Exposure Draft for Waste Topic Methodology

Draft for Public Consultation

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Impact Value Standards Board
hosted by CAPITALS COALITION

Explanatory note

Background
This document, the Exposure Draft for the Waste Topic Methodology (Waste Methodology), provides a draft proposal to solicit feedback on a methodology to value waste impacts, based on an impact pathway that causally links waste emissions with anticipated outcomes and impacts that affect the well-being of people through changes in the condition of the natural environment.
The purpose of the Waste Methodology is to guide preparers of impact accounts through the process of measuring and valuing in monetary terms an entity's waste impacts. This provides preparers and users with impact information about waste that aids decision-making regarding an entity's contribution to sustainability. It is one of a series of Topic Methodologies to be developed as part of the impact accounting system for a comprehensive assessment of material value created and destroyed by an entity.

The Waste Methodology was developed by the technical staff of the Impact Values Standards Board (IVSB). The development process involved a comprehensive literature review of methodologies for valuing waste impacts, including methods developed previously by the International Foundation for Valuing Impacts (IFVI) and Value Balancing Alliance (VBA). Subsequent research sought alignment with established protocols, frameworks, and disclosure requirements by relevant standard setters, including recent revisions intended to simplify sustainability reporting while preserving core reporting concepts. Throughout the process, the technical staff regularly sought expert consultation from various entities to better understand key technical aspects.

The Waste Methodology is intended to augment and build on the foundational work of other protocols and sustainability standard setters and has been designed to maintain interoperability with internationally recognized sustainability reporting frameworks. The Waste Methodology has been developed to align with the conceptual framework and disclosure architecture of the revised European Sustainability Reporting Standards (ESRS), including ESRS 1 General Requirements, ESRS 2 General Disclosures and ESRS E5 Resource Use and Circular Economy, while expanding upon those standards through the provision of an impact valuation methodology for waste-related impacts. The methodology also aligns with the Global Reporting Initiative (GRI) 306: Waste 2020. Ideas and definitions also build on work by leading international organizations and initiatives in order to build consensus on and advance the measurement and valuation of Waste impacts.

The methodology has also been reviewed against the revised ESRS adopted by the European Commission on 3 July 2026[1] in order to maintain consistency with the latest European sustainability reporting framework. The revisions introduced by the European Commission primarily simplify disclosure requirements and reduce reporting complexity, while preserving the underlying concepts of double

[1] At the publication date of the Waste Methodology, the Delegated Act remained subject to scrutiny by the European Parliament and the Council prior to entering into force.

materiality and sustainability-related governance, strategy, management and performance reporting.

The development of the Waste Methodology included engagement with the Impact Value Standards Board (IVSB) members. A Pre-Exposure Draft of the Waste Methodology was shared with the IVSB in advance of a May 2026 IVSB meeting to provide an opportunity for all members to share detailed feedback on the draft. Based on discussions at that meeting and written feedback received from members, revisions were incorporated into the Waste Exposure Draft and a complete version of the Exposure Draft was then shared with the IVSB for review in advance of the June 2026 IVSB meeting. The Waste Exposure Draft received approval at that meeting and was prepared for public comment.

Summary of Exposure Draft

The following provides a section-by-section summary of the key proposals set out in the Waste Methodology. It is not intended as an exhaustive overview of the document, but rather to support respondents in engaging with the public comment questions by highlighting key proposals and decisions made during the development of the Exposure Draft.

Section 1: Introduction
This section lays out the purpose of the Waste Methodology (Section 1.1), provides a high-level description of the topic and its impacts (Section 1.2), introduces key concepts and definitions (Section 1.3), and defines the scope of what is and is not included within the Waste Methodology (Section 1.4).

Section 1.1 states that the purpose of the Waste Methodology is to generate impact information by measuring and valuing impacts of corporate entities in monetary terms. It also acknowledges that practical considerations may challenge a full waste impact account but that the methodology should be followed to the fullest extent possible.

Section 1.2 serves as an introduction to the topic of waste including defining the impacts on society and other contexts including the global waste management approach.

Section 1.3 defines the following key terms: Waste, hazardous waste, incineration, landfill, municipal solid waste, recycling. A complete set of defined terms is included in the Glossary in Appendix A.

Section 1.4 provides guidance on the scope of the Waste Methodology. The Waste Methodology intentionally defines full value chain impacts and the process of attribution, but also acknowledges that waste in the value chain may need to be modeled due to the lack of complete data at present. The Waste Methodology does not cover environmental impacts associated with the broader practices and operations of waste disposal (e.g., GHG emissions from transporting waste), which are addressed by other environmental methodologies. It does, however, overlap with other Topic methodologies via the impacts related to waste disposal itself. The Waste Methodology is designed to individually select impacts to avoid potential double counting when aggregating different impact areas related to waste disposal. Plastic waste should be considered separately from hazardous and non-hazardous waste due to its high risk for mismanagement.

Section 2: Impact pathway
As laid out in General Methodology 1, the impact pathway serves as the framework for measuring impacts and defines the causal relationship between an entity's activities and changes in the well-being of people. Section 2 of the Waste Methodology lays out the impact pathway in both visual (Figure 1) and descriptive (Section 2.2) form. Both forms are structured to delineate inputs, activities, outputs, outcomes, and impacts as well as the linkages between each.

The valuation approaches of different impacts of the Waste Methodology align with existing methodologies and frameworks to the extent that they are relevant for the constructed impact pathway of Waste. The primary inputs for the waste impact pathway are the materials used in the creation and delivery of the product or service produced by the entity. The outputs from the entity are represented in three parts – Resource outflows, waste composition, and disposal method. Resource outflows are represented by the total weight of materials that are used by the entity and the waste directed to disposal (either by incineration or landfill).

Section 3: Impact driver measurements
This section focuses on the impact driver information needed from an entity to develop waste impact accounts. In addition to guiding preparers through data requirements and outlining how these data align with reporting standards (Section 3.1), the section also highlights approaches to address data sources, gaps, and uncertainty (Section 3.2).

Section 3.1 and Table 1 lay out the data required from the entity to produce waste impact accounts. Required data from the entity includes waste from own operations, upstream value chain and downstream value chain organized by the location of waste disposed. Waste data should be organized for the country where the final treatment of waste occurs, if known. If unknown, it should be organized for the country in which the waste was produced. Additionally, the waste disposal method should be known, including whether it is disposed via landfill or incineration. If the waste is considered unmanaged, littered, or the treatment method is not known, an "Unspecified" category should be applied. Lastly, as a minimum, the waste composition should be broken down into hazardous and non-hazardous waste, but more specific composition data related to plastic waste is preferred. If plastic waste data is provided separately as preferred, it should not also be reported as hazardous or non-hazardous.

Guidance is also provided in this section to highlight the ways in which the the data requirements and methodological approach are both aligned with and expand upon the disclosure requirements established by relevant standard setters including the revised European Sustainability Reporting Standards (ESRS), particularly ESRS 1

General Requirements, ESRS 2 General Disclosures and ESRS E5: Resource Use and Circular Economy and the Global Reporting Initiative 306: Waste 2020. Additional interoperability may exist with other regional or topic specific sustainability reporting standards, such as the Sustainability Accounting Standards Board (SASB). Further details are presented in Table 2 and Appendix C.

Because some data are likely to be missing or estimated using proxy data, Section 3.2 provides general guidance for preparers to address data gaps and uncertainty.

Section 4: Outcomes, impacts and valuation
This section provides the specific equations used to calculate the impacts in monetary terms (Section 4.1), explains the variables that translate impact driver measurements to outcomes (Section 4.2), and discusses the monetary valuation approach (Section 4.3) for the Waste Methodology.

The total monetary cost of waste impacts is calculated by the sum of all impacts across waste disposal methods and waste compositions. For each disposal method, site-level value factors are calculated, represented by their respective impact category (greenhouse gas emissions, disamenity, leachate, land use, heavy metals and dioxins, air pollutants and residual incineration ashes). If the composition is plastic, an additional impact on marine ecosystems is included. Once all individual sites are prepared, total impacts per disposal method are represented by the sum of the site-level tons of waste per disposal method multiplied by the site-level value factor.

Sections 4.2 describes the approach to determine outcomes and impacts, additional methodological details can be found in Appendix B.

Section 4.3 describes the valuation approach used to convert impacts described above to impacts in monetary terms. Monetary valuation estimates the relative importance, worth, or usefulness of changes in well-being indicators in monetary terms. A tailored valuation approach is developed for each impact in the Waste Methodology. Each approach is described briefly below with additional methodological details presented in Appendix B.

Section 5: Future development
The closing section reinforces that the Waste Methodology reflects the latest understanding of the impacts of waste and builds on decades of rigorous scientific work. At the same time, opportunities for the continued development of the Waste Methodology are highlighted.

Request for public comment

Instructions to comment

The IVSB invites comment letters on the proposals in the Waste Methodology, particularly on the questions set out below. Feedback from stakeholders will be incorporated impartially. The consultation period opens on July 20, 2026, and closes on September 20, 2026. Comments are most helpful if they:

a. address the questions as stated;
b. specify the paragraph(s) to which they relate;
c. contain a clear rationale;
d. identify any wording in the proposals that is ambiguous in its interpretation; and
e. include alternative proposals the IVSB should consider, if applicable.

In providing comments, not all questions need to be addressed. Where a question is addressed, please provide sufficient detail and context to support your comment. Comments are also welcome where there is strong support for a proposal. The IVSB is requesting comments only on matters addressed in the Methodology.

Please note that comment letters are a matter of public record and will be published on the Capitals Coalition website. Responses to the questions should be submitted via the survey linked here.

Questions for feedback

Each box outlines a series of questions pertaining to a specific topic. For additional context, use the 'Exposure Draft Summary' above for added context to each question.

Question 1 - Overall Usability of the Waste Methodology
1a. Is the presentation of Topic Methodology clear and understandable? Is it possible to be understood and implemented by a practitioner with a sufficient, but not necessarily advanced, level of expertise? If not, please clarify. 1b. Are the data requirements proposed in the Topic Methodology achievable? If not, what changes would better align it with best practices in data collection in a way that is sufficiently linked to the outcomes and impacts to be valued? 1c. As presented, does the Topic Methodology add value to an organization's impact management and/or reporting practices? Why? What would help improve the value proposition of the Topic Methodology?

1d. Do you foresee any barriers that will prevent users from adopting the Waste Value Factor (for example lack of data, unclear methodology, lack of mandatory regulation to value impacts, lack of Board level or stakeholder pressures to undertake impact valuation)? Please specify which barriers are foreseen and why, and how they might be overcome.

Question 2 - Scope of the Waste Methodology (Sections 1.2 and 1.4)
2a. Does the Exposure Draft clearly define what is inside and outside the scope of the Waste Methodology? 2b. Are there material waste streams or impact pathways that should be included within scope but are currently excluded? 2c. The Waste Methodology currently assumes that waste sent to landfill is unrecoverable. It is recognized that there is potential for landfilled waste to be recovered and valued, however consistent data on this is not yet readily available. Do you agree with this assumption? If no, what other approaches should be considered? 2d. The Waste Methodology currently assumes that all waste produced in a country remains in that country. It is recognized that trade in international waste does occur and this could affect the volume of waste sent to disposal for landfill or incineration, and this trade could also affect the final location of waste treatment. Do you agree with this assumption? If no, what consistent data exists to allow for cross border waste flows to be built into the Methodology? 2e. Does the methodology appropriately address potential double counting with other environmental methodologies (e.g.: GHG, land use, water, air pollution)? If not, where do the principal risks remain and why?

Question 3 - Practical implementation (Section 3.1)
3a. Do you agree with the approach of having two options (a preferred and minimum option) to use the methodology based on the availability of waste data? If no, how should challenges about data availability be addressed? 3b. Is the guidance provided in the Exposure Draft for when to use the Preferred Option (including plastic waste data) or Minimum Option (landfill and/or incineration data only) sufficiently clear to understand when each should be used? Is it sufficiently clear how data requirements for plastic waste

and non-hazardous waste should be treated together without introducing double counting? If no, what additional guidance would be valuable?

3c. For which parts of the value chain (upstream, own operations, downstream) is obtaining reliable waste data most challenging and why?

3d. Should the methodology establish materiality thresholds below which estimation approaches are acceptable and why?

Question 4 - Conceptual validity of the methodological approaches (Sections 4.2 & 4.3)

4a. Do you agree with the coverage of the impacts included in the impact pathway? If not, please clarify.

4b. Do you agree with the methodological approaches and assumptions used to determine outcomes, impacts, and valuation for each impact category? If no, what other approaches should be considered?

More specifically:

i. Disamenity impacts are represented by the changes in housing prices caused by the presence of a landfill or incineration site, and the approach uses a hedonic pricing function with data provided by a meta-analysis (see *Section B25*). The meta-analysis found that non-hazardous waste sites do not have an impact on housing prices and thus disamenity impact from non-hazardous waste are not included in the methodology. Do you agree with this assumption? If no, what other approach should be considered?

ii. The disamenity impact pathway depends on the number of waste facilities (incineration and landfill) per country, based on a review and various sources (see *Section B25*). More precise data on the number and quality of waste sites for countries, globally, would increase the precision of disamenity impacts. Do you agree with these estimates? If no, is there robust and consistent data available for sub national landfill and incineration sites that should be considered?

iii. Currently, the impact of mismanaged plastic waste focusses on marine ecosystems only and impacts on terrestrial and riverine systems are not incorporated (see *Section 91 and 100*). Do you agree with this assumption? If no, what other approaches for plastic leakage to terrestrial and riverine systems, and valuation of these impacts, should be considered?

4c. Is the guidance provided in *Sections 4.2, 4.3, and Appendix B* sufficient to understand how the value factors for each impact were developed? If no, what additional detail would be valuable?

4d. Are the valuation outputs sufficiently robust for strategic decision-making? If not, what level of uncertainty would limit their use and why?

4e. Should the methodology require disclosure of uncertainty ranges or confidence intervals alongside point estimates and why?

Question 5 - Waste Valuation Tool (Appendix E)

5a. The Waste Valuation Tool can be used to aid preparers in determining value factors for each waste site. In the tool, preparers enter waste related disclosures to determine value factors and impacts. For each waste site, the preparer enters the (1) country, (2) waste disposal method, (3) waste material type and (4) reported tons of waste. Additionally, the Tool is designed to individually select impacts to avoid potential double counting when aggregating different impact areas related to waste disposal (for example, this could apply for practitioners that already have established GHG accounts covering an entity's whole value chain).

Does the Tool provide the guidance needed to determine waste impacts and provide valuable insights? If no, what additional features should be considered to make the Tool more valuable?

5b. What additional output formats or analyses would increase decision usefulness?

5c. Does the Tool appropriately communicate uncertainty, limitations and assumptions underlying the results?

Question 6 - Decision usefulness

6a. Which decisions (e.g.: internal capital allocation, product design, procurement, investor engagement, sustainability reporting, regulatory

reporting, other) are most likely to be influenced by the outputs of the Waste Methodology, and please explain why? 6b. To what extent are monetary valuation of impacts more decision-useful than physical waste metrics alone? 6c. Would you expect boards, investors or management teams to use these valuations in practice? Why or why not?

Question 7 - Additional feedback
7a. Do you disagree or have concern with any additional proposal(s) in the Exposure Draft? For example, this could include feedback on references used and definitions, highest priority areas for future methodological development, among other areas. If so, what are they and what do you see as viable alternative approaches?

Due process of Exposure Draft

The Impact Value Standards Board (IVSB) is established and managed by the Capitals Coalition. It brings together the Value Commission (previously managed by the Capitals Coalition) and the Valuation Technical and Practitioners Committee (previously managed by the International Foundation for Valuing Impacts (IFVI) in partnership with the Value Balancing Alliance, VBA).

Public exposure is a vital step to ensure the development of high-quality methodologies that reflect stakeholder input. When the IVSB has reached general agreement on a methodology statement, the IVSB votes on whether to proceed with releasing a proposed methodology statement. An approval by a simple majority of the IVSB is required to proceed with releasing an exposure draft of a proposed statement.

The Exposure Draft herein reflects feedback provided by members of the IVSB and is a proposal of a statement that has been approved for public exposure.

After the conclusion of the public comment period, the IVSB reviews the received comment letters. To support the IVSB's considerations, the IVSB Secretariat will prepare a summary of the comment letters. The summary provides an overview of the significant issues raised in the letters and any additional related research and/or consultations. Comments are published on the website and significant matters are deliberated at a IVSB meeting.

Per the Due Process Protocol, after review and deliberation of the received comments, the IVSB will make a determination to:

a) Proceed with a vote to approve the methodology as proposed in the Exposure Draft;

b) Evaluate and proceed with a vote on a revised methodology with limited modifications based on public input and/or piloting; or

c) Direct IVSB Secretariat to conduct additional research and consultation on issues raised through public comments and/or piloting.

The IVSB may determine that an additional public comment period may be appropriate if the extent of modifications and evidence considered is fundamentally different compared to the proposed methodology in the Exposure Draft. In some circumstances, the IVSB may consider removing a project from the work plan based on its deliberations.

Upon an affirmative majority vote by the IVSB to issue a methodology statement, the statement will be made available to the public on the Capital Coalition website in a timely fashion. The issued statement will be accompanied with a published basis for conclusions containing a rationale for the statement, summary of research and consultation, and other supporting information as determined by the IVSB.

For more information, see the Due Process Protocol.

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Foreword

Waste is too often treated as a disposal problem to be managed, a cost to be minimized, and a compliance box to be ticked. This Waste Topic Methodology proceeds from a different premise: waste is a signal, revealing how an economy, an industry, or a company creates and destroys value.

There are four ways in which waste must be understood.

Waste is inefficiency. It often reflects poor product design, weak process control, or inadequate supply-chain coordination. Firms that reduce waste are rarely improving environmental outcomes alone — they are strengthening productivity and resilience.

Waste is pollution. Once generated, it imposes real costs on people and the environment — emissions, leachate, health effects, agricultural losses — costs too often borne by communities rather than the firm responsible. This methodology makes those effects visible and measurable.

Waste is a resource. A circular economy begins from the recognition that what one system discards, another may require as input. The relevant question shifts from "how do we dispose of this?" to "why did this become waste in the first place?"

Waste is a signal of the policy environment. Persistent waste problems reflect misaligned incentives, missing prices, and weak regulation. Where disposal is inexpensive because its full cost goes unrecognized, excess waste is the predictable outcome. Impact valuation shows policymakers where markets are failing and where stronger rules are needed.

These four dimensions explain why this methodology occupies a central place in the Impact Value Standards Board's broader agenda. Our mandate is to establish a common, rigorous baseline for impact valuation, and waste is among the clearest tests of that ambition. Success will not be measured in endorsements or downloads, rather in whether a company can examine its waste footprint and make more informed decisions about design, materials, operations, and capital allocation. The objective is not measurement for its own sake. It is accountability, learning, and better decisions.

George Serafeim, Professor at Harvard Business School & IVSB Chair

Executive Summary

The purpose of this document is to outline the **Topic Methodology for Waste** (henceforth, Waste Methodology) as part of the impact accounting methodology being developed by the Impact Value Standards Board (IVSB). The Waste Methodology builds on the Interim Waste Methodology which has been publicly available on the International Foundation for Valuing Impacts (IFVI) website.[2]

The impact accounting methodology measures and values the impacts of corporate entities (entities or an entity) in monetary terms for the purposes of preparing impact accounts and generating impact information to steer decision making. The Waste Methodology can be used to inform internal decision-making, investment decisions, and understand the significance of the waste impacts of an entity.

