466)	($67,627,427)	$0	$0	$0	($416,605)
2022	$205,976	$0	($30,157)	($40,823,039)	$0	$0	$0	($384,018)
2023	$219,972	$0	($37,696)	($46,142,690)	$0	$0	$0	($438,533)
2024	$215,984	$0	($22,618)	($21,165,364)	$0	$0	$0	($282,650)
2025	$199,792	$0	($15,078)	($10,090,514)	$0	$0	$0	($141,690)
2026	$191,388	$0	($18,848)	($15,775,067)	$0	$0	$0	($213,365)
2027	$201,976	$0	($30,157)	($32,462,176)	$0	$0	$0	($426,534)
2028	$219,970	$0	($37,696)	($51,366,526)	$0	$0	$0	($481,596)
2029	$233,970	$0	($37,696)	($63,153,664)	$0	$0	$0	($422,482)
2030	$267,957	$0	($52,774)	($88,410,978)	$0	$0	$0	($640,737)
2031	$305,951	$0	($56,544)	($93,741,172)	$0	$0	$0	($762,763)
2032	$337,952	$0	($56,544)	($96,557,829)	$0	$0	$0	($719,021)
2033	$361,955	$0	($52,774)	($83,659,322)	$0	$0	$0	($720,361)
2034	$345,979	$0	($22,618)	($28,443,165)	$0	$0	$0	($376,032)
2035	$319,989	$0	($11,309)	($19,791,386)	$0	$0	$0	($162,866)
2036	$293,989	$0	($11,309)	($19,417,851)	$0	$0	$0	($158,358)
2037	$261,996	$0	($3,770)	($4,768,605)	$0	$0	$0	($65,480)
2038	$231,999	$0	($3,770)	($1,250,548)	$0	$0	$0	($6,604)
2039	$215,990	$0	($15,078)	($13,748,598)	$0	$0	$0	($169,196)
2040	$219,979	$0	($26,387)	($31,792,317)	$0	$0	$0	($338,949)
2041	$213,985	$0	($18,848)	($23,963,999)	$0	$0	$0	($236,966)
2042	$196,194	$0	($7,539)	($8,453,233)	$0	$0	$0	($112,050)
2043	$176,197	$0	($3,770)	($3,784,511)	$0	$0	$0	($50,218)
2044	$157,997	$0	($3,770)	($7,951,527)	$0	$0	$0	($23,948)
2045	$141,997	$0	($3,770)	($7,951,527)	$0	$0	$0	($23,948)
2046	$124,400	$0	$0	$0	$0	$0	$0	$0
2047	$113,596	$0	($3,770)	($4,249,220)	$0	$0	$0	($56,418)
2048	$108,793	$0	($7,539)	($8,530,045)	$0	$0	$0	($113,019)
2049	$103,195	$0	($7,539)	($10,845,065)	$0	$0	$0	($76,314)

Table A-12 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - 1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,188	$0	($18,848)	$10,196,041	($3,395)	$0	($451,377)	$60,330
2004	$21,768	$0	($11,309)	$5,605,693	$0	$0	$0	$27,713
2005	$20,590	$0	$0	$401,448	$0	$0	$0	($20,943)
2006	$19,349	$0	$0	$401,448	$0	$0	$0	($20,943)
2007	$18,329	$0	$0	$401,448	$0	$0	$0	($20,943)
2008	$17,429	$0	$0	$401,448	$0	$0	$0	($20,943)
2009	$16,648	$0	$0	$401,448	$0	$0	$0	($20,943)
2010	$15,948	$0	$0	$401,448	$0	$0	$0	($23,194)
2011	$15,348	$0	$0	$401,448	$0	$0	$0	($23,194)
2012	$14,827	$0	$0	$401,448	$0	$0	$0	($23,194)
2013	$14,347	$0	$0	$401,448	$0	$0	$0	($23,194)
2014	$14,186	$0	($3,770)	$704,185	$0	$0	$0	($21,343)
2015	$25,948	$0	($18,848)	$14,031,442	$0	$0	$0	($13,996)
2016	$45,519	$0	($26,387)	$21,329,573	$0	$0	$0	($50,056)
2017	$57,734	$0	($18,848)	$14,685,257	$0	$0	$0	($74,658)
2018	$79,298	$0	($33,926)	$28,249,757	$0	$0	$0	($48,958)
2019	$123,023	$0	($60,314)	$47,735,563	$0	$0	$0	($168,625)
2020	$174,384	$0	($67,853)	$60,430,917	$0	$0	$0	($285,375)
2021	$195,858	$0	($41,466)	$40,043,951	$0	$0	$0	($167,667)
2022	$205,883	$0	($30,157)	$27,557,562	$0	$0	$0	($226,453)
2023	$219,869	$0	($37,696)	$31,280,028	$0	$0	$0	($260,469)
2024	$215,921	$0	($22,618)	$15,593,721	$0	$0	$0	($197,501)
2025	$199,756	$0	($15,078)	$7,477,842	$0	$0	$0	($101,084)
2026	$191,339	$0	($18,848)	$11,161,184	$0	$0	$0	($150,512)
2027	$201,886	$0	($30,157)	$23,030,455	$0	$0	$0	($297,893)
2028	$219,862	$0	($37,696)	$33,322,099	$0	$0	$0	($288,630)
2029	$233,862	$0	($37,696)	$38,458,390	$0	$0	$0	($192,053)
2030	$267,800	$0	($52,774)	$54,026,834	$0	$0	$0	($317,955)
2031	$305,772	$0	($56,544)	$58,382,683	$0	$0	$0	($418,052)
2032	$337,778	$0	($56,544)	$60,276,909	$0	$0	$0	($361,832)
2033	$361,790	$0	($52,774)	$53,919,204	$0	$0	$0	($404,564)
2034	$345,899	$0	($22,618)	$20,073,968	$0	$0	$0	($262,852)
2035	$319,946	$0	($11,309)	$12,144,670	$0	$0	$0	($90,924)
2036	$293,950	$0	($11,309)	$12,044,746	$0	$0	$0	($87,495)
2037	$261,980	$0	($3,770)	$3,418,544	$0	$0	$0	($46,335)
2038	$231,993	$0	($3,770)	$713,046	$0	$0	$0	($2,047)
2039	$215,950	$0	($15,078)	$9,522,377	$0	$0	$0	($116,076)
2040	$219,904	$0	($26,387)	$21,385,944	$0	$0	$0	($218,816)
2041	$213,932	$0	($18,848)	$15,911,160	$0	$0	$0	($146,779)
2042	$196,168	$0	($7,539)	$6,125,910	$0	$0	$0	($78,454)
2043	$176,184	$0	($3,770)	$2,777,188	$0	$0	$0	($35,324)
2044	$157,985	$0	($3,770)	$4,351,403	$0	$0	$0	$3,632
2045	$141,985	$0	($3,770)	$4,351,403	$0	$0	$0	$3,632
2046	$124,397	$0	$0	$0	$0	$0	$0	$0
2047	$113,585	$0	($3,770)	$3,059,277	$0	$0	$0	($39,412)
2048	$108,769	$0	($7,539)	$6,066,406	$0	$0	$0	($79,193)
2049	$103,172	$0	($7,539)	$6,464,498	$0	$0	$0	($37,645)

Table A-13 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - 10 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,032	$0	($18,848)	$10,947,420	($3,395)	$0	($451,377)	$72,939
2004	$21,643	$0	($11,309)	$6,186,051	$0	$0	$0	$37,452
2005	$20,497	$0	$0	$763,279	$0	$0	$0	($14,872)
2006	$19,252	$0	$0	$763,279	$0	$0	$0	($14,872)
2007	$18,227	$0	$0	$763,279	$0	$0	$0	($14,872)
2008	$17,323	$0	$0	$763,279	$0	$0	$0	($14,872)
2009	$16,539	$0	$0	$763,279	$0	$0	$0	($14,872)
2010	$15,835	$0	$0	$763,279	$0	$0	$0	($20,162)
2011	$15,233	$0	$0	$763,279	$0	$0	$0	($20,162)
2012	$14,710	$0	$0	$763,279	$0	$0	$0	($20,162)
2013	$14,228	$0	$0	$763,279	$0	$0	$0	($20,162)
2014	$14,063	$0	($3,770)	$1,082,335	$0	$0	$0	($18,174)
2015	$25,750	$0	($18,848)	$15,056,026	$0	$0	$0	($6,949)