Section 1 outlines key concepts and definitions, and defines the scope for the Topic Methodology. Waste is defined as anything that the holder discards, intends to discard, or is required to discard, in alignment with the Global Reporting Initiative (GRI). Within the Waste Methodology, waste is categorized as hazardous, non-hazardous and plastic waste. The methodology assumes that waste sent to landfills or incineration is scattered, chemically altered, or otherwise irretrievable or economically unviable to recover, rendering it inaccessible to future generations.

Section 2 develops the impact pathway for waste, consisting of inputs, outputs, outcomes, and impacts. The primary input to an entity's activities is physical material used in products or services, which results in waste being sent to landfills or incineration. Leading to outcomes that affect natural capital and environmental quality that can be linked to outcomes that affect well-being of people and society in general. In the Waste Methodology, there are nine outcome categories, of which one has a positive societal outcome.

These impacts include:

- Greenhouse gas emissions (GHG)
- Heavy metal and dioxin emissions from the incineration process
- Traditional air pollutant emissions from the incineration process
- Disamenity from noise, odor, pests, and visual intrusions caused by landfill and incineration plants
- Leachate production from landfills
- Land use and conversion
- Residual incineration ashes
- Impact of mismanaged marine plastic waste
- Energy recovery

[2] International Foundation for Valuing Impact: Interim Methodologies. https://ifvi.org/methodology/environmental-topic-methodology/interim-methodologies/

Section 3 establishes the data required for the Topic Methodology including waste data directed to disposal (metric tons) of the entity and its value chain, organized by the country where the final waste treatment occurs. Additionally, the waste disposal method and waste composition should be known. The Topic Methodology has two options for application based on the waste composition data.

The data requirements are aligned with and expand upon disclosure requirements established by relevant standard setters including European Sustainability Reporting Standards E5: Resource Use and Circular Economy and the Global Reporting Initiative 306: Waste 2020. Additional alignment may exist with other regional or topic specific reporting standards, such as the Sustainability Accounting Standards Board (SASB).

Section 4 outlines the approach of the Topic Methodology for measuring and valuing the impacts of waste, leading to value factors for every impact category described in the impact pathway, available for the described waste disposal methods (landfill, incineration, or unspecified) and waste compositions (hazardous, non-hazardous, and plastic).

- **Greenhouse Gas emissions**: GHG emissions are estimated using methods from the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories for landfill and incineration. Waste to energy was incorporated by estimating greenhouse gas emissions avoided due to energy production of incinerated waste and from landfilling, applying typical country-level grid emissions.
- **Air emissions of heavy metal and dioxin emissions**: Air emissions of heavy metals and dioxins are only applied to the incineration pathway and are considered negligible for landfills. Heavy metal emissions (lead, mercury, arsenic nickel, chromium, and cadmium) and dioxin emissions are represented by industrial and Municipal Solid Waste (MSW) emissions factors, applied to hazardous and non-hazardous waste, respectively.
- **Traditional air pollutants**: Similar to heavy metals and dioxins, traditional air pollutants are only applied to the incineration pathway and are considered negligible for. Traditional air pollutants (NO_x, SO_x, PM2.5 and PM10) were represented by industrial and MSW emissions factors and applied to hazardous and non-hazardous waste, respectively.
- **Reductions in well-being from Disamenity**: Disamenity impacts are represented via a hedonic pricing function. The hedonic pricing function uses housing prices as a proxy for people’s subjective well-being preferences and defines how housing prices are affected by their distance from a waste management facility (incineration or landfill).
- **Health and environmental outcomes from landfill leachate production**: To determine the chance that leachate will cause impacts via release into the natural environment, a risk-adjusted estimate of the likelihood of a leachate incident occurring in a country is estimated using the HARAS model.
- **Land use and conversion**: Land use and Conversion impacts are applied only to landfilled waste. These impacts were estimated by calculating the area

required to landfill one metric ton of waste, using weight-to-volume conversion factors, and typical landfill heights for managed facilities and unmanaged dumpsites.

- **Residual incineration ashes**: All fly ashes are landfilled as hazardous waste, where a portion of bottom ashes are used as secondary resources (substituted virgin metals, road/construction materials, etc.).
- **Environmental outcomes from mismanaged marine plastic waste**: The marine plastic pathway utilizes a model, calibrated with field-based observations, that estimates the probability that plastic waste discarded in a given country will reach the ocean via river and coastal systems.

- Each value factor can be determined at a global and/or national level. The total monetary cost of waste impacts is calculated by the sum of all impacts across waste disposal methods and waste compositions. For each disposal method, site-level value factors are calculated, represented by their respective impact category (greenhouse gas emissions, disamenity, leachate, land use, heavy metals and dioxins, air pollutants and residual incineration ashes). If the composition is plastic, an additional impact on marine ecosystems is included. Once all individual sites are prepared, total impacts per disposal method are represented by the sum of the site-level tons of waste per disposal method multiplied by the site-level value factor.

Section 5 articulates opportunities for further development of the Topic Methodology, including potential areas of improvements in data quality for waste, incorporation of waste trade, and advancement in valuation approaches and frameworks to quantify the effect of plastic waste in riverine and terrestrial systems.

The Waste Methodology builds on frameworks and protocols published by leading organizations in the impact management ecosystem and sustainability related disclosures required by governing jurisdictions and international standard setters, including:

- European Sustainability Reporting Standards[3];
- Global Reporting Initiative (GRI)[4];
- Intergovernmental Panel on Climate Change (IPCC)

The **appendices** consist of a glossary, methodological details of the valuation approaches for each of the impact categories, detailed alignment with reporting standards, tables for national and regional value factors, and the Waste Valuation Tool.

[3] ESRS 1 General Requirements, ESRS 2 General Disclosures and ESRS E5: Waste 2020.
[4] GRI. (2020). GRI 306: Waste 2020. Alignment with Disclosure 306-3 (a) and 306-5 (a)(b)(c)

Introduction

1.1 Document purpose

1. The purpose of this document is to outline the Topic Methodology for Waste (henceforth, Waste Methodology) as part of the impact accounting methodology being developed by the Impact Value Standards Board (IVSB). The Waste Methodology builds on the Interim Waste Methodology which has been publicly available on the International Foundation for Valuing Impacts (IFVI) website.[5]

2. The impact accounting methodology measures and values the impacts of corporate entities (entities or an entity) in monetary terms for the purposes of preparing impact accounts and generating impact information to steer decision making. The Waste Methodology can be used to inform internal decision-making, investment decisions, and understand the significance of the waste impacts of an entity.

3. Preparers of impact accounts should adhere to the entirety of the Methodology to the fullest extent possible and should disclose any deviations from it when shared with users of impact information.

1.2 Topic Description

4. Material resources are essential for human survival and development. However, their use typically generates waste. As of 2024, over 2 billion tons of municipal solid waste (MSW) are produced every year—a figure expected to increase sharply to 3.4 billion tons by 2050, outpacing population growth by more than twofold over the same period.[6] While much of this waste is properly managed, an increasing share is mismanaged. This is especially true for plastics, with 22% of global plastic waste ending up in uncontrolled dumpsites, being openly burned, or leaking into the environment.[7]

5. Material resources typically follow one of two possible paths at the end of their use: a linear path – where resources are sent to landfill or incineration – or a circular path, where resource use is avoided and resources are reused or recycled.[8] The linear path, often referred to as the linear economy, reflects the prevailing global waste management approach and is the focus of this Waste Methodology.

6. The circular economy aims to keep resources in circulation for as long as possible through strategies such as redesign, reuse, remanufacturing, and recycling. The Global Circularity Protocol for Business (GCP) from WBCSD excludes recovery from the R-Strategies. Also, ISO defines circularity in the following way "to maintain a circular flow of resources, by recovering, retaining or adding to their value, while contributing to sustainable development"

7. However, while the concept of circularity has gained increasing attention, the global share of secondary materials in use has paradoxically declined in recent years, from 9.1% in 2018 to 7.2% in 2023.[9] Guiding entities on how to measure and value circularity impacts across their business operations goes beyond end of life

[5] International Foundation for Valuing Impact: Interim Methodologies. https://ifvi.org/methodology/environmental-topic-methodology/interim-methodologies/
[6] World Bank Group. (2025). *Trends in Solid Waste Management*.
[7] OECD. (2022). *Global Plastics Outlook: Policy Scenarios to 2060*.
[8] Often referred to as the 10R-Strategy. See: Circularise. n.d. *R-Strategies for a Circular Economy*.
[9] Circle Economy Foundation. (2024). *The Circularity Gap*.

waste treatment, and is a cross-cutting consideration to be taken into account across the business value chain. Therefore, it is intended that Circularity will be the subject of separate consideration by the IVSB.

8. Corporate activities in all sectors result in the creation of solid waste across their value chains. Disposing of materials rather than reintegrating them into the economy produces numerous societal and environmental impacts. The magnitude of these impacts is mediated by two primary factors: the composition of the waste and the waste disposal method.

9. The Waste Methodology takes a societal perspective and not that of a discrete affected stakeholder group. This is undertaken by considering the impacts on all of society from each ton of waste produced.

10. The Waste Methodology covers an entity's own operations as well as its upstream and downstream value chain. The extent to which all value chain levels should be included in impact accounts is dependent upon the relevance of the impacts at each value chain level from an impact materiality perspective.

11. While the Waste Methodology measures the impacts of the entity on stakeholders, understanding and managing resource impacts may also help an entity manage production needs and resource allocation, reduce operational costs, avoid supply chain disruptions, resource allocation, and mitigate risks related to reputational damage and legal action.

1.3 Key Concepts and Definitions

12. For the Waste Methodology, important key terms are defined as follows:

13. **Waste**: anything that the holder discards, intends to discard, or is required to discard.[10]

14. **Hazardous waste**: waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste possesses characteristics outlined by Annex III of the Basel Convention (these hazardous properties (HP1–HP15) include explosiveness, flammability, toxicity, carcinogenicity, ecotoxicity).[11] In addition, hazardous waste can also formally be defined by national legislation, which can vary across territories.

15. **Non-hazardous waste** is any waste that does *not* meet the definition of hazardous waste.

16. **Incineration**: the controlled burning of waste at high temperatures. Incineration with energy recovery is the process of retaining additional useful energy created by the destruction and transformation of material by combustion for use in power generation.[12] In relatively few countries, landfill and incineration plants are fitted with infrastructure that allows for *thermal waste-to-energy* recovery. However, energy recovery is not the norm, and a significant portion – conservatively, 33% of annual MSW production – is left unmanaged, unregulated, and unsafe.

[10] GRI. (2018). *GRI Reporting Standards*.; UN Environment Programme. (1989). *Basel Convention on the control of transboundary movements of hazardous wastes and their disposal*.
[11] European Commission. (2026). *Commission Delegated Regulation amending the European Sustainability Reporting Standards (ESRS) as regards simplifications to sustainability reporting requirements*. C(2026) 5010 final, adopted 3 July 2026.; GRI. (2020). *GRI 306: Waste 2020*.; UN Environment Programme. (1989). *Basel Convention on the control of transboundary movements of hazardous wastes and their disposal*.
[12] European Commission. (2026). *Commission Delegated Regulation amending the European Sustainability Reporting Standards (ESRS) as regards simplifications to sustainability reporting requirements*. C(2026) 5010 final, adopted 3 July 2026.

17. **Landfill**: consists of both managed and unmanaged operations. Managed landfills can refer to *Sanitary landfills*, which are engineered facilities intended for the disposal of solid waste on and in a controlled manner. In unmanaged landfills, or open *dumpsites*, waste is not controlled, leading to increased escape of waste into the natural environment.[13]

18. **Unspecified**: within the Waste Methodology, If the waste disposal method is unknown, it is defined as 'unspecified'.

19. **Municipal Solid Waste (MSW)**: includes all residential and commercial waste but excludes industrial waste.[14]

20. **Recycling**: processing of waste materials for the original purpose or for other purposes, excluding energy recovery.[15] Recycling is part of a circular path, but distinct from other circular practices such as recovery or re-use, in that it requires additional resources to process and does not preserve the value and quantity of the resources. However, diversion of waste from disposal for recycling, reuse, remanufacturing or other circularity driven activities is excluded from the scope of the Waste Methodology.

21. A complete set of defined terms is included in the Glossary.

1.4 Scope and Assumptions

22. The Waste Methodology assumes that waste sent to landfills or incineration is scattered, chemically altered, or otherwise irretrievable or economically unviable to recover, rendering it inaccessible to future generations. However, it is recognized that there exists some potential for commercially viable reuse of waste materials disposed of in landfills, such as a source of materials for mining activities (e.g.: extracting gold from computers). Currently, this opportunity for reuse of landfill materials is likely to be available only in low concentrations, but this might change in the future.

23. The Methodology recognizes a range of negative impacts of waste sent to disposal, for either incineration or landfill treatment. It assumes a zero impact for materials that are diverted from disposal (e.g.: for recycling purposes).

24. The Waste Methodology does not include the direct impacts of material extraction. This is because, as highlighted above, the loss of resources is assumed to occur at end of life, rather than at the moment of extraction. Other impacts that occur as a result of resource extraction are already considered within other environmental methodologies, such as Land Use and Conversion, and will be addressed in future Environmental Topic Methodologies.

25. The Waste Methodology does not cover environmental impacts associated with the broader practices and operations of waste disposal (e.g., GHG emissions from transporting waste), which are addressed by other environmental methodologies. It does, however, overlap with other Topic methodologies via the impacts related to waste disposal itself. As presented, the Waste Methodology assumes that the GHG Emission and Land Use impacts of an entity's waste are not included in other calculations. If such impacts are already considered elsewhere, they should not be included in the Waste calculations to avoid double counting. In all cases, care should be taken by preparers to ensure double counting does not

[13] UNEP. (2024). *Beyond an age of waste: Turning rubbish into a resource. Global Waste Management Outlook*.
[14] UNEP. (2024). *Beyond an age of waste: Turning rubbish into a resource. Global Waste Management Outlook*.
[15] UNEP. (2024). *Beyond an age of waste: Turning rubbish into a resource. Global Waste Management Outlook*.

occur between the reporting in the Waste Methodology and respective impact accounts.

26. The impacts of air pollution and water pollution (e.g. leachate) build on the value factors derived from the Air Pollution and Water Pollution Interim methodologies, but do not overlap in impacts and thus there is no double counting for these impact categories. The Interim Air Pollution Methodology considers the impacts of six pollutants (PM10, PM2.5, SO_2, NO_x, NH_3, and VOCs), with several classes of pollutants being addressed in other methodologies. For example, Greenhouse Gas (GHG) emissions are omitted from this methodology. In addition, air pollution which results from waste incineration is covered elsewhere; key incineration pollutants are addressed in the Waste Methodology.[16] Similarly, the Interim Water Pollution Methodology focuses on the release of substances in surface water,[17] whereas the Waste Methodology looks at leakage from landfills.

27. The Waste Methodology (and the accompanying Tool, see Appendix E) is designed to individually select impacts to avoid potential double counting when aggregating different impact areas related to waste disposal. For example, this could apply for advanced practitioners that already have established GHG accounts covering an entity's whole value chain.

28. The scope and boundaries of the Methodology are design to capture waste generated across the full value chain. This includes upstream, direct, and downstream aspects of an entity's value chain as defined in General Methodology 1, and therefore includes the impacts of products disposed of after they are used by consumers in the downstream value chain. The starting point is that the scope for an entities' own operations should seek to be aligned with that used for its financial statements to ensure comparability, to the extent possible. The key exception to this is GHG emissions where under the Greenhouse Protocol the concept of own operations is not a recognized financial reporting term as it was designed to capture emissions for which an entity might have operational control but not financial control. Also, the inclusion of value chain waste production means that double counting will occur if aggregating across entities in the same value chain. However, this will not lead to double counting within an individual entity's impact statement.

29. The Waste Methodology presumes that an entity does not have full transparency into details about the end state of its waste disposal, including waste site specific locations (either landfill or incineration facilities). For that reason, the methodology calculates impacts based on national level assumptions regarding waste management. However, where data on local waste facilities is known then this data should be used.

30. The Methodology also currently suggests that the end location of the waste is applied if known and otherwise assumes that all waste produced in a country remains in that country. It is recognized that trade in international waste does occur and this could affect the volume of waste sent to disposal for landfill or incineration, and this trade could also affect the final location of waste treatment. Where feasible preparers should apply known data on their own cross border waste flows or apply international waste trade data derived from third party sources such as Circular Economy.Earth.[18]

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[16] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Air Pollution*.
[17] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Water Pollution*
[18] Chatham House (2021), 'circulareconomy.earth', https://circulareconomy.earth/

31. The Waste Methodology provides guidance for its application under distinct valuation perspectives:[19]

a) **Local Perspective**: this perspective expresses the Waste impacts using country-specific benchmarks and price levels. Waste impacts are measured in local terms, reflecting the economic conditions and purchasing power within each jurisdiction. This is suitable for assessments that prioritize local stakeholder relevance or require alignment with national standards and contexts.

b) **Global Perspective**: this perspective adjusts all key variables based on purchase power parity (PPP) and anchors calculations to global benchmarks such as a globally representative Value of a Statistical Life (VSL).[20] This allows for consistent valuation of impacts across countries, enabling comparability by removing distortions caused by income or price differences.

32. The Waste Methodology states that **plastic waste** should be considered separately from hazardous and non-hazardous waste due to its high risk for mismanagement.[21] Further, the long residence-time of plastic in the environment leads to significant and prolonged impacts. Land based plastic waste carried to the sea through rivers is considered a main source of marine plastic pollution and is included in the Waste Methodology. However, most waste plastics leakage never make it to the oceans, but these terrestrial ecosystem impacts are excluded because of insufficient research and data available. Also, human health impacts of plastic waste are excluded because the most significant effects arise during plastic use rather than disposal. Human health impacts are therefore a matter of industry specific impact accounting methodologies as based on the Framework for Industry Specific Product Impacts.

33. The Waste Methodology does not include a specific pathway for the unique impacts of Radioactive Waste.

34. Recognizing the complexity of collecting and managing entity specific waste data, the Waste Methodology includes options for preparers in which data is unclear or less granular.

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[19] For more information on local and global valuation perspectives, see Appendix B. In some instances, complementary assessments might be conducted to reflect utility weighing of the impacts, which sit outside the official methodology. Appendix B provides further recommendations for such assessments.

[20] OECD. (2025a). *Mortality Risk Valuation in Policy Assessment: A Global Meta-Analysis of Value of Statistical Life Studies*.

[21] Organization for Economic Co-operation and Development. (2022). *Plastic pollution is growing relentlessly as waste management and recycling fall short, says OECD*.

Impact Pathway

2.1 Summary

35. The impact pathway is a sequence of causal steps that begins with the total weight and composition of materials used in an entity's activities, and traces their effects on natural capital, environmental quality, and ultimately, societal well-being.