2016	$45,274	$0	($26,387)	$22,662,750	$0	$0	$0	($40,886)
2017	$57,522	$0	($18,848)	$15,670,225	$0	$0	$0	($67,883)
2018	$79,014	$0	($33,926)	$29,901,486	$0	$0	$0	($37,597)
2019	$122,602	$0	($60,314)	$50,164,318	$0	$0	$0	($151,919)
2020	$173,900	$0	($67,853)	$63,497,935	$0	$0	$0	($264,826)
2021	$195,506	$0	($41,466)	$42,171,597	$0	$0	$0	($153,412)
2022	$205,584	$0	($30,157)	$28,946,326	$0	$0	$0	($217,148)
2023	$219,546	$0	($37,696)	$32,822,650	$0	$0	$0	($250,133)
2024	$215,704	$0	($22,618)	$16,411,646	$0	$0	$0	($192,021)
2025	$199,603	$0	($15,078)	$7,982,041	$0	$0	$0	($97,719)
2026	$191,150	$0	($18,848)	$11,792,948	$0	$0	$0	($146,296)
2027	$201,608	$0	($30,157)	$24,093,204	$0	$0	$0	($290,801)
2028	$219,542	$0	($37,696)	$34,919,551	$0	$0	$0	($277,969)
2029	$233,534	$0	($37,696)	$40,410,416	$0	$0	$0	($179,025)
2030	$267,366	$0	($52,774)	$56,618,999	$0	$0	$0	($300,652)
2031	$305,304	$0	($56,544)	$61,112,951	$0	$0	$0	($399,827)
2032	$337,316	$0	($56,544)	$63,061,762	$0	$0	$0	($343,242)
2033	$361,352	$0	($52,774)	$56,283,908	$0	$0	$0	($388,779)
2034	$345,678	$0	($22,618)	$20,877,457	$0	$0	$0	($257,489)
2035	$319,811	$0	($11,309)	$12,728,683	$0	$0	$0	($87,025)
2036	$293,817	$0	($11,309)	$12,620,983	$0	$0	$0	($83,648)
2037	$261,906	$0	($3,770)	$3,582,327	$0	$0	$0	($45,242)
2038	$231,947	$0	($3,770)	$780,242	$0	$0	$0	($1,598)
2039	$215,833	$0	($15,078)	$9,920,166	$0	$0	$0	($113,421)
2040	$219,702	$0	($26,387)	$22,266,518	$0	$0	$0	($212,938)
2041	$213,782	$0	($18,848)	$16,571,919	$0	$0	$0	($142,368)
2042	$196,094	$0	($7,539)	$6,352,559	$0	$0	$0	($76,941)
2043	$176,139	$0	($3,770)	$2,878,845	$0	$0	$0	($34,645)
2044	$157,940	$0	($3,770)	$4,583,305	$0	$0	$0	$5,180
2045	$141,942	$0	($3,770)	$4,583,305	$0	$0	$0	$5,180
2046	$124,379	$0	$0	$0	$0	$0	$0	$0
2047	$113,545	$0	($3,770)	$3,174,033	$0	$0	$0	($38,646)
2048	$108,708	$0	($7,539)	$6,299,100	$0	$0	$0	($77,640)
2049	$103,117	$0	($7,539)	$6,781,883	$0	$0	$0	($35,526)

Table A-14 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - RS-G-1.7

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,136	$0	($18,848)	$10,196,041	($3,395)	$0	($451,377)	$60,330
2004	$21,737	$0	($11,309)	$5,605,693	$0	$0	$0	$27,713
2005	$20,579	$0	$0	$401,448	$0	$0	$0	($20,943)
2006	$19,339	$0	$0	$401,448	$0	$0	$0	($20,943)
2007	$18,318	$0	$0	$401,448	$0	$0	$0	($20,943)
2008	$17,417	$0	$0	$401,448	$0	$0	$0	($20,943)
2009	$16,636	$0	$0	$401,448	$0	$0	$0	($20,943)
2010	$15,936	$0	$0	$401,448	$0	$0	$0	($23,194)
2011	$15,335	$0	$0	$401,448	$0	$0	$0	($23,194)
2012	$14,815	$0	$0	$401,448	$0	$0	$0	($23,194)
2013	$14,334	$0	$0	$401,448	$0	$0	$0	($23,194)
2014	$14,173	$0	($3,770)	$704,185	$0	$0	$0	($21,343)
2015	$25,896	$0	($18,848)	$14,031,442	$0	$0	$0	($13,996)
2016	$45,439	$0	($26,387)	$21,329,573	$0	$0	$0	($50,056)
2017	$57,668	$0	($18,848)	$14,685,257	$0	$0	$0	($74,658)
2018	$79,197	$0	($33,926)	$28,249,757	$0	$0	$0	($48,958)
2019	$122,845	$0	($60,314)	$47,735,563	$0	$0	$0	($168,625)
2020	$174,168	$0	($67,853)	$60,430,917	$0	$0	$0	($285,375)
2021	$195,716	$0	($41,466)	$40,043,951	$0	$0	$0	($167,667)
2022	$205,765	$0	($30,157)	$27,557,562	$0	$0	$0	($226,453)
2023	$219,737	$0	($37,696)	$31,280,028	$0	$0	$0	($260,469)
2024	$215,842	$0	($22,618)	$15,593,721	$0	$0	$0	($197,501)
2025	$199,712	$0	($15,078)	$7,477,842	$0	$0	$0	($101,084)
2026	$191,278	$0	($18,848)	$11,161,184	$0	$0	$0	($150,512)
2027	$201,772	$0	($30,157)	$23,030,455	$0	$0	$0	($297,893)
2028	$219,724	$0	($37,696)	$33,322,099	$0	$0	$0	($288,630)
2029	$233,724	$0	($37,696)	$38,458,390	$0	$0	$0	($192,053)
2030	$267,600	$0	($52,774)	$54,026,834	$0	$0	$0	($317,955)
2031	$305,544	$0	($56,544)	$58,382,683	$0	$0	$0	($418,052)
2032	$337,556	$0	($56,544)	$60,276,909	$0	$0	$0	($361,832)
2033	$361,580	$0	($52,774)	$53,919,204	$0	$0	$0	($404,564)
2034	$345,798	$0	($22,618)	$20,073,968	$0	$0	$0	($262,852)
2035	$319,892	$0	($11,309)	$12,144,670	$0	$0	$0	($90,924)
2036	$293,899	$0	($11,309)	$12,044,746	$0	$0	$0	($87,495)
2037	$261,960	$0	($3,770)	$3,418,544	$0	$0	$0	($46,335)
2038	$231,986	$0	($3,770)	$713,046	$0	$0	$0	($2,047)
2039	$215,901	$0	($15,078)	$9,522,377	$0	$0	$0	($116,076)
2040	$219,809	$0	($26,387)	$21,385,944	$0	$0	$0	($218,816)
2041	$213,864	$0	($18,848)	$15,911,160	$0	$0	$0	($146,779)
2042	$196,136	$0	($7,539)	$6,125,910	$0	$0	$0	($78,454)
2043	$176,168	$0	($3,770)	$2,777,188	$0	$0	$0	($35,324)
2044	$157,970	$0	($3,770)	$4,351,403	$0	$0	$0	$3,632
2045	$141,971	$0	($3,770)	$4,351,403	$0	$0	$0	$3,632
2046	$124,395	$0	$0	$0	$0	$0	$0	$0
2047	$113,569	$0	($3,770)	$3,059,277	$0	$0	$0	($39,412)
2048	$108,738	$0	($7,539)	$6,066,406	$0	$0	$0	($79,193)
2049	$103,144	$0	($7,539)	$6,464,498	$0	$0	$0	($37,645)

Table A-15 Net Incremental Benefit (Cost) Associated with Attributes for Limited Dispositions Alternative ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,018	$0	($18,848)	$14,197,311	($3,395)	$0	($451,377)	$9,867
2004	$21,561	$0	($11,309)	$7,782,076	$0	$0	$0	$197
2005	$20,420	$0	$0	$401,448	$0	$0	$0	($20,943)
2006	$19,197	$0	$0	$401,448	$0	$0	$0	($20,943)
2007	$18,192	$0	$0	$401,448	$0	$0	$0	($20,943)
2008	$17,305	$0	$0	$401,448	$0	$0	$0	($20,943)
2009	$16,536	$0	$0	$401,448	$0	$0	$0	($20,943)