36. Detailed components of the impact pathway are outlined in subsequent sections, leading to the measurement and valuation of an entity's waste in *Section 4: Outcomes, Impacts, and Valuation.*

37. The impact pathway for Waste is presented as follows:

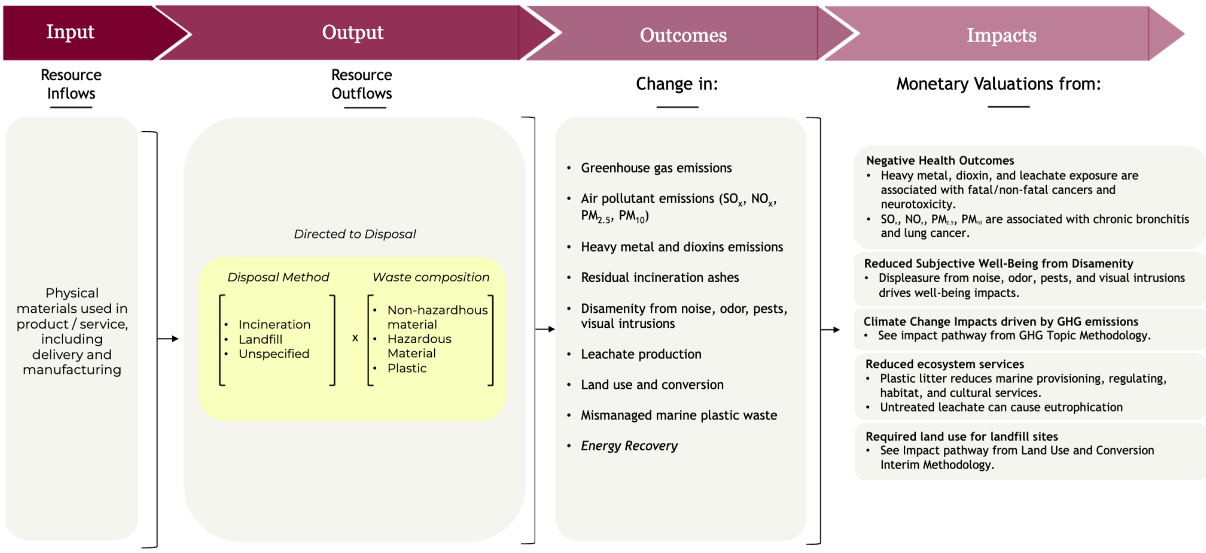

Figure 1. Impact pathway for the Waste Methodology

38. This methodology develops Value Factors for every impact category described in the Waste impact pathway, available for the described waste disposal methods (landfill, incineration, or unspecified) and waste compositions (hazardous, non-hazardous, and plastic), which can be found in Appendix D.

39. Unmanaged waste flows are embedded within all disposal methods, depending on the impact category. The 'unspecified' disposal method is for preparers who do not know where their waste ends up.

40. The valuation approaches of different impacts of the Waste Methodology align with existing methodologies and frameworks to the extent that they are relevant for the constructed impact pathway of Waste. As well as that they relate to the constructed country level value factors and are applicable for entities that have varying data structures depending on how waste flows are measured and quantified (e.g. Life Cycle Assessment (LCA) coverage of products or Input-Output data with a focus on value chain effects).

41. In identifying and measuring the waste flows of an entity, preparers may draw upon LCA frameworks to model in more granular detail the flow of resources

end of life to landfill or incineration disposal options. Guidance on these impact modelling methodologies fall outside the scope of this Topic Methodology which focuses on methodologies for valuing the different impacts arising from decisions to dispose of waste to landfill or incineration treatment options. This Topic Methodology also covers the impacts of unmanaged waste flows (embedded within different impact categories) and plastic leaking to marine environments. The impacts of waste flows diverted from disposal to recycling, reuse and other 'circularity' routes are also excluded from this Topic Methodology.

2.2 Description and Notes

42. The primary inputs for the waste impact pathway are the materials used in the creation and delivery of the product or service produced by the entity.

43. Resource outflows are represented by the total weight and composition of materials that are used by the entity and the waste directed to disposal (either by incineration or landfill).

44. Outcomes that affect natural capital and environmental quality can be linked to outcomes that affect well-being of people and society in general. Income and wealth, health, work and job quality, housing, safety, social connections, human capital, social capital, and economic capital are all affected due to the systemic and fundamental reliance on GHG emissions, air pollutants, dioxin and heavy metal emissions, disamenity, leachate, and land use changes. Energy recovery is noted as the only positive outcome of the waste production process. See Figure 1 for more details on these linkages.

45. The outcomes applied in the Waste Topic Methodology fall into nine categories, of which only one is a positive societal outcome:

46. **Greenhouse Gas emissions**. If the GHGs from the waste disposal process are accounted for within the entity's GHG accounts, this category can be disregarded here to avoid double-counting.

47. **Heavy metal and dioxin emissions** from the incineration process.

48. **Traditional air pollutant emissions** from the incineration process. If traditional air pollutants from the waste disposal process are accounted for within the entity's Air Pollution accounts, this category can be disregarded here to avoid double-counting.

49. **Disamenity** from noise, odor, pests, and visual intrusions caused by landfill and incineration plants.

50. **Leachate** production from landfills. If water pollution from the waste disposal process is accounted for within the entity's water pollution accounts, this category can be disregarded here to avoid double-counting.

51. **Impact of mismanaged marine plastic waste**. When plastic makes its way into the ocean, it causes a decrease in ecosystem services.

52. **Residual incineration ashes**. When waste is incinerated, ashes are created in the form of fly / flue gas ashes and bottom ashes, which is typically disposed of in landfills.

53. **Land use and conversion**. Landfilled waste requires the use of land that in turn cannot be used for other purposes or to support ecosystem services. If land use impact from the waste disposal process is accounted for within the entity's land use and conversion accounts, this category can be disregarded here to avoid double-counting.

54. **Energy recovery**. *A* byproduct benefit from incineration and landfill processes.

55. Present research has not yet captured all impacts on society in rigorous models. Therefore, impact accounts derived using the value factors described in Section 4.2 likely results in an understatement of negative impacts. New research will continue to develop techniques to capture additional impacts, leading to increases in the value factors. Opportunities to further advance waste impact accounting are discussed in Section 5.

Impact Driver Measurements

56. Impact drivers consider inputs and outputs and reflect the data needs expected of a preparer to provide an impact account for waste. The section below outlines the specific data needed along with how preparers should consider data gaps and uncertainty.

3.1 Data Requirements

57. To utilize the Waste Methodology, the following data are needed (Table 1):

58. An entity's total weight of waste directed to disposal including own operations as well as upstream and downstream in the value chain, considered separately. All waste data should be in units of metric tons.

59. Waste data should be organized along the following categories:

60. The country where the final treatment of waste occurs, if known. If unknown, the country in which the waste was produced should be applied.

61. The waste disposal method, including whether it is disposed via landfill or incineration. If the waste disposal method is not known, an "Unspecified" category should be applied.

62. The composition of the waste. As a minimum, waste composition should be broken down into hazardous and non-hazardous waste, but more specific composition data related to plastic waste is preferred. If plastic waste data is provided separately as preferred, it should not also be reported as hazardous or non-hazardous.

63. Data on waste diverted from disposal such as preparation for recycling, reuse or other recovery operations are not required for the Waste Methodology but could be needed to enable additional analysis.

Data input			Country 1	Country 2	Country 3
<u>Total</u> Waste Directed to Disposal, organized by treatment, from Own Operations, Downstream, and Upstream Value Chain. *					
	Minimum Data	***Preferred Data***			
Landfill (metric tons), by location of disposal	Hazardous				
	Non-Hazardous				
		Plastic			
Incineration (metric tons), by location of disposal	Hazardous				
	Non-hazardous				
		Plastic			
Unspecified (metric tons), by location of disposal	Hazardous				
	Non-hazardous				
		Plastic			
Data input			**Total Waste from All Countries**		
* *Values include both renewable and non-renewable waste sent to disposal*					

Table 1. Data required from the entity and from other sources, disaggregated by location of waste disposal

64. To provide sufficient detail for impact accounts, waste outputs should be collected separately for (1) own operations, (2) upstream value chain, and (3) downstream value chain.
65. All data should be provided at the most specific level of granularity available. This includes, where possible, applying the “Preferred” Data Requirements outlined above, via direct data collection or estimation techniques.
66. Supplemental notes or qualitative commentary should be included in waste impact accounts as noted in General Methodology 1. For waste, this should clearly state which options (Preferred or Minimum) were used and how location was considered for each impact. Additional commentary may include but is not limited to calculation methodologies, approaches to handling gaps, key assumptions, alignment with the Global Circularity Protocol,[22] and progress towards reduced resource use targets.
67. The data requirements of the Waste Methodology are aligned with and expand upon disclosure requirements established by relevant standard setters including the revised European Sustainability Reporting Standards (ESRS), particularly ESRS 1 General Requirements, ESRS 2 General Disclosures and ESRS E5: Waste 2020.[23] Expansions include options for reporting plastic waste.
68. Additional interoperability and alignment may exist with other regional or topic specific reporting standards, such as the Sustainability Accounting Standards Board (SASB). SASB provides more industry-specific reporting metrics (e.g.: waste management companies report landfill and recycling metrics) and are maintained by

[22] Global Framework to Measure, Manage and Communicate Business Circularity (WBCSD, 2025)
[23] European Commission (2026). Revised European Sustainability Reporting Standards adopted on 3 July 2026.

the IFRS Foundation as part of the International Sustainability Standards Board's (ISSB) sustainability-related resources. Further details are presented in Table 2 and Appendix C. To see which metrics fall within the minimum and preferred options, refer to Table 1.

Metric	ESRS	GRI
Waste Production – own operations	Fully aligned with E5-5- Resource Outflows (paragraphs 37–39, as amended)	Fully aligned with Disclosure 306-3 (a) and 306-5 (a)
Waste Production – value chain	Fully aligned with E5-5- Resource Outflows (paragraphs 37–39, as amended)	Expands upon Disclosure 306-3(a) and 306-5(a)*
Waste Composition	Fully aligned with E5-5- Resource Outflows (paragraphs 37–39, as amended)	Expands upon Disclosure 306-3(a) and 306-5(a)(b)(c)
Location of waste treatment	Independent of E5-5	Independent of GRI 306
Method of disposal	Fully aligned with E5-5- Resource Outflows (paragraphs 37-39, as amended)	Fully aligned with Disclosure 306-5(b)(c)

Table 2. Alignment with reporting standards[24]
**Both ESRS and GRI require significant analysis of value chain resource flow but do not explicitly require tonnage of value chain waste to be reported. ESRS references reflect the revised European Sustainability Reporting Standards adopted by the European Commission on 3 July 2026.*

3.2 Data Sources, Gaps, and Uncertainty

69. Preparers should strive to measure waste in a manner that is complete, neutral, and free from error. This includes faithfully representing waste from all parts of the value chain. They should ensure that disclosures derived from this methodology support a fair presentation of waste-related impacts, including transparent disclosure of assumptions, estimations, uncertainties and limitations.

70. In practice, obtaining full value chain waste data may be challenging for entities, particularly from upstream or downstream in the value chain. Barriers such

[24] Categories of alignment include (1) fully aligned: data from reporting can be used as is for preparation of impact accounts; (2) expands upon: data from reporting conceptually aligns with the impact accounting methodology, but additional detail, context, or presentation is necessary for an accurate accounting of impact; or (3) independent: Data needed for the preparation of impact accounts are not covered by the reporting standards and would require separate data collection and analysis.

as cost, accounting methods, or availability of data may require the use of secondary data or proxies to measure waste impacts in their entity.

71. Preparers should prioritize approaches that:[25]

a) directly measure waste over metrics based on calculations from activity data,

b) utilize primary data from specific activities within a company value chain over secondary data, and

c) consider sources of data that are of the highest quality possible.

72. High quality data sources should consider:[26]

a) technological representativeness. Does the data match the technology used?

b) temporal representativeness. Does the data represent the actual time or age of the activity?

c) geographical representativeness. Does the data reflect geographic considerations of the activity?

d) completeness. Is the data statistically representative of the activity?

e) reliability. Are the data sets or sources dependable?

73. Various estimation techniques can be used to determine waste. While a variety of techniques exist, those recommended for waste analysis include LCA and environmentally extended input-output (EEIO) tables. Both approaches have developed frameworks for determining waste but may differ in levels of data specificity or considerations depending on the context of application.

74. Other resources may provide guidance for developing waste data including the Global Circularity Protocol,[27] ISO 14001 Environmental Management Systems,[28] ISO 59004 Circular Economy,[29] the Product and Organizational Environmental Footprint Methods,[30] Plastic Footprint Network,[31] Ellen Macarthur Foundation,[32] or the CDP Corporate Questionnaire.[33] Additional guidance for developing waste data may also come from ESRS E5: Resource use and circular economy[34] and GRI 306: Waste 2020.[35]

75. Uncertainty will arise when quantifying waste impacts. Preparers should report qualitative uncertainty and, when possible, quantitative uncertainty. These may include but are not limited to propagated measured uncertainty, pedigree matrices, sensitivity analyses, or probability distributions.

[25] Language adapted to waste from the Greenhouse Gas Protocol. (2011). *Corporate value chain (scope 3) accounting and reporting standard*.
[26] Language adapted to waste from the Greenhouse Gas Protocol. (2011). *Corporate value chain (scope 3) accounting and reporting standard*.
[27] Global Circularity Protocol. Global Framework to Measure, Manage and Communicate Business Circularity (WBCSD, 2025)
[28] International Organization for Standardization. n.d. p. 14001. *ISO/DIS 14001*.
[29] *ISO 59004:2024*. n.d.
[30] *Environmental Footprint Methods - European Commission*. (2024)
[31] Plastic Footprint Network. n.d. *Harmonized methodology for assessing plastic leakage and impact*.
[32] Ellen Macarthur Foundation. (2016). *The new plastics economy: Rethinking the future of plastics*.; (2023). *What is the linear economy?*
[33] CDP. (2024). *Corporate Questionnaire 2024*.
[34] European Commission (2026). Revised European Sustainability Reporting Standards adopted on 3 July 2026.
[35] GRI. (2020). *GRI 306: Waste 2020*.

Outcomes, Impacts, and Valuation

76. The impacts that result from an entity's waste affect the environmental quality dimension of well-being and the well-being resource of natural capital. These are linked to the well-being of people through their effects on economic capital, human capital, and social capital.
77. The impact pathway in this statement has been developed using a value factor that collapses the impact measurement and valuation stages into a nation-specific summary value.

4.1 How to Calculate Impacts

78. The total impact of Waste is the sum of all impacts across waste disposal, waste compositions, and different disposal methods:

$$\boldsymbol{W\&C_{Total}} = \sum(Impact_{Waste,W,D})$$

Where $\sum(Impact_{Waste,W,D})$ is the sum of all waste compositions (W; hazardous, non-hazardous, and plastic) and categories of disposal methods (D; incineration, landfill, or unspecified).[36]
79. Impacts described in the table above combine monetary estimates of waste impacts with entity-specific information, as outlined in Section 3.1 (Data Requirements). To determine the monetary cost of the waste impacts ($W\&C_{Total}$) the following equations are used:
80. Calculating landfill waste impacts
Site-level landfill value factors ($VF_{W,L\text{-}site}$) are calculated separately for hazardous and non-hazardous waste, via the following equation:

$$VF_{W,L-site} = GHG_{W,L} + DIS_{W,L} + LEACH_{W,L} + LU_{W,L} + (ECO_{PL})^*$$

*ECO_{PL} is only applied when the waste composition is plastic.

Represented by greenhouse gas emissions (*GHG*), disamenity (*DIS*), leachate (*LEACH*), and land use (*LU*). *W* refers to waste composition (hazardous, *H*, non-hazardous, *N*, or plastic, *PL*), and *L* denotes landfill waste. If *W* is plastic (*PL*), an additional impact on marine ecosystems (*ECO*) is included. *ECO* represents the chances of plastic mismanagement occurring in the waste disposal process at a national level and is applied universally to all disposal methods when the waste composition is plastic. Once all individual sites are prepared, total landfill impacts are calculated via the following equation:

$$Impact_{W,L} = \sum(Waste_{W,L-site} \times VF_{W,L-site})$$

[36] For waste composition, subscript *W* can be denoted as hazardous (*H*), non-hazardous (*N*), or plastic (*PL*). For categories of disposal methods, subscript *D* can be denoted as landfill (*L*), incineration (*I*) or unspecified (*UN*).

Where total landfill impacts (*$Impact_{W,L}$*) are represented by the sum of the site-level tons of waste landfilled (*$Waste_{W,L\text{-}site}$*) multiplied by the site-level value factor (*$VF_{W,L\text{-}site}$*).

81. Calculating Incineration waste impacts

Site-level incineration value factors ($VF_{W,I\text{-}site}$) are calculated for either hazardous and non-hazardous waste, via the following equation:

$$VF_{W,I-site} = GHG_{W,I} + DIS_{W,I} + HM\&D_{W,I} + AP_{W,I} + Ash_{W,I} + (ECO_{PL})^{*}$$

*ECO_{PL} is only applied when the waste composition is plastic.

Represented by greenhouse gas emissions (*GHG*), disamenity (*DIS*), heavy metals and dioxins (*H&MD*), traditional air pollutants (*AP*), and residual incineration ashes (*Ash*), and where *W* is waste composition (hazardous, *H*, non-hazardous, *N*, or plastic, *PL*), and *I* denotes incineration waste. If *W* is plastic (*PL*), an additional impact on marine ecosystems (*ECO*) is included. *ECO* represents the chances of plastic mismanagement occurring in the waste disposal process at a national level and is applied universally to all disposal methods when the waste composition is plastic. Once all individual sites are prepared, total incineration impacts are calculated via the following equation:

$$Impact_{W,I} = \sum \left(Waste_{W,I} \times VF_{W,I-site}\right)$$

Where total incineration impacts (*$Impact_{W,I}$*) are represented by the sum of the site-level tons of waste incinerated (*$Waste_{W,I\text{-}site}$*) multiplied by the site-level value factor ($VF_{W,I\text{-}site}$).

82. Calculating Unspecified waste impacts

Where the disposal method is unspecified, the site-level value factors ($VF_{W,UN\text{-}site}$) are calculated via the following equation:

$$VF_{W,UN-site} = Maximum\left(VF_{W,L-site}, VF_{W,I-site}\right)$$

Represented by the site-level value factor that is the highest (landfill or incineration). Once all individual sites are prepared, total unspecified impacts are calculated via the following equation:

$$Impact_{W,UN} = \sum \left(Waste_{W,UN} \times VF_{W,UN-site}\right)$$

Where total unspecified impacts (*$Impact_{W,UN}$*) are represented by the sum of the site-level tons of waste unspecified (*$Waste_{W,UN\text{-}site}$*) multiplied by the site-level value factor ($VF_{W,UN\text{-}site}$).

4.2 Outcomes and Impacts

83. For each outcome, the approaches used to link waste to outcomes and impacts are described below. Additional methodological details are in Appendix B.