2010	$15,845	$0	$0	$401,448	$0	$0	$0	($23,194)
2011	$15,254	$0	$0	$401,448	$0	$0	$0	($23,194)
2012	$14,742	$0	$0	$401,448	$0	$0	$0	($23,194)
2013	$14,268	$0	$0	$401,448	$0	$0	$0	($23,194)
2014	$14,109	$0	($3,770)	$849,614	$0	$0	$0	($22,412)
2015	$25,692	$0	($18,848)	$20,294,026	$0	$0	$0	($51,928)
2016	$45,061	$0	($26,387)	$30,757,208	$0	$0	$0	($106,862)
2017	$57,250	$0	($18,848)	$21,009,910	$0	$0	$0	($112,490)
2018	$78,422	$0	($33,926)	$40,815,886	$0	$0	$0	($124,802)
2019	$121,496	$0	($60,314)	$68,608,128	$0	$0	$0	($294,188)
2020	$172,373	$0	($67,853)	$87,381,423	$0	$0	$0	($434,816)
2021	$193,702	$0	($41,466)	$57,994,670	$0	$0	$0	($267,221)
2022	$203,688	$0	($30,157)	$38,925,140	$0	$0	$0	($289,311)
2023	$217,635	$0	($37,696)	$44,177,926	$0	$0	$0	($331,556)
2024	$213,780	$0	($22,618)	$21,717,759	$0	$0	$0	($230,606)
2025	$197,731	$0	($15,078)	$10,393,612	$0	$0	$0	($115,989)
2026	$189,368	$0	($18,848)	$15,610,281	$0	$0	$0	($173,396)
2027	$199,810	$0	($30,157)	$32,237,495	$0	$0	$0	($345,142)
2028	$217,742	$0	($37,696)	$47,458,259	$0	$0	$0	($362,202)
2029	$231,732	$0	($37,696)	$55,452,885	$0	$0	$0	($281,346)
2030	$265,320	$0	($52,774)	$77,845,672	$0	$0	$0	($440,936)
2031	$302,587	$0	($56,544)	$83,836,251	$0	$0	$0	($548,861)
2032	$334,024	$0	($56,544)	$86,511,515	$0	$0	$0	($496,572)
2033	$357,912	$0	($52,774)	$76,840,506	$0	$0	$0	($522,109)
2034	$342,330	$0	($22,618)	$28,115,088	$0	$0	$0	($303,341)
2035	$316,753	$0	($11,309)	$17,495,562	$0	$0	$0	($118,441)
2036	$291,053	$0	($11,309)	$17,314,591	$0	$0	$0	($114,640)
2037	$259,388	$0	($3,770)	$4,767,711	$0	$0	$0	($53,191)
2038	$229,664	$0	($3,770)	$1,039,773	$0	$0	$0	($3,727)
2039	$213,803	$0	($15,078)	$13,394,872	$0	$0	$0	($135,806)
2040	$217,751	$0	($26,387)	$30,288,586	$0	$0	$0	($264,217)
2041	$211,768	$0	($18,848)	$22,595,140	$0	$0	$0	($180,834)
2042	$194,122	$0	($7,539)	$8,546,877	$0	$0	$0	($90,711)
2043	$174,291	$0	($3,770)	$3,869,445	$0	$0	$0	($40,888)
2044	$156,223	$0	($3,770)	$6,409,222	$0	$0	$0	($7,249)
2045	$140,340	$0	($3,770)	$6,409,222	$0	$0	$0	($7,249)
2046	$122,899	$0	$0	$0	$0	$0	$0	$0
2047	$112,196	$0	($3,770)	$4,273,399	$0	$0	$0	($45,512)
2048	$107,476	$0	($7,539)	$8,492,696	$0	$0	$0	($91,404)
2049	$101,981	$0	($7,539)	$9,366,489	$0	$0	$0	($52,720)

Table A-16 Net Incremental Benefit (Cost) Associated with Attributes for LLW Disposal/Prohibition ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,240	$0	$0	($73,920,446)	($3,395)	$0	($451,377)	($1,351,186)
2004	$21,800	$0	$0	($40,658,693)	$0	$0	$0	($748,626)
2005	$20,600	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2006	$19,360	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2007	$18,340	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2008	$17,440	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2009	$16,660	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2010	$15,960	$0	$0	($1,258,455)	$0	$0	$0	($37,104)
2011	$15,360	$0	$0	($1,258,455)	$0	$0	$0	($37,104)
2012	$14,840	$0	$0	($1,258,455)	$0	$0	$0	($37,104)
2013	$14,360	$0	$0	($1,258,455)	$0	$0	$0	($37,104)
2014	$14,200	$0	$0	($3,786,318)	$0	$0	$0	($58,973)
2015	$26,000	$0	$0	($110,336,652)	$0	$0	$0	($869,442)
2016	$45,600	($3,000,000)	$0	($166,672,604)	$0	$0	$0	($1,343,199)
2017	$57,800	$0	$0	($113,153,026)	$0	$0	$0	($953,974)
2018	$79,400	($3,000,000)	$0	($221,499,649)	$0	$0	$0	($1,766,820)
2019	$123,200	($3,000,000)	$0	($370,548,333)	$0	$0	$0	($3,045,724)
2020	$174,600	($6,000,000)	$0	($476,523,809)	$0	$0	$0	($3,882,996)
2021	$196,000	($3,000,000)	$0	($316,685,220)	$0	$0	$0	($2,557,769)
2022	$206,000	($3,000,000)	$0	($203,821,677)	$0	$0	$0	($1,776,704)
2023	$220,000	($3,000,000)	$0	($230,998,348)	$0	$0	$0	($2,017,746)
2024	$216,000	$0	$0	($111,368,638)	$0	$0	$0	($1,048,154)
2025	$199,800	$0	$0	($53,446,760)	$0	$0	$0	($507,678)
2026	$191,400	$0	$0	($81,690,258)	$0	$0	$0	($770,178)
2027	$202,000	($3,000,000)	$0	($168,078,021)	$0	$0	$0	($1,573,300)
2028	$220,000	($3,000,000)	$0	($253,848,686)	$0	$0	$0	($2,205,131)
2029	$234,000	($3,000,000)	$0	($301,106,048)	$0	$0	$0	($2,458,214)
2030	$268,000	($6,000,000)	$0	($423,707,002)	$0	$0	$0	($3,506,905)
2031	$306,000	($6,000,000)	$0	($454,526,287)	$0	$0	$0	($3,841,802)
2032	$338,000	($6,000,000)	$0	($465,214,749)	$0	$0	$0	($3,869,573)
2033	$362,000	($6,000,000)	$0	($409,053,868)	$0	$0	$0	($3,494,984)
2034	$346,000	($3,000,000)	$0	($146,617,553)	$0	$0	$0	($1,375,545)
2035	$320,000	$0	$0	($95,813,268)	$0	$0	$0	($811,560)
2036	$294,000	$0	$0	($94,277,422)	$0	$0	$0	($797,212)
2037	$262,000	$0	$0	($24,782,108)	$0	$0	$0	($234,579)
2038	$232,000	$0	$0	($5,758,210)	$0	$0	$0	($45,244)
2039	$216,000	$0	$0	($70,662,333)	$0	$0	$0	($651,322)
2040	$220,000	($3,000,000)	$0	($160,765,424)	$0	$0	$0	($1,434,706)
2041	$214,000	$0	$0	($119,976,438)	$0	$0	$0	($1,053,851)
2042	$196,200	$0	$0	($44,137,625)	$0	$0	$0	($413,971)
2043	$176,200	$0	$0	($19,970,375)	$0	$0	$0	($187,167)
2044	$158,000	$0	$0	($35,920,975)	$0	$0	$0	($265,193)
2045	$142,000	$0	$0	($35,920,975)	$0	$0	$0	($265,193)
2046	$124,400	$0	$0	$0	$0	$0	$0	$0
2047	$113,600	$0	$0	($22,051,134)	$0	$0	$0	($207,028)
2048	$108,800	$0	$0	($44,157,004)	$0	$0	$0	($414,442)
2049	$103,200	$0	$0	($51,776,404)	$0	$0	$0	($426,412)