84. **Greenhouse Gas emissions**: GHG emissions are estimated using methods from the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National

Greenhouse Gas Inventories for landfill[37] and incineration.[38] Landfill waste typically decomposes slowly and anaerobically, where incinerated waste degrades instantaneously and aerobically. As a result, GHG emissions in landfills are generally emitted as methane (CH4, a more potent GHG) where GHG emissions from incineration are generally emitted as CO2, with trace amounts of other GHGs such as nitrous oxides (N2O). For landfills, emissions were projected 90 years from the year in which materials are sent to landfill. Methane emissions are converted to CO2e using the global warming potential (GWP) for non-fossil methane.[39] For incineration, the carbon content of waste was estimated to determine the emissions of CO2 at the time of combustion. For both landfill and incineration, outcomes are noted in terms of metric tons of CO2 or CO2e. Waste to energy was incorporated by estimating greenhouse gas emissions avoided due to energy production of incinerated waste and from landfilling, applying typical country-level grid emissions.

85. **Air emissions of heavy metal and dioxin emissions**: Air emissions of heavy metals and dioxins are only applied to the incineration pathway and are considered negligible for landfills. The outcomes for this pathway rely on reported emissions factors from the EMEP/EEA air pollutant emission inventory (converted to kg pollutant emission/ton waste).[40] Heavy metal emissions (lead, mercury, arsenic, nickel, chromium, and cadmium) and dioxin emissions are represented by industrial and MSW emissions factors, applied to hazardous and non-hazardous waste, respectively. Air emissions factors are then multiplied by estimates of a series of health outcomes (decreased IQ, non-fatal cancers, and fatal cancers) for the emission of each pollutant (cases per kg of emitted pollutant).[41]

86. **Traditional air pollutants**: Similar to heavy metals and dioxins, traditional air pollutants are only applied to the incineration pathway and are considered negligible for landfills and rely on reported emissions factors from the EMEP/EEA air pollutant emission inventory (converted to kg emission/ton waste).[42] Traditional air pollutants (NO_x, SO_x, PM2.5 and PM10) were represented by industrial and MSW emissions factors and applied to hazardous and non-hazardous waste, respectively. In many countries, incineration plants have waste-to-energy capacity and act as sources of energy production. To account for this, typical country-level grid emissions are subtracted from incineration emissions where data is available.

87. **Reductions in well-being from Disamenity**: Disamenity impacts are represented via a hedonic pricing function (HPF) outlined by Eunomia (2002),[43] with new data inputs provided by a meta-analysis of 83 hedonic pricing studies in multiple countries.[44] The HPF uses housing prices as a proxy for people's subjective well-being preferences and defines how housing prices are affected by their distance from a waste management facility (incineration or landfill). Housing prices

[37] Intergovernmental Panel on Climate Change (IPCC). (2019). p. 3. *Chapter 3: Solid Waste Disposal. 2019 Refinement of the 2006 IPCC Guidelines for National Greenhosue Gas Inventories*.
[38] Intergovernmental Panel on Climate Change (IPCC). (2019). p. 5. *Chapter 5: Incineration and Open Burning of Waste. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*.
[39] See table 7.15 of the Intergovernmental Panel On Climate Change (IPCC). (2023). *Climate Change 2021 - The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*.
[40] European Environment Agency. (2023). *EMEP/EEA air pollutant emission inventory*.
[41] Rabl, A. et al. (2008). *Environmental impacts and costs of solid waste: a comparison of landfill and incineration*.
[42] European Environment Agency. (2023). *EMEP/EEA air pollutant emission inventory*.
[43] See page 25 of Eunomia. (2002). *Economic analysis of options for managing biodegradable municipal waste*.
[44] Schütt, M. (2021). *Systematic Variation in Waste Site Effects on Residential Property Values: A Meta-Regression Analysis and Benefit Transfer*.

decline linearly until a distance of 8.5km from a waste management facility is reached.

88. **Health and environmental outcomes from landfill leachate production**: Typical pollutant concentrations (kg/m3) in leachate were extracted from various sources in the literature.[45] An empirical formula developed by Veolia,[46] which relates landfill area to mean annual precipitation, along with waste volume-to-weight conversion factors,[47] were used to estimate leachate pollutant concentrations attributable to a metric ton of landfilled waste.[48] To determine the chance that leachate will cause impacts via release into the natural environment, a risk-adjusted estimate of the likelihood of a leachate incident occurring in a country is estimated using the HARAS model.[49] The HARAS model is used to determine a risk factor based on three characteristic ratings: source of waste (here, hazardous vs non-hazardous), pathway (soil permeability of a site), and receptor (population density around the site). Risk factors are reported separately based on the management of landfills (based on national statistics of the ratio of sanitary landfills to open dumpsites).

89. **Land use and conversion**: Land use and Conversion impacts are applied only to landfilled waste. These impacts were estimated by calculating the area required to landfill one metric ton of waste, using weight-to-volume conversion factors,[50] and typical landfill heights for managed facilities and unmanaged dumpsites. Country-level estimates of waste flows to managed and unmanaged sites were then used to determine the land area needed per metric ton of landfilled waste.

90. **Residual incineration ashes**: All fly ashes are landfilled as hazardous waste, where a portion of bottom ashes are used as secondary resources (substituted virgin metals, road/construction materials, etc.). Using a case study described in Rigamonti et al., 2020,[51] the fly / flue gas ashes and bottom ashes left over from incineration represented 4.8% and 4.5% of the original waste weight, respectively. Thus, the Waste Methodology assumes 9.3% of original weight of waste sent to incineration will be sent to hazardous landfill sites.

91. **Environmental outcomes from mismanaged marine plastic waste**: Approximately 80% of marine plastics enter the ocean through riverine. The marine plastic pathway utilizes a model, calibrated with field-based observations, that estimates the probability that plastic waste discarded in a given country will reach the ocean via river and coastal systems.[52] This probability is multiplied by the

[45] Thousands of pollutants can be found in leachate, and the pollutant composition is highly dependent on the waste composition. Here, we note 21 commonly cited pollutants in the literature: Anthracene, antimony, arsenic, barium, benzene, benzo[a]pyrene, cadmium, chromium, copper, dibenzo[a,h]anthracene, fluaranthene, fluorene, lead, mercury, naphthalene, nickel, phosphorus, pyrene, silver, total nitrogen, and zinc.
[46] See equation 8 of Zhou, W. et al. (2024)b. *A review of existing methods for predicting leachate production from municipal solid waste landfills*.
[47] U.S. Environmental Protection Agency. (2016). *Volume-to-Weight Conversion Factors*.
[48] See appendix B for more details.
[49] Singh, R. K. et al. (2013). *Evaluating Groundwater Contamination Hazard Rating of Municipal Solid Waste Landfills in India and Europe Using a New System*.
[50] U.S. Environmental Protection Agency. (2016). *Volume-to-Weight Conversion Factors*.
[51] See Figure 4, Rigamonti, L. et al. (2020). *A step forward in quantifying the substitutability of secondary materials in waste management life cycle assessment studies*.
[52] Meijer, L. J. J. et al. (2021). *More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean*.

weight of plastic reported by an entity to determine the weight of plastic emitted to the ocean.

	Waste		
Data Organized by Waste Composition	*Hazardous (H), Non-hazardous (N), Plastic (PL)*	*Hazardous (H), Non-hazardous (N), Plastic (PL)*	*Hazardous (H), Non-hazardous (N), Plastic (PL)*
Categories of Waste Impacts	**Incineration (I)**	**Landfill (L)**	**Unspecified (UN)**
Greenhouse Gasses	✓	✓	
Heavy Metals & Dioxins	✓		
Disamenity	✓	✓	
Air Pollution	✓		
Residual Incineration Ashes	✓		
Leachate		✓	
Land Use		✓	
Marine Ecosystems* **For Plastic Waste Only*	✓*	✓*	
Value Factors (VFs)	VFs = Sum of site-level waste impacts **by waste composition**	VFs = Sum of site-level waste impacts **by waste composition**	VFs = Maximum of site-level incineration or landfill VFs **by waste composition**
IMPACTS	*Impacts* = Sum of VFs and entity-specific reports **by waste composition**	Impacts = Sum of VFs and entity-specific reports **by waste composition**	Impacts = Sum of VFs and entity-specific reports **by waste composition**
WTOTAL	**Sum of all *IMPACTS* of all waste compositions described above**		

Table 3. Summary of how to complete calculations for Waste Impacts

4.3 Monetary Valuation

92. Monetary valuation estimates the relative importance, worth, or usefulness of changes in well-being indicators in monetary terms. A tailored valuation approach

is developed for each impact in the Waste Methodology. Each approach is described briefly below with additional methodological details presented in Appendix B.

93. **Greenhouse Gas emissions**: GHG emissions are valued using the Social Cost of Carbon, taken as the average of two prominent valuation models, the Greenhouse Gas Impact Value Estimator, GIVE,[53] and the Data-driven Spatial Climate Impact Model, DSCIM.[54] More details on the application of these models can be found in the GHG Topic Methodology.[55] For incinerated waste, all related GHG emissions occur in the same year that waste is incinerated. Thus, the SCC-GHG value ($/ton CO2e) for the year in which waste is incinerated is applied.[56] For landfilled waste, GHGs are estimated over a 90-year trajectory.[57] Thus, SCC-CO2 was discounted across the 90-year decomposition trajectory by applying the near-term target certainty-equivalent discount rate described by the U.S. Environmental Protection Agency.[58]

94. **Air emissions of heavy metal and dioxin emissions**: Lead emissions were valued using an estimate of the social cost of lost IQ points.[59] Mercury emissions were valued based on cognitive and cardiovascular health outcomes.[60] For cadmium, chromium, nickel, arsenic, and dioxins, fatal and non-fatal cancers were valued by estimating the lost Disability Adjusted Life Years (DALYs) associated with cancerous diseases.[61] DALYs lost are valued using the value of a statistical life (VSL). The VSL applied uses a single, globally representative value of $US 2,895,021 (2024), based on a VSL of $US 2.7 million (2022) from the OECD,[62] adjusted for inflation.[63] The VSL is converted to the valuation of one year of life lost by taking account of life expectancy estimates.

95. **Traditional air pollutants**: SO_x, NO_x, PM2.5 and PM10 were valued using the health, agriculture, and visibility impacts for peri urban areas value factors described in the Air Pollution Interim Methodology.[64] The Air Pollution Interim Methodology combines the results of an air dispersion model (ATMOS) and societal costs from morbidity, mortality, willingness-to-pay (WTP) for improved visibility,[65] and reductions in agricultural productivity. For more details, please refer to the Air Pollution Interim Methodology.

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[53] Rennert, K. et al. (2022). *Comprehensive evidence implies a higher social cost of CO2.*
[54] The Climate Impact Lab. (2022). *Documentation for Data-driven Spatial Climate Impact Model (DSCIM): Version 092022-EPA.*
[55] International Foundation for Valuing Impacts & Value Balancing Alliance. (2024). *Environmental Methodology 1; Greenhouse Gas Emissions Topic Methodology.*
[56] For 2024, the SCC used is $US 239 per ton of CO_{2e} emissions.
[57] As described in the IPCC Waste Model, International Panel on Climate Change. (2019). *Chapter 3: Solid Waste Disposal. 2019 Refinement of the 2006 IPCC Guidelines for National Greenhosue Gas Inventories.*
[58] See Section 2.4.1 of U.S. Environmental Protection Agency. (2023). *EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances.*
[59] Vincent, N., & Rabl, A. (2016). *Costs of Health Damage from Atmospheric Emissions of Toxic Metals: Part 2-Analysis for Mercury and Lead.*
[60] Martinez-Sanchez, V. et al. (2017). *Evaluation of Externality Costs in Life-Cycle Optimization of Municipal Solid Waste Management Systems.*; Rice, G., & Hammitt, J. (2005). *Economic Valuation of Human Health Benefits of Controlling Mercury Emissions from U.S. Coal-Fired Power Plants.*
[61] Global Burden of Disease 2019 Cancer Collaboration. (2022). *Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability, and Disability-Adjusted Life Years for 29 Cancer Groups From 2010 to 2019: A Systematic Analysis for the Global Burden of Disease Study 2019.*
[62] See the Global mean value in Table 6.1 of OECD. (2025a). Mortality Risk Valuation in Policy Assessment: A Global Meta-Analysis of Value of Statistical Life Studies.; Range of the global VSL values (95% confidence interval) is between $US 1.9 and 3.6 million.
[63] Inflation adjusted using OECD's Inflation (Consumer Price Index) and Inflation Forecast data series, which can be accessed via: https://data.oecd.org/price/ inflation-cpi.htm
[64] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Air Pollution.*
[65] Leading to physical and economic benefits in both recreational and residential settings.

96. **Disamenity**: Disamenity is valued in two steps. First, the country-level total decline in property values caused by landfill or incineration presence was calculated by multiplying the HPF (described in Section 4.2) by the average country household density to estimate the likely number of properties affected by disamenity from waste sites. Second, the estimated decline in property values is divided by a projected weight of waste flow to each landfill or incineration site to determine the dollar impact per ton of waste.

97. **Leachate**: Pollutants in leachate were valued using value factors described in the Water Pollution Interim Methodology.[66] The Water Pollution Interim Methodology utilizes USEtox, a model capable of providing human health outcomes (DALYs) from more than 1,250 pollutants with geographic specificity.[67] The Water Pollution Interim Methodology also provides value factors for the decline in water quality via WTP for eutrophication mitigation. For more details, please refer to the Water Pollution Interim Methodology.

98. **Land use and conversion**: This impact is assessed based on the reduction of ecosystem services resulting from the conversion of land from its natural state (land conversion) and the continued loss of ecosystem services while the land remains in use (land use). Impact estimates are based on value factors for 'paved' land conversion, as defined in the Land Use and Conversion Interim Methodology,[68] which provides separate valuations for land conversion and land use. Country-level impacts from landfilled waste were calculated by multiplying land conversion values by the estimated land area required (see Section 4.2). For land use, the net present value of occupying the land over the landfill's operational lifetime[69] was calculated using a 2% discount rate.

99. **Residual incineration ashes**: The valuation for fly/flue and bottom ash is based on the landfill specific impacts for disamenity, leachate, and land use and conversion as described in the paragraphs above. The residual ash sent to landfill from incineration, equivalent to 9.3% of the original waste weight,[70] is multiplied by the combined value of these impacts.

100. **Mismanaged marine plastic waste**: The valuation for marine plastics is based on an estimate by marine ecosystem experts that assumes a 1-5% reduction of marine ecosystem services due to plastic pollution (in 2011, where the stock of plastic in the ocean was 75-150 million tons),[71] and is aligned with valuation strategies described by the World Wide Fund for Nature.[72] Here, the annual impact of marine plastic was calculated by multiplying the value of the open ocean provided by the Ecosystem Service Valuation Database (ESVD)[73] by the conservative estimate of a 1% ecosystem service reduction. The impact costs incurred by a single ton of marine plastic will take place until the plastic breaks down completely, which can take thousands of years. The impact of marine plastic is represented as the net present value of impacts, discounted at 2% for 200 years, at which point the costs are being discounted by more than 98% and no longer significantly contributed

[66] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Water Pollution*.
[67] *The USEtox® Model - Life Cycle Initiative*. (2013)
[68] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Land Use and Conversion*.
[69] Assumed to be 40 years.
[70] See Fig 4, Rigamonti, L. et al. (2020). *A step forward in quantifying the substitutability of secondary materials in waste management life cycle assessment studies*.
[71] Beaumont, N. J. et al. (2019). *Global ecological, social and economic impacts of marine plastic*.
[72] WWF. (2021). *Plastics: The Costs to Society, the Environment and the Economy*.
[73] De Groot, R. et al. (2012). *Global estimates of the value of ecosystems and their services in monetary units*.

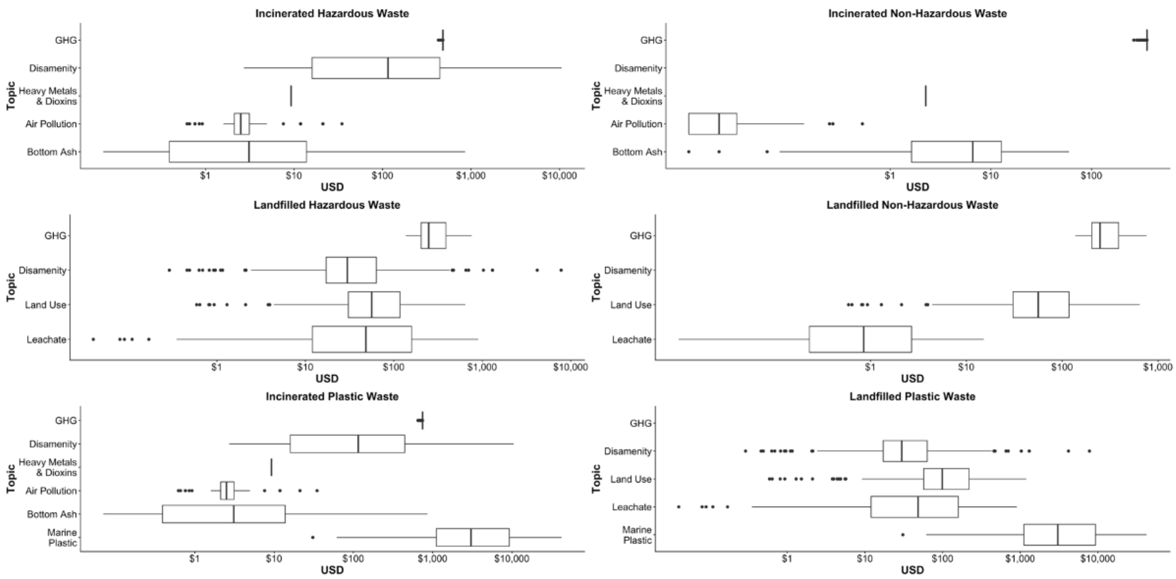
to the lifetime marine plastic cost.[74] This value is multiplied by the country-specific probability of plastic emissions into the ocean via riverine systems when plastic is discarded in a particular country to determine the marine plastic value factor.[75]

101. The value factors will be reviewed and updated regularly. These updates will be made to the value factor only without revision to the methodology itself. For summary details of the value factor quantification, see Box 1 below.

Box 1: Characterizations of Country-Level Value Factors

Pathway results

The country-level distribution of impacts for each pathway (GHG, disamenity, land use, etc.) are presented in the graph below. GHG emissions are typically the highest category of impact for hazardous and non-hazardous wastes, where marine plastic is the highest impact for plastic waste specifically. As plastic is not expected to break down microbially in landfills, the GHG impacts of landfilled plastic are considered negligible. Disamenity impacts have a high range of values across all waste types and disposal methods, with final values dependent on the amount of waste flow, housing density, and property values within each country.



*X-axes are logarithmic

[74] Aligned with WWF. (2021). *Plastics: The Costs to Society, the Environment and the Economy*.
[75] Meijer, L. J. J. et al. (2021). *More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean*.

Future Development

102. The Waste Methodology represents the current state of knowledge on waste disposal impacts and builds upon decades of rigorous scientific work. But some opportunities for improvement exist including further enhancement of how to account for value chain impacts and further development of the valuation of impacts.

103. Opportunities to further advance waste impact accounting include:

104. **Incorporation of the waste trade**: Due to data constraints, the current Methodology does not incorporate estimates of how much waste material is shipped internationally. For example, 2% of plastic waste is traded internationally, and generally exported to low-income countries.[76] Thus, if waste is reported to have been discarded in one country, it could be exported to another country unbeknownst to the reporter, creating impact accounting discrepancies.

105. **More robust categories of waste composition**: The current Methodology requires entities to categorize their waste composition by whether it has hazardous or non-hazardous characteristics. However, the chemical composition of waste can have a dramatic effect on the magnitude of impacts. For example, 58% of landfill fugitive methane emissions in the United States are associated with food waste, yet food waste only comprises ~24% of landfilled MSW.[77] In another example, the composition of landfilled waste can affect both the rate of leachate production and the contained concentrations of water pollutants.[78] The current categorizations of waste included in the Methodology are limited by comprehensive data availability and reporting standards.[79] Though currently not in scope, future efforts will be made to assess, measure, and value the impacts of radioactive waste.

106. **Plastic waste environmental impacts**: The current Methodology only captures the impact of marine plastic and does not incorporate the effect of plastic in riverine and terrestrial systems. Plastic waste can cause significant impacts through reduced agricultural productivity, loss of tourism and recreational value, soil degradation, harm to wildlife, water pollution, altering ecosystems and disrupting the natural processes across both land and freshwater environments. Of the 353 million tons of plastic waste generated in 2019, around 22% was mismanaged and only 0.5% of plastic generation ended up in the ocean, meaning the vast majority of mismanaged plastic waste remains on land and freshwater systems.[80] As a result, the impacts of plastic waste on the environment are deeply conservative in the current Methodology.

107. **Disamenity**: The current Methodology uses national-level statistics of population densities and counts of waste management facilities to estimate disamenity impacts. More precise locations of global waste management facilities and the quality of these facilities would increase the precision of disamenity impact estimates. However, such data is not readily available and not available on a consistent basis.

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[76] *Charted: The key countries that trade in global plastic waste*. (2023)
[77] EPA. (2023). *Quantifying Methane Emissions from Landfilled Food Waste*.
[78] Zhou, W. et al. (2024)b. *A review of existing methods for predicting leachate production from municipal solid waste landfills*.
[79] European Commission (2026). Revised European Sustainability Reporting Standards adopted on 3 July 2026.
[80] OECD. (2022). *Global Plastics Outlook: Policy Scenarios to 2060*.

108. **Updates to Underlying Methodologies**: Some waste impacts are based on the methodologies of other Topics, including Air Pollution and Water Pollution. Updates to these methodologies will in turn affect results of the Waste Methodology as well. This also includes future plans to incorporate Resource Extraction impacts in future Methodologies.

109. **Circularity**: Central to a circular economy is the notion that the 'loss of' a resource occurs only when those resources 'exit' the circular system and are discarded. The Waste Methodology considers the impacts of an entity's decision to discard resources and treat end of life waste through disposal to landfills or incineration. However, there are alternative waste treatment options which involve diverting waste from disposal through recycling, reuse, remanufacturing, refurbishment, repairing and repurposing of waste materials. Circularity is considered the ideal system for sustainable resource management, but this involves decisions taken at multiple points by the entity and across its value chain, which go beyond the decisions on waste treatment. Therefore, a systems wide approach to assessing the outcomes and impacts of circularity is required, and this is intended to be the subject of a separate consideration by the IVSB in the future.

110. Significant updates on any of the above, among other developments in the landscape will be used to inform future updates to the Waste Methodology, which will be considered periodically.

Appendices Table of Contents

Appendices

Appendix A: Glossary

Term	Definition	Source
Air Pollution	Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere.	World Health Organization
Biodiversity	The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems.	IPBES
Biome	Global-scale zones, general defined by the type of plant life that they support in response to average rainfall and temperature patterns (e.g., tundra, coral reefs, or savannas).	TNFD
Circular Economy	One of the current sustainable economic models, in which products and materials are designed in such a way that they can be reused, remanufactured, recycled, or recovered and thus maintained in the economy for as long as possible, along with the resources of which they are made, and the generation of waste, especially hazardous waste, is avoided or minimized, and greenhouse gas emissions are prevented or reduced, can contribute significantly to sustainable consumption and production.	UNEP

Cultural Services	The experimental and intangible benefits related to the perceived or actual qualities of ecosystems, i.e. the non-material benefits from spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including the appreciation of the existence of diverse species.	ESVD
Dioxins	A group of toxic chemical compounds that share certain chemical structures and biological characteristics. Dioxins are not produced commercially but are instead produced as a biproduct of industrial activities. Dioxins are highly toxic and can cause cancer, reproductive and developmental problems, damage to the immune system, and can interfere with hormones.	Based on the US EPA description
Direct Operations/ Operational Processes (Gate-to-Gate)	Covers activities over which the business has direct operational control, including majority owned subsidiaries.	Natural Capital Protocol
Disability-Adjusted Life Year (DALY)	One DALY represents the loss of the equivalent of one year of full health. DALYs for a disease or health condition are the sum of the years of life lost to due to premature mortality (YLLs) and the years lived with a disability (YLDs) due to prevalent cases of the disease or health condition in a population.	World Health Organization
Disamenity	A negative characteristic affecting the environment of a location or property.	Mendelsohn and Olmstead, 2009
Downstream Processes (gate-to-grave)	Covers activities linked to the purchase, use, re-use, recovery, recycling, and final disposal of the business' products and services.	Natural Capital Protocol
Dumpsite	Places where collected waste has been deposited in a central location and where the waste is not controlled through daily, intermediate or final cover, thus leaving the top layer free to escape into the natural environment through wind and surface water.	UNEP

Ecosystem Services	The benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling.	Millennium Ecosystem Assessment
Environmentally Extended Input Output Models	A family of models designed to bridge the gap between traditional economic calculations, sustainability, and environmental decision-making.	The U.S. Environmental Protection Agency
Greenhouse Gasses	Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrochlorofluorocarbons (HCFCs), ozone (O3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).	UNFCCC
Habitat Services	The benefits of ecosystems providing space (habitat) to allow the proper functioning of evolutionary processes needed to maintain a healthy gene pool, and by providing essential habitats in the life cycle of migratory species. Some classifications, like CICES, combine Regulating and Habitat services into one category.	ESVD
Hazardous Waste	Waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste is generated from many sources, ranging from industrial manufacturing process wastes to batteries and may come in many forms.	US EPA
Heavy Metals	The term heavy metal is used loosely but generally refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations (e.g., mercury, cadmium, arsenic, chromium, titanium, lead).	Ojovan M.I. 2005

Hedonic Pricing Function	Hedonic pricing - or the hedonic pricing method - is used in the determination of the economic value for an ecosystem service or external factor that may influence the market price of a good or asset. The method is commonly applied in the valuation of properties, such as houses, and accounts for economic costs or benefits, which may influence the overall value of the asset or, as commonly presumed, a house. Hedonic price valuation is very quantitative and relies on statistical analysis and informed model specifications.	Corporate Finance Institute
Impact	A positive or negative change in one or more dimensions of wellbeing, following a change in capitals (stock or flow) as a result of human activities.	Capitals Coalition
Impact Accounting	The system for measuring and valuing the impacts of corporate entities and generating impact information to inform decisions related to sustainability performance.	IFVI
Impact Drivers	Refers to the sequence of an entity's inputs and outputs that may have positive and/or negative impacts on people's well-being.	Impact Management Platform
Impact pathway	The series of consecutive, causal relationships, ultimately starting at an input for an entity's activities and linking its actions with related changes in people's well-being.	IFVI
Incineration	Destruction and transformation of material to energy by combustion.	UNEP
Input	The resources and business relationships that the entity draws upon for its activities.	Impact Management Platform
Landfill Leachate	Formed when rainwater filters through wastes placed in a landfill. When this liquid comes in contact with buried wastes, it leaches, or draws out, chemicals or constituents from those wastes.	EPA
Monetized Impact	The assignment of monetary values to damages.	N/A

Municipal solid waste	Includes all residential and commercial waste but excludes industrial waste.	UNEP
Natural Resources	Natural assets (raw materials) occurring in nature that can be used for economic production or consumption.	United Nations
Outcome	The change in the state or condition capital(s), in physical, biological, psychological, human rights, or equity terms, that results from an entity's activities.	Capitals Coalition
Output	The direct result of an entity's activities, including an entity's products, services, and any by-products.	Impact Management Platform
Plastic Pollution	Defined broadly as the negative effects and emissions resulting from the production and consumption of plastic materials and products across their entire life cycle. This definition includes plastic waste that is mismanaged (e.g. openly burned and dumped in uncontrolled dumpsites) and leakage and accumulation of plastic objects and particles that can adversely affect humans and the living and non-living environment.	UNEP
Potential Evapotranspiration (PET)	The amount of water evaporated (both as transpiration and evaporation from the soil) from an area of continuous, uniform vegetation that covers the whole ground and that is well supplied with water.	American Meteorological Society
Provisioning Services	The products or resources that can be harvested or extracted from ecosystems (e.g., food and raw materials) and which can usually be traded in markets.	ESVD
Recovery	Any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function in the plant or in the wider economy.	Eurostat

Recycling	Processing and use of wastes in production and consumption processes, for example, melting of scrap iron so that it can be converted into new iron products.	UN
Regulating Services	The benefits obtained from ecosystem processes that maintain environmental conditions beneficial to individuals and society (e.g., air quality, flood protection, biological control). Generally, these services have an indirect market value.	ESVD
Reuse	Use of a product more than once in its original form.	UNEP
Sanitary Landfill	An engineered facility for the disposal of solid waste on and in a controlled manner.	UNEP
Stakeholders	Stakeholders are defined as those who can affect or be affected by the entity.	European Sustainability Reporting Standards
The 10 R's	A concept for behaviors that promote circularity – Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover.	Circularise
Upstream Processes (Cradle-to-gate)	Covers the activities of suppliers, including purchased energy.	Natural Capital Protocol
Value Factor	Value factors help to translate the impact drivers of an entity into estimations of the relative importance, worth or usefulness of impacts to the people who experience the impact, expressed as a monetary value.	IFVI - VBA
Value of a Statistical Life	The amount individuals would be willing to pay or to accept to experience small changes in mortality risk, aggregated to estimate the monetary value of a reduction in mortality risk of 100%.	US EPA
Waste (Solid waste)	Solid waste covers discarded materials that are no longer required by the owner or user. Solid waste includes materials that are in solid or liquid	UNDRR

	state but excludes wastewater and small particulate matter released into the atmosphere.	
Well-being	Well-being is the state of being or doing well in life; happy, healthy, or prosperous condition; moral or physical welfare. According to the OECD Well-being Framework, well-being encompasses 11 dimensions of current well-being and 4 dimensions for future well-being.	Impact Management Platform

Appendix B: Methodological Details

1. Introduction

B1. Eight categories of value factors were developed to assess impacts in the Waste Methodology: Greenhouse Gas emissions, Air pollution, Heavy metals and dioxins, Disamenity, Leachate, Marine plastics, Land use, and Incineration ashes. Waste disposal methods – incineration or landfill – were valued separately where appropriate. Each pathway was informed by a range of methodologies, including academic, industry, and internally developed approaches. Key considerations included valuation techniques, data recency, spatial resolution, model complexity, and underlying assumptions. Detailed descriptions of how each pathway was calculated are included in the sections below.

2. Greenhouse Gas emissions

B2. Greenhouse Gas (GHG) emissions from waste were calculated using recommendations from the IPCC for landfilling[81] and incineration.[82] GHGs are differentially emitted depending on whether waste is incinerated or landfilled. When waste is incinerated, the majority of GHGs are instantaneously emitted in the form of CO_2. When waste is landfilled, the majority of GHGs are emitted in the form of CH_4 over a 90-year trajectory.

B3. GHGs for both landfilled and incinerated waste were valued in monetary terms via the IFVI GHG Topic Methodology, where the social cost of one metric ton of carbon dioxide (SCC-CO_2) was $US 255.12 (2024).[83] This value was adjusted to the type of GHG emitted by multiplying by the 100-year GWP (GWP-100) for non-fossil CH_4 (GWP = 27) and for N_2O (GWP = 273).[84]

B4. Value factors for Hazardous and non-hazardous waste were reported separately for both incinerated and landfilled waste.

2a GHG emissions from landfilled waste

B5. GHG emissions from landfilled waste were estimated using the first order decay method.[85] The amount of decomposable degradable organic carbon in waste (DDOCm) disposed in a given year was calculated using the following general equation:

$$DDOCm = W \times DOC \times DOC_f \times MCF$$

Where DDOCm is the mass of decomposable degradable organic carbon deposited (metric tons), W is the mass of waste deposited (here, 1 metric ton), DOC is

[81] Though described briefly in this appendix, full details of the calculations can be found in the *IPCC Waste Model*, found via: Intergovernmental Panel On Climate Change. (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.
[82] Intergovernmental Panel on Climate Change. (2006). *IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 5: Incineration and open burning of waste*.
[83] See Appendix C of *Environmental Methodology 1: Greenhouse Gas Emissions Topic Methodology*. (2024) Social costs of Carbon estimated in Appendix C were reported in $US (2023). The value of $US 255.12 per ton CO_{2e} described here represents a ton of CO_2 emitted in 2025, adjusted for inflation to $US (2024).
[84] See Table 7.15 Intergovernmental Panel On Climate Change (IPCC). (2023). *Climate Change 2021 - The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*.
[85] Intergovernmental Panel on Climate Change. (2006). *IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 3: Solid Waste Disposal*.

degradable organic carbon fraction in the year of deposition,[86] DOC_f is the fraction of DOC that can decompose,[87] and MCF is the methane correction factor for aerobic decomposition in year t.[88]

B6. To project the amount of DDOCm decomposition for each year over the 90-year trajectory, a decay constant was applied via the following equation:

$$DDOCm_{decomposed,t} = DDOCm_{accumulated,t-1} \times (1 \times e^{-k})$$

Where $DDOCm_{decomposed,t}$ represents the decomposition of DDOCm in year t, $DDOCm_{accumulated,t-1}$ is the mass of DDOCm accumulated in the previous year,[89] and k is the methane generation constant. k values require the application of a climate zone to apply to individual countries.[90] Country-level mean annual temperature (MAT), mean annual precipitation (MAP), and potential evapotranspiration (PET) data were used to determine climate zones.[91]

B7. The quantity of methane generated was determined via:

$$CH_{4,generated,t} = DDOCm_{decomposed,t} \times \frac{16}{12} \times F$$

Where $DDOCm_{decomposed,t}$ is the amount of DDOCm decomposed in year t, 16/12 is the carbon to methane conversion factor, and F is the fraction of methane in landfill gas.[92] Generated methane values were converted to CO_{2e} by multiplying by the global warming potential (GWP) of methane:

$$CO_{2e,generated,t} = CH_{4,generated,t} \times GWP_{CH_4}$$

Landfills are often fitted with methane capture technologies, which are flared or used for energy production. The total amount of KwH produced by captured landfill methane was calculated via the following equation:

[86] A weighted average DOC was applied to each country using waste composition percentages from the World Bank and good practice defaults from the IPCC. The following defaults were used for each World Bank Category; organic waste (0.15 for food waste), paper/cardboard (0.4 for paper and textiles), wood (0.3 for wood and straw waste), yard waste (0.17 for garden, park waste, other non-food organic putrescibles), and other (0.18 for bulk MSW, applied to all remaining waste weight). Where country-level waste composition was completely missing, a value of 0.18 for bulk MSW was applied. See composition data and defaults applied via the following references: Intergovernmental Panel On Climate Change. (2018). *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*.; World Bank Group. (2018). *What a Waste 2.0: A global snapshot of solid waste management to 2050*.
[87] See page 5.10 of: Intergovernmental Panel On Climate Change. (2018). *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Page 5.10 notes it is good practice to use a value of 0.5-0.6. Thus, the Waste Methodology uses a value of 0.55 (middle of the range) for both hazardous and non-hazardous waste.
[88] See Table 5.1 of: Intergovernmental Panel On Climate Change. (2018). *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. A value of 1 ('managed' default) was applied to high-income countries. A value of 0.6 (uncategorized SWDS) was applied to upper-middle and lower-middle income countries, as the good practice guide value where MCF is unknown. A value of 0.4 was applied to low-income countries based off the Table's recommendations, where "inventory agencies in developing countries are encouraged to use 0.4."
[89] In the year waste is deposited, this value is zero.
[90] See table 3.4 of Intergovernmental Panel on Climate Change. (2006). *IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 3: Solid Waste Disposal*.
[91] MAT and MAP data were derived from the Bioclim CHELSA dataset, Climatologies at High Resolution for the earth's land surface area. (2016). *Bioclim*. PET data were derived from Zomer, R. J. et al. (2022). *Version 3 of the Global Aridity Index and Potential Evapotranspiration Database*. Average values across each country area was determined using the *Zonal Statistics Tool* in QGIS: QGIS Development Team. (2024). *QGIS*.
[92] The Waste Methodology uses the recommended default value of 0.5, noted in Intergovernmental Panel On Climate Change. (2018). *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*.

$$KwH_{produced,i} = EP_{waste} \times CH_{4,\%\,captured,i} \times CH_{4,\%captured,burned,i}$$

Where EP_{waste} is the energy potential of landfilled waste, $CH_{4,\%captured,i}$ is the % of methane captured,[93] and $CH_{4,\%captured,burned,i}$ is the amount of methane captured that is burned for energy.[94] The kilowatt-hours produced by landfill gas energy capture were compared to each country's national grid efficiency to determine the amount of avoided GHGs via the following equation:

$$CO_{2e,avoided} = KwH_{produced,i} \times \left[\frac{CO_{2e}}{KwH}\right]_i$$

Where the Kilowatt-hours produced are multiplied by the carbon intensity of the national grid in country i.[95] Finally, the total net CO_{2e} emitted from each country was determined via the following equation:

$$CO_{2e,net\ emitted} = \left[CO_{2e,generated} \times (1 - CO_{2e,captured})\right] - CO_{2e,avoided}$$

Where the CO_{2e} avoided is subtracted from the portion of CO_{2e} generated but not captured for energy production.

B8. For landfilled waste, the SCC-CO_2 was discounted across the 90-year decomposition trajectory by applying the near-term target certainty-equivalent discount rate described by the U.S. Environmental Protection Agency.[96] The value factor for GHG landfilled waste represents the sum of SCC-CO_2 values across the 90-year trajectory.

2b. GHG emissions from incinerated waste

B9. All GHG emissions from incinerated waste are emitted directly as a result of combustion and occur instantaneously. The GHG emissions for incinerated waste include both fossil carbon and non-fossil carbon, accounting for both CO_2 and N_2O emissions. CO_2 emissions from discarded waste are calculated via:

$$CO_{2,generated} = W \times CC_w \times Ef_{combustion,w} \times 3.67$$

Where W is the weight of waste discarded, CC_w is the carbon content in waste type w, $Ef_{combustion}$ is the efficiency of combustion of waste type w, and 3.67 is the carbon to CO_2 molecular ratio.[97]

[93] Default of 20%, as described in: Intergovernmental Panel on Climate Change. (2006). *IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 5: Incineration and open burning of waste*.
[94] An energy potential of 65 kwh per metric ton was noted by Dadario, N. et al. (2023). *Waste-to-Energy Recovery from Municipal Solid Waste: Global Scenario and Prospects of Mass Burning Technology in Brazil*. Percentages of methane captured and burned were sourced from World Bank Group. (2018). *What a Waste 2.0: A global snapshot of solid waste management to 2050*.
[95] Carbon intensity of the national grid for each country was provided by EMBER. (2024). *Global Electricity Review, 2024*. Data was compiled by Our World in Data, via: https://ourworldindata.org/electricity-mix
[96] See Section 2.4.1 of U.S. Environmental Protection Agency. (2023). *EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances*.
[97] Hazardous and non-hazardous carbon content in waste and efficiency of combustion were determined using default values in table 5.6 of Intergovernmental Panel on Climate Change. (2007). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste*.

B10. CO_2 emissions avoided due to energy production of incinerated waste was determined via:

$$CO_{2,avoided} = CO_{2,generated} \times \%CO_{2,avoided} \times EP_{waste}$$

Where $\%CO_{2,avoided}$ was determined via multiple sources, and EP_{waste} was the energy potential of incinerated waste.[98] Similar to the landfill GHGs, net CO_2 emissions were determined by subtracting avoided emissions from generated emissions.
B11. N_2O emissions were estimated using an emission factor for N_2O emissions from incineration.[99] The value factor for incineration GHGs was determined via:

$$VF_{GHG,incineration} = CO_{2,net} + (N_2O \times GWP_{N2O})$$

Where N_2O emissions were converted to CO_{2e} by multiplying by the global warming potential for N_2O, 273.[100]
B12. Additionally, to the above-described methodology of incinerated waste, incinerated waste from plastics specifically is also included in the GHG impact pathway.[101] The approach is as described above, but here the plastic carbon content is applied.

3. Air Pollution – NO_x, SO_x, PM2.5, PM10, heavy metals, and dioxins

B13. The impacts of air pollution are only associated with waste incineration and are not applied to landfilled waste. The air pollutants from incineration are defined in two categories within the Waste Methodology: (1) heavy metals (Pb, Cd, Cr^{VI}, Ni, As, and Hg) and dioxins, and (2) traditional air pollutants (NO_x, SO_x, PM2.5, and PM10). The quantitative details for each of these categories are discussed below.
B14. Impacts of air pollution from incinerated plastic waste are assumed to be the same as the hazardous waste impacts.

3a. Heavy metals and dioxins

B15. Heavy metals and dioxins are common air emissions from incineration plants that have cancerous or neurotoxic effects when inhaled. Here, heavy metals refer to lead (Pb), cadmium (Cd), hexavalent chromium (Cr^{VI}), nickel (Ni), arsenic (As), and mercury (Hg). Within the Waste Methodology, Cd, Cr^{VI}, Ni, As, and dioxin exposure were valued via carcinogenic effects, where Pb exposure was valued via neurotoxic effects. Hg is known to have both carcinogenic and neurotoxic effects and thus was valued using a combination of both health outcomes.

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[98] $\%CO_{2,avoided}$ was determined via multiple sources, including UN Data (*UNdata | record view | Hazardous waste incinerated*. n.d.) and OECD data (OECD. (2025b). *Data Explorer; Waste - Municipal waste: generation and treatment*.). The energy potential of incinerated waste used was 550 kilowatt-hours per ton of waste, based on information from US EPA, O. (2016). *Energy Recovery from the Combustion of Municipal Solid Waste (MSW)*.
[99] See Table 5.7 in Intergovernmental Panel on Climate Change. (2007). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste*. A value of 8.5 kg N_2O/Gg waste (dry) was used for non-hazardous waste, representing the middle range of average values for 'hearth or grate' incineration plants for municipal solid waste. A value of 225 kg N_2O/Gg waste (dry) was used for hazardous waste, representing the middle range of 'rotating' incineration plants for hazardous waste.
[100] Intergovernmental Panel On Climate Change (IPCC). (2023). *Climate Change 2021 - The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*.
[101] GHG impacts from landfilled plastic waste are assumed to be zero, as plastic does not biogenetically decompose.

B16. Carcinogenic effects were valued as the sum of fatal and non-fatal cancers. Fatal cancers were valued via the following equation:

$$\frac{\$_{cancer,fatal}}{kg_p} = \left(XF_p \times \%cancer_{mortality}\right) \times (\$_{DALY} \times DALYs_{cancer})$$

Where the XF_p was the exposure factor for pollutant p,[102] $\%cancer_{mortality}$ was the percent of cancers that resulted in premature death,[103] $\$_{DALY}$ was the Value of a Statistical Life,[104] and $DALYs_{cancer}$ was the average number of disability-adjusted life years (DALYs) associated with fatal cancer.[105] Non-fatal cancers were valued via the following equation:

$$\frac{\$_{cancer,nonfatal}}{kg_p} = \left(XF_p \times \left(1 - \%cancer_{mortality}\right)\right) \times (\$_{YLL} \times DALY_{cancer} \times \%_{YLD})$$

Where $\%_{YLD}$ was the percentage of DALYs represented by years of healthy life lost due to disability (YLD).[106]

B17. Neurotoxic impacts of pollutant exposure are often evaluated by cognitive effects. Here, cognitive impacts are represented by diminished *intelligence quotients* (IQ) due to exposure.[107] The neurotoxicity of Pb emissions were valued via:

$$\frac{\$_{neurotox}}{kg_{Pb}} = IQ_{pts.lost,Pb} \times \$_{IQ\ pt.lost}$$

Where $IQ_{pts.\ lost,\ Pb}$ is the total number of IQ points lost per Kg Pb,[108] and $\$_{IQ\ pts.\ lost}$ is the social cost of lost IQ points.[109]

[102] In units of cases per kg of pollutant. See impact per kg column of Table 2 in Rabl, A. et al. (2008). *Environmental impacts and costs of solid waste: a comparison of landfill and incineration.*
[103] Parameter was based on information provided in Global Burden of Disease 2019 Cancer Collaboration. (2022). *Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability, and Disability-Adjusted Life Years for 29 Cancer Groups From 2010 to 2019: A Systematic Analysis for the Global Burden of Disease Study 2019.* From the paper, cancer deaths worldwide (10 million, est.) were divided by new non-melanoma global cancer cases (17.2 million), or 58.1%.
[104] The value of Statistical Life used was the average VSL ($US 2,700,000 (2005)), adjusted for inflation to $US 2,895,021 (2024)) found in OECD. (2025a). *Mortality Risk Valuation in Policy Assessment: A Global Meta-Analysis of Value of Statistical Life Studies.* This study was associated with an average age of 41.6 years and the UN notes the average global life expectancy in 2022 was 72.6 years. Thus, the study is associated with 31 years of lost life, and the valuation of a DALY was represented as this VSL divided by 31, or $US 93,388 (2024).
[105] Parameter was based on information provided in Global Burden of Disease 2019 Cancer Collaboration. (2022). *Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability, and Disability-Adjusted Life Years for 29 Cancer Groups From 2010 to 2019: A Systematic Analysis for the Global Burden of Disease Study 2019.* 250 million DALYs were associated with cancer in 2019, with 17.2 million new non-melanoma global cancer cases. Thus, the DALYs lost per individual with cancer was determined to be 14.5.
[106] Parameter was based on information provided in Global Burden of Disease 2019 Cancer Collaboration. (2022). *Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability, and Disability-Adjusted Life Years for 29 Cancer Groups From 2010 to 2019: A Systematic Analysis for the Global Burden of Disease Study 2019.* Of the 250 million DALYs associated with cancer in 2019, 3.1% of the valuation was represented by years living with disability. Thus, the DALYs associated with non-fatal cancer were determined to be 3.1% of the total DALY valuation for cancer.
[107] Rabl, A. et al. (2008). *Environmental impacts and costs of solid waste: a comparison of landfill and incineration.*
[108] See Table 2 in Rabl, A. et al. (2008). *Environmental impacts and costs of solid waste: a comparison of landfill and incineration.*
[109] A value of $US 14,500 (2000) per IQ point was adjusted for inflation to 2024 ($US 26,406.01), Grosse, S. D. et al. (2002). *Economic gains resulting from the reduction in children's exposure to lead in the United States.*

B18. The valuation for Hg emissions was based on the median value from Rice and Hammit,[110] as cited in Martinez-Sanchez et al. 2017.[111] This valuation was selected as previous estimates have focused only on the cognitive effects of Hg emissions.

B19. Finally, the impacts for heavy metals and dioxins were determined via:

$$HM\&D_w = \sum \left(\frac{\$}{kg_p} \times EF_{p,w} \right)$$

Where the summation of non-fatal, fatal cancers and/or neurotoxic costs for pollutant *p* were multiplied by the emission factor for waste type *w* and pollutant *p*.[112]

Pollutant	Non-hazardous Waste Emission Factor (Kg/ton)	Hazardous Waste Emission Factor (Kg/ton)
Pb	5.8E-05	1.3E-03
Hg	1.88E-05	5.6E-05
As	6.2E-06	1.6E-05
Ni	2.16E-05	1.4E-04
Cr^{VI}	1.64E-05	1.64E-05
Cd	4.6E-06	1.0E-04
Dioxin	5.25E-11	1.0E-06

Table B1. Emission factors used for hazardous and non-hazardous waste

3b. Air Pollution

B20. Similar to the GHG pathway, energy recovery is incorporated into the Air Pollution pathway. This is undertaken by comparing air pollution of the national grid (tons of pollutant per unit energy produced) to air pollution caused by incineration, using the following formula:

$$AP_{net,p,i} = EF_p - AP_{avoided,p,i}$$

B21. Where $AP_{net,p,i}$ is air pollutant *p* emissions in country *i* after accounting for avoided emissions (metric tons of pollution per metric ton of waste), EF_p are emission factors of air pollutant *p* from the incineration of one metric ton of waste (See Table B2 below),[113] and $AP_{avoided,p,i}$ is the difference in incinerated emissions of air pollutant *p* compared to the air pollutant intensity of country *i*'s national grid.

[110] Rice, G., & Hammitt, J. (2005). *Economic Valuation of Human Health Benefits of Controlling Mercury Emissions from U.S. Coal-Fired Power Plants.*

[111] A value of $US 87,000 per kg Hg emission, adjusted from $US (2015) to $US (2024), Martinez-Sanchez, V. et al. (2017). *Evaluation of Externality Costs in Life-Cycle Optimization of Municipal Solid Waste Management Systems.*

[112] Emissions factors for pollutant emitted per ton of waste incinerated came from European Environment Agency. (2023). *EMEP/EEA air pollutant emission inventory*. Tier 1 emissions factors for MSW were used for non-hazardous waste, where tier 1 emissions factors for industrial waste were applied for hazardous waste estimates.

[113] European Environment Agency. (2023). *EMEP/EEA air pollutant emission inventory.*

Air Pollutant	Hazardous EF (Tons emitted per ton waste)	Non-Hazardous (MSW) EF (Tons emitted per ton waste)
SO_x	4.7×10^{-5}	8.7×10^{-5}
NO_x	8.7×10^{-4}	1.1×10^{-3}
$PM_{2.5}$	4.0×10^{-6}	1.1×10^{-6}
PM_{10}	7.0×10^{-6}	3.0×10^{-6}

Table B2. Emissions factors for air pollutants utilized within the Waste Methodology.

B22. The reduction of air pollutant emissions due to waste-to-energy capture ($AP_{avoided,p,i}$) was determined using the following formula:

$$AP_{avoided,p,i} = EP_{waste} \times \%_{ER,i} \times Grid\ Intensity_{p,i}$$

Where EP_{waste} is the energy potential of incinerated waste,[114] $\%_{ER,i}$ is the percentage of incinerators with energy recovery potential in country i,[115] and $Grid\ Intensity_{p,i}$ which refers to the amount of emissions of pollutant p that occur from the national grid in country i.

B23. National grid intensity is determined by the breakdown of electricity production by fuel source, via:

$$Grid\ Intensity_{p,i} = \sum (\%Electricity_{s,i} \times EF_{s,p})$$

Where the grid intensity for pollutant p in country i (tons pollutant per kwH) was determined by the summation of electricity sources s in country i [116] multiplied by the emission factors (tons emitted per ton waste) for each electricity source s (See Table B3 below for emissions factors).

[114] The energy potential of waste (*EP*) was estimated at 550 KwH/ton waste via US EPA, O. (2016). *Energy Recovery from the Combustion of Municipal Solid Waste (MSW)*.
[115] OECD. (2025b). *Data Explorer; Waste - Municipal waste: generation and treatment*.
[116] Data from EMBER, organized and downloadable from Our World in Data; EMBER. (2024). *Global Electricity Review, 2024*.; Ritchie, H., & Rosado, P. (2020). *Electricity Mix*.

EMEP Tier 1 Pollutant Emissions Factors (Tons per KwH)				
Air Pollutant	Brown Coal	Heavy Fuel Oil	Natural Gas	Biomass
SO_x	6.0×10^{-6}	1.8×10^{-6}	1.0×10^{-9}	3.9×10^{-8}
NO_x	8.9×10^{-7}	5.1×10^{-7}	3.2×10^{-7}	2.9×10^{-7}
$PM_{2.5}$	1.2×10^{-8}	6.9×10^{-8}	3.2×10^{-9}	4.8×10^{-7}
PM_{10}	2.8×10^{-8}	9.1×10^{-8}	3.2×10^{-9}	5.6×10^{-7}

Table B3. Air Pollutant Emissions produced by electricity source[117]

B24. Air pollution emissions were valued by multiplying net air pollution emissions ($AP_{avoided,p,l}$, tons of pollutant per ton of waste) by the country-level value factors ($/ton of pollutant) described by the Interim Air Pollution Methodology.▫ The Interim Air Pollution Methodology determines changes in the pollutant concentrations on a country level via a Lagrangian[118],[119] which models how each pollutant concentration affects human health outcomes (i.e., DALYs), and applies a monetary valuation to human health outcomes.[120] For more information, refer to the Interim Air Pollution Methodology.

4. Disamenity

B25. Within the Waste Methodology, the impacts of disamenity are represented by the changes in housing prices caused by the presence of a landfill or incineration site. The method for valuing disamenity used a *hedonic pricing function* (HPF) outlined by Eunomia 2002,[121] with new data inputs provided by a meta-analysis of 83 hedonic pricing studies in multiple countries.[122] The meta-analysis found that disamenity only applied to hazardous waste sites, and that non-hazardous waste sites had no effect on housing prices. Going forward future research could test this assumption that there is no impact on disamenity from non-hazardous waste sites, particularly across different territories.

B26. The country-level disamenity value factors were determined via:

[117] Inputs described above can be found via European Environment Agency. (2023). *EMEP/EEA air pollutant emission inventory*. EMEP Tier 1 Pollutant emissions factors are converted to tons per KwH, and EFs are converted to tons emitted per tons waste incinerated for quantification purposes.
[118] Simplified ATMoS-4.0 Dispersion Model. n.d.
[119] Muller, N. Z., & Mendelsohn, R. (2009). *Efficient Pollution Regulation: Getting the Prices Right*.
[120] The value of Statistical Life used was the average VSL ($US 2,700,000 (2022)), adjusted for inflation to $US2,895,021 (2024)) found in OECD. (2025a). *Mortality Risk Valuation in Policy Assessment: A Global Meta-Analysis of Value of Statistical Life Studies*. This study was associated with an average age of 41.6 years and the UN notes the average global life expectancy in 2022 was 72.6 years. Thus, the study is associated with 31 years of lost life, and the valuation of a DALY was represented as this VSL divided by 31, or $US 93,388 (2024).
[121] See page 25 of Eunomia. (2002). *Economic analysis of options for managing biodegradable municipal waste*.
[122] Schütt, M. (2021). *Systematic Variation in Waste Site Effects on Residential Property Values: A Meta-Regression Analysis and Benefit Transfer*.

$$\$VF_{c,s} = \frac{\$_{property,i} \times \rho_i \times \#_{s,i} \times HPF}{DWF}$$

Where $\$VF_{c,w}$ was the value factor in \$US (2024) for country *i* from site type *s* (incineration or landfill), $\$_{property}$ was the average property price in country *i*,[123] $\#_s$ is the count of waste sites (incineration or landfill) in country *i*,[124] HPF is the Hedonic Pricing Function,[125] and DWF is the discounted waste flow (tons). The following paragraphs describe the process for determining HPF and DWF.

B27. The first step in the disamenity valuation process was to determine the hedonic pricing function. The hedonic pricing studies meta-analysis found that property values increased with distance from the waste site, with an increase of 1.5%-2.9% one mile (1.61km) away from the waste site, and 0.35%-0.68% 4.29 miles (6.9 km) away from the waste site (the mean distance in the meta-analysis sample).[126] Using the middle of these ranges and assuming a linear relationship between housing disamenity and distance from waste sites, the radius from the hazardous waste site where housing prices were no longer effected was determined to be 8.52 kilometers, and the maximum reduction on housing prices (at zero km from the waste site) was determined to be 2.71%. Integrating the linear distance-price function from 0-8.52 km yields a cumulative spatial effect equivalent to 11.6% (i.e., the area under the linear distance-price gradient).

B28. The next step was to determine the total disamenity effect on housing prices within the 8.52-kilometer radius. The hedonic pricing function was determined via the following equation:[127]

$$HPF = 2\pi \times \int_0^{8.52} (b - mx)x\,dx = 36.2952\,(0.116) - \ 206.156736\left(\frac{0.116}{8.52}\right) = 8.79$$

B29. The HPF is adjusted for country differences by accounting for country-averaged property prices[128] and household sizes (people per household),[129] as described in paragraph B23.

B30. The total waste flow to landfills and incinerators per country is discounted over an estimated lifespan of a site's active years to determine the present discounted waste flow (DWF) via:

$$DWF = \frac{WF_{i,s}}{(1 + r)^t}$$

[123] Finder UK. (2023). *Average property price by country around the world*.
[124] The count of waste sites for both incineration and landfill is based on a review and consists of various resources. More precise data on the number and quality of waste sites for countries across the globe would increase the precision of disamenity impact estimates. However, such data is not readily available and not available on a consistent basis.
[125] Eunomia. (2002). *Economic analysis of options for managing biodegradable municipal waste*.
[126] Schütt, M. (2021). *Systematic Variation in Waste Site Effects on Residential Property Values: A Meta-Regression Analysis and Benefit Transfer*.
[127] Eunomia. (2002). *Economic analysis of options for managing biodegradable municipal waste*.
[128] Finder UK. (2023). *Average property price by country around the world*.
[129] United Nations. (2022). *Household Size and Composition | Population Division*.

Where $WF_{i,s}$ is the waste flow to site type *s* in country *i*,[130] *r* is the discount rate,[131] and *t* is the estimated lifespan of the site.[132]

B31. Impacts of disamenity for plastic waste are assumed to be the same as the hazardous and nonhazardous waste pathways.

5. Leachate

B32. The leachate pathway is structured via four parts: (a) estimating the average pollutant concentrations in a typical m^3 of leachate (kg/m^3), (b) estimating the volume of leachate produced by 1 metric ton of waste (m^3/ton), (c) applying the Interim Water Pollution Methodology[133] value factors to determine impacts in monetary terms ($/ton), and (d) applying a national *hazard score*, which acts as a proxy for determining how much leachate leaks into the natural environment.

5a. Pollutant Concentration Database

The pathway starts with the development of a database of leachate related pollutant concentrations based on academic literature. Pollutant concentrations included are matched with the pollutants described in the Interim Water Pollution Methodology, described below:

[130] World Bank Group. (2018). *What a Waste 2.0: A global snapshot of solid waste management to 2050*.
[131] A near-term target certainty-equivalent rate of 2% was applied in the same manner as described for the social cost of carbon, Rennert, K. et al. (2022). *Comprehensive evidence implies a higher social cost of CO2*.
[132] The current estimate for the average lifespan of a waste site, incineration or otherwise, is 40 years.
[133] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Water Pollution*.

Pollutants	Pollutant Concentration Applied (kg/m^3)
Anthracene	1.16×10^{-7}
Antimony	6.25×10^{-5}
Arsenic	4.33×10^{-4}
Barium	1.74×10^{-3}
Benzene	2×10^{-5}
Benzo[a]pyrene	2.23×10^{-7}
Cadmium	2.79×10^{-5}
Chromium	2.82×10^{-4}
Copper	2.88×10^{-4}
Dibenzo[a,h]anthracene	5.03×10^{-7}
Fluoranthene	4.29×10^{-7}
Fluorene	8.7×10^{-8}
Lead	3.99×10^{-4}
Mercury	2×10^{-7}
Naphthalene	3.43×10^{-7}
Nickel	8.59×10^{-4}
Phosphorus	3.1×10^{-2}
Pyrene	2.93×10^{-7}
Silver	1.51×10^{-4}
Total Nitrogen	6.87×10^{-1}
Zinc	2.11×10^{-3}

Table B4. Leachate pollutant concentrations applied within the Waste Methodology [134]

5b. Estimating volume of pollutants per metric ton of waste

B33. The volume of leachate produced per metric ton was estimated based on an empirical formula described in Zhou et al., 2024,[135] via:

$$L_i = \frac{I_i - 4}{1000} \times CA$$

Where L_i (m^3/year) is the average leachate production from a ton of waste in country i, I (m) is the average yearly rainfall in country i, C is a coefficient of seepage (taken as 0.5, as recommended), and A (m^2) is the area each metric ton of waste is expected to take up in landfill. Average yearly rainfall per country was determined in QGIS[136] using data from BIOCLIM.[137] The area needed for each metric

[134] Pollutants and averages described are determined using the following publications: Brennan, R. B. et al. (2016). *Management of landfill leachate: The legacy of European Union Directives*.; Jabłońska-Trypuć, A. et al. (2021). *Potential toxicity of leachate from the municipal landfill in view of the possibility of their migration to the environment through infiltration into groundwater*.; Jayawardhana, Y. et al. n.d. *Detection of benzene in landfill leachate from Gohagoda dumpsite and its removal using municipal solid waste derived biochar*.; Moody, C. M., & Townsend, T. G. (2017). *A comparison of landfill leachates based on waste composition*.; Vaccari, M. et al. (2019). *Characteristics of leachate from landfills and dumpsites in Asia, Africa and Latin America: an overview*.
[135] Zhou, W. et al. (2024)a. *A review of existing methods for predicting leachate production from municipal solid waste landfills*.
[136] QGIS Development Team. (2024). *QGIS*.
[137] Climatologies at High Resolution for the earth's land surface area. (2016). *Bioclim*.

ton of waste was determined separately for managed and unmanaged landfills using weight-to-volume (ton/m^3) conversion factors from the United Nations Environment Programme for 'in landfill' and 'loose' mixed MSW, respectively,[138] multiplied by default estimates for the heights of managed and unmanaged landfills.[139] More precise data on the waste density of managed and unmanaged waste sites would increase the precision of leachate impact estimates. However, such data is not readily available and not available on a consistent basis.

B34. To determine pollutant concentrations (kg/m^3) created per ton of landfilled waste per year, L_i estimates were multiplied by the concentrations of each leachate pollutant described in *Section 5a*.

5c. Determining the Impacts of Leachate Pollutants in Monetary Terms

B35. Valuations described in the Interim Water Pollution Methodology were used to represent the results of S*ection 5c* in monetary terms. The Interim Water Pollution Methodology is built on the UNEP-endorsed USETox model,[140] which is used to assess the health effects (e.g., gastrointestinal disease, cancer, neurological disorders, DALYs, etc.) associated with the emission of water pollutants into freshwater systems. The methodology also allows for the assessment of water pollutant impacts on recreation, property values, fish stocks, livestock, agriculture, and ecosystem services. For more details, please refer to the suite of Interim Water Pollution Methodology documentation. [141]

B36. Once all pollutant concentrations (kg/m^3) were represented in monetary terms (\$/m^3), the sum of all pollutants were used to represent the per-year leachate impact. Because each ton of leachate is expected to continue to produce leachate for many years, the net present leachate impact prices for managed and unmanaged landfills was calculated using a 2% discount rate.[142]

5d. Applying National Hazard Scores

B37. Depending on the level of management at a landfill, the risks of leachate leakage into the natural environment could be very high or very low. Thus, the valuations described in *Section 5c* must be risk-adjusted. To estimate risk, the HARAS model was applied.[143]

B38. The HARAS model determines risk factors based on three characteristic ratings: *source* of waste (whether waste is hazardous or non-hazardous), *pathway* (soil permeability at waste site) and *receptor* (population density around site). The HARAS score assigns a rating to each of these factors ('best' (B), 'middle' (M), or 'worst' (W)) and does so separately for whether sites are lined or unlined. The HARAS score is most sensitive to whether landfills are lined or unlined, followed by the *source* rating, the *receptor* rating, and is least sensitive to the *pathway* rating.

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[138] United Nations Environment Programme. (2005). *Solid waste management*.; U.S. Environmental Protection Agency. (2016). *Volume-to-Weight Conversion Factors*.
[139] The default heights applied for managed and unmanaged landfills were 20 meters and 5 meters, respectively.
[140] *The USEtox® Model - Life Cycle Initiative*. (2013)
[141] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Water Pollution*.
[142] Similar to the Interim Waste Methodology, the lifetime of a landfill was determined to be 40 years, and thus leachate impacts were projected forward through this timeframe. Using this default mirrors the U.S. EPA's recommendation for leachate monitoring for at least 30-40 years after landfill closure.
[143] Singh, R. K. et al. (2013). *Evaluating Groundwater Contamination Hazard Rating of Municipal Solid Waste Landfills in India and Europe Using a New System*.

Because data at the waste-facility level is not available, national statistics were used to determine this score. Applying national level statistics on the number and location of landfill sites is the approach adopted in the absence of localized data, but in the future additional data on the locality of landfills at territory level would enhance the robustness of the Waste Methodology. For details, see the table below.

B39. *Source* ratings were assigned based off of whether waste reported is hazardous (assigned 'worst', or W) or non-hazardous (assigned 'B', or B). No middle (M) rating was assigned to *source* within the Waste Methodology.

B40. *Pathway* was determined using National soil permeability averages, in units of logarithmic hydraulic conductivity (logk), via the Global Hydrogeology MaPs (GLHYMPS) dataset for permeability and porosity.[144] Country *logk* values less than -15 were assigned a 'best' (B, least porous) rating, between -15 and -12 assigned a 'middle' (M) rating, and less than -12 assigned a 'worst' (W, most porous) rating.

B41. *Receptor* was determined using national population densities (people per km^2) provided by the World Bank.[145] Population densities less than 100 were assigned a 'best' (B, least densely populated) rating, between 100 and 250 were assigned a 'middle' (M) rating, and greater than 250 were assigned a 'worst' (W, most densely populated) rating.

B42. Once lined and unlined HARAS ratings were assigned to each country, ratings were converted to values using the information described in the table below. A weighted average of these scores was determined using national statistics of percent of waste sent to controlled (assumed to be 'lined'), open dump (assumed to be 'unlined') and unspecified (assumed to be 'unlined') landfill sites provided by the World Bank.[146]

B43. Finally, weighted HARAS scores were multiplied by the results described in *Section 5c* above to represent the final leachate impacts per country.[147]

B44. Impacts of leachate from landfilled plastic waste are assumed to be the same as the hazardous waste impacts.

[144] Gleeson, T. (2018). *GLobal HYdrogeology MaPS (GLHYMPS) of permeability and porosity*.
[145] *World Bank Open Data*. (2024)
[146] World Bank Group. (2018). *What a Waste 2.0: A global snapshot of solid waste management to 2050*.
[147] HARAS scores are divided by 1,000 (the highest HARAS rating on the scale) before multiplying by the $/ton values described in Section 6c.

Source (S), Pathway (P), Receptor (R) conditions			HARAS score for Unlined Landfills	HARAS score for Lined Landfills
S	P	R		
B	B	B	5	0.4
B	B	M	8	0.7
B	B	W	9	0.8
B	M	B	6	0.5
B	M	M	10	0.9
B	M	W	12	1
B	W	B	8	0.7
B	W	M	14	1.2
B	W	W	16	1.4
W	B	B	280	25
W	B	M	476	42
W	B	W	560	49
W	M	B	356	31
W	M	M	605	53
W	M	W	712	63
W	W	B	500	44
W	W	M	850	75
W	W	W	1,000	88

Table B5. HARAS scores applied to best (B), middle (M), and Worst (W) score rankings

6. Mismanaged Marine Plastic Waste

B45. The Waste Methodology accounts for the fact that a portion of reported waste becomes mismanaged, ultimately polluting land surfaces, waterways, and oceans. This is particularly critical for plastic waste, which decomposes over extremely long timeframes. The Waste Methodology includes a method to estimate the weight of mismanaged plastic that reaches the ocean due to improper disposal, along with a valuation of its associated impacts. While the effects of plastic on terrestrial and freshwater ecosystems will be addressed as more data becomes available, the marine plastic pathway is currently structured in two parts: (A) estimating the proportion of discarded plastic that enters the marine environments by country, and (B) determining the monetary impact of marine plastic on ecosystem services. The leakage of plastic has a range of impacts (see figure below), however in the Waste Methodology the focus is on valuing the impacts of plastic waste on marine ecosystems. This approach is also depicted in the impact pathway developed by the Plastics Footprint Network set out in Figure B1. In the future, more impacts of plastic leaking will be measured and valued in updates to the Waste Methodology.

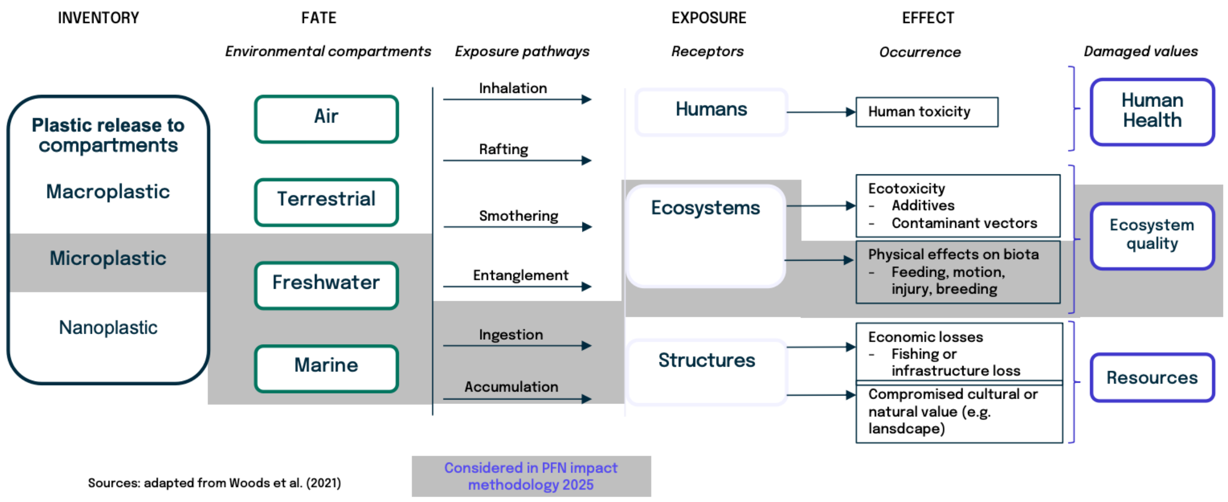

Figure B1. Plastic impact pathway adopted by the Plastic Footprint Network[148]

6a. Estimating country-level mismanaged plastic

B46. The flow of plastic waste to the ocean is estimated using an analysis by Meijer et al. (2021), which attributes 80% of global marine plastic emissions to riverine transport.[149] Using 136 field observations from 67 rivers across 14 countries, the paper models the mechanics of river-transported marine waste via three components: mobilization on land (influenced by wind and precipitation), transport to the nearest river (affected by terrain slope, land use, and distance), and transport from rivers to the ocean (dependent on river discharge, stream order, and distance to the ocean). The resulting model is applied globally to determine the country-level average likelihood (%) of plastic emission to the ocean.[150]

6b. Monetary Impacts of Marine Plastic on Ecosystem Services

B47. The monetary valuation of marine plastic is based on an analysis completed by the World-Wide Fund for Nature (WWF).[151] The method starts by utilizing a valuation of $US 75.2 Trillion (2024) for the total ecosystem services provided by global marine systems.[152] It then utilizes the results from an expert scientific panel that reviewed the available estimates of damage caused by marine plastics on ecosystem services, concluding a 1-5% reduction in total ecosystem services each year attributable to plastic pollution.[153] The same analysis reported the stock of

[148] Plastics impact pathway adopted in the Plastic Footprint Network. Plastic Footprint Guidelines: Module on impacts of microplastic leakage, version 2025.
[149] Meijer, L. J. J. et al. (2021). *More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean.*
[150] See P[E] in Supplementary Table S8 in: Meijer, L. J. J. et al. (2021). *More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean.*
[151] WWF. (2021). *Plastics: The Costs to Society, the Environment and the Economy.*
[152] An estimated $US 61.3 Trillion, from Costanza et al. (2014) who utilize the Ecosystem Services Value Database, updated for inflation to $US 75.2 Trillion (2024). Costanza, R. et al. (2014). *Changes in the global value of ecosystem services.*; WWF. (2021). *Plastics: The Costs to Society, the Environment and the Economy.*
[153] Beaumont, N. J. et al. (2019). *Global ecological, social and economic impacts of marine plastic.*

plastics in the ocean to be between 75 and 150 million tons.[154] The per-year impact of marine plastics is then calculated via:

$$\frac{\$US\ 75.2\ Trillion\ (2024)\ \times\ 1\ to\ 5\%}{75{,}000{,}000\ to\ 150{,}000{,}000} = \mathbf{\$US\ 5{,}014 - \$US\ 10{,}029\ (2024)}$$

B48. Marine plastic can take more than 400 years to break down, with many specific types of plastic capable of remaining undegraded in the ocean for thousands of years.[155] To incorporate lifetime impacts of marine plastic emission, a net present value was calculated over a 200-year span at a discount rate of 2%. A 2% discount rate is aligned with expert recommendations for setting social discount rates[156] and *Environmental Methodology 1: GHG Emissions Topic Methodology*.[157] By the end of the 200-year period, the price of marine plastics impacts is discounted by more than 98%.[158]

B49. Net-present values are then inflated to $US (2024) using consumer price index (CPI) data from the OECD.[159] This results in a per-ton valuation of $US 307,622 - $US 615,243 (2024), of which the lower bound is applied in the Waste Methodology.

B50. To estimate the price of mismanaged plastic waste per country associated with entity reported waste, the national average probability of plastic emission into the ocean from S*ection 6a* is multiplied by the lifetime value impact of plastic waste of S*ection 6b*. The data does not allow for the impact of different types of plastic waste to be separately valued

B51. However, if more localized probabilities of plastic leaking into marine ecosystems are known, the marine plastic waste value factor could be calculated by multiplying the lifetime value impact of plastic waste ($US 307,622) with the localized probability factor.

7. Land use and conversion (Landfills only)

B52. Landfills require a significant amount of space for the storage of solid wastes, contributing to losses in habitat and ecosystem services. Land use impacts are structured in three parts: (A) Estimating the area (m^2) required to landfill each ton of waste (traditional managed/unmanaged waste and managed/unmanaged plastic waste), (B) Determining the percent of waste going to managed and unmanaged landfills, and (C) valuation. For both land use and conversion, hazardous and non-hazardous value factors are assumed the same.

7a. Estimating the area (m^2) required to landfill waste

B53. The area needed to landfill waste is highly dependent upon site-level management practices. Waste density is generally higher at managed landfill sites

[154] Beaumont, N. J. et al. (2019). *Global ecological, social and economic impacts of marine plastic*.
[155] WWF. (2021). *Plastics: The Costs to Society, the Environment and the Economy*.
[156] Drupp, M. A. et al. (2018). *Discounting Disentangled*.
[157] *Environmental Methodology 1: Greenhouse Gas Emissions Topic Methodology*. (2024)
[158] WWF. (2021). *Plastics: The Costs to Society, the Environment and the Economy*.
[159] *Inflation (CPI)*. n.d.

than unmanaged dumpsites because waste is typically compressed at managed sites. Further, managed sites are typically deeper than unmanaged sites and therefore require less land per unit volume of waste. Thus, managed and unmanaged sites were estimated separately in the Waste Methodology.

B54. Area estimates require inputs for average waste densities (tons/m^3) and site depths (m) for managed and unmanaged waste. Waste densities were estimated using defaults from the United Nations Environment Programme conversion factors in the same fashion as described for leachate in *Section 5b*.[160] Average managed and unmanaged site depths were determined by average estimates in the literature, with depths of 20 and 5 meters, respectively. These inputs were converted to hectares and used to determine the average area needed to store managed and unmanaged waste (ha/ton).

7b. Determining the country-level percent of waste sent to managed and unmanaged landfills

B55. Country-level waste production (tons of waste), along with the proportion (%) of waste sent to managed or unmanaged sites, was determined using national statistics provided by the World Bank.[161] This dataset distinguishes the proportion of waste sent to controlled landfills, open dumpsites, and 'unspecified' landfills at a country level. Waste allocated to unspecified landfills was assumed to be sent to open dumpsites within the Waste Methodology. These values were multiplied by the results of *Section 7a* to determine the area (m^2) required to store waste in managed and unmanaged landfills at the country level.

B56. A weighted average of the country-level managed and unmanaged areas, averaged by % of waste allocated to each site, was calculated to determine the average area needed to store waste at a country level.

7c. Valuation

B57. The Waste Methodology applies value factors from the Interim Land Use and Conversion Methodology to estimate the monetary value of land used for landfill storage per ton waste.[162] These value factors account separately for *land use* [163] and *land conversion*,[164] reflecting the loss of ecosystem services when pristine land is converted to another use. Within this methodology, the values associated with 'paved' land are used. For further details, see the Interim Land Use and Conversion Methodology.

B58. Disposing of waste in landfill involves both the initial conversion of land to create the landfill and the long-term use of that land for waste storage. To reflect

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[160] Defaults for uncompacted, mixed MSW and compacted, mixed MSW were used to estimate unmanaged and managed wastes, respectively. Values given in pounds per cubic yard, but converted to metric tons per cubic meter; United Nations Environment Programme. (2005). *Solid waste management*.
[161] World Bank Group. (2018). *What a Waste 2.0: A global snapshot of solid waste management to 2050*.
[162] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Land Use and Conversion*.
[163] Broadly, land use is defined as the land that is being used for production or industrial processes, which has been changed from the pristine land it would have been before human use. The land use value factors in this methodology specifically value the ecosystem services lost due to land use change in a given year (i.e., the difference in value between the ecosystem service provided by a pristine biome and a changed land use).
[164] Land Conversion is the specific act of converting land from its pristine state to a state used for industrial or productive purposes. The land conversion value factors represent the total value of future lost ecosystem services as a result of conversion in the present year. This is seen as distinct from the land use value factors as the use factors represent opportunity cost in a given year, whereas land conversion is over multiple years.

both impacts, land conversion value factors are applied in the first year of land conversion. Thereafter, the net present value of ongoing land use is calculated over the landfill's operational lifetime using the following equation:

$$LU_{W,L} = (VF_{LC,interim} \times Area) + \sum_{y=1}^{40} \left(\frac{VF_{LU,interim} \times Area}{(1+d)^y} \right)$$

Where $VF_{LC,interim}$ is the Interim Land Use and Conversion value factor for 'paved' conversion, *Area* is the country-level area required to store landfilled waste, *d* is a discount factor,[165] and *y* is years. Landfilled waste is discounted through a hypothetical landfill lifetime (40 years), at which point it is assumed that landfill area will be converted to a secondary land use.

8. Residual Incineration Ashes (Incineration Only)

B59. Fly ashes, flue ashes, and bottom ashes are a byproduct of incinerated waste and are only applied to the incineration pathway in the Waste Methodology. These ashes are either used in construction materials or sent to hazardous landfills. The Waste Methodology estimates the impacts of incineration ashes in two steps: (1) determining the % of original weight of MSW that needs to be landfilled, and (2) monetary valuation.

8a. Determining the % of incinerated waste sent to landfill

B60. A case study in Rigamonti et al. 2020 describing the flows of materials from the incineration process was used to determine the weight of waste that needs to be landfilled in the incineration process.[166] The case study found that the incineration of 100 kg of MSW yields 24.5 kg of total ashes, of which 4.5 kg are flue gas residue and fly ashes, and 20 kg are bottom ashes. All flue gas residue and fly ashes are landfilled as hazardous waste, where bottom ashes still contain some useful resources. As a result, 23% of the bottom ashes are landfilled as hazardous waste, where the remaining are harvested for secondary resources such as metals and granulates for road pavement. Taking all results from the case study together, it can be derived that approximately 9.3% of the total weight of waste sent to incineration must be landfilled as hazardous waste.

8b. Valuation

B61. As incinerated ashes are treated as hazardous waste, the country-level value factors for disamenity, leachate, and land use are applied to value the impacts of incinerated ashes (for details on these impacts, see *Sections 4, 5, and 7*, respectively, of Appendix B). Disamenity, leachate, and land use value factors are multiplied by the 9.3% of original waste that must be landfilled to determine the final impacts of incinerated ashes.

[165] Discount factor is consistently 2% for all pathways of the Waste Methodology.
[166] See Fig. 4 in: Rigamonti, L. et al. (2020). *A step forward in quantifying the substitutability of secondary materials in waste management life cycle assessment studies.*

B62. Impacts of residual ashes from incinerated plastic waste are assumed to be the same as the hazardous waste impacts.

9. Gap-Filling

B63. Gap filling was conducted at the country level using World Bank regional and income classifications.[167] Where country-level data was not available for a given pathway, we applied a hierarchical approach to gap filling: (1) fill gaps using the average of countries in the same combined region-income cohort; (2) if no such average could be calculated, gaps are filled with an average of the available value factors for the pathway in question.

10. Local/Global Transformation

B64. Monetary valuations are often transferred between countries by adjusting values by a metric such as Purchase Power Parity (PPP). However, adjusting valuations for purchasing power alone can lead to unintended consequences, such as expressing impacts as lower in low-income countries versus high income countries. To combat these issues when currencies are adjusted, the Waste Methodology allows for value factors to be adjusted to local, global, and utility weighted perspectives.[168]

B65. Local, global, and utility weighted transformations are applied to each of the eight pathways of the Waste Methodology separately.

B66. In the local perspective, results are aligned with the actual prices and the local context. This perspective is relevant when using impact accounting within a single jurisdiction (e.g., Managers of the entity making decisions at a local context or operating in a single country). In the Waste Methodology, the local perspective value factors should not be utilized when making cross-country comparisons.

B67. The global perspective avoids differences in impact accounts that are only driven by price-level differences and not by performance. This perspective is intended to remove disparities related to income effects. This perspective is relevant when using impact accounting across jurisdictions or presenting results to cross-country stakeholders removing the influence of income. In the Waste Methodology, the global perspective value factors should not be utilized when making analyses only within a single country.

B68. The utility weighted perspective is not part of the scope of the Waste Methodology but can be used for complementary assessments. This perspective is an extension of the global perspective, but accounts for higher marginal sensibility to impacts in lower income countries and lower marginal sensibility to impacts in higher income countries. The utility weighted perspective provides additional considerations for recognizing different well-being implications from marginal effects. In the Waste Methodology, utility weighted value factors should not be utilized when making analyses only within a single country, similar to the global perspective. Utility weighted value factors can be selected if the entity wishes to present results to stakeholders to illustrate the implications of addressing additional equity concerns.

[167] The World Bank. (2025). *The World by Income and Region*.
[168] Please note that the utility weight perspective is outside of the official methodology and should be considered for additional, complementary assessments.

B69. To understand the calculations behind the local, global and utility weighted perspectives, please refer to the table below.

Pathway	Perspective	Description
GHGs	Local	$\$SCC_{GHG,local} = \frac{GNI\ PPP_{per\ capita,c}}{GNI\ PPP_{per\ capita,United\ States}} \times SCC_{GHG,global}$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI\_PPP_{per\ capita,United\ States}$ is the gross national income for the United States, and $\$SCC_{GHG,global}$ is the Social Cost of Carbon described in the Greenhouse Gas Approval Methodology.
GHGs	Global	$\$SCC_{GHG,Global}$ =$US 255.12 (2024), applied universally to all geographies, based on an inflation-adjusted valuation described in the Environmental Methodology 1; Greenhouse Gas Emissions Topic Methodology.[169]
GHGs	Utility	$\$SCC_{GHG,Utility} = \left(\frac{GNI\ PPP_{per\ capita,c}}{GNI_{per\ capita,LCU}}\right)^{-\varepsilon} \times \$SCC_{GHG,Global}$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI_{per\ capita,\ LCU}$ is the World Gross national income per capital in local currency units, and $\$SCC_{GHG,Global}$ is the global valuation of the Social Cost of Carbon.
Heavy Metals and Dioxins	Local	$\$DALY_{local} = \frac{GNI\ PPP_{per\ capita,c}}{GNI\ PPP_{per\ capita,United\ States}} \times \$DALY$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI\_PPP_{per\ capita,United\ States}$ is the gross national income for the United States, and $DALY is the global

[169] International Foundation for Valuing Impacts & Value Balancing Alliance. (2024). *Environmental Methodology 1; Greenhouse Gas Emissions Topic Methodology.*

		valuation of a year of life lost ($US 93,388 (2024)).
Heavy Metals and Dioxins	Global	$DALY_{Global}$ = $\$DALY$ =$US 93,388 (2024), applied universally to all geographies.
Heavy Metals and Dioxins	Utility	$\$DALY_{Utility} = \left(\frac{GNI\ PPP_{per\ capita,c}}{GNI_{per\ capita,LCU}}\right)^{-\varepsilon} \times \$DALY$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI_{per\ capita,\ LCU}$ is the World Gross national income per capital in local currency units, and $DALY is the global valuation of a year of life lost ($US 93,388 (2024)).
Air Pollution	Local	$\$AP_{local} = \frac{GNI\ PPP_{per\ capita,c}}{GNI\ PPP_{per\ capita,United\ States}} \times \$AP_{Global}$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI\_PPP_{per\ capita,United\ States}$ is the gross national income for the United States, and $\$AP_{Global}$ is the country-level values for Air Pollution in the Global Perspective.
Air Pollution	Global	$\$AP_{Global}$ are represented by the Value Factors for NO_x, SO_x, $PM_{2.5}$, and PM_{10} for health, agriculture and visibility impacts described in the Air Pollution Interim [170][171]
Air Pollution	Utility	$\$AP_{Utility} = \left(\frac{GNI\ PPP_{per\ capita,c}}{GNI_{per\ capita,LCU}}\right)^{-\varepsilon} \times \$AP_{Global}$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI_{per\ capita,\ LCU}$ is the World Gross national income per capital in local currency units, and $\$AP_{Global}$ is the Air Pollution values in the Global Perspective.

[171] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Air Pollution*.

Disamenity	Local	$\$DIS_{Local}$ valuations are based on average country-level housing prices.[172]
Disamenity	Global	$\$DIS_{Global} = \frac{DIS_{Local}}{\left(\frac{GNI\ PPP_{per\ capita,c}}{GNI\ PPP_{per\ capita,United\ States}}\right)}$
Disamenity	Utility	$\$DIS_{Utility} = \$DIS_{Global} \times \left(\frac{GNI\ PPP_{per\ capita,c}}{GNI_{per\ capita,LCU}}\right)^{-\varepsilon}$
Leachate	Local	$\$DALY_{local} = \frac{GNI\ PPP_{per\ capita,c}}{GNI\ PPP_{per\ capita,United\ States}} \times \$DALY$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country c, $GNI\_PPP_{per\ capita,United\ States}$ is the gross national income for the United States, and $DALY is the global valuation of a year of life lost ($U 93,388 (2024)).
Leachate	Global	$DALY$_{Global}$ = $\$DALY$ = $US 93,388 (2024), applied universally to all geographies.
Leachate	Utility	$\$DALY_{Utility} = \left(\frac{GNI\ PPP_{per\ capita,c}}{GNI_{per\ capita,LCU}}\right)^{-\varepsilon} \times \$DALY$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country c, $GNI_{per\ capita,\ LCU}$ is the World Gross national income per capital in local currency units, and $DALY is the global valuation of a year of life lost ($US 93,388 (2024)).
Marine Plastics	Local	$\$ECO_{PL,Local} = \frac{GNI\ PPP_{per\ capita,c}}{GNI\ PPP_{per\ capita,United\ States}} \times \$ECO_{PL,Global}$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country c, $GNI\_PPP_{per\ capita,United\ States}$ is the gross national income for the United States, and $\$ECO_{PL,Global}$ is the valuation for

[172] Finder UK. (2023). *Average property price by country around the world.*

		marine plastic emissions in the global perspective.
Marine Plastics	Global	$ECO_{PL,Global}$ Utilizes a minimum cost per ton of \$US 4,085 (2019),[173] adjusted for inflation to \$US 5,014 (2024).
Marine Plastics	Utility	$\$ECO_{PL,Utility} = \left(\frac{GNI\ PPP_{per\ capita,c}}{GNI_{per\ capita,LCU}}\right)^{-\varepsilon} \times \$ECO_{PL,Global}$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI_{per\ capita,\ LCU}$ is the World Gross national income per capital in local currency units, and $\$ECO_{PL,Global}$ is the valuation for marine plastic emissions in the global perspective.
Land Use	Local	$\$LU_{local} = \frac{GNI\ PPP_{per\ capita,c}}{GNI\ PPP_{per\ capita,United\ States}} \times \$LU_{Global}$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI\_PPP_{per\ capita,United\ States}$ is the gross national income for the United States, and $\$LU_{Global}$ is the country-level values for Land Use in the Global Perspective.
Land Use	Global	$\$LU_{Global}$ are represented by the Value Factors for land use and conversion from natural ecosystems to ‘paved’, described by the Interim Land Use Methodology[174]
Land Use	Utility	$\$LU_{Utility} = \left(\frac{GNI\ PPP_{per\ capita,c}}{GNI_{per\ capita,LCU}}\right)^{-\varepsilon} \times \$LU_{Global}$ Where $GNI\_PPP_{per\ capita,c}$ is the gross national income for country *c*, $GNI_{per\ capita,\ LCU}$ is the World Gross national income per capital in local currency units, and $\$LU_{Global}$ is the country-level values for Land Use in the Global Perspective.

[173] WWF. (2021). *Plastics: The Costs to Society, the Environment and the Economy*.
[174] International Foundation for Valuing Impacts. (2024). *Interim Methodologies: Land Use and Conversion*.

Bottom Ash	Local	Utilizes the Leachate, Disamenity, and Land Use values in the Local Perspective.
Bottom Ash	Global	Utilizes the Leachate, Disamenity, and Land Use values in the Global Perspective.
Bottom Ash	Utility	Utilizes the Leachate, Disamenity, and Land Use values in the Utility Weighted Perspective.

Table B6. How local, global and utility weighted perspectives are applied to each pathway in the Waste Methodology

Appendix C: Detailed Alignment with Reporting Standards

C1. The data inputs required to prepare the waste impact accounts closely align with and expand upon disclosure requirements established by relevant standard setters including the revised European Sustainability Reporting Standards particularly ESRS 1 General Requirements, ESRS 2 General Disclosures and ESRS E5: Resource Use and Circular Economy and the Global Reporting Initiative 306: Waste 2020. Expansions include options for reporting plastic waste.
C2. Under the revised ESRS, entities shall report information relating to ESRS E5 where Resource Use and Circular Economy has been identified as a material sustainability matter following the entity´s materiality assessment in accordance with ESRS 1 General Requirements.
C3. This standard takes account of EU regulatory frameworks, including the EU Circular Economy Action Plan (2020), the Eco-design for Sustainable Products Regulation (Regulation (EU) 2024/1781), the Waste Framework Directive (Directive 2008/98/EC), the Right to Repair Directive (EU) 2024/1799) and the Critical Raw Materials Act (Regulation (EU) 2024/1252).
C4. This Waste Topic Methodology has been reviewed against the revised European Sustainability Reporting Standards (ESRS) adopted by the European Commission on 3 July 2026 to ensure continued consistency with the latest ESRS reporting framework. The methodology remains aligned with the disclosure requirements set out in ESRS E5 Resource Use and Circular Economy and in particular, with the disclosure requirements on Resource Outflows (E5-5), which form the basis for the waste-related data inputs required under this methodology The relevant provisions are reproduced below for ease of reference. A description of the undertaking’s waste streams;
C5. Under ESRS E5-5 Resource Outflows (paragraphs 37–39, as amended), the undertaking shall disclose the following information on waste from its own operations:
C6. The proportion of waste diverted from disposal, expressed as a percentage of total waste generated, with a breakdown between hazardous waste and non-hazardous waste, and a breakdown by the following operation types:
a. Reuse
b. Recycling
c. Other recovery operations
C7. The proportion of waste directed to disposal, expressed as a percentage of total waste generated, with a breakdown between hazardous waste and non-hazardous waste, and a breakdown by the following operation types:
C8. Incineration
a. Landfill
b. Other disposal operations;
C9. (new) The proportion of waste for which the final destination is unknown, expressed as a percentage of total waste generated.
C10. (39 amended) The undertaking shall disclose the total amount of radioactive waste it generates, in accordance with the definition of radioactive waste in Article 3(7) of Council Directive 2011/70/Euratom.’
C11. The Waste Topic Methodology also requires data to be collected in alignment with the Application Requirements (AR) for Waste as follows:

C12. 'AR 4 for para. 16(a) (Waste) When reporting in accordance with paragraph 16(a) on waste streams, it is sufficient to provide a name (for example, in accordance with the European List of Waste by Commission Decision 2000/532/EC) and an indication of the key materials that are included in the waste stream, such as biomass, metals, non-metallic minerals, plastics, textiles, critical raw materials, rare earths, etc.
C13. AR 5 for paras. 16(b)–(d) and 17 (Waste) When reporting in accordance with paragraphs 16(b)–(d) and 17, the data shall reflect the material's weight in its original state and shall not be presented with further data manipulation, such as reporting it as 'dry' or 'wet' weight.
C14. AR 6 for para.16(c)(iii) (Waste) A list of recovery operations is found in Annex II, Directive 2008/98/EC on waste (Waste Framework Directive). 'Other recovery operations' should meet the definitions and requirements in the WFD. When reporting Waste in accordance with paragraph 16(c)(iii), the undertaking shall specify, if relevant, what these 'other recovery operations' are. Incineration with energy recovery is considered an 'other recovery operation' only when it meets the conditions of point R1 in Annex II 'Recovery operations' of the WFD.
C15. AR 7 for para. 16(d)(iii) (Waste) A list of disposal operations is found in Annex I, Directive 2008/98/EC on waste (Waste Framework Directive).'
C16. The Waste Topic methodology is aligned with the Global Reporting Initiative GRI 306: Waste 2020. This GRI Standard addresses the significant environmental impacts related to water discharges and hazardous waste disposal.
C17. The data requirements under the Waste Methodology is aligned with the requirements under the GRI Disclosure 306-2020: waste by type and disposal method. The reporting organization is expected to report the following information:
C18. 'Total weight of hazardous waste, with a breakdown by the following disposal methods where applicable:

a. Reuse
b. Recycling
c. Composting
d. Recovery, including energy recovery v. Incineration (mass burn)
e. Deep well injection
f. Landfill
g. On-site storage
h. Other (to be specified by the organization)

C19. Total weight of non-hazardous waste, with a breakdown by the following disposal methods where applicable:

a. Reuse
b. Recycling
c. Composting
d. Recovery, including energy recovery
e. Incineration (mass burn)
f. Deep well injection
g. Landfill
h. On-site storage
i. Other (to be specified by the organization)

C20. How the waste disposal method has been determined:

a. Disposed of directly by the organization, or otherwise directly confirmed
b. Information provided by the waste disposal contractor
c. Organizational defaults of the waste disposal contractor

C21. When compiling the information specified in Disclosure 306-2, the reporting organization shall:
a. Identify hazardous waste as defined by national legislation at the point of generation;
b. Exclude non-hazardous wastewater from the calculation of non-hazardous waste;
C22. If no weight data are available, estimate the weight using available information on waste density and volume collected, mass balances, or similar information.’

Appendix D: National Value Factors – Global perspective

D1. Table D1 provides national value factor in the global perspective.[175] Value Factors can be found for every impact category described in the Waste impact pathway, available for the described waste disposal methods (landfill, incineration, or unspecified) and waste compositions (hazardous, non-hazardous, and plastic). The World Bank classifications for region and income class are also included.
D2. Where national value factors for a particular country are missing, an aggregate value, represented as the average value of other countries within the same region and income class, is used. In Table D1, aggregated values are noted with an asterisk (*). Regional and Income averages are provided separately in Table D2. All values are rounded to the nearest cent ($US 0.01 (20$24)).
D3. Value factors will be updated regularly considering: (1) adjustments for inflation, (2) updated impact functions that more fully represent the impacts of waste, (3) updated estimation of future damages as they are closer to present day, and (4) advancements in waste research that align with principles and concepts laid out in the General Methodology.

Table D1 National Value Factors available here

Table D2 Regional Value Factors available here

[175] Local, global, and utility weighted perspectives can be found within the Waste Valuation Tool in Appendix E.

Appendix E: Waste Valuation Tool

E1. The Waste Valuation Tool can be used to aid preparers in determining value factors for each waste site. In the tool, preparers enter waste related disclosures to determine value factors and impacts. For each waste site, the preparer enters the (1) country, (2) waste disposal method, (3) waste material type and (4) reported tons of waste.

Waste Valuation Tool available here

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